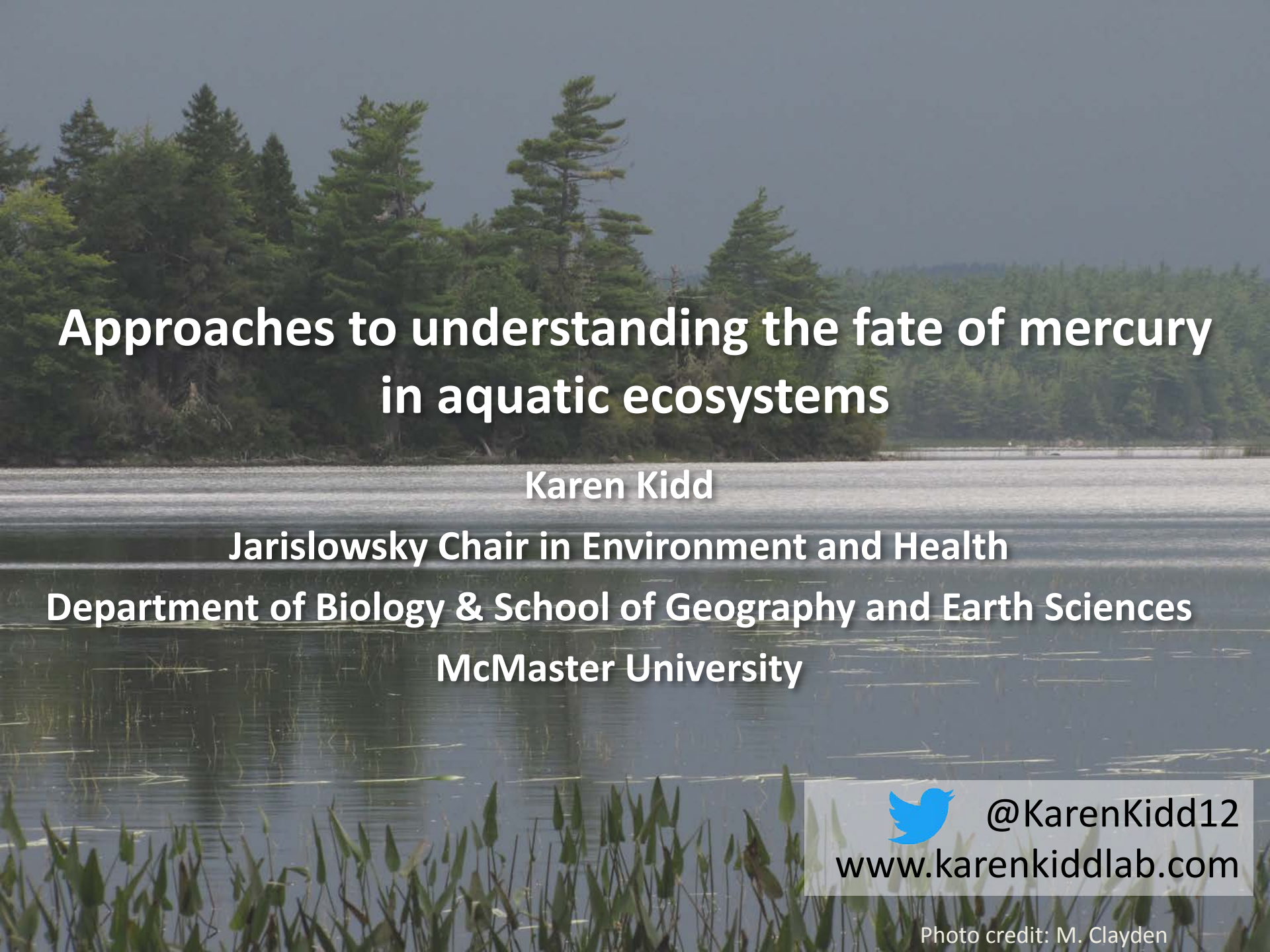


Approaches to understanding the fate of mercury in aquatic ecosystems

Karen Kidd

Jarislowsky Chair in Environment and Health

Department of Biology & School of Geography and Earth Sciences

McMaster University

@KarenKidd12

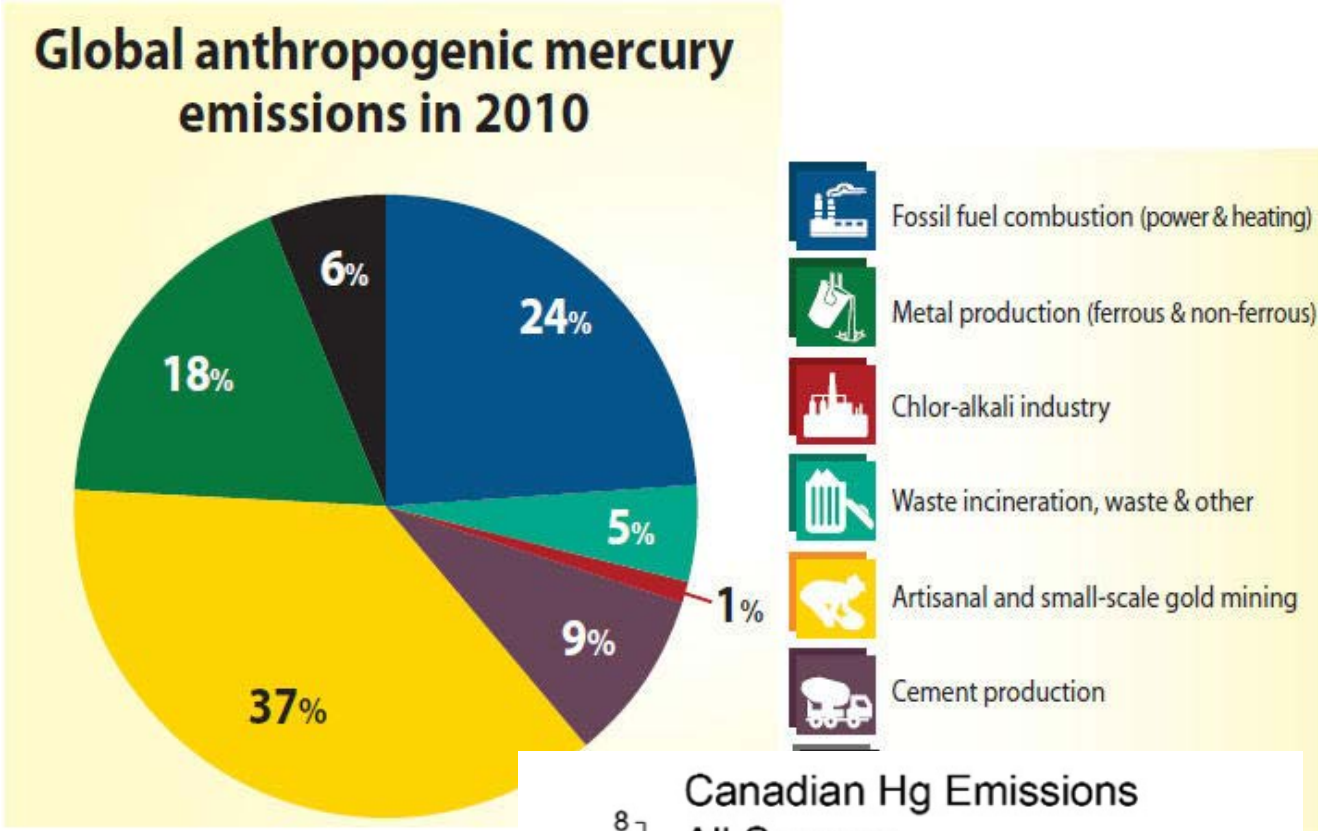
www.karenkiddlab.com

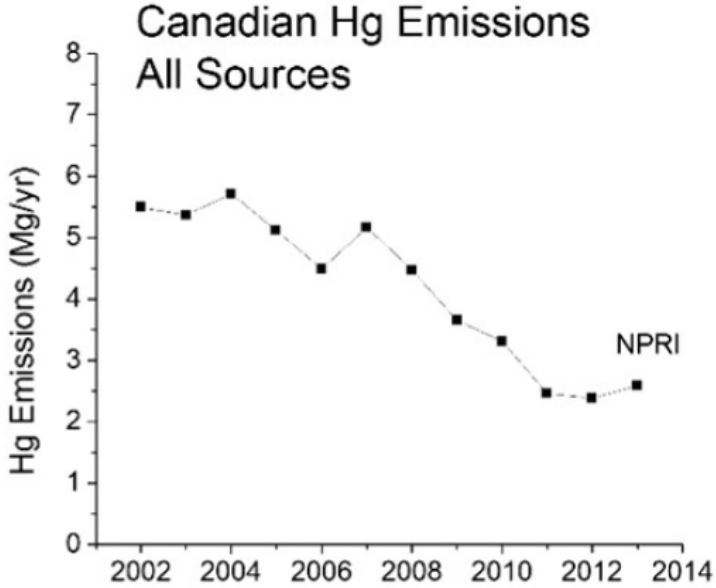
Photo credit: M. Clayden

What am I going to talk about?

- Why do fish vary in their mercury levels?
- What happens to mercury in aquatic food webs?
  - Mercury hotspot – Nova Scotia
  - Arctic lakes
  - Global trends in mercury
- The future – climate change, Minamata Convention

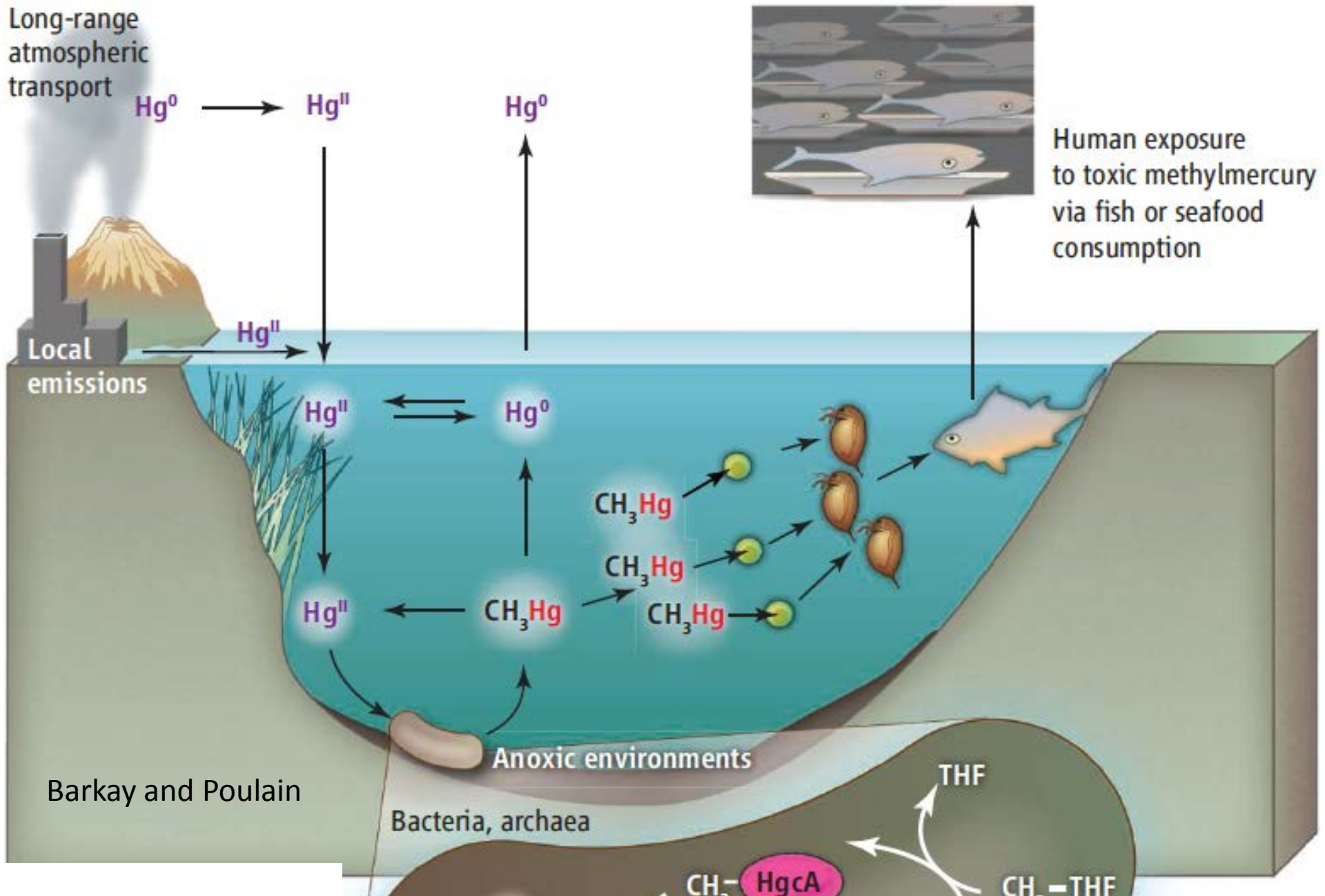
Photo credit: M. Clayden





Weiss-Penzias, P. et al. 2016 Sci. Total Env.

Mercury in aquatic systems

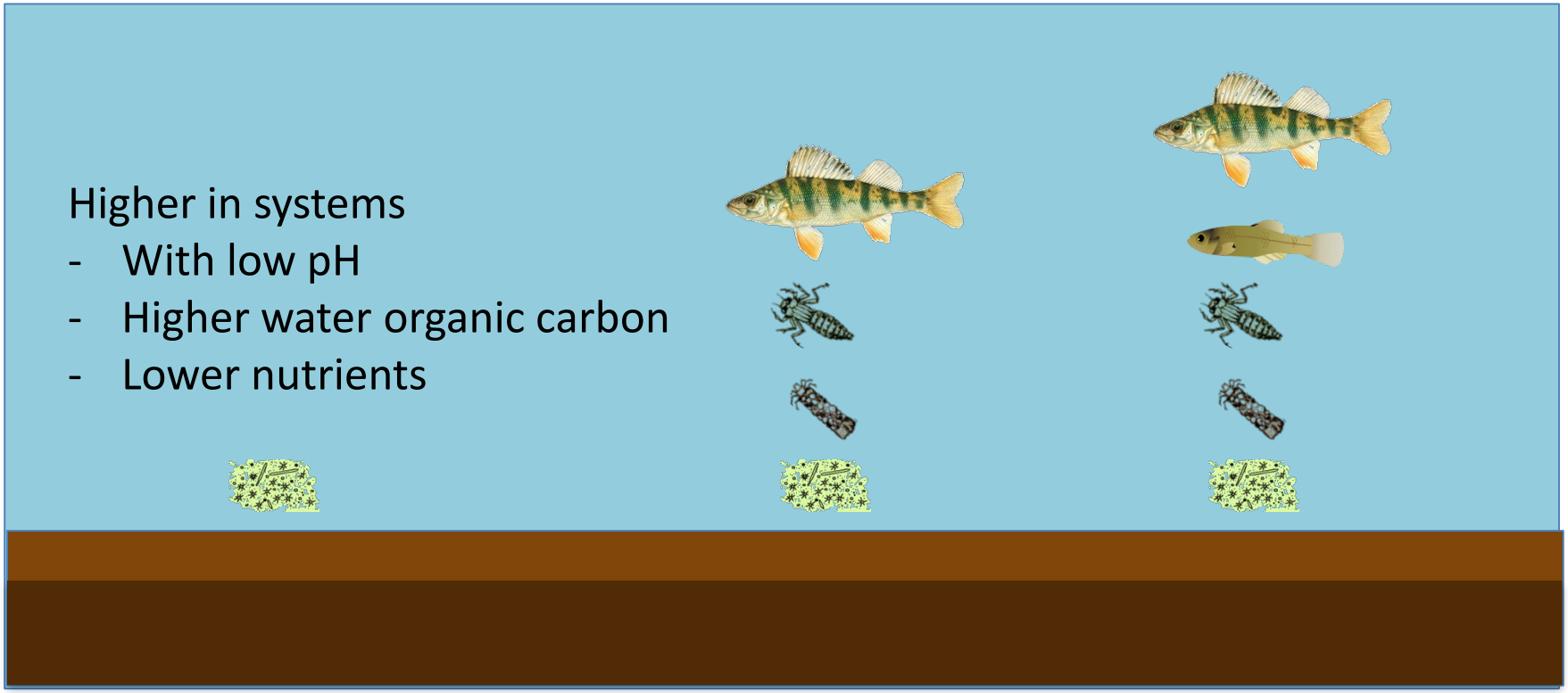


Barkay and Poulain

Methylmercury (MeHg) in aquatic ecosystems

Diet and environment matter

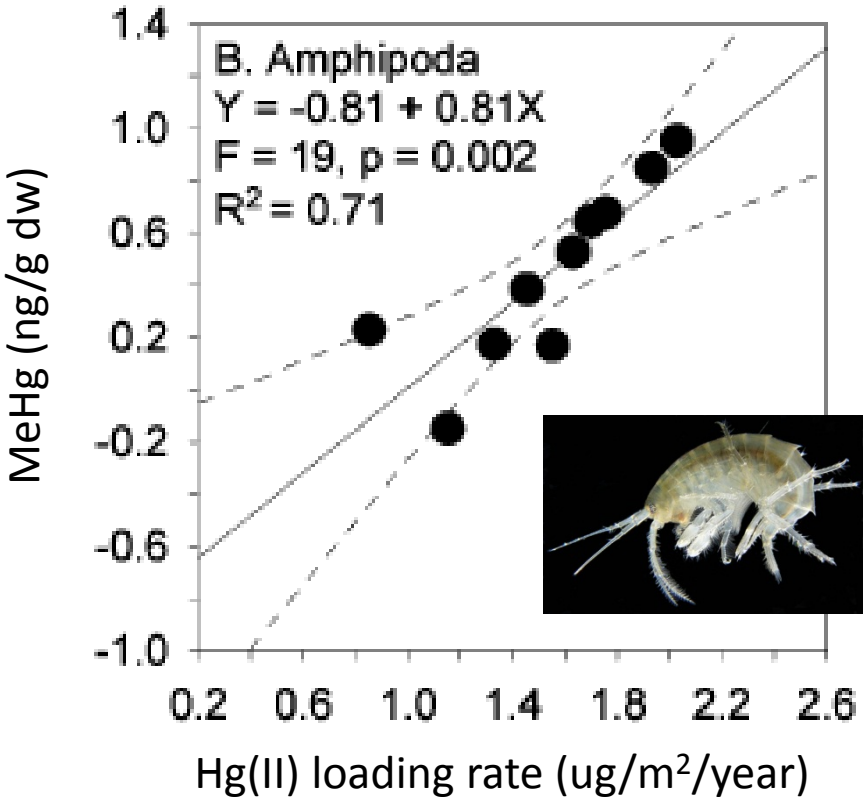
Global concerns about human and wildlife exposure

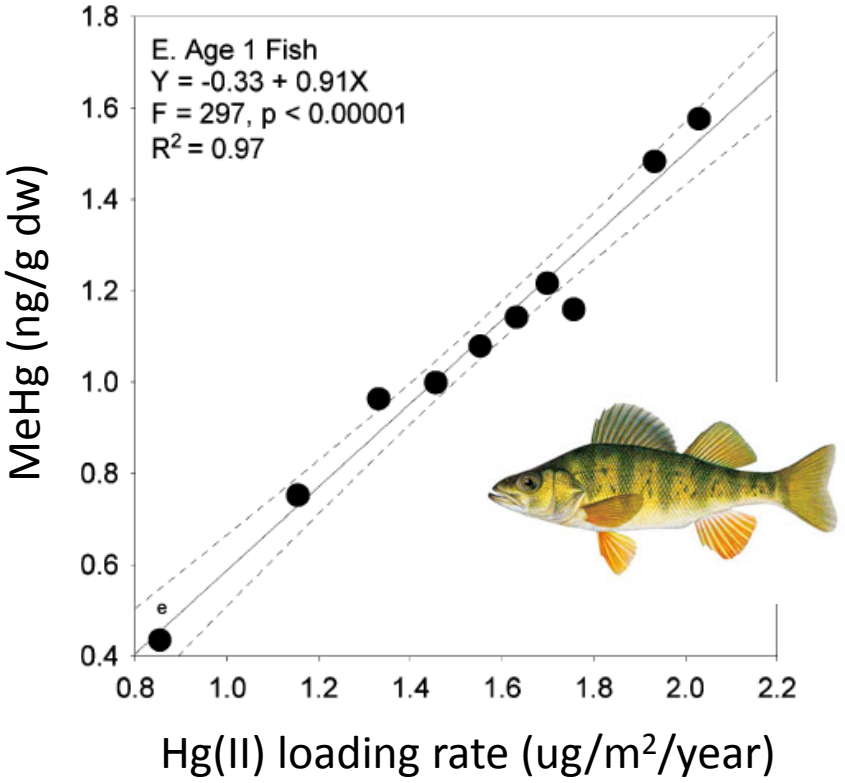


Accumulates in body, neurotoxic and impairs reproduction in fish and fish-eating wildlife and humans (Hammerschmidt et al. 2001; Burgess & Meyer 2008)

Inputs drive methylmercury in prey and fish

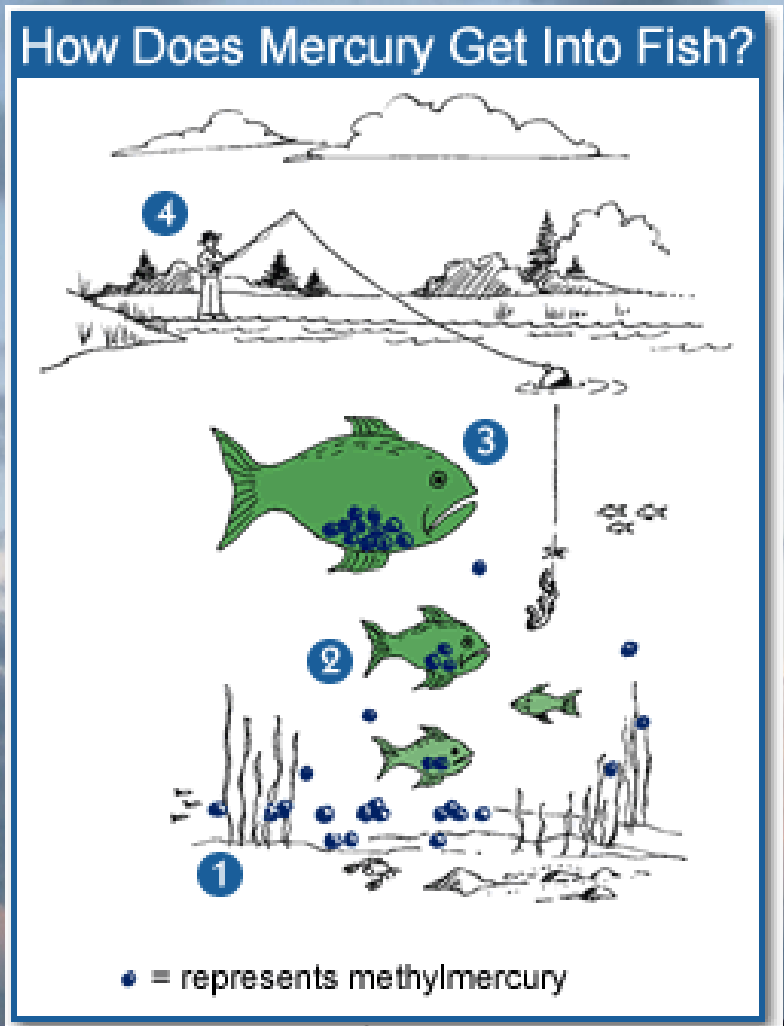
Orihel et al. 2007 ES&T





Why does mercury vary?

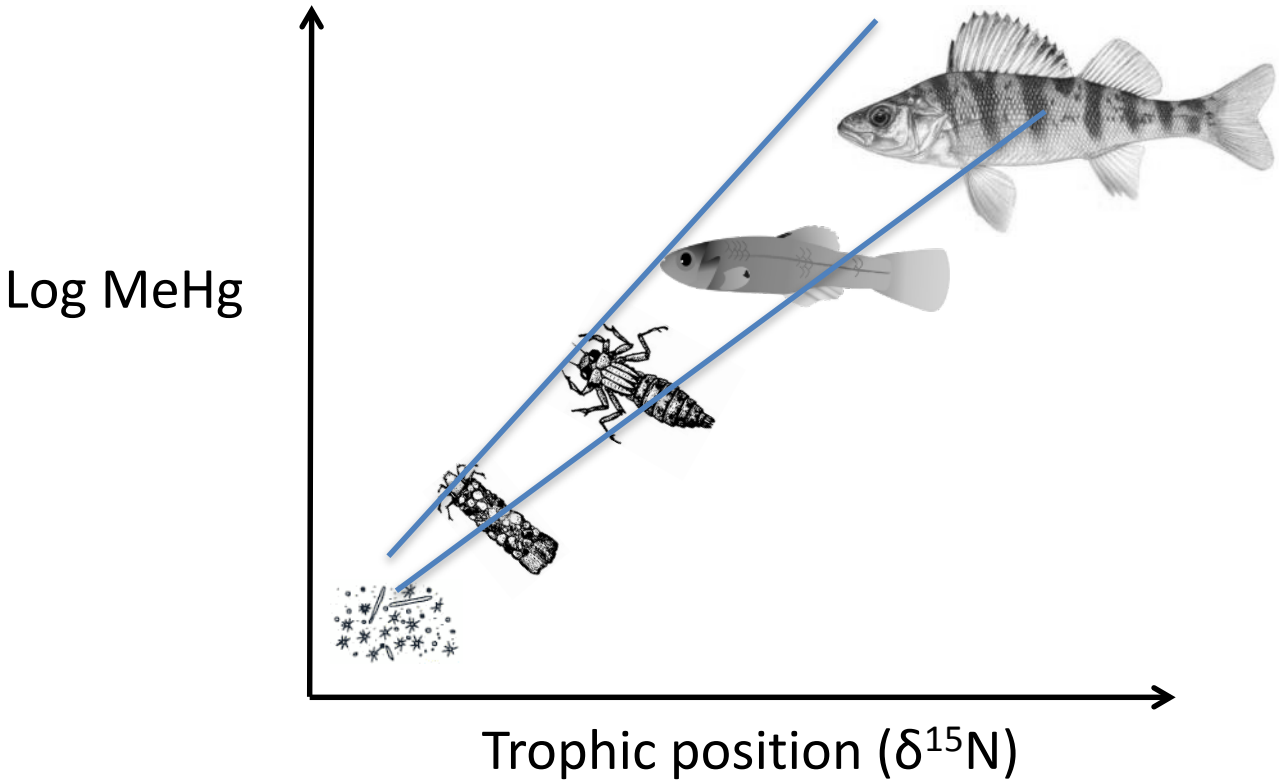
- Inputs (point sources)
- Water quality (pH, nutrients, etc.)
- Physical characteristics (size, wetlands, depth)
- Biology (diet, age/size, growth)



Vermont Agency of Natural Resources

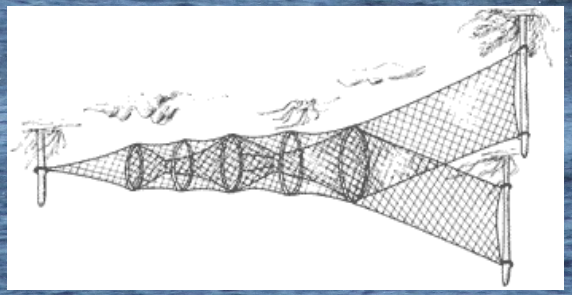
Mercury in aquatic food webs

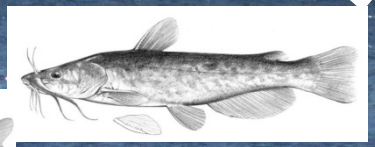
- Using nitrogen isotopes ($\delta^{15}N$) to measure trophic position
- Log [MeHg] and $\delta^{15}N$ positively related
- Slope of regression is average biomagnification

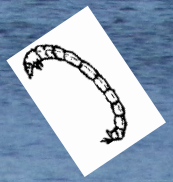


Kejimkujik National Park and National Historic Site (Keji)

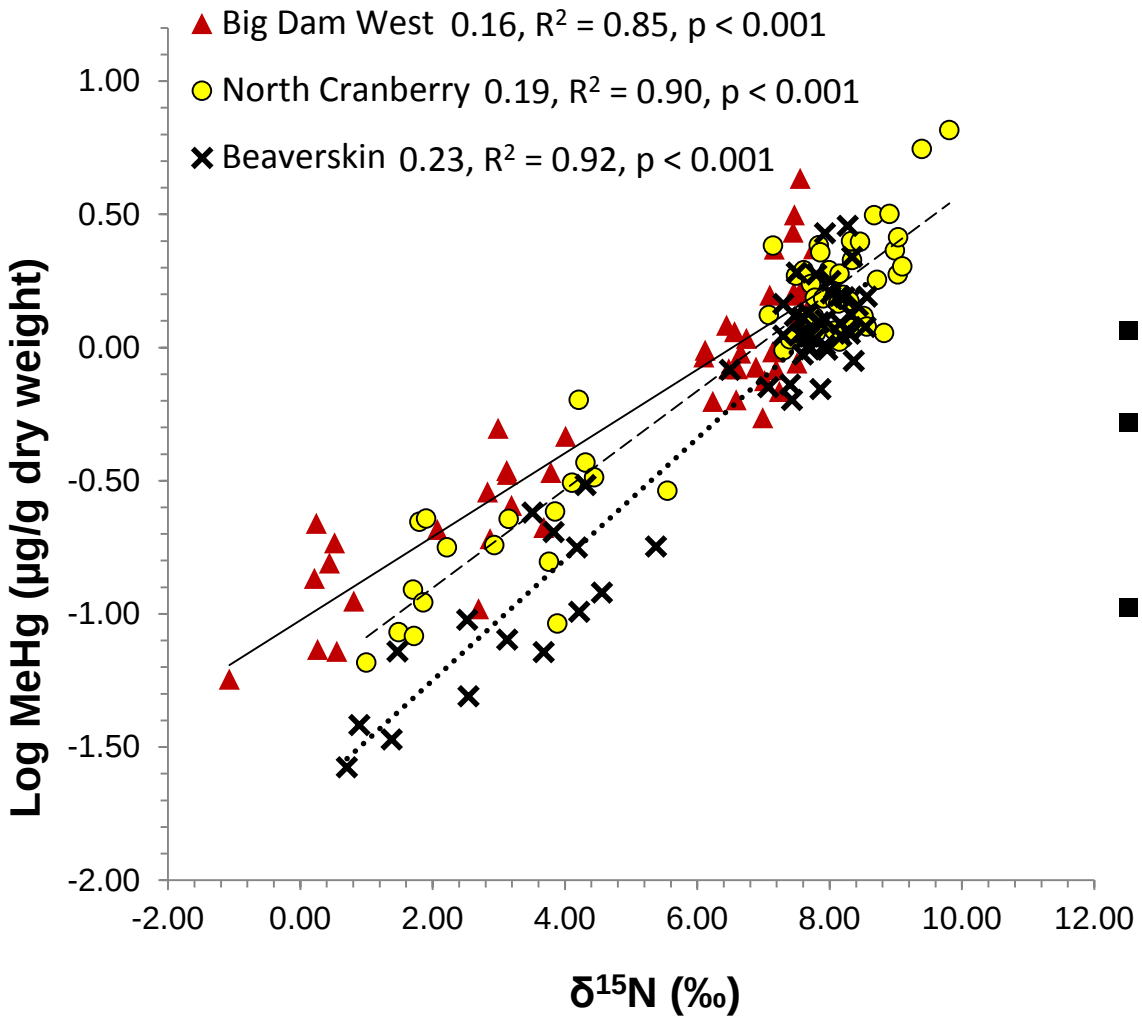
Biological “mercury hotspot”





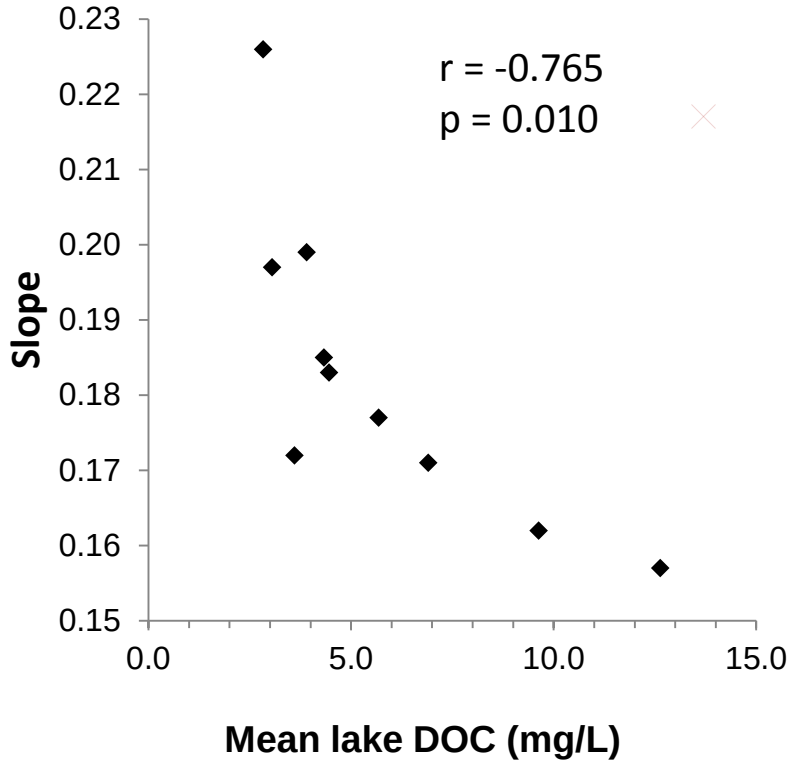


Some lake food webs concentrate mercury more than others



- Studied 11 lakes
- Slopes varied
- Why?

Slopes related to water chemistry



- Higher mercury transfer in food webs of lakes with:
  - Lower N, P, organic carbon, Fe, Al, Ca
  - Why?

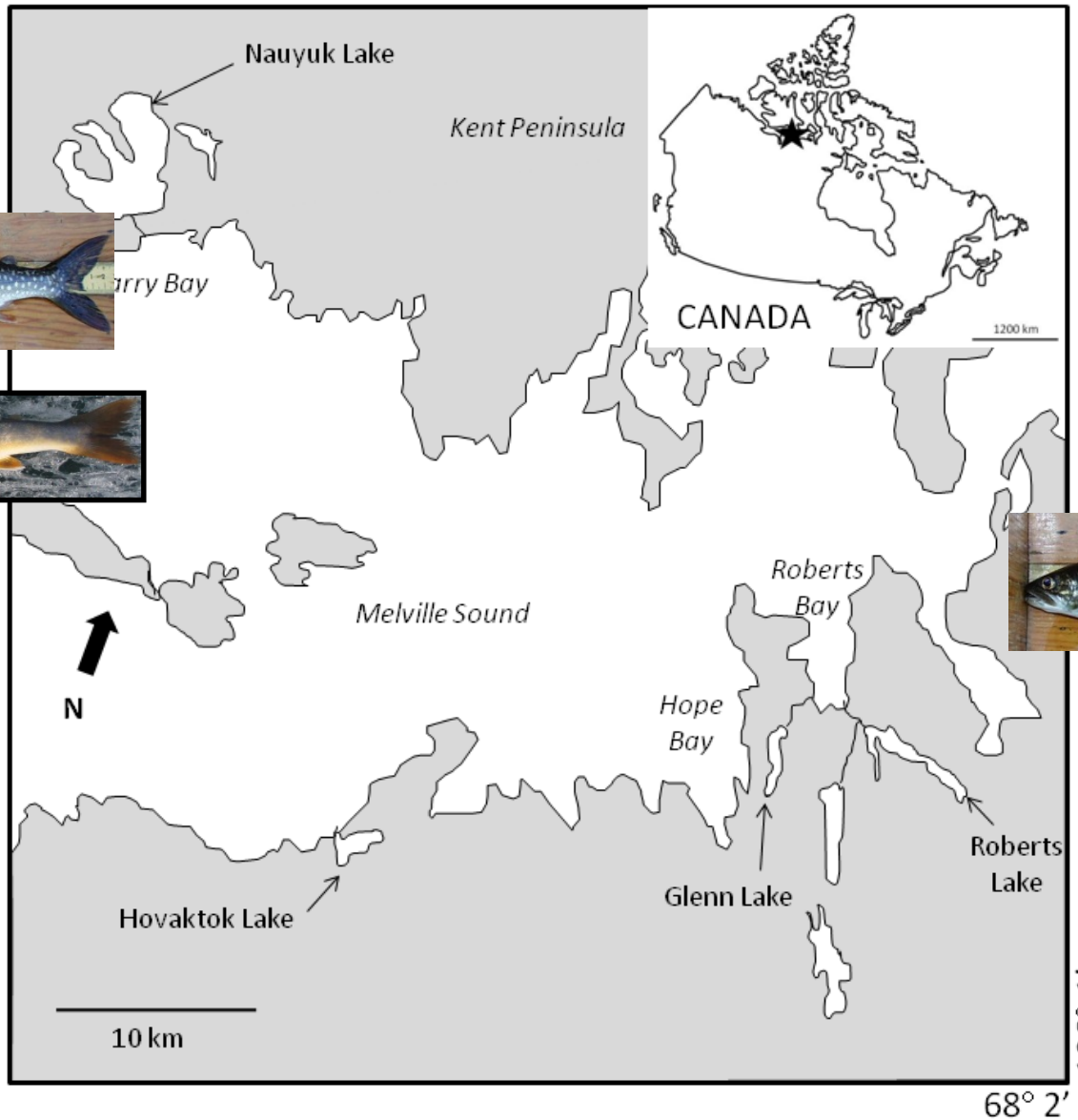
Clayden, M. et al. 2013. Environ. Sci. Technol.
Wyn, B. et al. 2009. Can. J. Fish. Aquat. Sci.

What is happening in Arctic lakes?
Arctic charr in Nunavut

- Important cultural and economic value
- Source of contaminants to consumers
- Susceptible to climate change
- Anadromous (sea-run) and lacustrine (lake-dwelling) populations

Coastal Arctic lakes with lake trout
(three with anadromous Arctic charr)

3 lakes



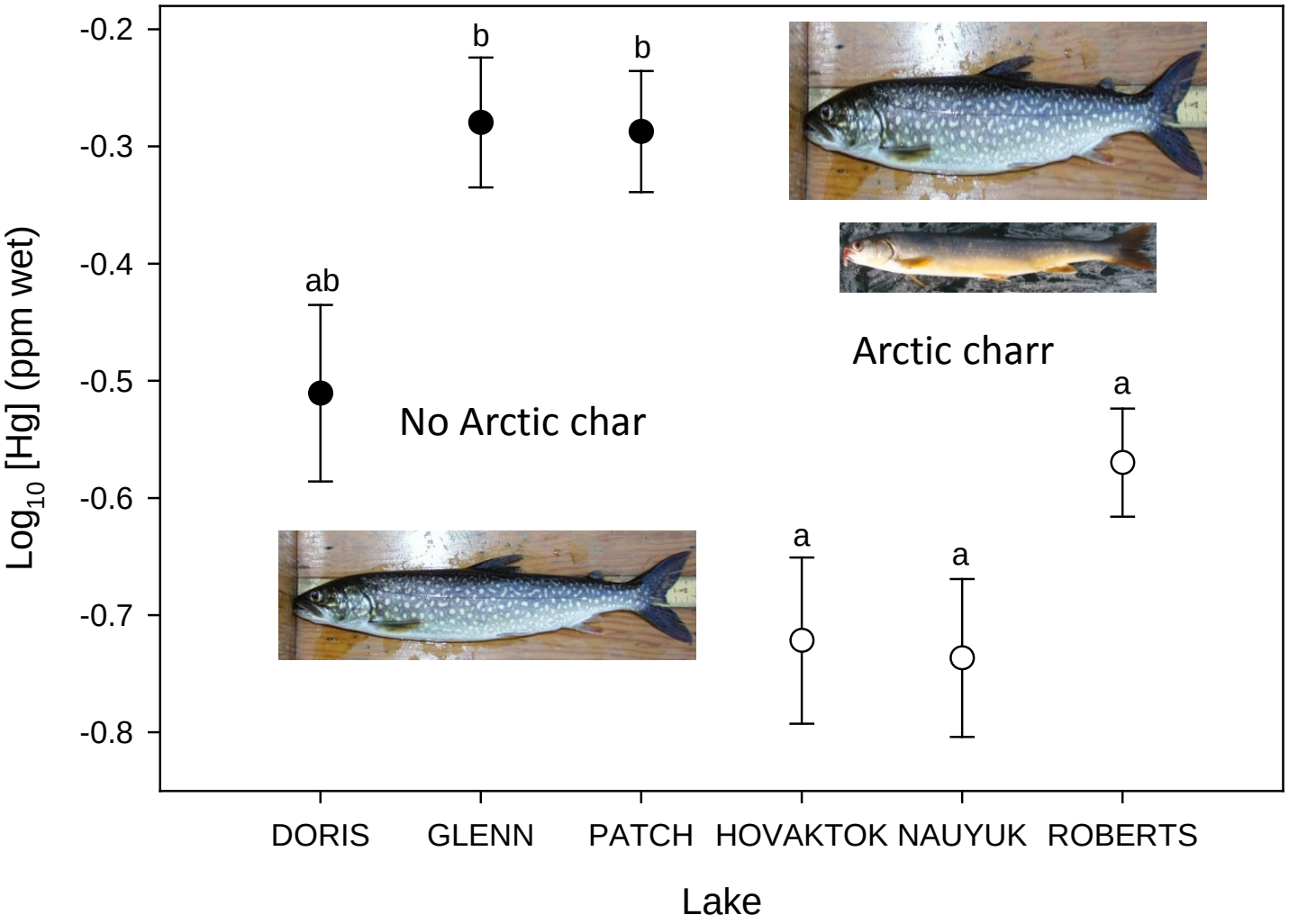
3 lakes

Heidi's fun in the field

Watching for bears is important

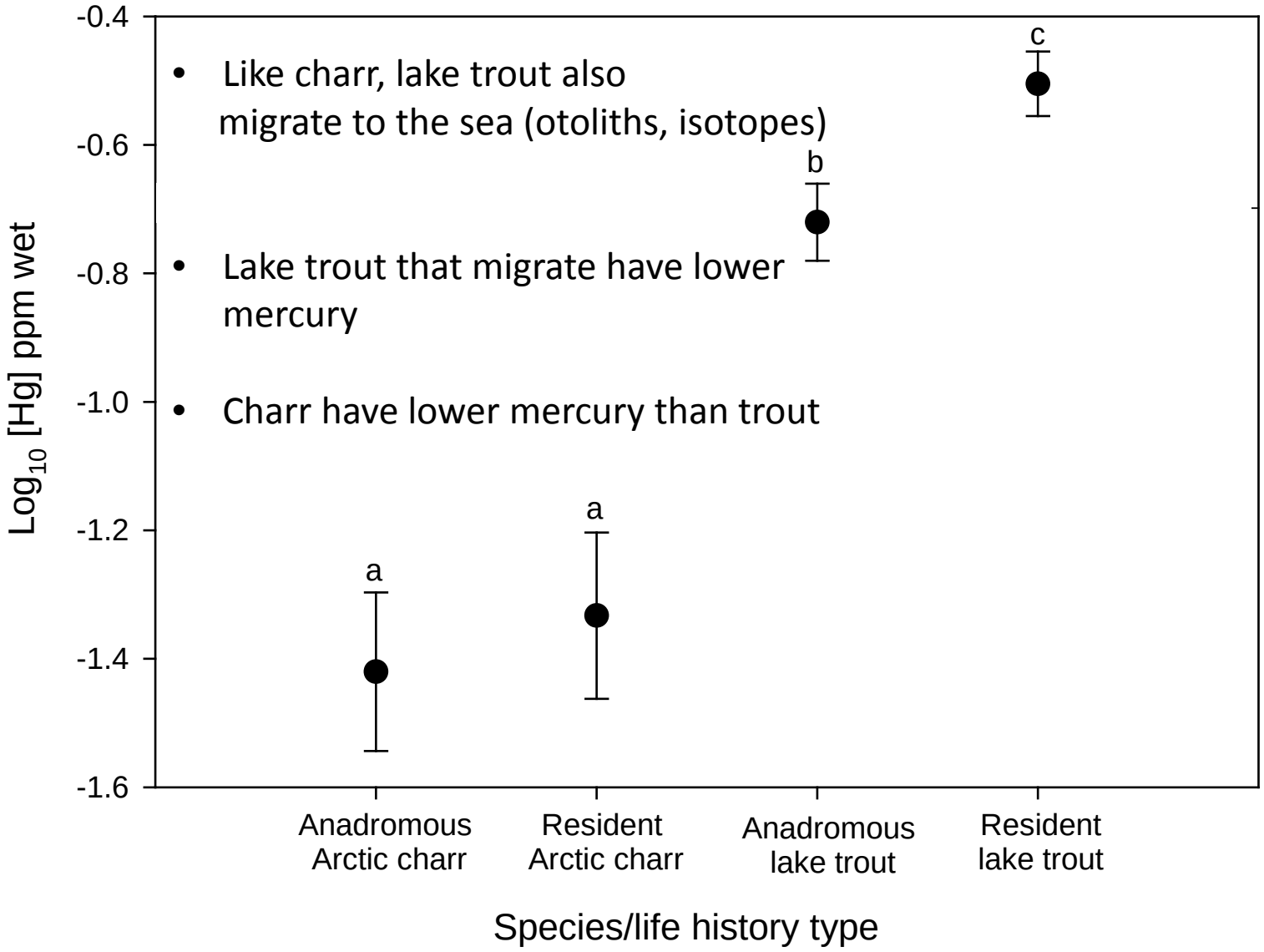
Gill netting at Nauyuk Lake

Fish community affects mercury in lake trout



Swanson and Kidd, 2010, Environ. Sci. Technol.

Life history also affects mercury in fish



Swanson and Kidd, 2010, Environ. Sci. Technol.

What drives mercury in food webs globally?

69 studies
205 food webs

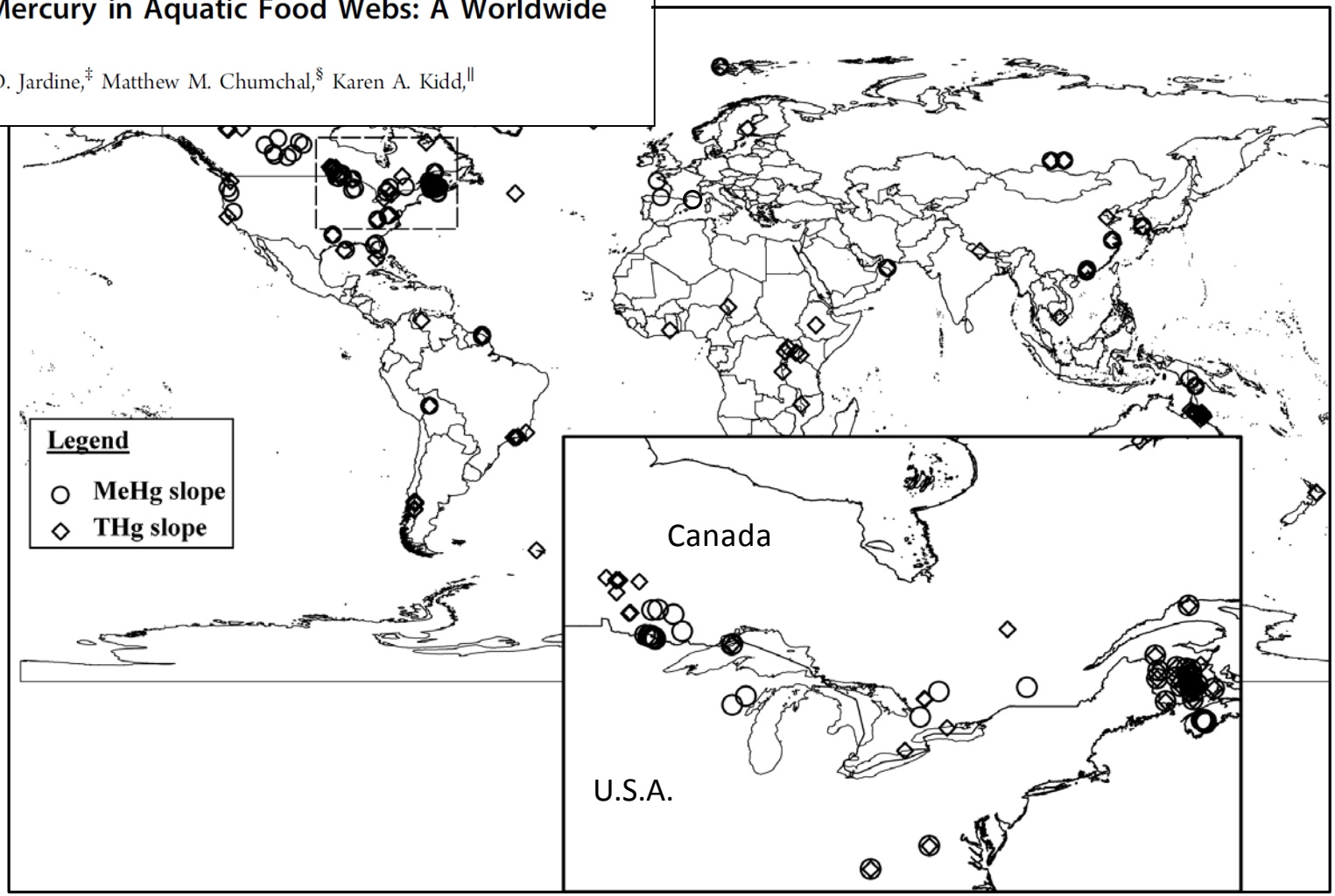
ENVIRONMENTAL Science & Technology

Article

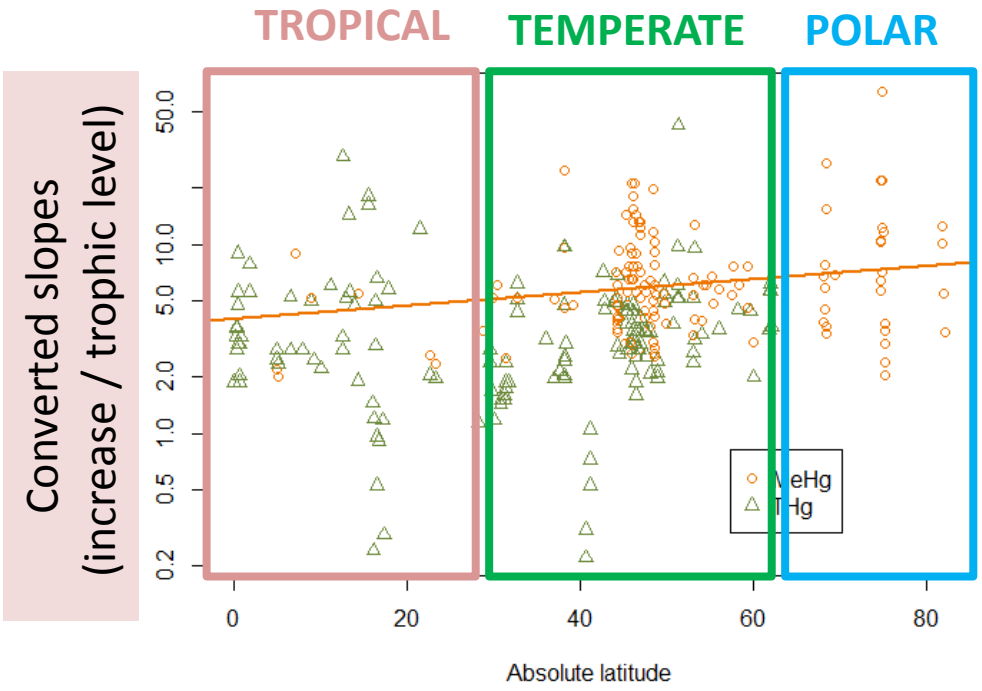
pubs.acs.org/est

Biomagnification of Mercury in Aquatic Food Webs: A Worldwide Meta-Analysis

Raphael A. Lavoie,[†,*] Timothy D. Jardine,[‡] Matthew M. Chumchal,[§] Karen A. Kidd,[∥] and Linda M. Campbell[†,⊥]

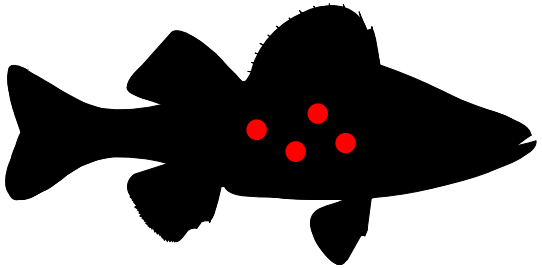


Lavoie *et al.* 2013 Environ. Sci. Technol.

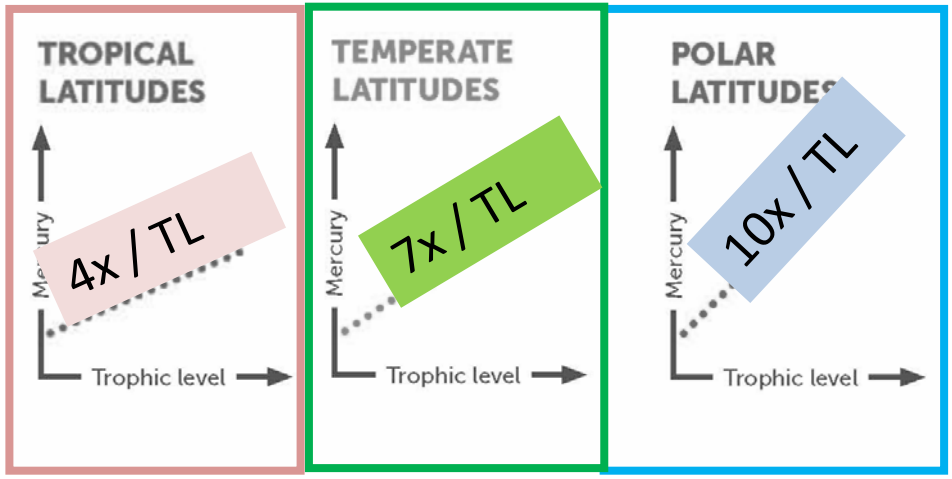


Latitude explains some variability:

- cold T°:
  - ↓ somatic growth dilution
  - ↓ excretion rate = ↑ accumulation



MeHg
(freshwater only)

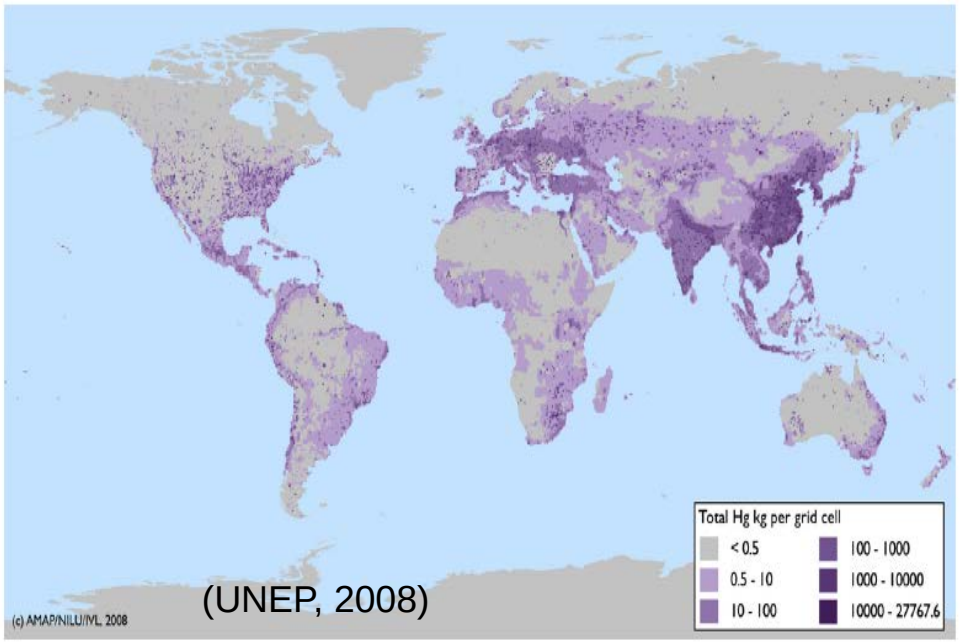


What about international mercury pollution?

- Hg pollution is a global concern due to long range transport
- Emissions decreasing in N. America, increasing in Asia
- Artisinal gold mining now largest source
- Most (~70%) of Hg in atmosphere from outside N. America (Selin and Jacob, 2008)

Minamata Convention came into force in August, 2017 (yahoo)

- Will it help reduce Hg in fishes?
- How long will it take?
- How will climate change affect its success?



(UNEP, 2008)

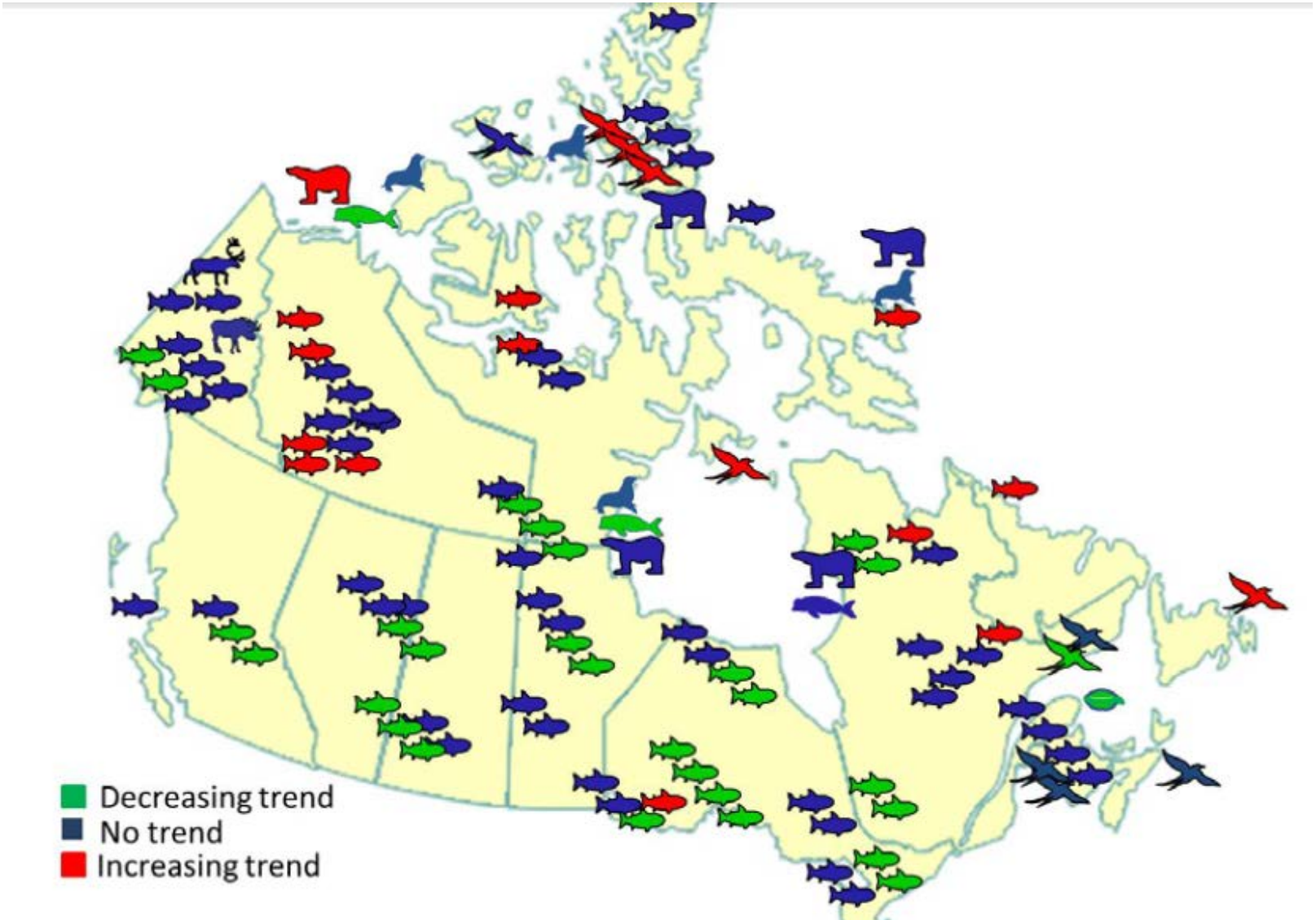
How will mercury be affected by climate change?

- Higher temperature and precipitation could increase
  - Methylation of HgII to MeHg
  - Availability of MeHg to base of food web
  - Primary production

- Also changes in biology and ecology
  - Distributions of species
  - Habitat use (e.g. access to ocean)
  - Diets
  - Growth/condition /metabolism of food web organisms

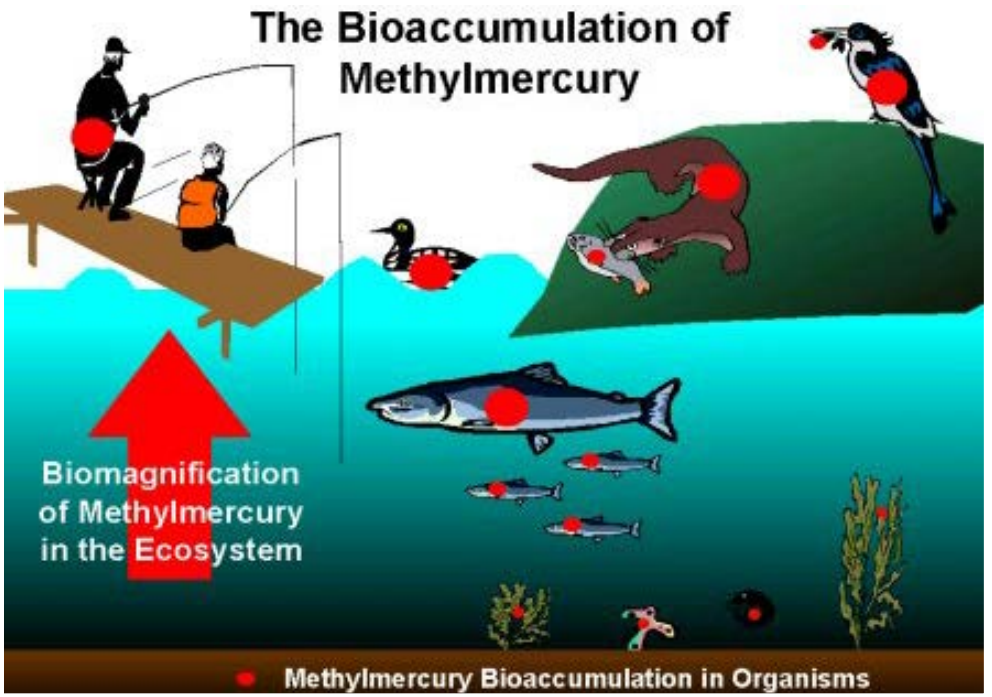
- Overall impact difficult to predict, will depend on local climate changes and environment

Temporal trends of mercury in fish and wildlife in Canada - Canadian Mercury Science Assessment led by Environment Canada



Summary

- 50+ years of Hg studies, but lots of unknowns for GWF
- Mercury remains critical issue for human, wildlife and fish health
- Inputs, ecosystem and ecological characteristics important drivers
- Minamata Convention fantastic, should decrease exposure
- Monitoring is critical for understanding risks and environmental change



(Environment Canada 2002)

Acknowledgements

Support from:

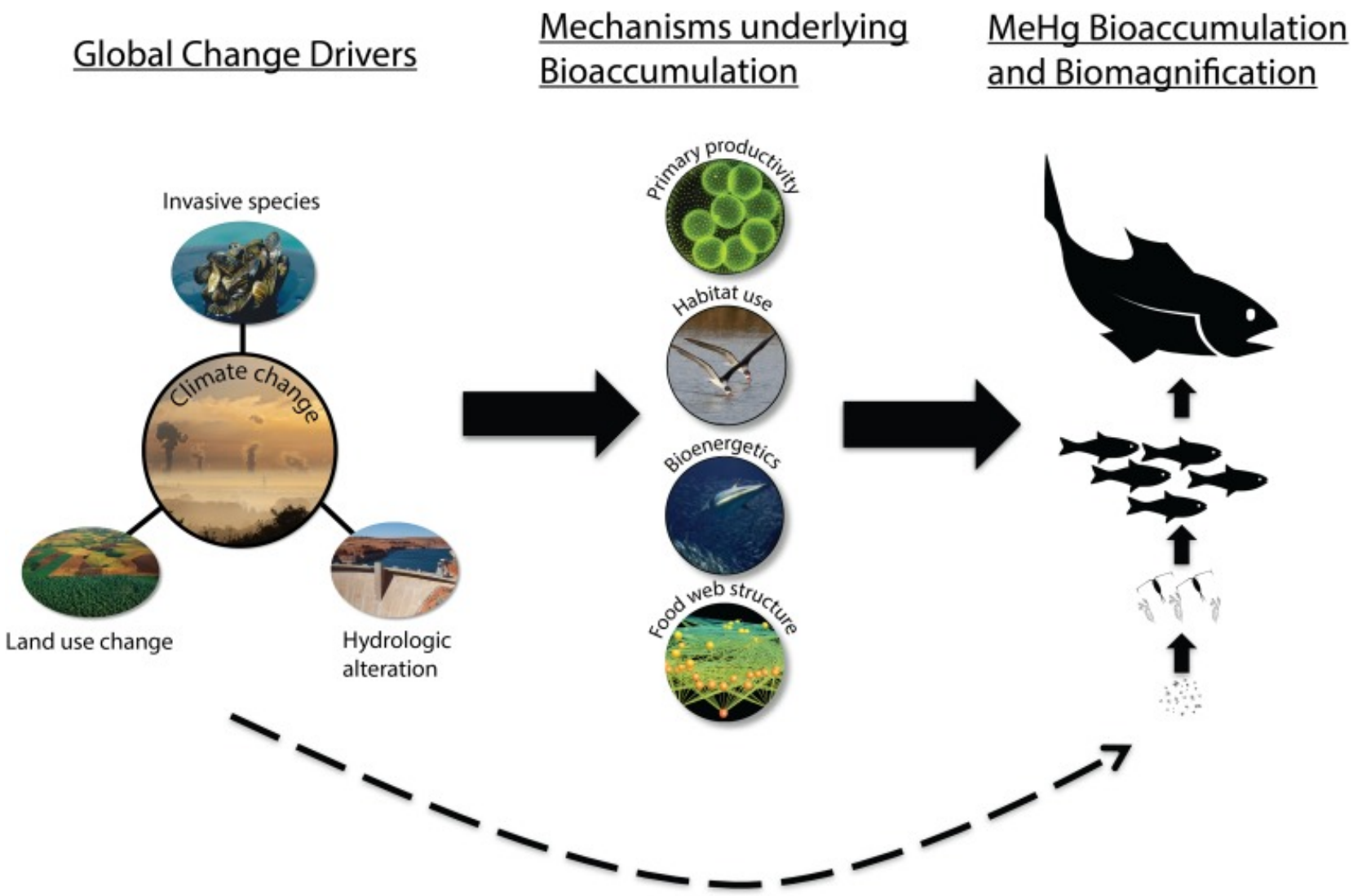
- NSERC CRC, Discovery, and CRD programs
- Environment Canada CARA program
- Northern Scientific Training Program
- Northern Contaminants Program
- Hope Bay Mining Ltd (Newmont Mining Corporation)
- International Polar Year
- Golder Associates Ltd
- Garfield Weston Foundation
- Canadian Northern Studies Trust
- Arctic Institute of North America
- Parks Canada
- Communities of Cambridge Bay, Gjoa Haven, Resolute Bay, and Umingmaktok

NSERC CRSNG

Canada

Canadian Rivers Institute

Links for GWF



Eagles-Smith, C. et al. 2018 Ambio