People, Aquatic Plants and Healthy Lakes: Finding the Balance in Eastern Ontario's Lake Country

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Carleton UNIVERSITY

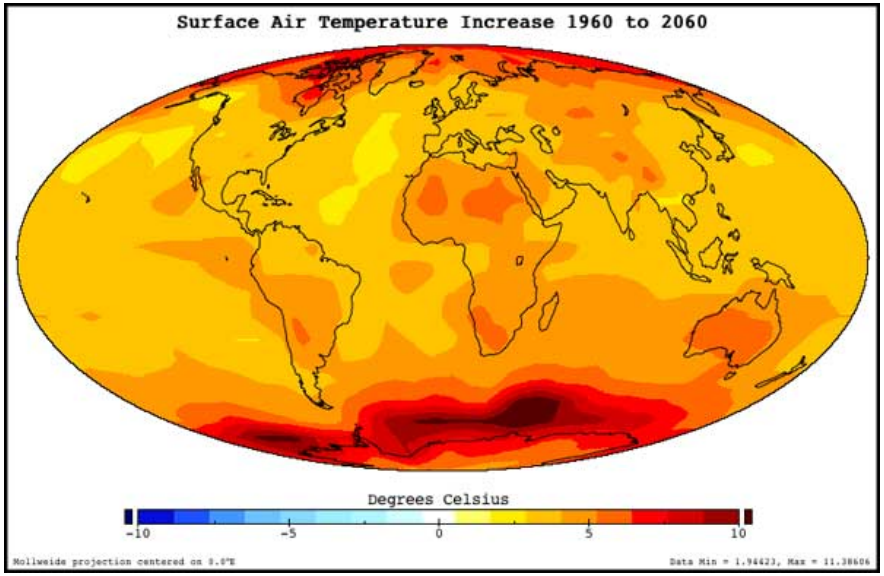
Human Induced Rapid Environmental Change (HIREC)

Humans have left their mark on pretty well every ecosystem

Invasive species

Land-use change

Climate change



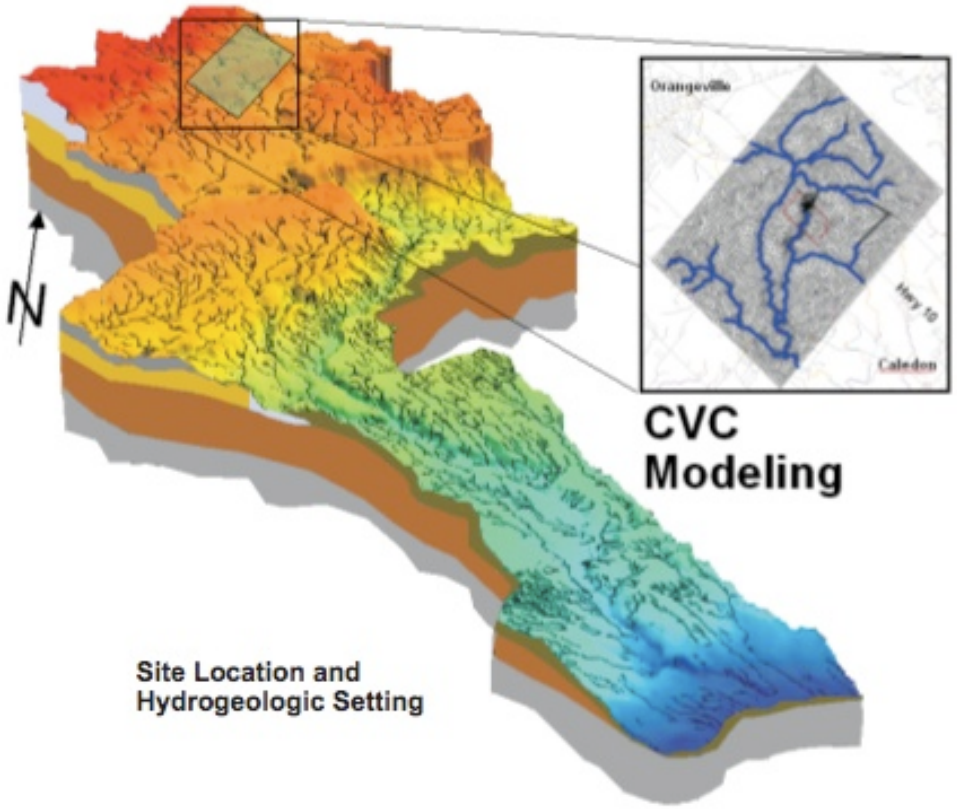
Pollution

http://www.foe.co.uk/

Environmental Goods and Services

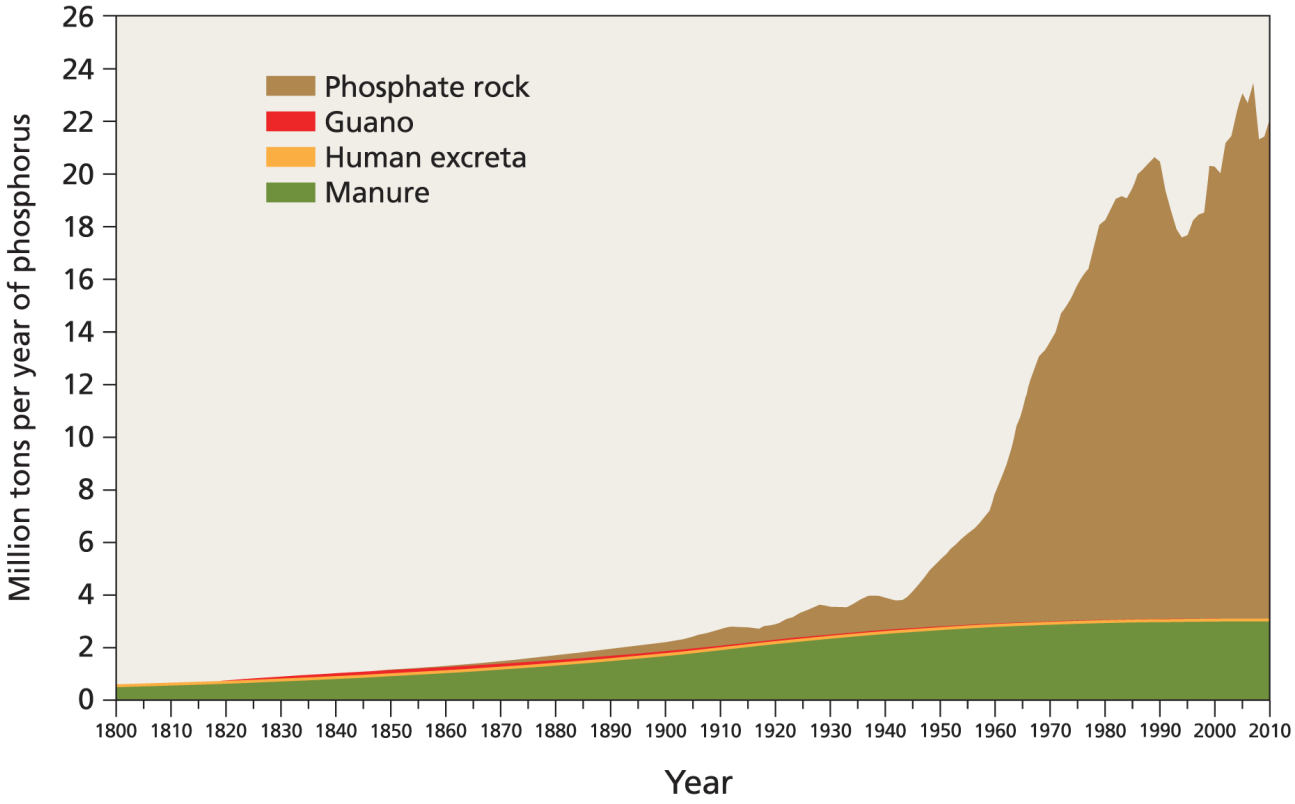
An example of environmental goods and services

Groundwater in the Credit River Watershed



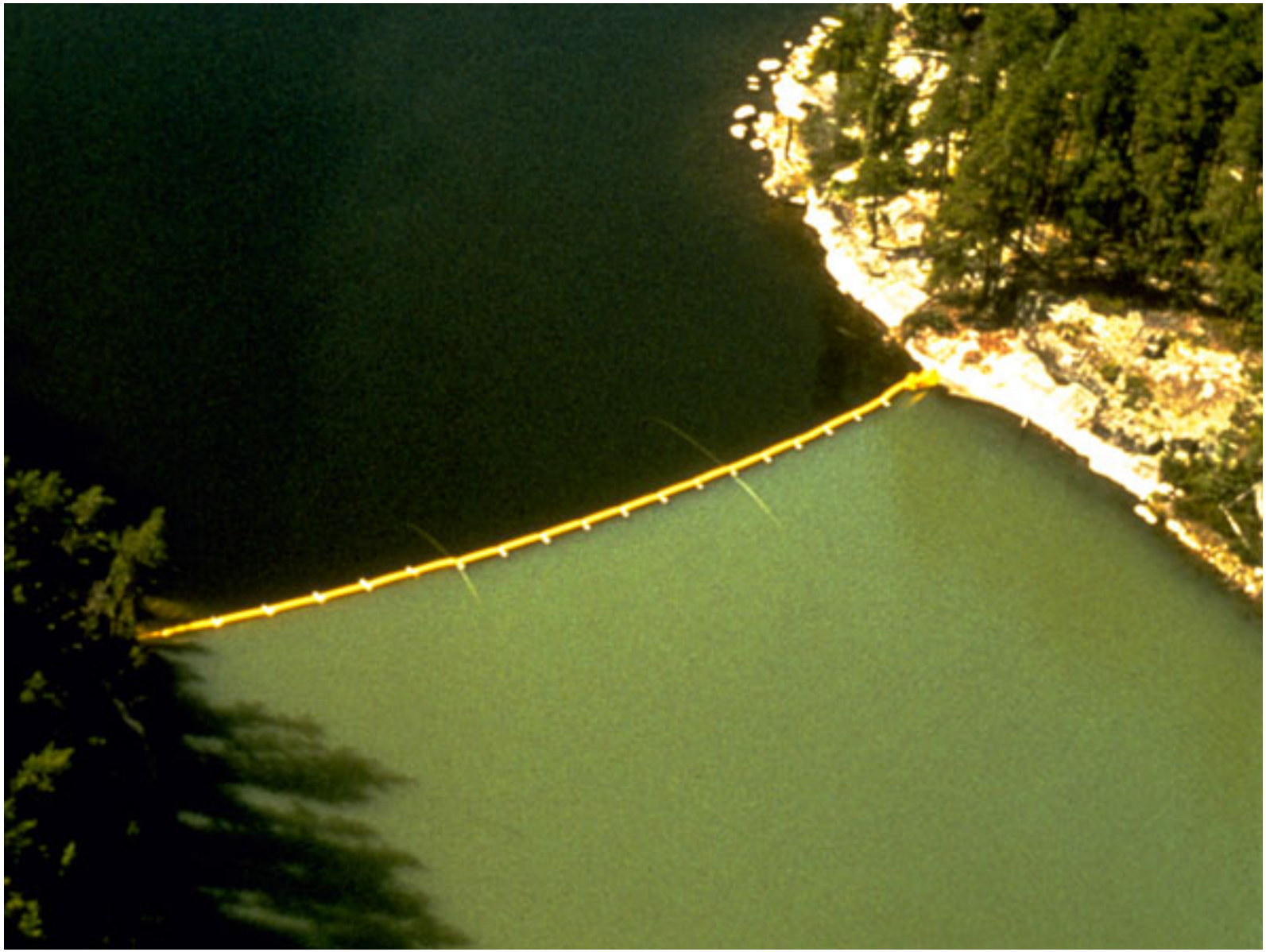
- ~90,000 people rely on groundwater for drinking water
- It would cost ~$100 million a year to pump, treat, and store water from Lake Ontario to replace the groundwater resource

Phosphorus



We greatly increased the amount of available phosphorus with important consequences for primary production

Eutrophication (increased algal production in lakes)

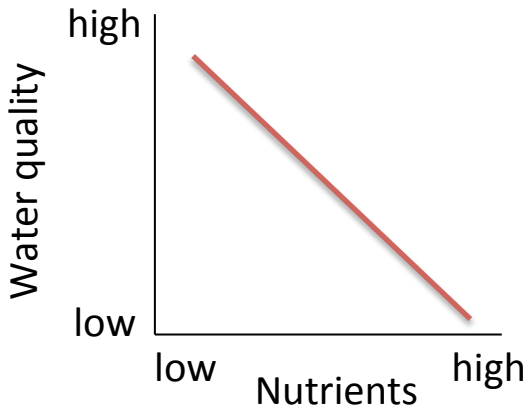


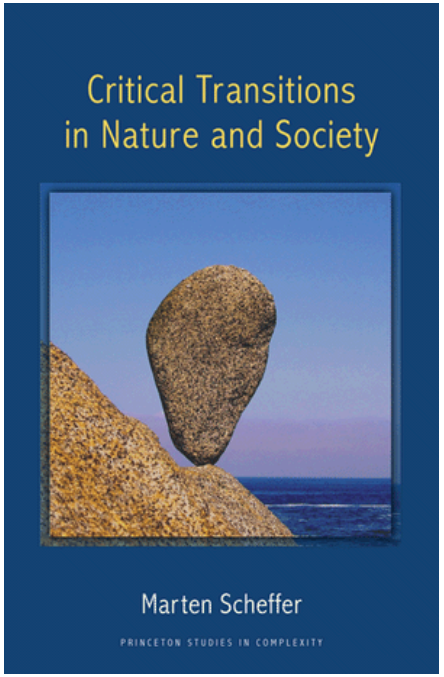

Danger
Baignade interdite
No Swimming
Algues bleu-vert abondantes (cyanobactéries)
ÉVITEZ DE TOUCHER OU DE BOIRE L'EAU
DON'T TOUCH AND DRINK THE WATER

Water Quality Concerns Among Lake Users

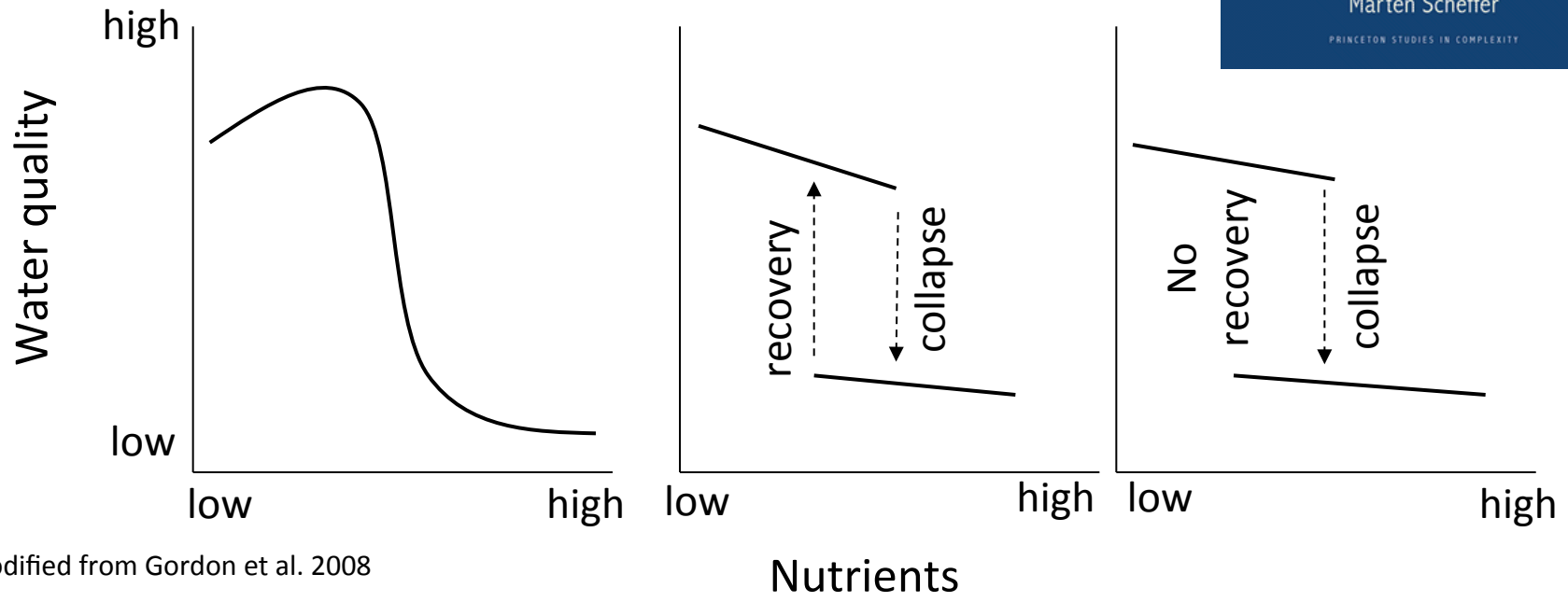
Non-linear Ecosystem Response

Phosphorus has been accumulating for years, why the abrupt change in water quality?



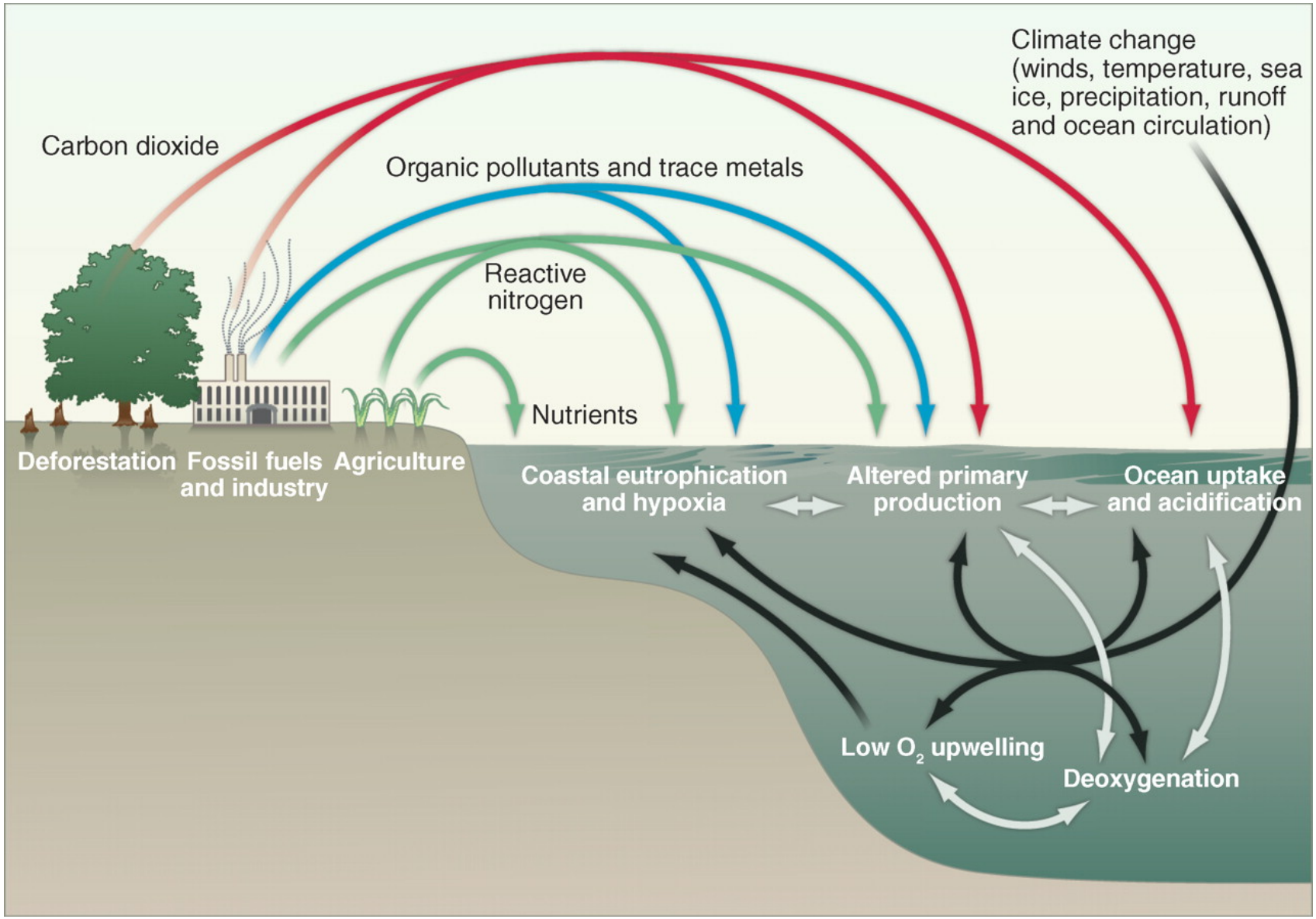


Ecosystems can display a threshold response



Modified from Gordon et al. 2008

Multiple Ecosystem Stressors



Science 18 June 2010:

Research component of the OTF

Research objective:

- Determine the probable driver(s) of the reported increase in algal concentrations and macrophyte biomass in eastern Ontario

We are examining 3 possible drivers

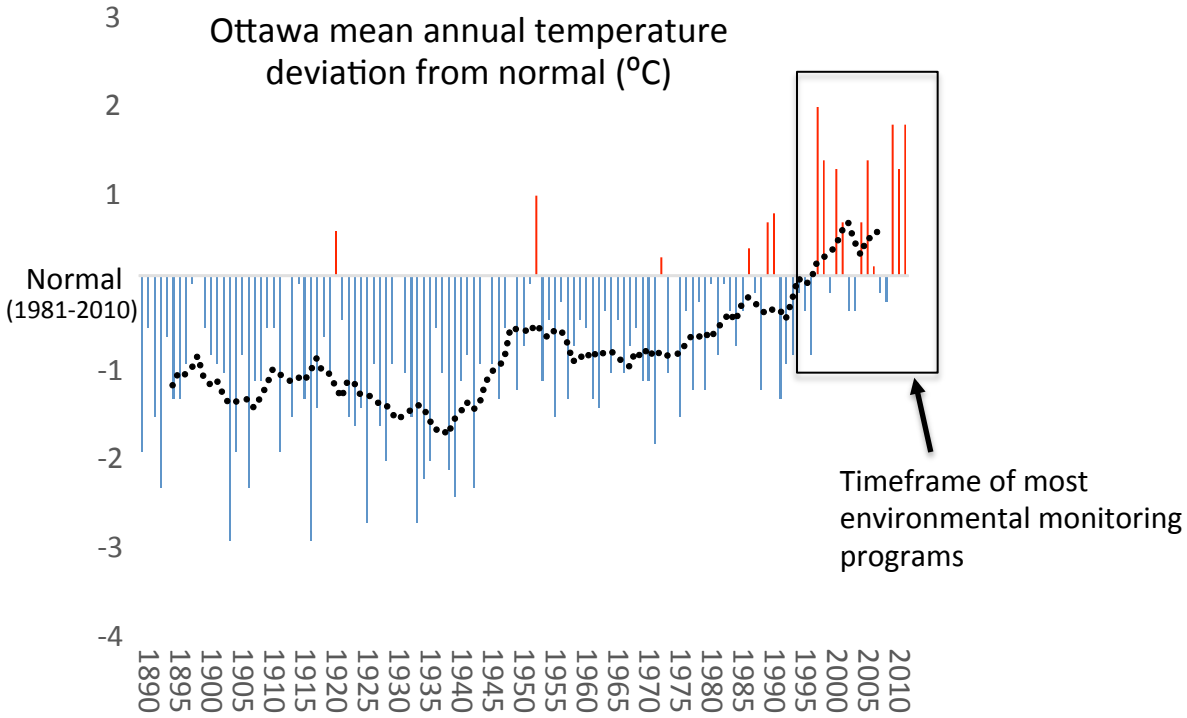
1) Nutrient loading

2) Climate change

3) Invasive species

The need for long-term data

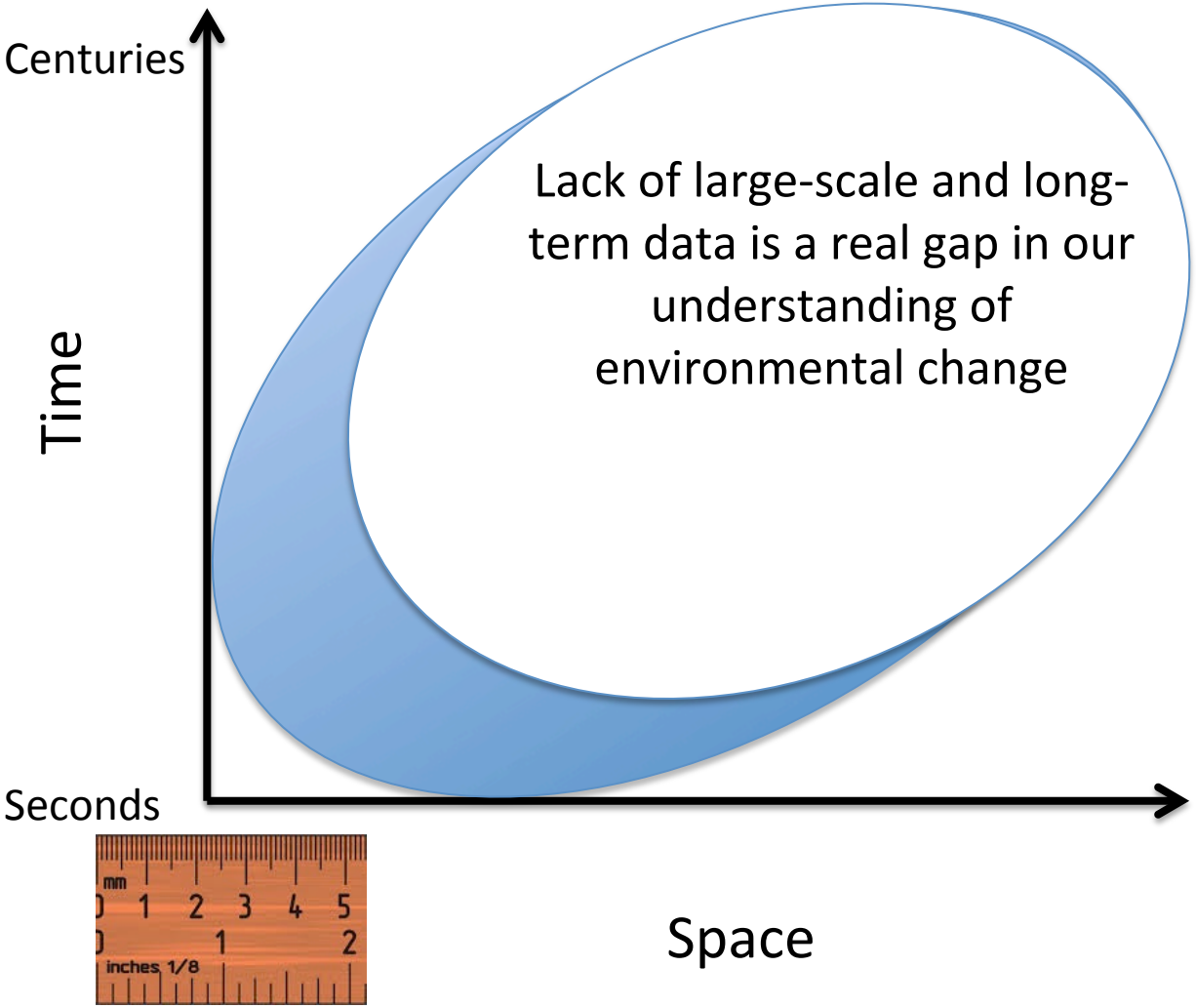
- Needed to know the magnitude and speed by which humans have altered ecosystems
- Needed to set realistic restoration targets



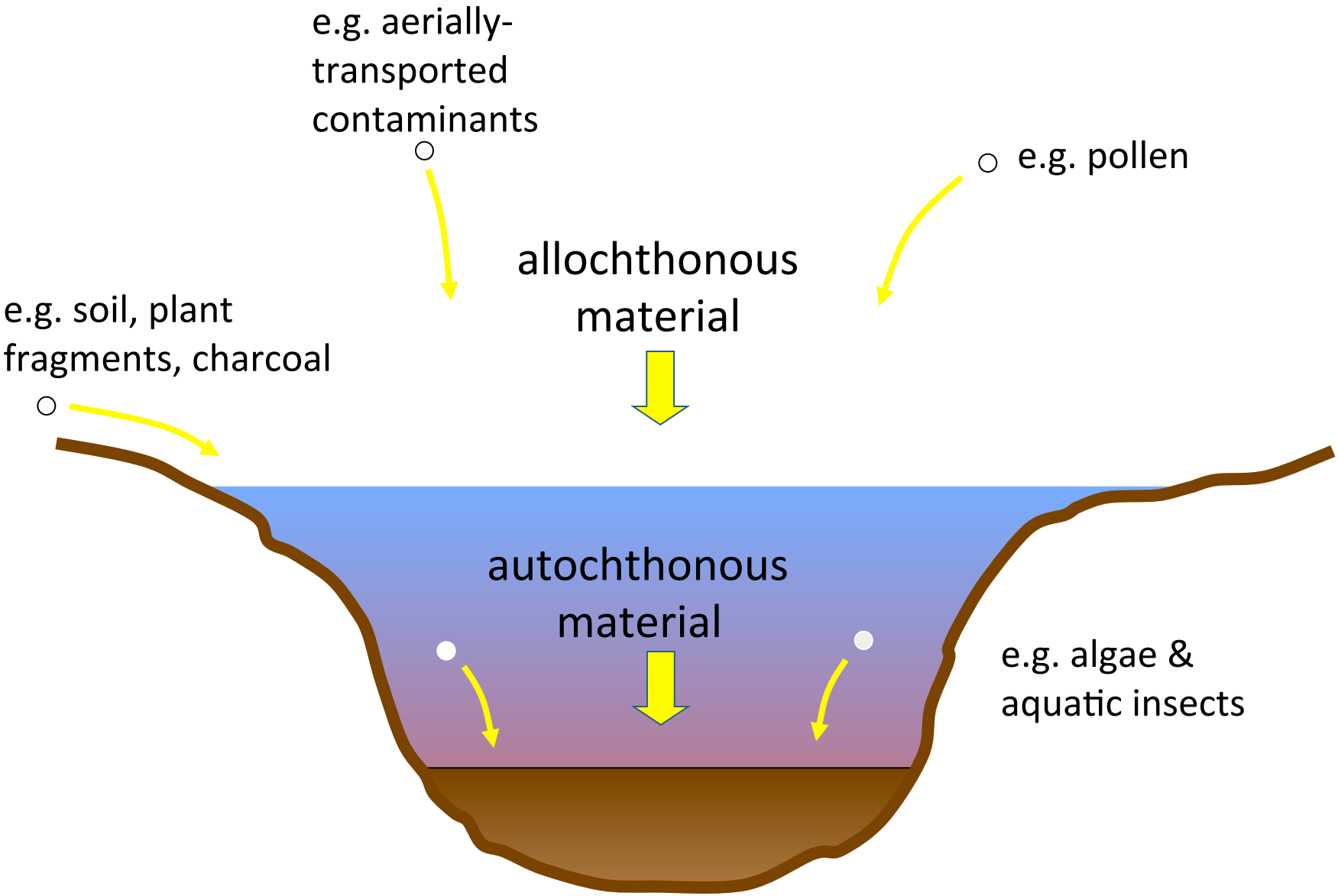
Zebra mussels first detected in great lakes in late 80's

Nutrient enrichment started to take off in the 50's and 60's

Environmental impacts occur over multiple spatial and temporal scales



Sediments: environmental archives



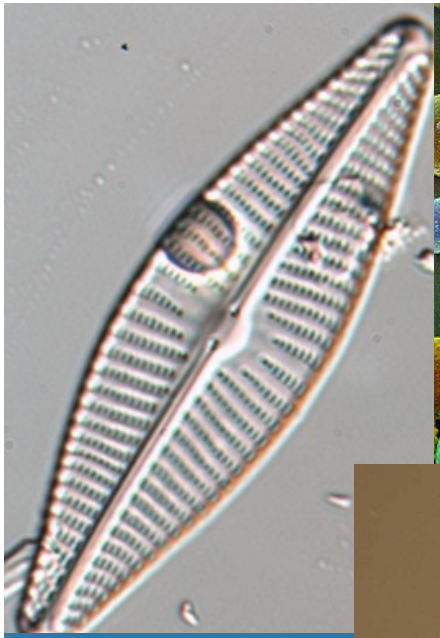
Lake Sediments: Natural Environmental Archives

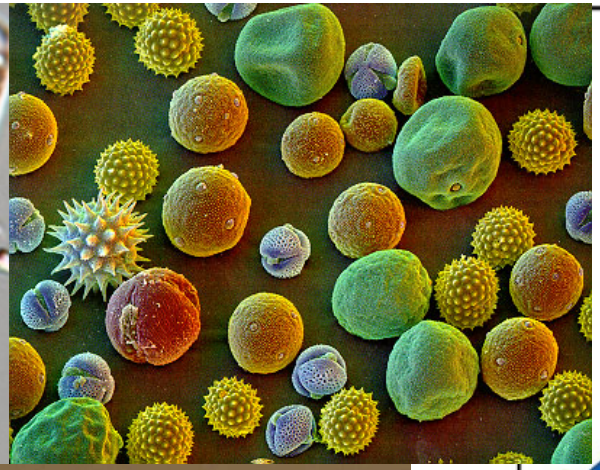
Lake Sediments:

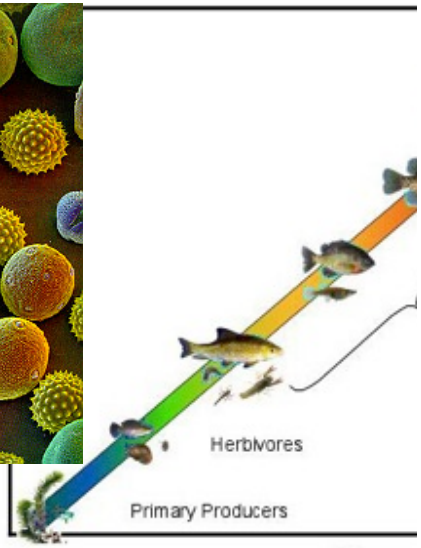
- Continuous record of environmental change over thousands of years
- Chronology based on radio-isotope analysis (^{210}Pb, ^{137}Cs, ^{14}C)
- Preserves a physical, chemical, and biological record of both aquatic and terrestrial environments

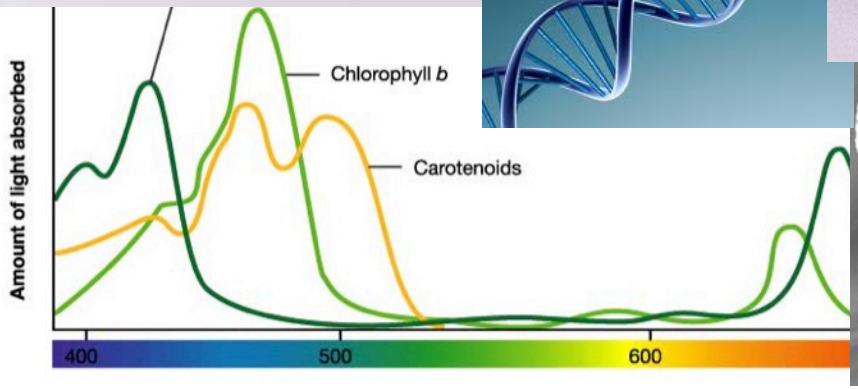
Can provide insight into:

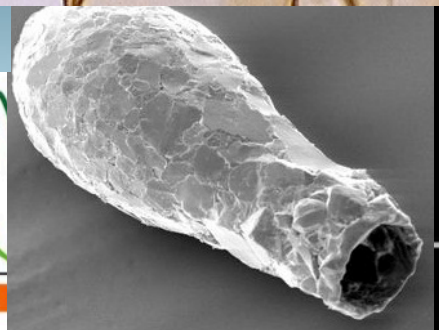
1) Water and sediment quality
2) Water quantity
3) Vegetation
4) Climate
5) and many other ecosystem components






Herbivores
Primary Producers
δ13C (%


Amount of light absorbed
Chlorophyll b
Carotenoids
400
500
600

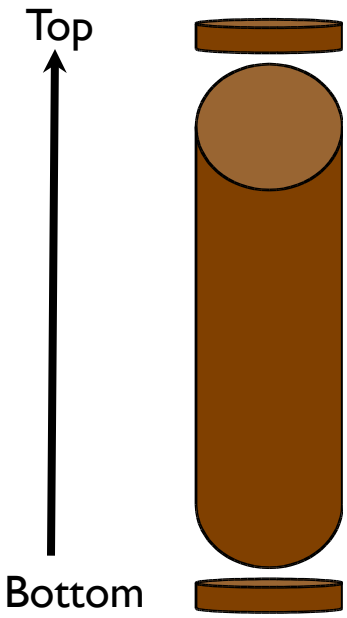



1 inch
1
2
cm

Research component of the OTF

Research questions:

1) How much have phosphorus and algae concentrations changed from “natural” conditions?



← Present day

- Regional assessment of phosphorus and algal change in 20 lakes

← Pre-1850
Historical conditions

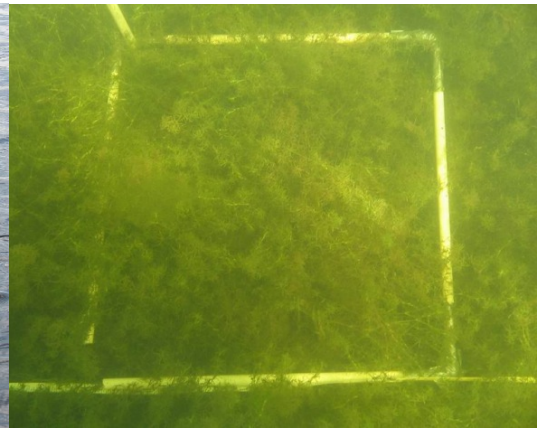
Research component of the OTF

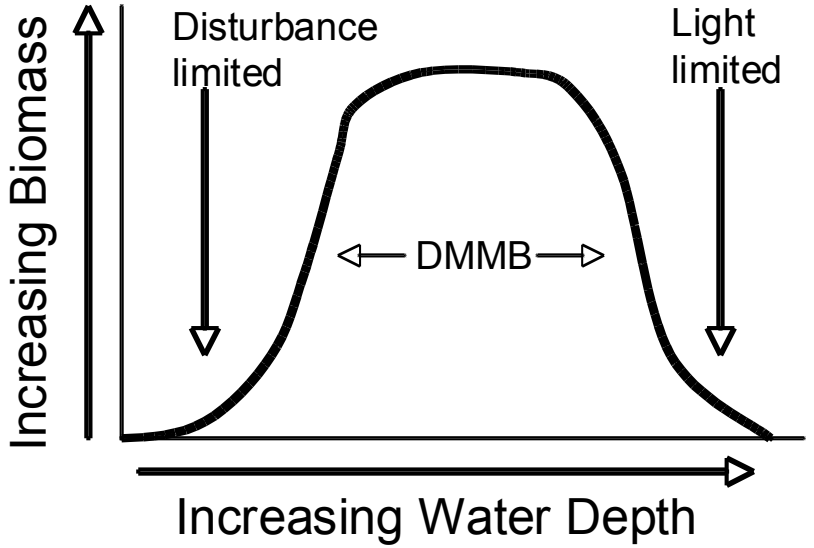
Research questions:

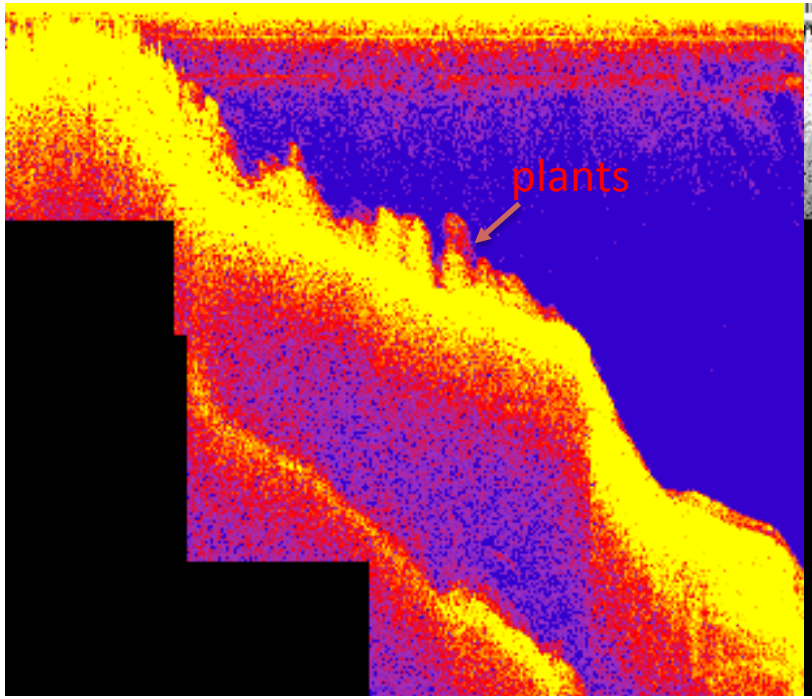
2) What are the important controls on algal and macrophyte abundance in eastern Ontario?

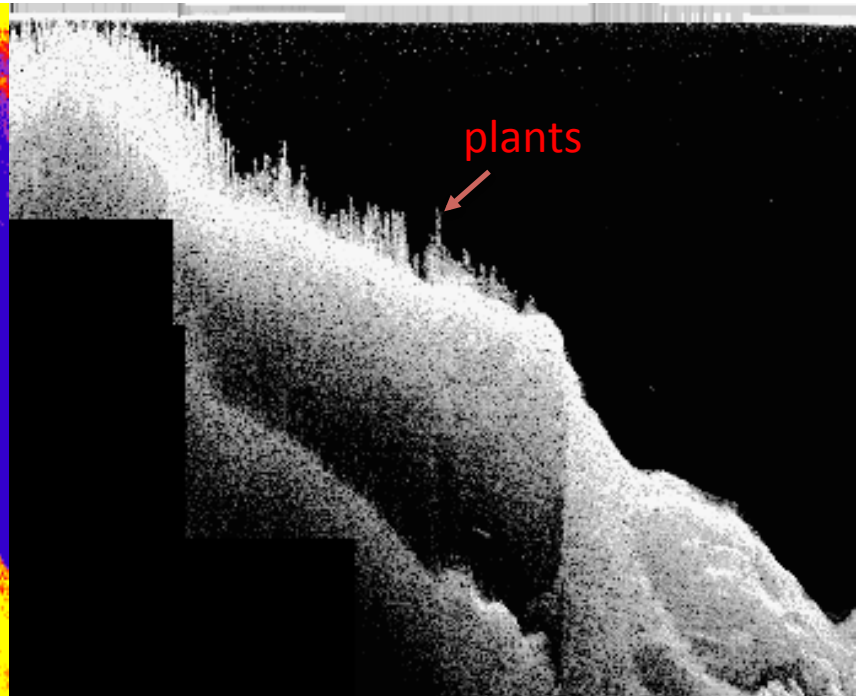
- Spatial survey of 20 lakes in the RVCA and MVCA watersheds (10 lakes in year 1 and 10 lakes in year 2)
  - Lakes were selected over a nutrient gradient
  - Study lakes includes those with and without zebra mussels
  - Study lakes are part of the CA monitoring programs

Macrophyte Sampling







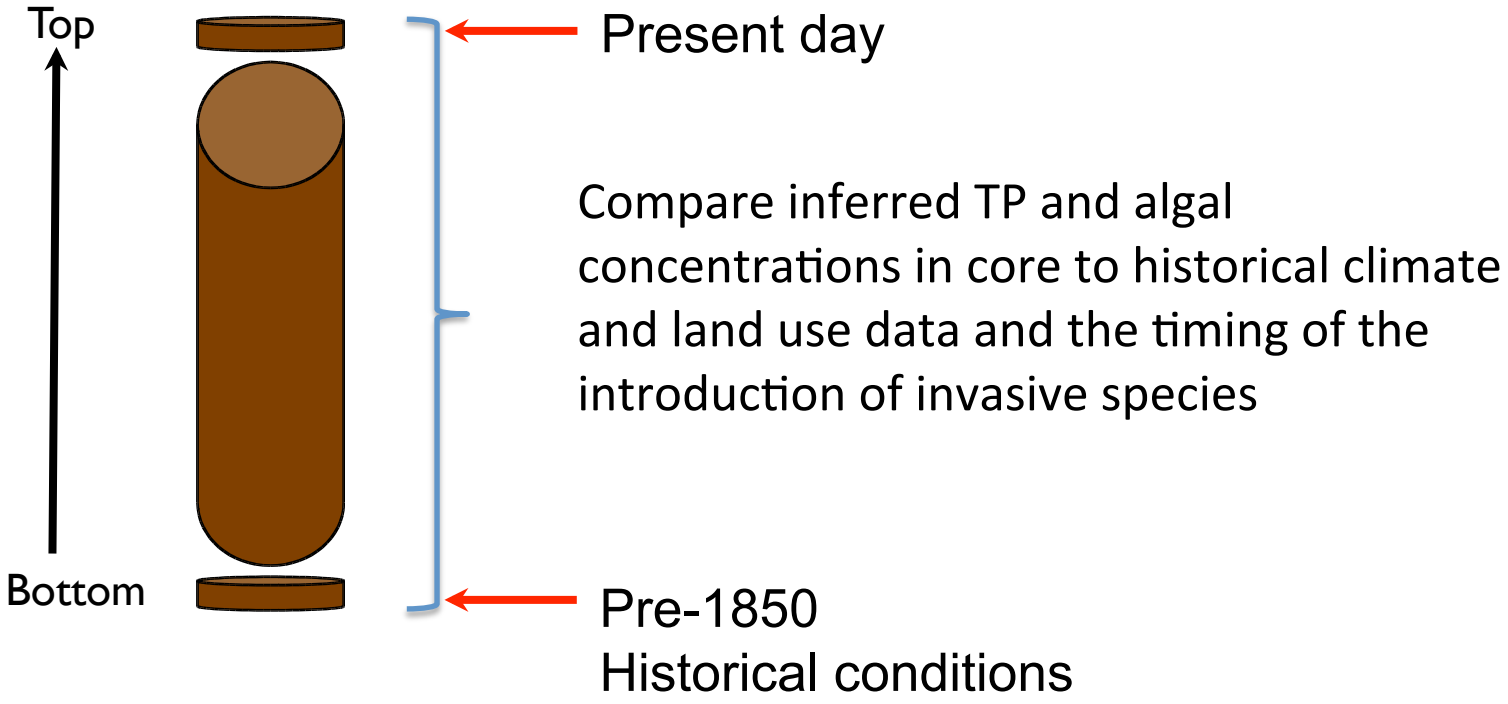


Research component of the OTF

Research questions:

3) Is climate warming related to increased algae and macrophytes?

- Detailed sediment core analysis of 3 lakes
  - Lakes will be selected over a nutrient gradient
  - Study lakes will have similar size, mean depth, and be part of the CA monitoring program



Research Update

20 study lakes

Bobs (Green Bay)	Mosque
Burridge	Malcolm
Crosby	Shabomeka
Bobs (Buck Bay)	Clayton
Christie	Bennett
Otty	Dalhousie
Long Pond	Big Gull
Tommy	Kashwakamak
Adam	Pine
Upper Rideau	Sharbot (East basin)

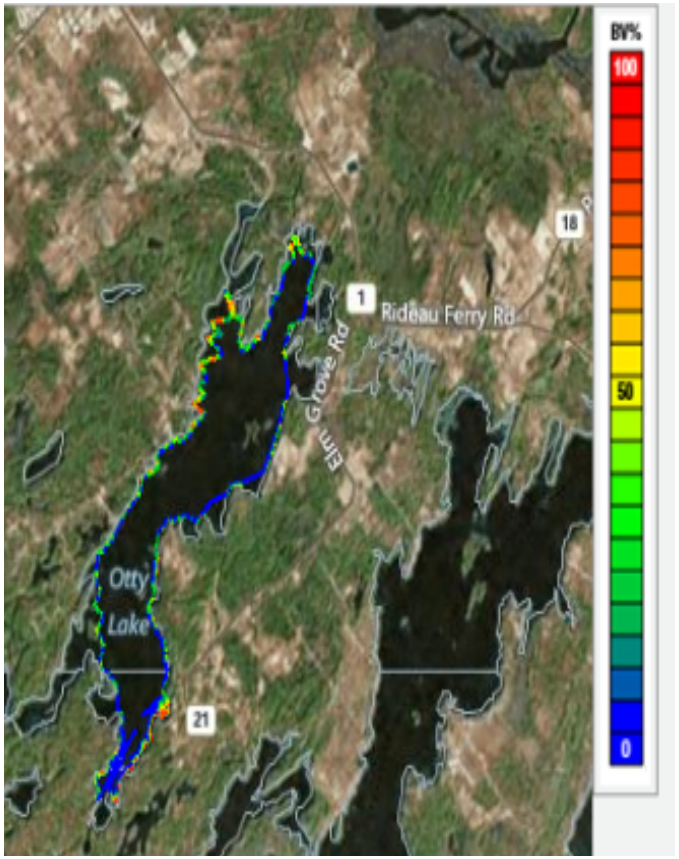
Sediment core analysis

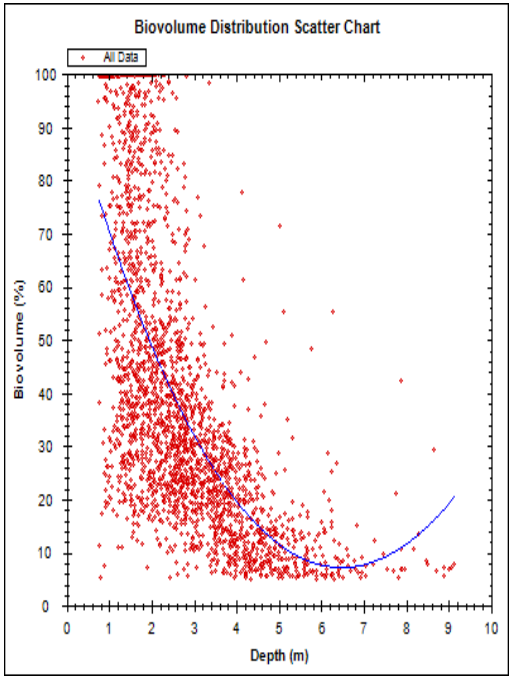
- All 20 study lakes have been cored
- Samples are currently being processed for diatom analysis
- 4 Honours students are working on this project (plan to have diatom IDed before start of winter semester)
  - Alex Crew
  - Emily Barrie
  - Sharon Odongo
  - Kathryn Sweet
- 4 Work-study students are helping with the lab work
  - Evan
  - Idil
  - Carly
  - Aisha

73 lakes were cored

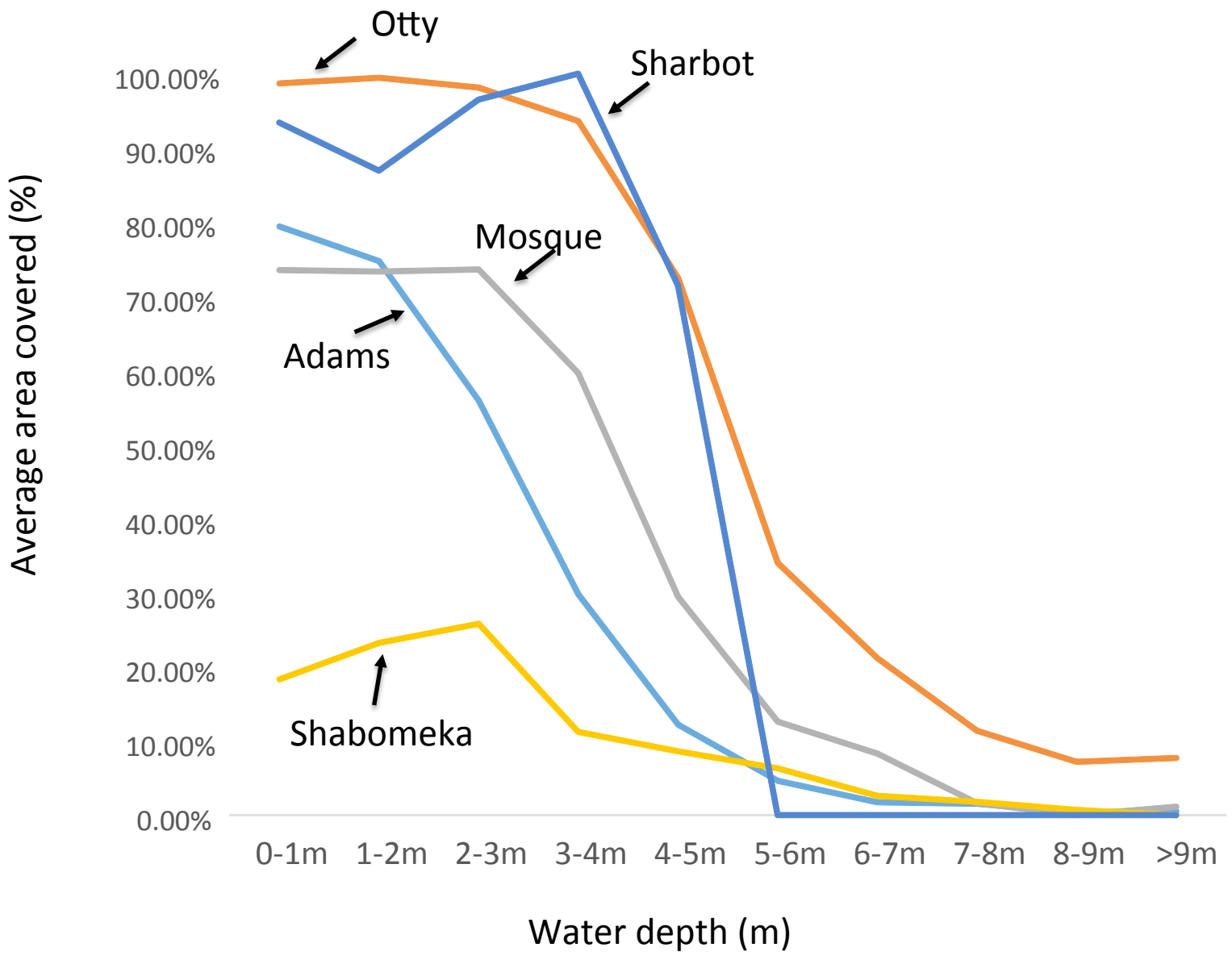
Macrophyte and algae analysis

- 10 study lakes have been sampled
- Samples are currently being analyzed
- Macrophyte biovolume assessed using echosounder
- Colonial algae noted during sampling along with presence of invasive macrophytes



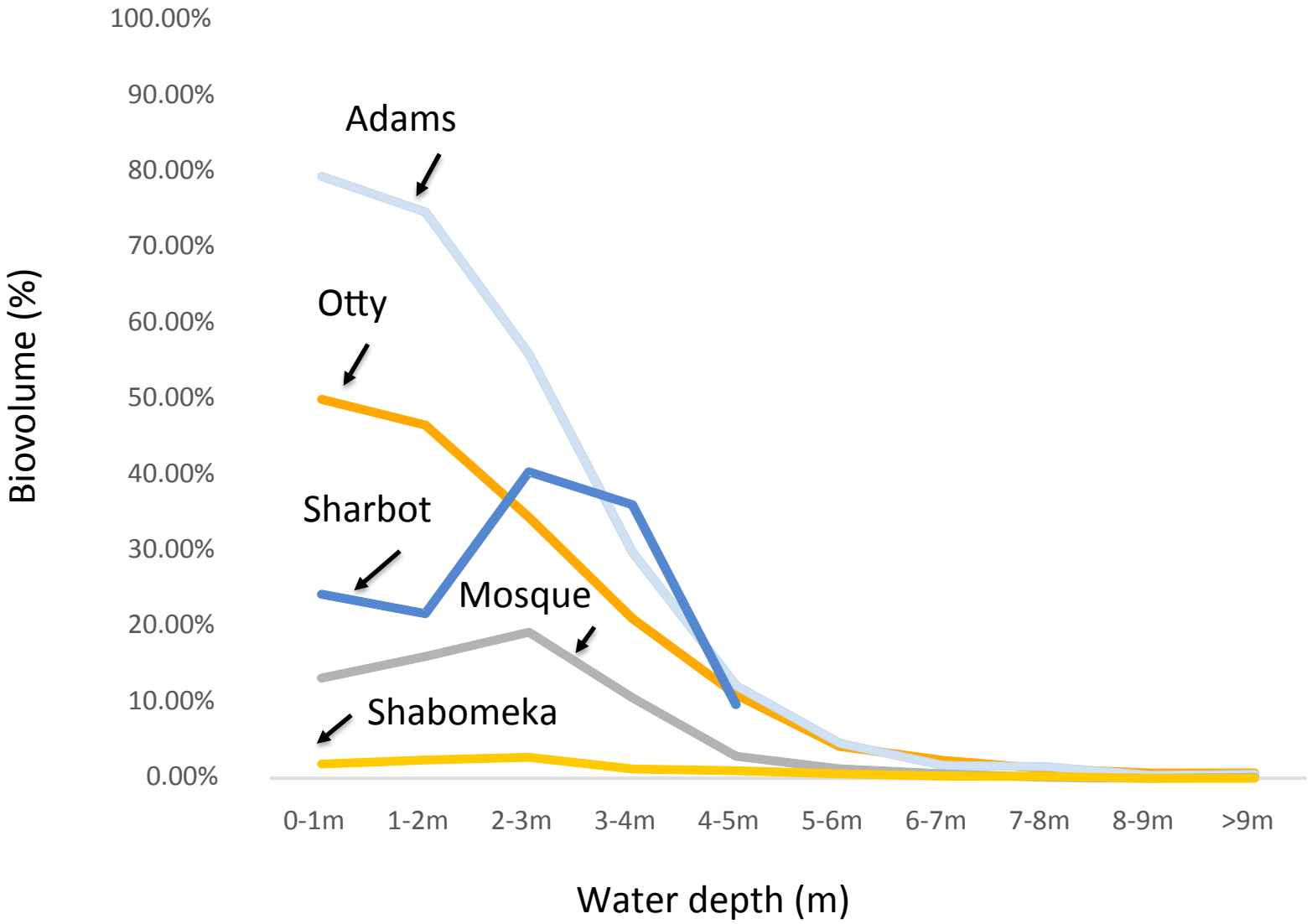


Percent Area Covered by Macrophytes

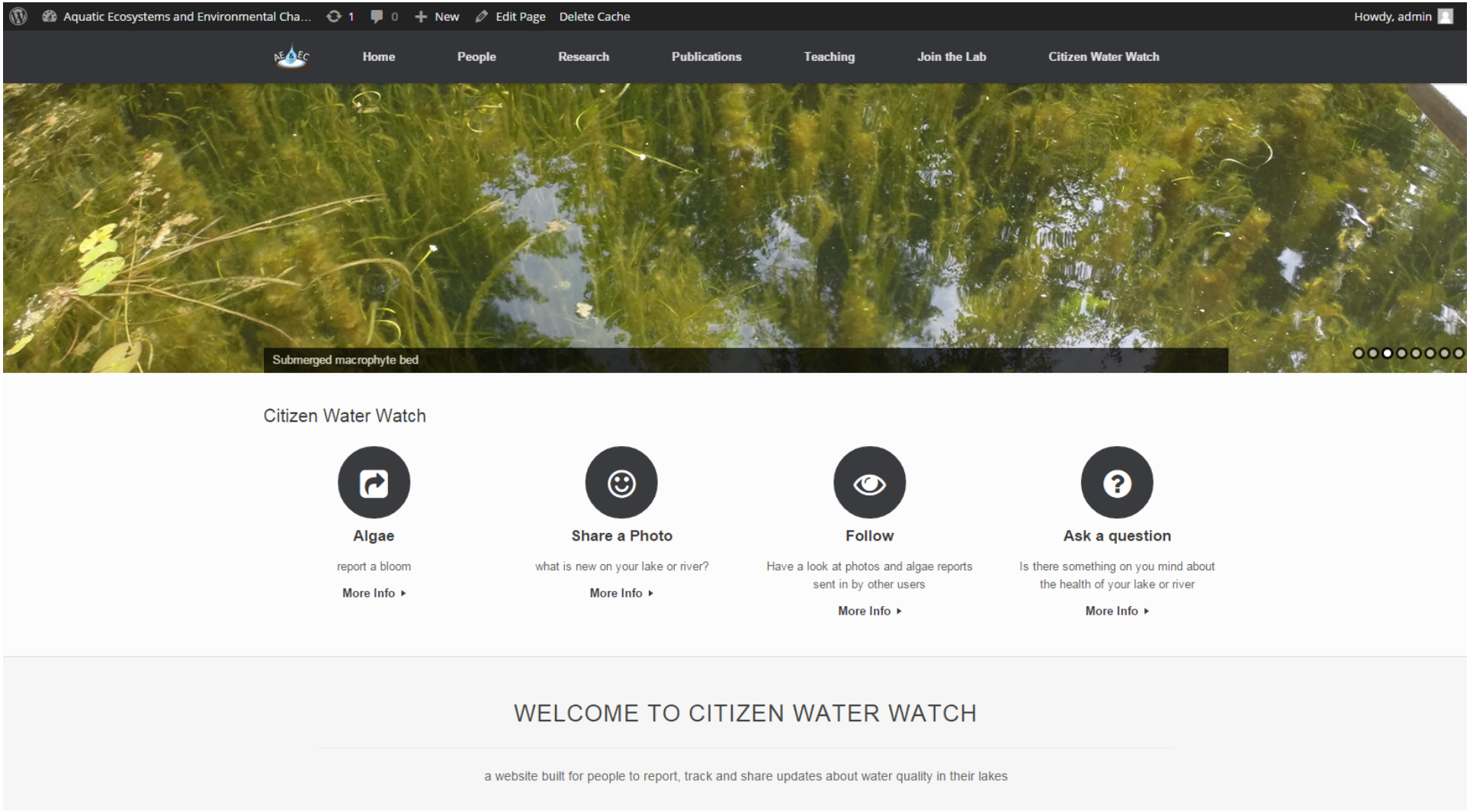


Percent Biovolume of Macrophytes

(% of water column occupied by plants)



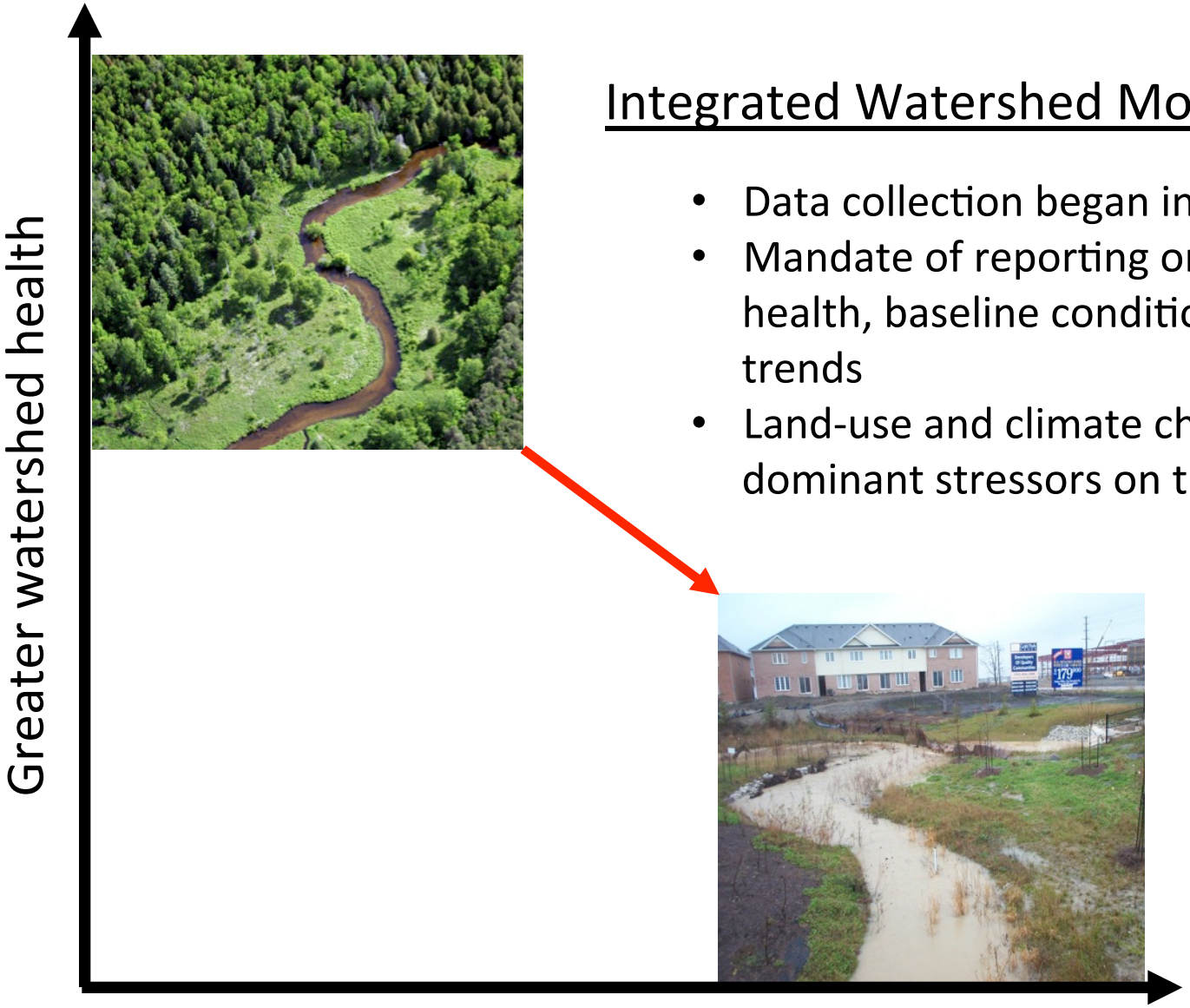
Citizen Science Website and App



"The picture's pretty bleak, gentlemen. ... The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut."

Luckily our brains are about the size of a cantaloupe not a walnut!

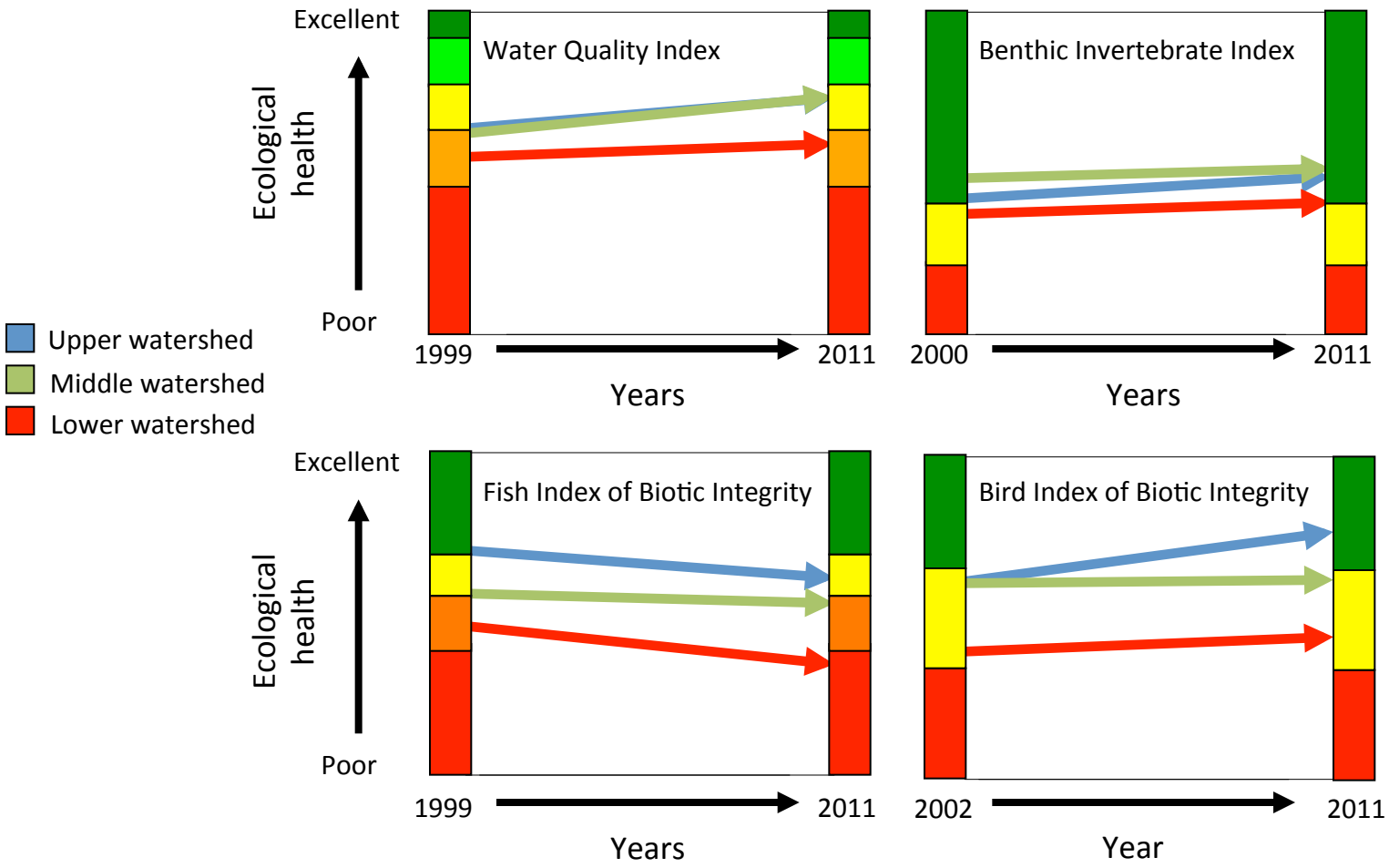
Once we have identified a problem we can begin to take action to solve it.



Integrated Watershed Monitoring Program

- Data collection began in 1999
- Mandate of reporting on ecosystem health, baseline conditions and long-term trends
- Land-use and climate change are the dominant stressors on the watershed

Trends in ecosystem health



Evidence for improving ecosystem health at the subwatershed scale

Vermaire *et al.* in prep

Ontario Trillium Foundation

Fondation Trillium de l'Ontario

An agency of the Government of Ontario.
Relève du gouvernement de l'Ontario.


Thomas
4 months old
Warren
99 years old

Slater St. 1913 (Downtown Ottawa)

Warren 4 months old

Slater St. 2013

Thomas 4 months old

Humans are changing the world quickly and this level of change is unprecedented.

Anthropocene: A proposed geological time period where earth system processes have been altered by humans

Growing consensus that we have entered this new geological epoch debate is largely about when it started