Effects of low oxygen on internal phosphorus loading in Prospect Park Lake

Abstract

Prospect Park Lake is a shallow lake in Brooklyn, New York, which has been receiving copious loads of orthophosphates. The water in New York City is treated with orthophosphates in order to prevent lead in the municipal pipes from entering the tap water. This same water is what is fed into Prospect Park Lake, thus loading the lake with excess phosphorus. The lake is highly eutrophic, and is dominated by *Lemna minor* and cyanobacteria blooms (Liu et al, 2017). Prospect Park Lake also undergoes the process of internal phosphorus loading - the storage of phosphorus in the sediments which can then be gradually released over time via diffusion. The rate of the diffusion of phosphorus is affected primarily by the levels of O_2 in the water in the benthic boundary layer; when oxygen levels are lower, the rate of phosphorus release is faster. This is because P becomes bound to Fe(III) when settling into the sediments. While bound to Fe(III), the complex is insoluble and phosphorus cannot be released into the water. However, in the presence of low O_2, organisms which undergo respiration (bacteria and microbes) use Fe(III) in place of O_2 as a final electron acceptor. Doing this causes the conversion of Fe(III) to Fe(II), rendering it soluble. Thus, phosphorus is able to enter the water (Scheffer, 2004). It is important to note that pH also affects the rate of phosphorus release (Lijklema, 1977). However, for the intent of this study, the oxygen levels are likely more sensible to focus on than pH, due to the increased rates of respiration (and therefore decreased levels of oxygen) which occurs during the summer months.

It is known that SRP levels are higher in Prospect Park Lake in the summer (May-August) than in other months. It is unknown, however, what the primary cause of this increase in phosphorus is. It is suggested that it is due to the increased release of SRP from sediments due to internal phosphorus loading (Liu et al, 2017). Because of the increased temperature in the summer months, there should be an increase in respiration which in turn causes a decrease in oxygen. Thus, I hypothesize that there will be a relationship between oxygen levels and SRP levels in the sediment. I predict that as oxygen levels go down in the benthic boundary layer of the water column, the rate of phosphorus release will increase, in turn increasing the amount of phosphorus in the water column. The results of this study could potentially be applied for management purposes; understanding the mechanisms which govern phosphate release from internal loading may assist in decreasing the overall phosphorus load in Prospect Park Lake, thereby decreasing the duckweed and cyanobacteria blooms.

Experimental Design

I intend to collect 16 sediment samples, all from the Audubon Center. I also plan on collecting 8 samples from the Peninsula, and 8 from the Lake Proper. However, these samples will only be analyzed for sediment content, and not used in the oxygenation experiment. After collecting the 16 sediment samples from the Audubon Center, the samples will be homogenized,

and grain size, organic matter content, and porosity will be measured. Phosphate will be extracted from the sediments at this time using the modified Williams Protocol (Ruban et al, 1999). Phosphate content will be measured using the Ascorbic Acid Method. The samples will then be separated into mesocosms - 1 L polypropylene jars. The jars will be filled with 3.47 cm of sediment. DI water will be added to the mesocosms. All 16 jars are to be put in a water bath to control for temperature, and the temperature will be monitored regularly. 8 of the samples with be in anoxic conditions, and the lids will be left on. The remaining 8 samples will be aerated. Aerated and non-aerated samples will be placed intermittently throughout the water bath as to prevent plate effect. The mesocosms will be left to run for 2 weeks. After the completion of the two weeks, the water in the mesocosms will once again be measured for pH, Chl-a, temperature, and SRP.