

# Determining the cause and timing of water quality changes in Musselman Lake: Setting lake management objectives using paleolimnological techniques



**Lake Simcoe Region**  
conservation authority

**Melissa T. Moos and Brian K. Ginn**

Lake Simcoe Region Conservation Authority, Newmarket, Canada

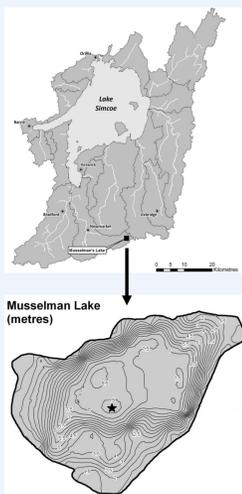
## Objectives

- Determine pre-disturbance conditions to develop effective lake management strategies
- Compare present-day water quality and diatom assemblages with historic conditions
- Assess long-term environmental changes and account for natural variability in Musselman Lake

## Background

- Many lakes lack water quality information on pre-disturbance conditions for setting remediation goals and developing management strategies
- Musselman Lake is a relatively small (surface area ~46 ha, max depth = 8.5 m) kettle lake on the Oak Ridges Moraine that is the headwater of the East Holland River<sup>1</sup>
- Residents have expressed concerns over water quality issues indicative of nutrient enrichment
- Musselman Lake has high phosphorus concentrations (TP = 15-36 µg/L), high macrophyte biomass, and has experienced toxic cyanobacterial blooms<sup>2</sup>
- There is a lack of pre-disturbance monitoring in Musselman Lake, and several likely sources of phosphorus (septic systems vs watershed run-off)
- A sediment core and paleolimnological methods were used to determine historical trends in phosphorus and help set mitigation targets<sup>3</sup>

## Study Site



1954



1999



2002

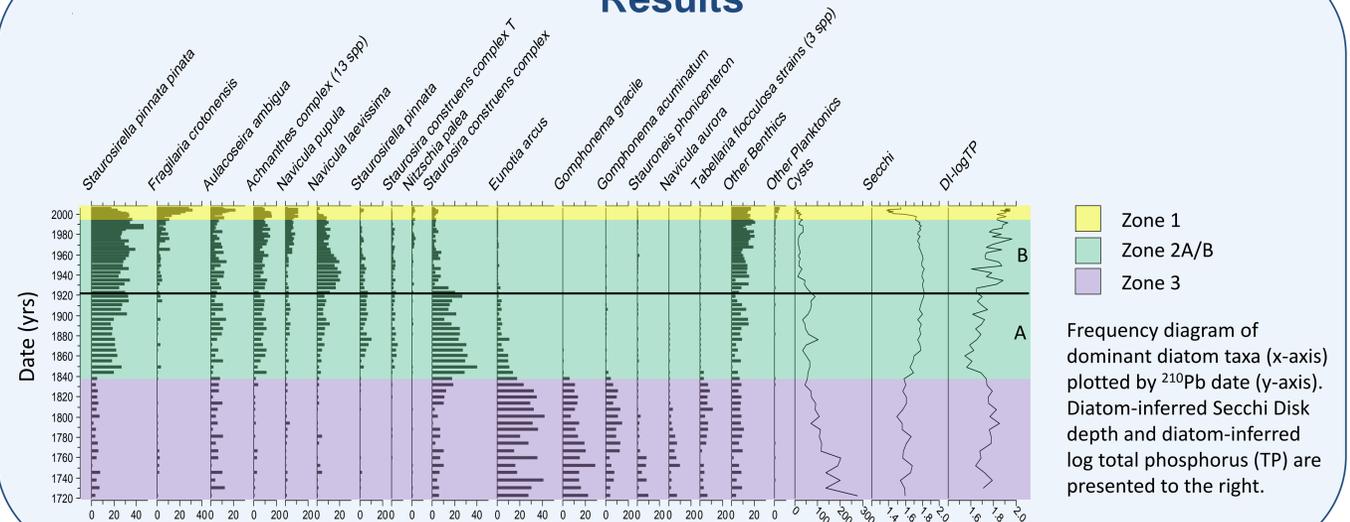


2012

### Methods

- A sediment core (total length of 37.5 cm) was collected from the deep basin (8.5 m) of Musselman Lake
- Diatoms were identified to the lowest taxonomic level possible using published references
- Radiometric dates were calculated to establish continuous age/depth relationships in the sediment core.
- Species with greater than 5% in at least one sample were graphed using the computer program C2<sup>4</sup>
- Inferred values for Secchi Disk depth and total phosphorus (TP) were calculated using a 64 lake diatom calibration set for southern Ontario<sup>5</sup>

## Results



## Discussion

- Inferred lake environmental conditions were relatively stable pre-1840 and indicative of a forested catchment with a lake slightly acidic from DOC inputs (Zone 3 ■)
- With increased land clearance and agricultural activities, the lake slowly became more mesotrophic (1840 - 1920) (Zone 2A ■)
- Further increases in productivity associated with the establishment of seasonal cottages and a hotel along the shoreline (~1920), and the conversion of these dwellings to year-round homes (1960-1990) (Zone 2B ■)
- Wastewater treatment in this community has historically relied on small, individual, septic systems. The greatest decline in water quality has occurred since the 1990s when individual groundwater wells were replaced by servicing homes with the municipal water supply (Zone 1 ■)

## Conclusions

- Rapid urbanization of the watershed along with inadequate waste water treatment led to decreases in water quality over time
- By identifying the major source of nutrient inputs, and pre-disturbance environmental conditions, restoration targets and a lake management strategy can be developed for remediation of this lake

## References

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