Cyanobacterial Bloom Risk Assessment of Pontoosuc Lake

Adam Galambos – October 16, 2017

Abstract

Cyanobacterial blooms can be toxic to human and animal health. The purpose of this study was to examine temperature, dissolved oxygen, zooplankton density, and nutrient level data which influence algal succession patterns and determine if Pontoosuc Lake is at risk for a cyanobacteria bloom. We expected that the lake's biological and physical characteristics would moderately support a cyanobacterial bloom due to the heavy development around the shoreline and probable commercial and residential use of synthetic fertilizers on adjacent parcels. As such, we hypothesized that N:P ratios would be less than the threshold of 7:1, supporting the possibility of a cyanobacteria bloom. The data supported the hypothesis, showing that total nitrogen to phosphorus ratio (N:P) is 6.125:1 in the epilimnion and 14.15:1 in the hypolimnion, which is within the threshold for cyanobacterial bloom risk.

Introduction

Lake Pontoosuc in Pittsfield and Lanesborough Massachusetts is a 480-acre great pond with an average depth of 14 feet with a densely developed shoreline along with supporting heavy recreational use throughout the year. A local non-profit, Friends of Pontoosuc Lake Watershed, Inc, is particularly interested in knowing the trophic state of the lake and if cyanobacteria pose a major threat to the lake. As such, they are vested in the health of the lake and, peripherally, the ability for residents to recreate on and within the lake. Understanding the trophic state of the lake can help steer management and monitoring efforts towards a healthier lake. Cyanobacteria grow well in water that has high amounts of nutrients like phosphorus and nitrogen. Blooms of cyanobacteria can occur under the right conditions, forming thick mats of foam along the shoreline, along with tinted water. These organisms are inedible by consumers and, upon decomposition, deplete available dissolved oxygen in the water, leading to eutrophication (Paerl, 2008). The purpose of this study was to examine temperature, dissolved oxygen, zooplankton density, and nutrient level data which influence algal succession patterns and determine if Pontoosuc Lake is at risk for a cyanobacteria bloom. We expected that the lake's biological and physical characteristics would moderately support a cyanobacterial bloom due to the heavy development around the shoreline and probable commercial and residential use of synthetic fertilizers on adjacent parcels. As such, we hypothesized that the N:P ratio would be less than the threshold of 7:1, supporting the possibility of a cyanobacteria bloom.

Methods

On September 19, 2017, field data were collected from Lake Pontoosuc in Lanesborough/Pittsfield, Massachusetts at approximately 42.49906, -73.25008 (Figure 1). Data include air and water temperature, dissolved oxygen, nitrate, ammonia, and phosphate nutrient levels. Conditions at the time of collection were overcast skies with an air temperature of approximately 19°C. The last significant rainfall of 0.1" was on September 15th, 2017. Water temperature and dissolved oxygen data were obtained at 1-meter intervals using a handheld YSI 85 multimeter (YSI, Inc./Xylem Inc.). Inorganic nutrient data were obtained using a YSI 9500 photometer with accompanying YSI supplied reagents. Using a Van Dorne sampler, water samples were obtained at 1-meter and 6.5-meter depths. Water clarity data were obtained using a Secchi disk. Zooplankton data were obtained using a 12.5 cm diameter plankton tow net from a depth of 4 meters. The total volume sampled = depth* π *radius^2 = 400cm*3.1415*(6.25cm)^2 = 49,086 cc = 49.1 L. The zooplankton-rich water sample was then transferred to a sterile container containing ethyl alcohol. In the lab, zooplankton species were visually identified under a microscope using a dichotomous key. Species count data were multiplied by a factor of 8 to accommodate lab time restrictions and the ability to count only 1/8 of the entire sample.

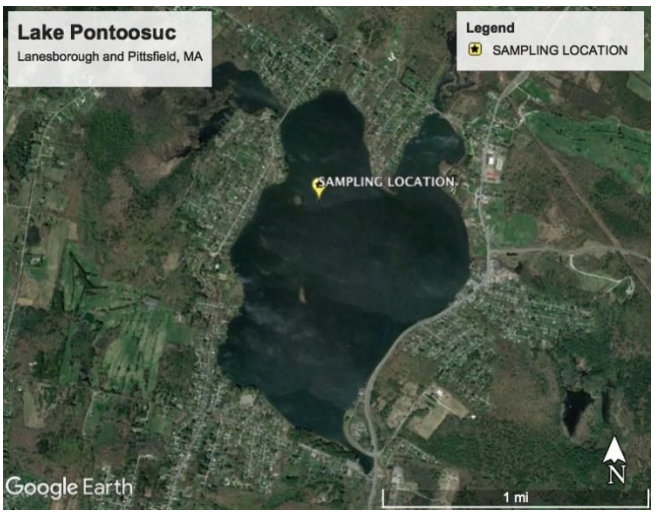

Figure 1 Data were collected on Lake Pontoosuc at the location indicated on September 19, 2017.

Results

Nitrate-nitrogen level data show 0.195 mg/L at the epilimnion and 0.233 mg/L at the hypolimnion. Nitrate-nitrogen was the most abundant nutrient sampled. Ammonium-nitrate data show 0.05 mg/L at both the epilimnion and the hypolimnion. Phosphate-phosphorus data show 0.04 mg/L at the epilimnion and 0.07 mg/L at the hypolimnion. (Figure 5). The total nitrogen to phosphorus ratio (N:P) is 6.125:1 in the epilimnion and 14.15:1 in the hypolimnion. Zooplankton species density is dominated by cladocerans at 26.6/L followed by rotifera at 22.3/L. Copepods totaled 19.9/L with calanoid copepods at 12.2/L and cyclopoid copepods at 7.7/L (Figure 2). Temperature data show that the lake is in a summer stratification pattern with a thermocline between 2 and 3 meters, transitioning from 21.5°C to 19.4°C. This establishes that the epilimnion depth from 0 to 2 meters, the metalimnion is between 2 and 3 meters and the hypolimnion is between 8 and 3 meters (Figure 3). Dissolved oxygen data obtained at 1-meter intervals show an average of 8.38 mg/L between 0 to 3 meters followed by a steep decline to 6.62 mg/L at 4 meters. Oxygen levels continue to drop to 0.8 mg/L at the bottom of the lake (Figure 4). Water clarity data using a Secchi disk established a visible depth of 2.35 meters, establishing a potential photosynthetic zone of up to 7 meters, according to the "rule of thumb".

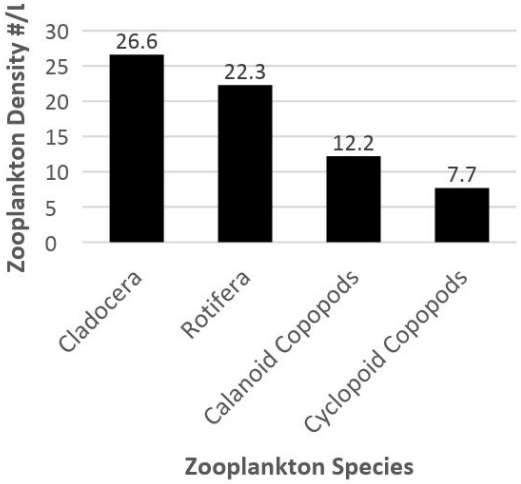

Figure 2 Three main categories of zooplankton, cladocerans, rotifers, and copepods, were identified within a total water sample volume of 49.1L. Cladocera were the most abundant, followed by rotifera and copepods. Data collected 9/2017, Lake Pontoosuc, MA.

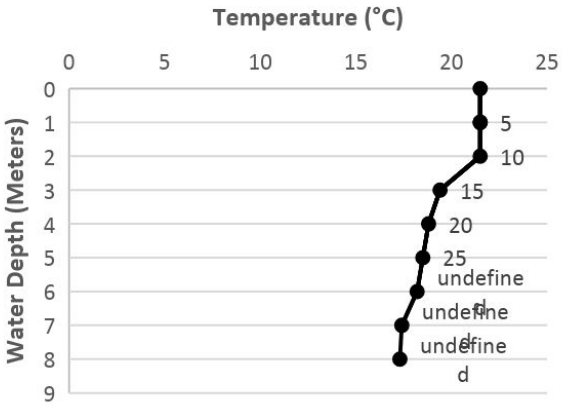

Figure 3 Temperature data taken at 1-meter intervals support a stratified lake with the epilimnion between 0-3 meters, the metalimnion/thermocline between 2-3 meters and the hypolimnion between 3-8 meters. The total difference between epilimnion and hypolimnion is 4.2°C. Data collected 9/2017, Lake Pontoosuc, MA.

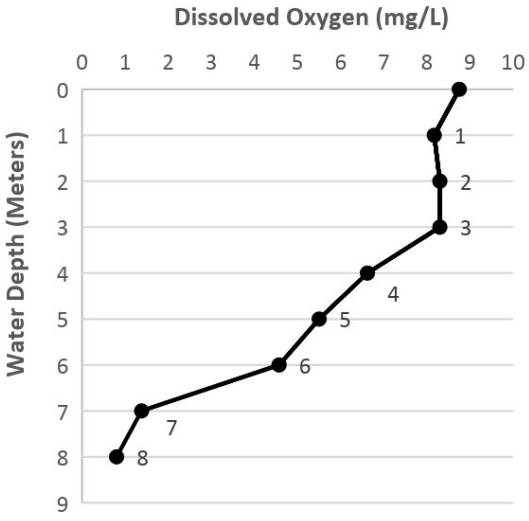

Figure 4 Dissolved oxygen data sampled at 1-meter intervals. Average of 8.38 mg/L between 0 to 3 meters followed by a precipitous decline to 6.62 mg/L at 4 meters. Oxygen levels continue to drop to 0.8 mg/L at the bottom of the lake. Data collected 9/2017, Lake Pontoosuc, MA.

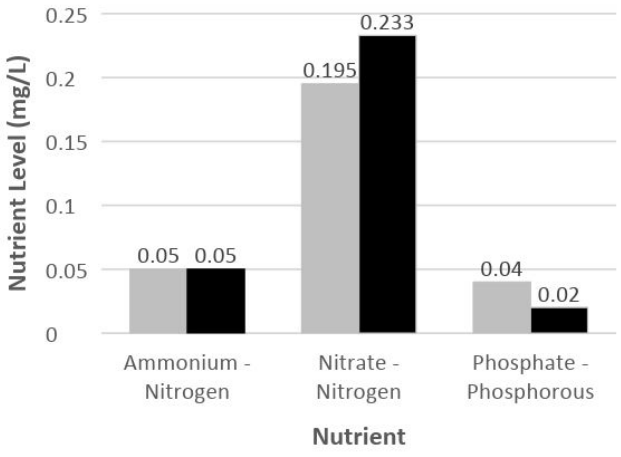

Figure 5 Nutrient levels of ammonium-nitrogen, nitrate-nitrogen, and phosphate-phosphorus, as sampled at the epilimnion (light bars) and hypolimnion (dark bars). Data collected 9/2017, Lake Pontoosuc, MA.

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Discussion

In this study, we expected that the lake's biological and physical characteristics would moderately support a cyanobacterial bloom due to the heavy development around the shoreline and probable commercial and residential use of synthetic fertilizers on adjacent landscapes. We hypothesized that N:P ratios would be less than the threshold of 7:1, supporting the possibility of a cyanobacteria bloom. The data supported the hypothesis, showing that total nitrogen to phosphorous ratio (N:P) is 6.125:1 in the epilimnion and 14.15:1 in the hypolimnion. According to Axler et al. 2004, epilimnion nutrient concentrations will typically decrease during summer stratification as nutrients are taken up by the algae but are then transported downward into the hypolimnion when the algae die. During this period, the summer stratification, any new inputs of nutrients can trigger an algae bloom.

The dense development around Pontoosuc Lake influenced the hypothesis that nutrient loads are greater than 7:1 but the data do not support this, showing that the nutrient levels are below this threshold. Although the nutrient levels in the hypolimnion are greater than the threshold of 7:1, the lake is stratified, and there is no mixing. Stratification is evidenced by the temperature gradient and the presence of the thermocline, the dissolved oxygen gradient, as well as the average Secchi disk depth of 2.35 meters. Also, the high relative density of primary consumers is also a positive sign that the lake is grazed at an appropriate rate. Compared to 2016 data, there is a marked increase in zooplankton density this year.

Sample size was limited to only one sampling location, and this has been identified as a source of potential error. In order to properly assess the trophic state of the lake as well as the risks of a cyanobacteria bloom, a larger sample size would be indicated in a follow-up study. This would also provide a larger context to any localized trends and possible hotspots for nonpoint source or point source pollution.

The Friends of Pontoosuc group can greatly affect the future of the lake. By using these data, the group will be adequately armed to ensure high water quality in the lake and maintain high environmental standards in the watershed. Due to the high volume of recreational activities on the lake, the eutrophication cascade that would ensue following a cyanobacteria bloom would be detrimental to the many visitors as well as abutting property owners. In addition, the health of the lake and the species contained within it would suffer greatly. By furthering the understanding of the algal succession within the lake, funding can be secured and actions can be taken to remediate incoming sources of N and P.

Conclusion

The data supported the hypothesis that N:P ratios would be less than the threshold of 7:1, allowing for the possibility of a cyanobacteria bloom. The lake is still stratified and shows that the epilimnion has a 6.125:1 N:P nutrient load. Due to the high density of development surrounding the lake, it is inferred that anthropogenic sources of these nutrients in the form of fertilizer, septic system failure, as well as stormwater runoff are all part of the source. The Friends of Pontoosuc group could benefit greatly by using their influence, coupled with the data, to motivate adjacent landowners to deploy corrective actions.

Works Cited

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