THE PHOSPHATE CONCENTRATION OF THE NORTH AND SOUTH BASINS OF LAKE CONESUS: ANTHROPOGENIC AND AGRICULTURAL LAND USE PRACTICES

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Introduction

The geohistorical record yields valuable data on past environmental and ecological changes that can be used as tools for conservation and restoration/remediation. This study sets out to address anthropogenic effects, specifically land use practices, and how they influence sediment chemistry of Conesus Lake to see if remediation efforts have worked. This research looks at sediment chemistry at differing depths, in the north deep and south deep basin.

Research Goals

This research is part of a multifaceted approach that aims to assess the paleobiological and sedimentary record of the finger lakes using multiple proxies. The research presented here is a small portion of the overall project with a goal to produce a detailed record of the paleoclimatic and paleoenvironmental record using ostracodes, pollen, diatoms, and mollusks combined with elemental analyses and age-calibrations. Here we present some of the preliminary work of this project with specific goals in mind:

- Develop a sedimentary archive of Conesus Lake for the past 300 years
- Compare elemental compositions of the sediments through time to determine post-European and industrial impacts on the lake chemistry
- Use dynamic magnetic susceptibility to time the arrival of European colonization and influence on the lake community
- Assess phosphate concentrations overtime and between the north and south basins of Conesus lake

Setting

Conesus Lake is the westernmost lake of the Finger Lakes, located in Livingston Country. The 11 Finger Lakes of Central and Western New York, United States were originally a set of north flowing rivers and river valleys that were later carved deeper by glaciers at the end of the Pleistocene ice age. All of the water in the Finger Lakes eventually drains into Lake Ontario. The Finger Lake region also attracts many tourists to its shores for its beautiful shores and famous wine. Humans have been living near Conesus Lake for hundreds of years before European colonization of the region took place. The agricultural practices of the indigenous peoples in the region likely had subtle effects on the environment of Conesus Lake. Europeans began settling around the lake in 1792, and soon after started clearing trees, farming, and building houses. Over the years mills, boats, cars, pipes, mining, and agricultural nutrients and pollutants from the watershed have flowed into the lake. Conesus Lake was selected for this study because it has been rated as a mesotrophic lake that has been undergoing continual remediation and monitoring since the introduction of invasive taxa and harmful cyano-algal blooms in the mid-1990s. Mesotrophic lakes are lakes that have moderate amounts of nutrients where the water clarity is reduced with an increase in algal growth. Conesus Lake being located in Livingston County, known for its prolific crops, agriculture the main source of industry, makes it a perfect selection for looking at the effects of land use practices on the lake.

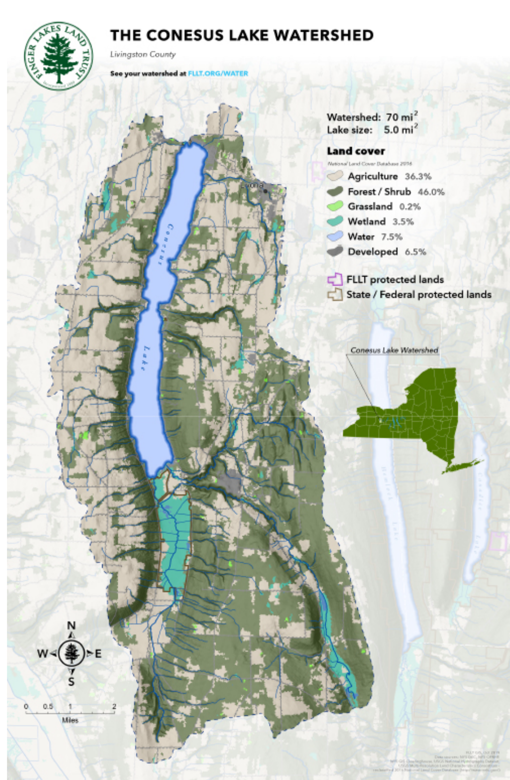


Figure 1. Map of Conesus Lake Watershed, in Livingston County, highlighting land cover uses. *From Livingston County, Finger Lakes Land Trust*

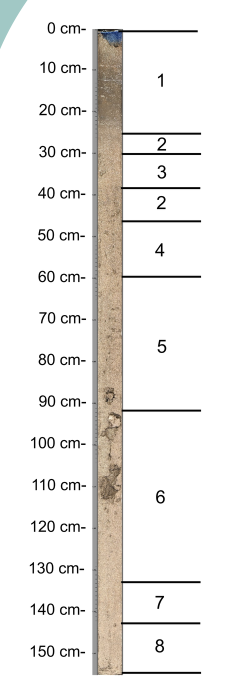
Methods

Figure 2. Field work with SUNY Maritime and SUNY Geneseo. Core collection in June 2021. (Left to right: Christian Street, Emily Abbati , Dr. Andrew Michelson, Griffin Rose, Kaitlyn Gerstler), Photo *from CLA*

Piston and bolivia cores were collected from the south basin of Conesus lake to evaluate the sedimentology and its influence on the lake ecosystem. A piston and bolivia core of the deep south basin was collected at 17 meters in water depth and resulted in 121 cm of cored sediment. A piston core of the deep north basin was collected at 11 meters in water depth and resulted in 145.5 cm of cored sediments. Both cores were split, imaged, and analyzed for magnetic susceptibility, and XRF using a multi-sensor core logger. A photometer was used to analyze the concentration of phosphate in the sediment at 20 sample depths in each core. 1g samples were taken from each sample depth, put into beakers, weighed and dried in an oven at 50 degrees Celsius. A sulfuric acid solution was made, and 20mL of the mixture was added to the dried sediment. 10mL of the sulfuric acid and sediment mixture were added to a photometer tube, where a phosphate HR tablet was added to the mixture and crushed. Each sample was run through the photometer three times, and the average concentration in mg/L was calculated, and graphed. This was repeated for each core.

Results

Core Description



1. Olive gray to dark olive gray. Medium bedded, silt and clay with dominant sapropel, diatoms common.

2. Alternating olive gray to dark gray. Thickly laminated, bioturbation, silt and clay with dominant diatoms and sapropel common.

3. Olive gray. Thinly bedded, silt and clay, abundant sapropel and occasional diatoms.

4. Olive gray to gray. Medium bedded, silt and clay, dominant sapropel and scarce diatoms.

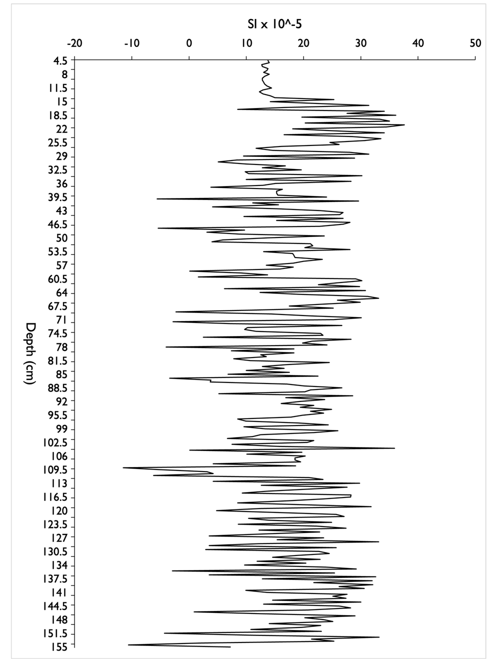
5. Dark olive gray. Thickly bedded, silt and clay, dominant sapropel and scarce diatoms.

6. Olive gray. Thickly bedded with thin laminae, silt and clay, dominant sapropel and scarce diatoms.

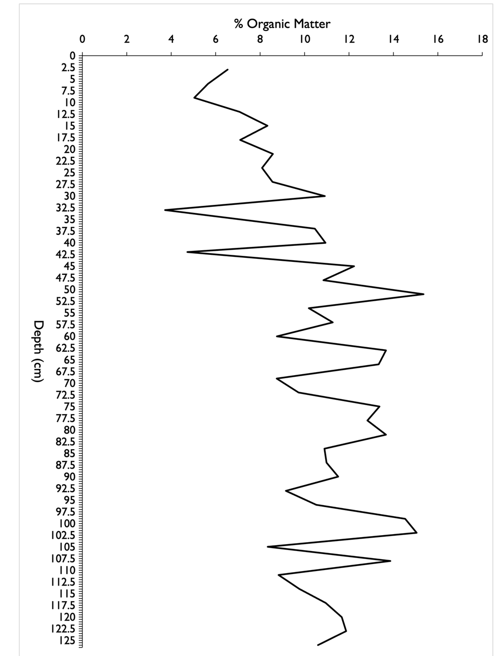
7. Dark olive. Thinly bedded, silt and clay, dominant sapropel and scarce diatoms.

8. Olive brown. Thinly bedded, silt and clay, dominant sapropel and scarce diatoms.

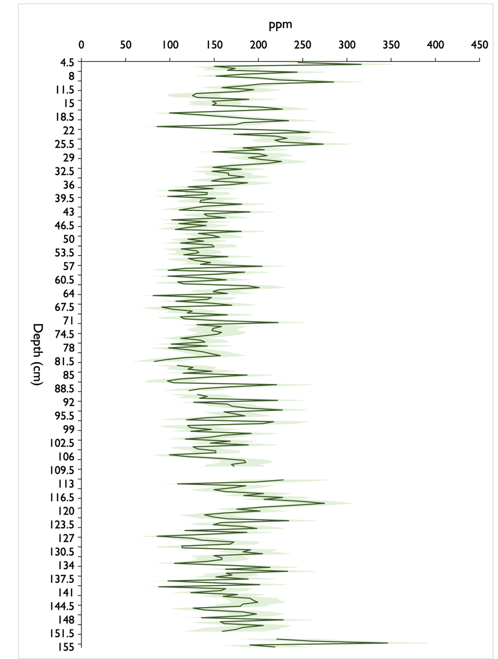
Figure 3: A scanned image of the deep north basin core



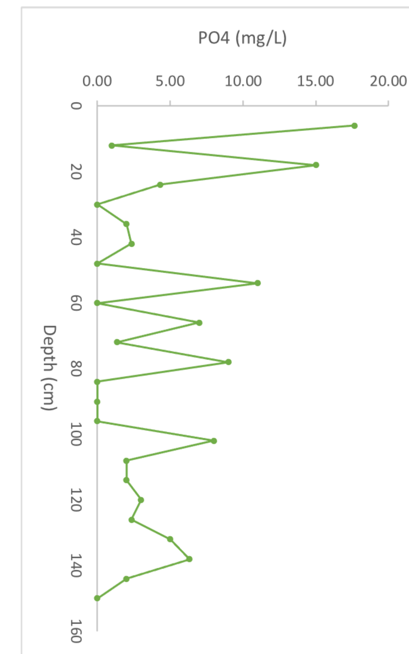
Magnetic Susceptibility



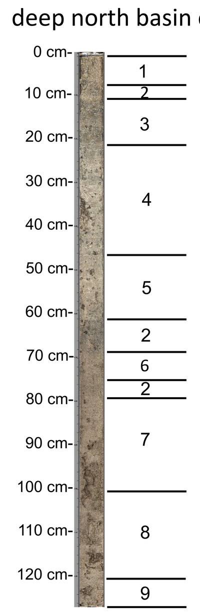
Organic Matter



Elemental Phosphorous Concentration XRF



Photometry of PO4



1. Greenish brown. Indistinct bedding. Well shorted, subrounded abundant clay, and common sapropel. Diatoms common.

2. Dark gray to green gray. Diffuse bedding. Abundant clay and sapropel. Diatoms common to abundant. Some bioturbation.

3. Greenish brown to olive green. Diffuse bedding. Abundant clay and sapropel, and diatoms common.

4. Light gray to olive gray gradient packets. Diffuse lamination. Dominant clay, common diatoms and sapropel.

5. Brownish gray. Massive indistinct bedding. Dominant clay, common diatoms and sapropel.

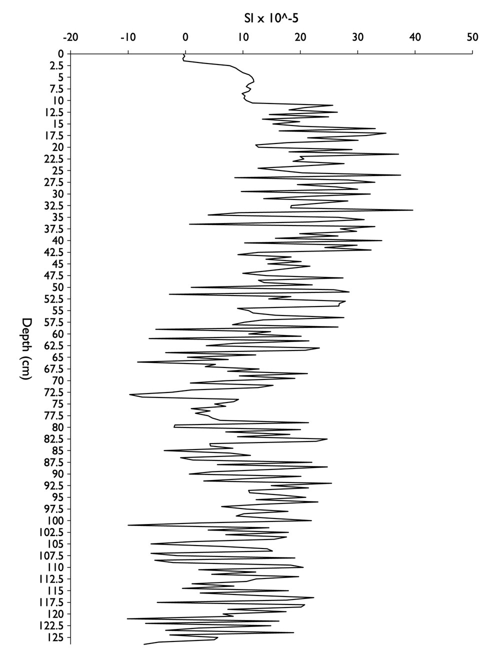
6. Brownish gray. Indistinct lamination. Dominant clay, abundant diatoms, and common sapropel.

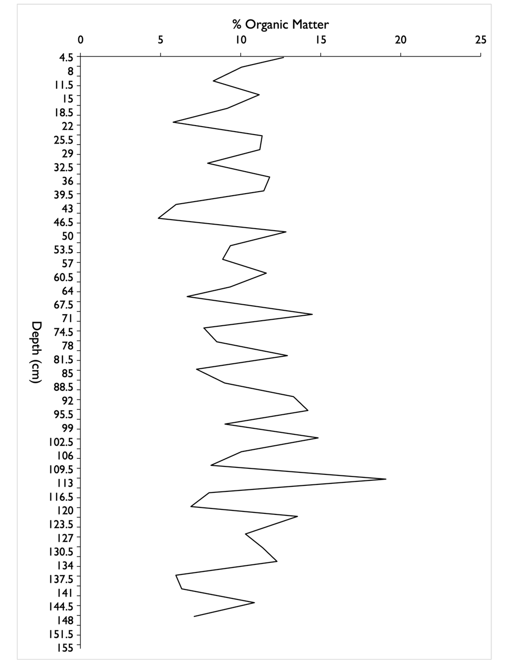
7. Brownish gray to olive green. Massive diffuse bedding. Abundant clay, dominant diatoms, and common sapropel.

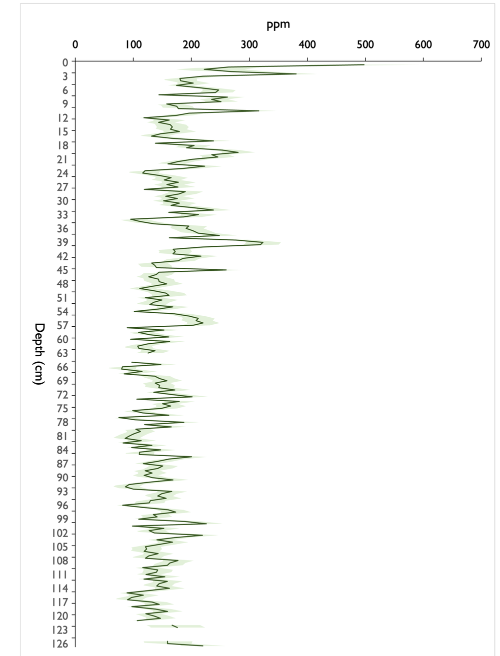
8. Olive green. Massive bedded clay. Abundant diatoms and common sapropel.

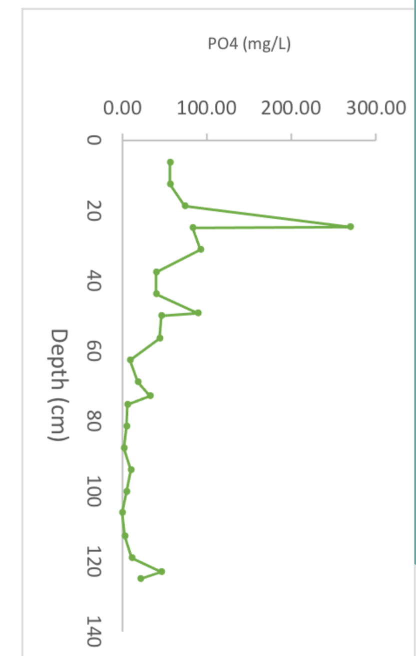
9. Dark gray to olive green. Indistinct bedding. Dominant sapropel, abundant clay, and common diatoms

Figure 4: A scanned image of the deep south basin core









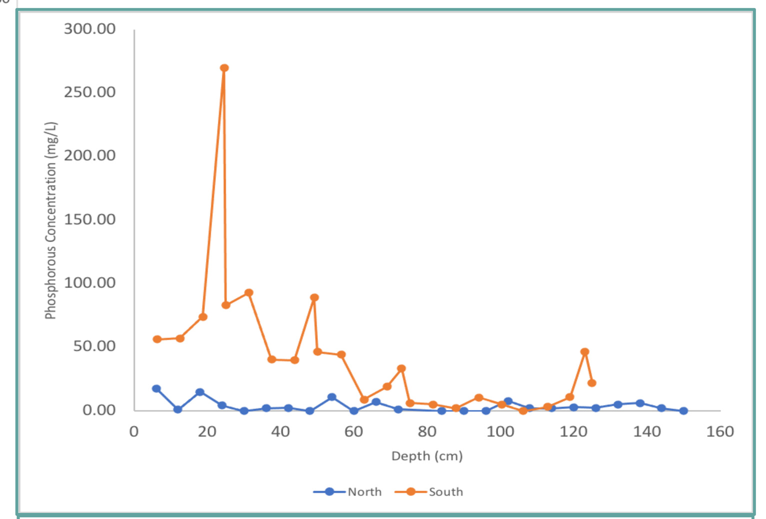


Figure 5: Combined phosphate concentration data for North and South Cores

Figure 3: Sedimentary piston core collected at (11m) in depth in the deep region of the (north) basin in Conesus lake. Smear slide initial core descriptions and identified as (eight) distinct facies with diatom presence identified as rare, common, or abundant(see 1-8).

Figure 4: Sedimentary piston core collected at (17m) in depth in the deep region of the (south) basin in Conesus lake. Smear slide initial core descriptions and identified as (nine) distinct facies with diatom presence identified as rare, common, or abundant(see 1-9).

Line graphs: Magnetic susceptibility; percent organic matter; elemental concentration from XRF of phosphorus and from photometry of PO4 (phosphate).

Discussion

Conesus lake was chosen as a lake for this study as it is impacted greatly by surrounding land practices. The land practices surrounding this lake are mainly agricultural land practices, with these intensified agricultural practices come increase in fertilizer usage, which is high in phosphate. An increase of phosphorus in lakes cause them to become eutrophic. Eutrophication is a process where water in a lake, stream or ocean changes from low biological activity to high biological activity. Anthropogenic effects and nutrient loading has rapidly accelerated the growth and biological activity. Excess phosphorus can leach into streams and lakes, and lead to high levels of nutrient load in these lakes. In 2010, New York State passed a law that restricted the usage of phosphorus lawn and turf fertilizer, however agricultural lands were exempt from the passing of this bill. Phosphorus use in fertilizer has more than doubled from 1950 to 1980, where there was a peak usage of about 2.5 million metric tons per year. The USEPA (United States Environmental Protection Agency) has established a federal recommended limit of 0.05 mg/L for total phosphorus load for streams entering lakes, in hopes to control eutrophication. Data on Conesus lake from the Citizens Statewide Lake Assessment Program (CSLAP), shows that the southern basin has a continually higher phosphorus concentration than the northern site, this is likely due to the high sediment delivery in the southern basin, yielding a higher signal. There is increase sediment delivery here because of the several tributaries that feed into the lake (fig 1). Results have shown that the bans and remediation have helped in the restoration of the lake, as phosphate concentration is on a steady decline.

Future Research

This research is part of a long term project, with this presentation being just a portion of the project. Along with continual analysis of elemental concentrations, we intend to:

- Create an age calibration using Cs-137 and 210-Pb dating methods
- Create an age calibration using radiocarbon and cesium methods
- Use the age calibration to determine changes in sedimentation rate over time
- To use ion chromatography to provide scientifically accurate phosphate concentrations
- Use ArcGIS Pro to evaluate the inputs to the lake
- Identify and count the macrofossil record of mollusks

References

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