Multiple Stressors in Canadian Shield Lakes: Monitoring and the role citizen science

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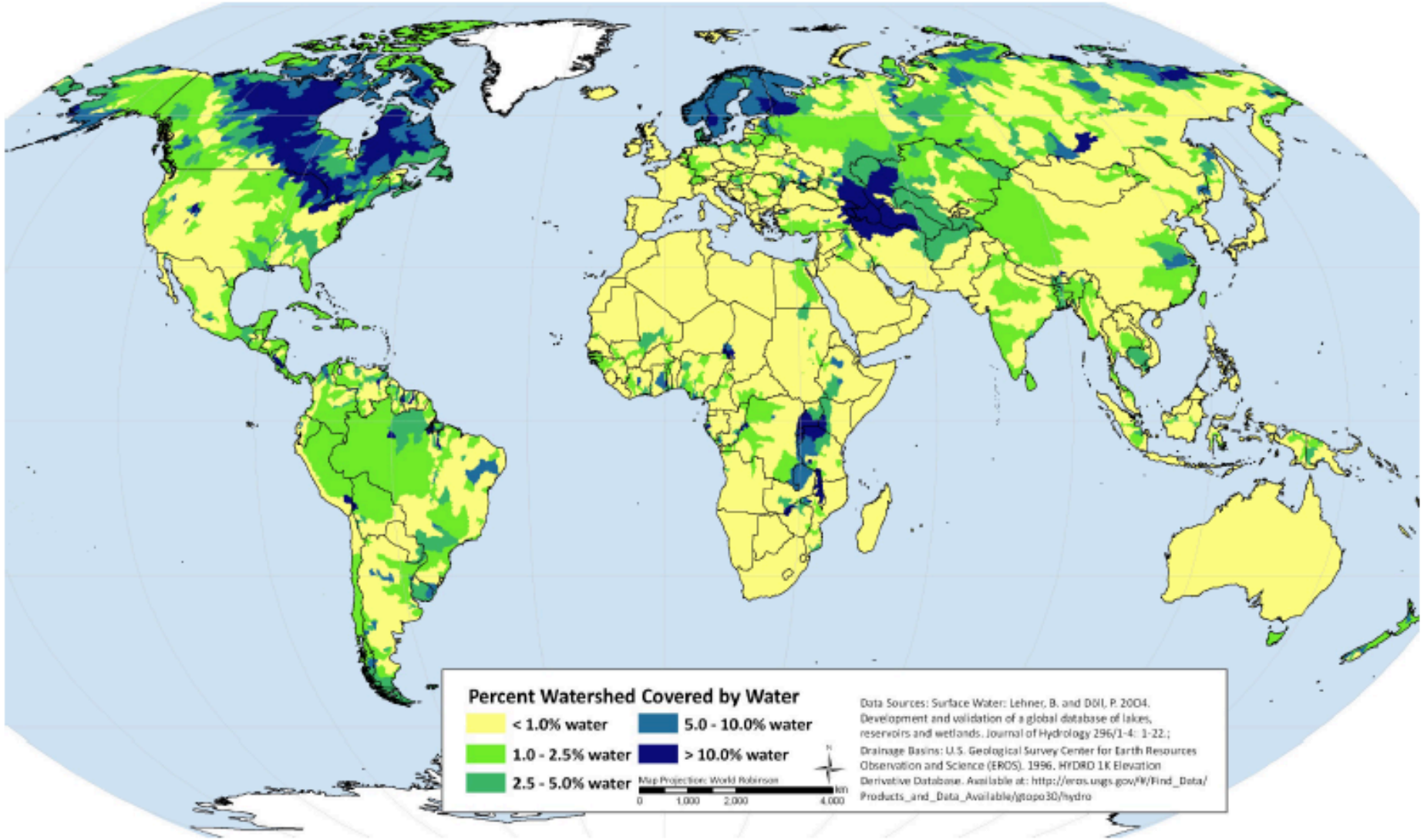
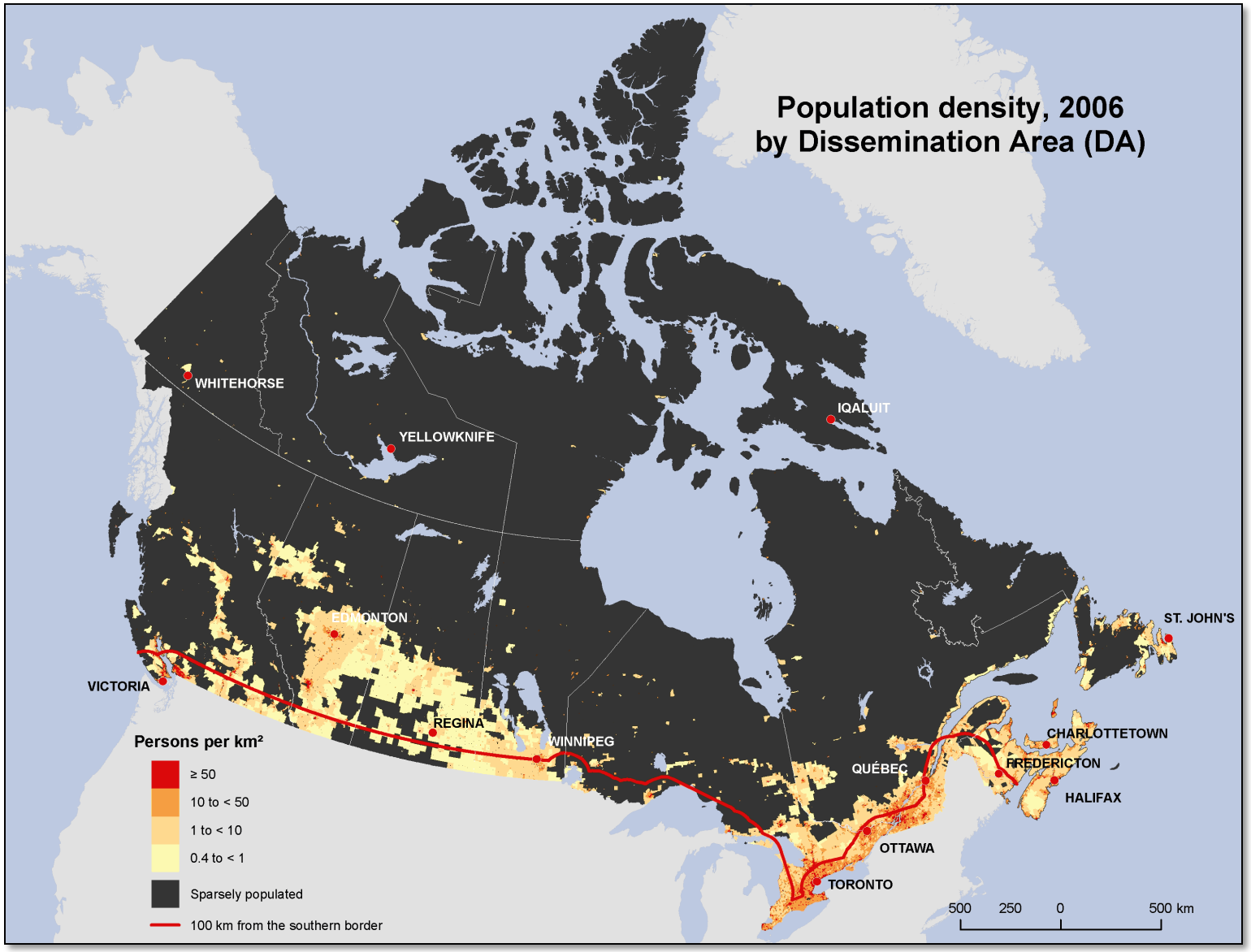
Canada's boreal forest contains 25% of the world's freshwater



Where do Canadians live?



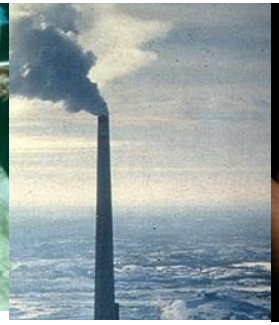
Canada's lakes are facing many challenges

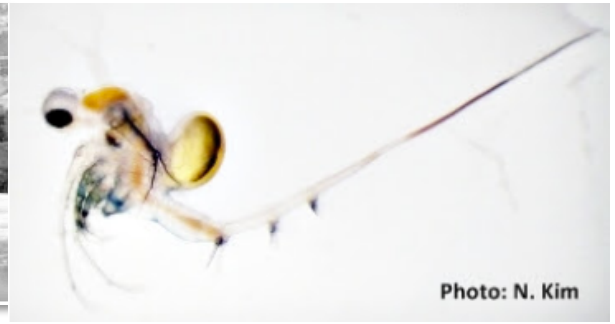
Historical (on-going)

- Eutrophication
- Acid rain
- Metals
- Pesticides

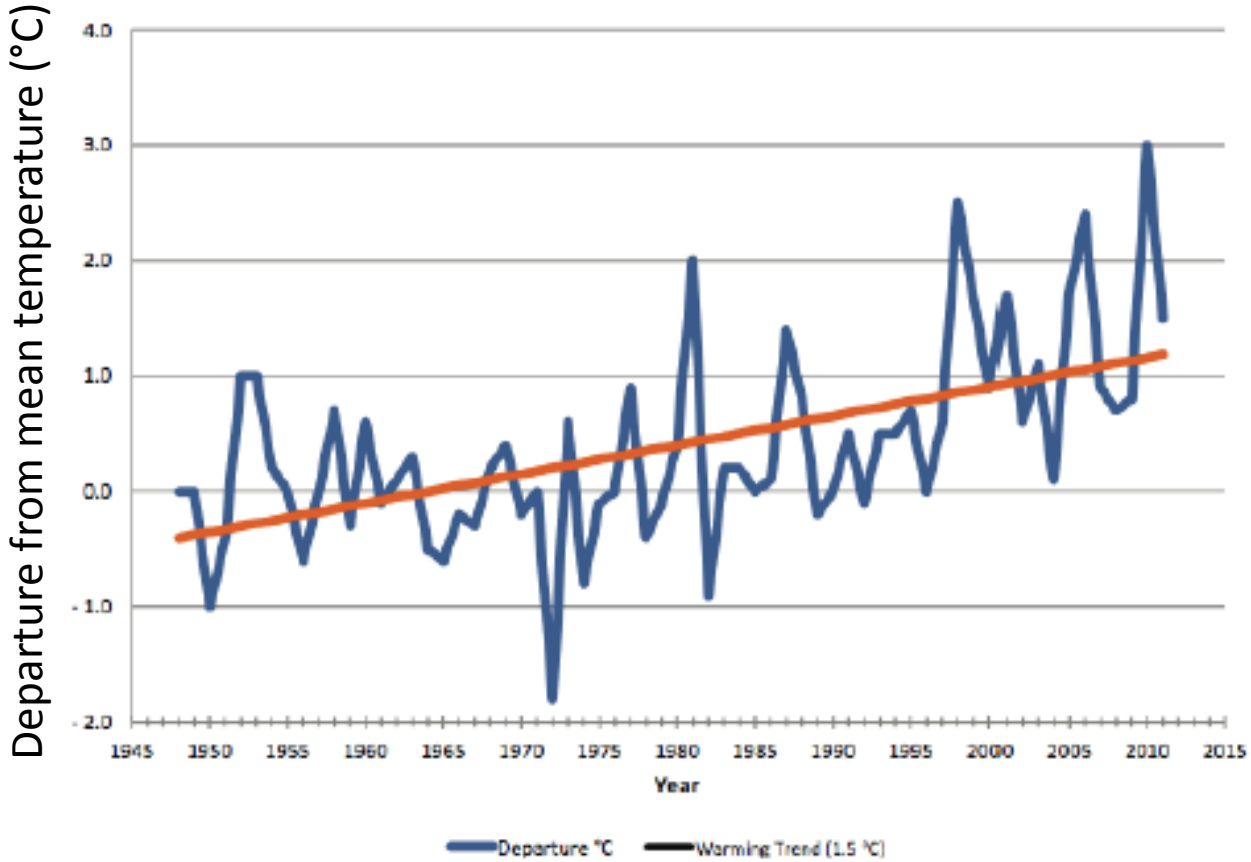
Emerging issues

- Climate change
- Invasive species
- Calcium decline
- Road salt
- "brownification"

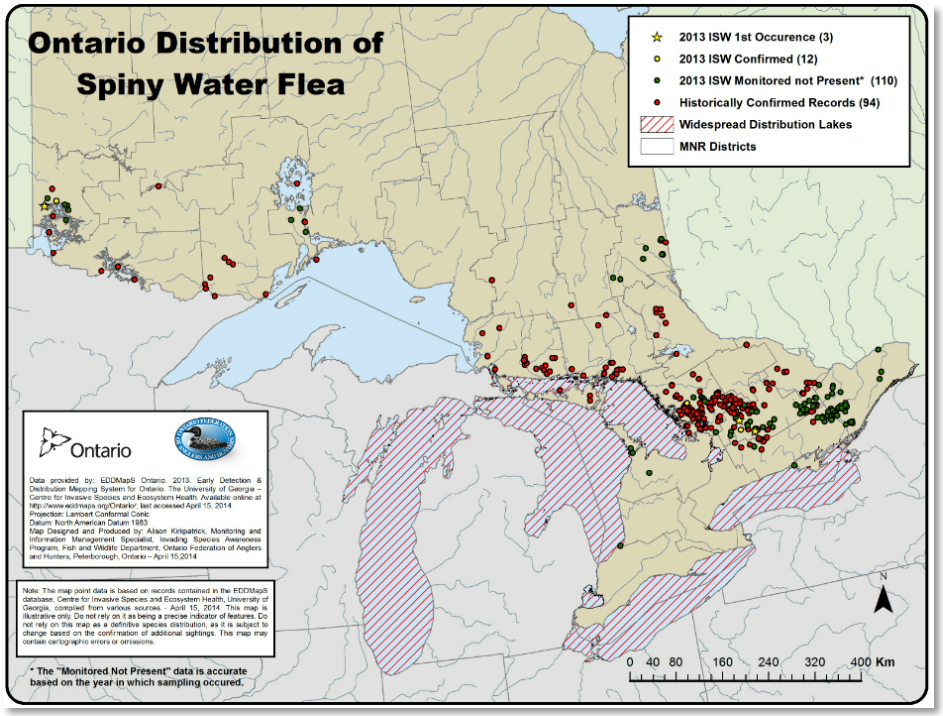
Climate change is happening

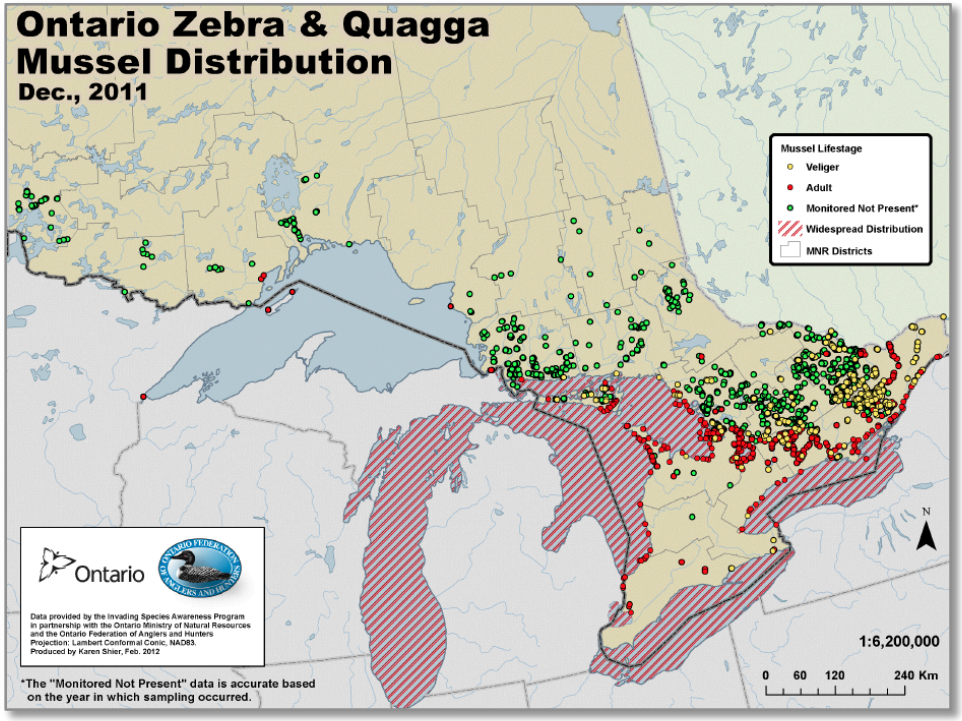


Source data: Environment Canada (2012)

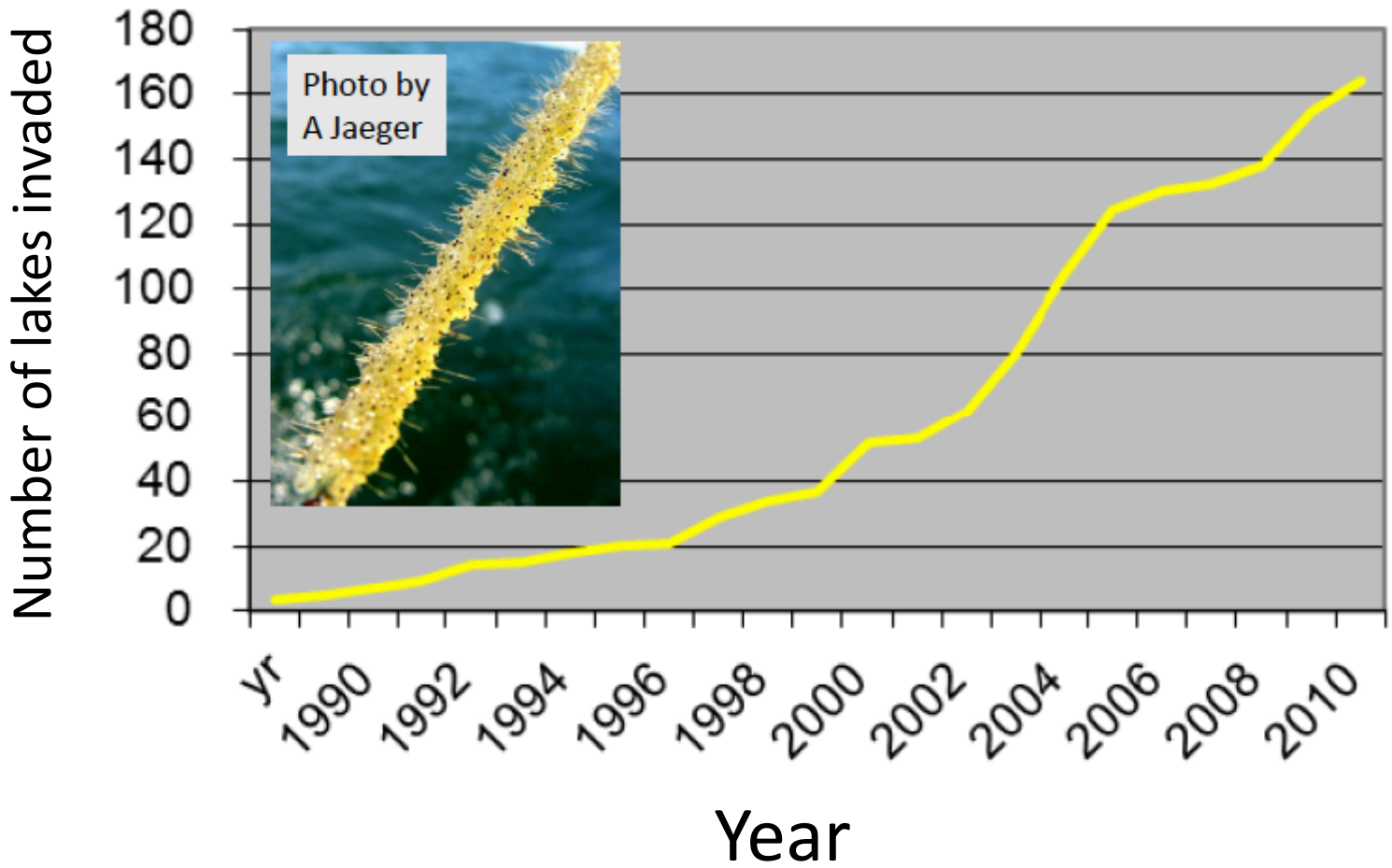
Departures of air temperature from 1950-1980 mean

Invasive species are spreading





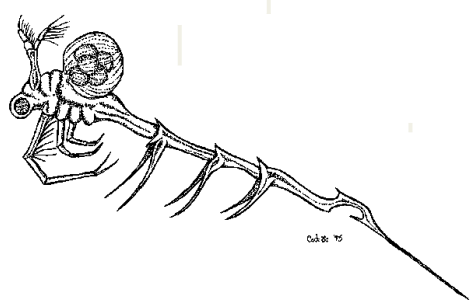
Bythotrephes is spreading through Ontario lakes

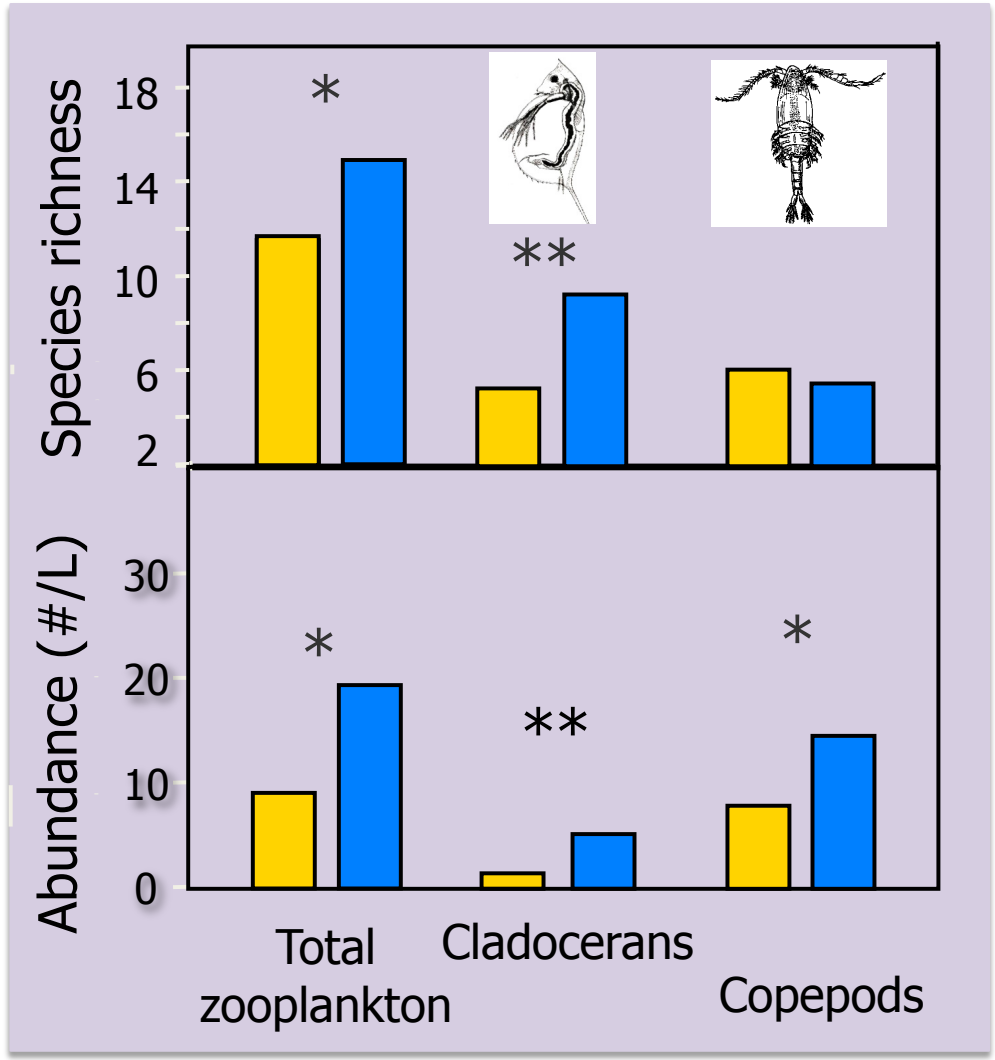


Bythotrephes has large effect on zooplankton communities

Lake survey every two weeks

- invaded (n=10)
- not invaded (n=4)

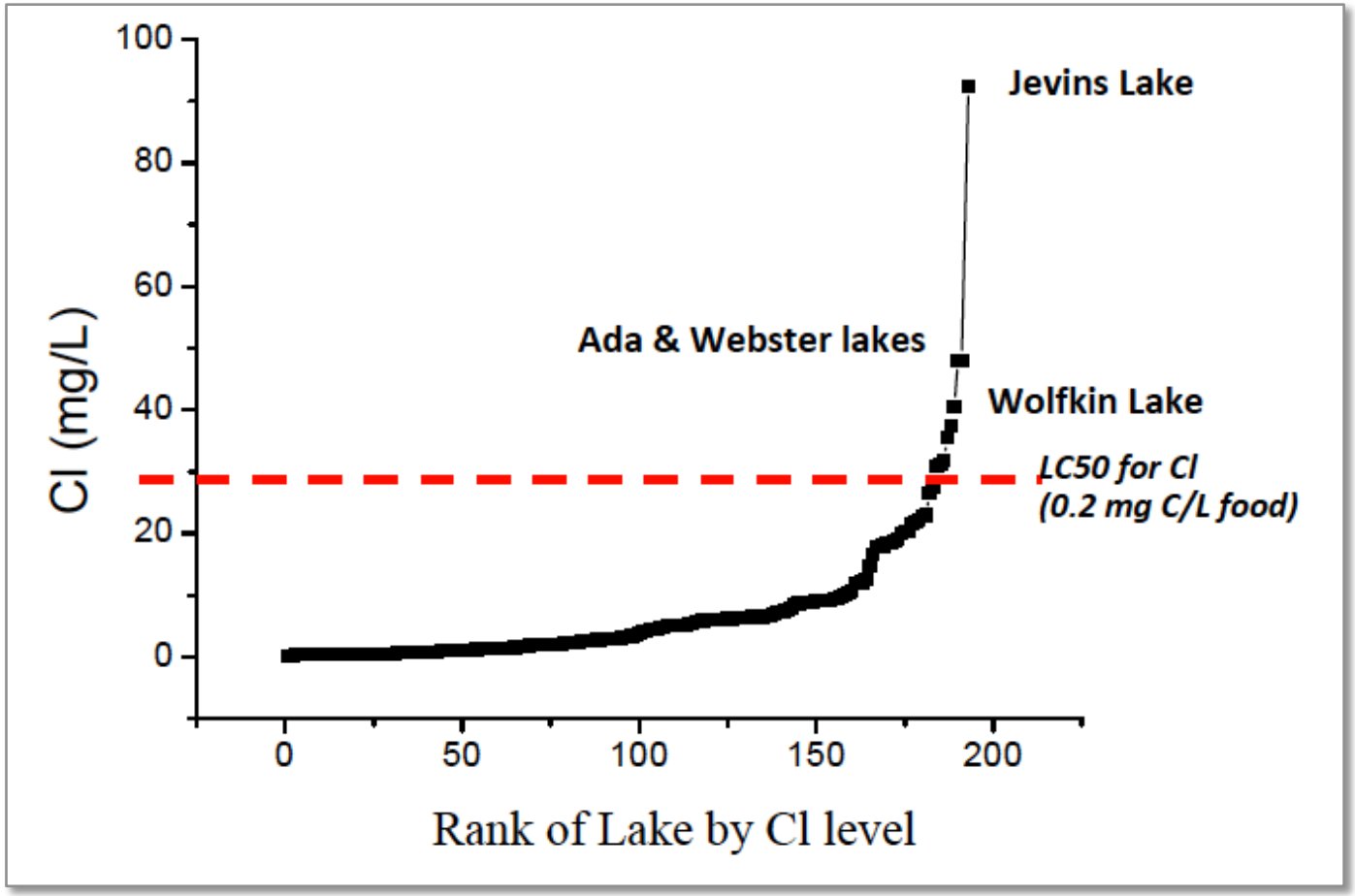




Chloride concentrations in lakes are increasing

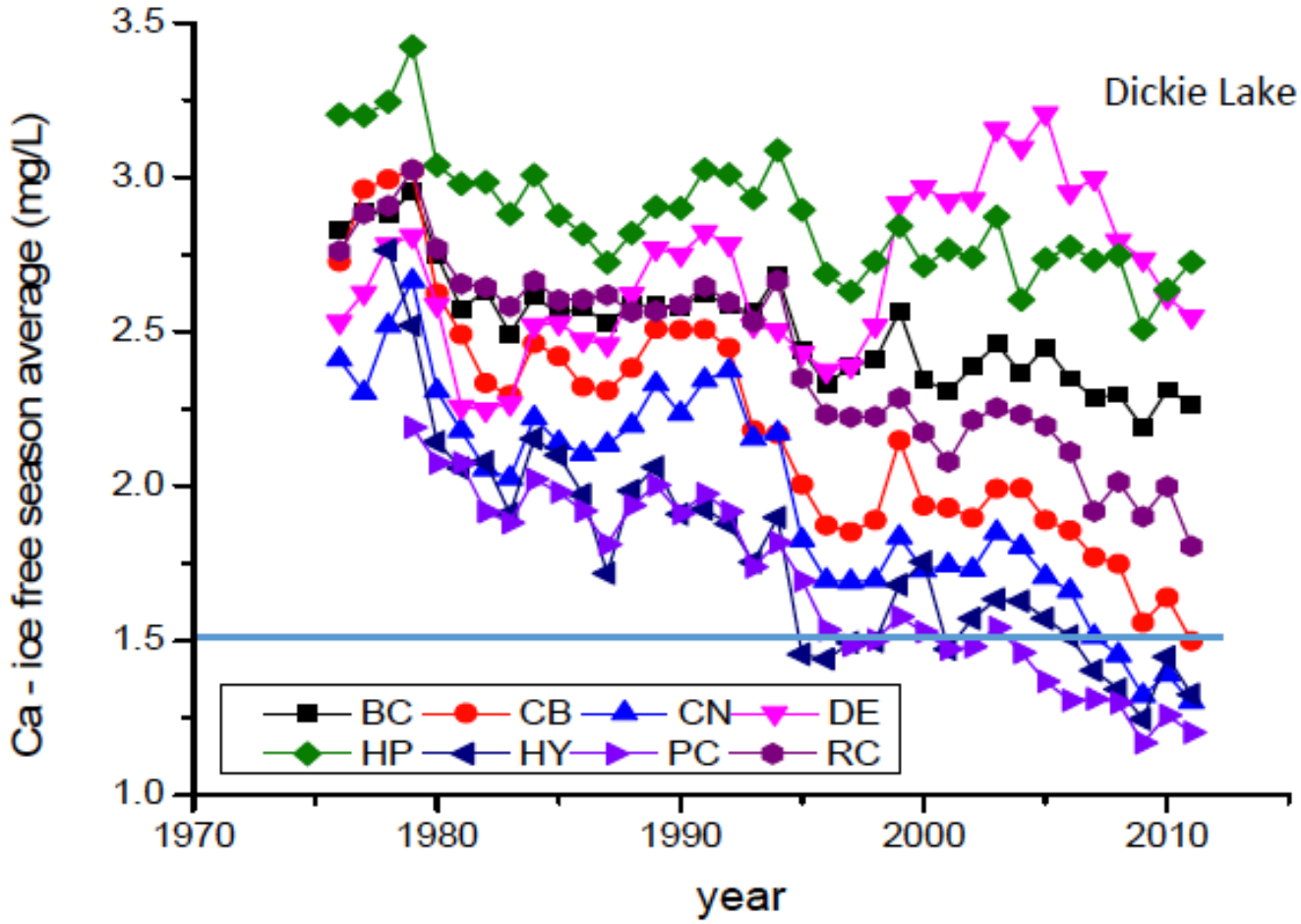
1,500,000 tonnes of salt is used to de-ice Canadian roads

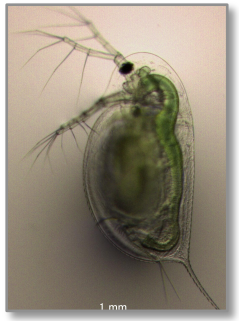
Chloride concentration in 180 Ontario lakes



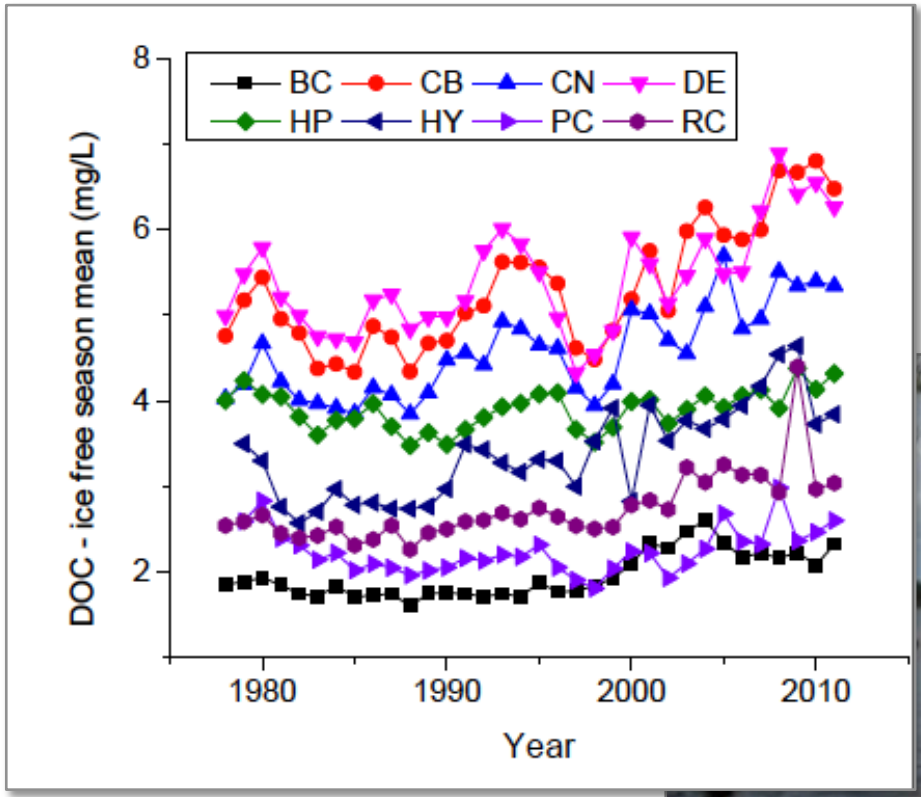
Could be a problem for lakes near highways

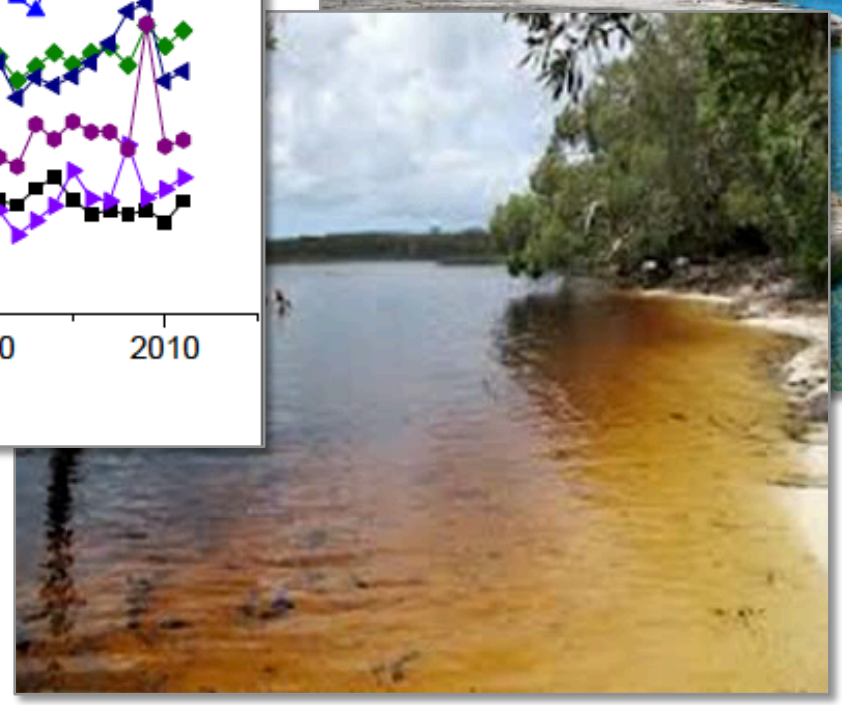
Calcium concentrations are declining



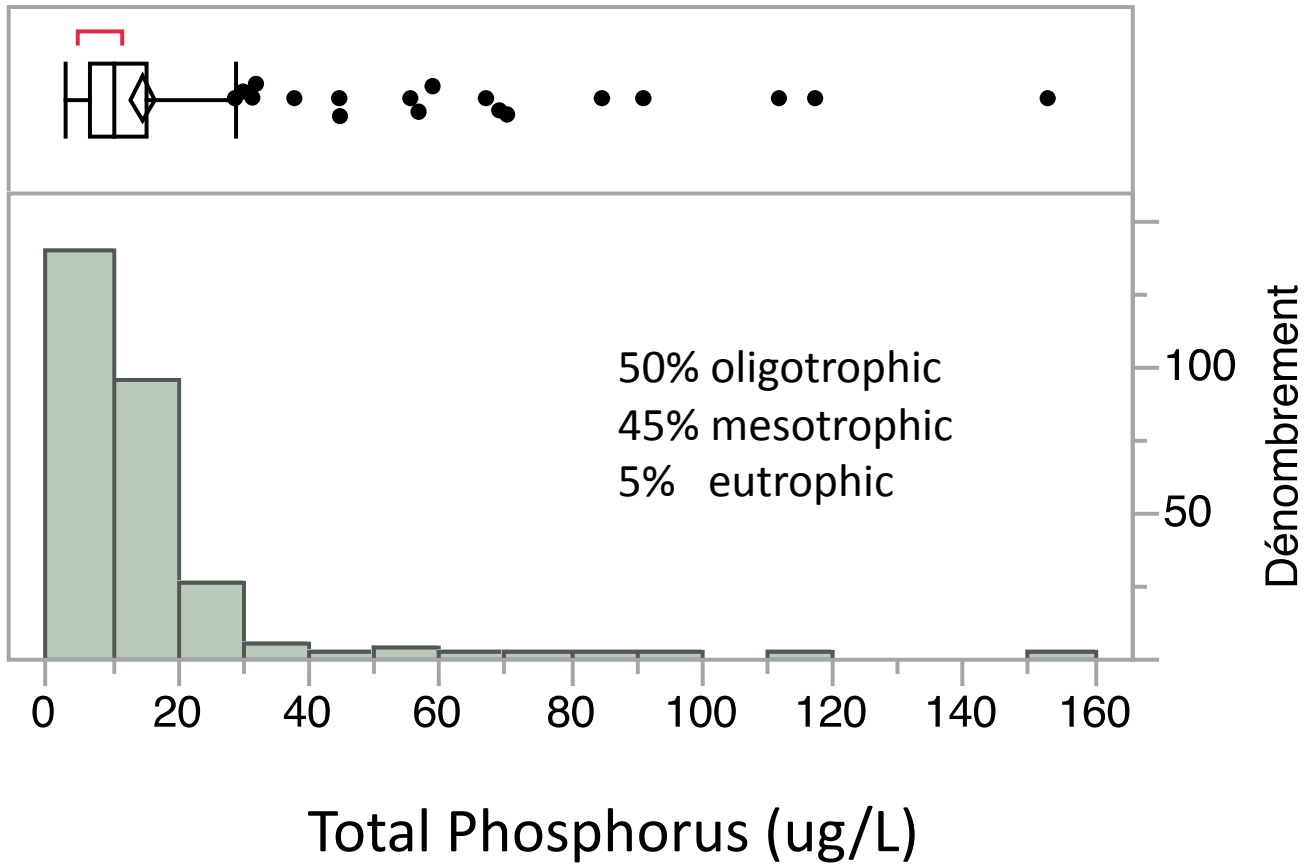


Dissolved Organic Carbon (DOC) is increasing



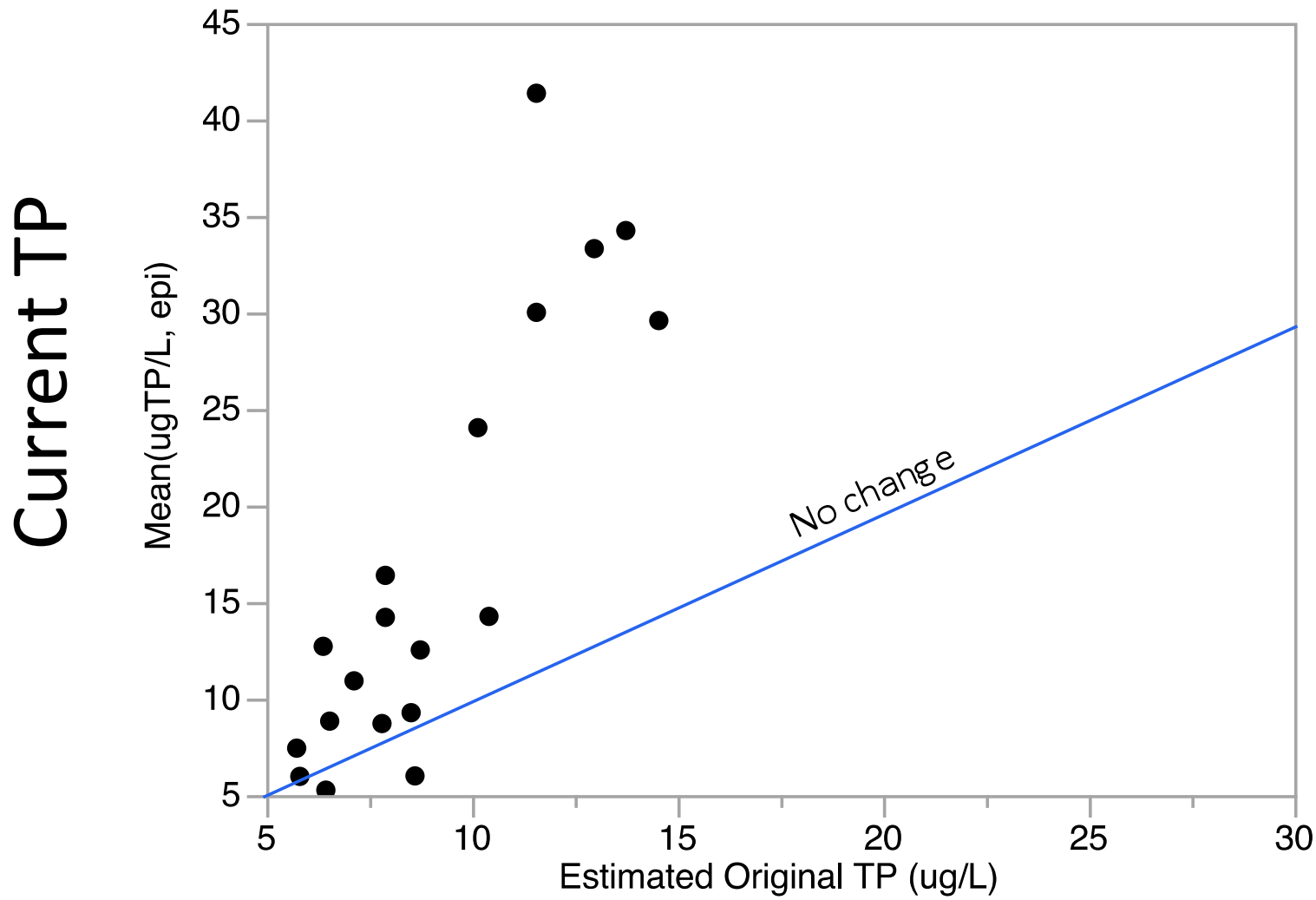


Eutrophication

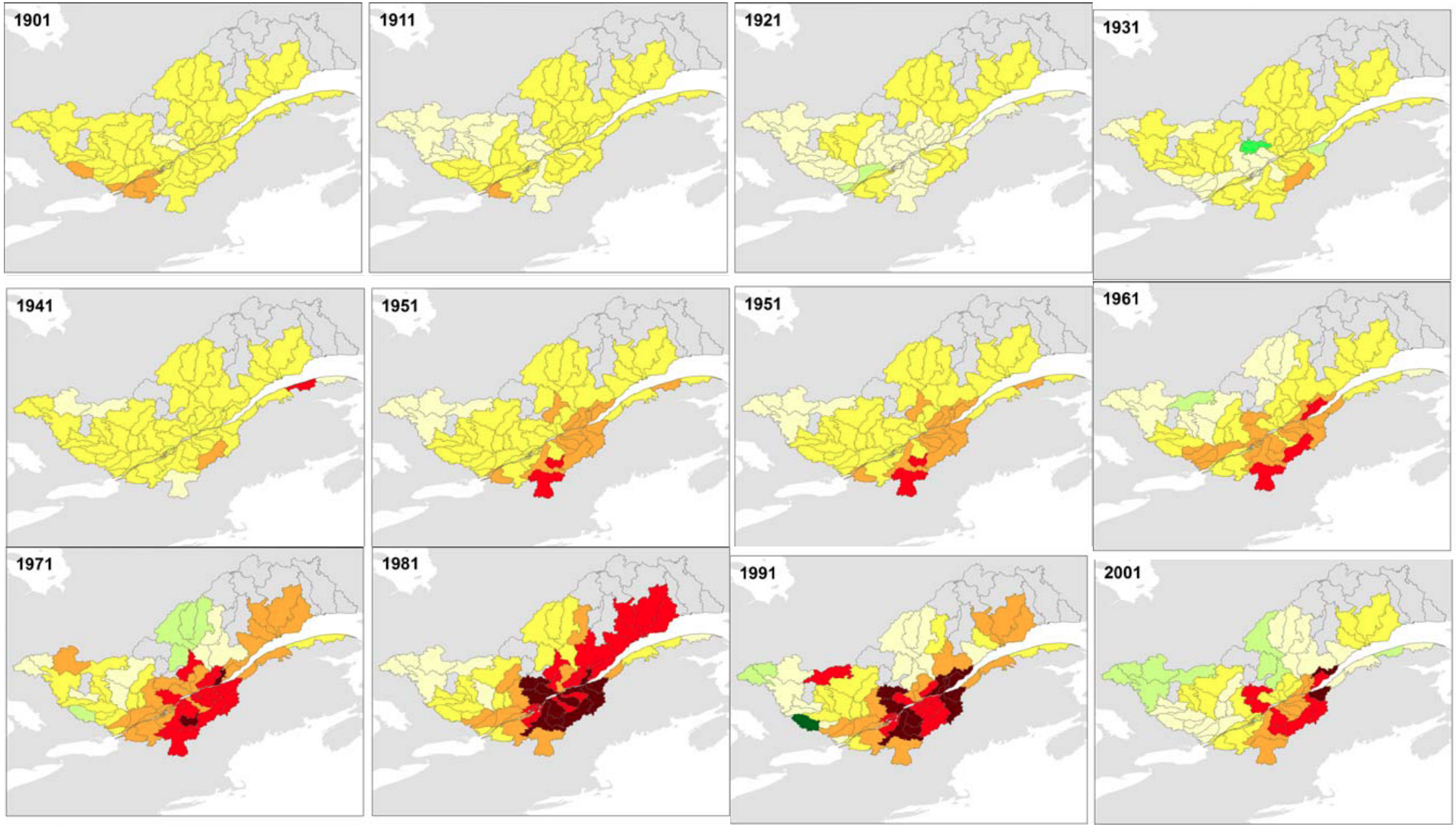


Nutrient levels are generally low…

But, conditions are changing…



Phosphorus burden in soils has increased through time



Blue-green algal blooms in the news…

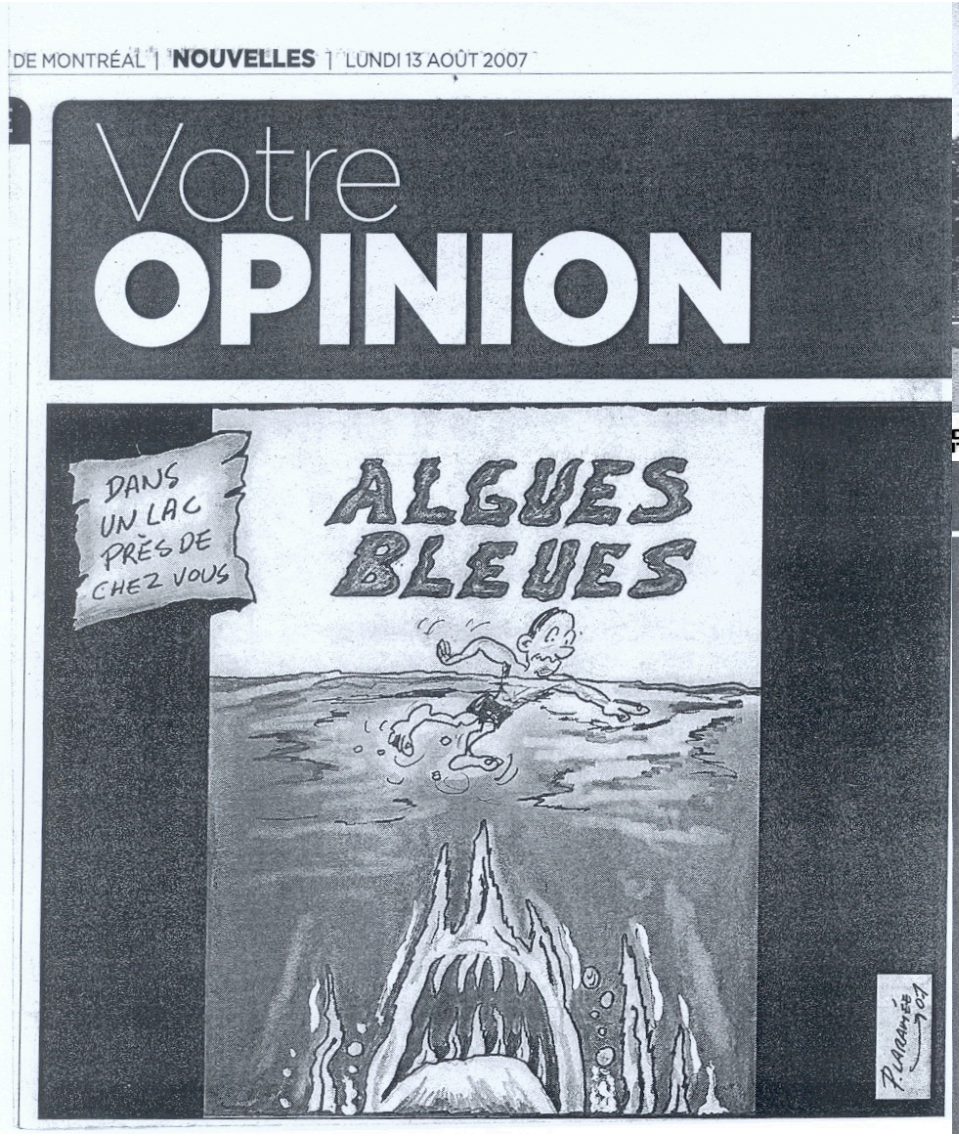
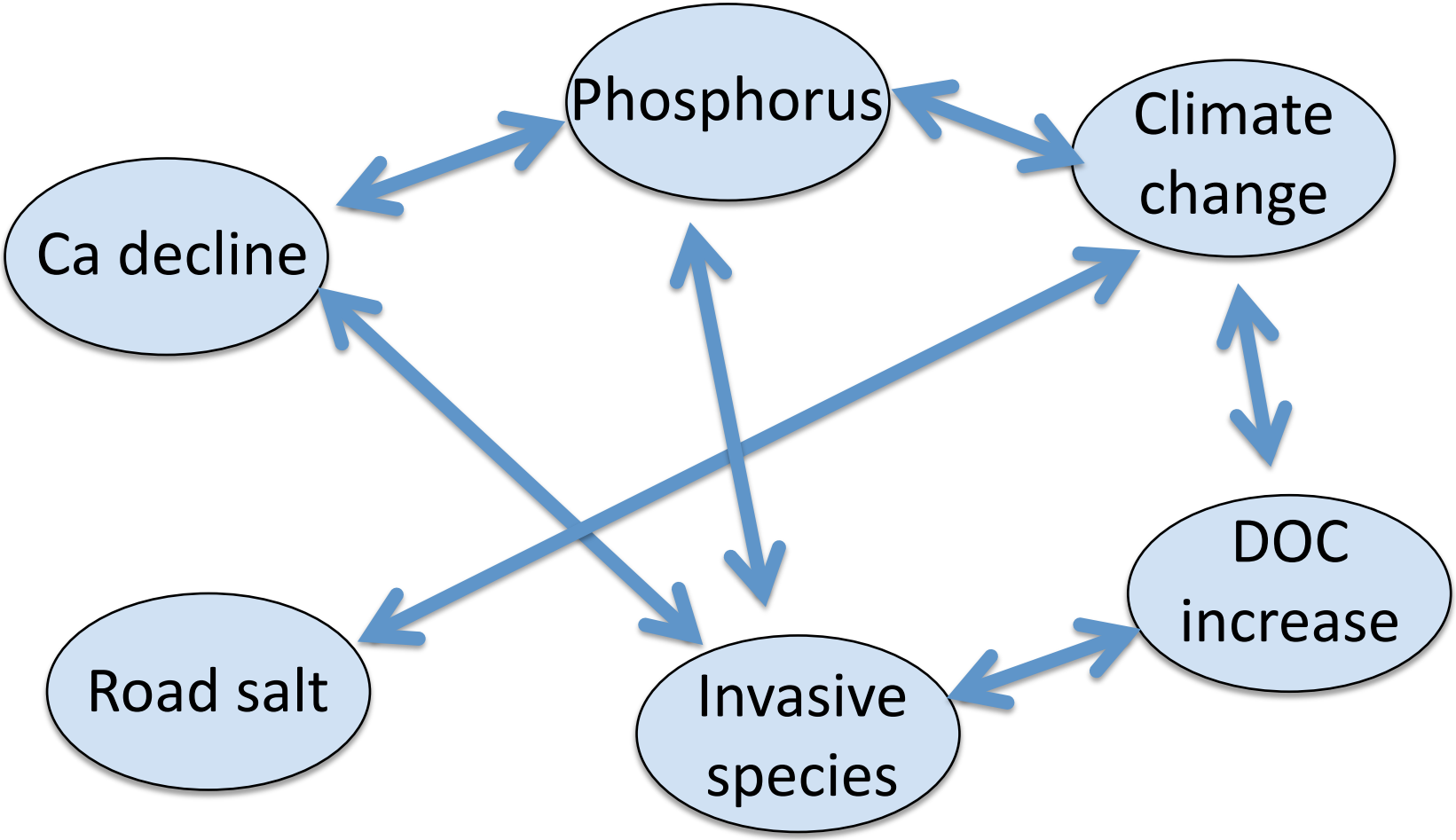


PHOTO ROBERT MAILLOUX, LA PRESSE ©

Dès qu'il y a signalement par un citoyen et confirmation visuelle de la présence d'algues bleues par le ministère de l'Environnement, le lac visé se retrouve sur la fameuse liste des cours d'eau contaminés.

Interactions among stressors



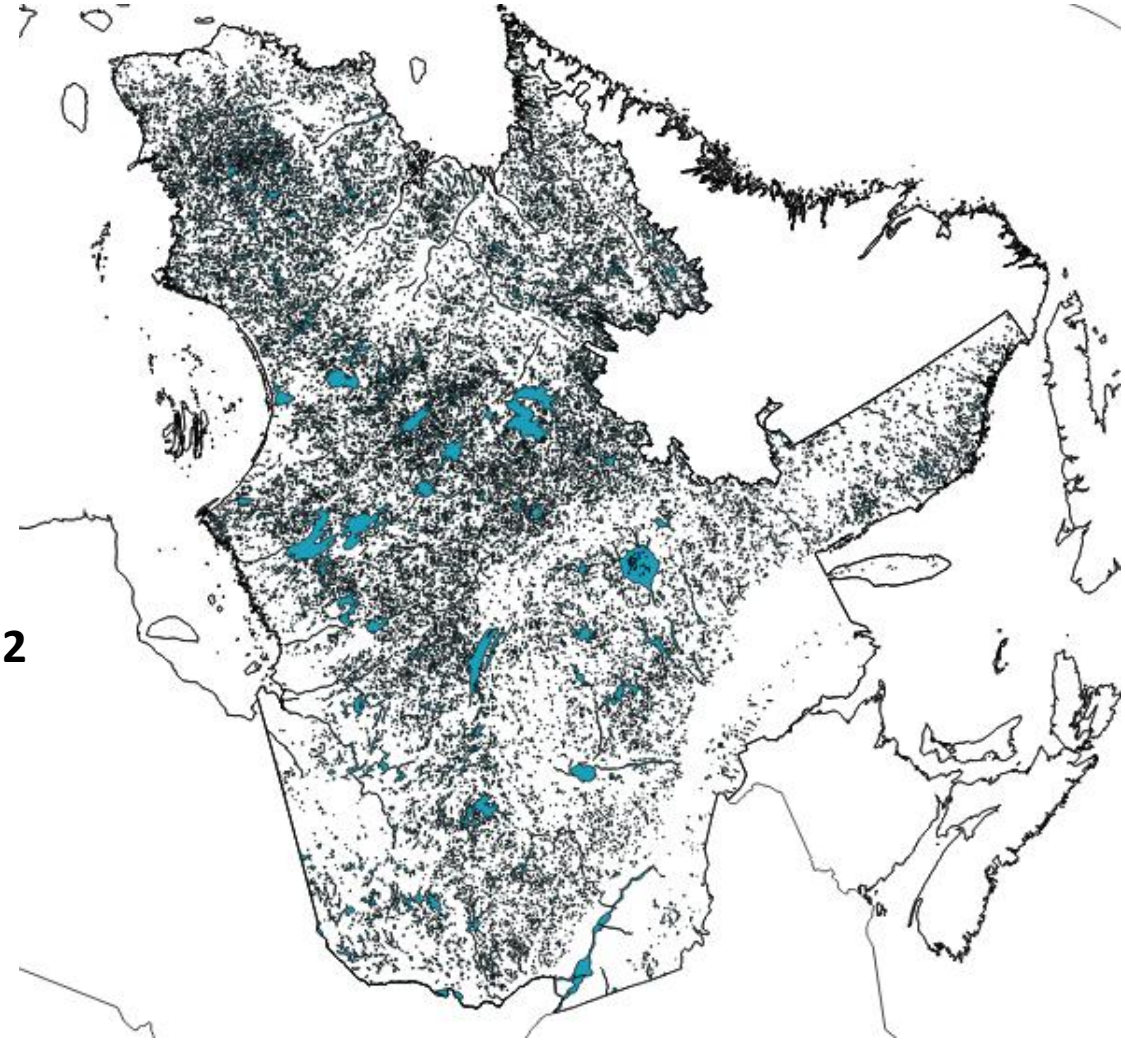
910,000 lakes >10 ha in Canada
37% of the global total

Many are in Quebec…

Average Lake Size: **8ha**

Lake area: **340,000 km^2**

Lake coverage: **22.6%**



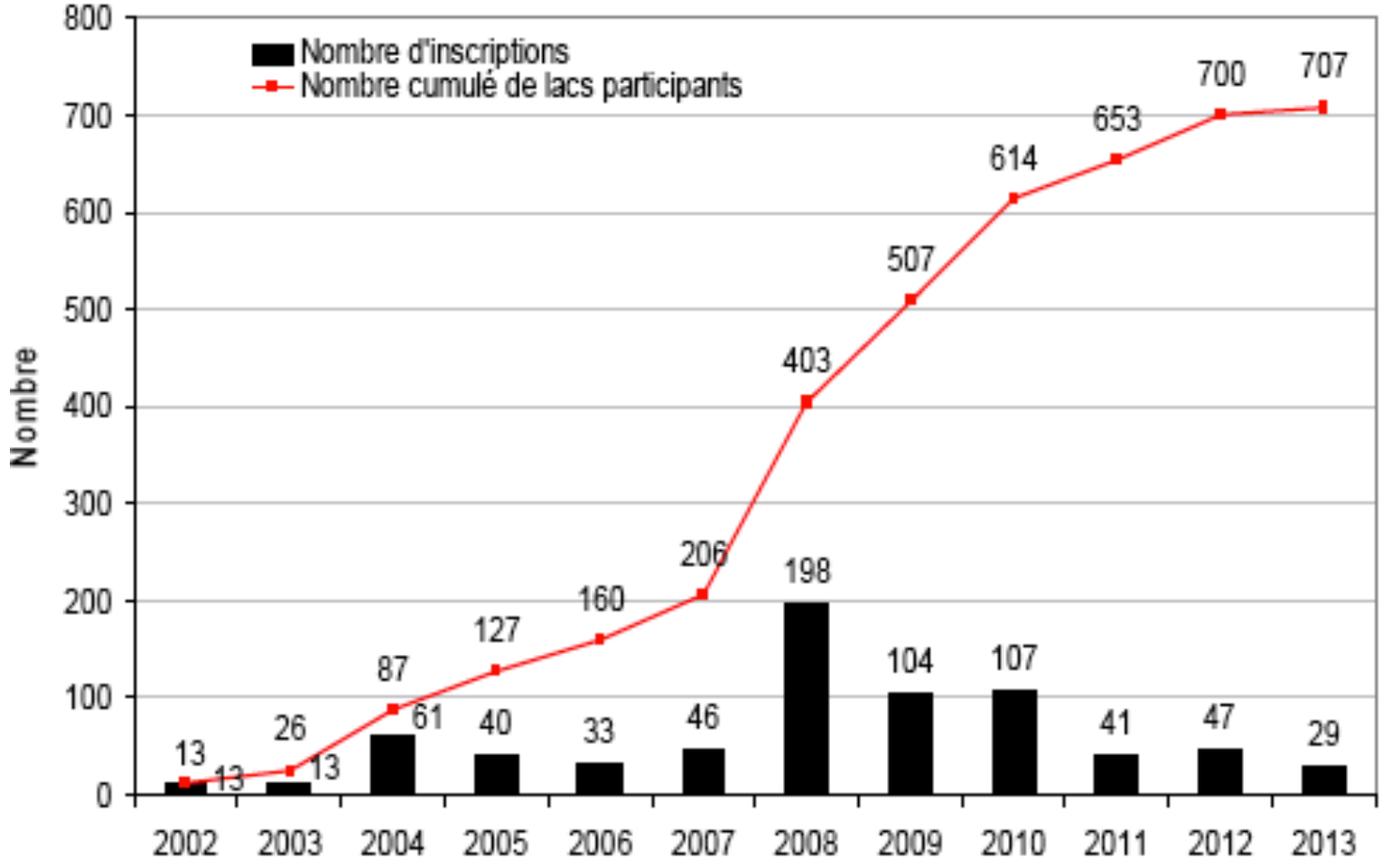
Volunteer Lake Monitoring Program (VLMP) in Quebec

- Lake associations (and sometimes individuals) enroll in program (~ 300$/year)
- Volunteers receive training to collect water samples for chemical analysis
- They receive a sampling kit with detailed instructions
- Three times in summer, they collect sample & associated measurements

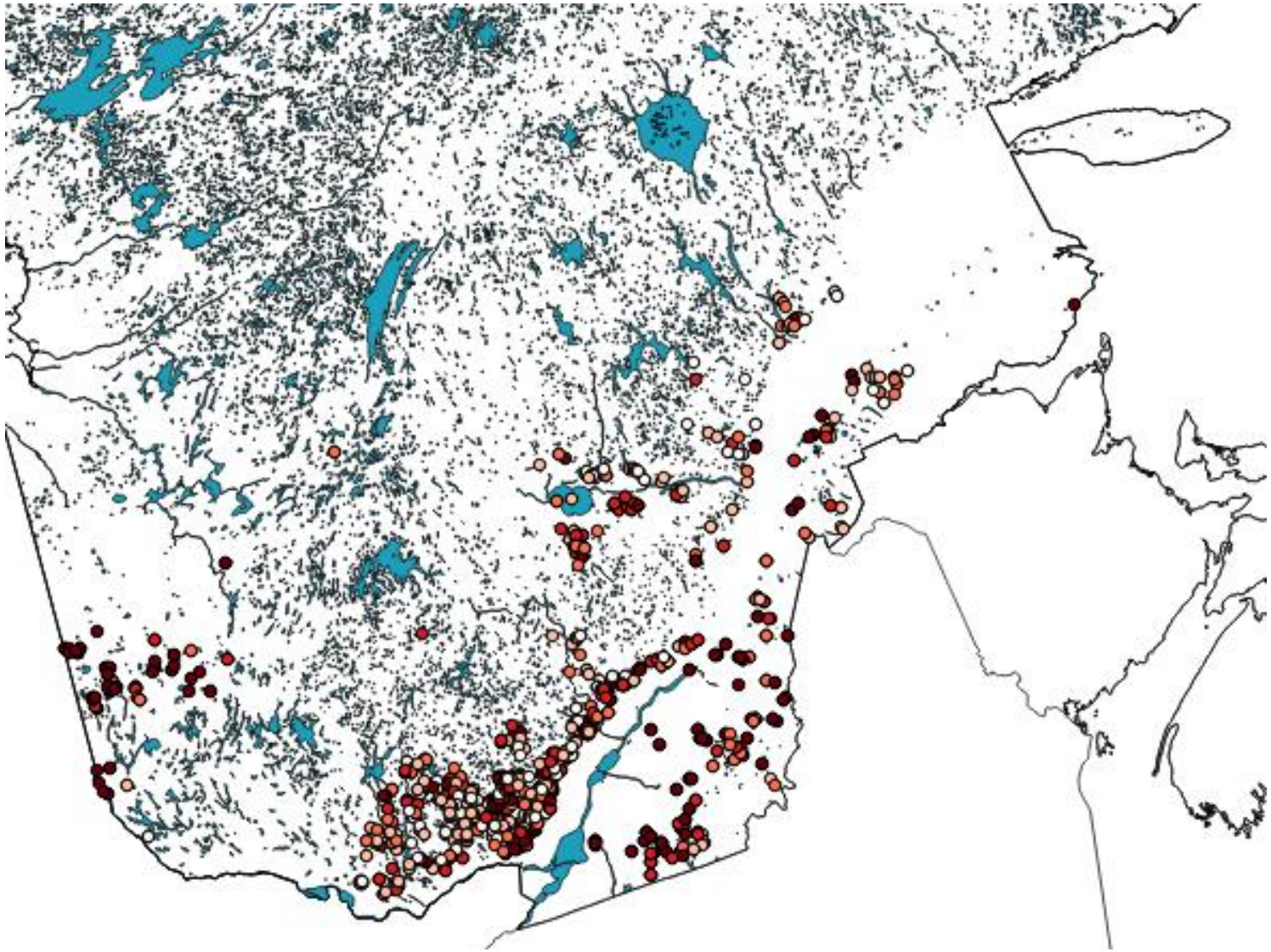
Parameters measured

- Total phosphorus
- Chlorophyll a , as a measure of algal biomass
- Dissolved organic carbon
- Water transparency

Participation in the VLMP



Location of active VLMP lakes

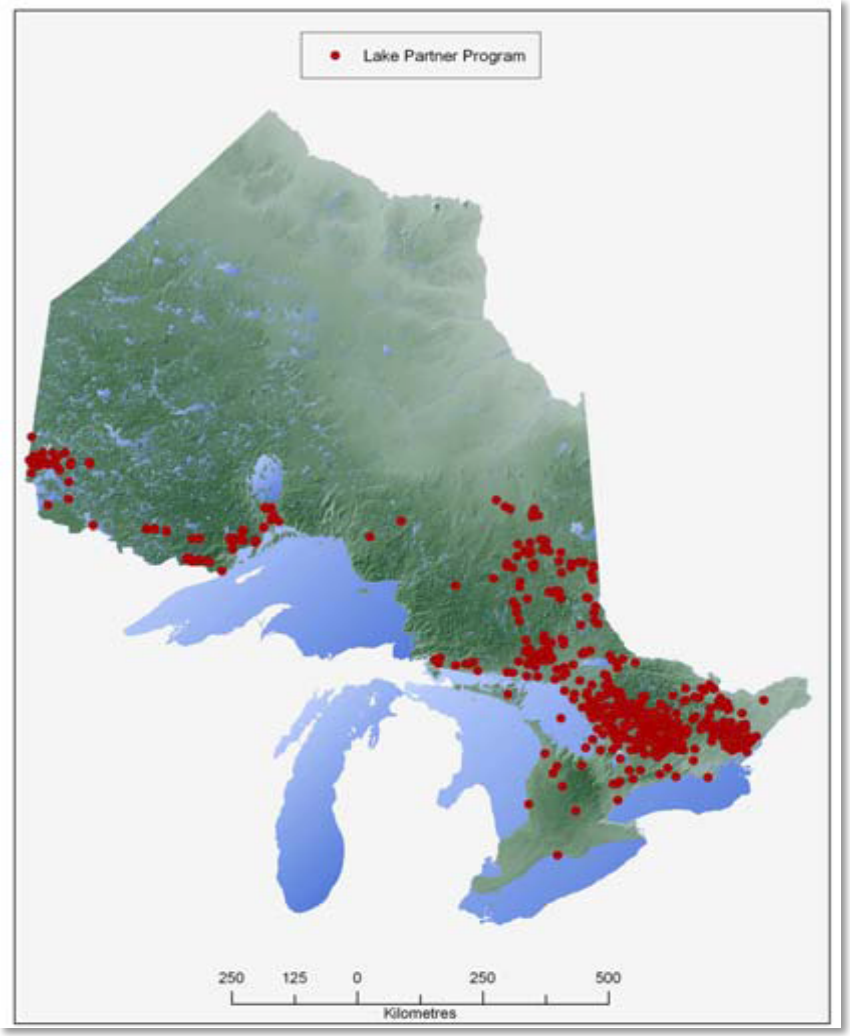


Ontario's Lake Partner Program

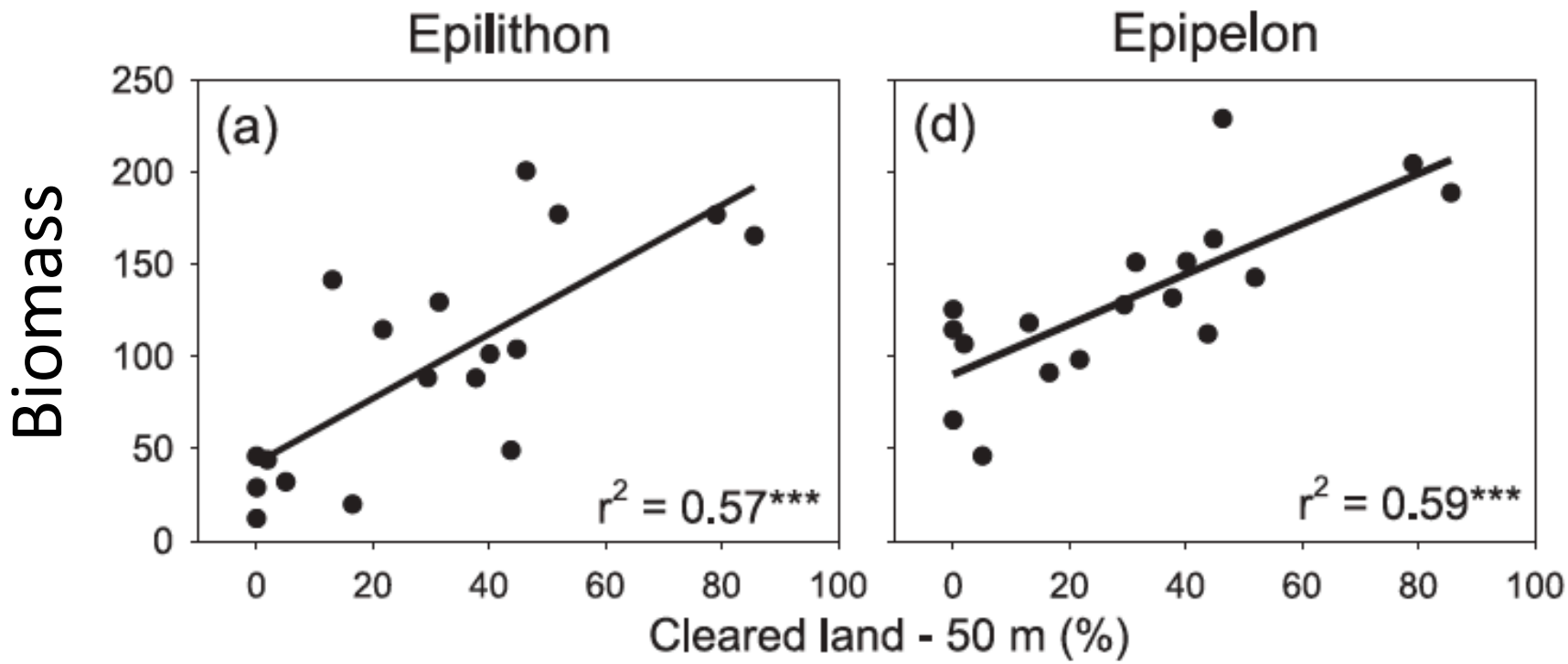
- Approx. 800 volunteers monitoring phosphorus and water clarity at almost 600 locations

- Building a nutrient database of thousands of recreational lakes across the province

- Data available online at www.ontario.ca/lakepartner



Expansion of the scope of the VLMP



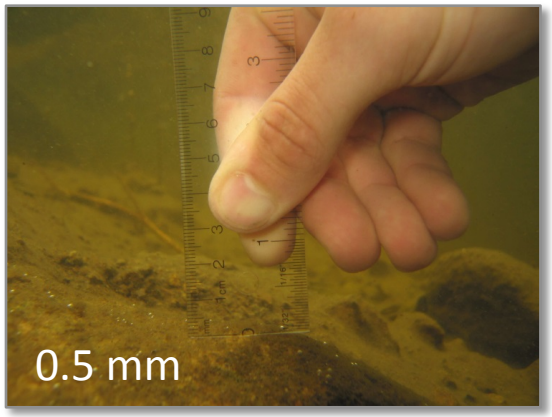
EARLY WARNING SYSTEM OF HUMAN-INDUCED LAKE PERTURBATION AND EARLY EUTROPHICATION

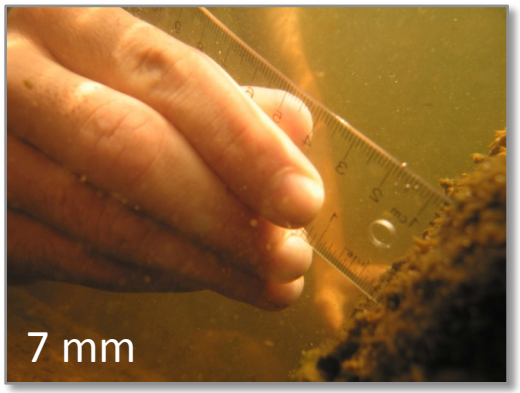
Lambert and Cattaneo 2008.

Monitoring using periphyton

Protocol elaborated with the Quebec Ministry of the Environment (MDDEP) for the monitoring by lake residents

Periphyton thickness measured on rocks between 0.5 & 1m depth



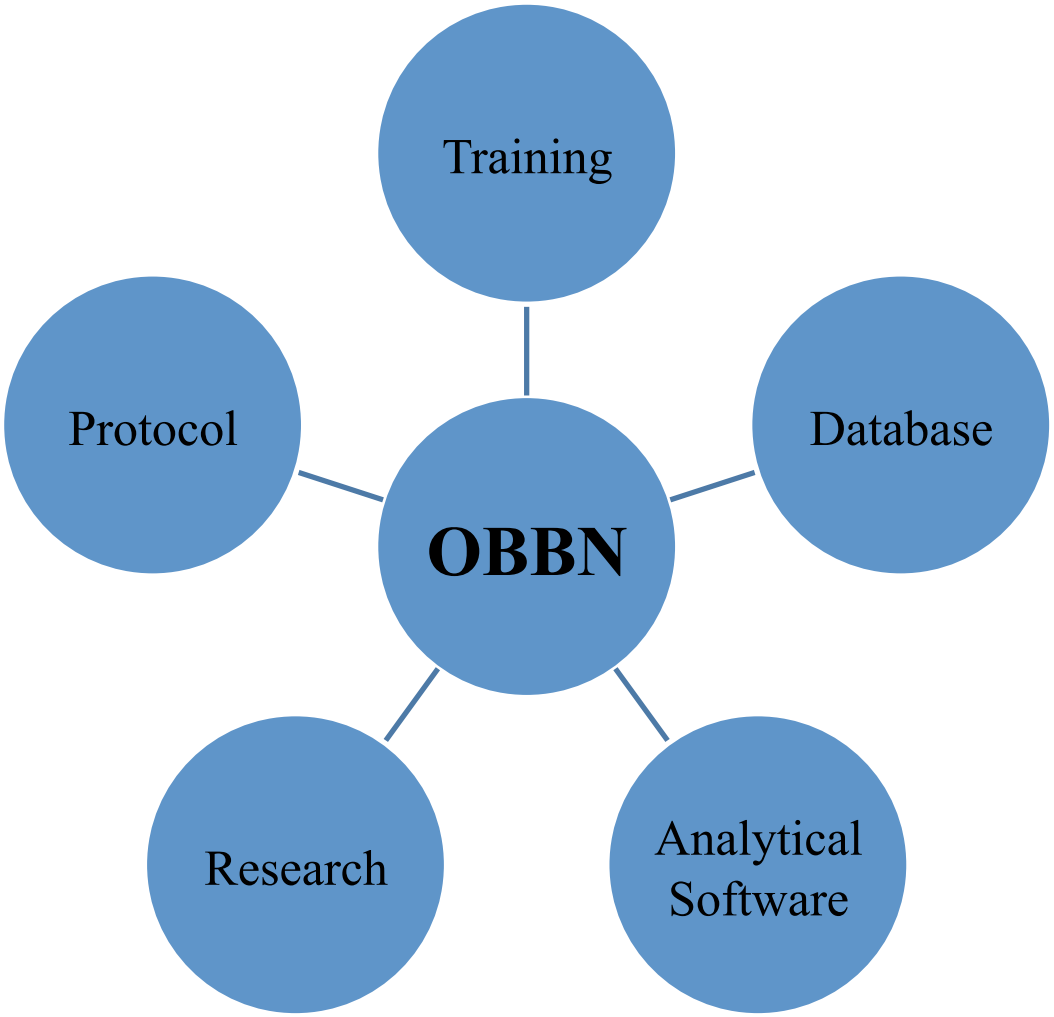


Periphyton thickness > 5mm indicates perturbation

The Ontario Benthic Biomonitoring Network

OBBN is a collaborative lake-, stream-, and wetland-bioassessment network

lead by: Ontario Ministry of Environment and Climate Change



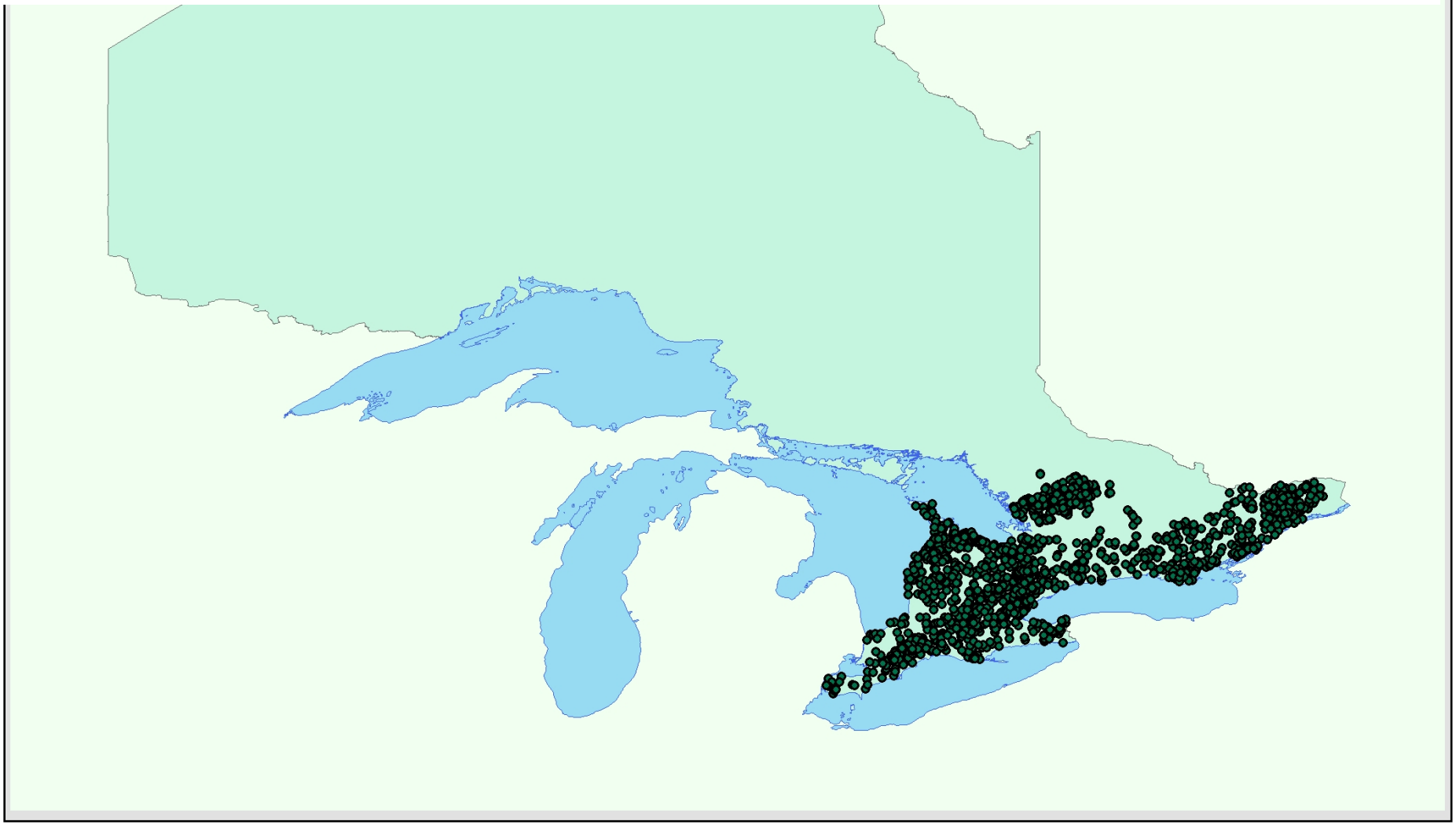
Why Use Benthos As Bioindicators?

Benthos are excellent indicators of aquatic ecosystem health.

- Abundant and widespread
- Many species with different tolerances
- Respond to water chemistry
- Provide early-warning

Stream benthos collection in the Raisin River watershed

Ontario Benthic Biomonitoring Network Coverage



Importance of Citizen Scientists

- Increase spatial coverage of sampling
- Providing early-warning indications of environmental change
- Increased communication between lake associations and scientists

Benefits to Citizen Scientists

- Increased personal networks among volunteers
- Increased feelings of community connectedness among volunteers in lake associations
- Enhanced stewardship of local environment
- Contribute to improved management of water resources

Overdevest et al. 2004

Empowerment of Citizen Scientists

- Volunteers with data and knowledge possess the tools to raise environmental concerns with local politicians
- Changes in policy often arise from citizens rather than scientists identifying problems
- Can help advance positive environmental change