Effects of suboxic versus oxygenated conditions on phosphorus release from shallow lake sediments

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INTRODUCTION

Prospect Park Lake is a eutrophic, shallow, man-made lake, fed with the municipal water supply containing high concentrations of orthophosphate.[1] The lake suffers from toxic cyanobacteria blooms and dense coverage of duckweed (Fig. 1). Phosphorus bound to sediments can be released under certain conditions in a process called internal loading. Low oxygen concentration affects the solubility of the phosphorus-iron complex, potentially increasing the internal load in Prospect Park in the summer. [2]

Hypothesis: low oxygen conditions will release higher amounts of phosphorus than those in well-oxygenated conditions.

Fig. 1. Prospect Park Lake *Lemna minor* and cyanobacteria blooms, formed as a result of excess phosphorus. Picture courtesy of Eliana Green.

METHODS

- Sediments collected via an Ekman Dredge, then placed in 16 mesocosms and filled with deionized water
- 8 of the mesocosms were aerated, the remaining 8 were left in suboxic conditions
- Dissolved oxygen levels were recorded daily using an YSI Optical Probe
- Phosphorus samples were taken on 3 occasions and analyzed using the ascorbic acid method[3] (Fig. 2)

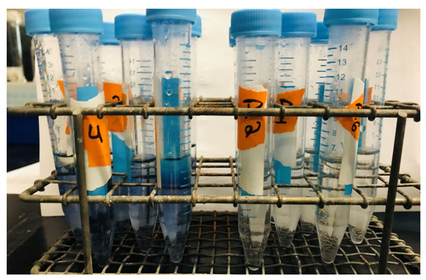

Fig. 2. Samples being analyzed for phosphorus concentration using the ascorbic acid method.

RESULTS

- There is a highly statistically significant difference in phosphorus concentration change in the water of the nonaerated mesocosms between sampling intervals 1 and 2 (t_{calc}= 7.3621, $p \leq 0.05$) (Fig. 3.A)
- There is also a significant difference in aerated mesocosms between sampling intervals 1 and 2 (t_{calc}= 1.87, $p \leq 0.05$) (Fig. 3.A)

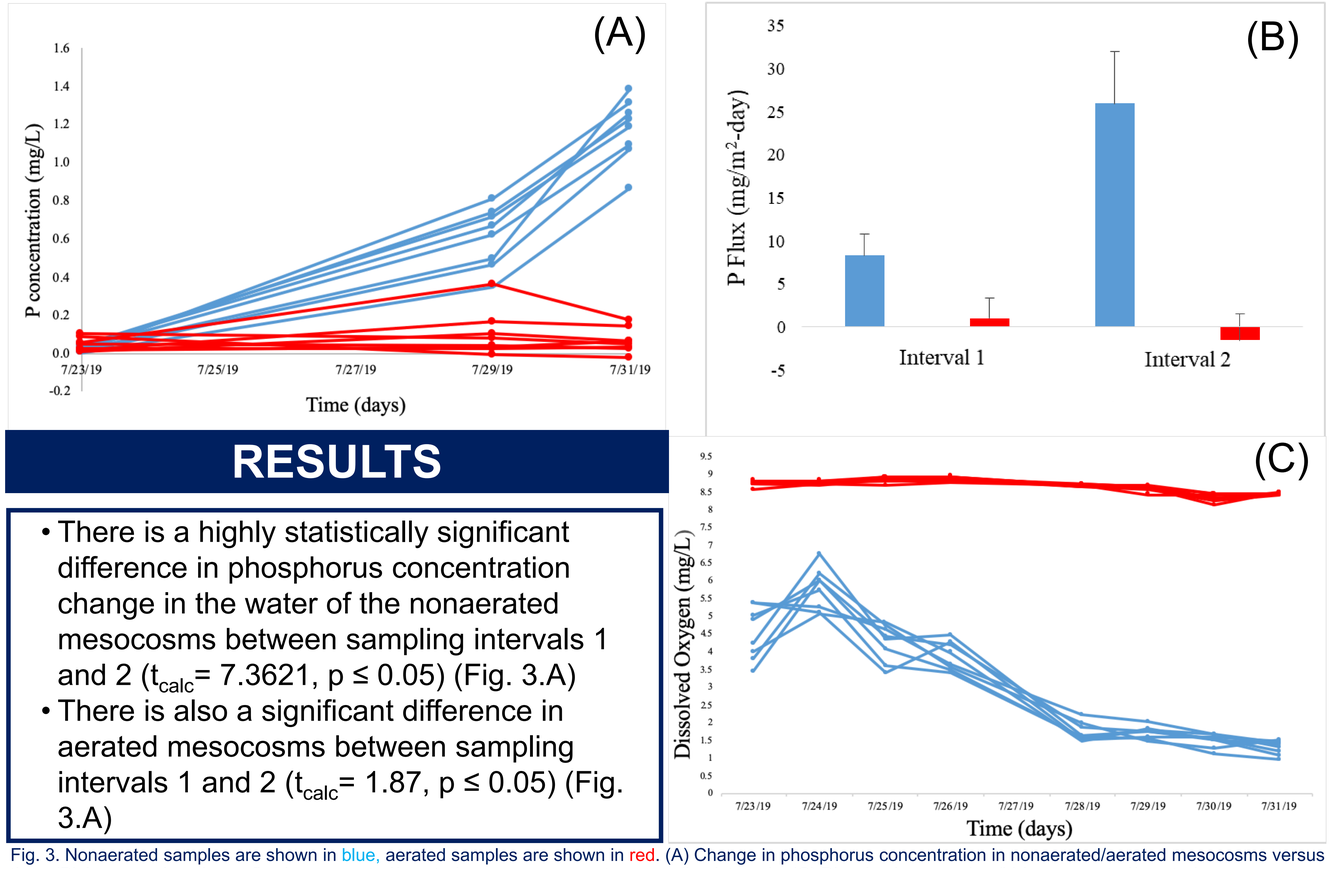

Fig. 3. Nonaerated samples are shown in blue, aerated samples are shown in red. (A) Change in phosphorus concentration in nonaerated/aerated mesocosms versus time. (B) Average phosphorus flux in nonaerated/aerated mesocosms over two sampling intervals. (C) Dissolved oxygen (mg/L) in nonaerated/aerated mesocosms versus time.

CONCLUSIONS

- Overall, the hypothesis was supported. Mesocosms in suboxic conditions had greater phosphorus fluxes than those that were aerated (Fig. 3.B)
- Big Picture: Internal loading of phosphorous may be a large factor in the increased levels of phosphorus in Prospect Park Lake in the summer. (Fig. 4)
- Results are useful from an integrated management perspective (Fig. 1). Internal loading must be addressed to reduce the impact of phosphorus on the lake's water quality.
- Limitations: Small sample size?
- Future directions: measure phosphorus and organic matter content in the sediments.

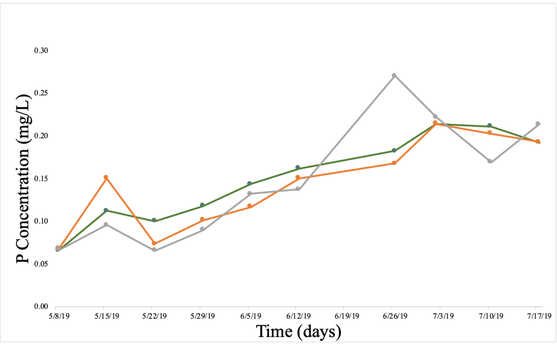

Fig. 4. Phosphorus concentration in Prospect Park Lake versus time from 3 sampling depths. Green represents the surface of the water column, orange represents the middle, and grey represents the bottom. Figure courtesy of Majid Sahin.

REFERENCES

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(3) American Public Health Association, American Water Works Association, Water Environment Federation. 2005. Standard Methods for the Examination of Water & Wastewater, Centennial Edition. American Public Health Publishing.

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