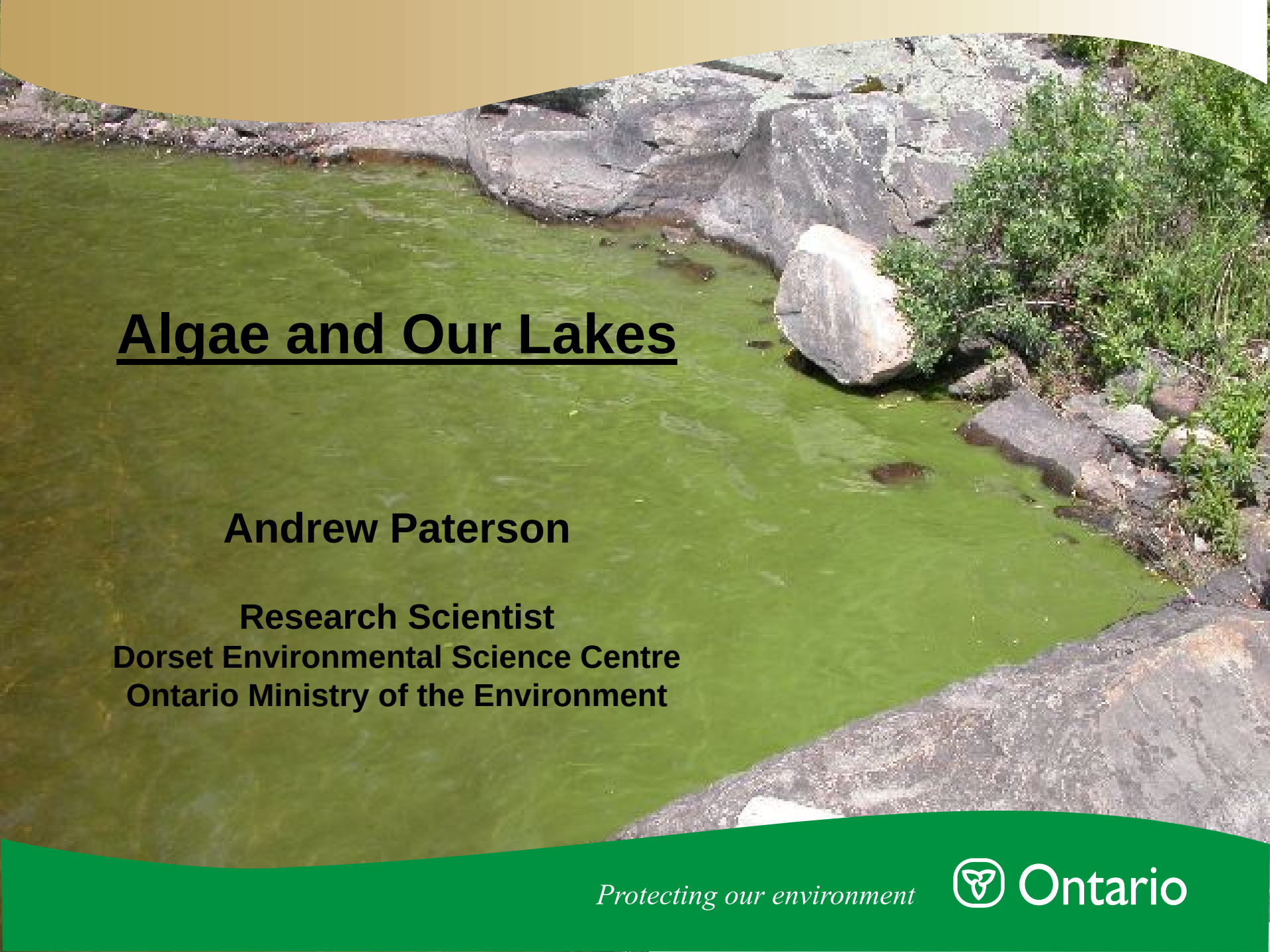


Algae and Our Lakes

Andrew Paterson

Research Scientist
Dorset Environmental Science Centre
Ontario Ministry of the Environment

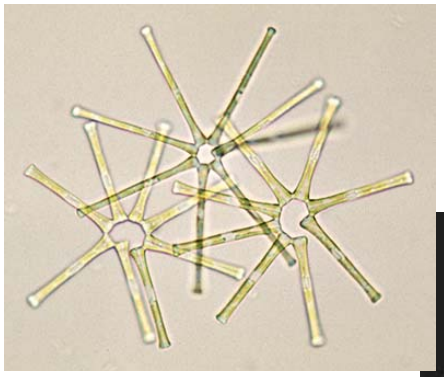
Protecting our environment

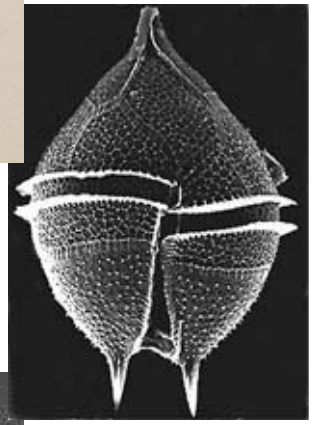
Ontario

Confusing terms…

Phytoplankton ?

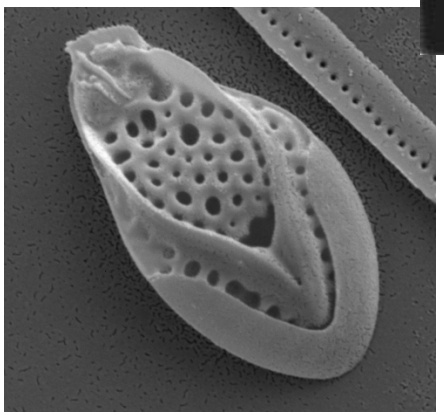
Algae ?





Periphyton ?

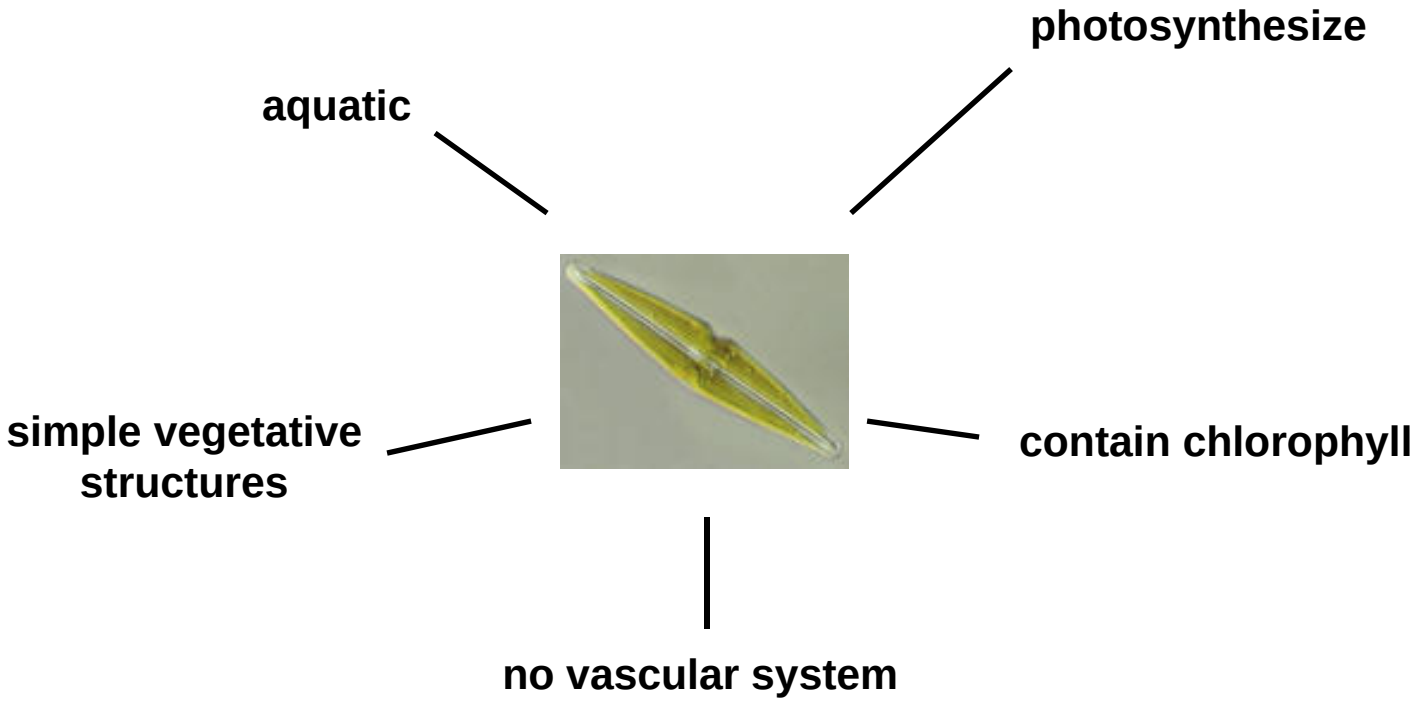
Chlorophyll *a* ?



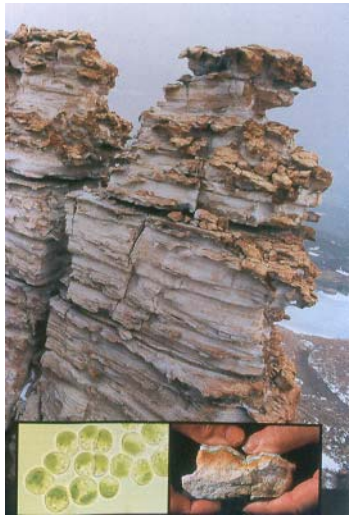
Blue-greens ?

Algae are extremely diverse

- algae don't belong to a single taxonomic group
- many algae aren't "plants"
- algae are considered to be a loose collection of organisms that share the following characteristics:



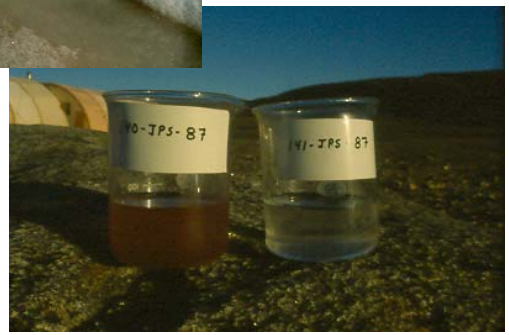
Algae exist anywhere there is moisture



Nat. Geog. Oct. 1998

Cryptoendolithic algae

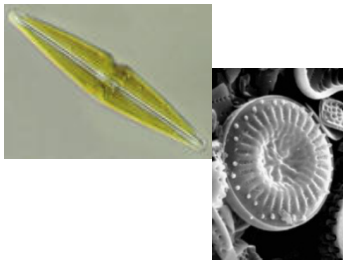
“Snow” algae



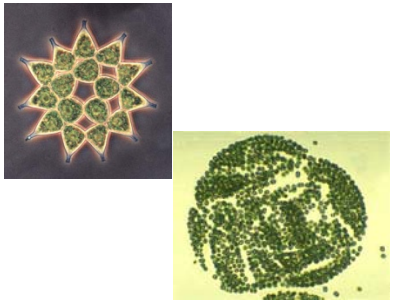
Courtesy J.P.Smol

Sheba the polar bear in Singapore

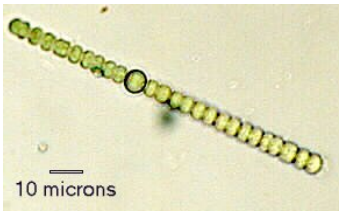
Algae come in many forms and sizes



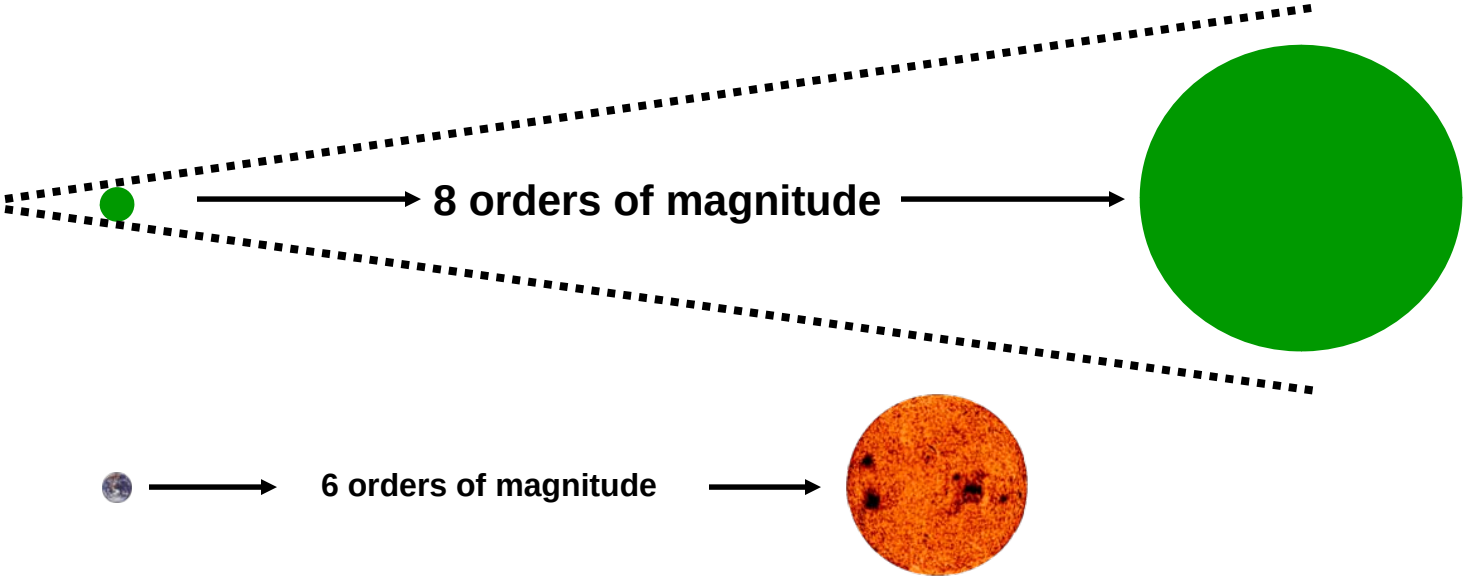
Single cells



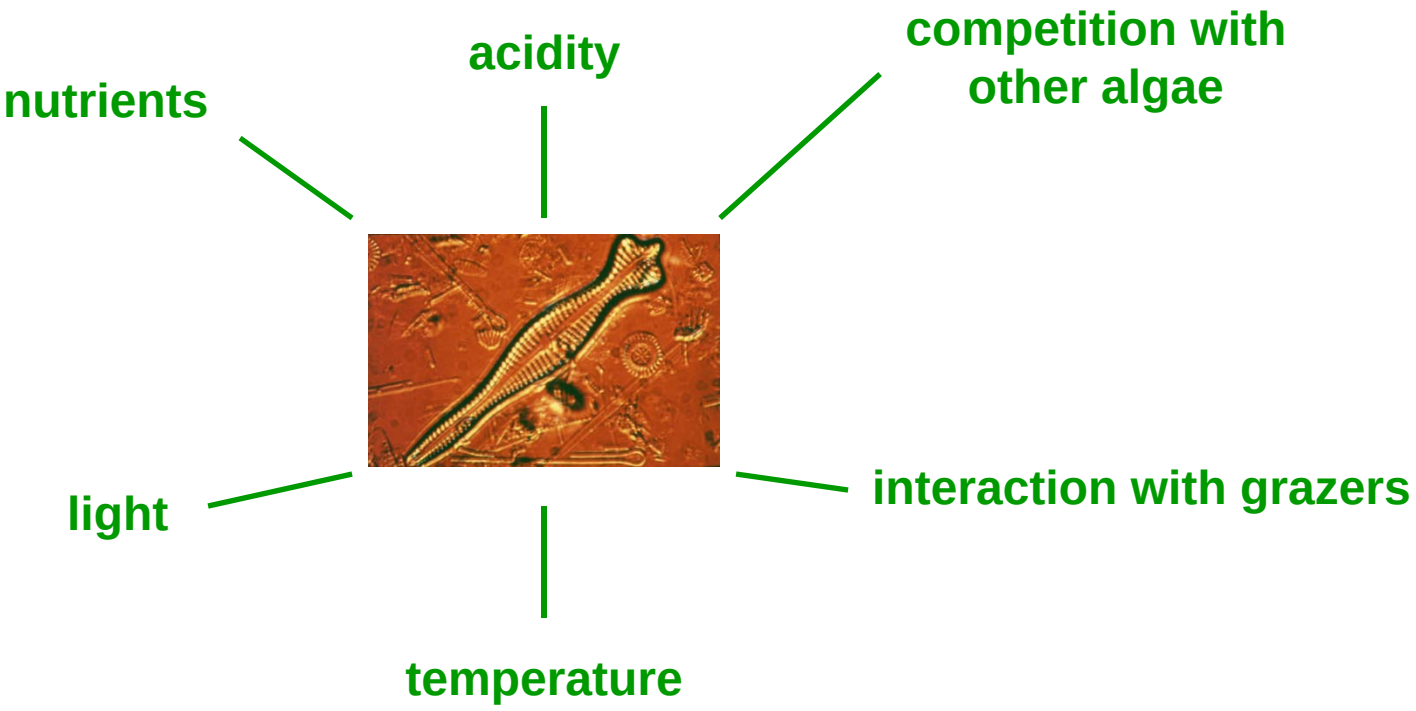
Colonies



Filaments



The composition of algae is controlled by many factors



- each species differs in its tolerance to these factor
- growth of a species is best at “optimal” conditions
- in reality, optimal conditions are rarely achieved

“…the water foul, frequently with a green scum of vegetable matter…”

- Major Joseph Delafield, LOW, 1823

(Photos: Bev Clark)

Algal blooms:

1) Reduced water clarity

2) Loss of deep-water oxygen

3) Toxins

4) Taste and odour

But conditions have to be right for a bloom

1) Nutrients (phosphorus)

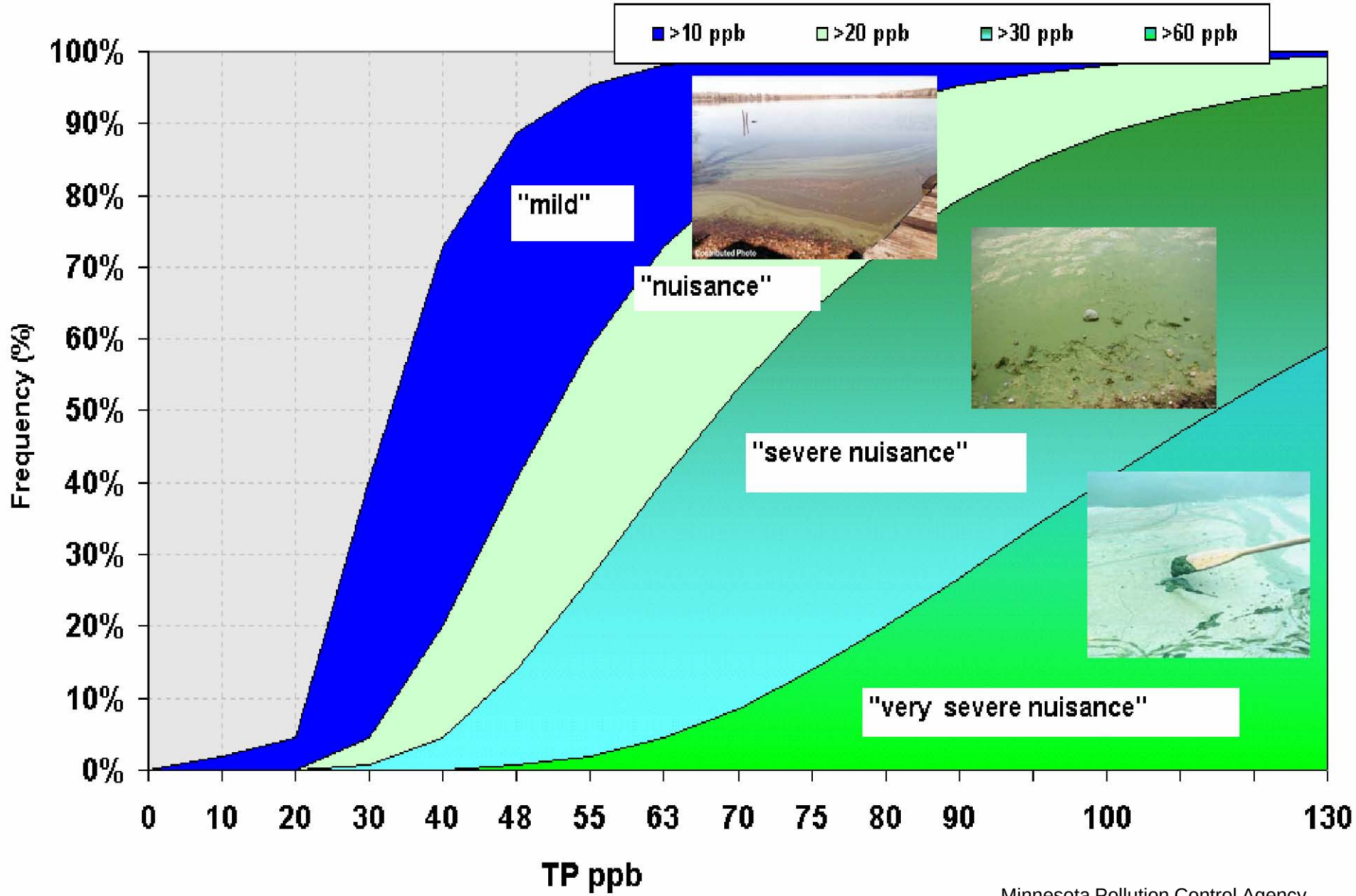
2) Water column with low turbulence

Experimental Lakes Area, NW Ontario

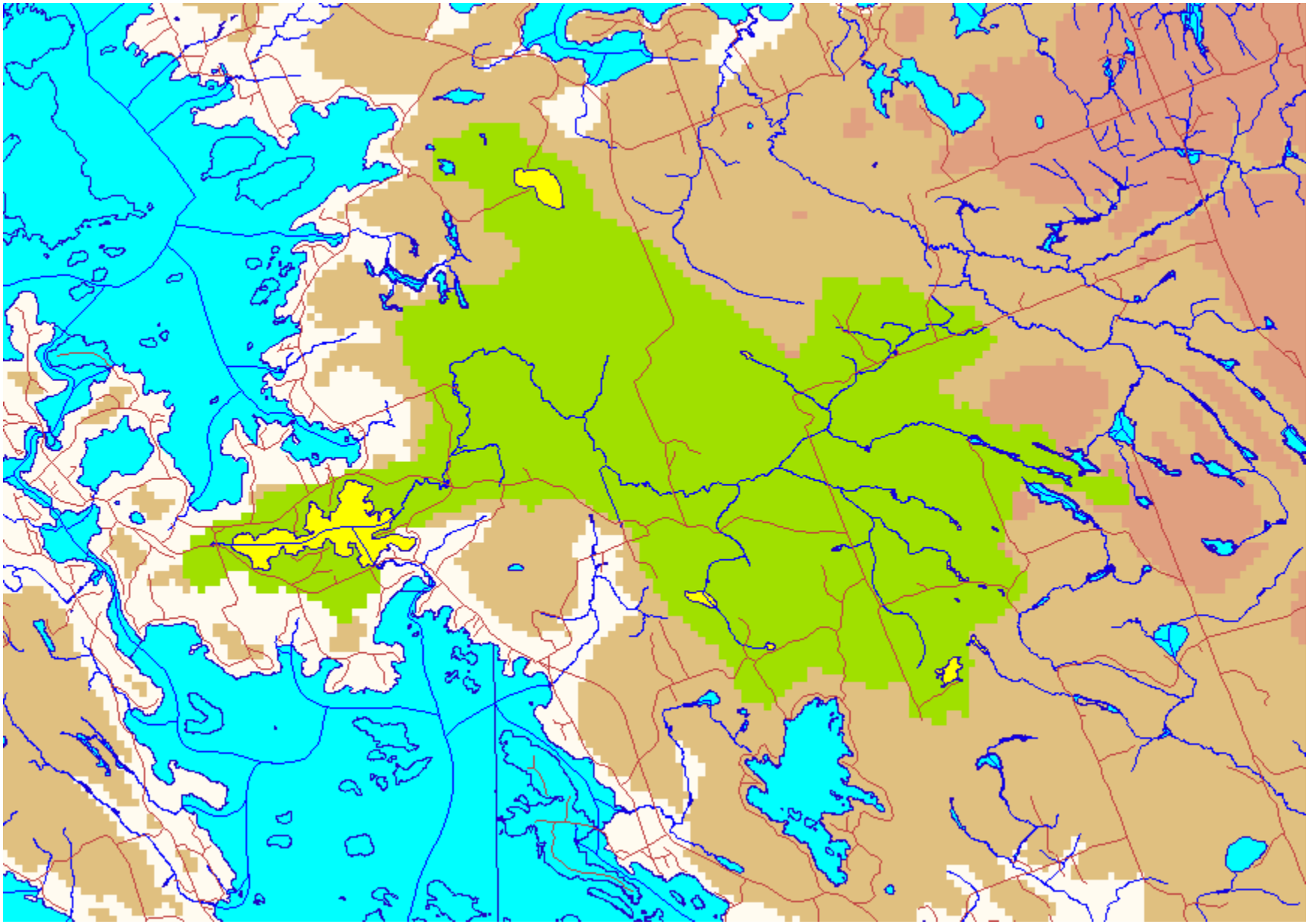
3) Warm temperatures/ high sunlight

4) Biological factors

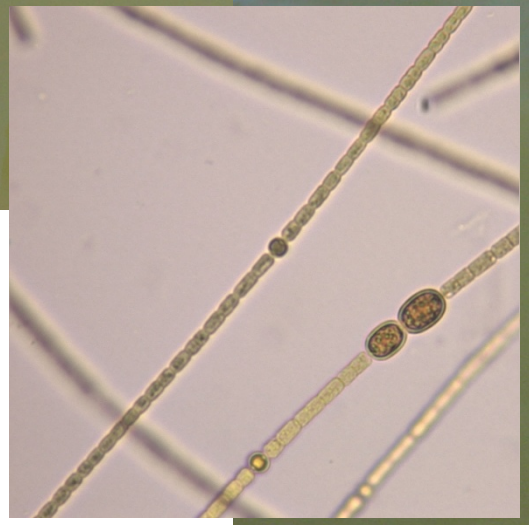
Chlorophyll-a interval frequency versus total phosphorus.



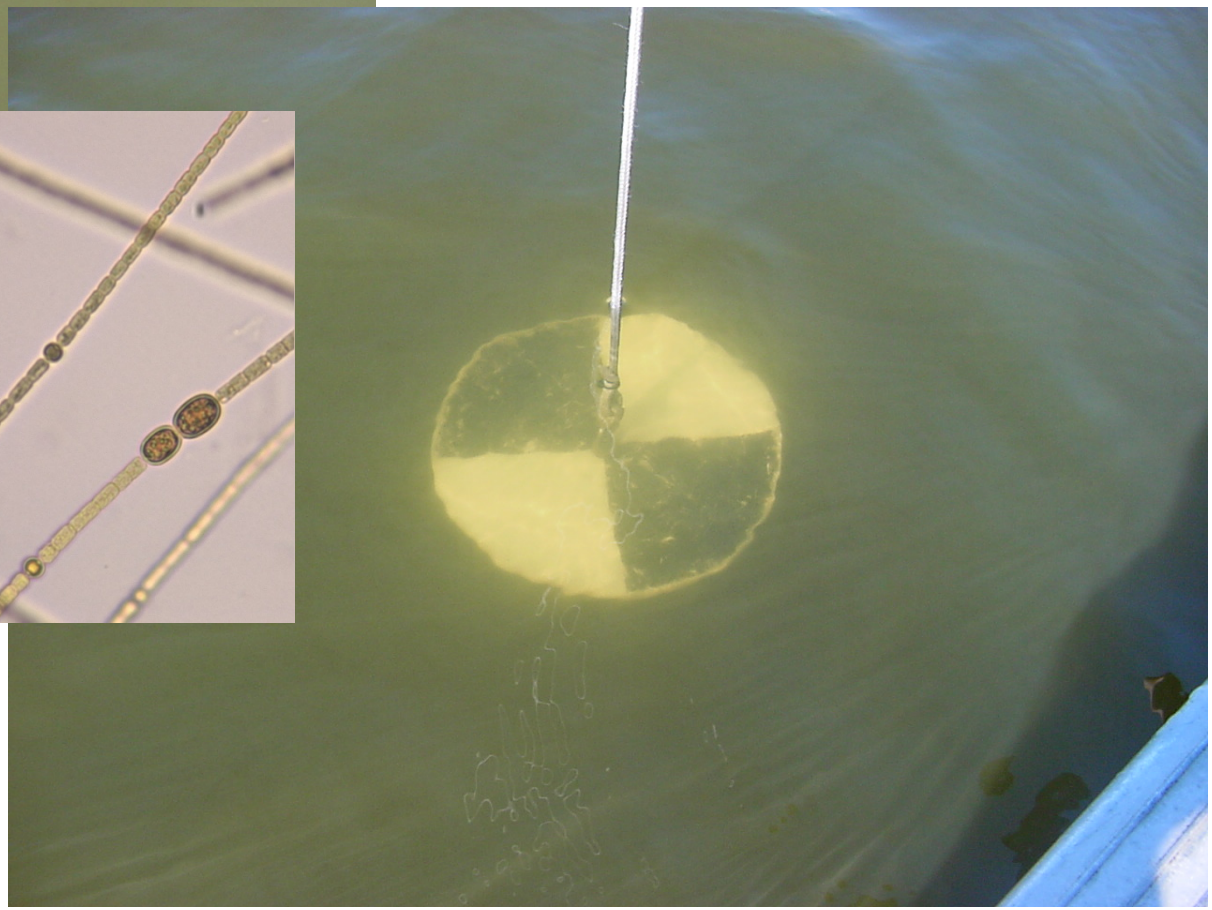
Minnesota Pollution Control Agency



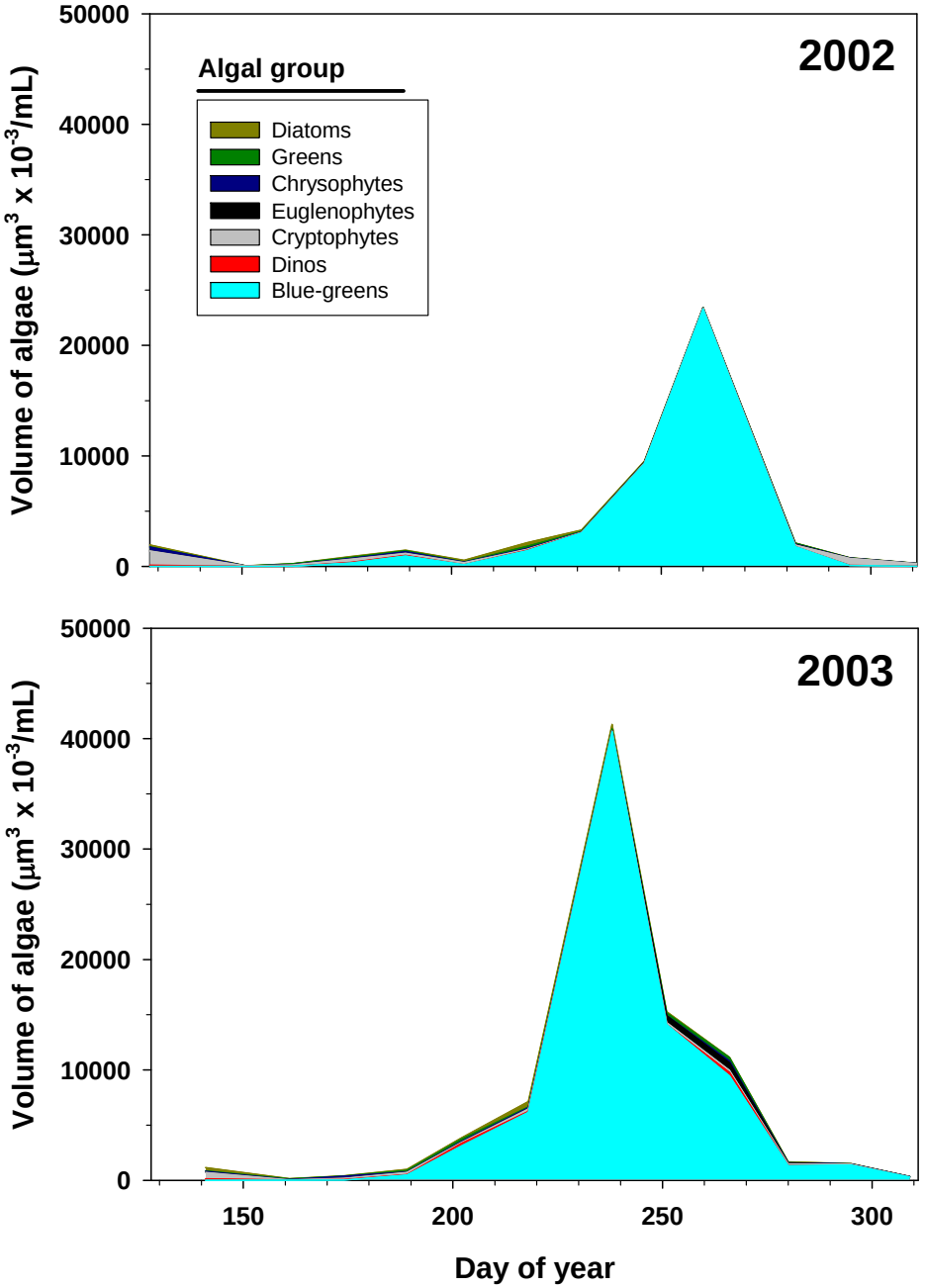
Ron Ingram

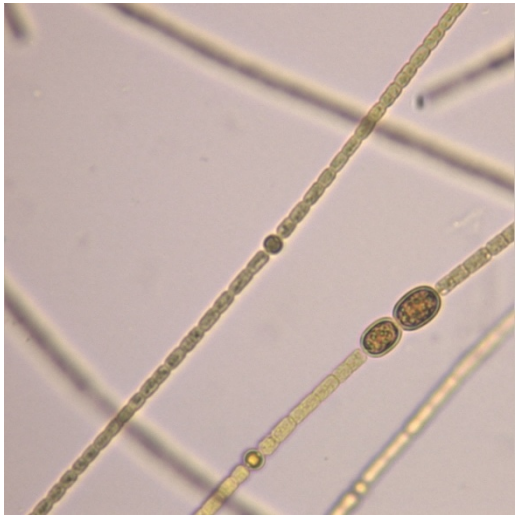


L. Heintsch

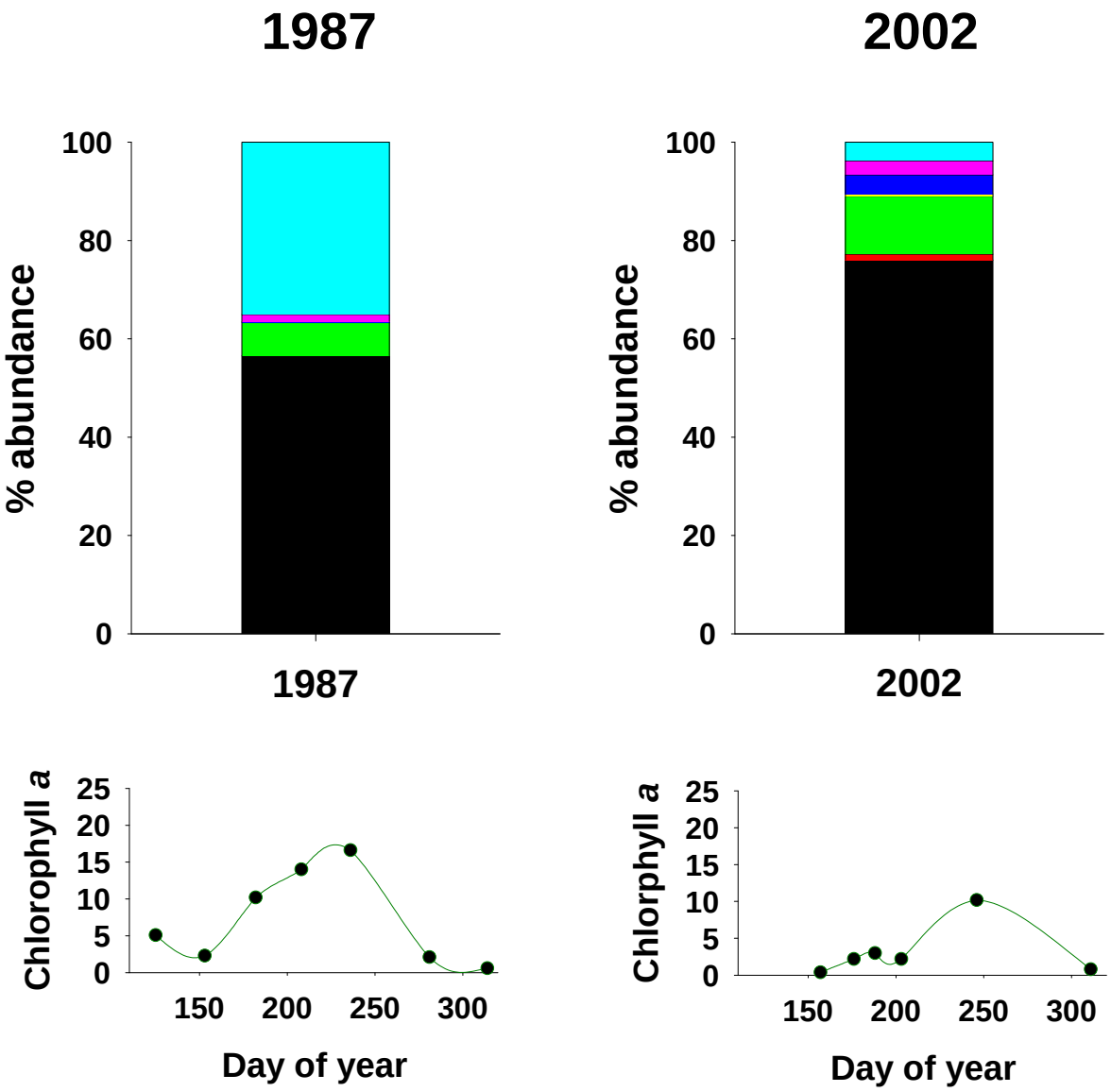


Ron Ingram

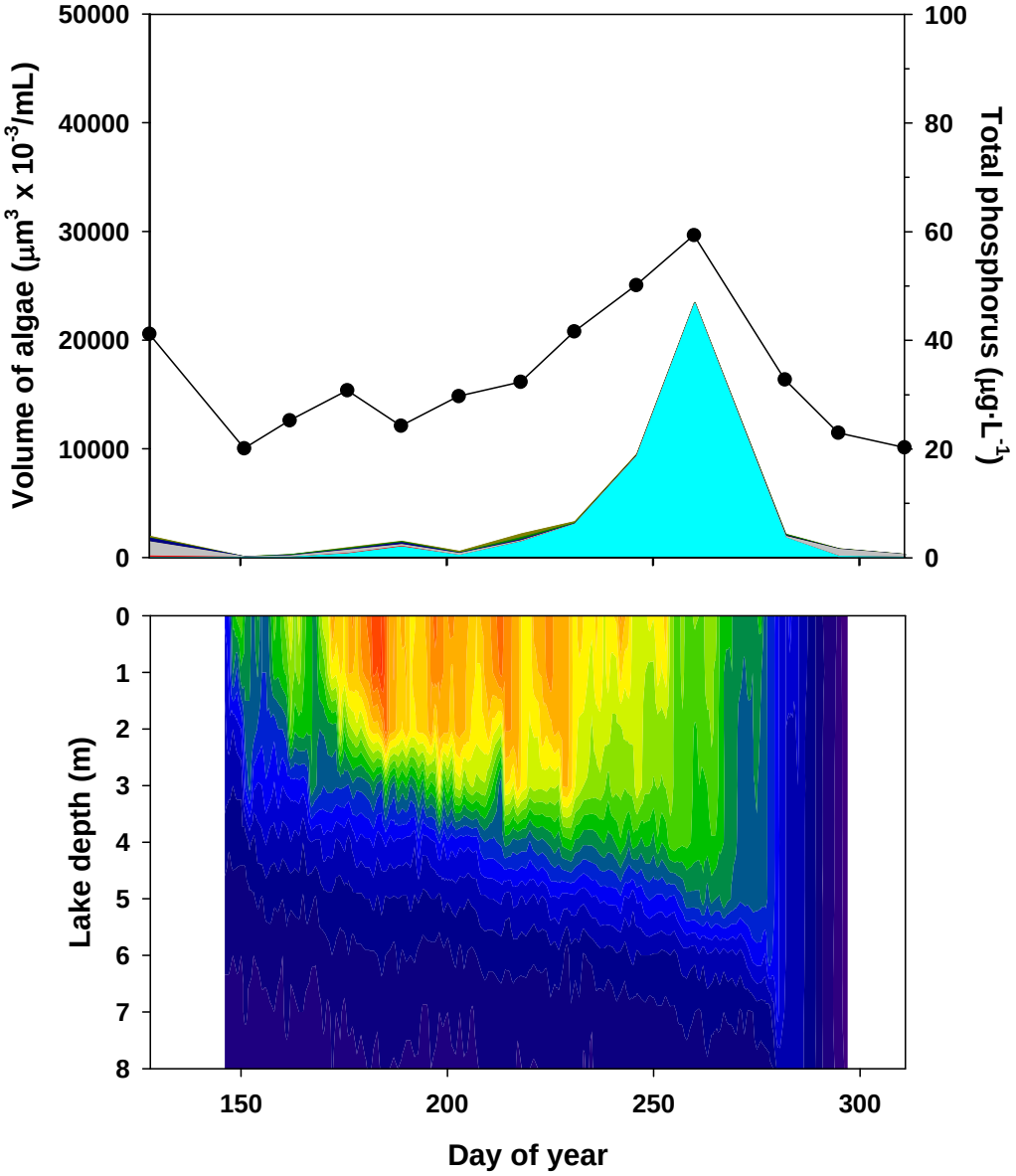




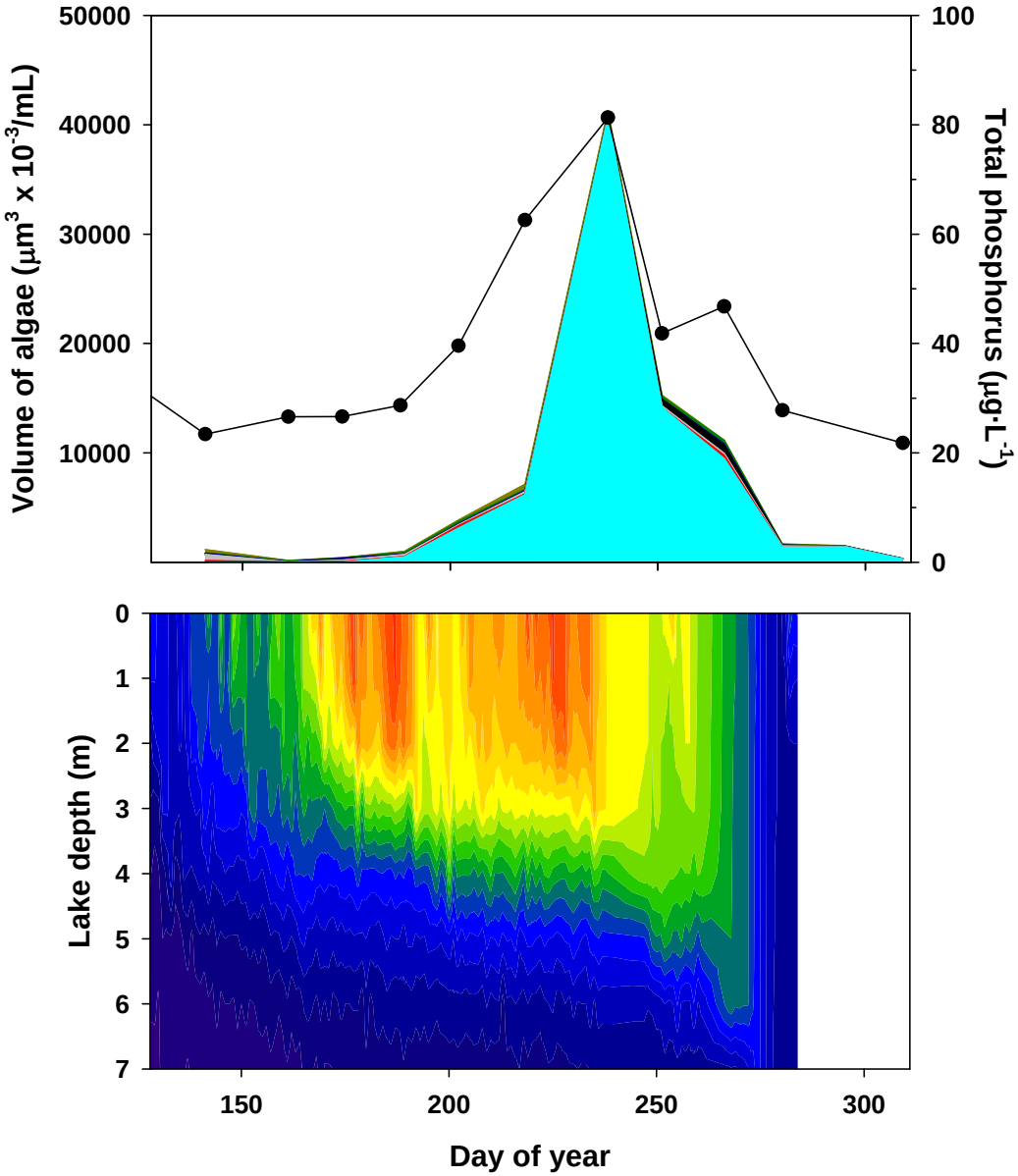
Aphanizomenon schindleri


1987
2002
100
80
60
40
20
0
% abundance
1987
2002
Chlorophyll a
25
20
15
10
5
0
150
200
250
300
Day of year

Phosphorus and Algae - 2002

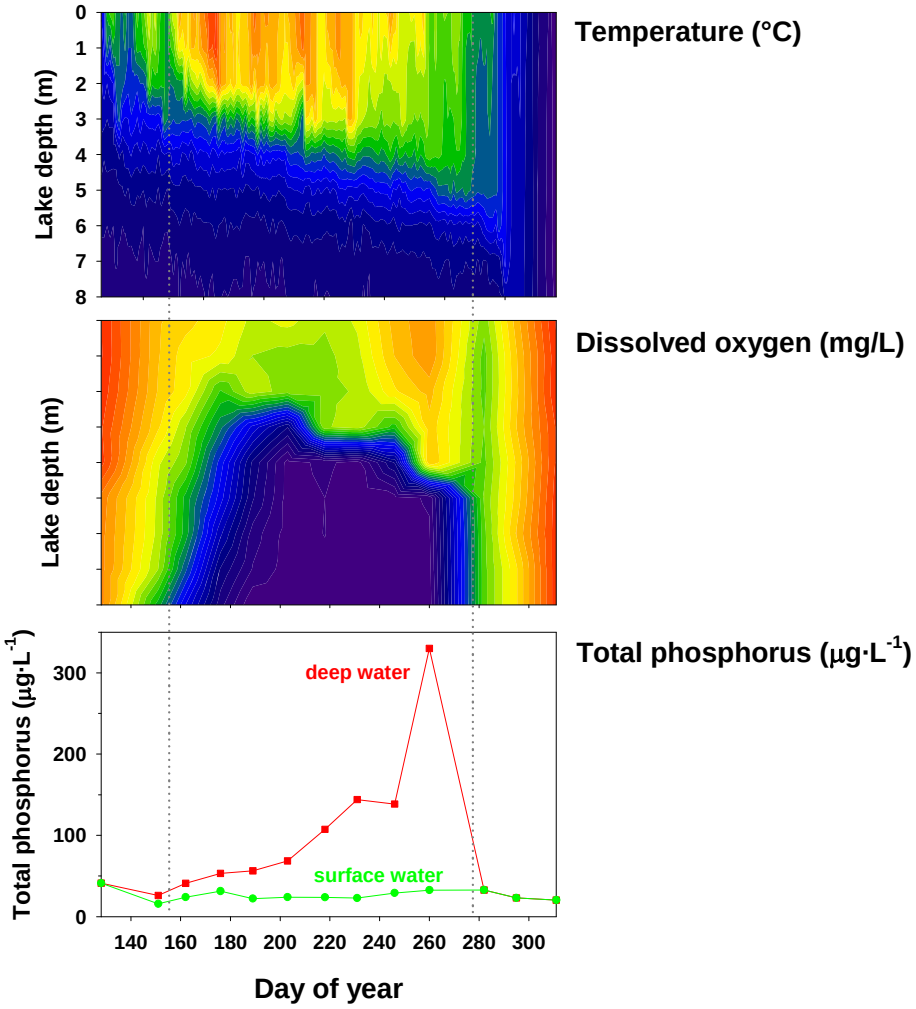


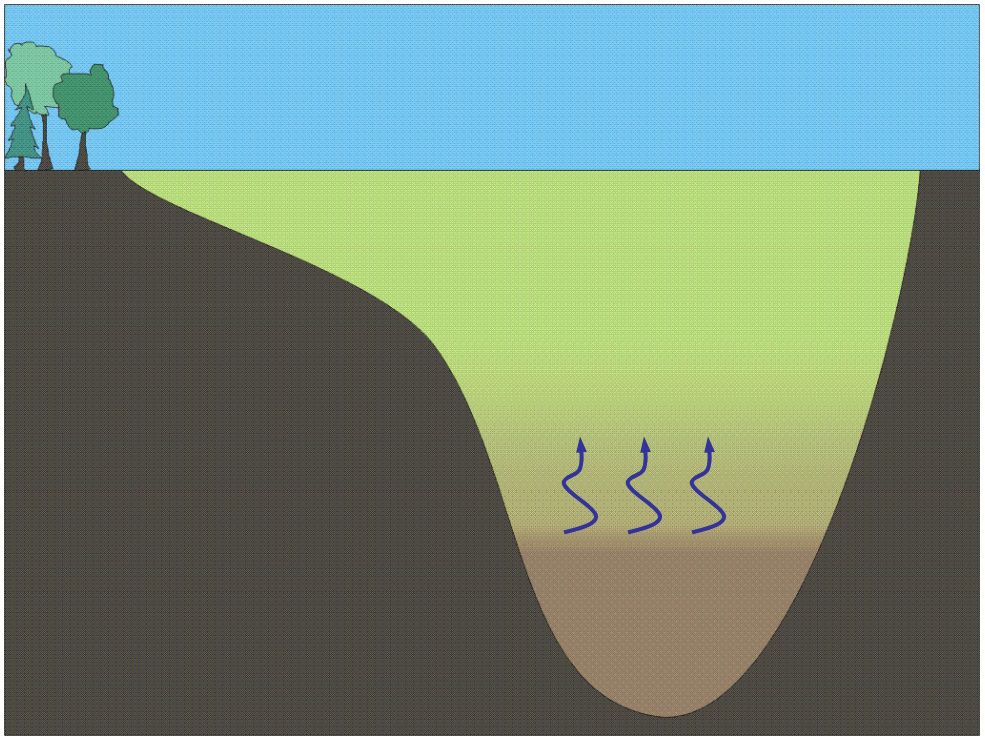
Phosphorus and Algae - 2003

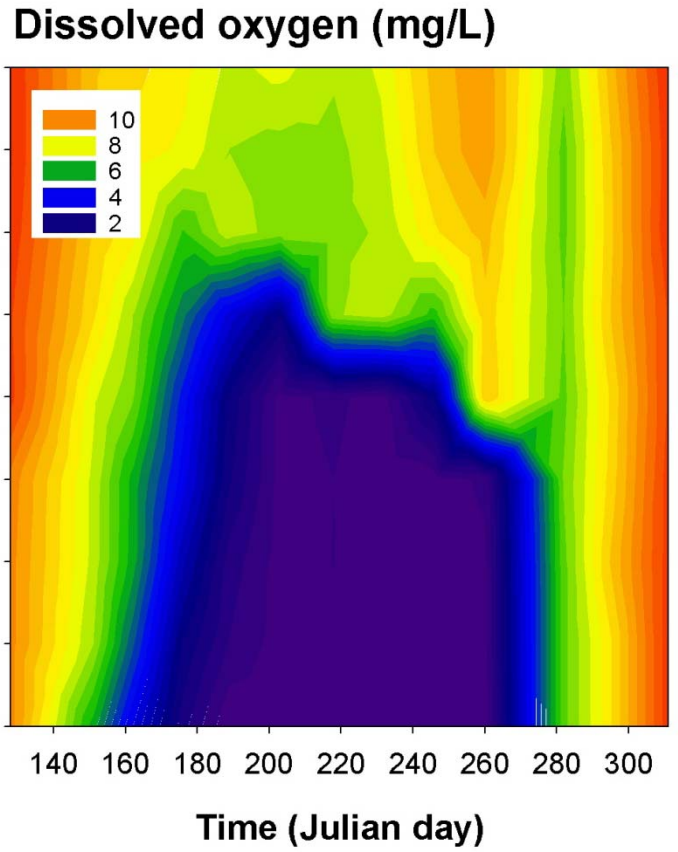


Phosphorus from sediments

The development of anoxia in deep waters

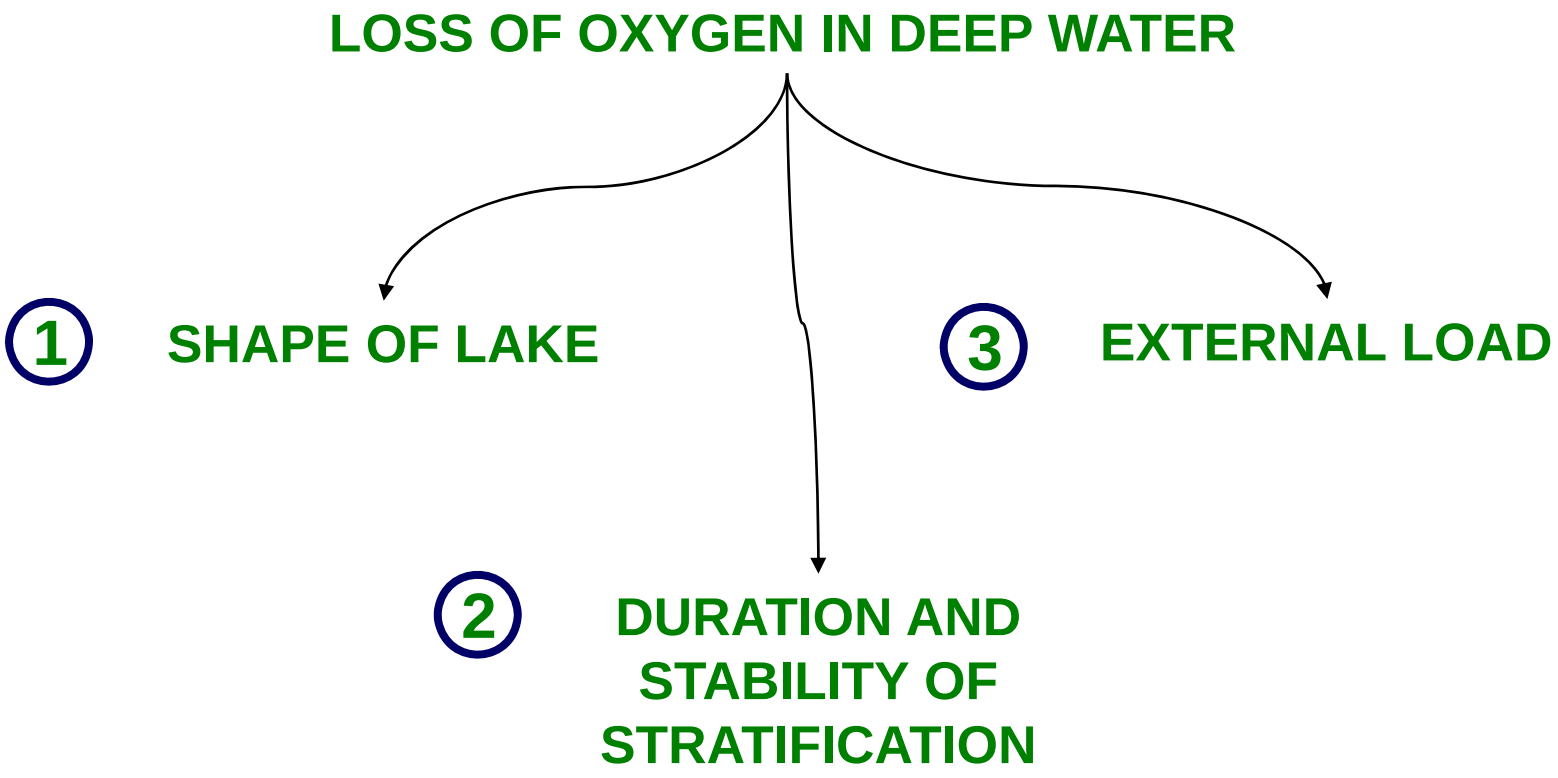






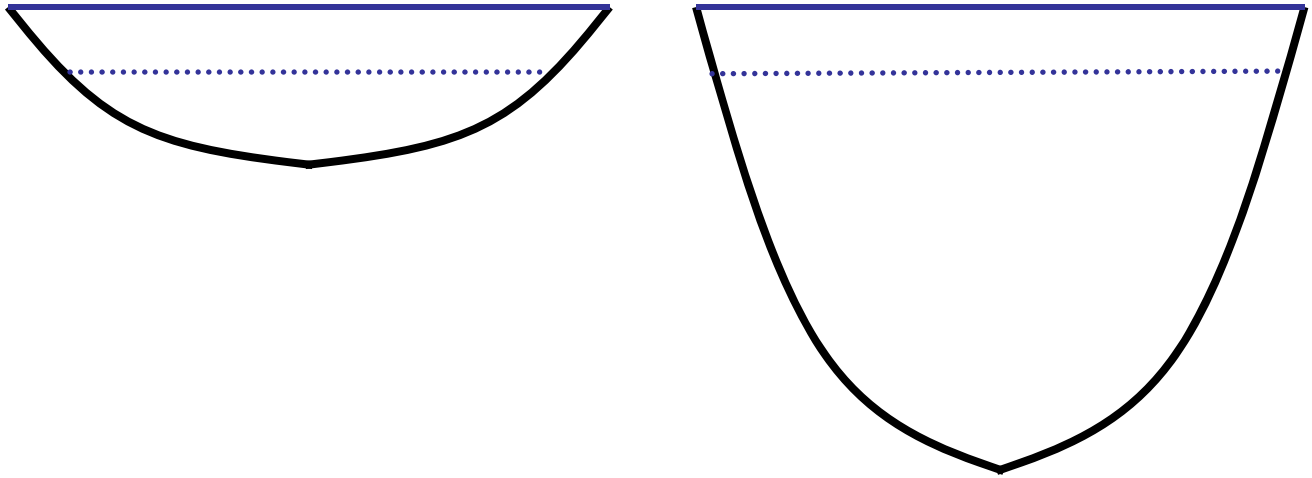
Internal load from lake sediments

The internal load is controlled by…



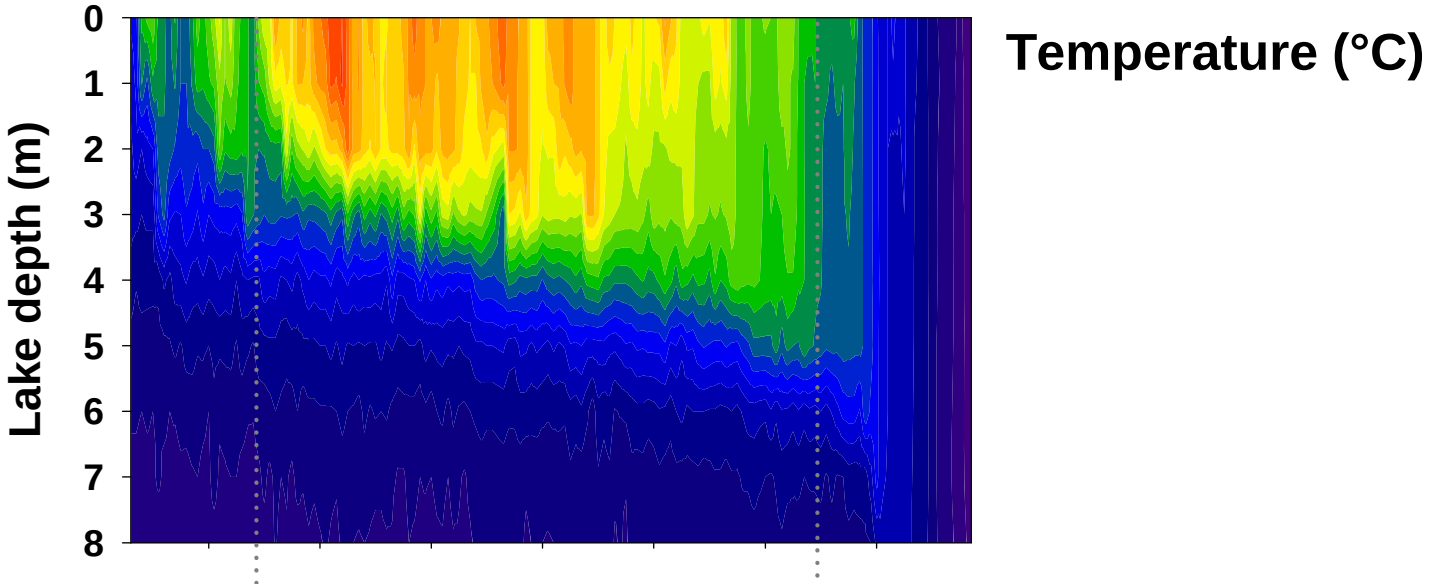
Phosphorus from sediments

1) The shape of the lake



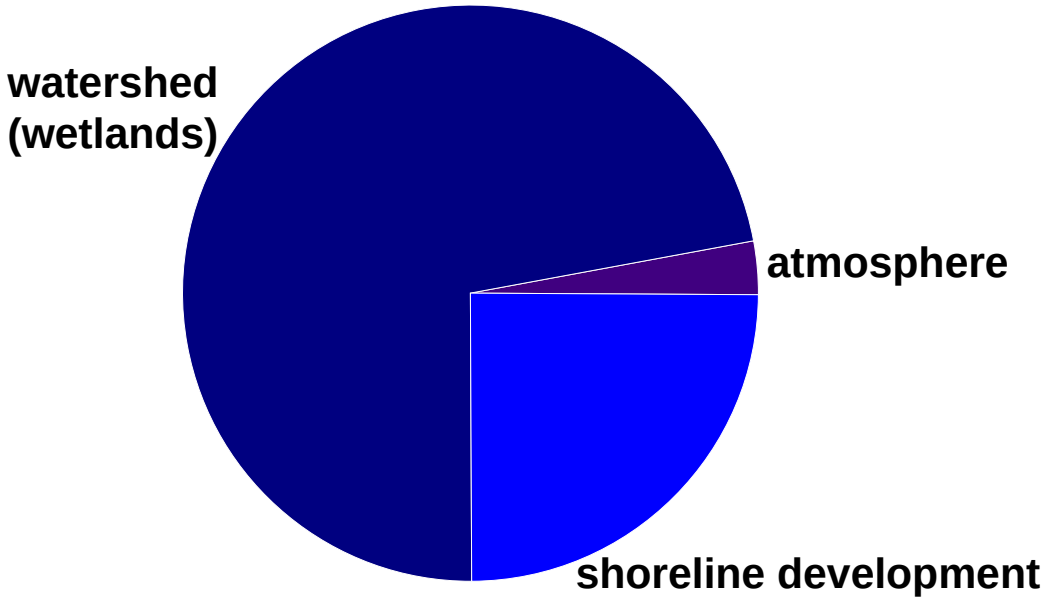
Phosphorus from sediments

2) The duration and stability of stratification



Phosphorus from sediments

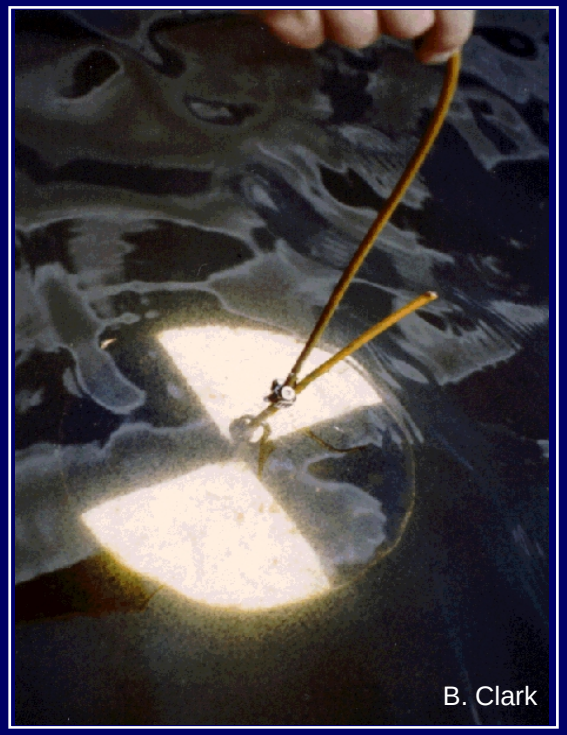
3) The external load of phosphorus



Algal blooms are not always associated with higher phosphorus concentrations in lakes

- chrysophyte blooms occur more frequently in Muskoka lakes than blue-green algal blooms

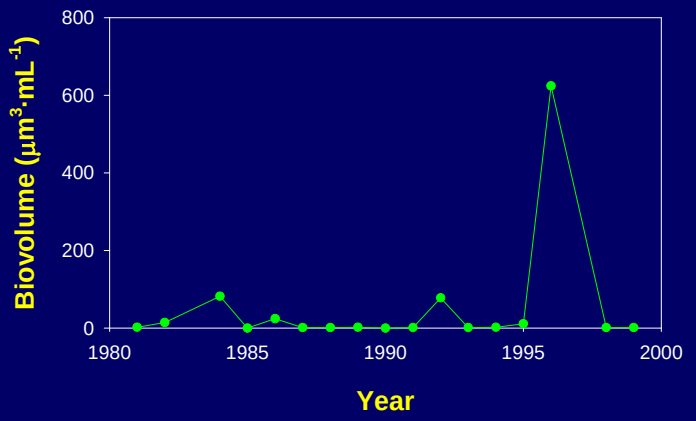
Harp Lake, Huntsville, ON



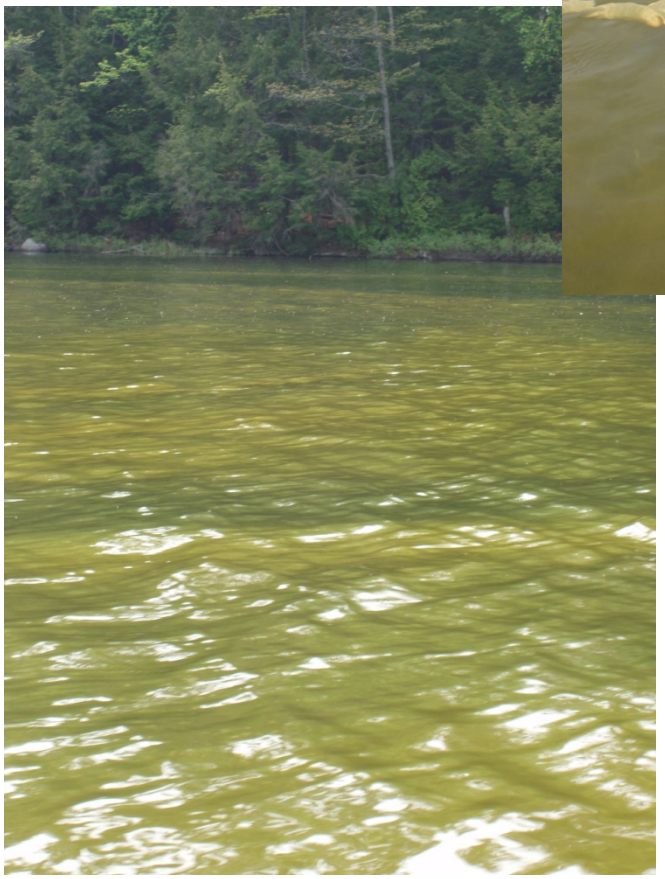
Chrysophyte bloom in spring 2006

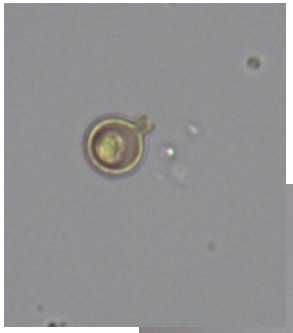
Secchi = 0.5 m
(long-term mean = 3.8 m)

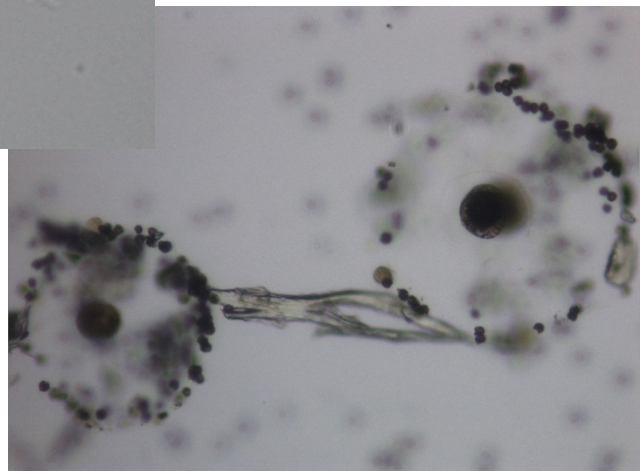
Chlorophyll = 88 ug/L
(long-term mean = 3.1 ug/L)



Shoe Lake, near Dorset

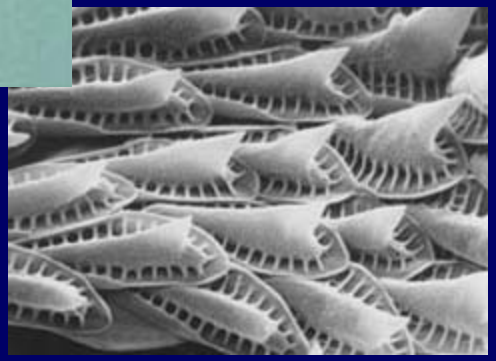




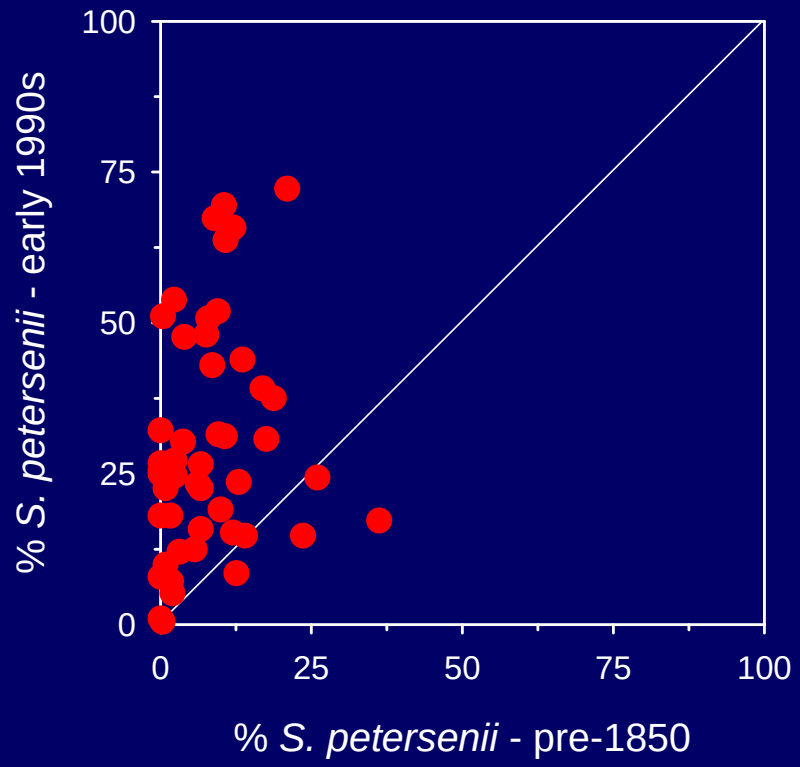


- **chrysophyte blooms are more likely now than in the past**

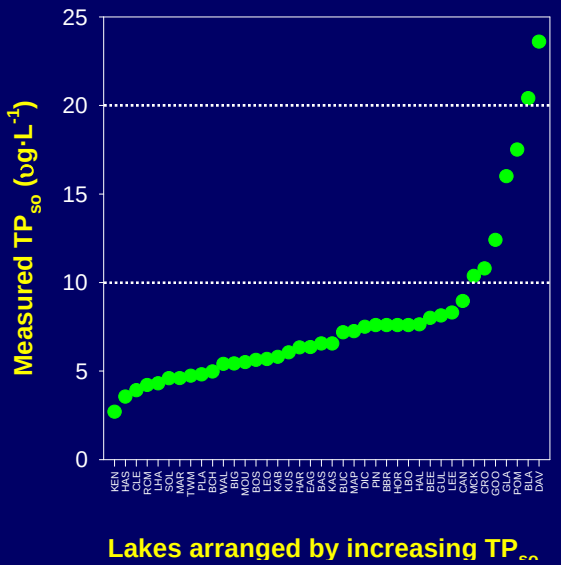
Synura petersenii



Courtesy of Peter Siver



- **bloom-forming chrysophytes have increased in lakes with and without cottages, and in low phosphorus lakes**



But conditions have to be right for a bloom

1) Nutrients (phosphorus)

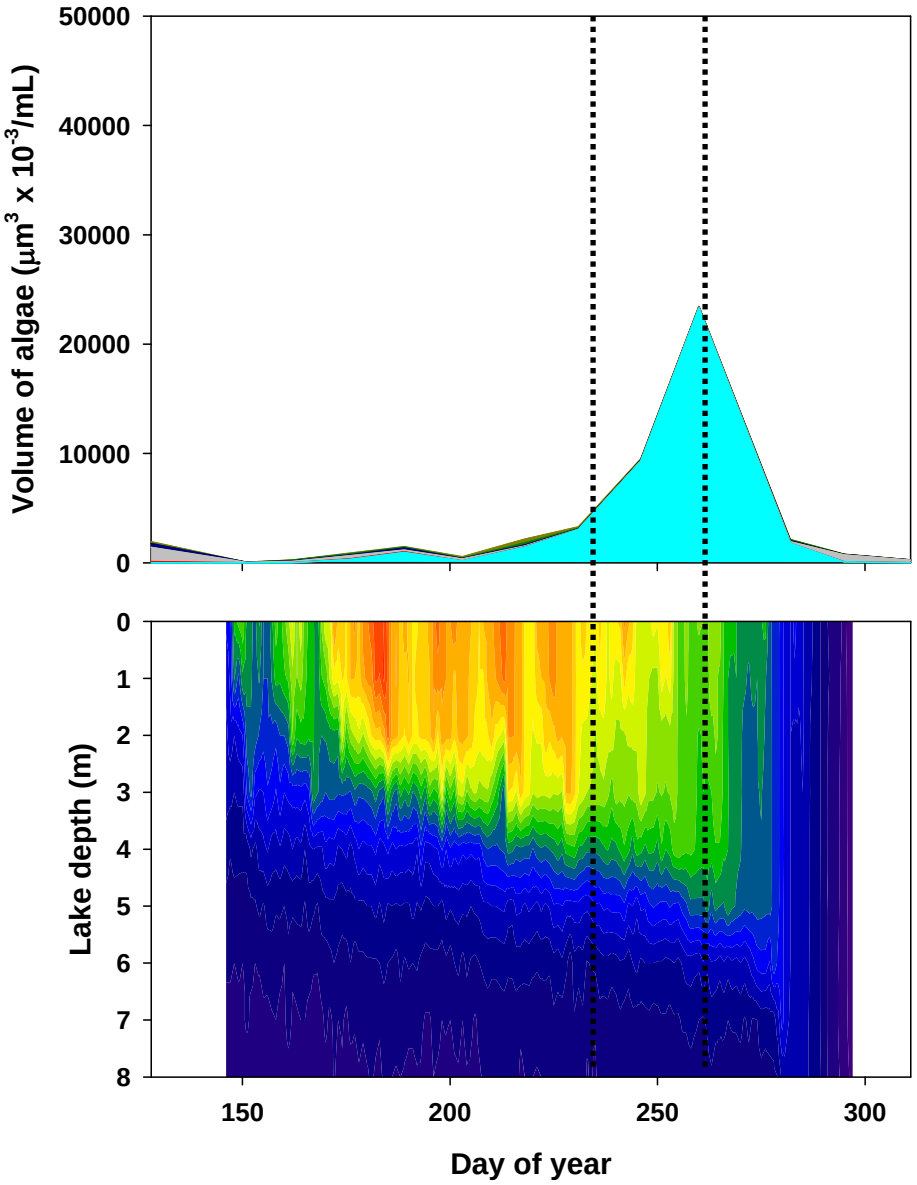
2) Water column with low turbulence

Experimental Lakes Area, NW Ontario

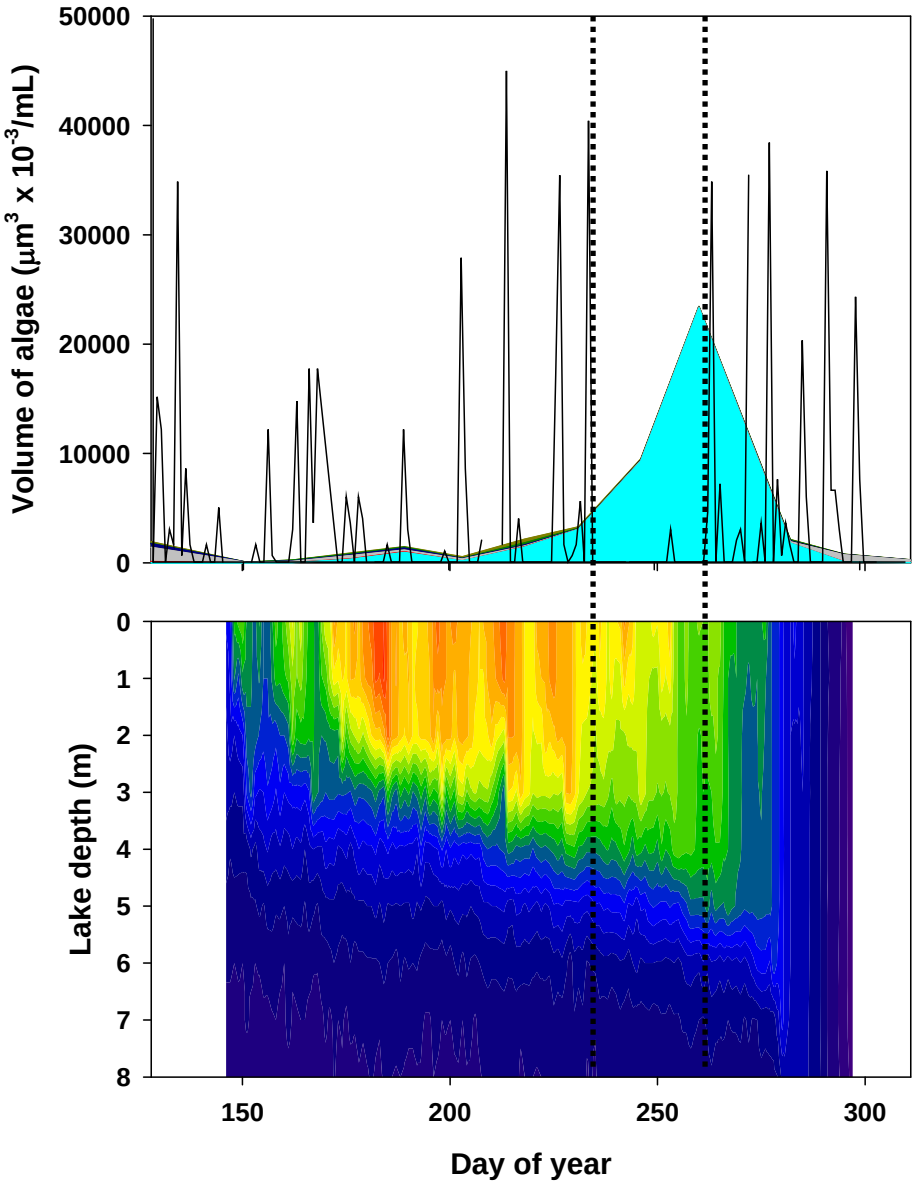
3) Warm temperatures/ sunlight

4) Biological factors

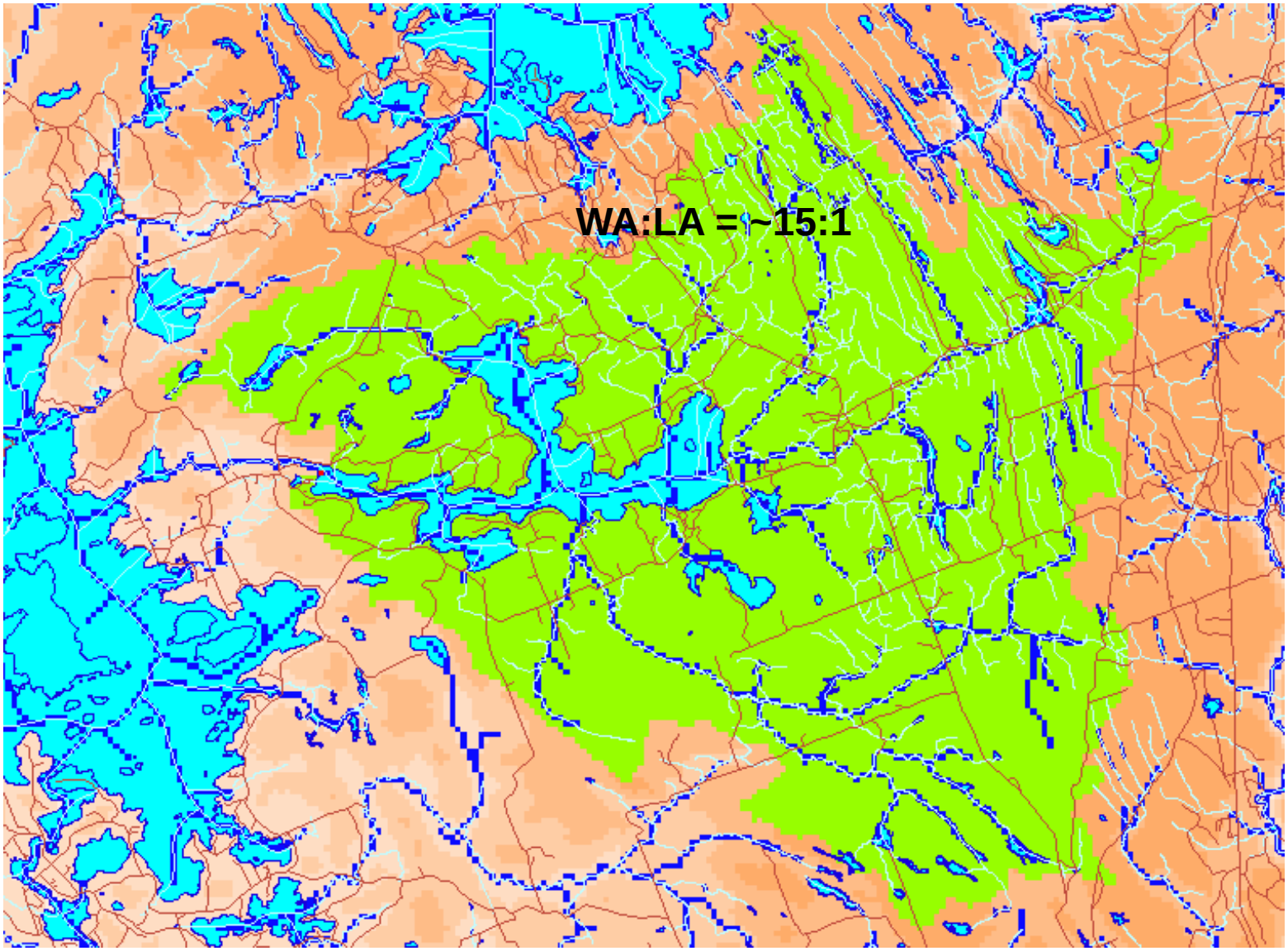
What other factors are important?



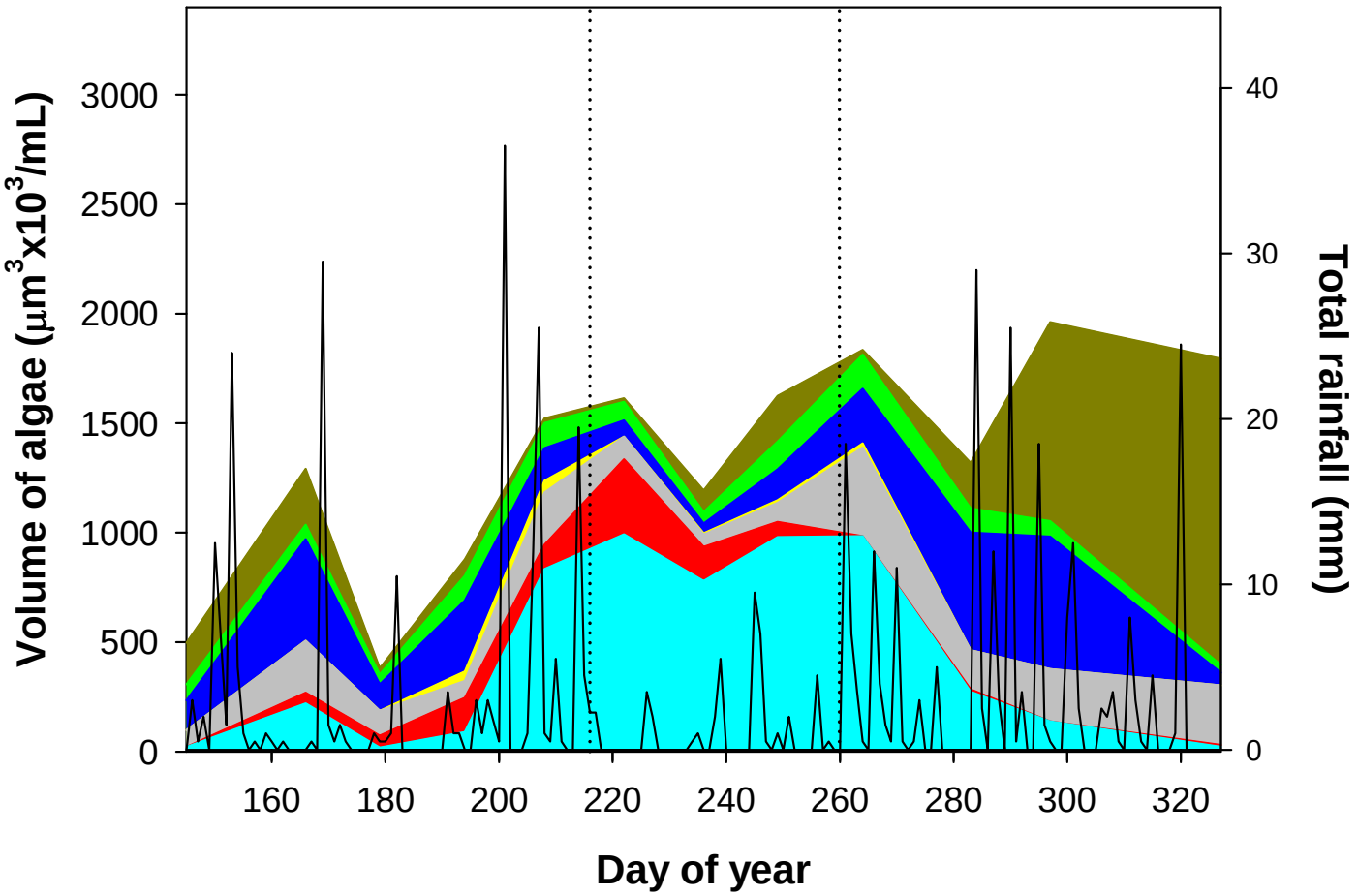
What other factors are important?



Weather


WA:LA = ~15:1

The importance of weather – 3 Mile Lake, 2006

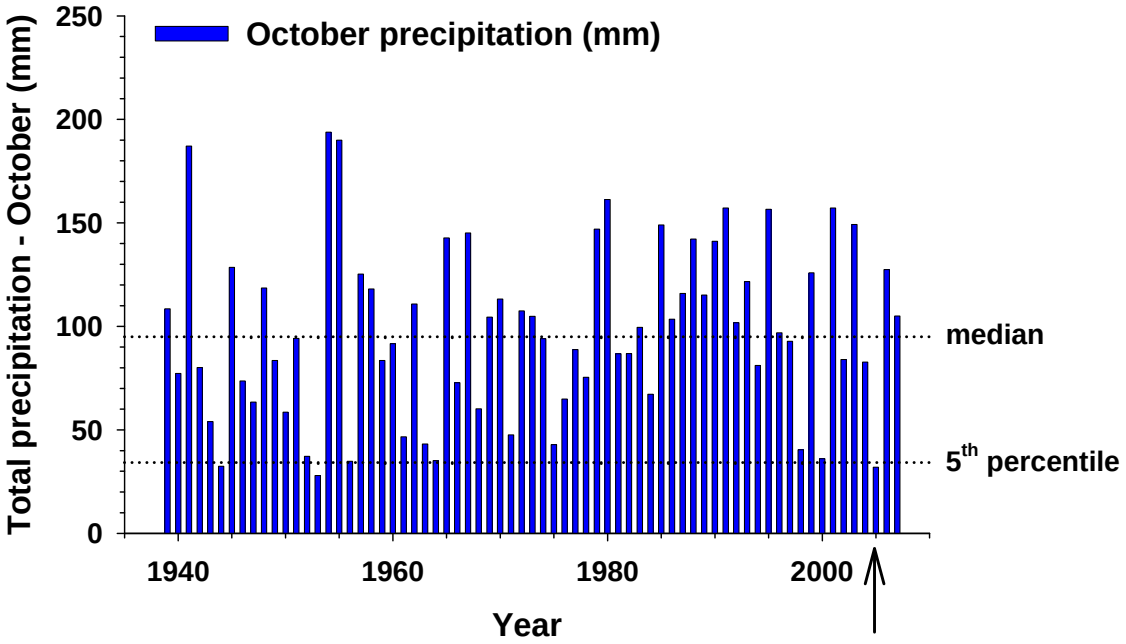


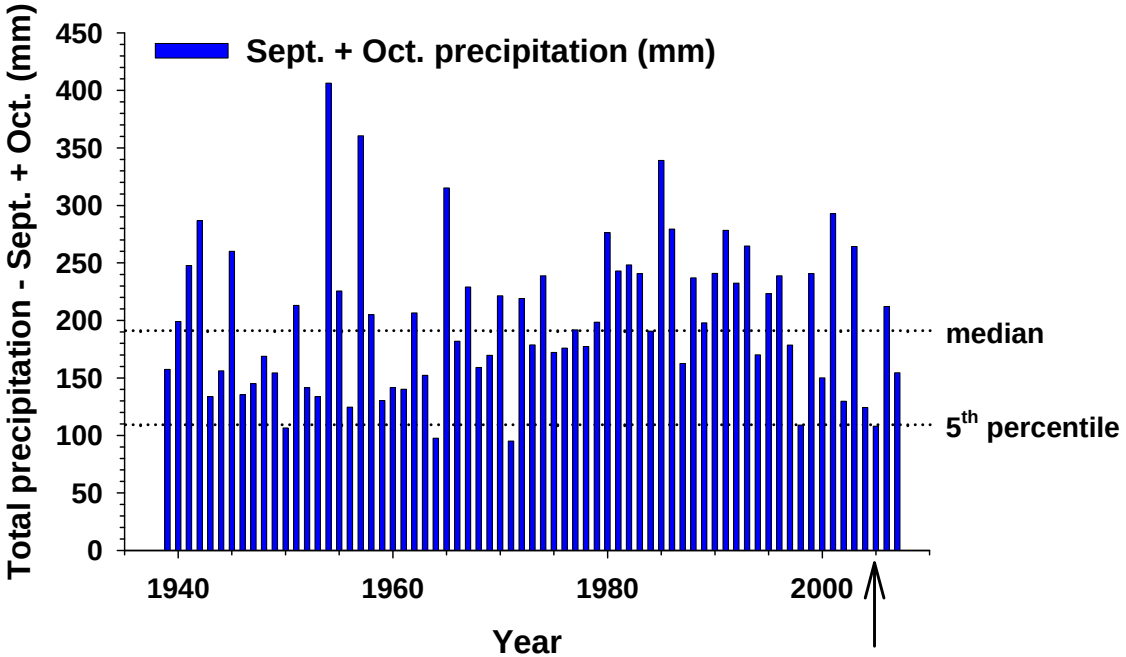
On occasion, these blooms may produce a surface scum

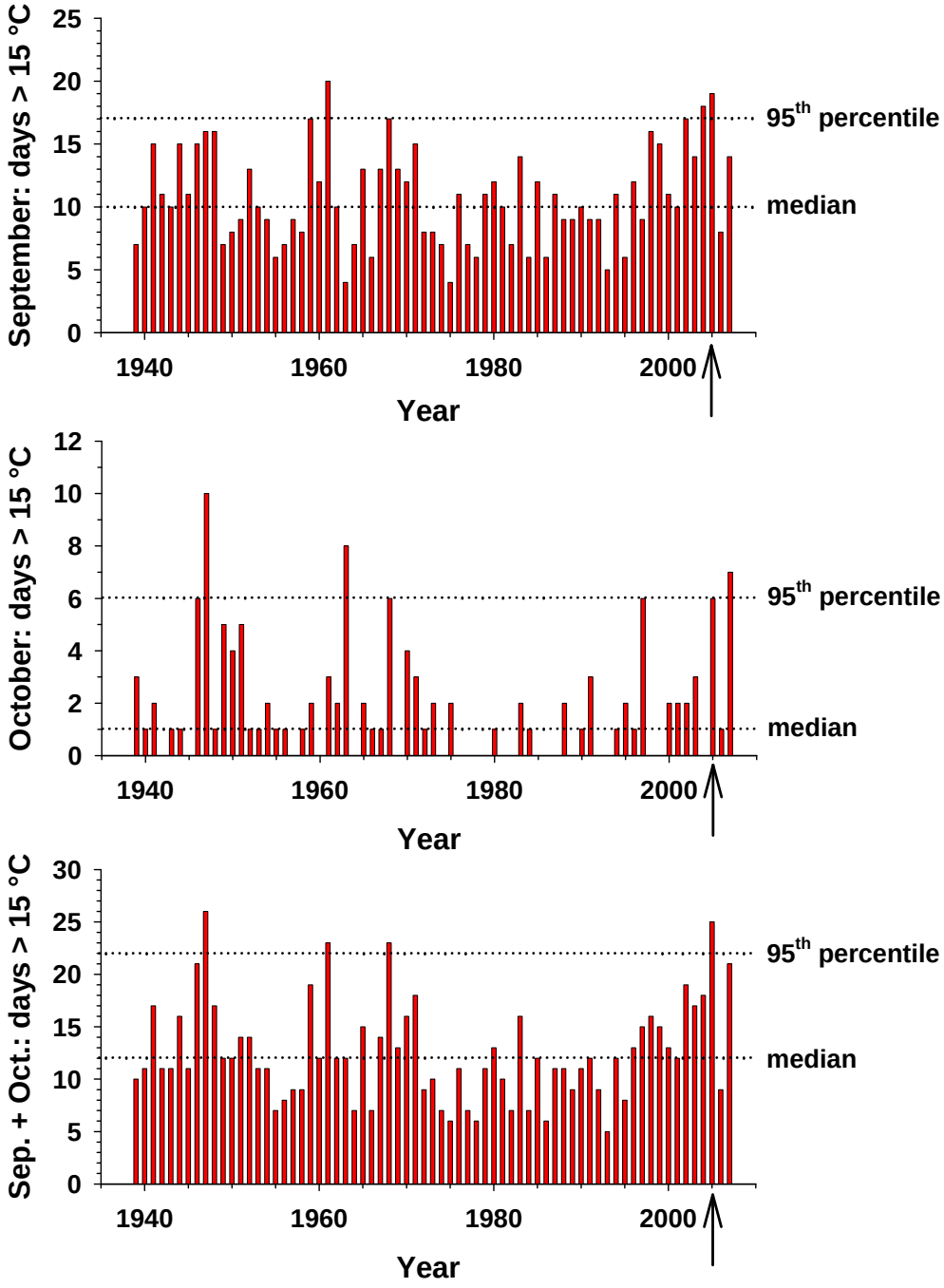
B. Clark

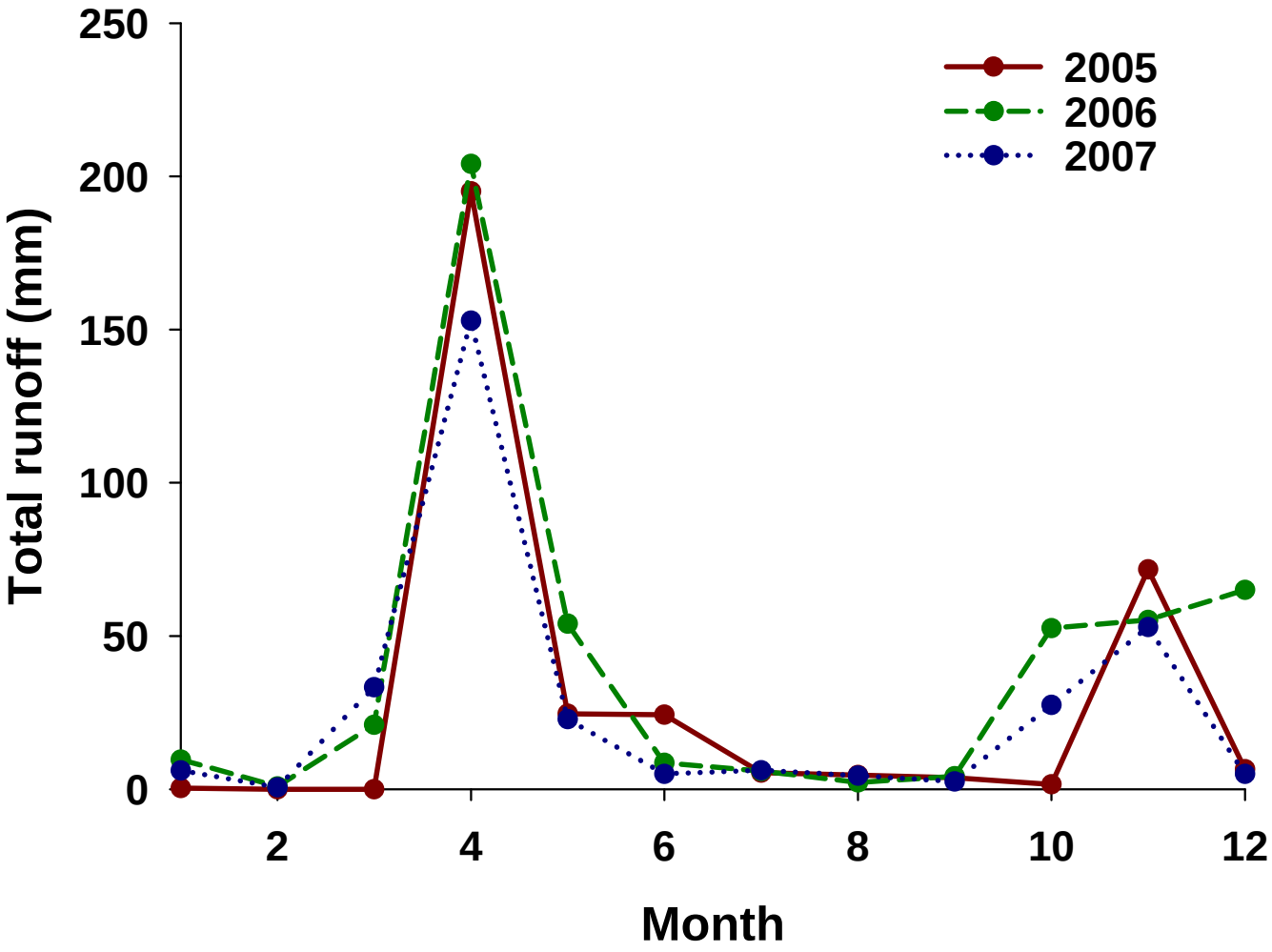
- **detailed work in Wisconsin (Lake Mendota) found that surface scums are more likely to occur when:**

  - **Wind velocities are low**
  - **precipitation is absent**
  - **solar radiation is higher than average**
  - **atmospheric pressure is high**


October precipitation (mm)
Total precipitation - October (mm)
250
200
150
100
50
0
median
5th percentile
1940
1960
1980
2000
Year

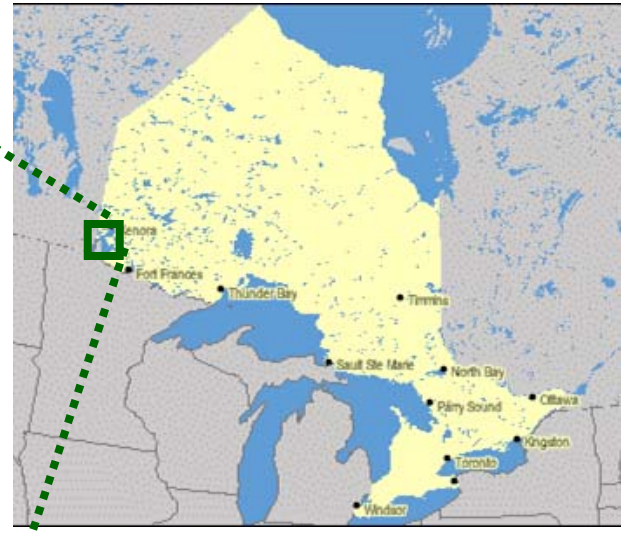

Sept. + Oct. precipitation (mm)
Total precipitation - Sept. + Oct. (mm)
450
400
350
300
250
200
150
100
50
0
median
5th percentile
1940
1960
1980
2000
Year


September: days > 15 °C
25
20
15
10
5
0
95th percentile
median
1940
1960
1980
2000
Year
October: days > 15 °C
12
10
8
6
4
2
0
95th percentile
median
1940
1960
1980
2000
Year
Sep. + Oct.: days > 15 °C
30
25
20
15
10
5
0
95th percentile
median
1940
1960
1980
2000
Year


250
200
150
100
50
0
Total runoff (mm)
2
4
6
8
10
12
Month
2005
2006
2007

Climate change and algae in our lakes

(LANDSAT Image, provided by G. McCullough, U. Manitoba)

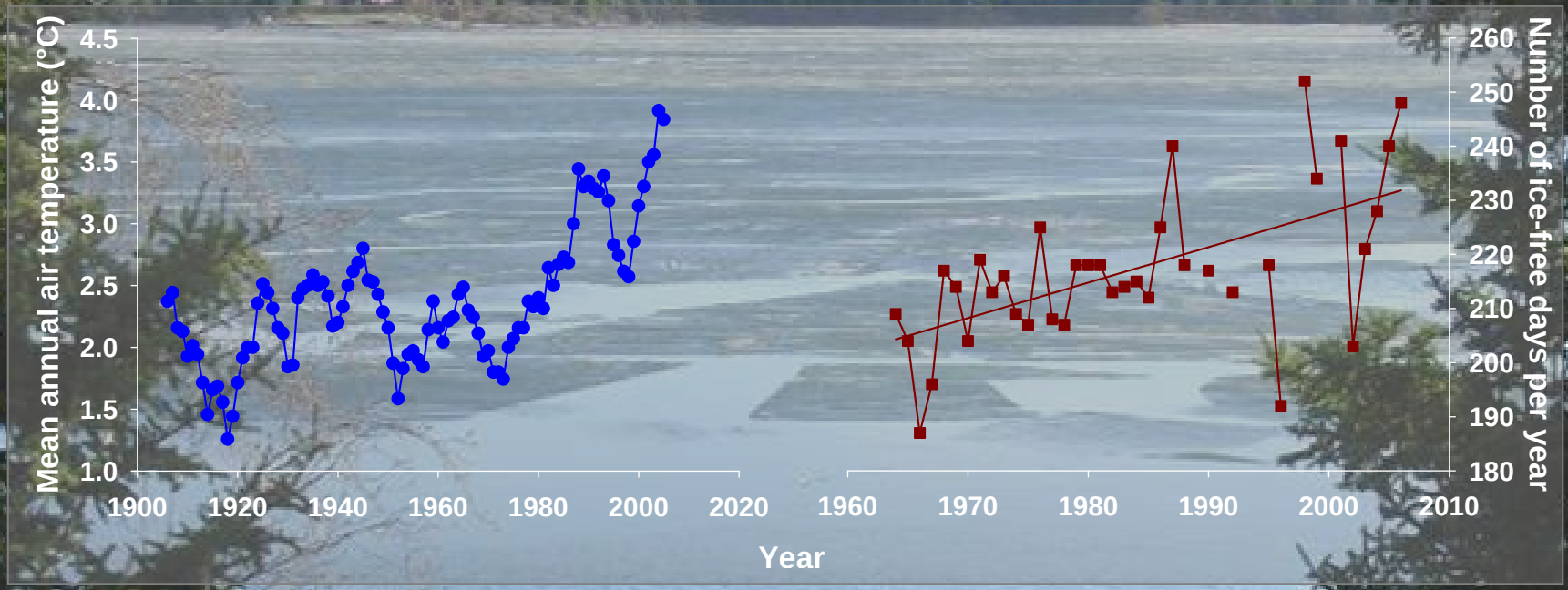


- **surface area: ~385,000 ha**
- **14,500 islands**
- **flows north**
- **70% of tributary inflow from Rainy R.**

Development of an Algal Bloom - 2003

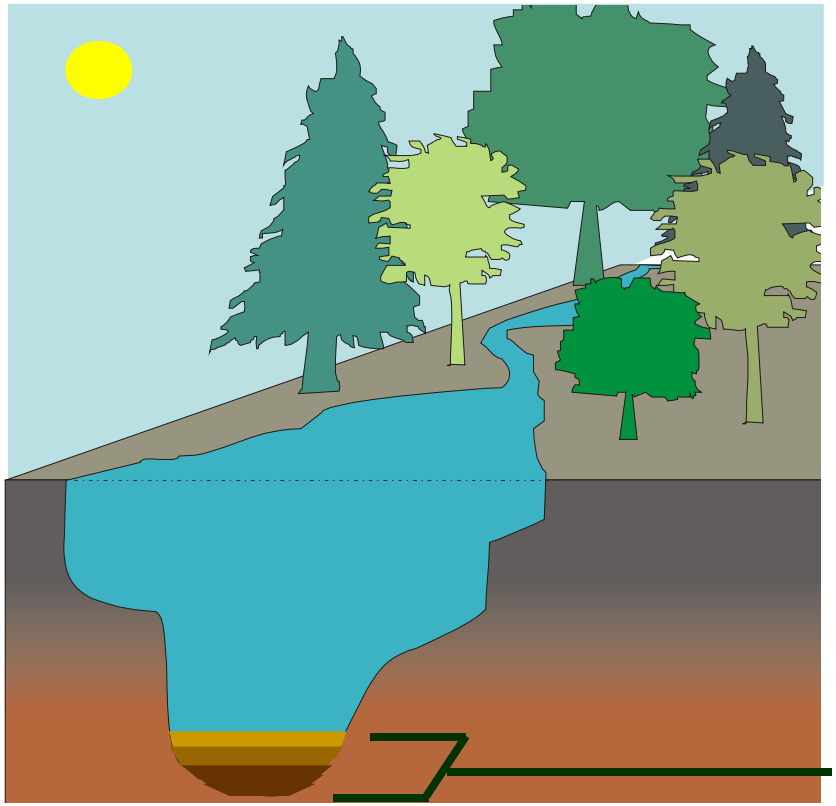
(Terra MODIS images – G. McCullough, U. of Winnipeg)

A region sensitive to climate change

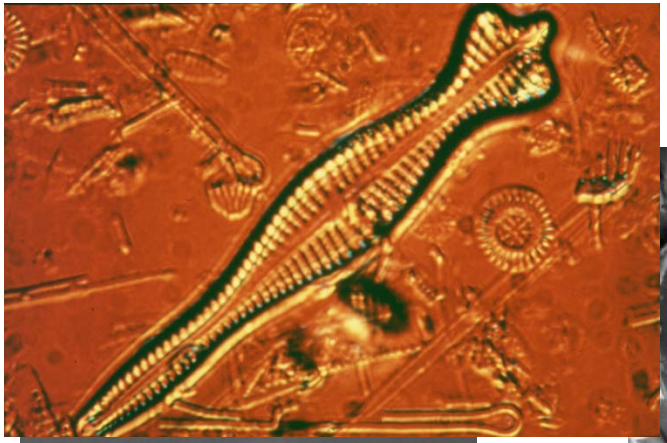


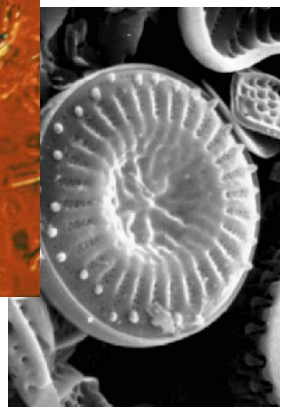
(Temperature data from Kenora Airport, Environment Canada; Ice data from T. Mosindy, MNR, Kenora FAU)

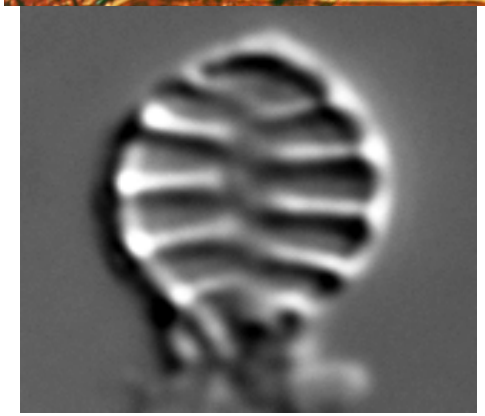
Gaining a historical perspective - paleolimnology



Lake sediments are archives of environmental change

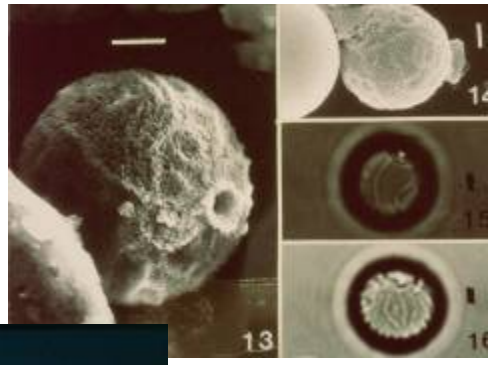


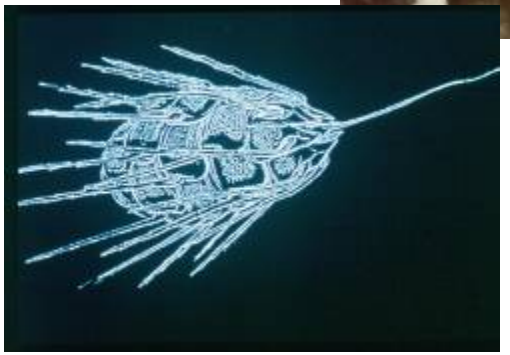




Diatoms

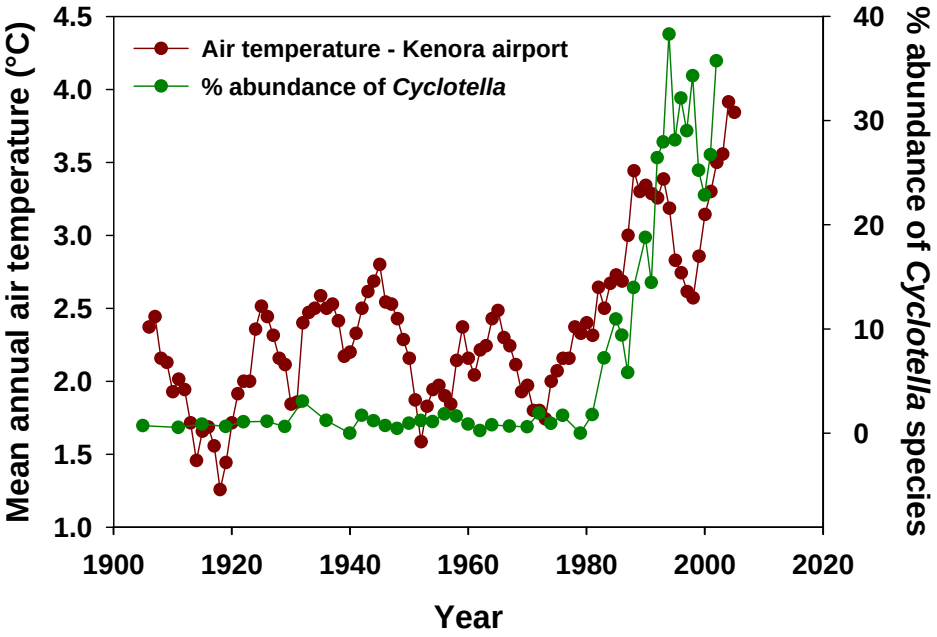
Algae from the lake

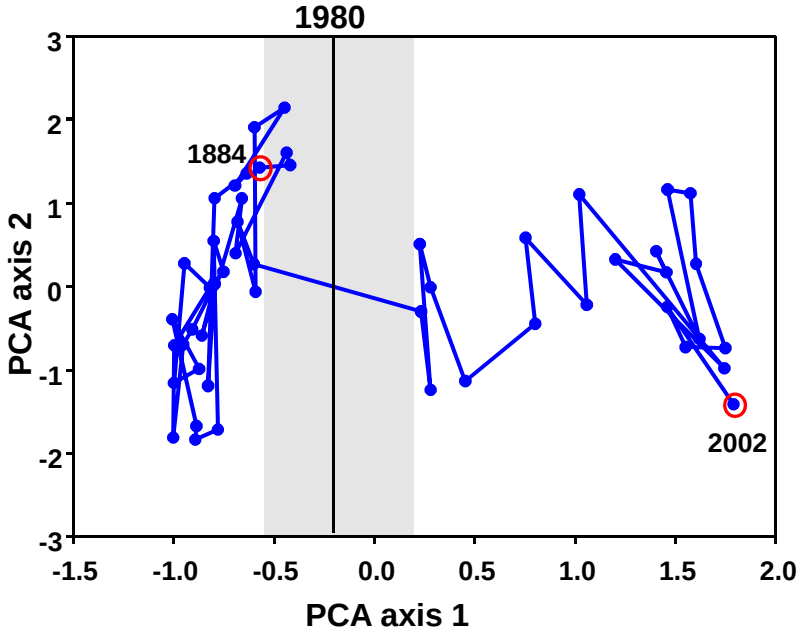




Chrysophytes

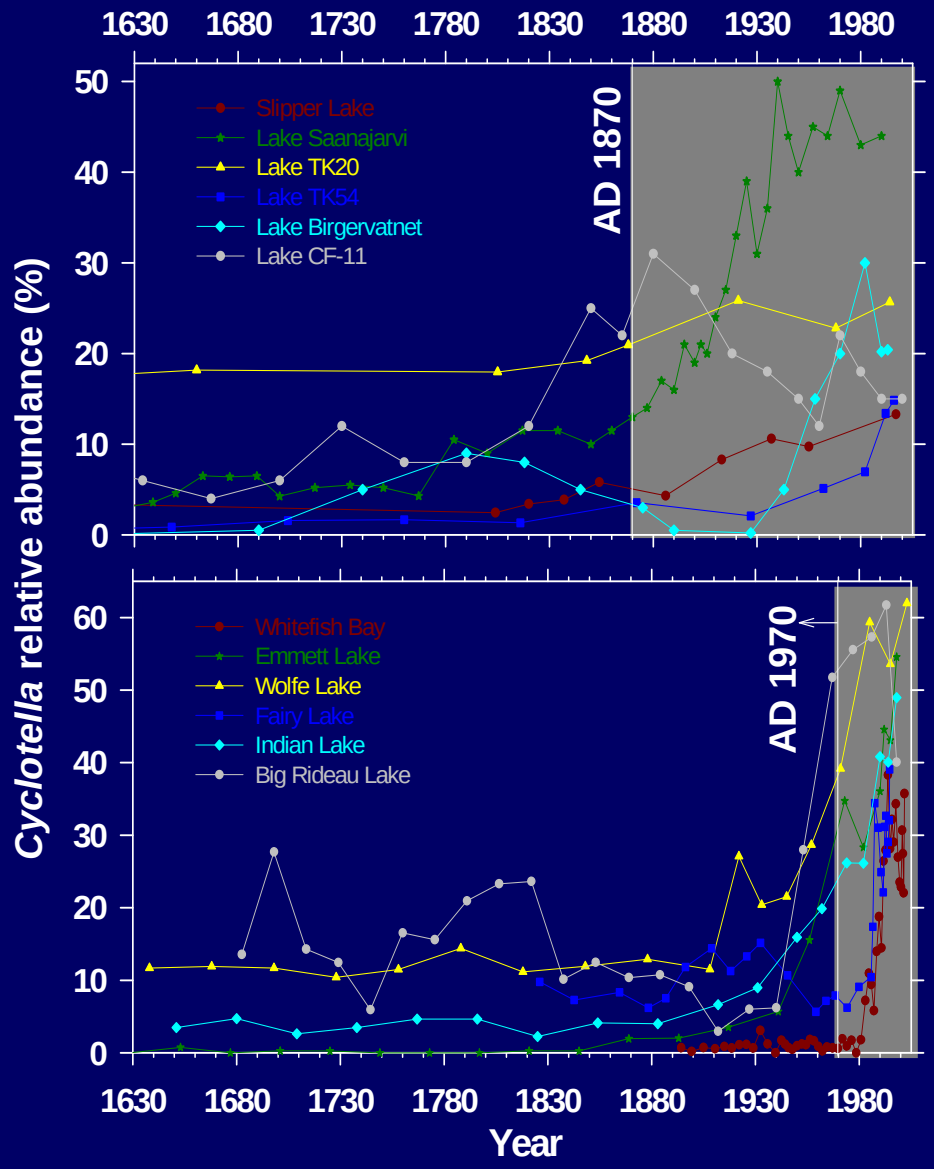
Climate change and algae in our lakes





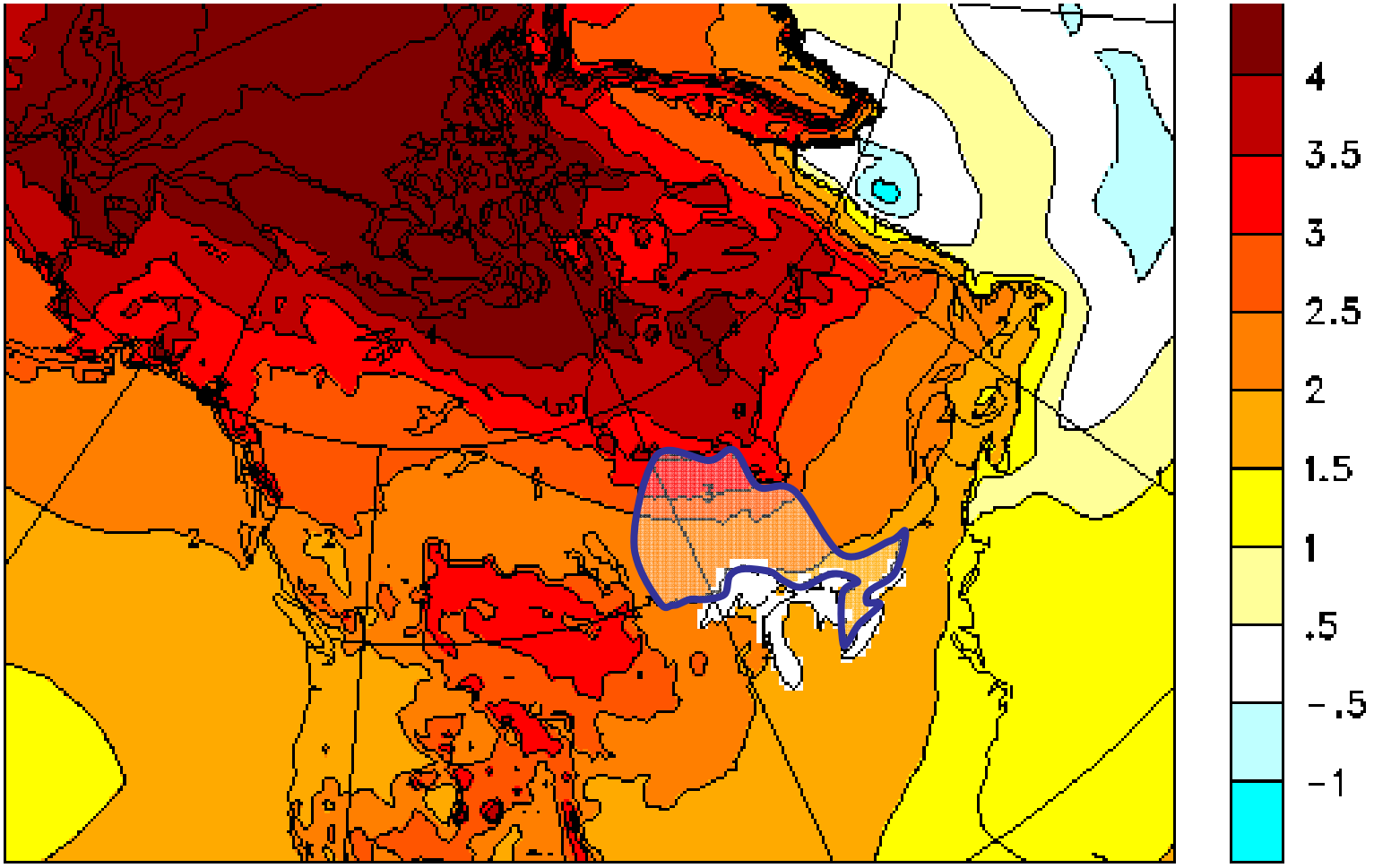
(Figures modified from Rühland, Paterson and Smol. 2008. Global Change Biology)

Differences in the timing of the changes: Arctic versus temperate lakes



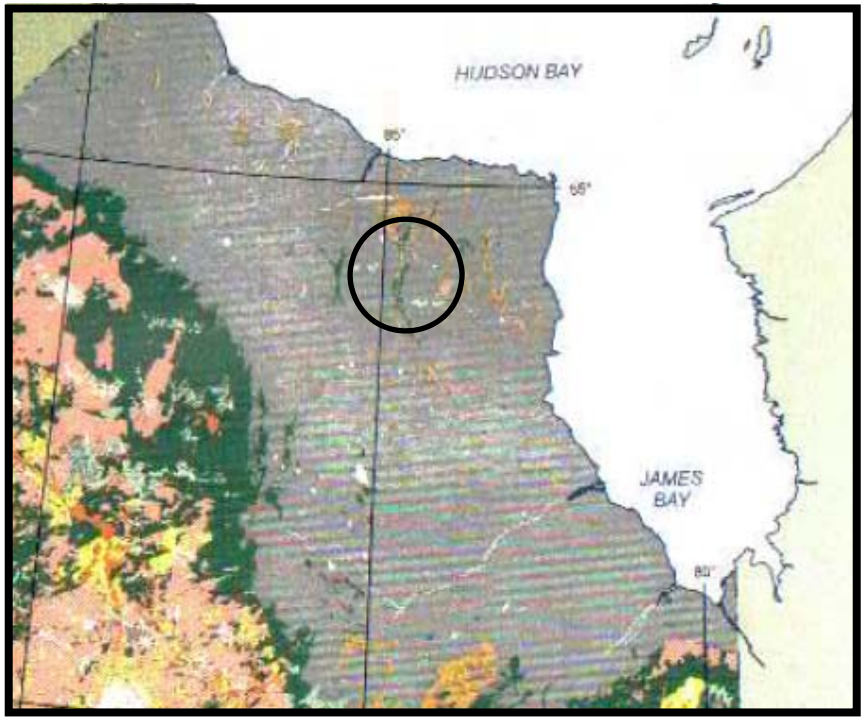
(Rühland, Paterson and Smol, 2008)

Northern lakes -- The canaries in the mine

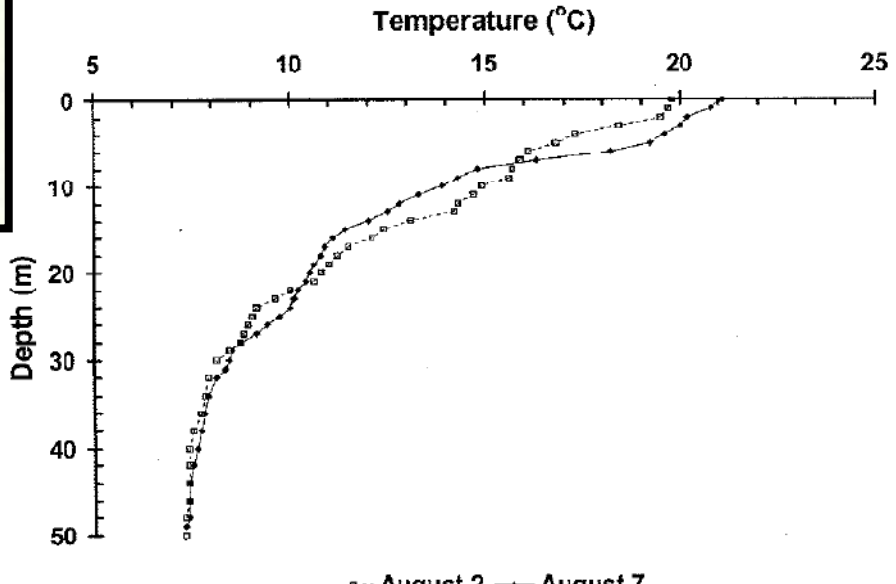


(Environment Canada; Canadian Regional Climate Model (v.3.6.1))

Northern lakes -- The canaries in the mine



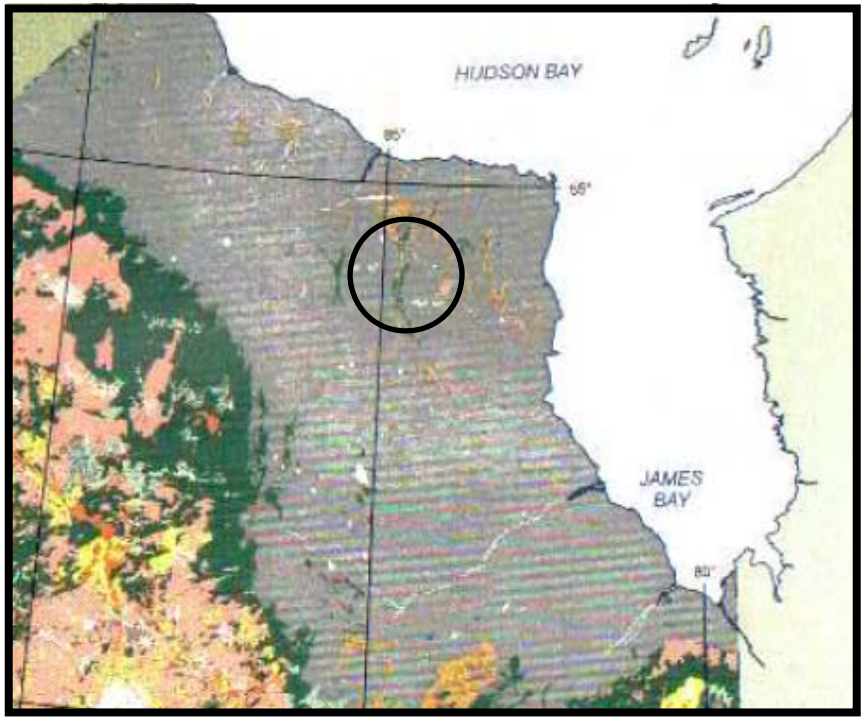
Ontario Geological Survey



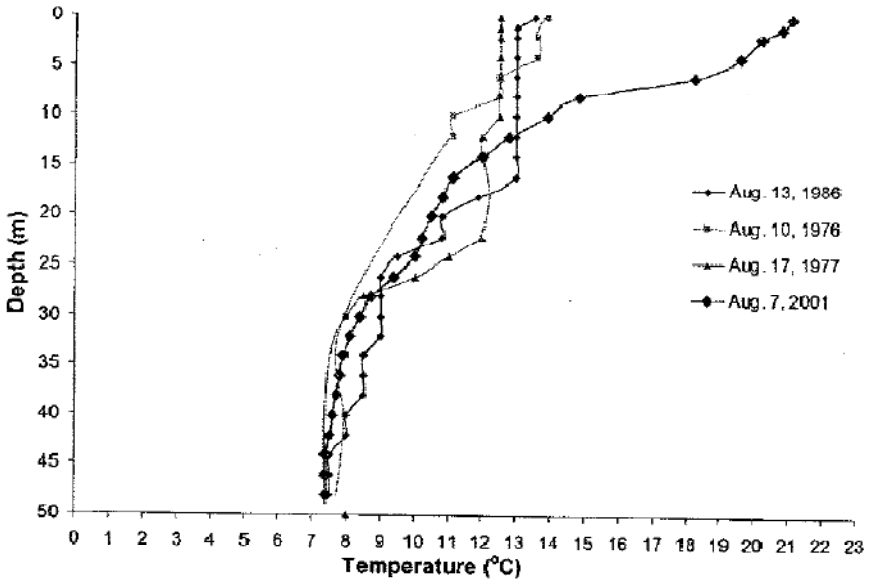
2001

(Snucins and Gunn, 2003)

Northern lakes -- The canaries in the mine



Ontario Geological Survey



(Snucins and Gunn, 2003)

But conditions have to be right for a bloom

1) Nutrients (phosphorus)

2) Water column with low turbulence

Experimental Lakes Area, NW Ontario

3) Warm temperatures/ sunlight

4) Biological factors

Acknowledgements

Brandy Lake

- Ron Ingram (MOE)
- Bev Clark (MOE)
- Lucja Heintsch, Lynda Nakamoto (MOE)
- MOE lab staff and students
- MOE summer students
- Brandy Lake Association (Jim Cormack)
- District Municipality of Muskoka (Judi Brouse)

3 Mile Lake

- Ron Ingram (MOE)
- Brad Allen (MOE – Barrie)
- MOE lab staff and students
- MOE summer students
- 3 Mile Lake Association (Jamie Delaney)
- District Municipality of Muskoka (J. Brouse, R. Willison)
- Members of 3 Mile Working Group

Lake of the Woods and Taste and Odour work

- John Smol, Kathleen Rühland (Queen's University)
- Brian Cumming (Queen's), Roland Hall (U of W)
- Bev Clark, Anna DeSellas, Ron Ingram (MOE)
- MOE lab staff and students
- MNR Fisheries Assessment Unit – Kenora (Tom Mosindy)
- Lake of the Woods Water Sustainability Foundation (Todd Sellers)
- Lake of the Woods District Property Owner's Association

Northern Climate work

- Bill Keller, Chris Jones (MOE)
- John Gunn (Laurentian), Lee Haslam, Jason Houle (MNR)
- John Smol, Kathleen Rühland (Queen's), Jules Blais (U of O)