Evaluation of Legacy Phosphorus, Internal Loading, and Zooplankton in Loon Lake for Future Management Decisions

ENV499 Lake Management and Harmful Algal Blooms
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Background

Primary producers in lakes can be sensitive to changes in concentrations of nutrients distributed in the water. Of these, phosphorus (P) has often been identified as one of the most influential chemicals in lentic systems, and typically catalyzes growth in aquatic photosynthetic organisms[5]. By evaluating possible sources of P and implementing corrective actions, lake managers can attempt mitigation of negative ecological consequences.

Study Location: Loon Lake is a small (67 ha), shallow (maximum depth = 13 m), mesotrophic lake in Steuben County, NY[1]. In recent years, the Loon Lake Watershed Improvement Alliance (LLWIA) has documented an increase in algal blooms within the lake's northern littoral zone "coves" [4].

Objective: Develop a baseline understanding of what limnological factors may be contributors to the increased frequency of algal blooms in Loon Lake, ultimately assisting the LLWIA with future management decisions.

Methods

On 8/10, 8/20, and 9/27/2020, 4 sites on Loon Lake were investigated: (1) "deep lake", (2) Antler's Inn cove, (3) Serenity Cove, and (4) Laf-A-Lot Cove (Figure 1).[3,4]

Research conducted included:

- Collection of discrete and integrated water samples and measurement of *in situ* physical and chemical parameters at potential future aerator sites (Table 1, Figures 2 & 3)

Laboratory analyses of water samples included:

- Orthophosphate and total phosphorus (Figure 2A)

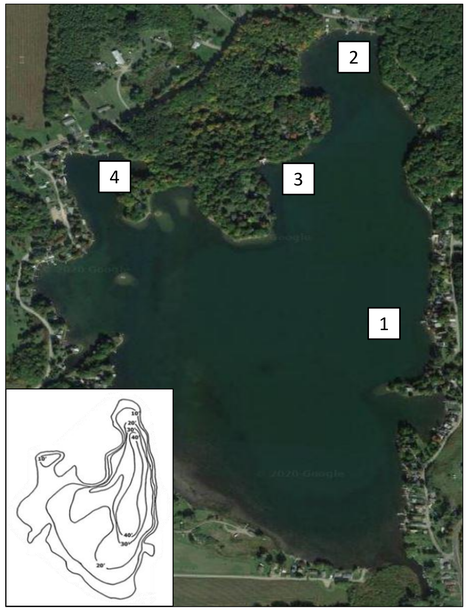

Figure 1. Satellite image and bathymetric map (isopleth interval=10') of Loon Lake with labeled sampling sites[4,6].

Key Findings

- Antler's Inn and Serenity Cove were deemed candidates for future aeration experimental and reference sites since they were found to be similar in sediment composition, physical, and chemical properties.
- High levels of P were found within the hypolimnion, aggregated towards the benthic zone (Figure 2A).
- The hypolimnion was also found to be a highly reducing chemical environment, which is likely facilitating the release of legacy P from stored inorganic sources (Figure 2B).
- Zooplankton (*Daphnia* species) collected at depths ≥ 6 m, appeared red (Figure 3), suggestive of traits (e.g., hemoglobin) facilitating survival at low oxygen levels (Figure 3) [3].
- Agricultural watershed land use may also contribute to lake P concentrations (Table 2)[5].

Figure 3. Zooplankton collected on 8/20/2020.

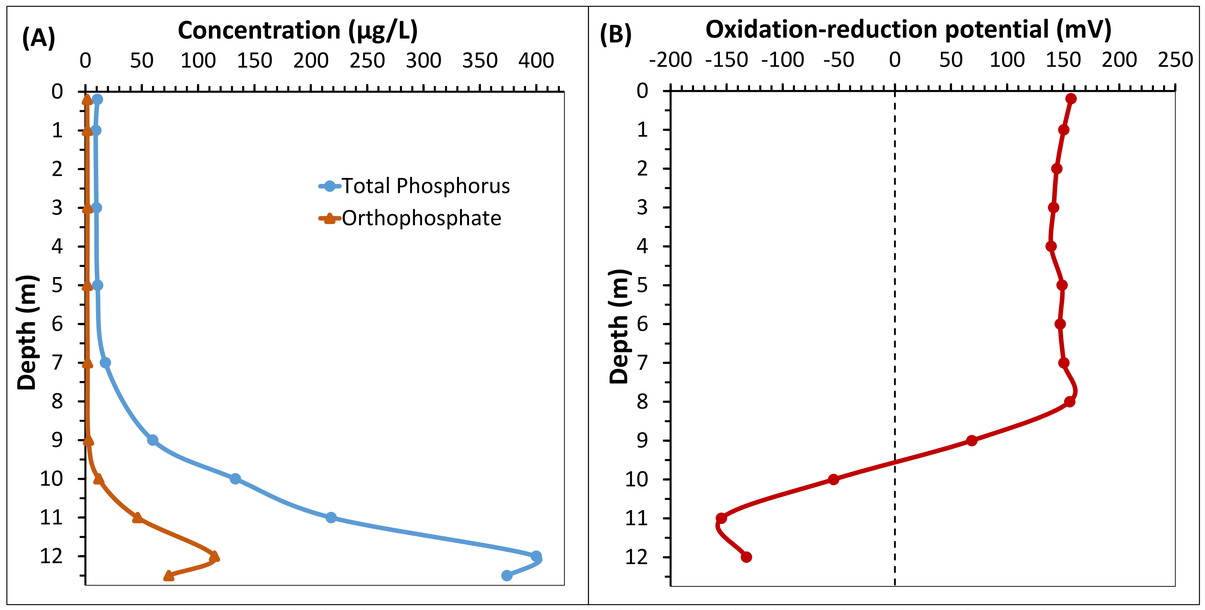

Figure 2. Vertical profiles of (A) orthophosphate (orange triangles) and total phosphorus (light blue circles) and (B) oxidation-reduction potential (ORP) on 8/20/2020 at "deep lake" site. ORP values above 0 represent oxidizing conditions, while negative values are indicative of reducing conditions.

Table 1. *In situ* water chemistry measurements and total phosphorus data for littoral zone "coves" as potential future aeration sites.

Cove	Temp. (°C)	Dissolved oxygen (%)	Dissolved oxygen (mg/L)	Specific conductivity (µS/cm)	pH	Oxidation-reduction potential (mV)	Chlorophyll-α (RFUs)	Phycocyanin (RFUs)	Total phosphorus (µg/L)
Antler's Inn	18.5	103	9.17	144.2	8.17	158.0	0.58	0.24	12
Serenity	18.2	104	9.33	143.8	8.16	139.6	0.40	0.21	10
Laf-A-Lot	18.5	107	9.43	144.7	8.32	164.8	0.30	0.17	9

Table 2. Surrounding 602 ha watershed of Loon Lake land-use type as percent composition[1].

Watershed land-use type	Composition (%)
Agricultural	44%
Forests, shrubs and grasses	42%
Lake and wetland	8%
Residential	7%
Urban	0%

Future Directions

The results of nutrient analyses in "deep lake", coupled with the strong reducing environment, indicates the occurrence of internal nutrient loading within the hypolimnion. Decreasing the high concentrations of P released by this process is likely a more effective approach to reducing algal blooms than aeration of littoral cove sites alone. Therefore, Loon Lake may be a candidate lake to consider for future NYSDEC aluminum sulfate treatments ($Al_2(SO_4)_3$) (i.e., alum), which flocculates to prevent P release.

Regardless of the selected method for managing algal blooms, careful consideration should be given before manipulating the natural environment of a system. For this reason, studying the ecology (and sensitivity to alum) of the unique zooplankton observed in Loon Lake will be a critical component of future research.

References

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