

USING PALEOLIMNOLOGY TO ASSESS THE EFFECTS OF ROAD SALT APPLICATION ON LAKES WITHIN THE MUSKOKA RIVER WATERSHED, ONTARIO

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Road Salt

- ~5 million tonnes of salt are applied to Canadian roads annually
 - Ontario contributes ~1.8 million tonnes annually
 - MTO Maintenance Manual MBP-703 suggests 70 to 220 kg salt for paved roads per salting event
- Began in the 1950's



Picture: Newly-completed Hwy 11 Diversion between Gravenhurst and Bracebridge showing new zone markings, 1/2 mile north of Airport Road. Photograph taken on September 8, 1950.

Road Salt and the Environment

- Ecological effects of Road salt on both terrestrial and aquatic systems
 - Ground water
 - Vegetation
 - Aquatic life
 - Mammals and Birds



Photo credit: Algonquin parks twitter account

Current Guidelines and Research

- Canadian Water Quality Guidelines for the Protection of Aquatic Life
 - Ontario Guideline 120 mg/l
 - Current Canadian Guidelines 120 mg/l – 640 mg/l
- Brown A, Yan N. 2015. Food Quality and the Sensitivity of *Daphnia* to Road Salt. *Environmental Science and Technology*. 49(7):4673–4680.
 - *Daphnia* in softwater bioassays
 - Chloride toxicity
 - LC₅₀ ranged from 55.7 mg/L to 284.8 mg/L



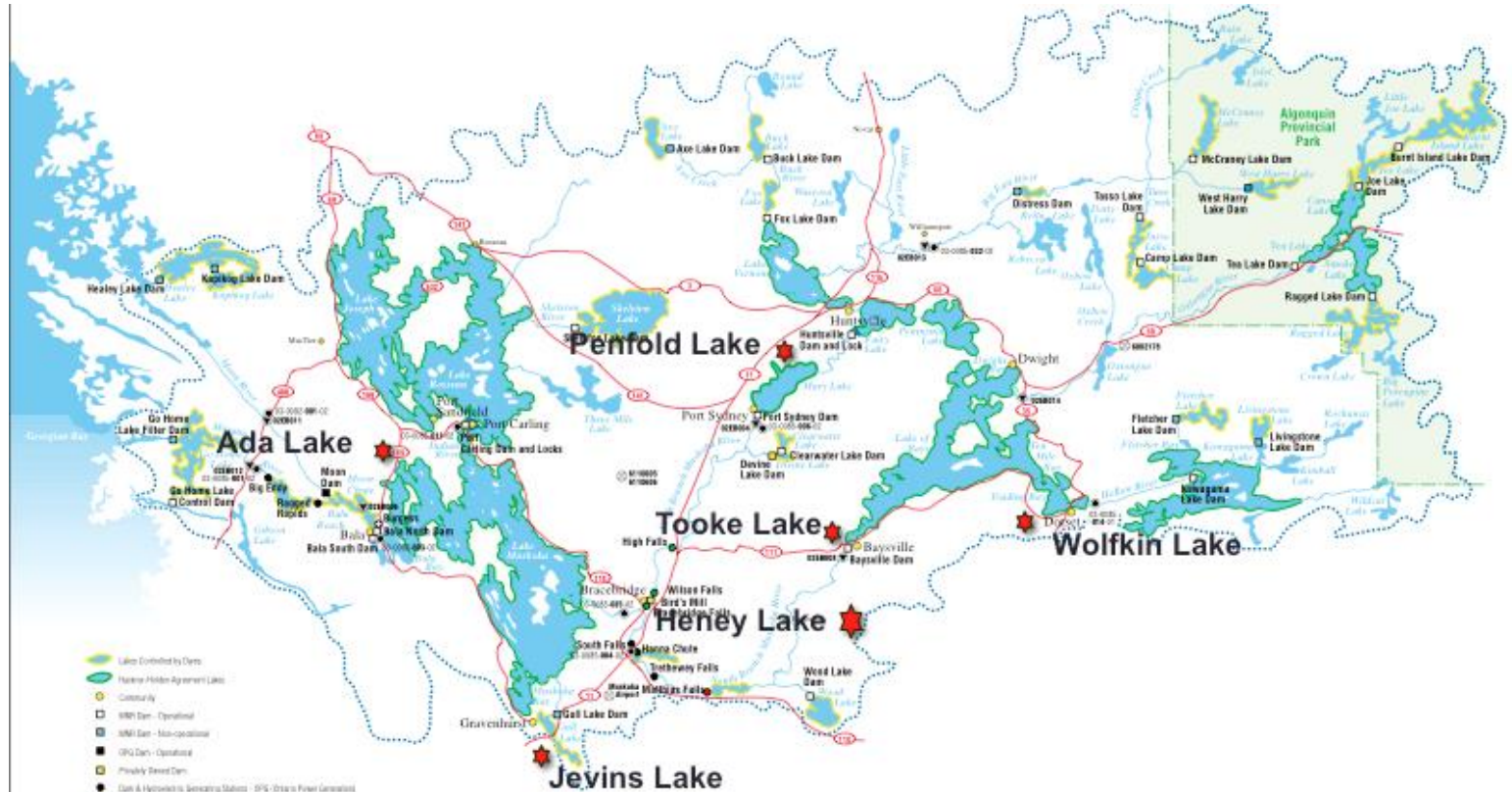
Muskoka

- Development in the Muskoka area began in 1868
- Hwy 11
 - Built in the 1920s
 - Upgraded and opened to public in 1927
 - In the 1960s and early 1970s upgraded to a four lane highway



Penfold Lake May 2015

The Muskoka River Watershed



	<u>Heney</u>	<u>Ada</u>	<u>Wolfkin</u>	<u>Penfold</u>	<u>Tooke</u>	<u>Jevins</u>
<u>Zmax</u> (m)	5.8	3	10	3	6	3
<u>Surface area</u> (km ²)	0.22	0.23	0.19	0.34	0.32	0.36
<u>TP</u> (µg/L)	6.2	21.9	7.0	15.7	5.7	14.0
<u>Secchi</u> (m)	4.7	2.1	4.9	1.6	4.8	1.9
<u>Chloride</u> (mg/L)	0.94	34.3	38.0	44.5	46.2	84.0
<u>Sodium</u> (mg/L)	0.79	21	23.1	21.1	25.2	50.4

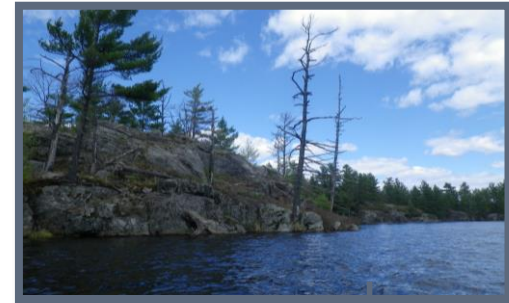
Ada Lake



Penfold Lake



Jevins Lake



Wolfkin Lake



Heney Lake



Tooke Lake

Chloride Concentration

Low

High

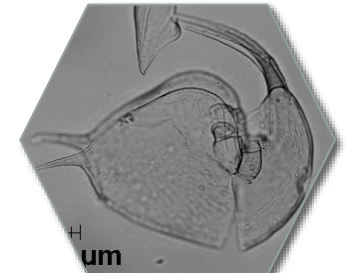
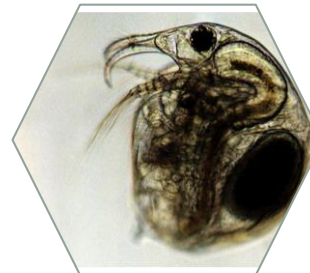
Objectives

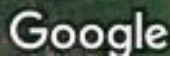
- Do we see biological changes consistent with road salt application?
- Assess at what loads we see ecological effects.
- What lakes or regions are most at risk for toxicity?



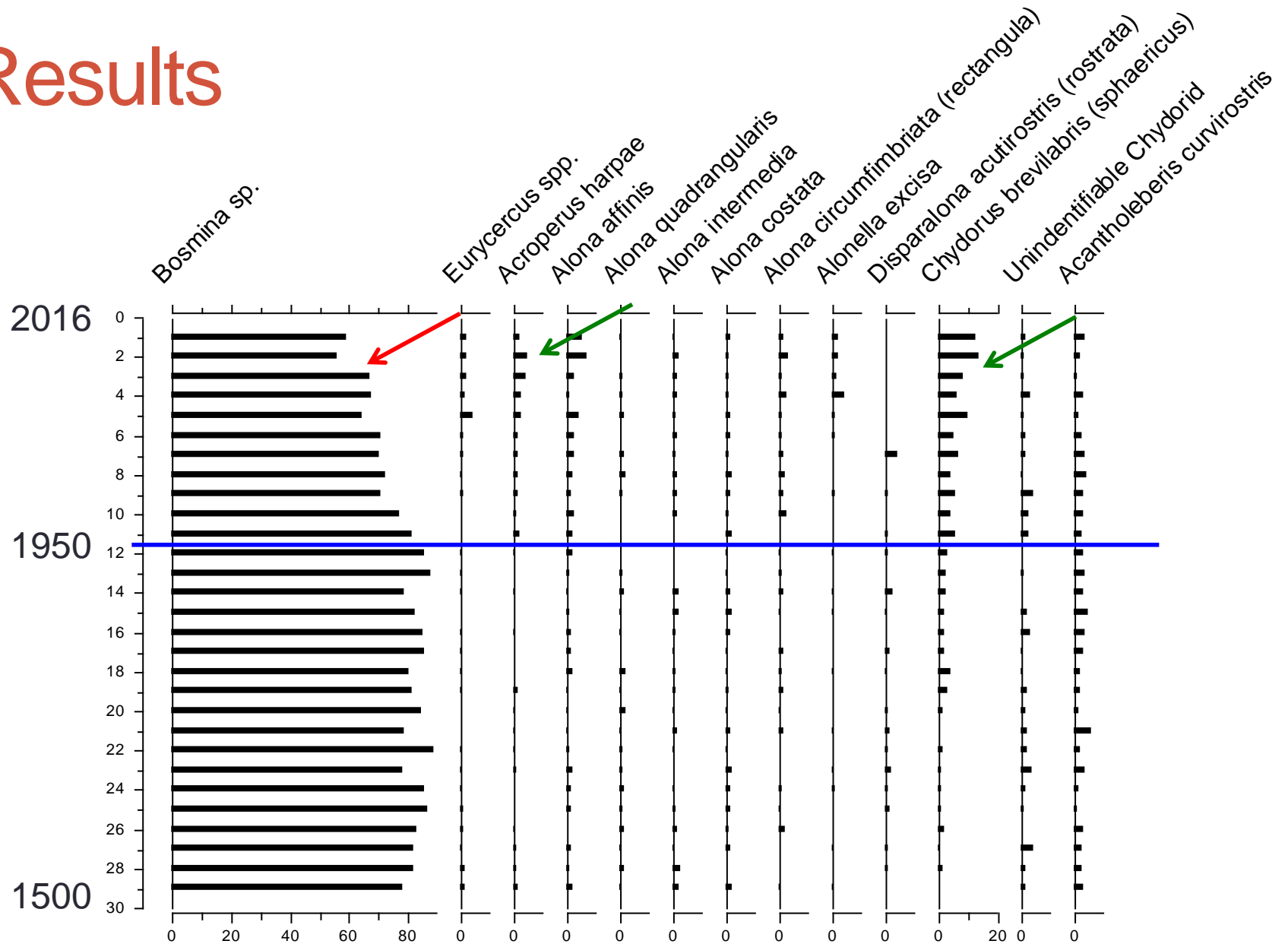
Methods

- Cladocera
 - invertebrate class
- Preserved in the sediment
- Identifiable to a species level
- ~ 400 species of cladocerans have been described worldwide in about 80 genera.
 - Species assemblage controlled by a number of factors
 - habitat and nutrient availability, chemical characteristics of lakes, and predation



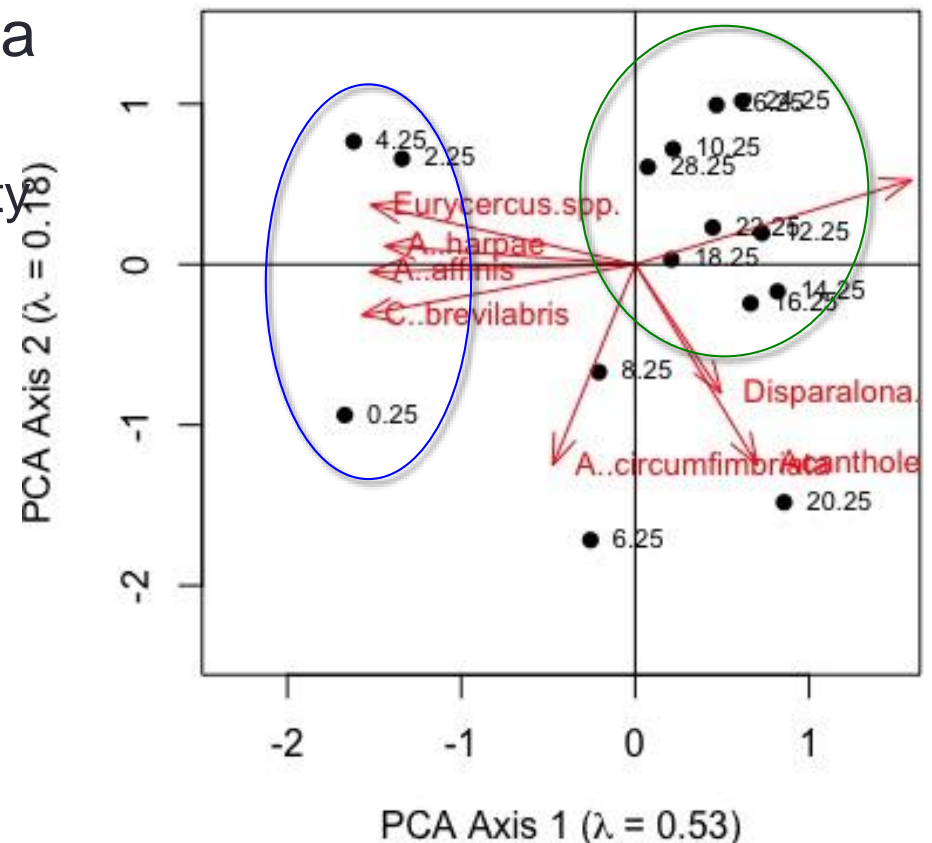


Results

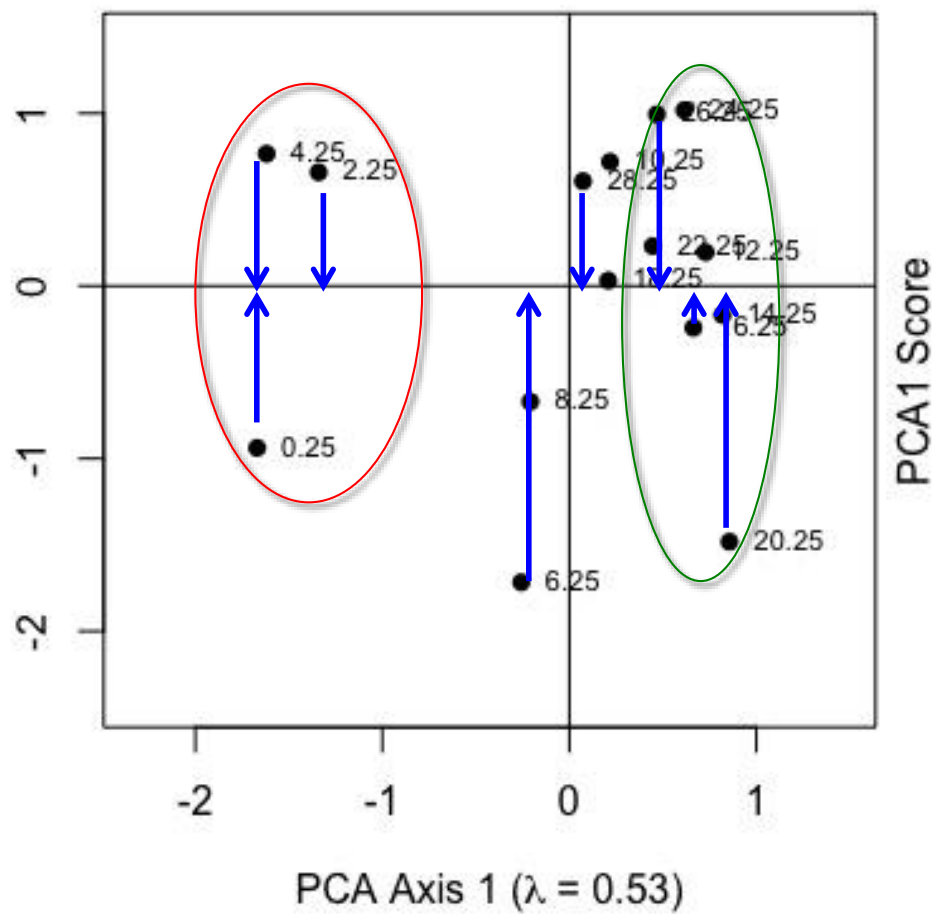


Principal Components Analysis (PCA)

- Ordination Method
 - Ordination is a widely-used family of methods which attempts to reveal the relationships between ecological communities
- Summarize multivariate data
 - Or data with many factors
 - i.e. to reduce the dimensionality
- Uncover the fundamental underlying structure



PCA Axis 2 ($\lambda = 0.18$)



How do we know it's Road Salt?

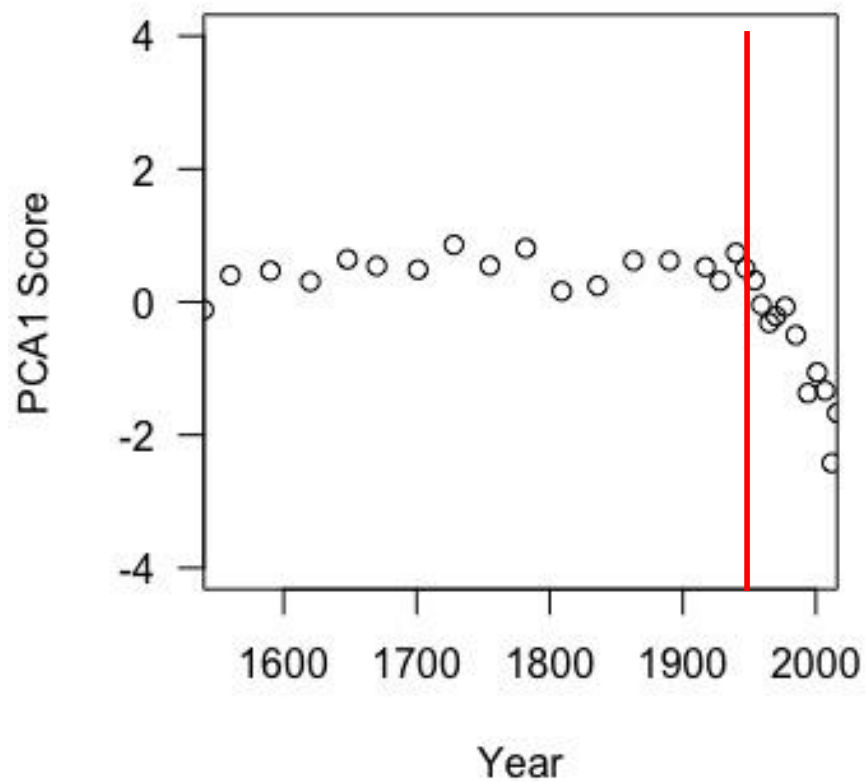
- Heney Lake
 - Muskoka Lake
 - Monitored long term by the District of Muskoka and the MOECC
 - Similar physical and chemical characteristic
 - i.e. Calcium, TP, acidity ect.

	Heney	Jevins
Area (km ²)	0.22	0.36
Depth (m)	5.8	3
Chloride (mg/L)	0.94*	84.0*

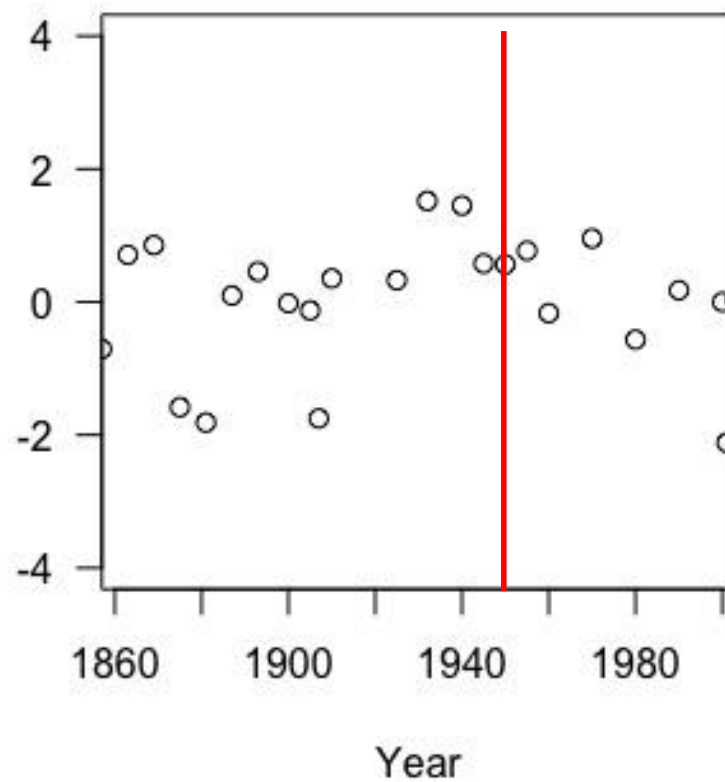
*2015 Monitoring data



Jevins Lake



Heney Lake



Next steps

- Diatoms
 - Most abundant algal group in freshwater systems
 - Well preserved in the sediment record
 - Used extensively to chemical changes in lakes
- Tackle second and third objectives...
 - Assess at what loads we see ecological effect
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Acknowledgments

- Dr. Andrew Paterson and John Smol for their supervision
- Anna DeSellas, Mark Giles and Charlotte Heller for their help in the field
- The Create Grant



Thank You!



Thank You!



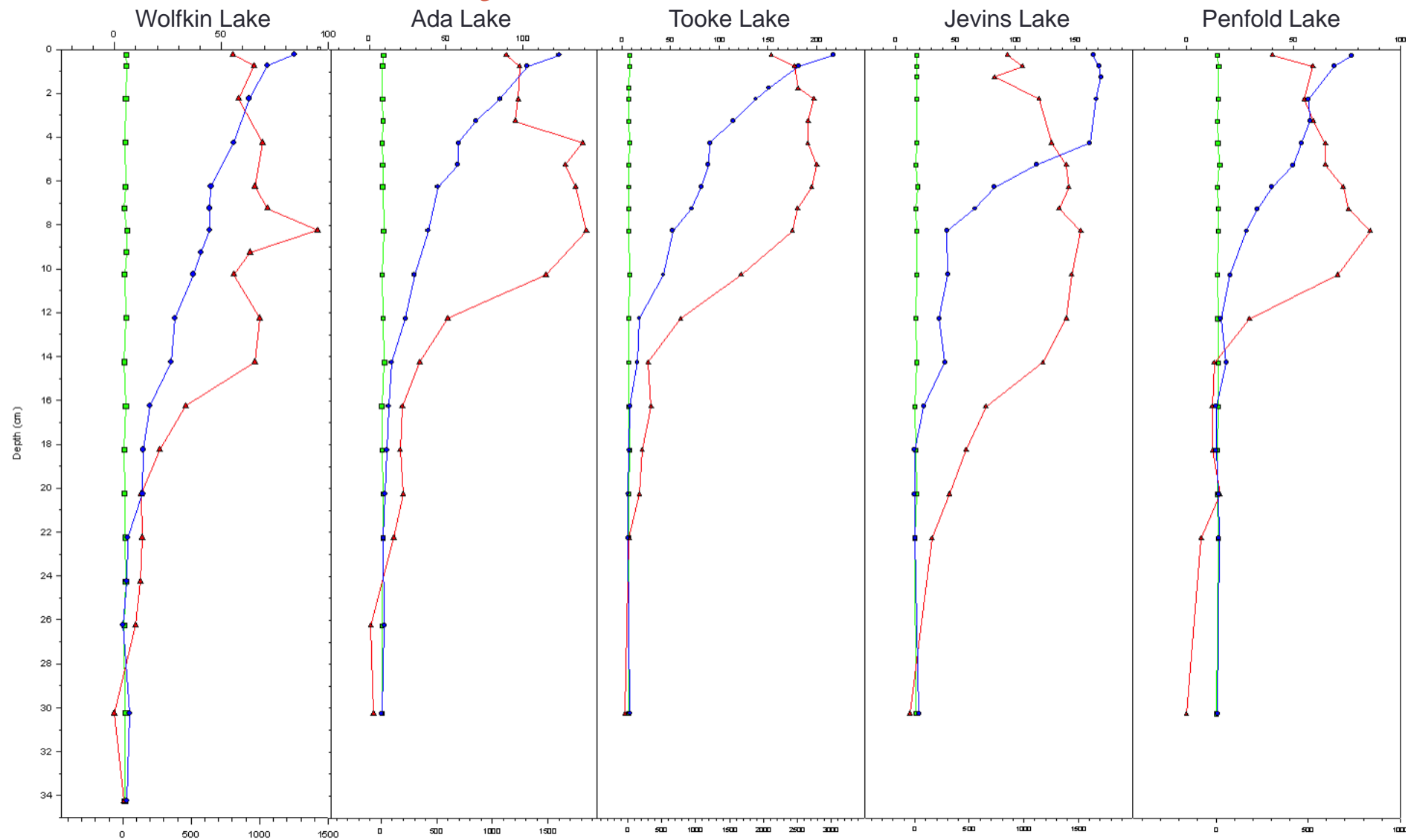
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Chemistry Summary

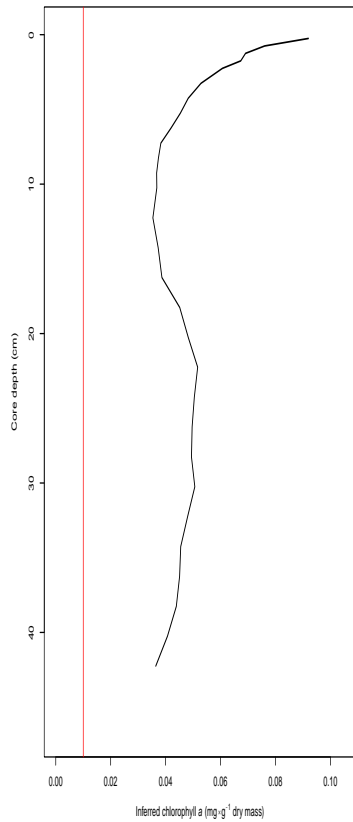
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^{210}Pb Activity

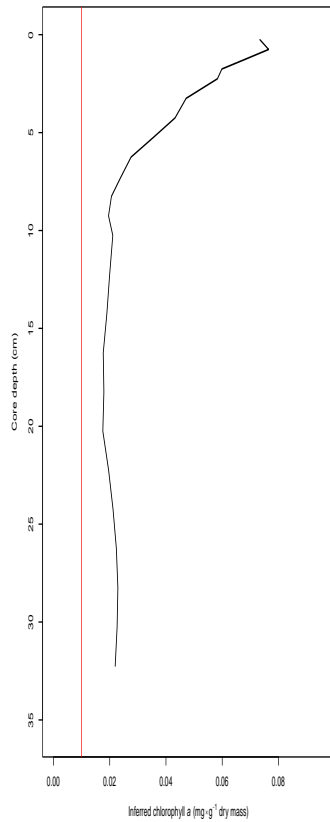


Chlorophyll-*a*

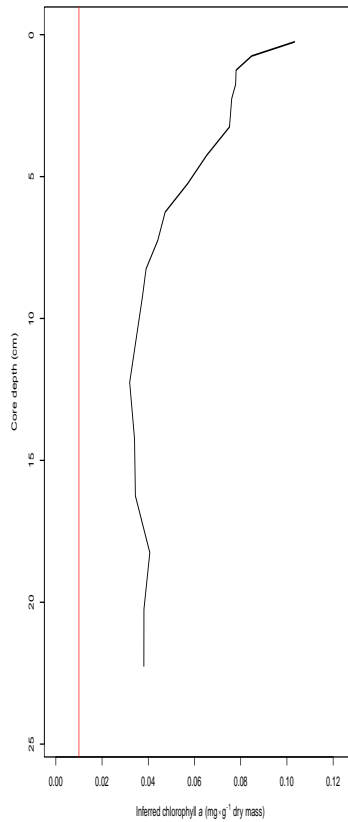
Ada Lake



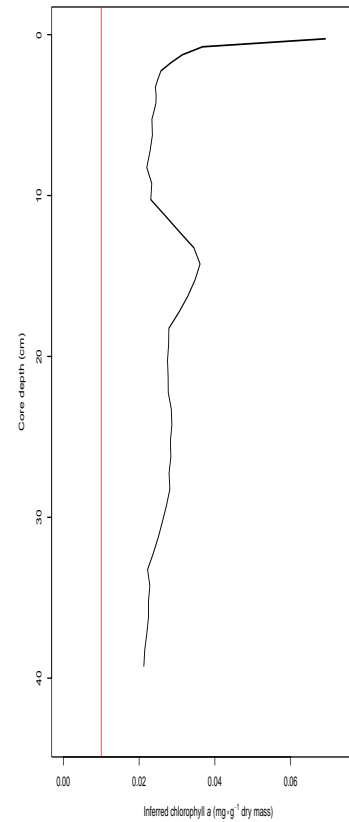
Jevins Lake



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Tooke Lake



Wolfkin Lake

