Paleolimnological evidence from diatoms for recent environmental and climatic changes in the Lake of the Woods

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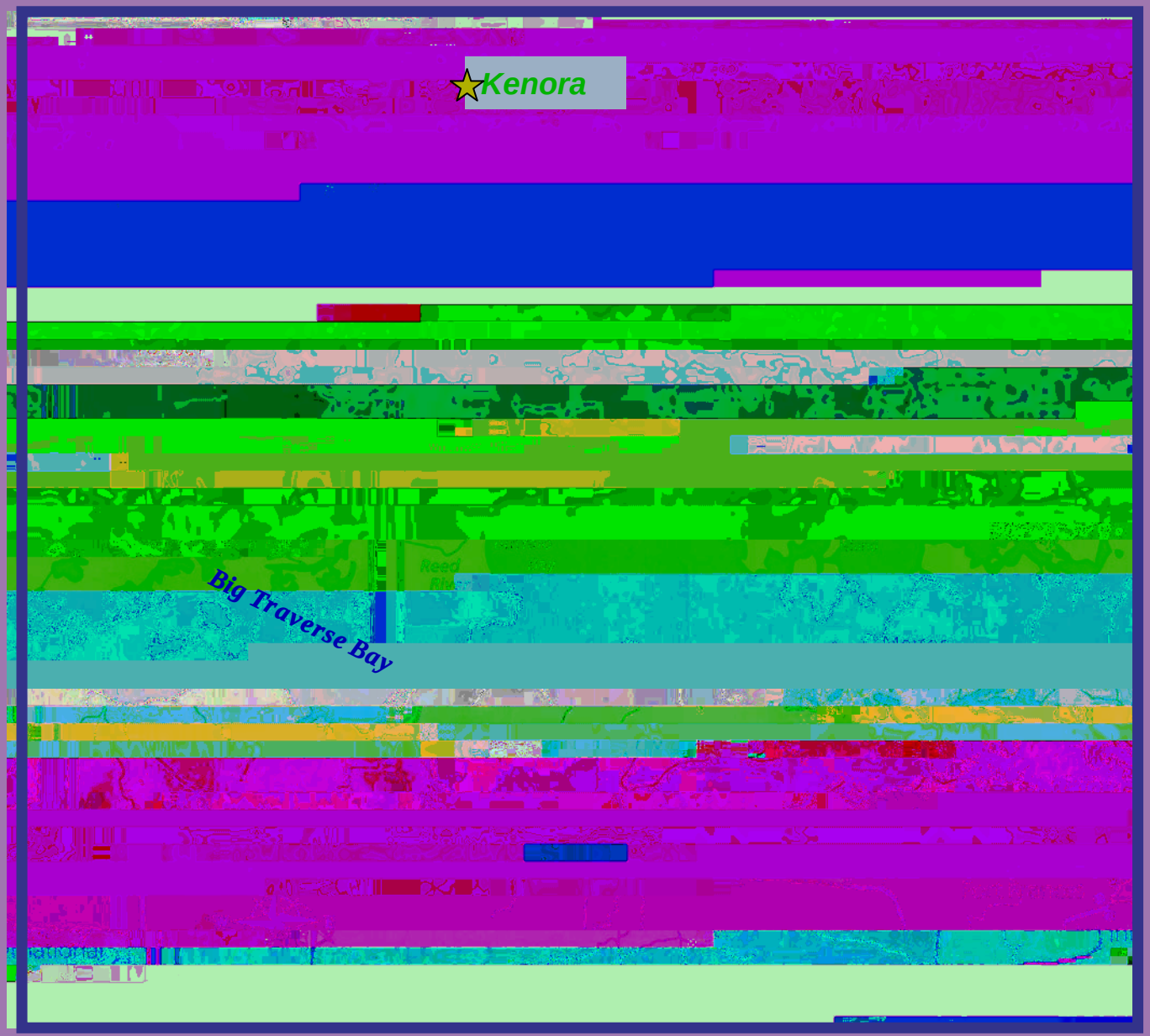
SIL 2007



Modified from Robertson & McCracken 2003

Development of an Algal Bloom - 2003

(Terra MODIS images –
G. McCullough, U. of Winnipeg)

“The islands were numerous and crowded, the water shoal and foul, frequently with a green scum of vegetable matter”

- Major Joseph Delafield, July 30th, 1823

“…the water became tinged with green, derived from a minute vegetable growth”

- S. J. Dawson, Summer 1857

“…deposits of green vegetable matter” in the lake’s bays during the summer.

- objection to a proposal to use LOW to supply clean water to Winnipeg 1883

Some Important Lake Management Questions:

1) What is the ‘natural’ or baseline condition of the lake?

2) Has the water quality changed since pre-development (or pre-industrial) times?

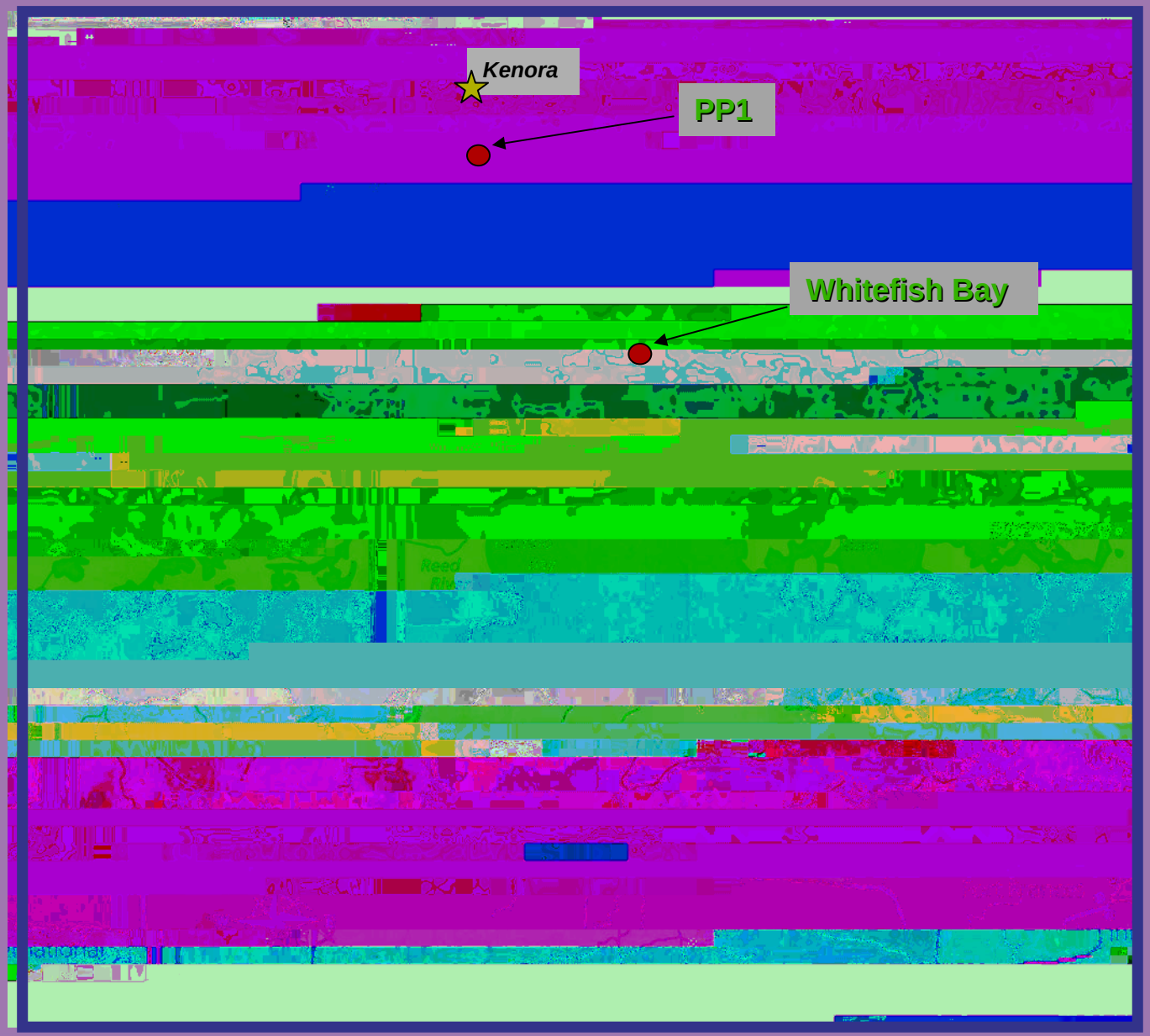
3) If so, when did these changes occur?

4) What is the direction and magnitude of this change?

5) What are the possible reasons for this change?

The Paleolimnological

Location of sampling sites for sediment cores

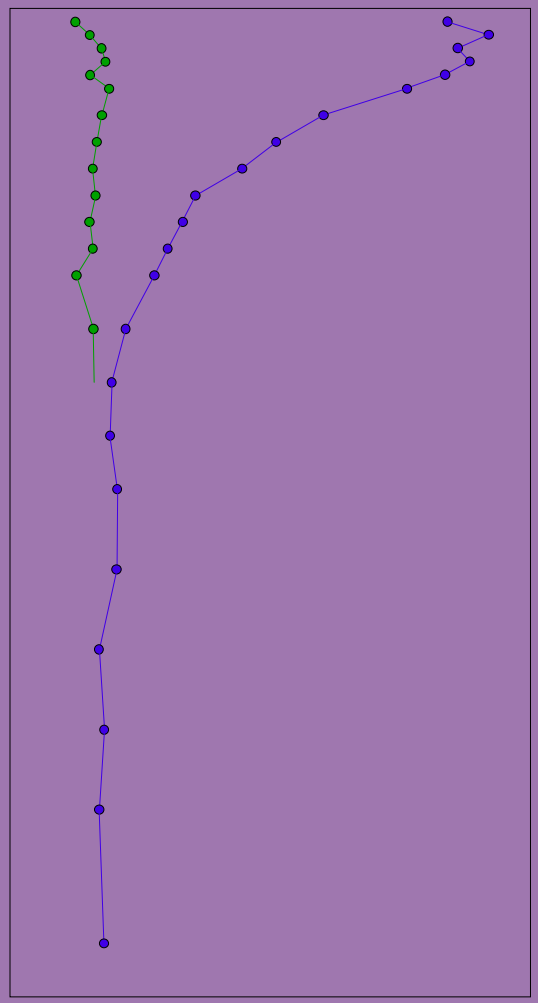


Modified from Robertson & McCracken 2003

The Paleolimnological Method

Core retrieval

- gravity cores retrieved from deep, quiet locations
- undisturbed 999 169uedd4t09eT0018 r 0005 TclC ons



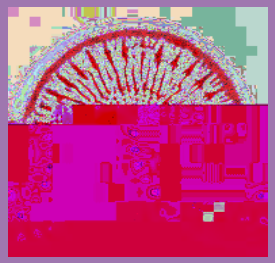
Dating the sedimentary sequences

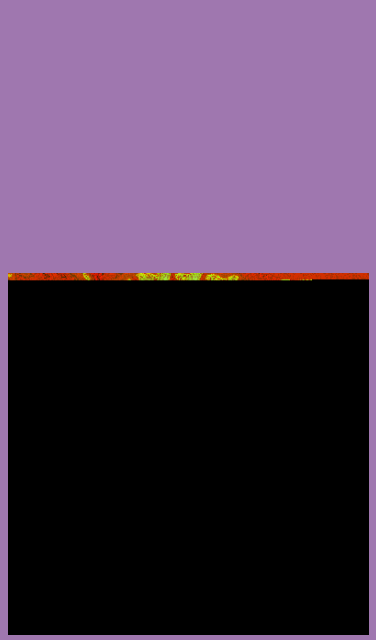
- ^{210}Pb (radioisotope)

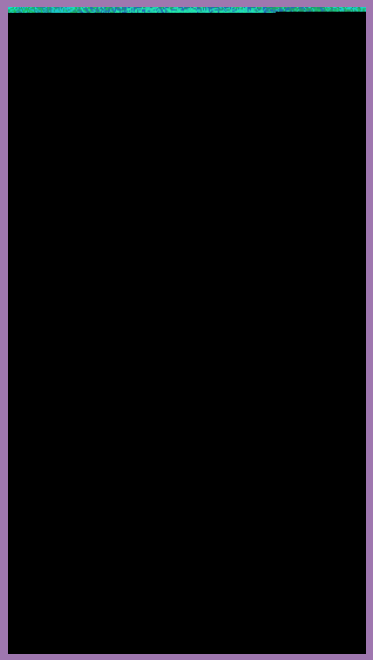
The Paleolimnological Method

Diatoms as Indicators of Environmental Change

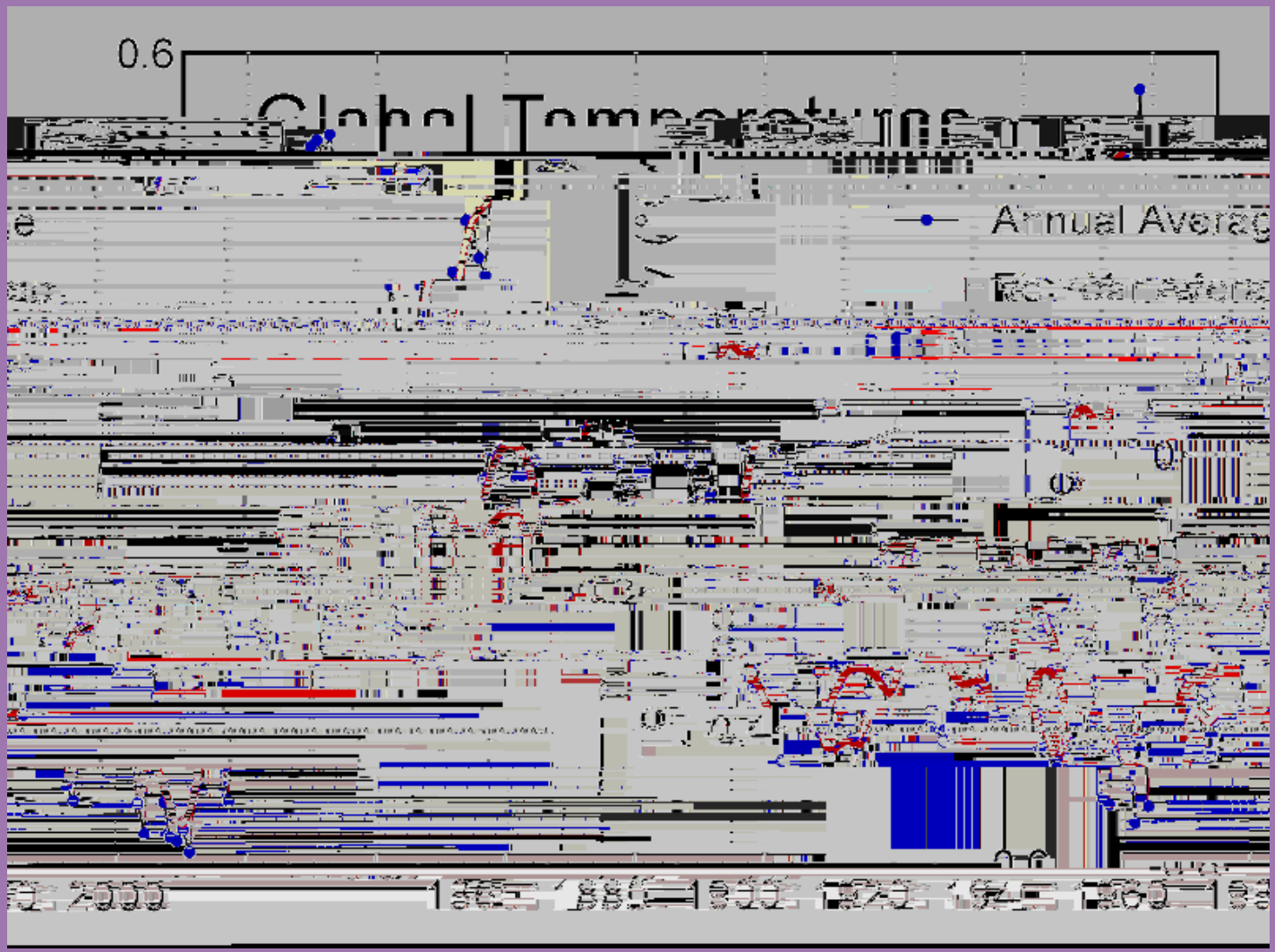
- well preserved in lake sediments
- remain stable in sedimentary sequences
- taxonomically specific ornamentation
- many have narrow optima and tolerances
- respond rapidly to environmental change



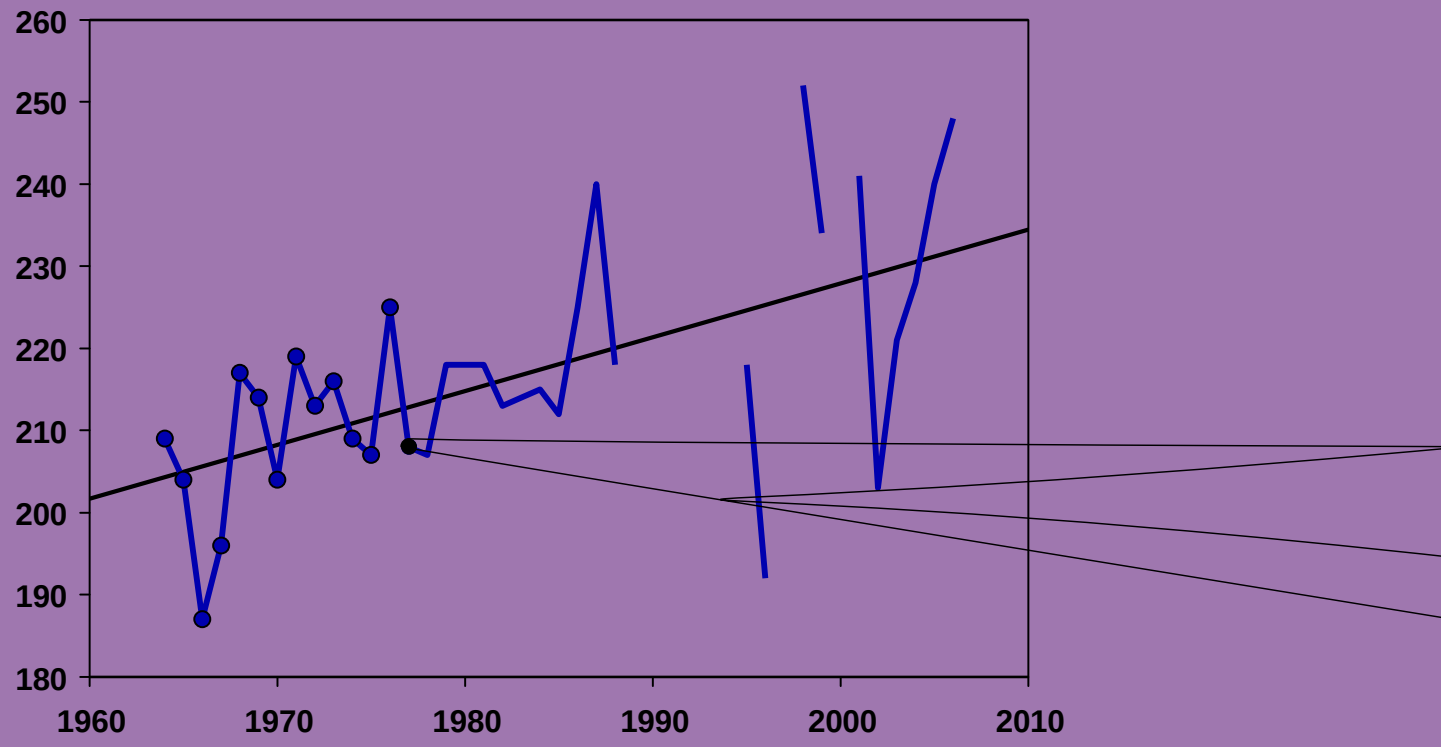




The Instrumental Record



Historical Ice Cover Records



Whitefish Bay Diatom Profile

Reference site

Whitefish Bay Diatom Profile

Whitefish Bay Diatom Profile

Reference site

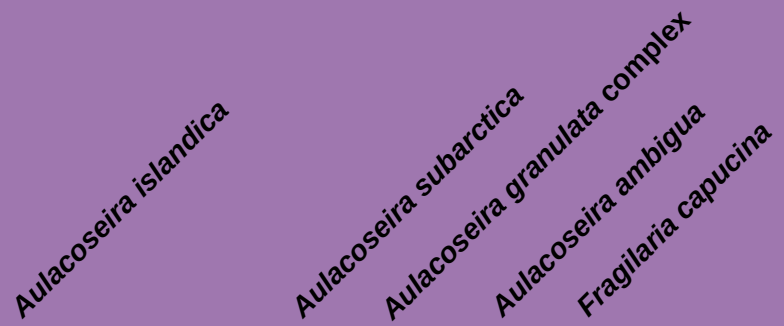
PP1 Diatom Profile

Impact site

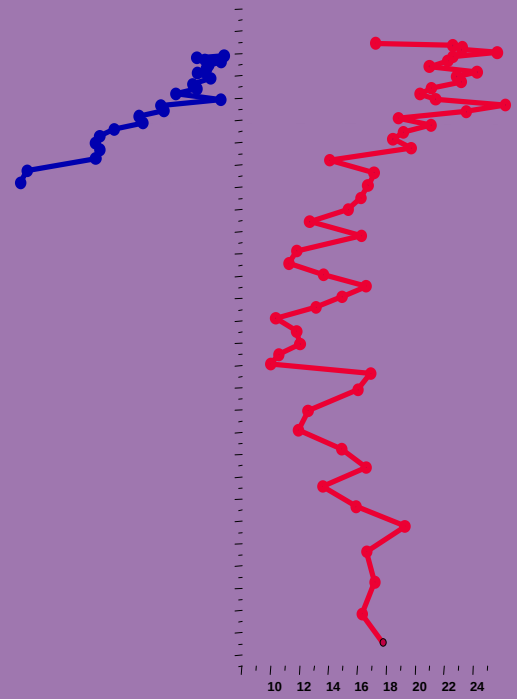
PP1 Diatom Profile

ca. 1905 Rise in water level

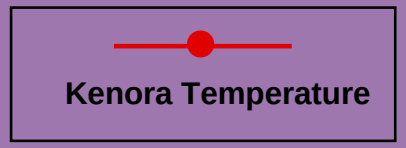
Impact site

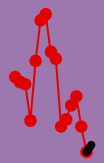


Summary of Diatom Trends



Diatom – Temperature Relationships





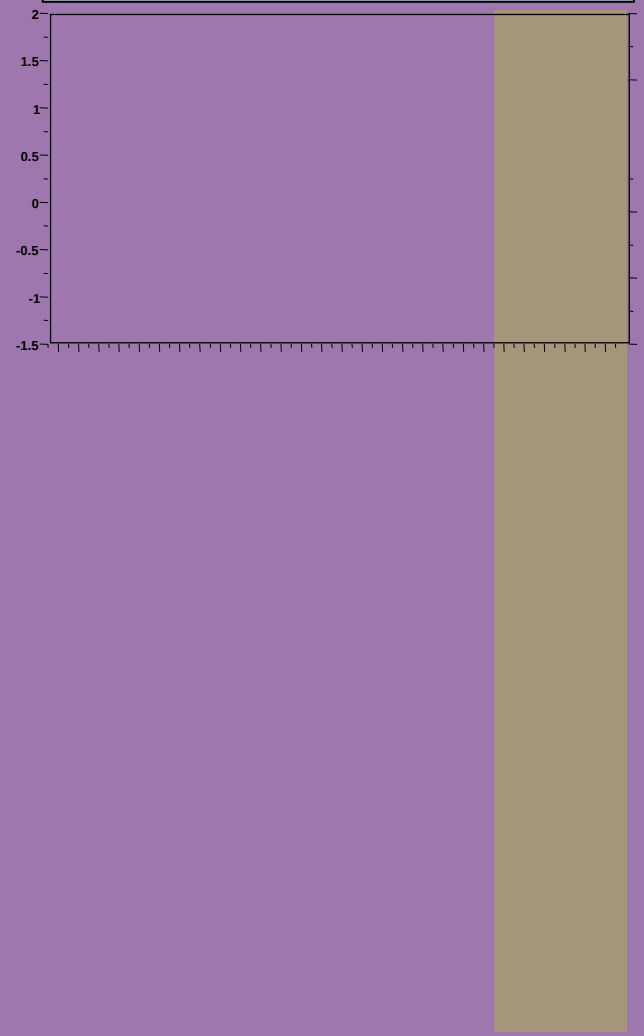
Diatom – Temperature Relationships

PP1

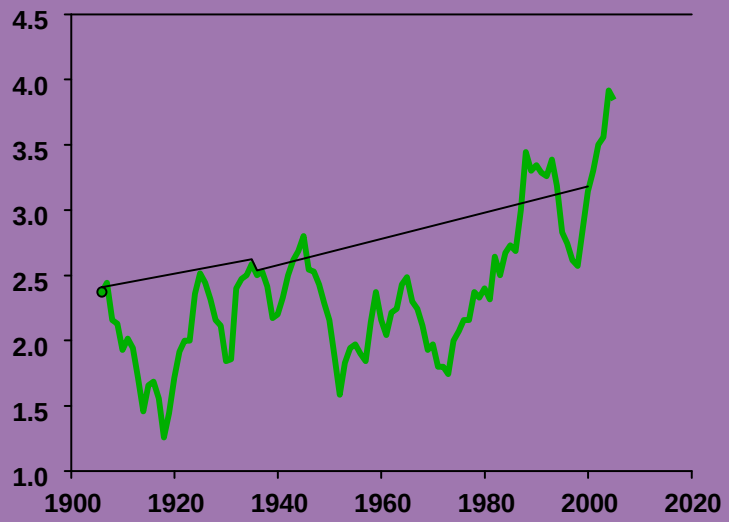
Kenora Temperature

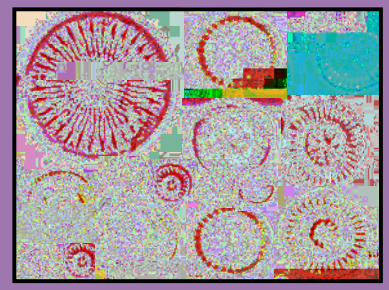
Mean Winter Temperature (°C)

Whitefish Bay



Whitefish Bay: Taxon-Specific Relationships





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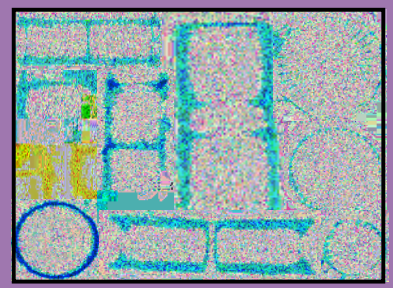
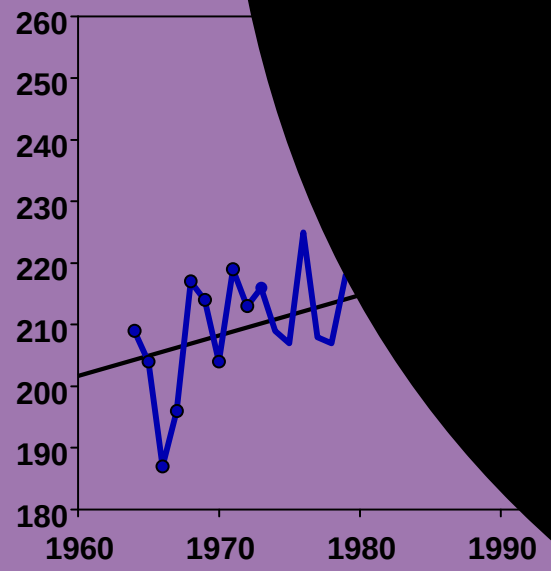



260
250
240
230
220
210
200
190
180
1960
1970
1980
1990

Length of ice cover

Growing Season

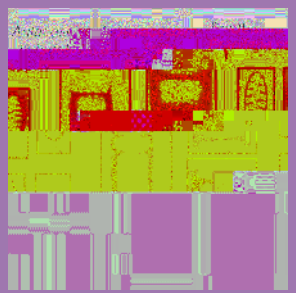
Thermal Stratification – onset, duration & strength

***Cyclotella* species**

Diatom-Inferred TP

Allochthonous sources of TP

Climatic Warming and increases in *Cyclotella* species



Climatic Warming and increases in *Cyclotella* species

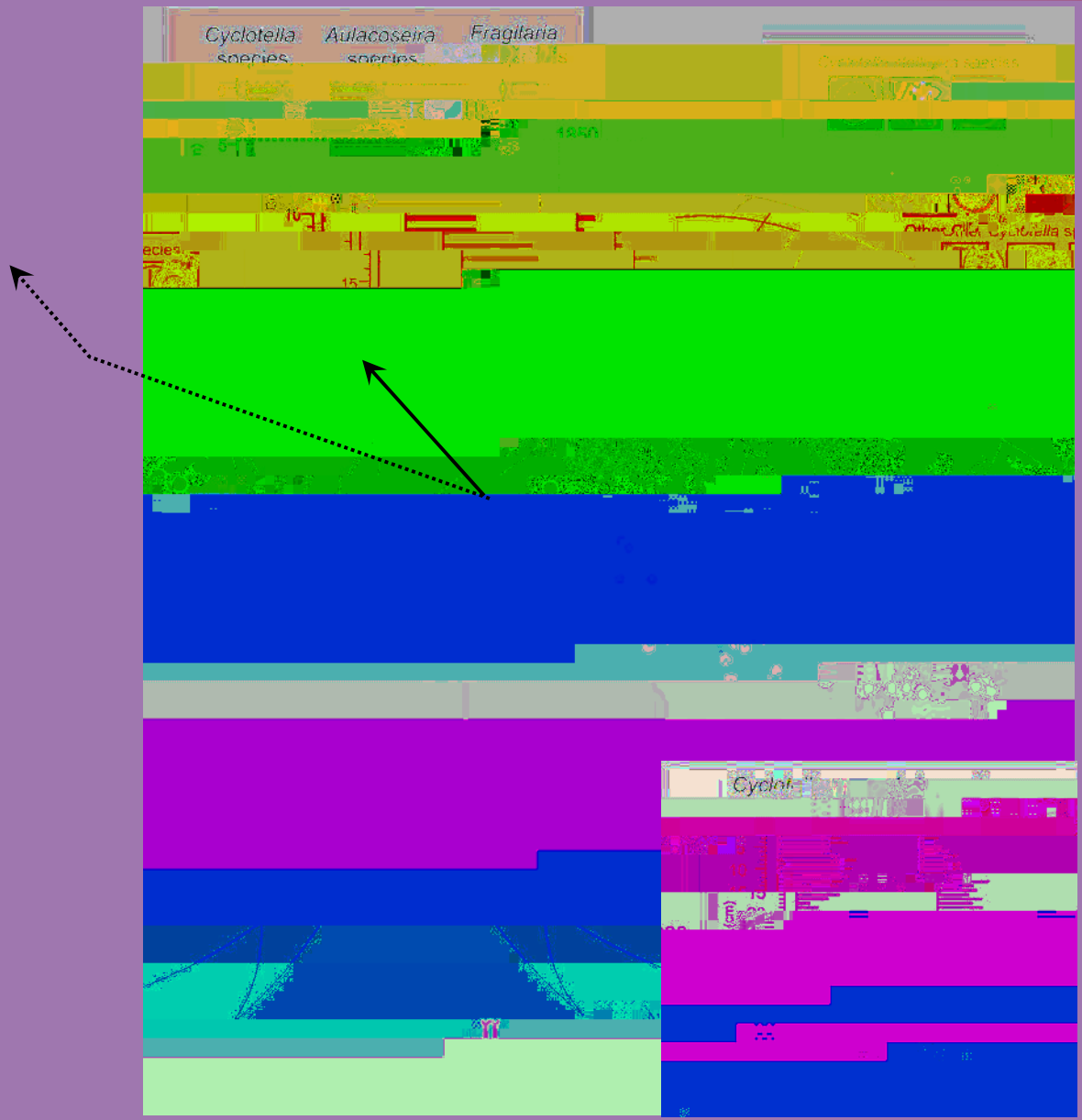
Subarctic Finland
Sorvari et al. 2002

Sweden
Bigler & Hall 2003

High Arctic Canada
Perren et al. 2003

Climatic Warming and increases in *Cyclotella* species

Climatic Warming and increases in *Cyclotella* species



Summary of Results

Concluding Remarks

- Phosphorus has long been an important component of the LOW
- Climatically-induced limnological changes = primary mechanism
- Climate must be considered an important part of the equation
- LOW fits into global pattern of recent taxon-specific diatom shifts

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