

Paleolimnological assessment of nutrients and algae in the LOW:

Review of initiatives and update on research

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 - Training set of LOW sites along TP gradient
 - Identify areas of elevated and low nutrient concentrations
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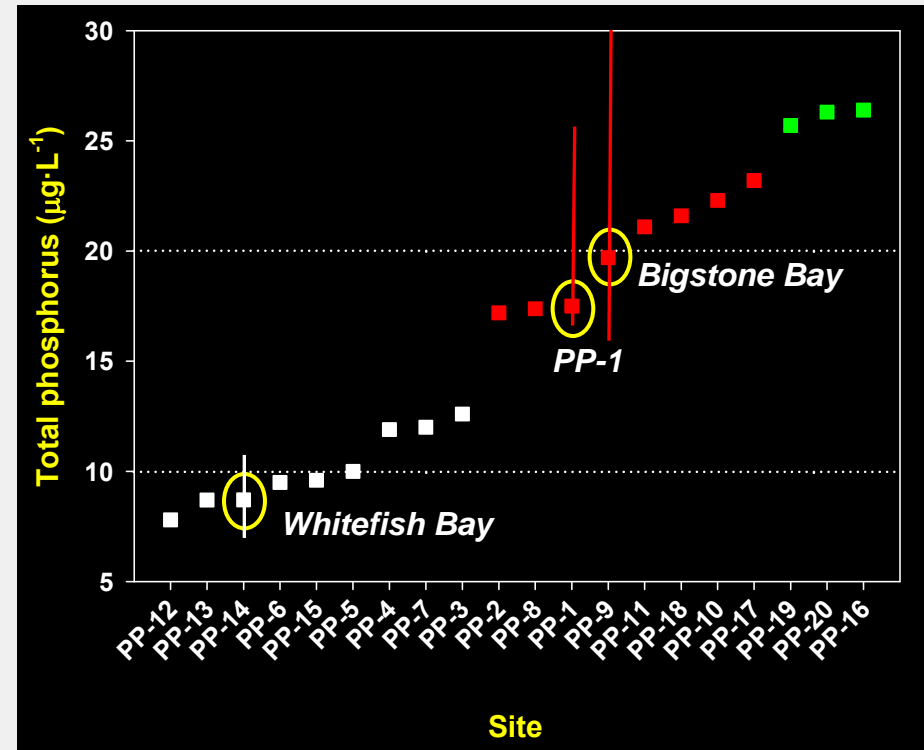
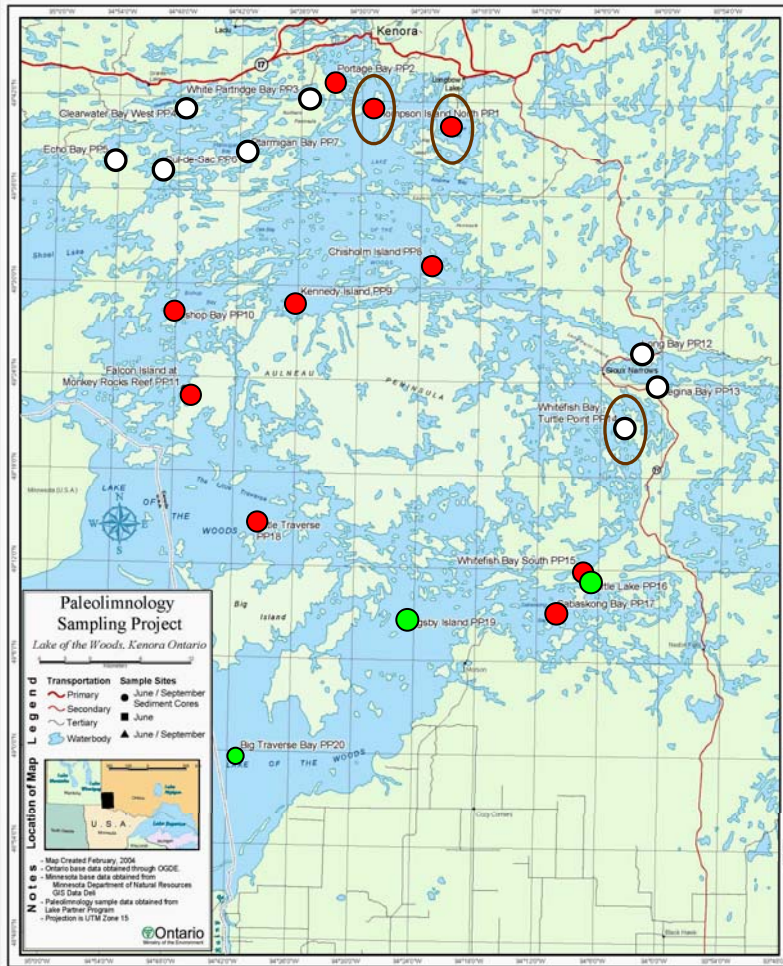
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 - Comparisons between reference & impact sites
 - reference = lower nutrients & no algal blooms
 - impact = elevated nutrients & algal blooms occur
 - Have nutrient levels changed over the past ca. 200 years?
 - Explore alternative mechanisms for recent changes

Total Phosphorus Gradient

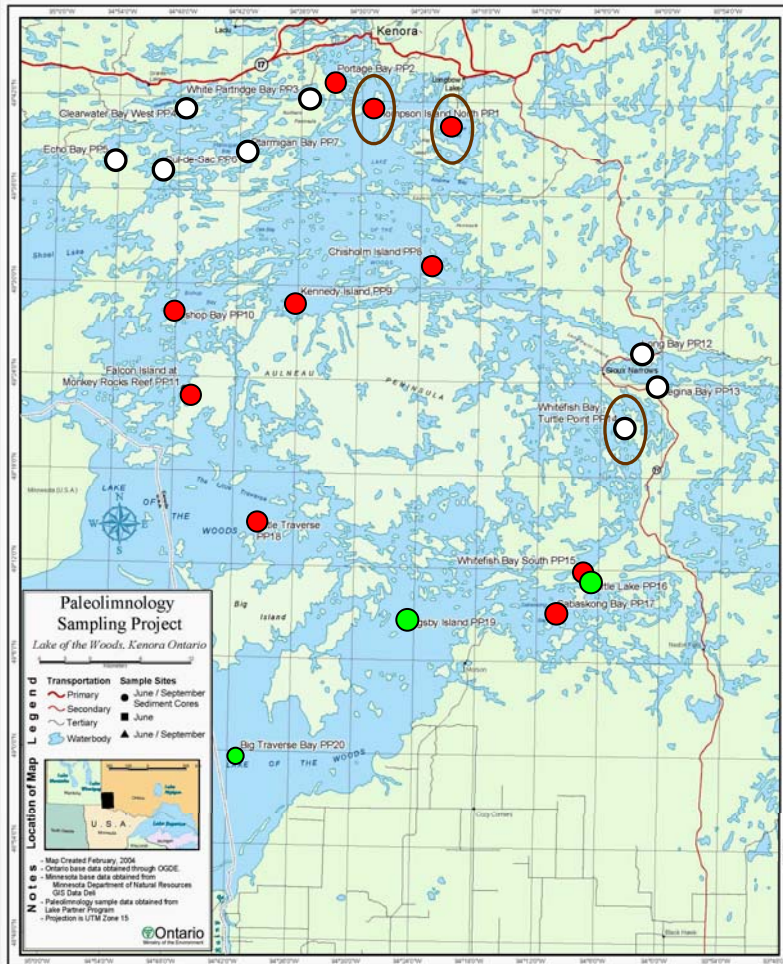


Summer measurements

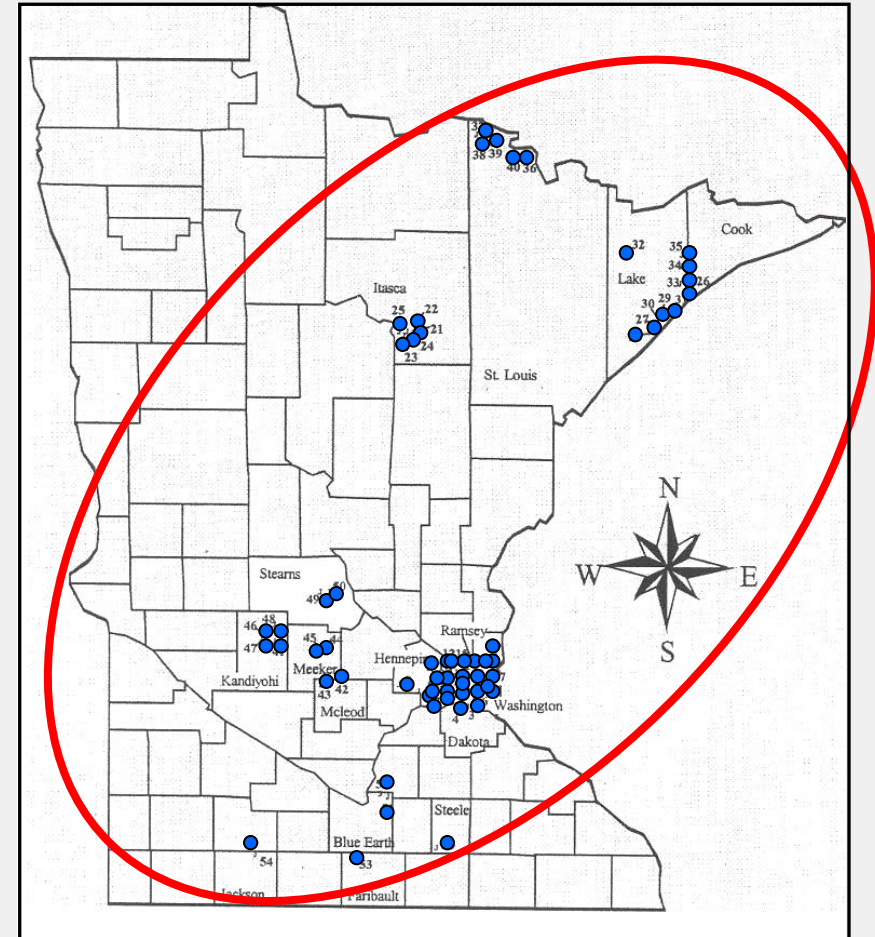
Lake of the Woods training set

DI-TP model development for LOW

16 sites in LOW



55 Minnesota lakes



+

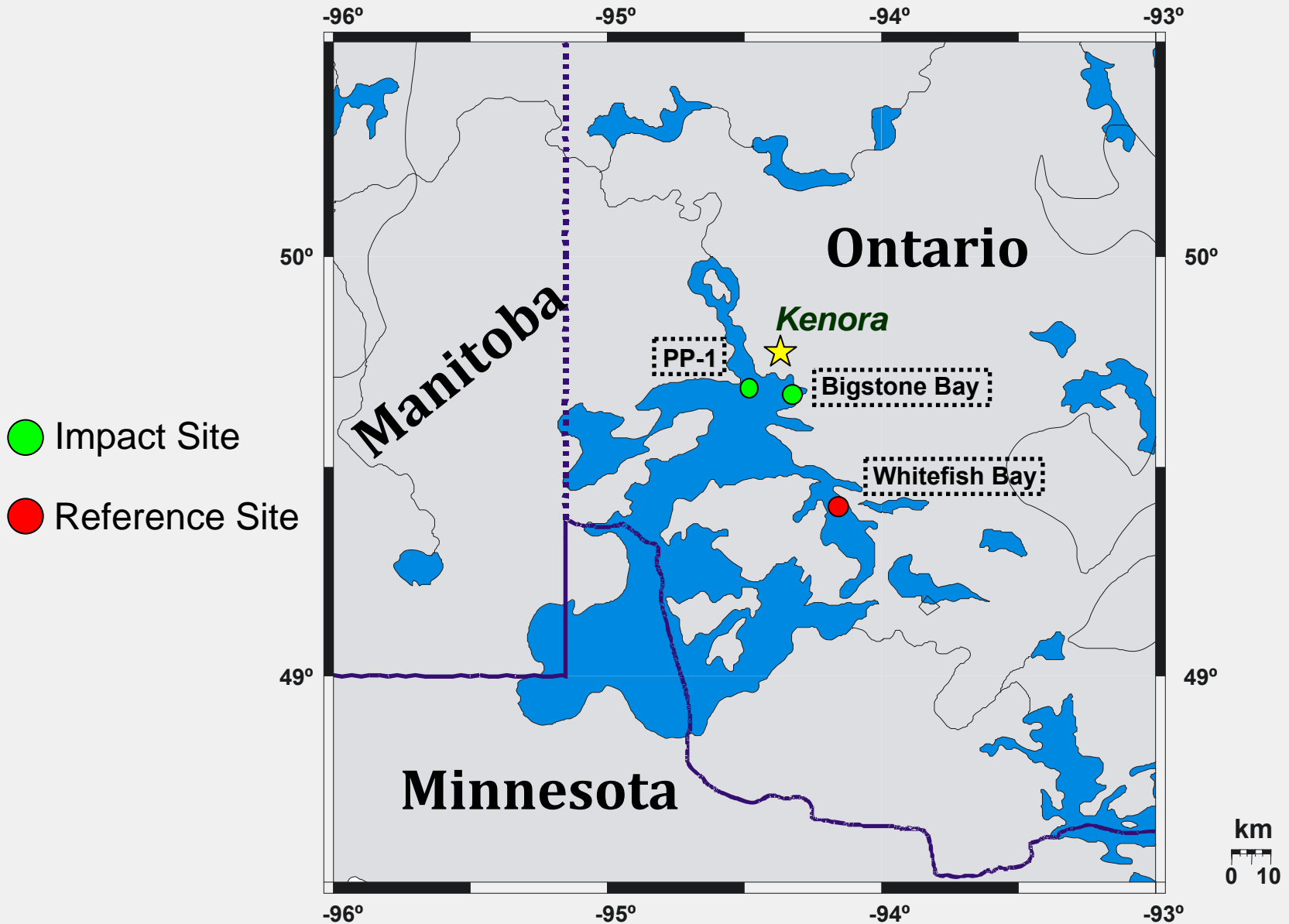
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From J Great Lakes Res Pla et al. 2005 31: 253-266

Northern Lakes and Forests (NLF) sites

From J Paleolimnol Ramstack et al. 2003 29: 79-94

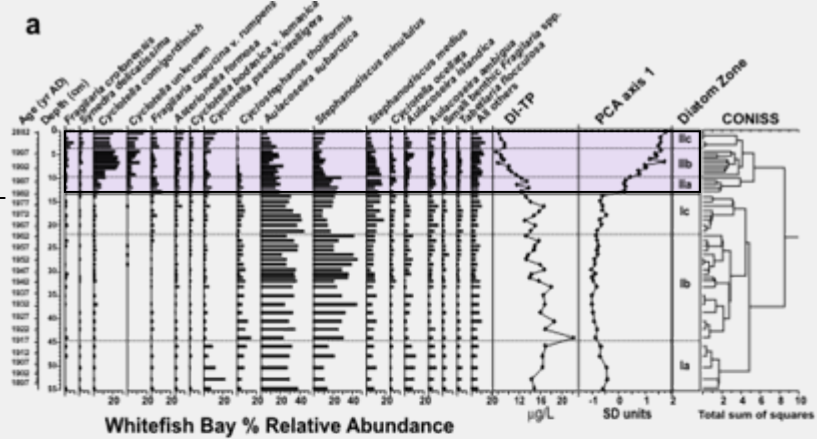
Location of sampling sites for sediment cores



Update on research
 Diatom analysis complete

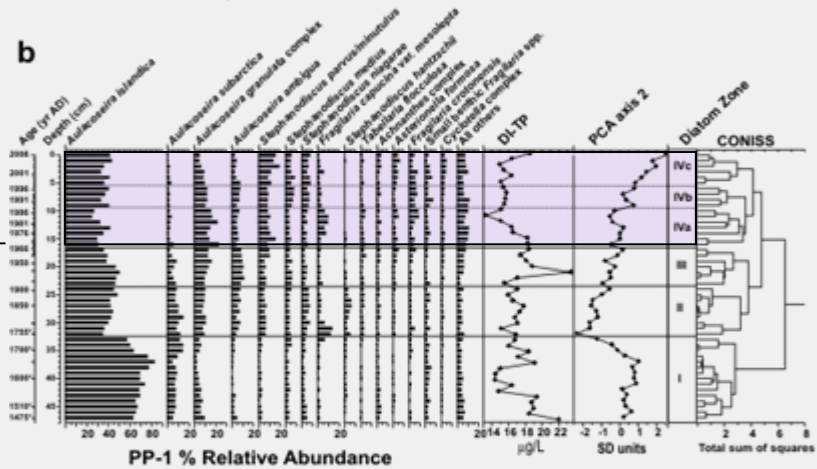
Please visit our poster!

~ 1980



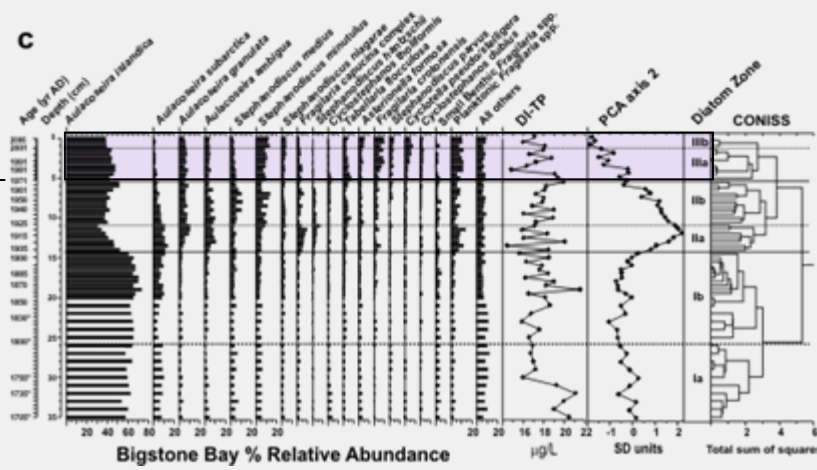
REFERENCE SITE
 Whitefish Bay

~ 1970



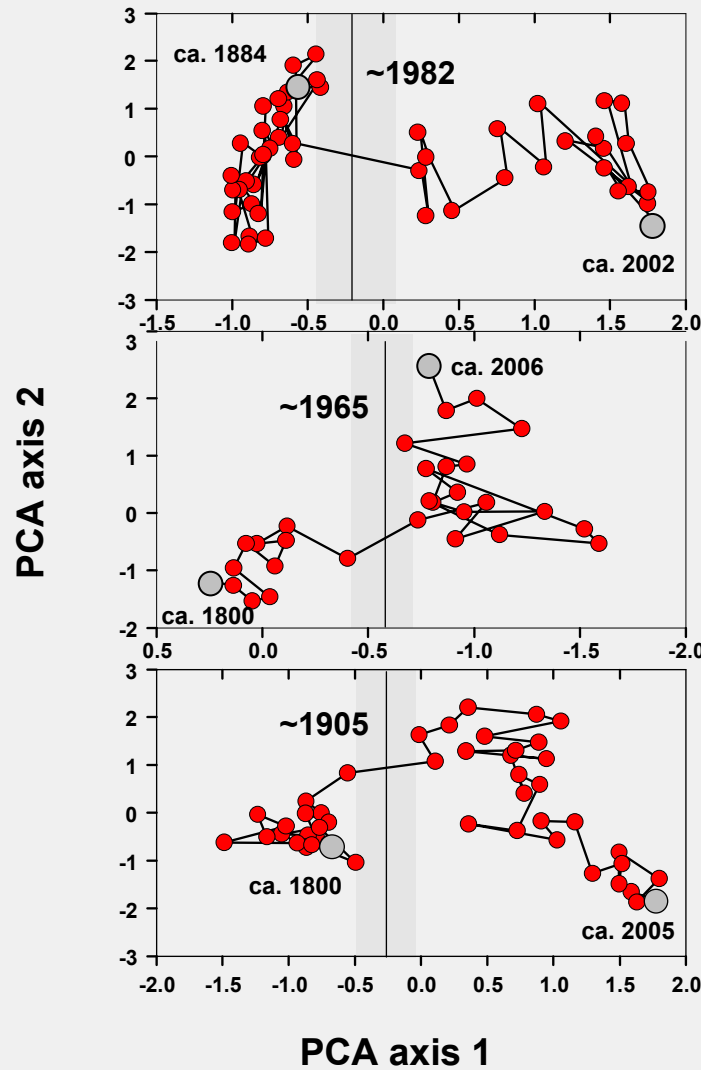
IMPACT SITE
 PP-1

~ 1970



IMPACT SITE
 Bigstone Bay

Trajectories of diatom change over time

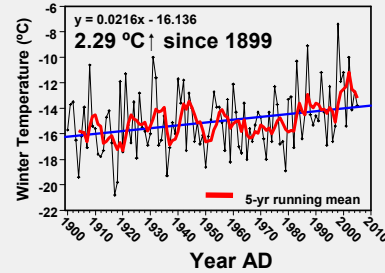
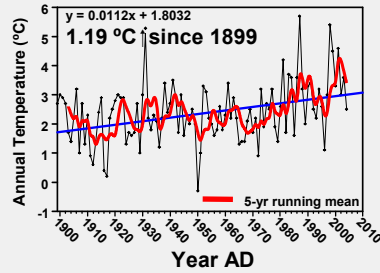
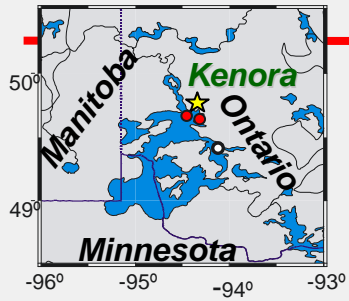


*Whitefish Bay
Reference*

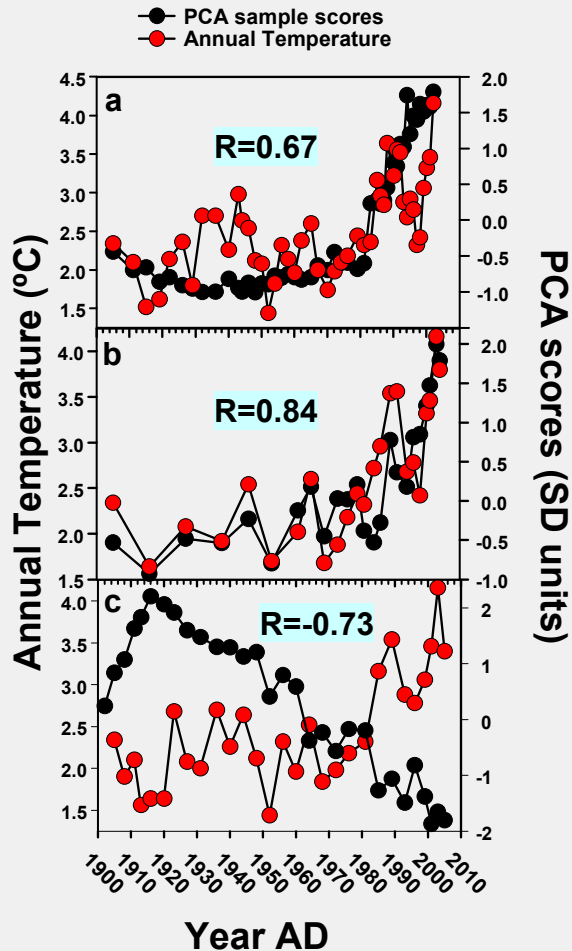
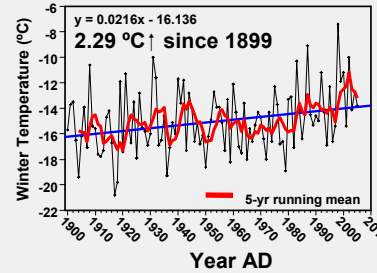
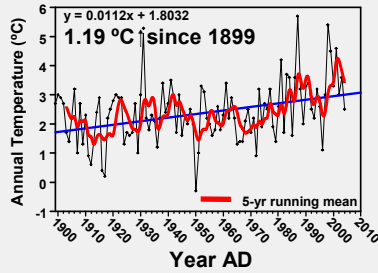
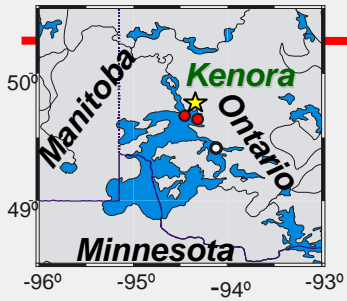
*PP-1
Impact*

*Bigstone Bay
Impact*

Kenora Temperature vs. Diatom trends



Kenora Temperature vs. Diatom trends



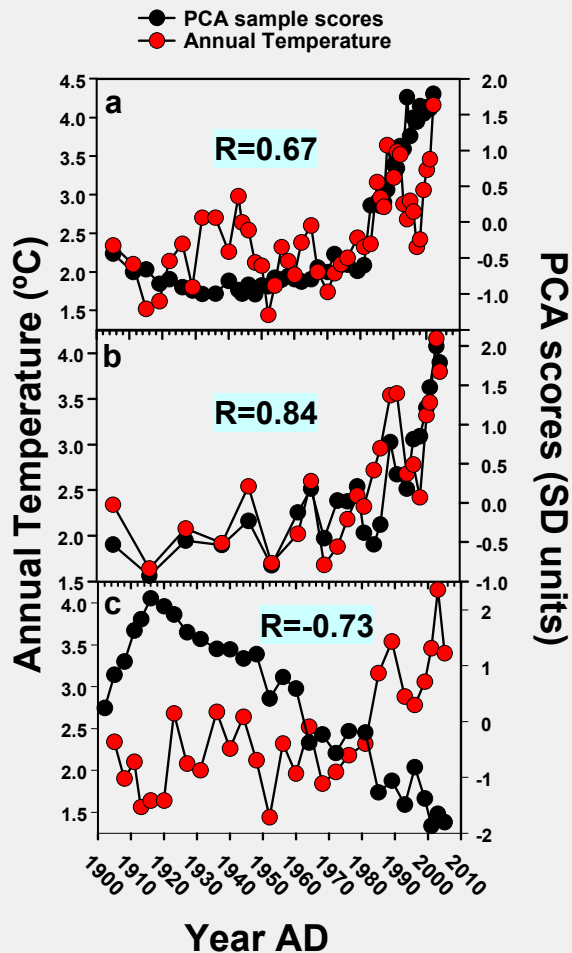
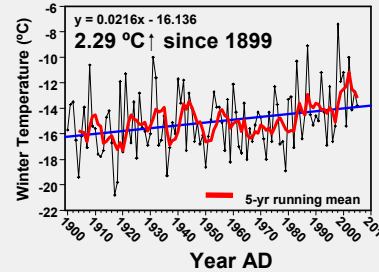
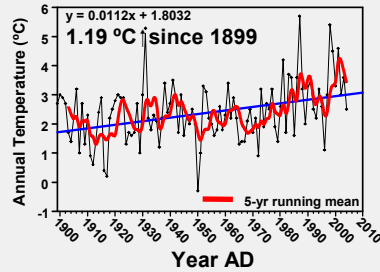
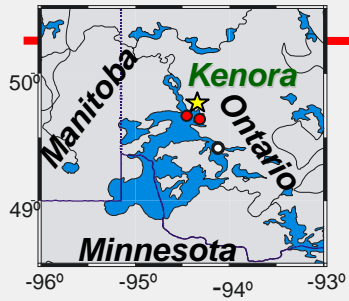
Whitefish Bay
Reference

PP-1
Impact

Bigstone Bay
Impact

PCA scores (SD units)

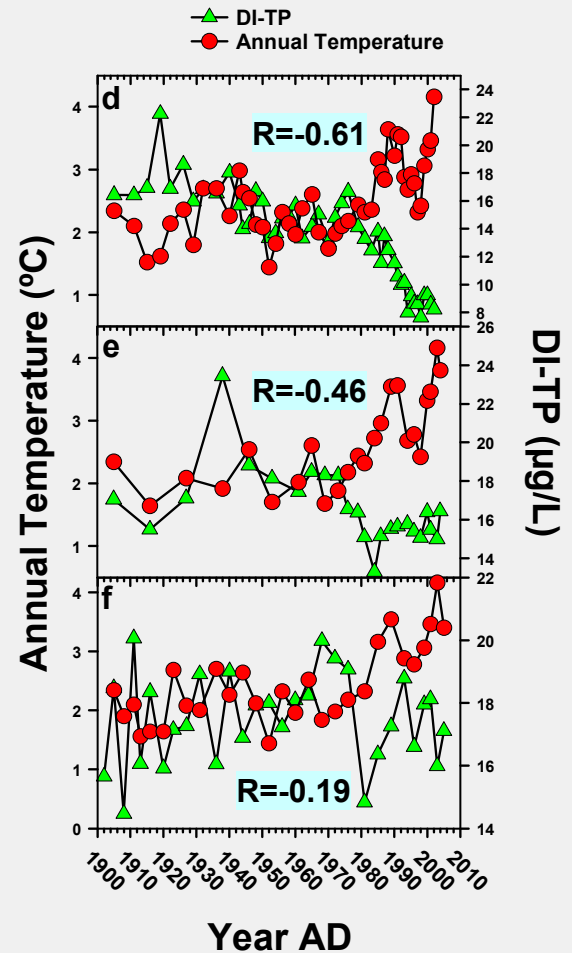
Kenora Temperature vs. Diatom trends



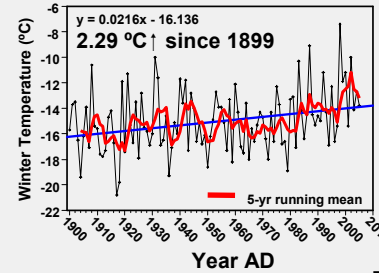
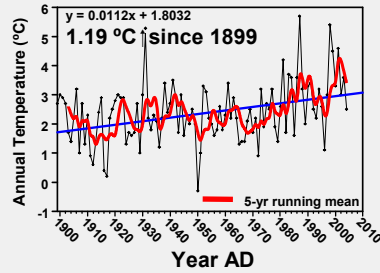
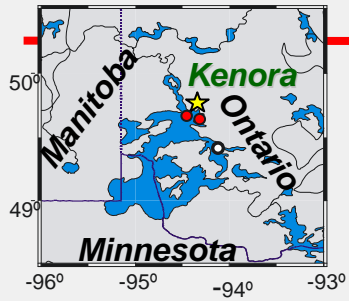
Whitefish Bay Reference

PP-1 Impact

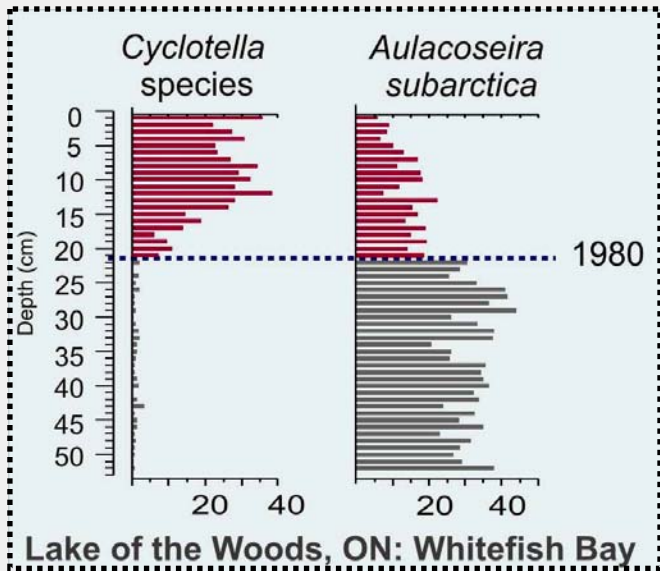
Bigstone Bay Impact



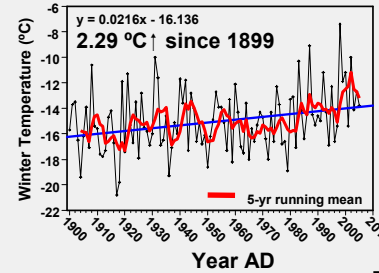
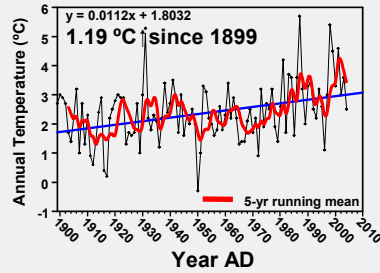
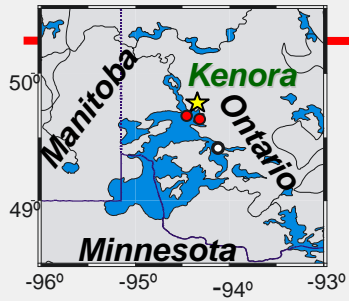
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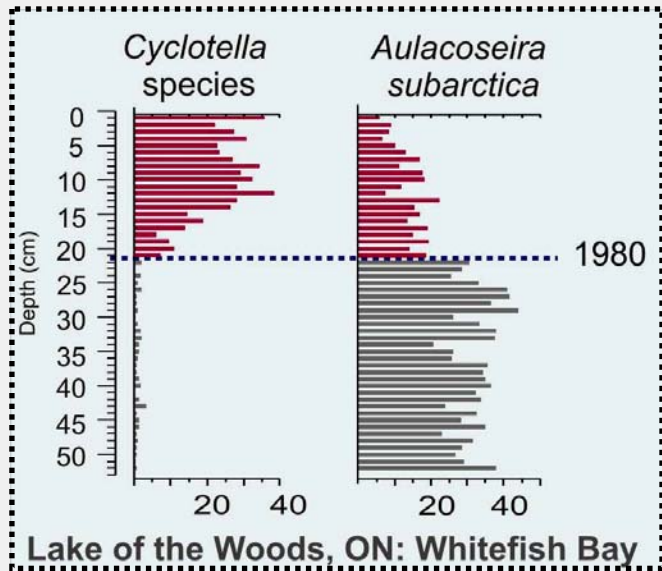
Planktonic *Cyclotella* species



Kenora Temperature vs. Diatom trends

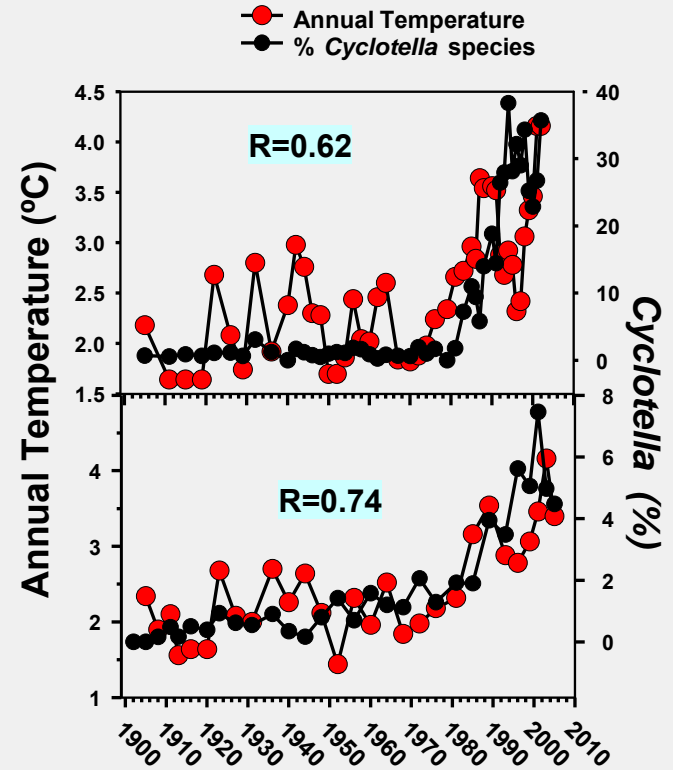


Planktonic *Cyclotella* species

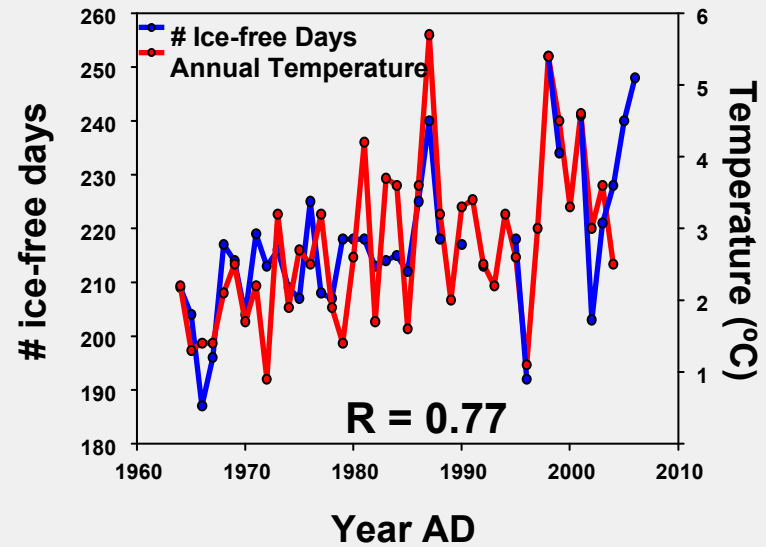
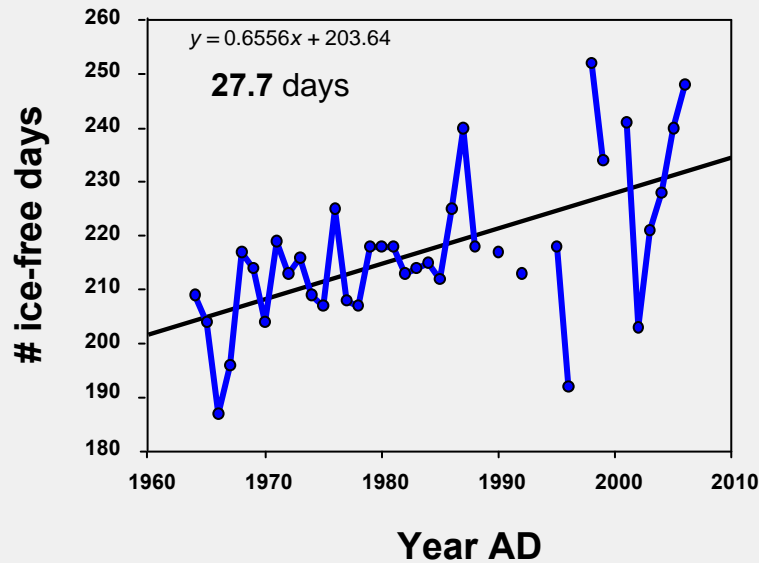


Whitefish Bay Reference

Bigstone Bay Impact



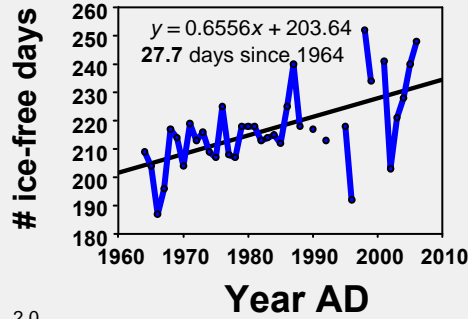
Whitefish Bay Ice-out vs. Diatom trends



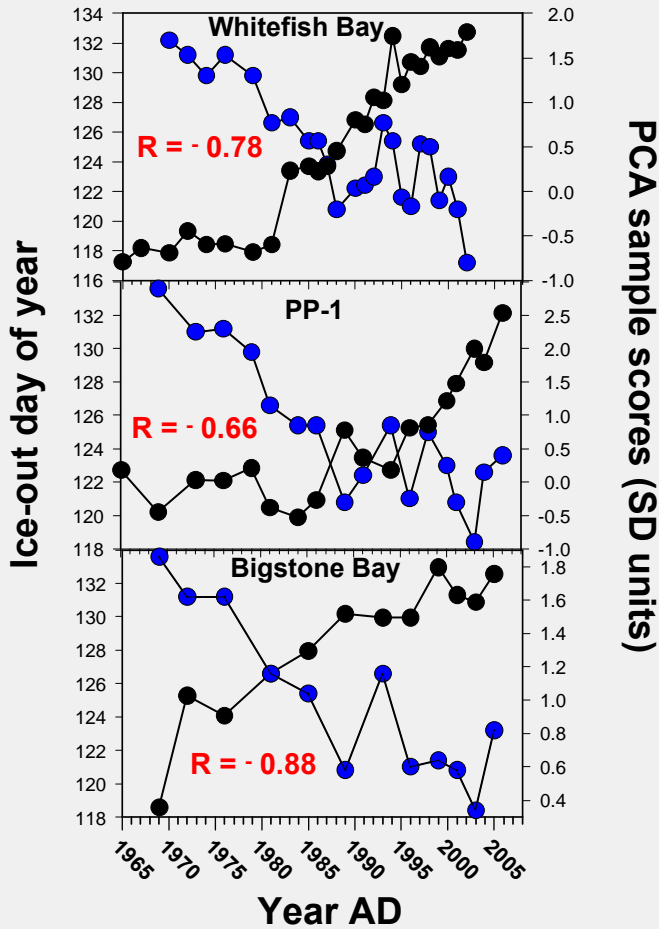
Ice-free period has increased by **27.7** days since 1964

Corresponds to increases in Kenora temperature

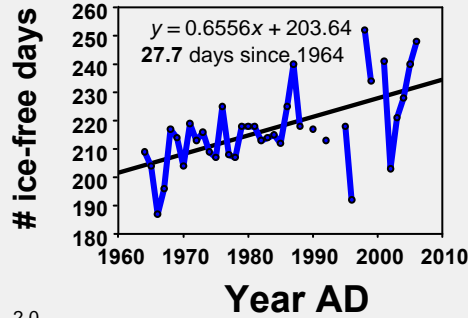
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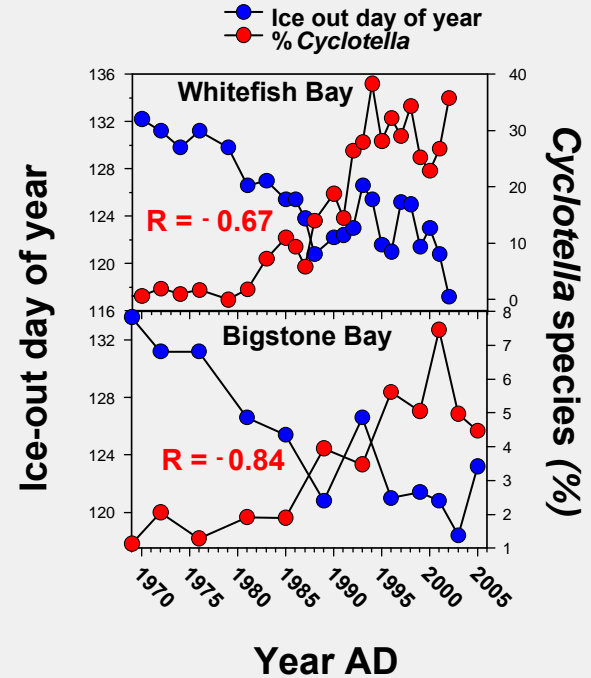
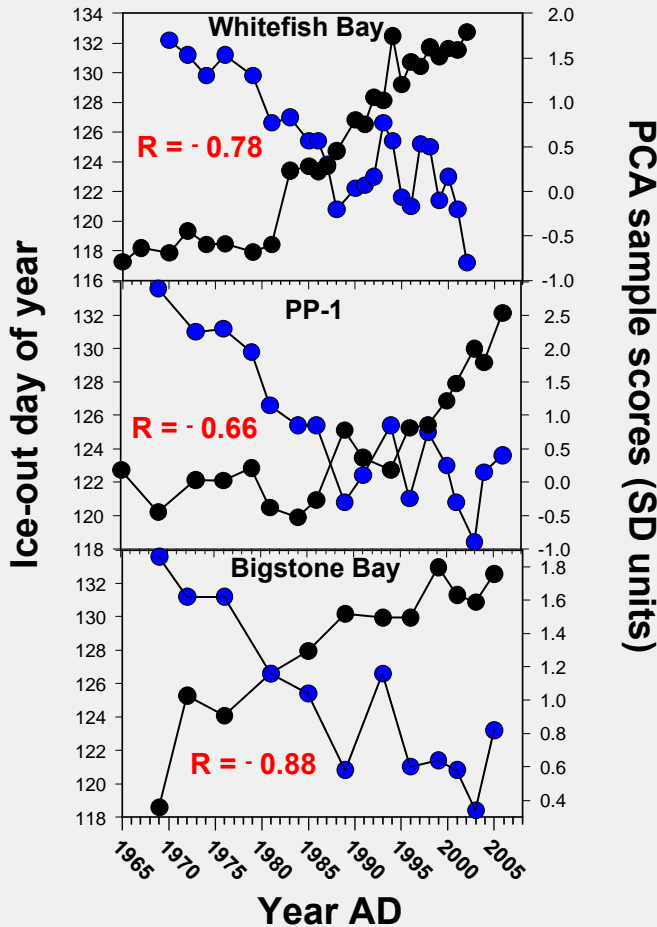
- Ice-out day of year
- PCA sample scores



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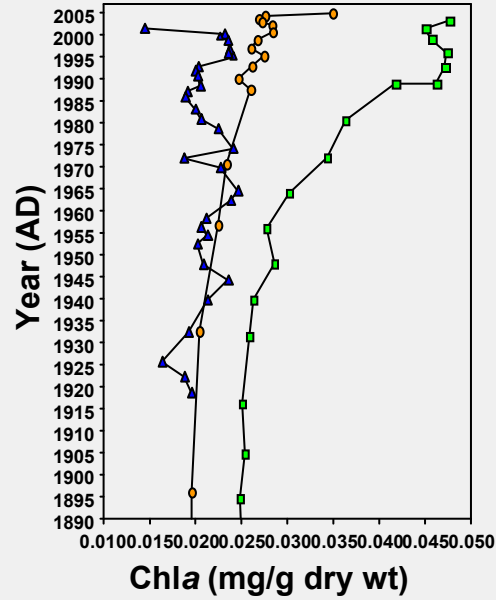


Planktonic *Cyclotella* species



Spectrally-inferred Chl *a* trends: all sites

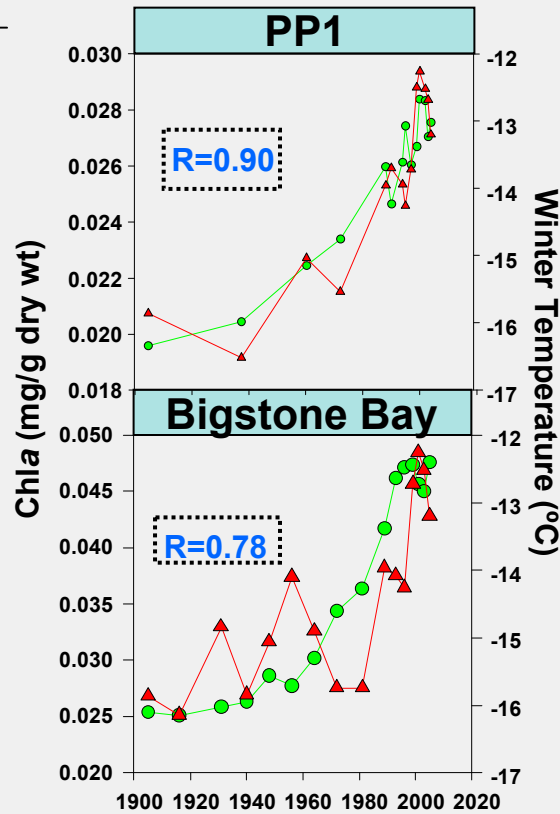
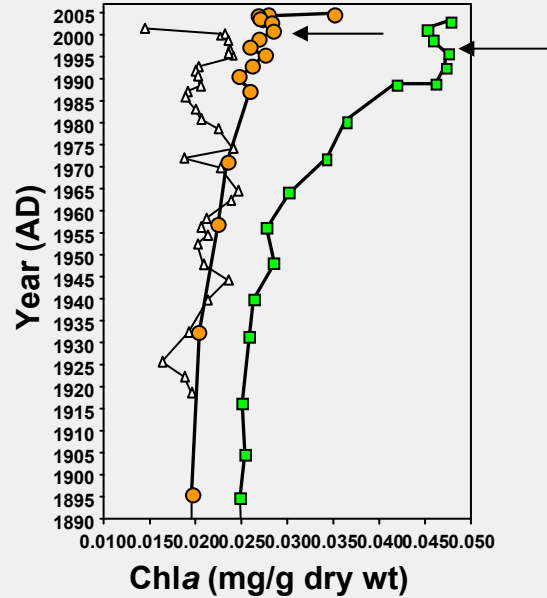
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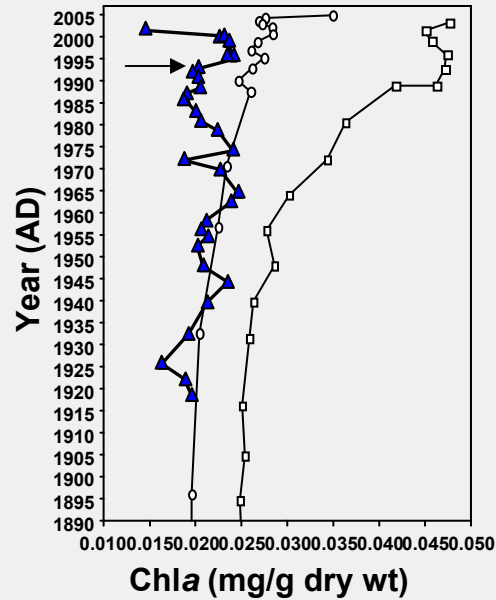
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Winter Temperature trends

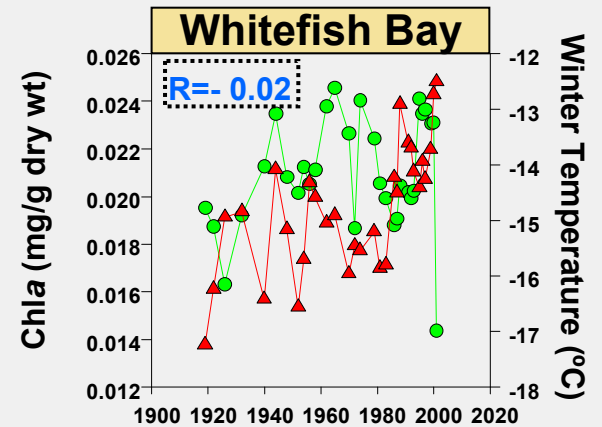
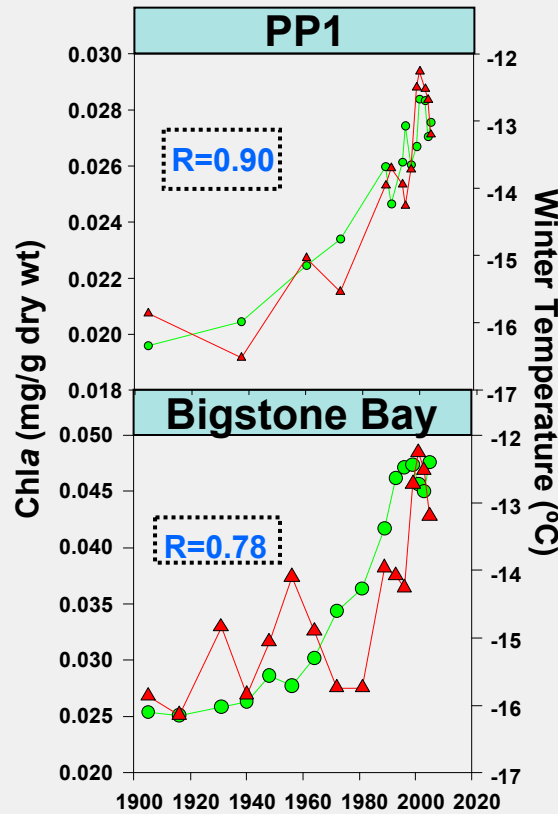


Spectrally-inferred Chla trends: all sites

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Winter Temperature trends



Summary & Conclusions

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 - likely tracking algal blooms
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- **Recent diatom shifts in LOW best explained by recent warming & associated limnological changes**

Refereed papers: LOW paleo studies (so far)

- 1) Pla, S., Paterson, A., Smol J. (2005). Spatial variability in water quality and surface sediment diatom assemblages in a complex lake basin: Lake of the Woods, Ontario, Canada. *J. Great Lakes Res.* **31**: 253-266.
- 2) Yang, Z., Teller, J. (2005). Modeling the history of Lake of the Woods since 11,000 cal yr B.P. using GIS. *J. Paleolimnol.* **33**: 483-498.
- 3) Reavie E., N. Baratono (2007). Multi-core investigation of a lotic bay of Lake of the Woods (Minnesota, USA) impacted by cultural development. *J. Paleolimnol.* **38**: 137-156.
- 4) Suchy, K., Hann, B. (2007). Using microfossil remains in lake sediments to examine the invasion of *Eubosmina coregoni* (Cladocera, Bosminidae) in Lake of the Woods, Ontario, Canada. *J. Great Lakes Res.* **33**: 867-874.

*****COMING SOON*****

- 1) Serieyssol C., Edlund, M., Kallemeyn L. (submitted). Impacts of settlement, damming, and hydromanagement in a large, boreal lake: a paleolimnological Before-After, Control-Impact study.
- 2) Rühland, K., Paterson, A., Smol, J. (submitted). Hemispheric-scale patterns of climate-related increases in planktonic diatoms from North American and European lakes.
- 3) Rühland, K., Paterson, A., Hargan, K., Michelutti, N., Clark, B., Smol, J. (submitted). Evidence for linkages between recent warming and diatom community reorganization in the Lake of the Woods, Ontario, Canada.