Evidence For A Shift To A Later Fall Overturn in a Large Dimictic Lake in Ontario Due to Climate Change
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Abstract
Aquatic ecosystems play a crucial role in maintaining the balance of our planet’s biogeochemical cycles and supporting diverse ecosystems. However, these delicate systems are increasingly susceptible to the effects of climate change, which can lead to significant alterations in their physical and biological processes. In this study, we investigate the potential impacts of climate change on the Fall mixing dynamics of Opeongo Lake, a representative aquatic ecosystem.

Introduction

Hypothesis: In Opeongo, we will see a later Fall mixing date due to:
- Lake Size Dependence
- Peak Summer Dates
- Habitat Changes

Motivation From Prior Studies: In an analysis of Lake Simcoe from 1980-2008, E.A. Stainsby et al. found the Fall mixing date to change by a month (1). A similar 30-year study by Eric J. Anderson et al. of Lake Michigan found as the summer stratified period is extended, indicated by Fall warming trends at the surface, the Fall turnover date is delayed (2).

Methodology

- Samples: HOBO’s Onset were placed at different depths in the water column. We can see it is an overlap.
- Thermistor lines form a trend.
- Water Temp Pro is at the water column temperature of < 1°C.
- Maximum Density of 4 °C.
- Solar Radiation warms the surface layer of the lake, causing stratification with the warmer layer being separated from the cooler, lower layers by the thermocline.
- Fall: Cool air and wind mix the water column, redistributing oxygen and nutrients throughout the water column. Then, water cools to 8°C, the Temperature of Maximum Density.
- Winter: The lake freezes over, insulating the water below. Thus, the lake stratifies once again, with the denser 4°C water at the bottom of the lake.
- Spring: With melting ice and a warming surface layer, water begins to mix redistributing oxygen and nutrients throughout the water column.

Results

- Definition: The date of Fall turnover is when the difference between thermistors 1 and 9 was + 6 °C.
- We indicated the date of the Fall Turnover on the plot. We can see it is where the thermistor lines overlap.
- The 12°C Start/End dates are when the daily mean averaged temperature of the shallowest thermistor rises above 12°C and then falls below 12°C.
- We can also notice data from previous years which form a trend.

Discussion

- It is significant that we can see such a large delay in Fall mixing due to what it means for the ecosystem. Opeongo breathes during Fall turnover. Since Fall turnover leads to a mixing of the water layers, the timing of the distribution of oxygen and nutrients in the water column changes. A Later Fall turnover affects the Habitat and Food availability for fish!
- Peak Summer Dates: There is high variability indicated by a low R2 value, allowing us to turn away from suspecting increased peak summer water temperatures.
- 12°C Start/End Dates: The start and end dates are both trending towards being 10 days later. However, the duration of 12°C dates remains similar throughout the years. We do not suspect it to cause a delayed Fall mixing. The 12°C dates are significant for the fish population as it is period that most fish will be able to access the entire water column.
- Fall Mixing Date Temperature: Fall air temperature plays a large part in Fall Mixing. As warmer temperatures correlate to an earlier mixing date. However, to account for the large difference in date between Smoke, Canoe, and Opeongo we must look at wind data as we could presume the air temperature to be same across the lakes, while wind is variable.

Conclusion

- Lake Size Dependence: Another Parameter is lake size. A larger surface area of the lake exposes the lake to wind more. A deeper lake will also affect Fall mixing, as the deeper layers require more energy to upwell.
- Future Sustainability: What recommendations can be made to help maintain healthy fish populations and ecosystem function considering a changing Fall turnover schedule?

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