Progress and challenges in managing multiple stressors of Muskoka and Haliburton lakes

Norman Yan

York University and

Dorset Environmental Science Centre

YORK UNIVERSITÉ UNIVERSITY

redefine THE POSSIBLE.

DESC

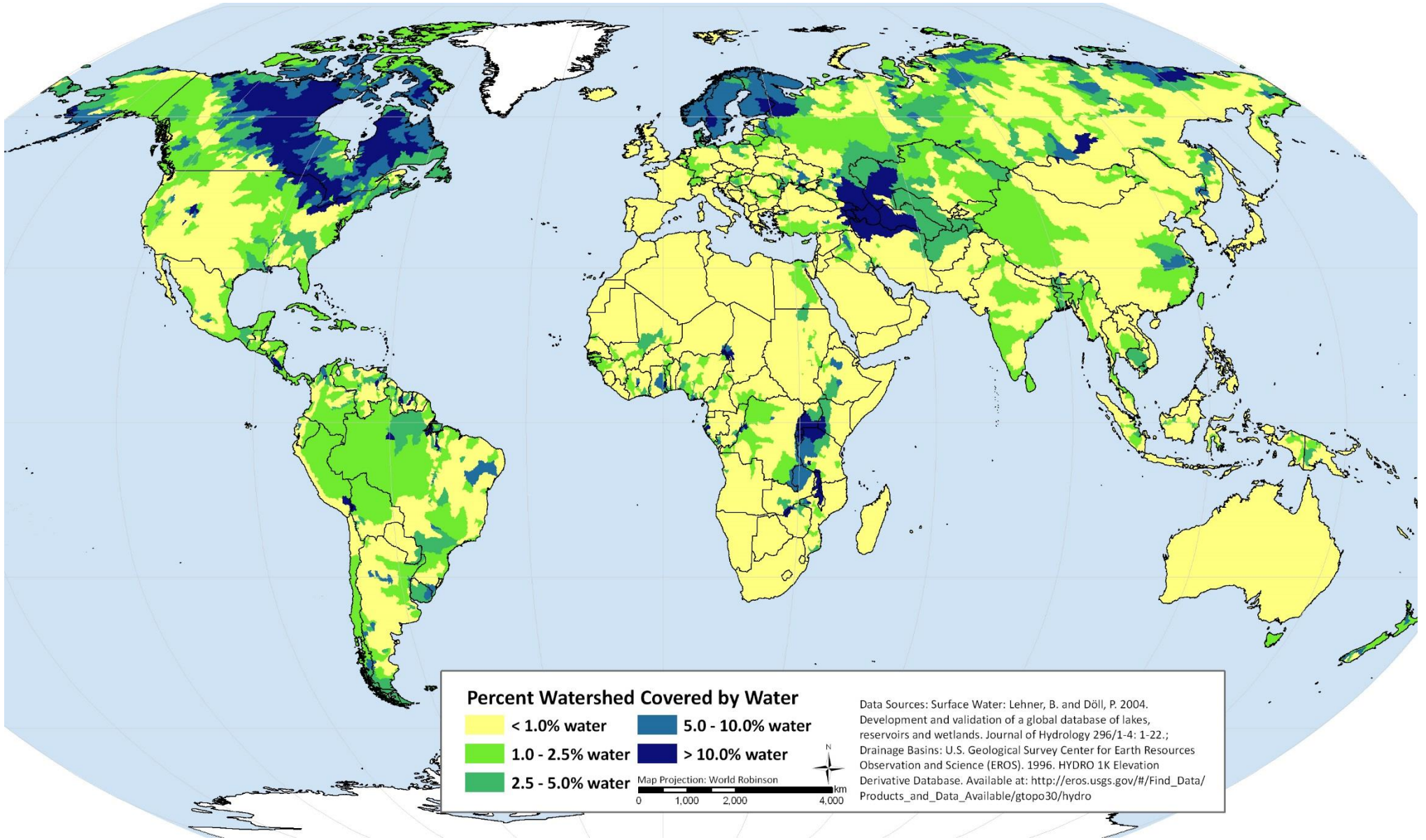
DORSET ENVIRONMENTAL SCIENCE CENTRE

Acknowledgements

- Dorset Environmental Science Centre (DESC) for supporting both my lab and long-term monitoring of Muskoka lakes
- My Dorset colleagues (Andrew, Chris, Don, Huaxia, Jim, Keith, Peter)
- York U, CFI and NSERC for financial support
- My lab technicians: Dallas, Leanne and Courtney, and Martha Celis Salgado - the "*Daphnia* whisperer"
- Paul for the invitation

Objectives

1. To review the progress and challenges in the management of multiple stressors affecting Muskoka and Haliburton lakes, especially to:
    1. Prove we have solved many large problems of the past, but
    2. Some other long-standing problems remain, while
    3. Some new problems are emerging, and
    4. They may well interact
2. To encourage the generation of the knowledge and the will needed to deal with these management issues



http://www.pewenvironment.org/uploadedImages/PEG/Publications/Other_Resource/Surface-Water-map-credit-Global-Forest-Watch-Canada-hi-res.jpg

The good news -
We have fixed many problems that affected our lakes, and were once thought too difficult to solve

- Eutrophication
- Acid rain
- DDT and other chlorinated pesticides
- Lead
- Ozone Depletion
- The cosmetic use of pesticides

Eutrophication

***Eutrophication**

Acid Rain

DDT

Lead

Ozone Depletion

Lawn pesticides

Development

Mercury

Climate Change

Calcium decline

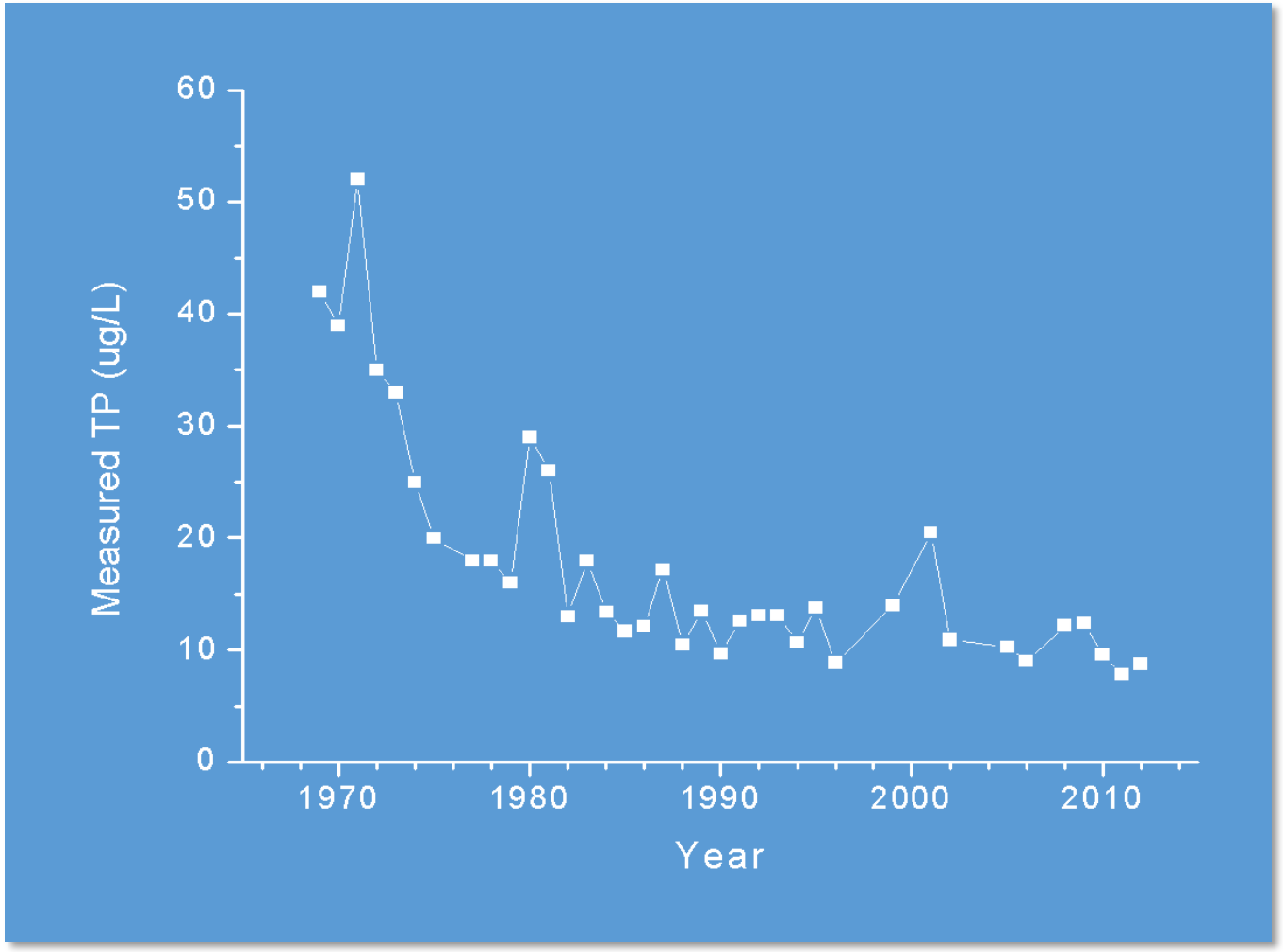
Road Salt

Invaders

Novel chemicals

Interactions

Oligotrophication of Gravenhurst Bay



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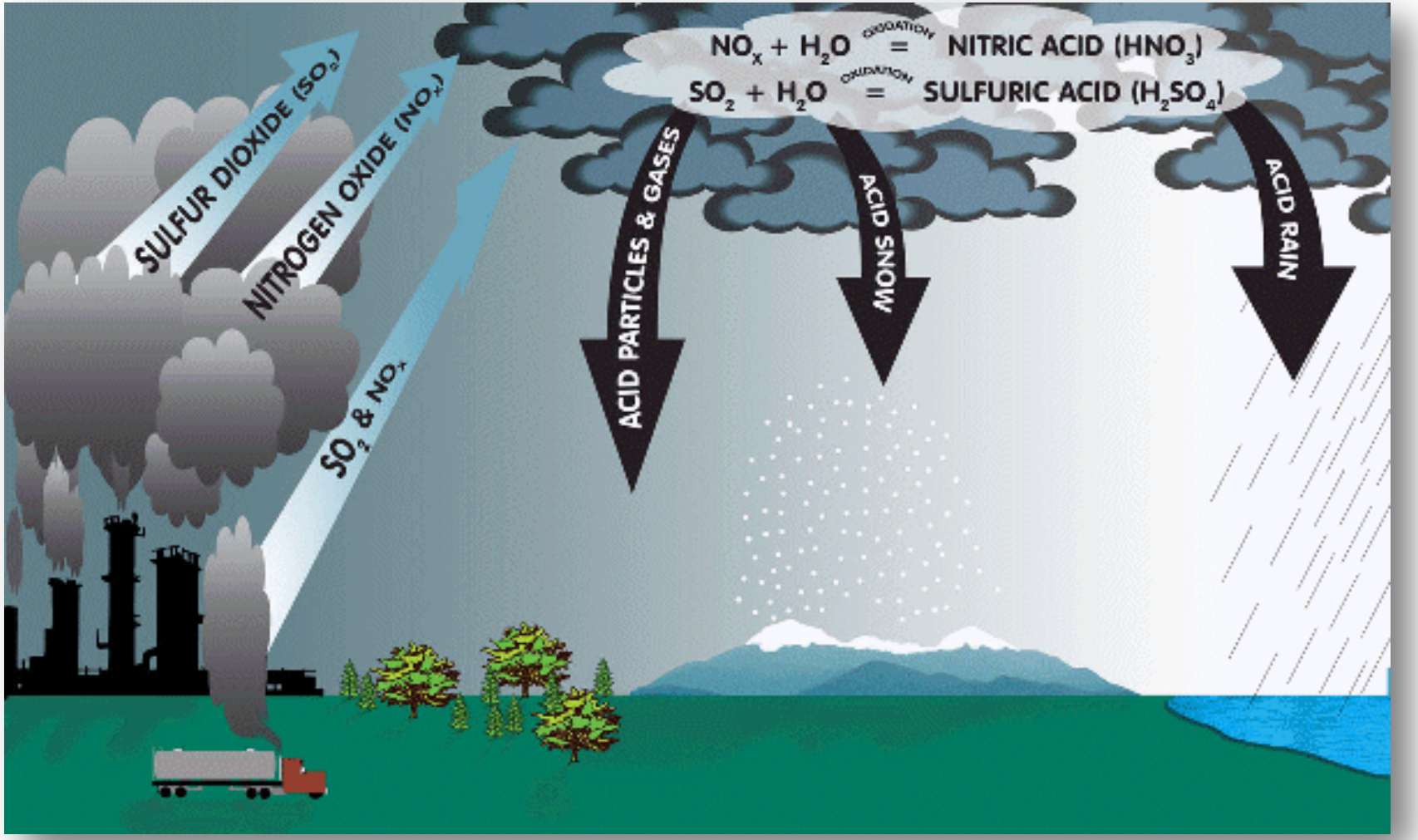

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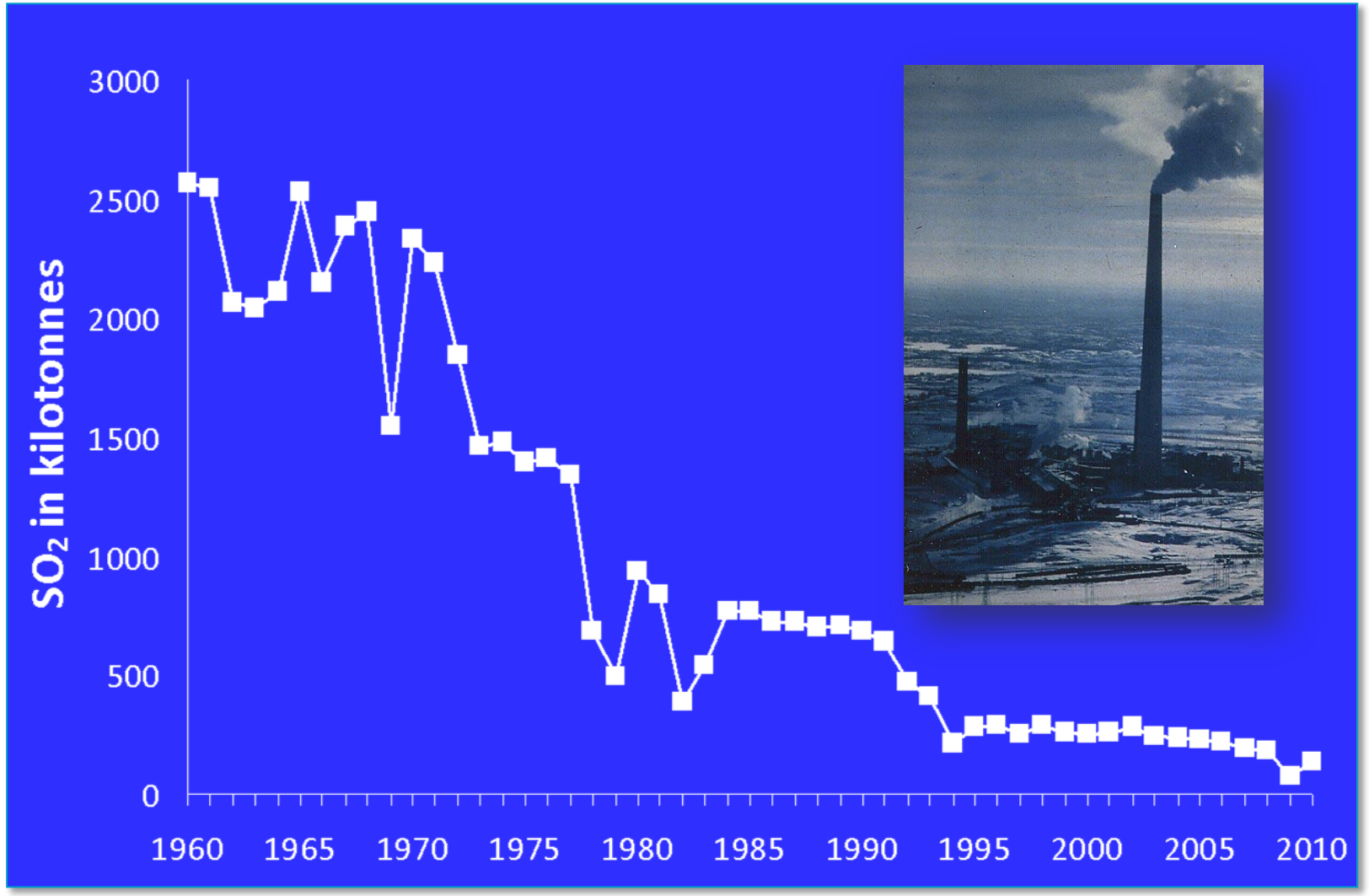
SO_2 emissions have fallen



Data from J. Bailey, MOE

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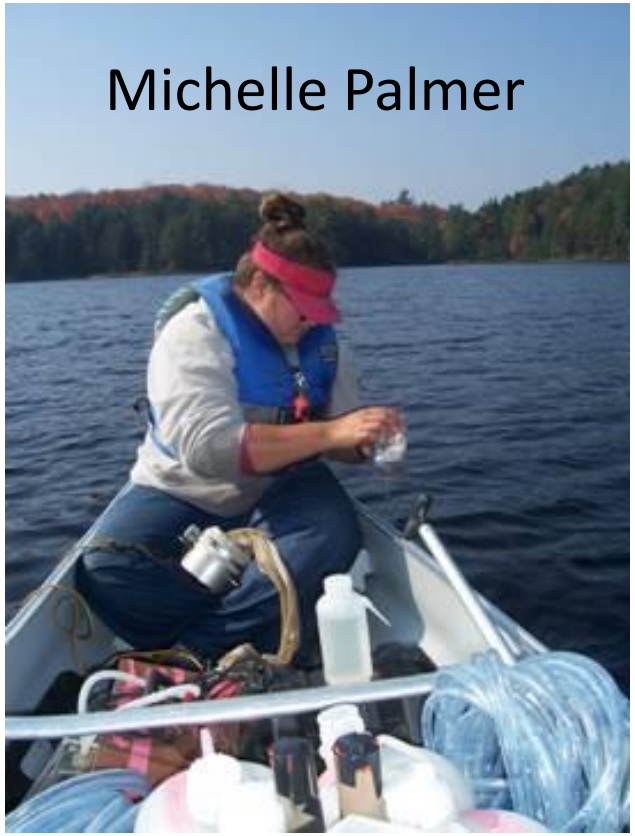
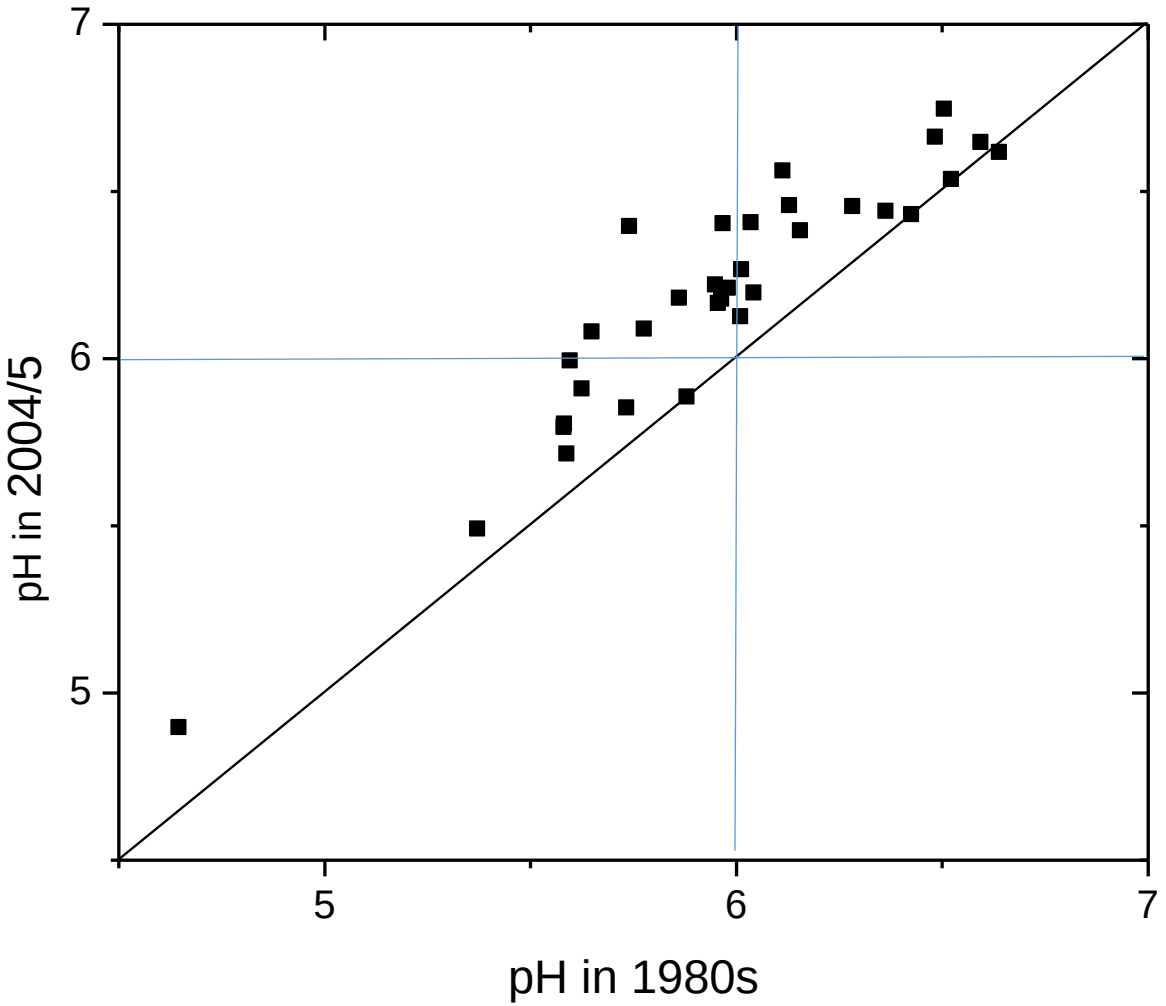
Lake acidity has declined in Muskoka
(31 lakes sampled monthly)*





*Palmer et al. 2011 CJFAS

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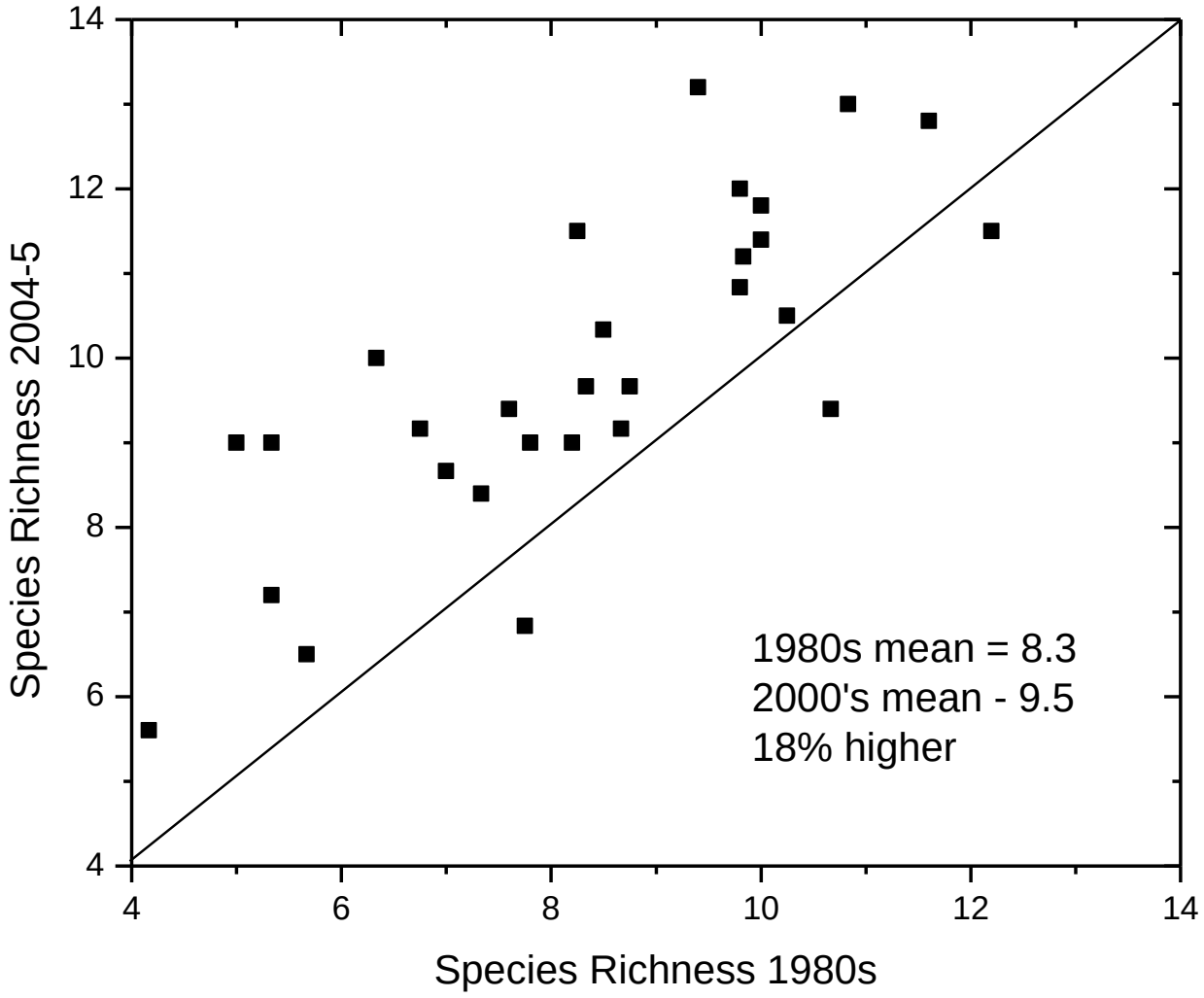
And zooplankton species richness has increased*



*Palmer and Yan 2013 FWB

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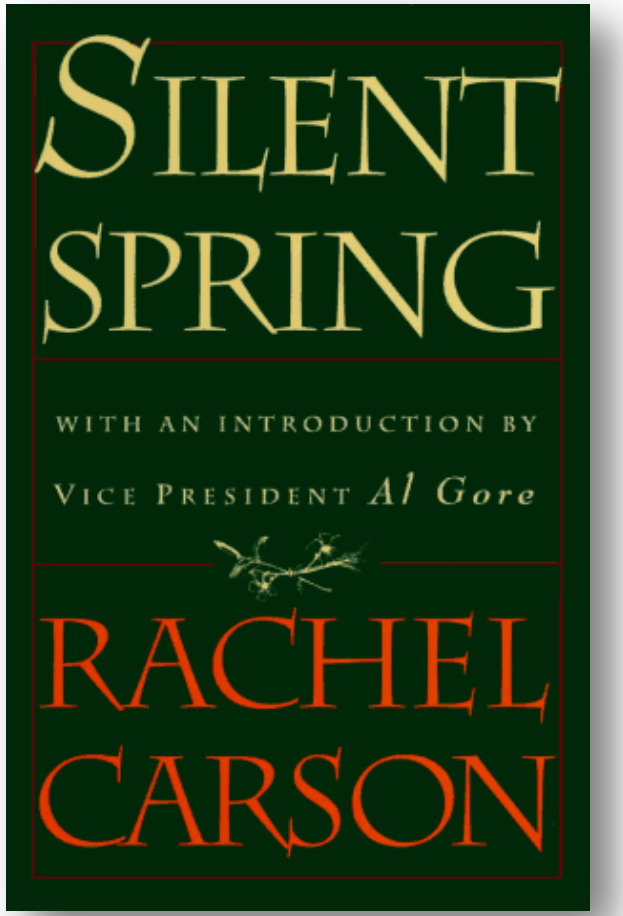

Florida State Archives

DDT's use was banned in the USA in 1972

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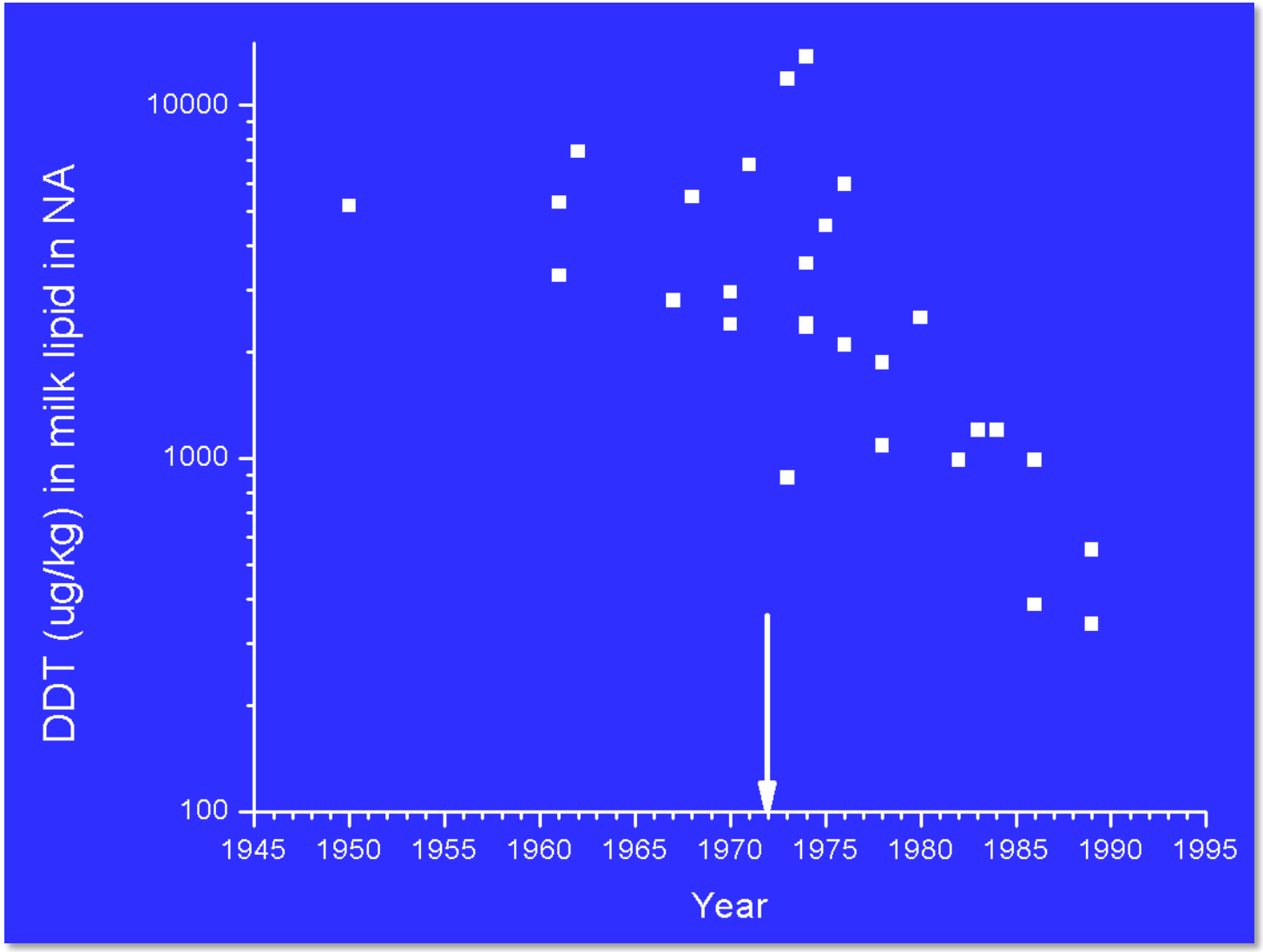
DDT in breast milk of N. American women*



*taken from 21 separate studies from Smith (1999)

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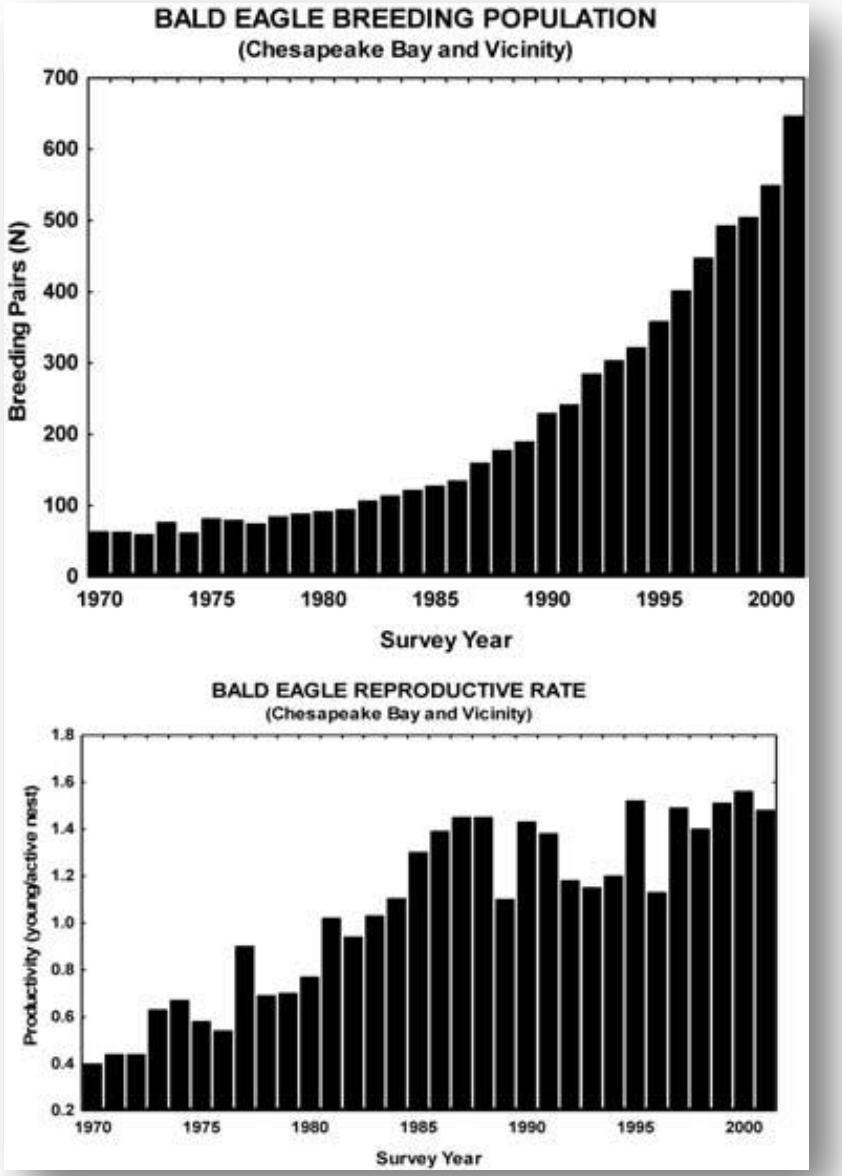

* Watts et al. 2007 Status, Distribution and the future of bald eagles in the Chesapeake Bay Area. Waterbirds 30: 25-38

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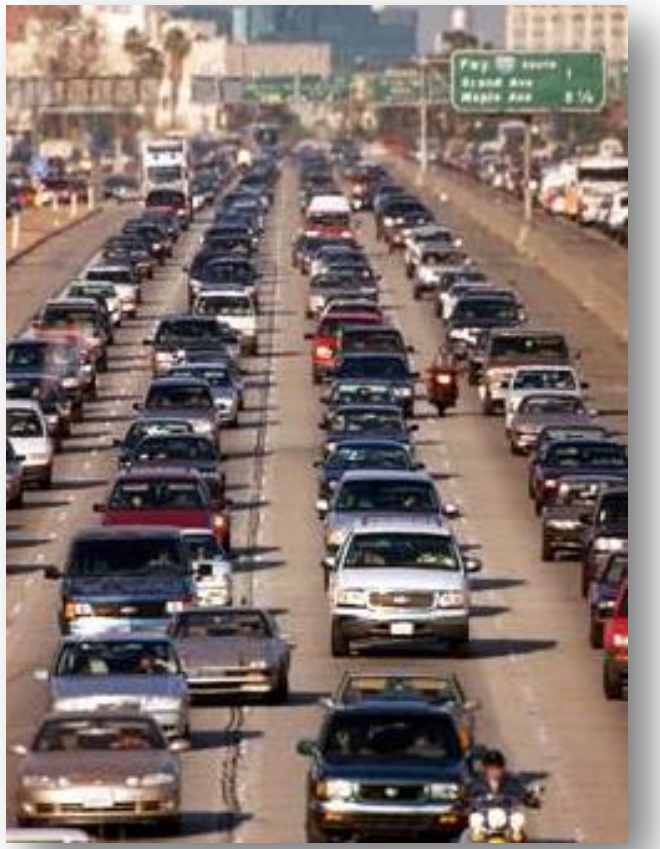
Lead pollution from gasoline



Reed Saxon / AP File

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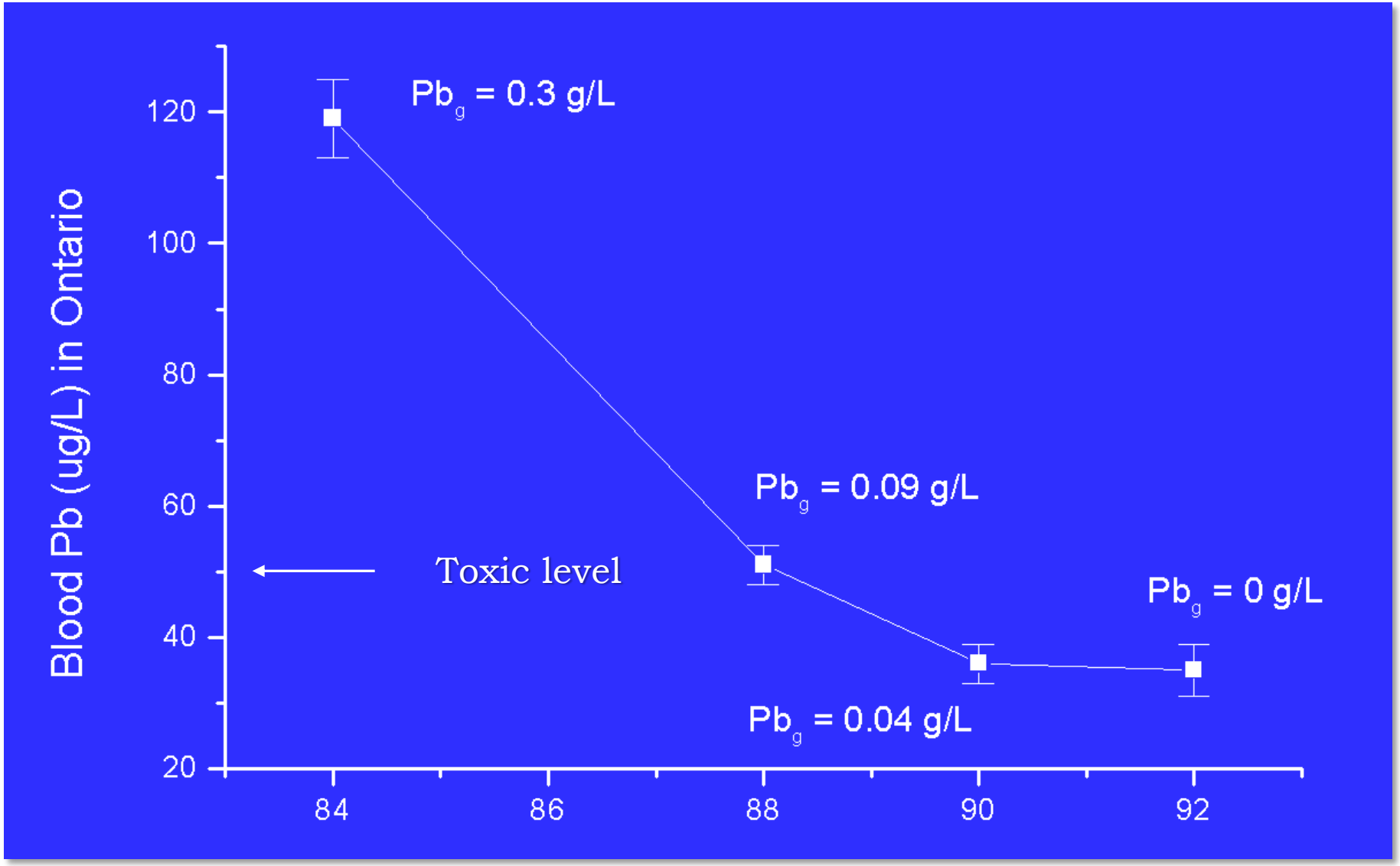
Interactions

Blood lead levels of Ontarions reflected use of leaded gasoline (Thomas et al. 1999)



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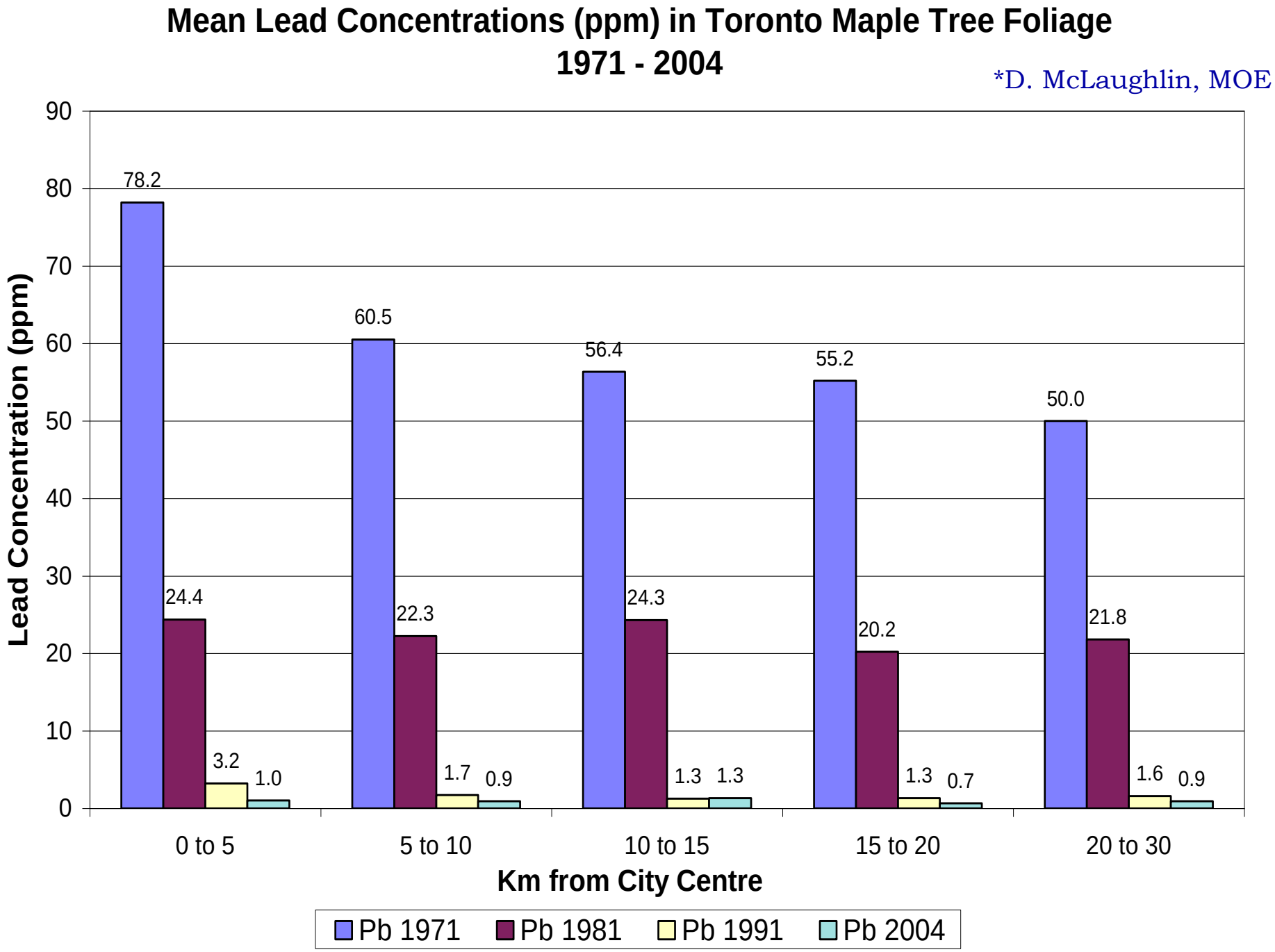

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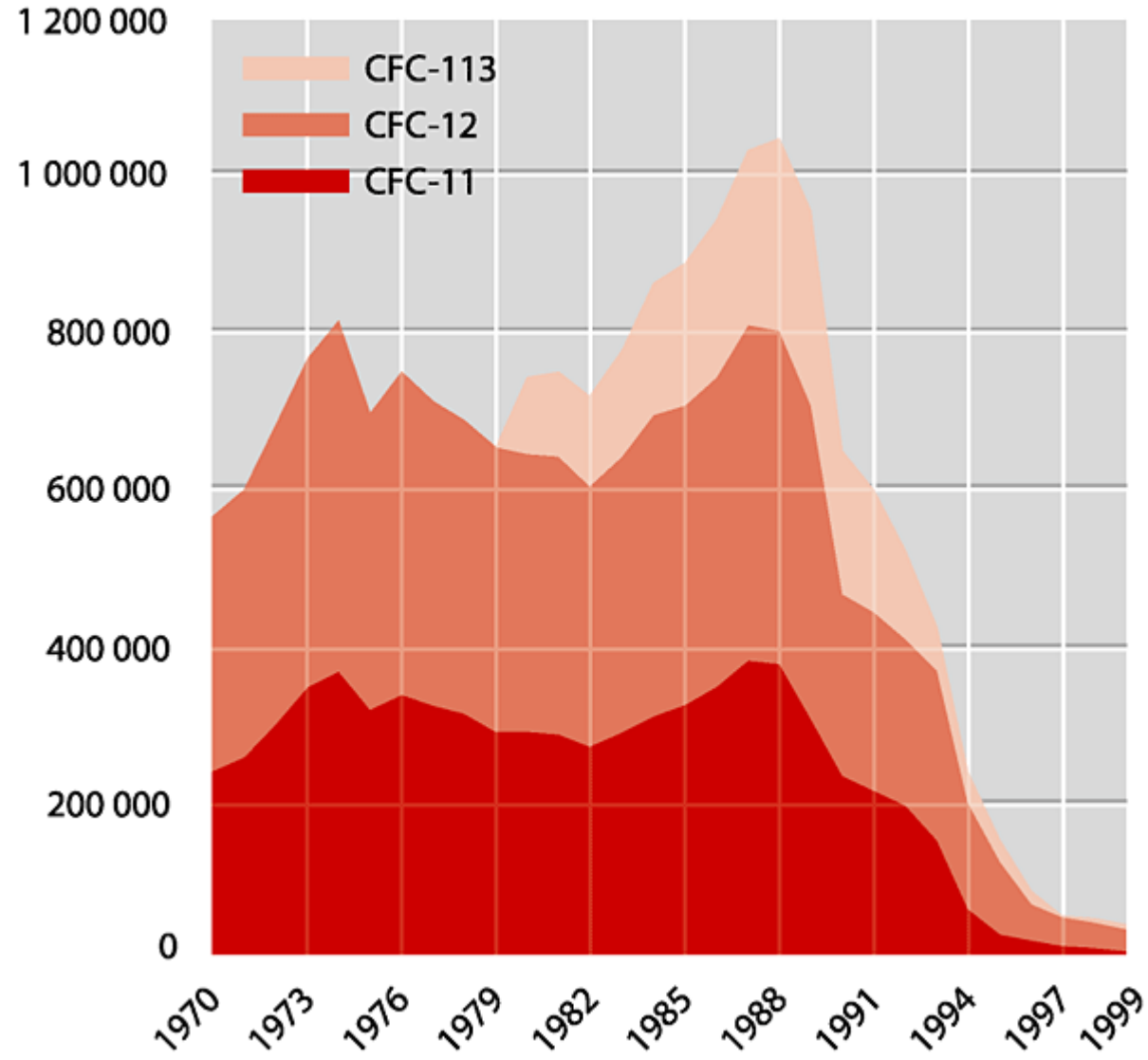
Global chloroflourocarbon production (t/year)*



*UNEP Global Environmental Outlook Program

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Interactions

The park behind my house

Eutrophication

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Interactions

Can we solve environmental problems?

- It takes knowledge
  - Problem recognition, identification of causes, evaluation of possible solutions
- It takes will
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- It takes action
  - policy change, intervention, re-assessment

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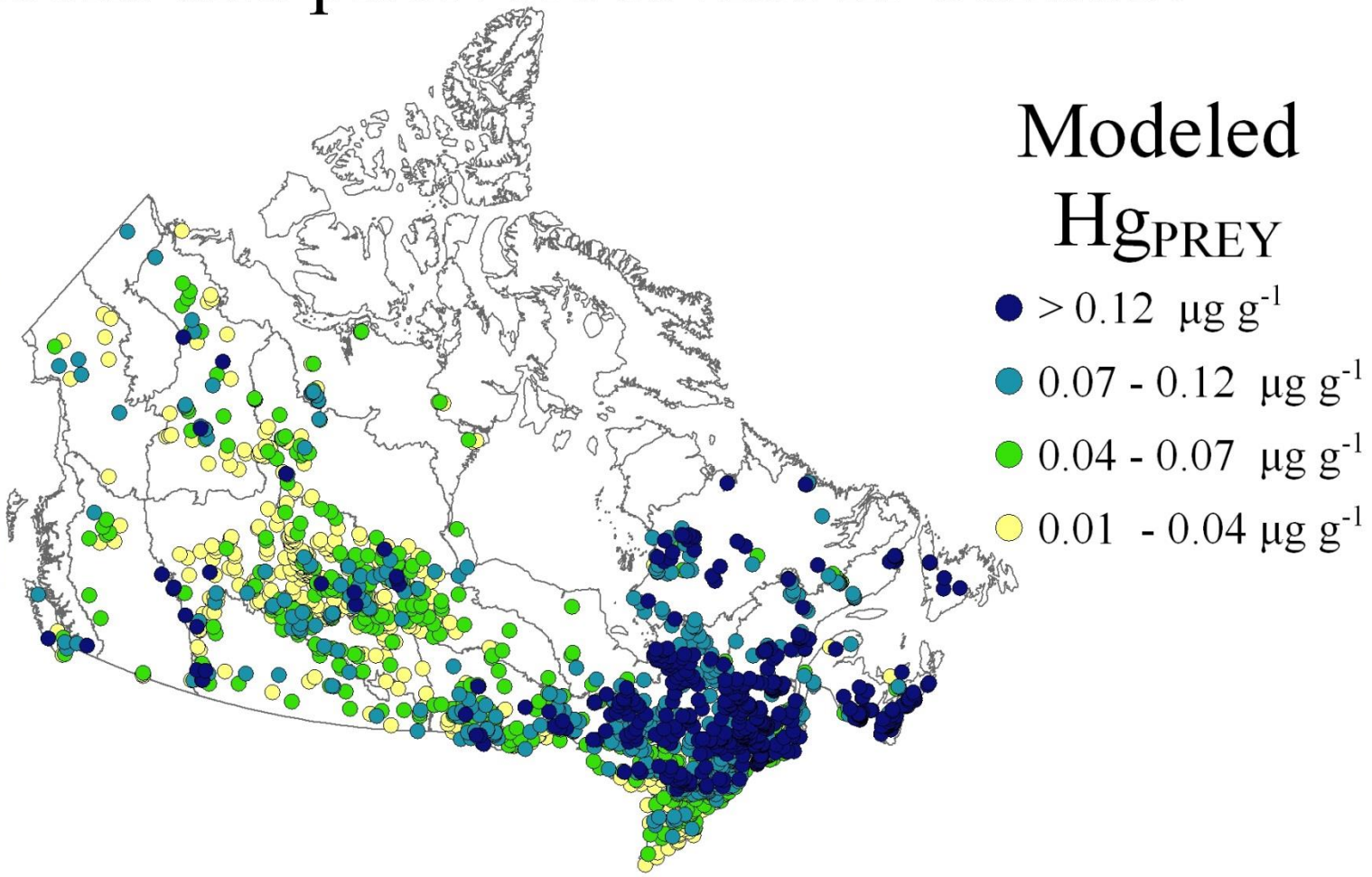
Interactions

What is the extent of MeHg risk to common loons and piscivorous fish in Canada?



Depew, Burgiss and Campbell 2013 ES&T 47:13093

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Climate Change

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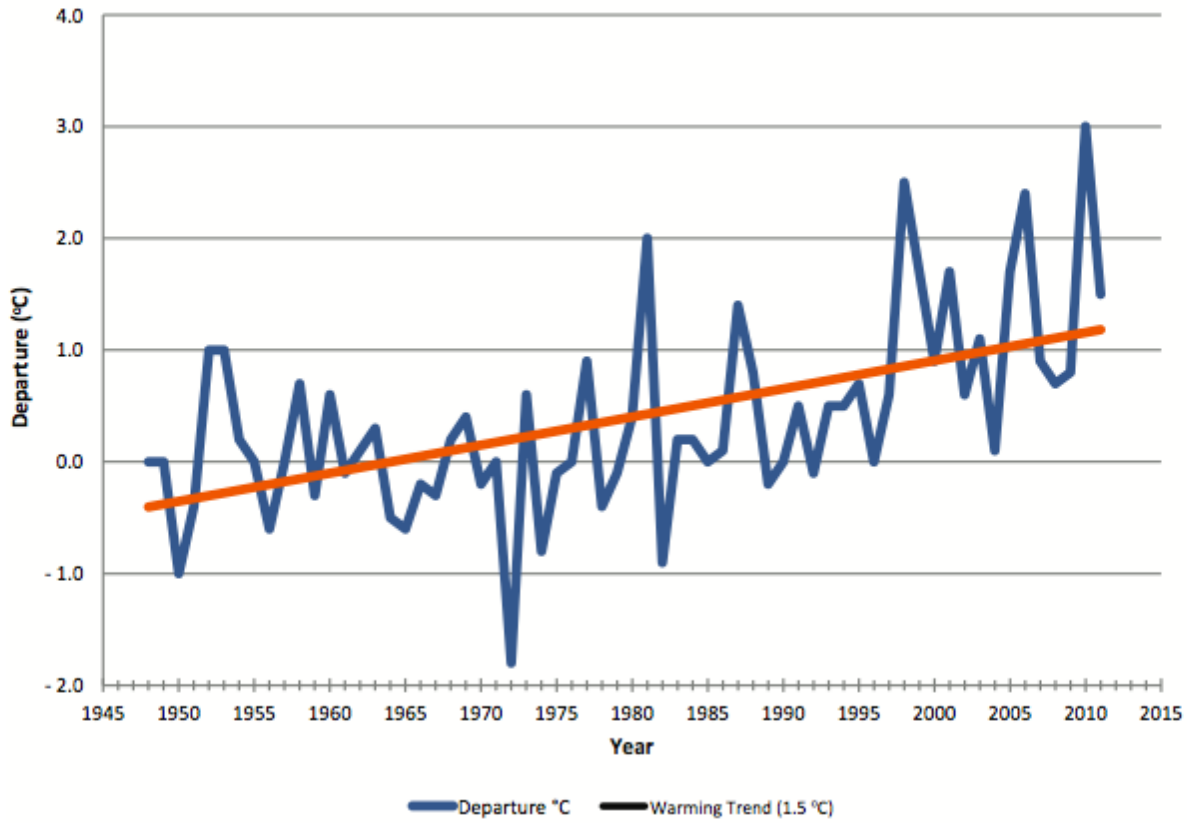
Interactions

Climate change
(departures of air temperature from 1950 to 1980 mean)

Figure 1–1 Annual Canadian Temperature Departures and Long-term Trend, 1948–2011 (°C)



Source data: Environment Canada (2012)

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*Climate Change

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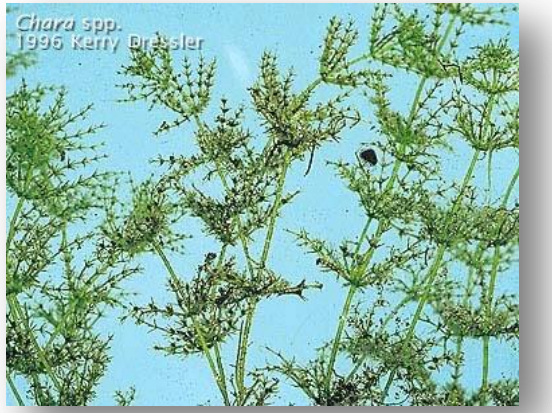
All life needs lots of calcium (Ca)



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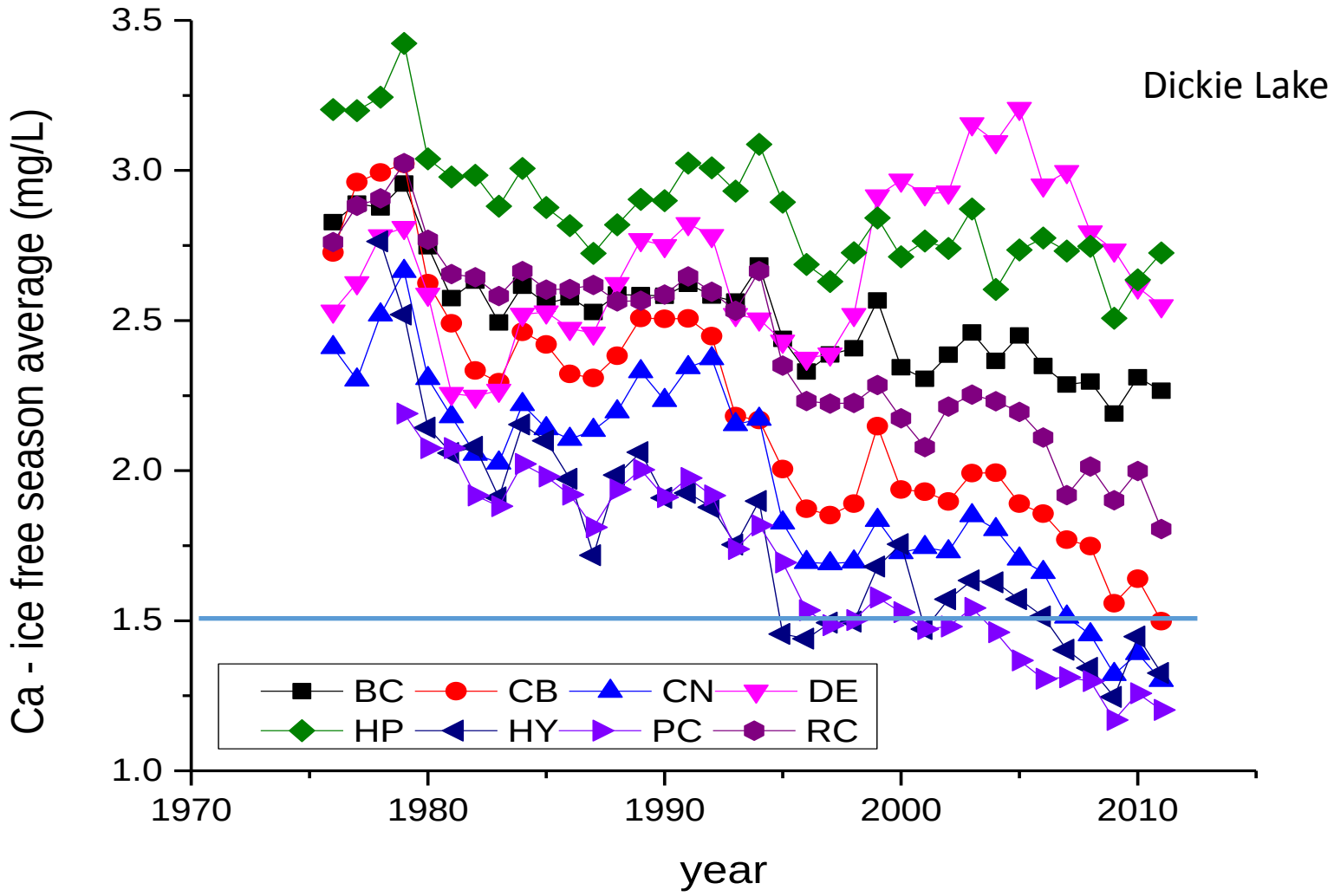
Interactions

Calcium levels are falling (Ca in the A lakes, 1976-2011)



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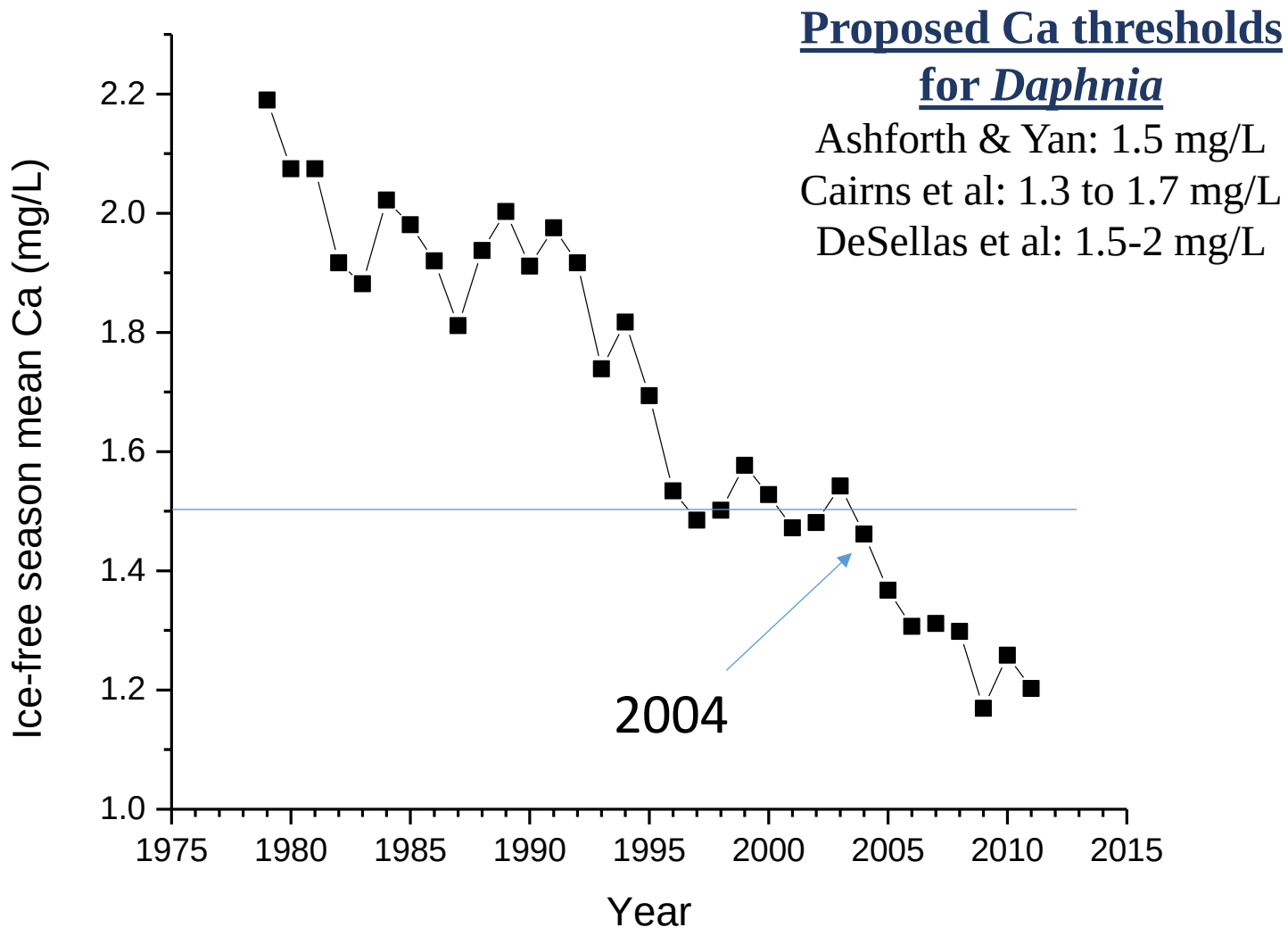
Lake water Ca trend in Plastic Lake



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1,500,000 tonnes of salt is used to de-ice Canada's roads

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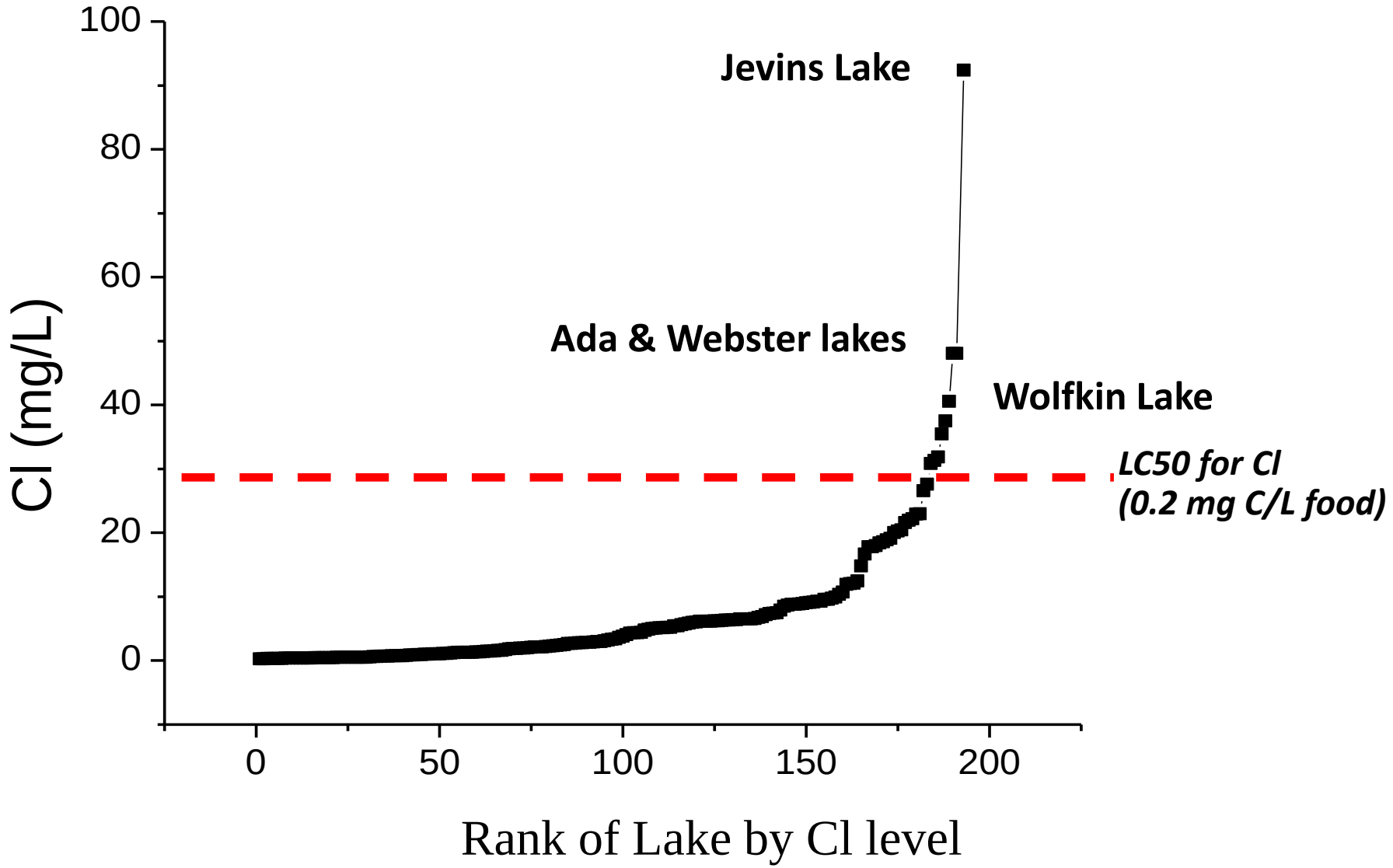
Interactions

Current Cl levels may be problematic in lakes near highways (Survey of 180 Muskoka lakes in 2010)



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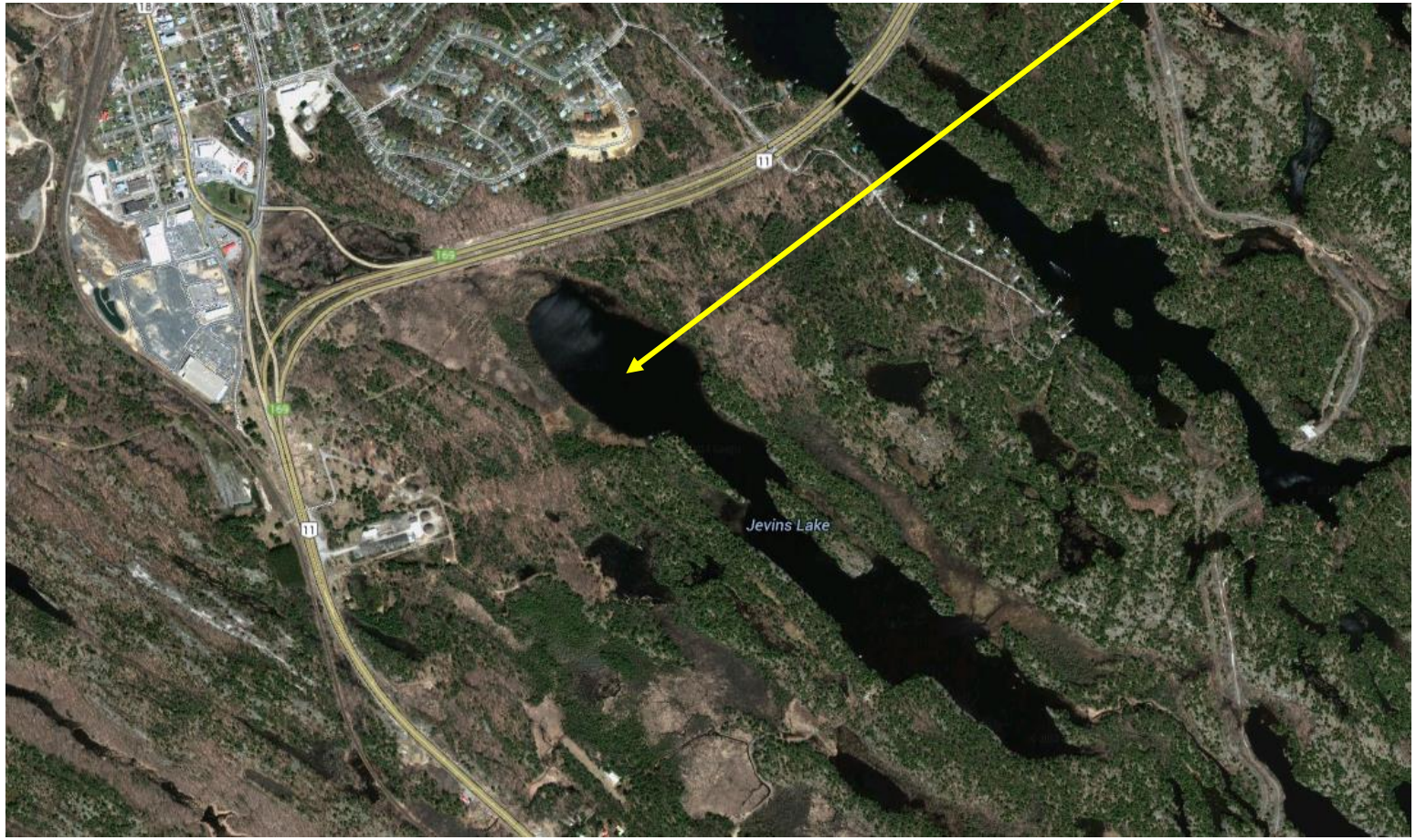
Interactions

All of the lakes with high Cl are beside winter-maintained highways, eg. Jevins Lake



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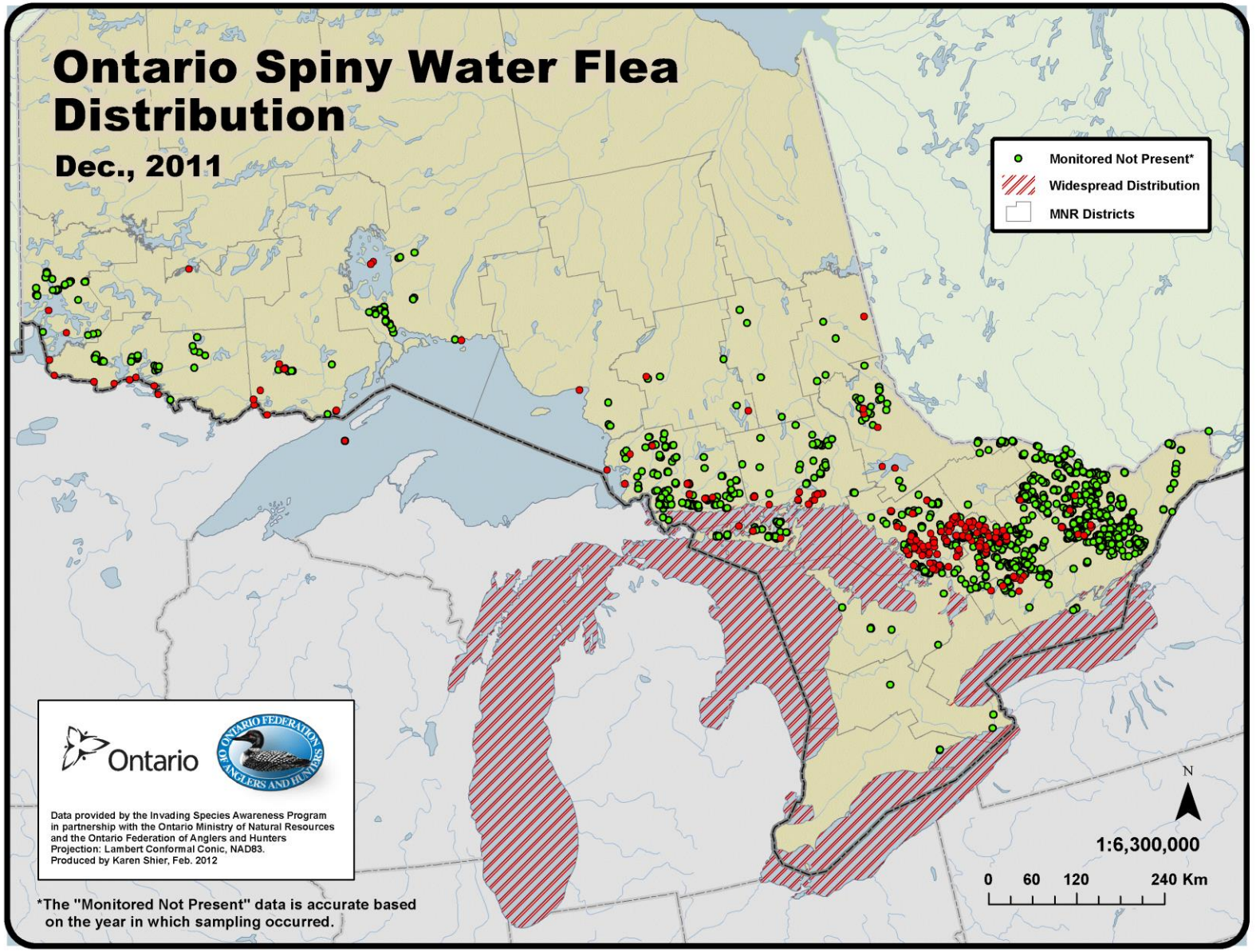

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Interactions

Novel chemicals

- Pharmaceuticals
- Flame retardants
- Cosmetics
- Plasticizers
- Nano-materials
- Micro-plastics

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***Novel chemicals**

Interactions

Is the limnology and the ecology of our lakes changing?

- Lake physics – fall temperatures have warmed
- Water quality – pH, Ca, TP, DOC & Cl
- Ecology - food quality and quantity, predators

- Might these changes interact?

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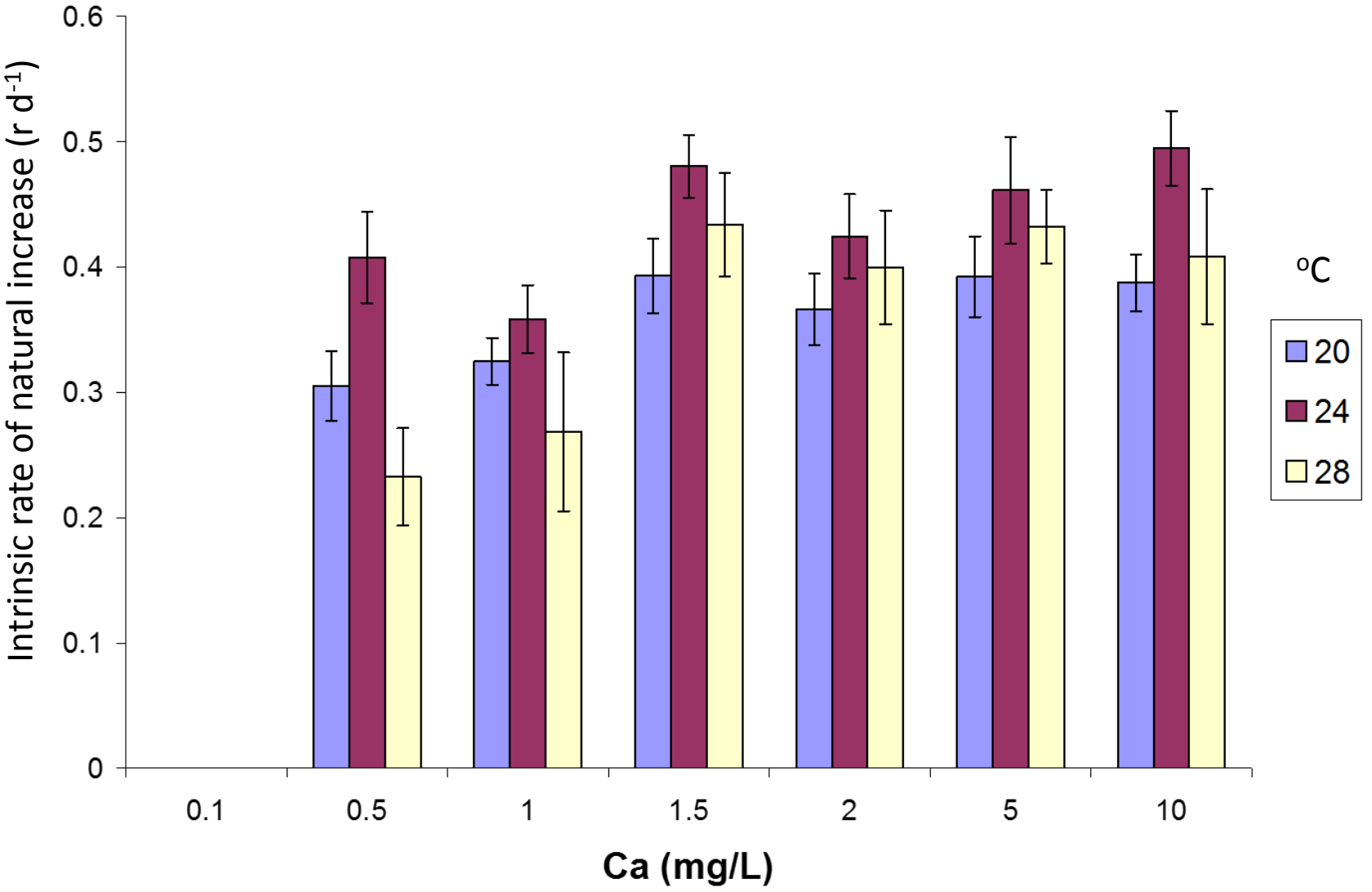
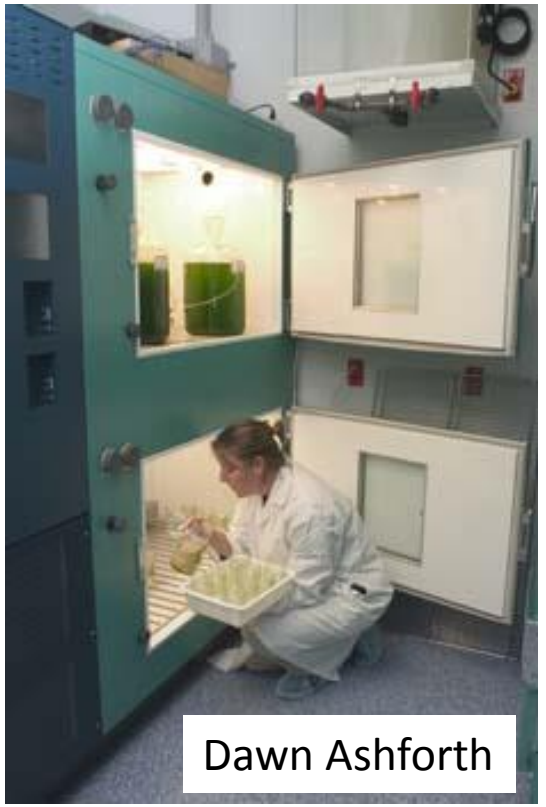
***Interactions**

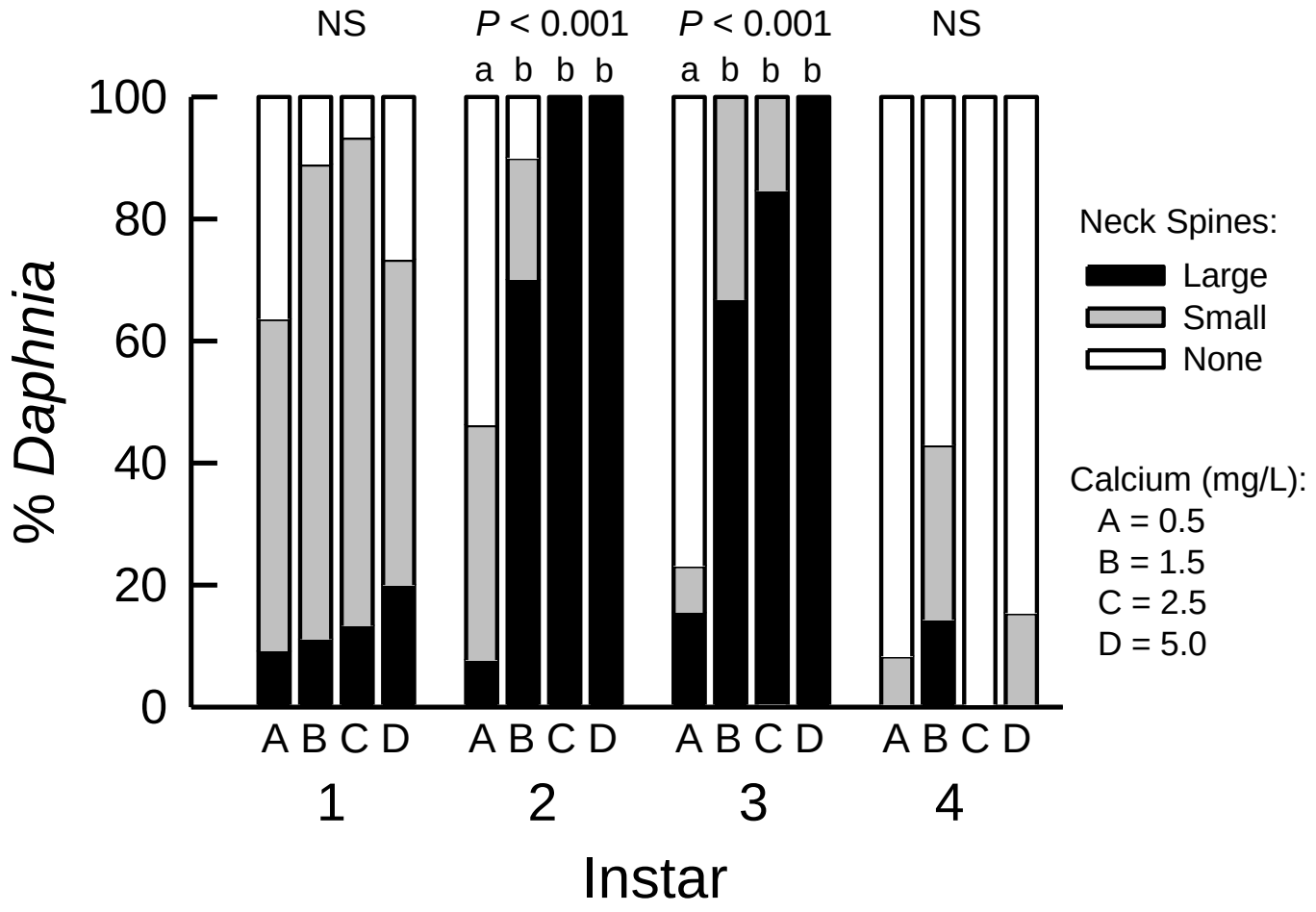
Low Ca is more damaging to *Daphnia* at high temperature





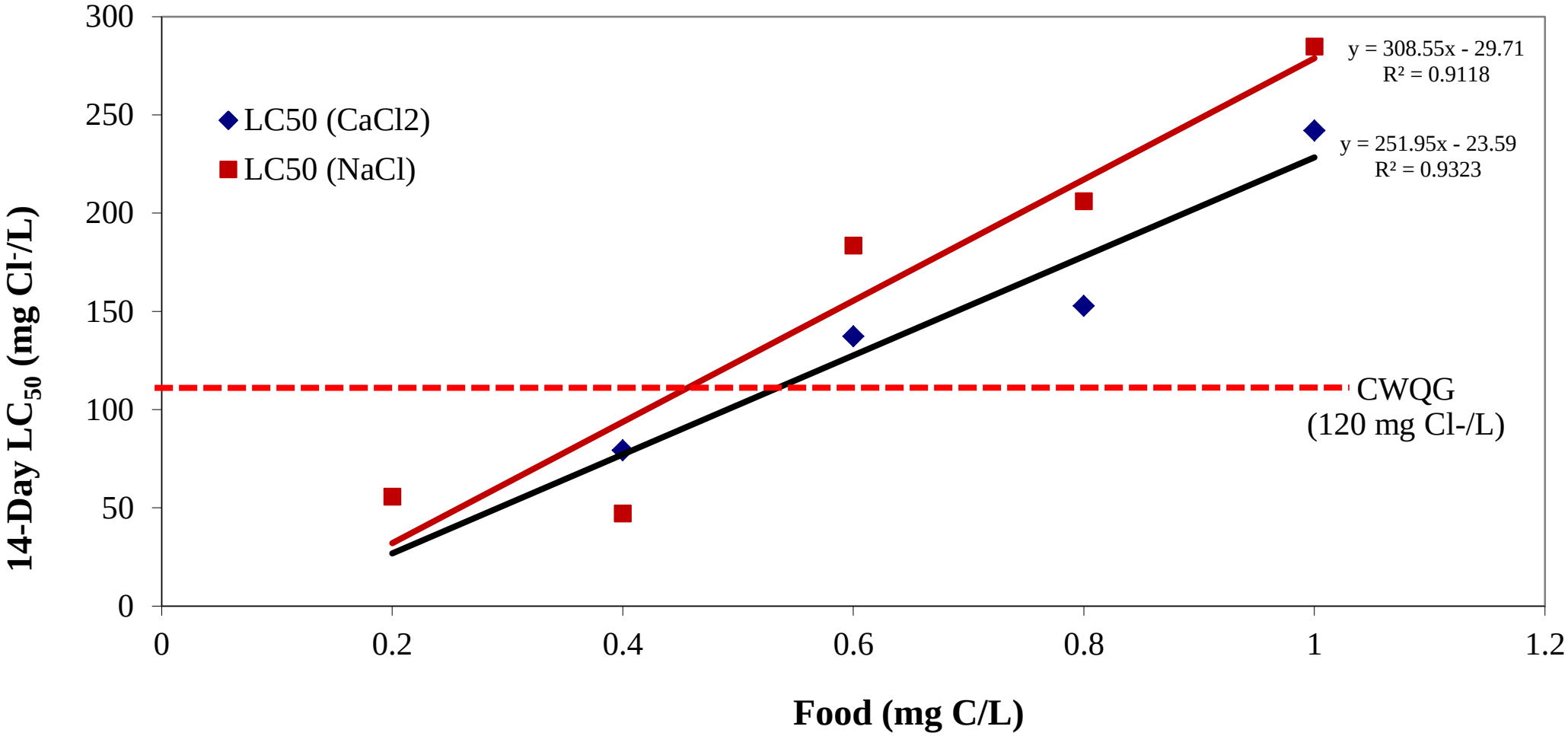
Ashforth & Yan 2008 L&O

Low Ca prevents neck teeth induction in *Daphnia* increasing risk of predation*



*Riessen et al. 2012 PNAS

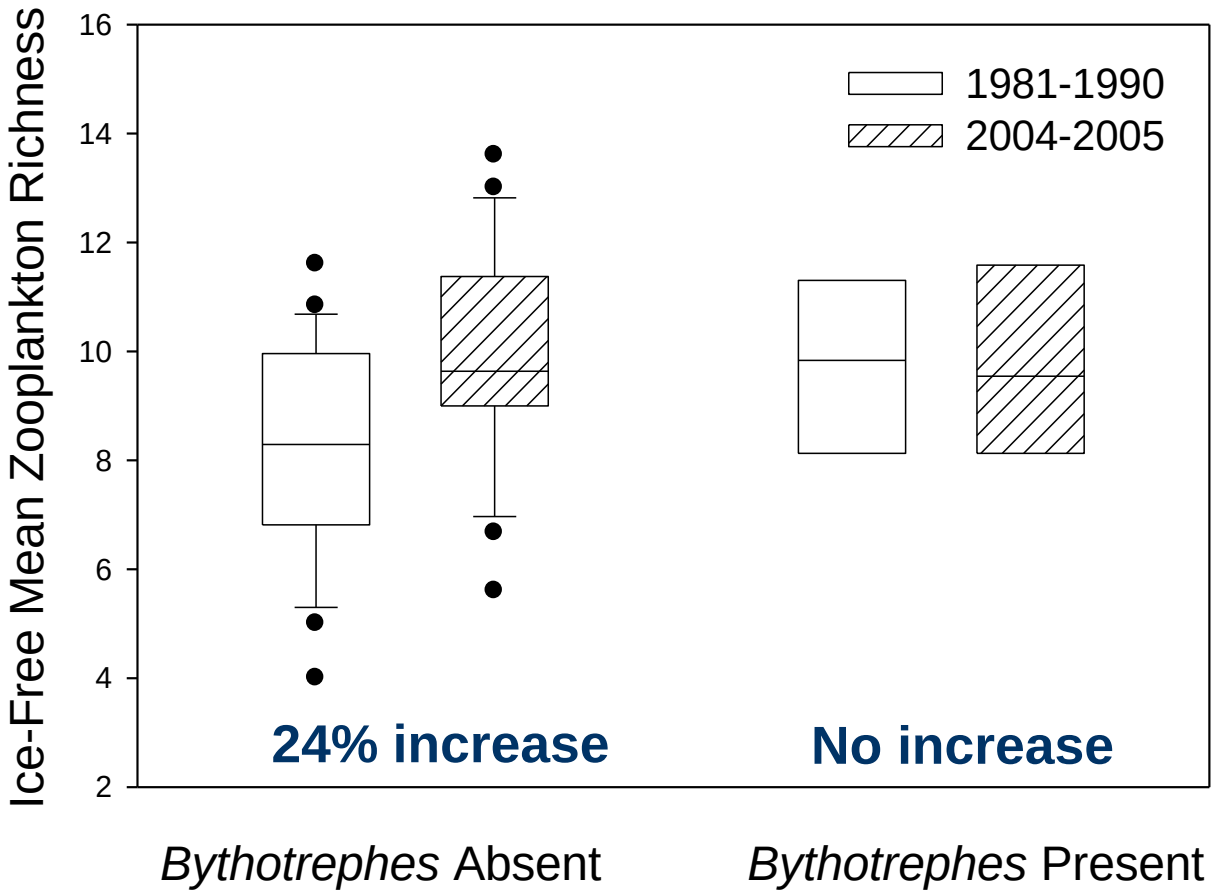
Oligotrophication increases the risk of road salt*



*Brown and Yan (in prep)

Bythotrephes interferes with recovery of species richness from historical acidification*

- richness & diversity ↑
  - ↑ pH
  - ↑ temperature
  - ↑ TP
- *Bythotrephes* had a negative impact



*Palmer and Yan 2013 FWB

In summary,
the threat of acidification is falling,
but Calcium decline, road salt, and *Bythotrephes*
are current widespread drivers of change, and
development and climate pressures are real.

We must remain engaged to protect our lakes

Can we solve these developing problems?

- It takes knowledge
  - Problem recognition, identification of causes, evaluation of possible solutions, modelling of time frames
- It takes will
  - Public engagement, education, hope
- It takes action
  - policy change, intervention, re-assessment

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Will we solve these developing problems??