Long-term environmental trends in Ontario lakes that support a Lake Trout population

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PEARL

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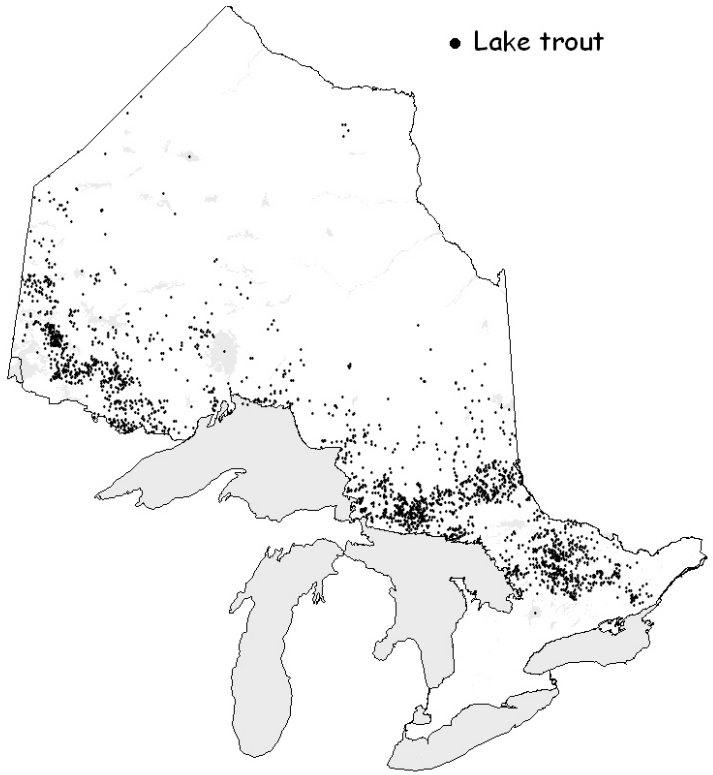
Lake Trout in Ontario

- Rare and valuable resource
  - Present in ~1% of Ontario's 250,000 lakes
  - Ontario contains 20-25% of all Lake Trout lakes worldwide
- Important to recreational fisheries
- Specific habitat requirements make them particularly sensitive to environmental stressors



http://www.hookhack.com/html/fom020113_laketrout.html

Habitat Requirements

Warm Surface Waters

Usable: < 15 °C, Lethal: > 23.5 °C

Cold Bottom Water

Usable: > 4 mg O_2 /L, Lethal: < 3 mg O_2 /L

Evans et al. (1991)

Habitat Requirements

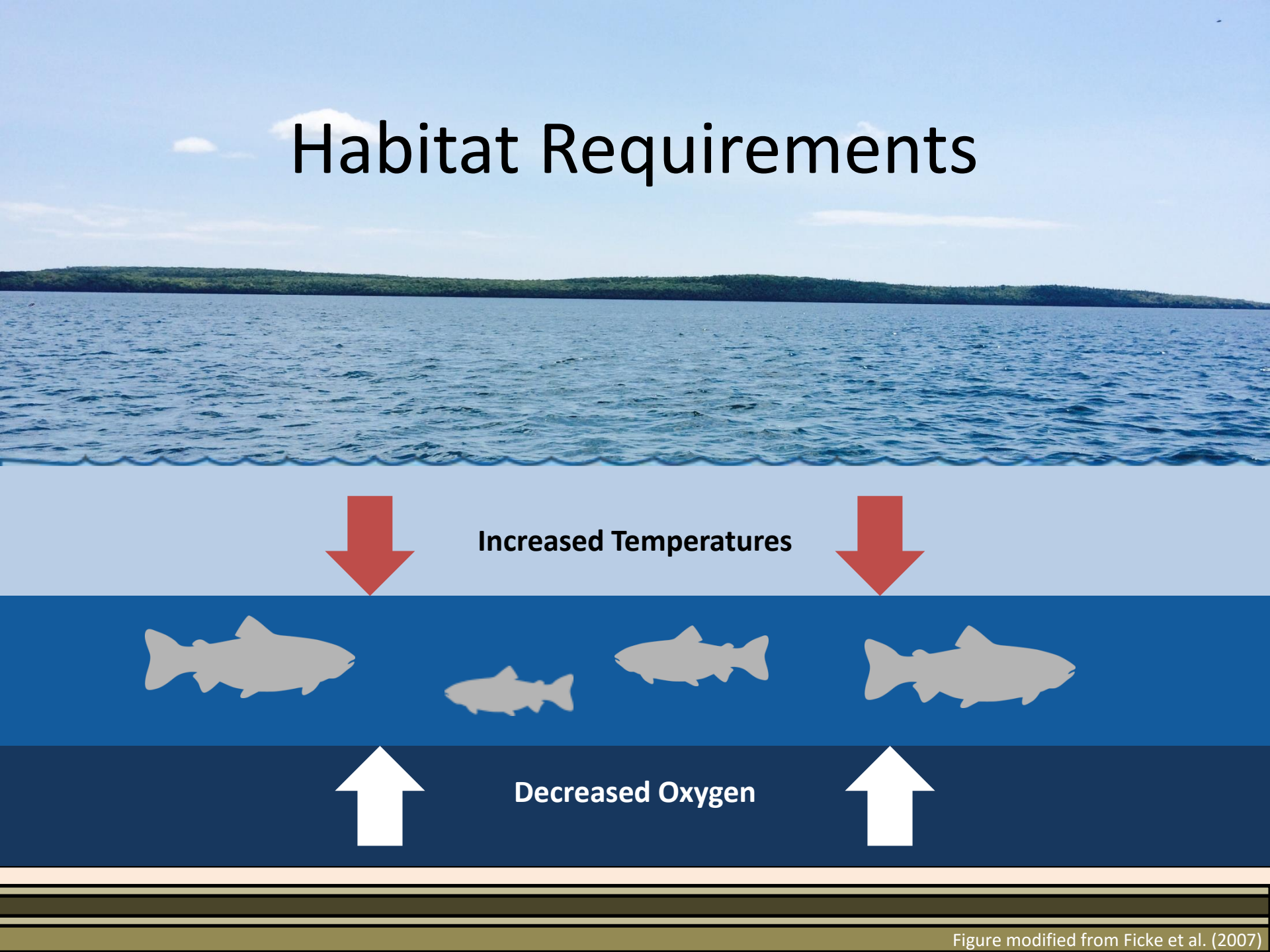
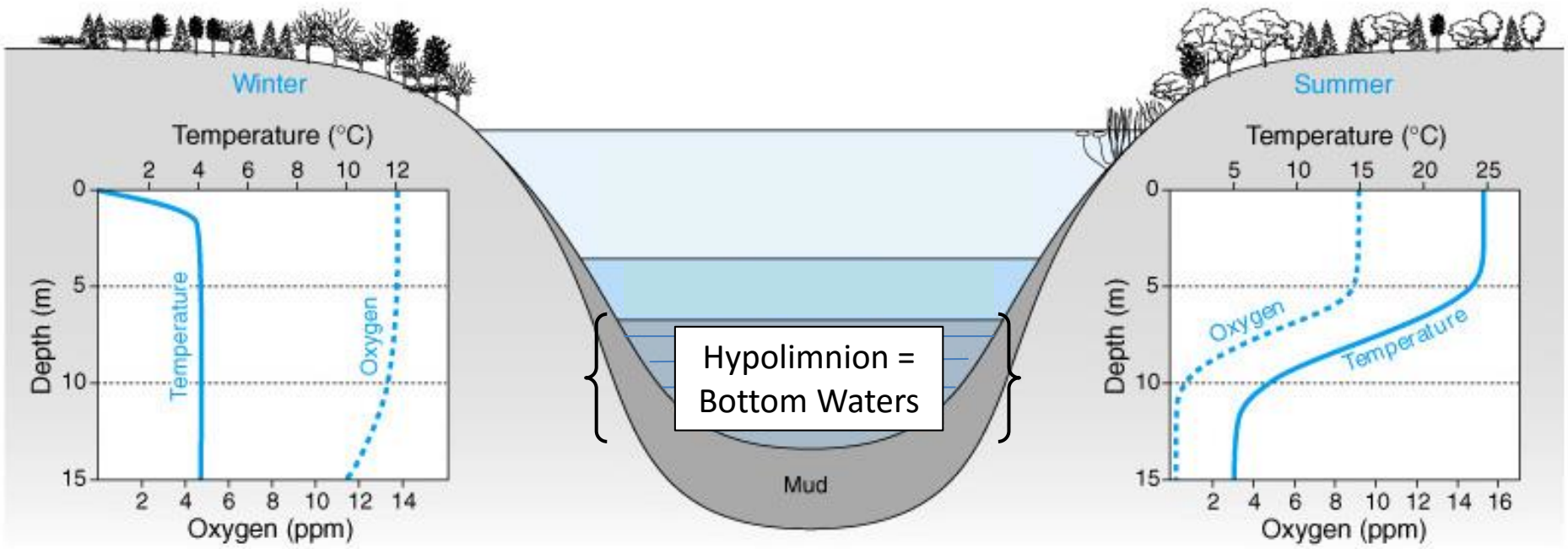


Figure modified from Ficke et al. (2007)

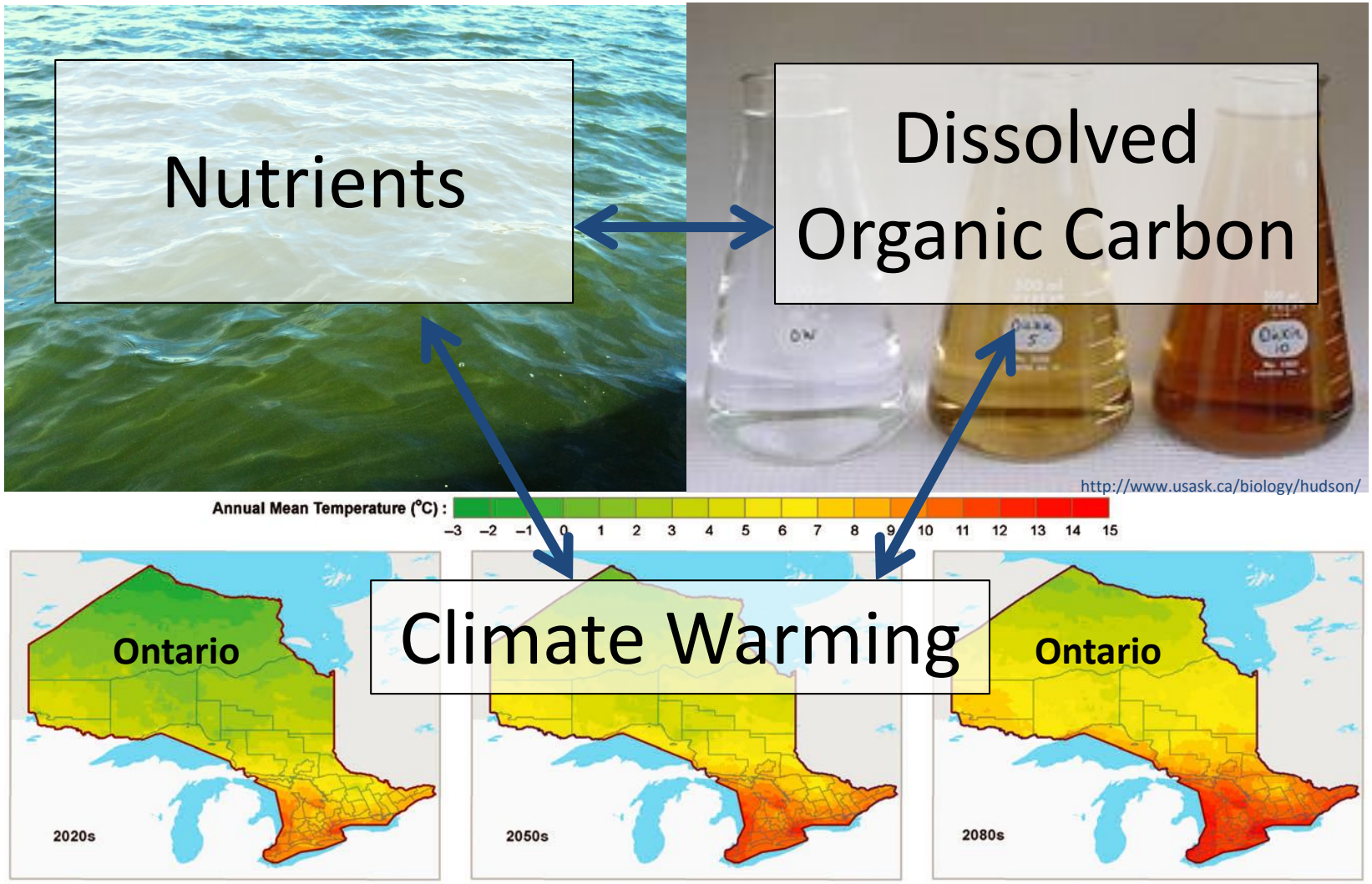
Volume Weighted Hypolimnetic Oxygen



$$\text{VWHO} = \frac{\text{Sum of (Oxygen x Volume of Water at each 1 m strata)}}{\text{Total Volume of Hypolimnion}}$$

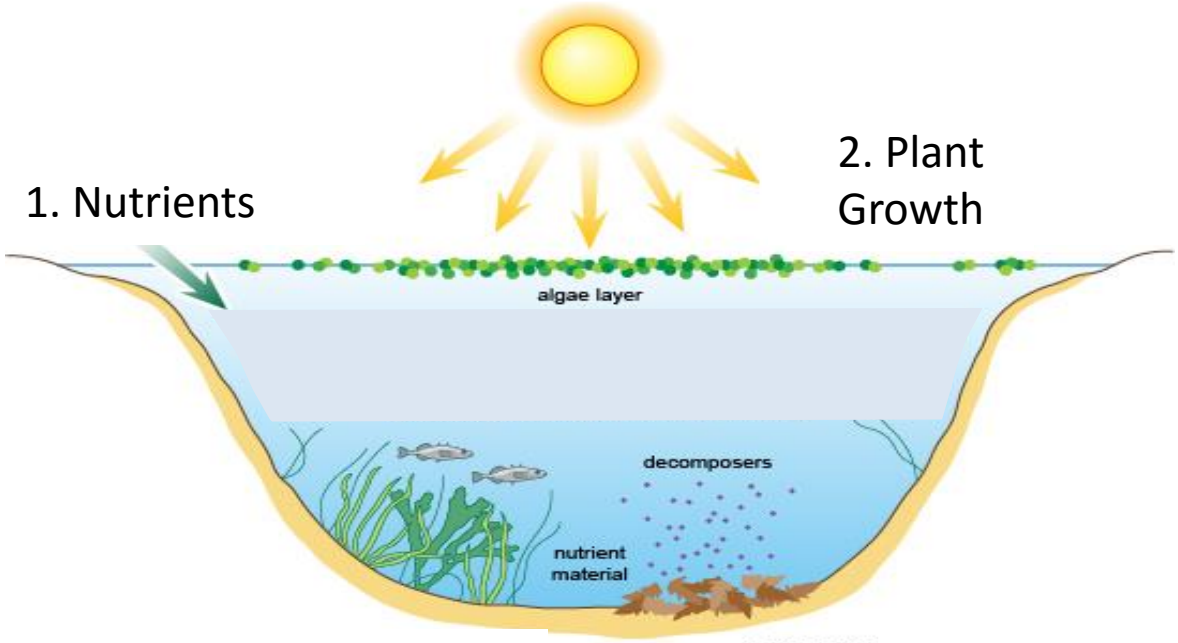
Provincial standard for end-of-summer VWHO in a Lake Trout lake > 7 mg/L (Evans et al. 2007)

Variables that Influence Hypolimnetic Dissolved Oxygen (DO)



(Figure: Wang et al. 2014)

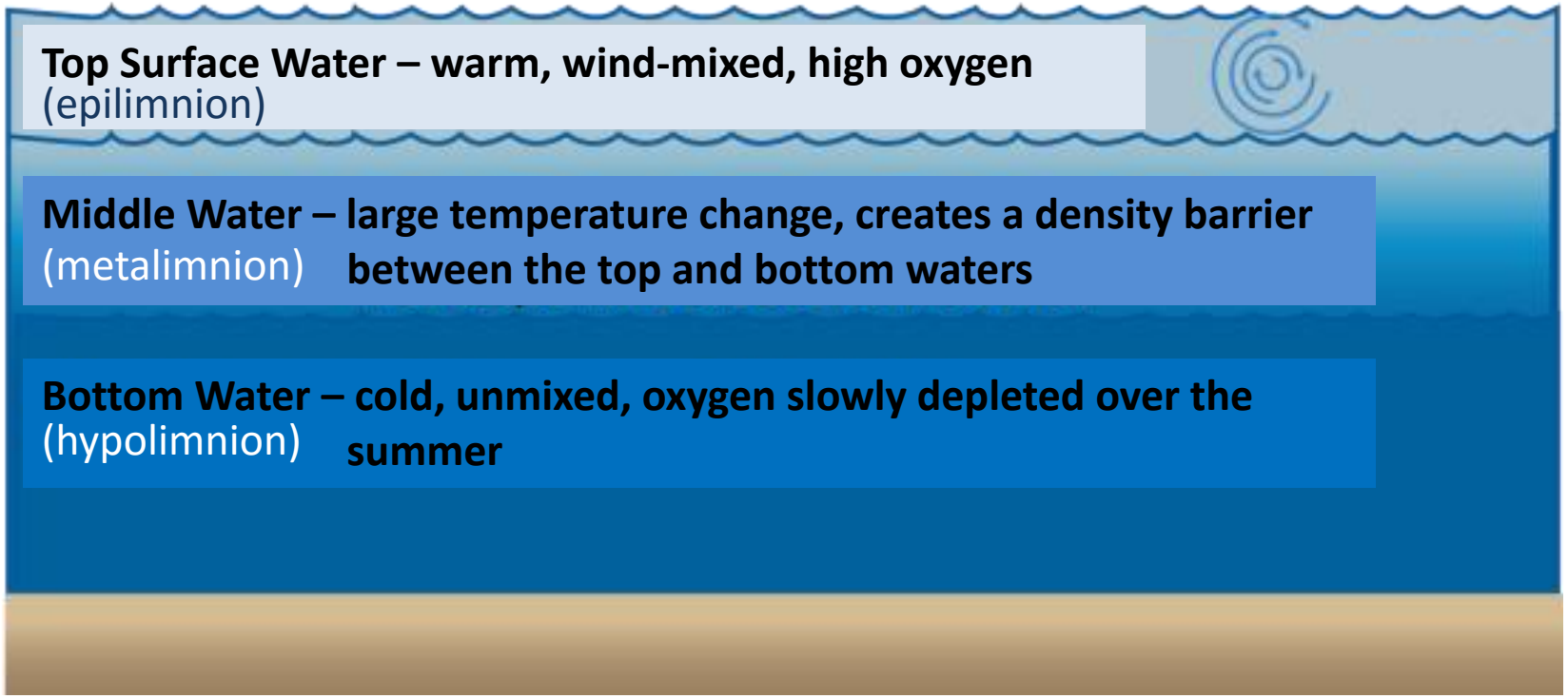
Increased Nutrient = Decreased Oxygen



3. Decomposition depletes O_2

Sources: Runoff from agricultural and urban areas, atmospheric deposition, septic systems, decaying organic matter, soil erosion

Increased Warming = Decreased Oxygen

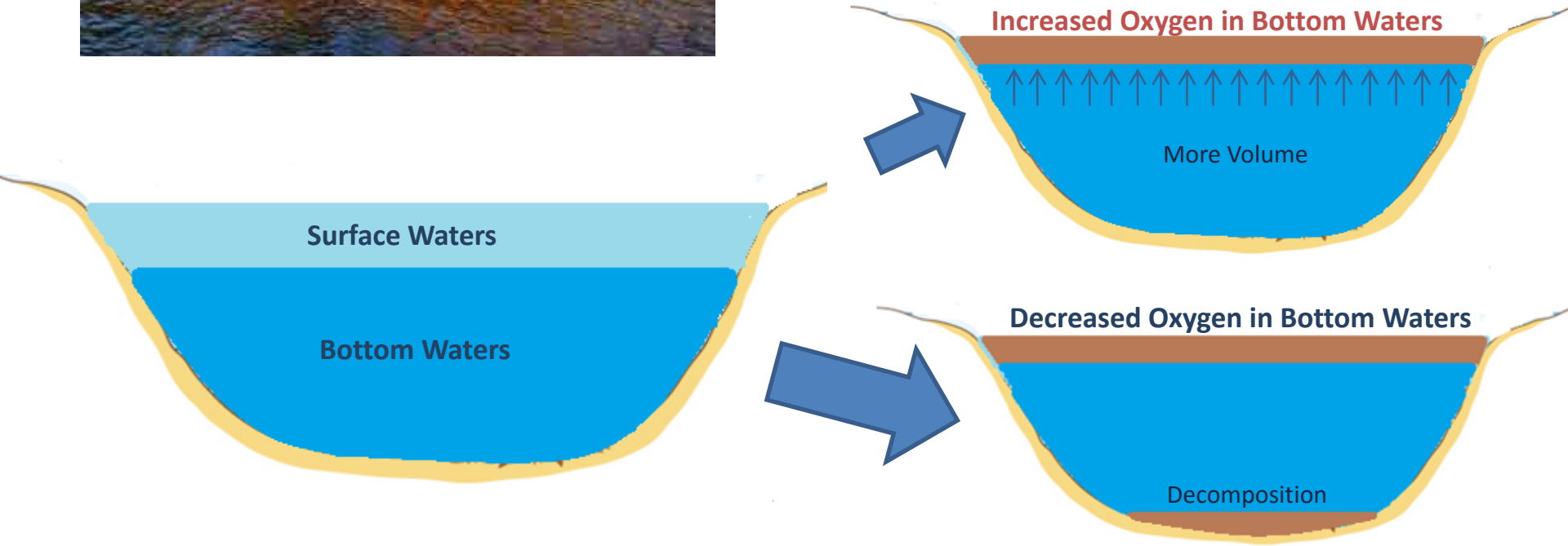


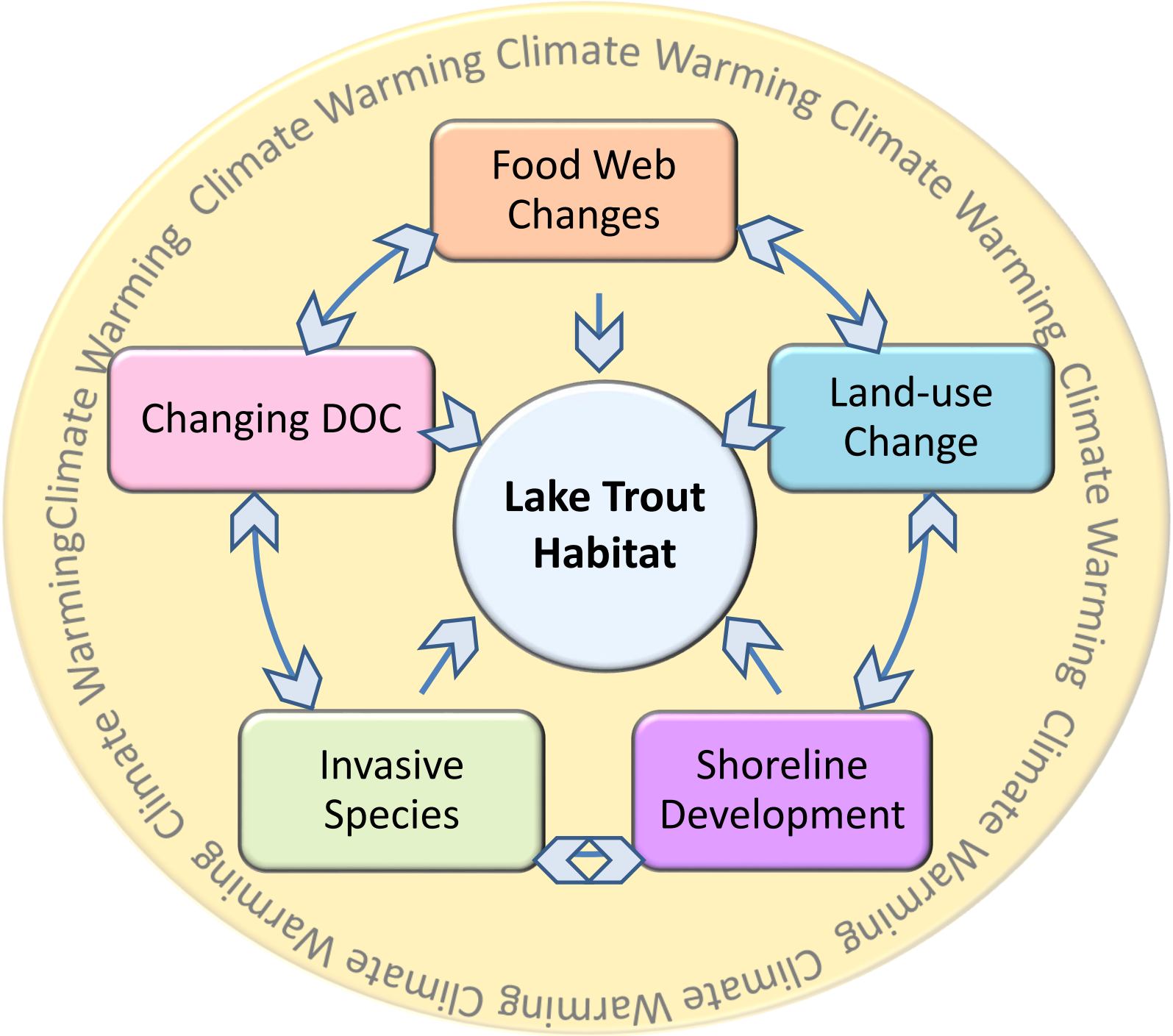
Climate warming can lead to longer and stronger periods of stratification
= greater depletion of DO

Modified from: http://nchsapes.pbworks.com/w/page/6971044/Freshwater%20Zone%204

Increased DOC = Increased or Decreased Oxygen

- Dissolved Organic Carbon gives water brown colouring
- From the terrestrial environment, wetlands, groundwater, and living organisms in the lake

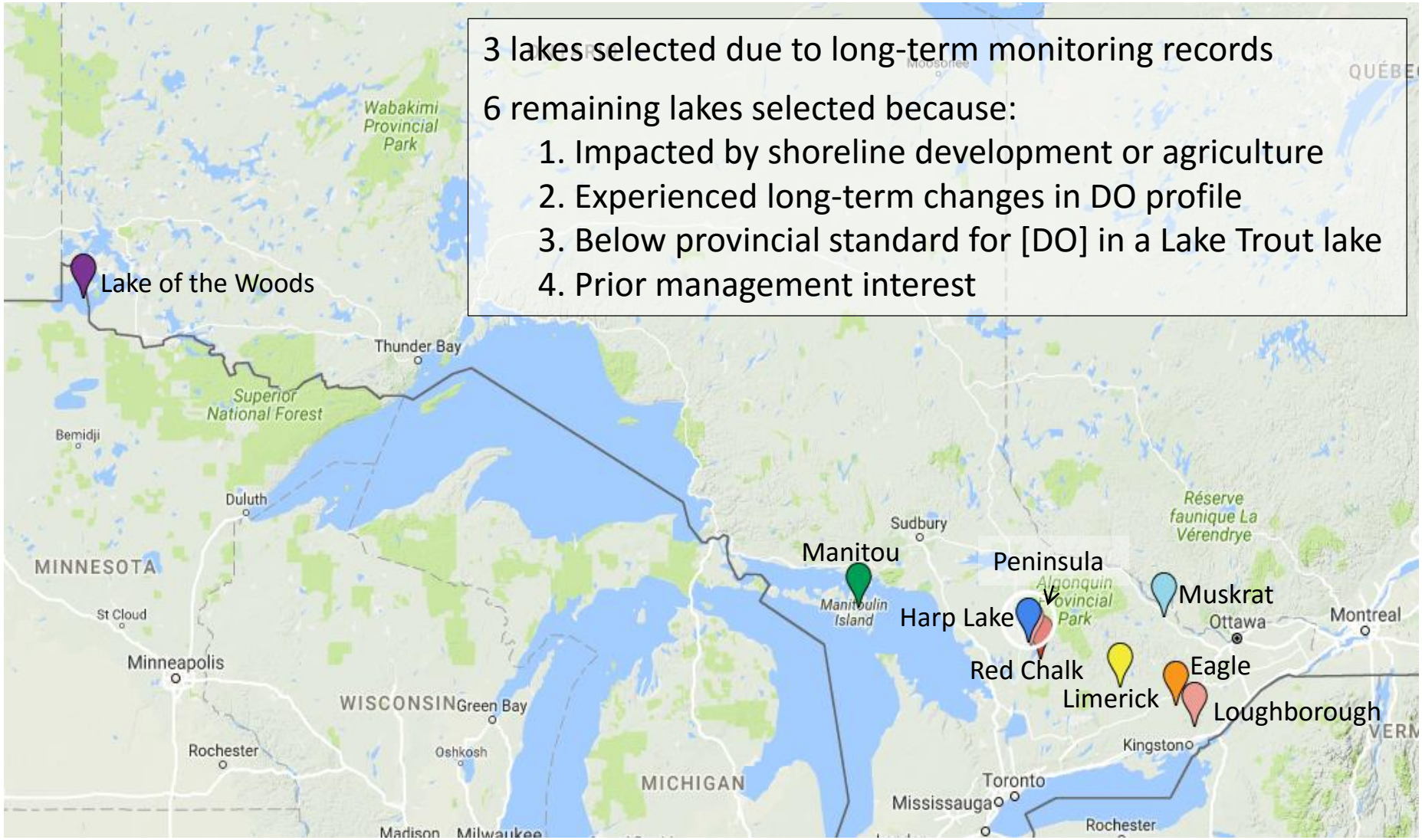



Climate Warming Climate Warming Climate Warming Climate Warming Climate Warming Climate Warming Climate Warming Climate Warming
Food Web Changes
Land-use Change
Shoreline Development
Invasive Species
Changing DOC
Lake Trout Habitat

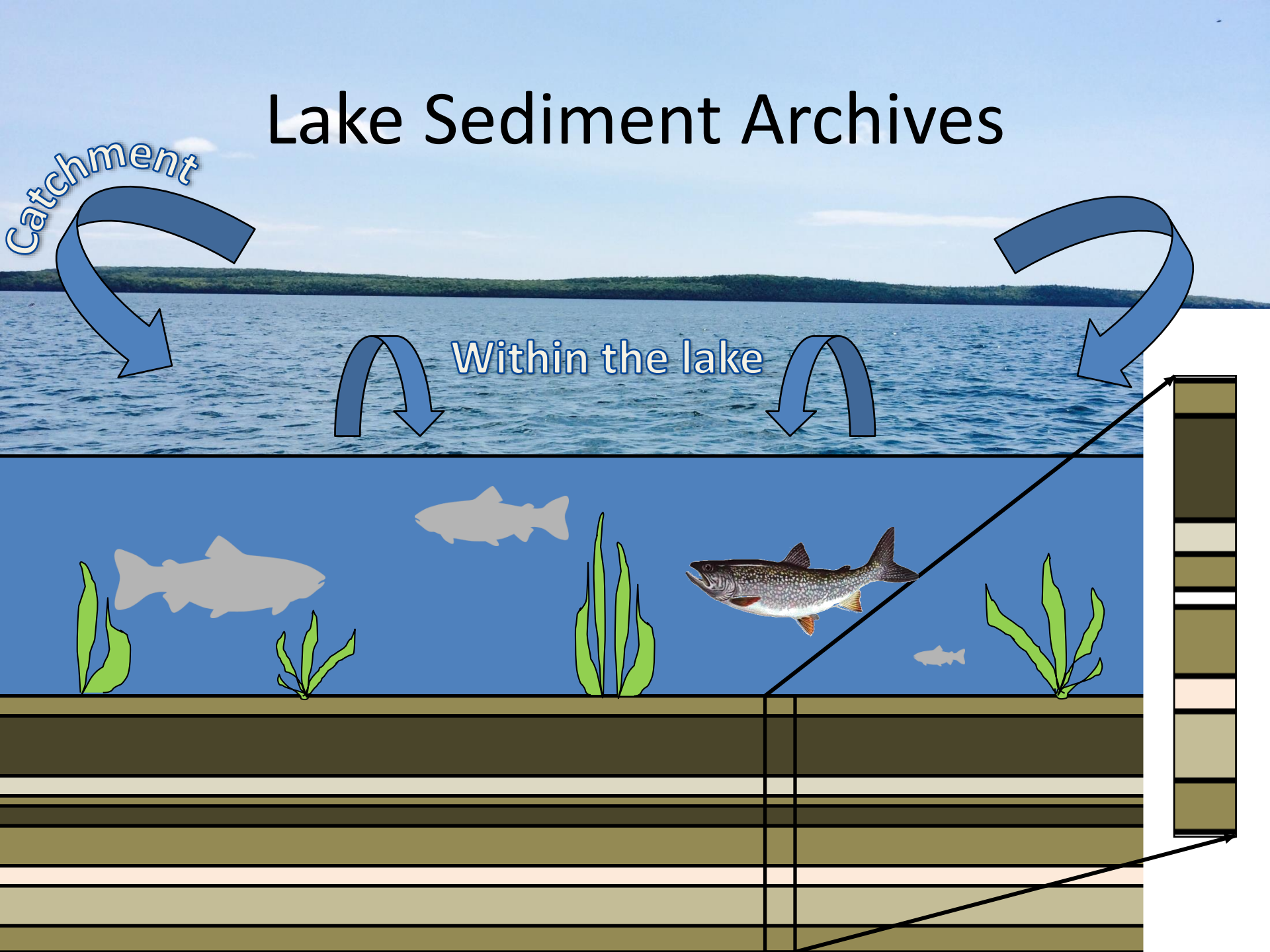
Research Questions

- How have Ontario Lake Trout lakes changed over time?
- Have end-of-summer DO concentrations changed?
- And if so, what stressors (warming, nutrients, DOC) are driving this change?

Study Lake Selection



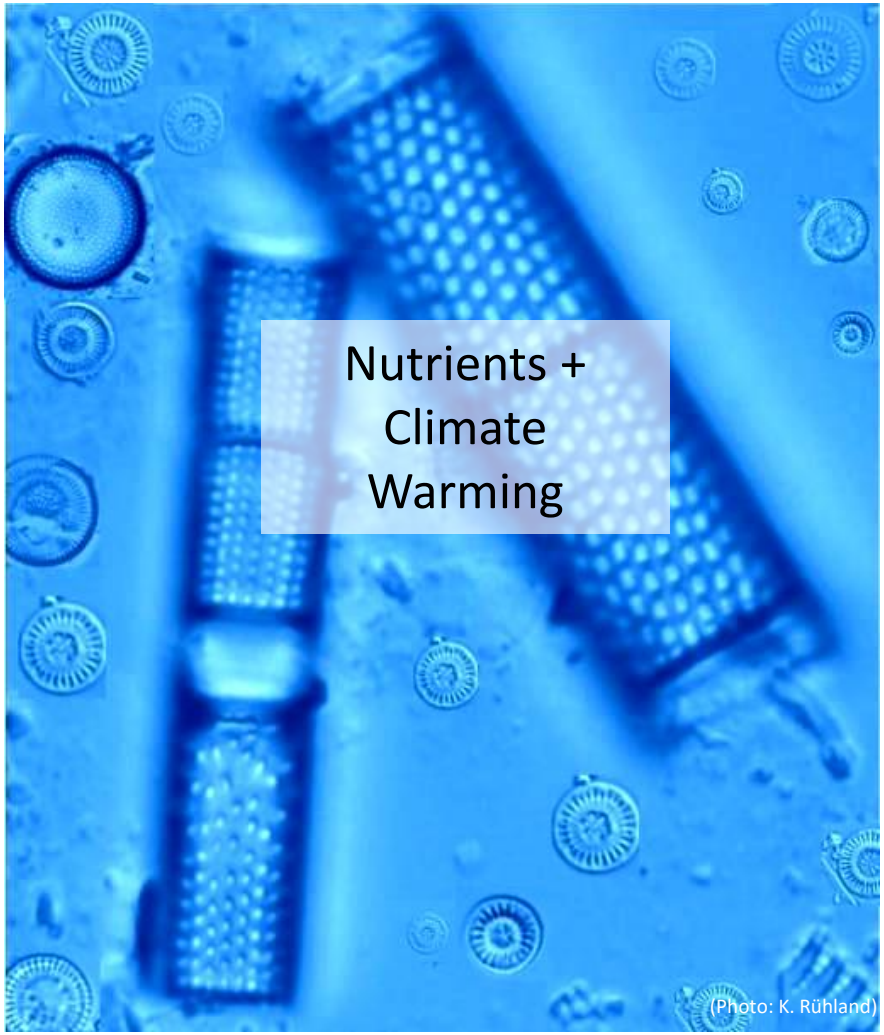
Lake Sediment Archives



Indicators in Lake Sediments

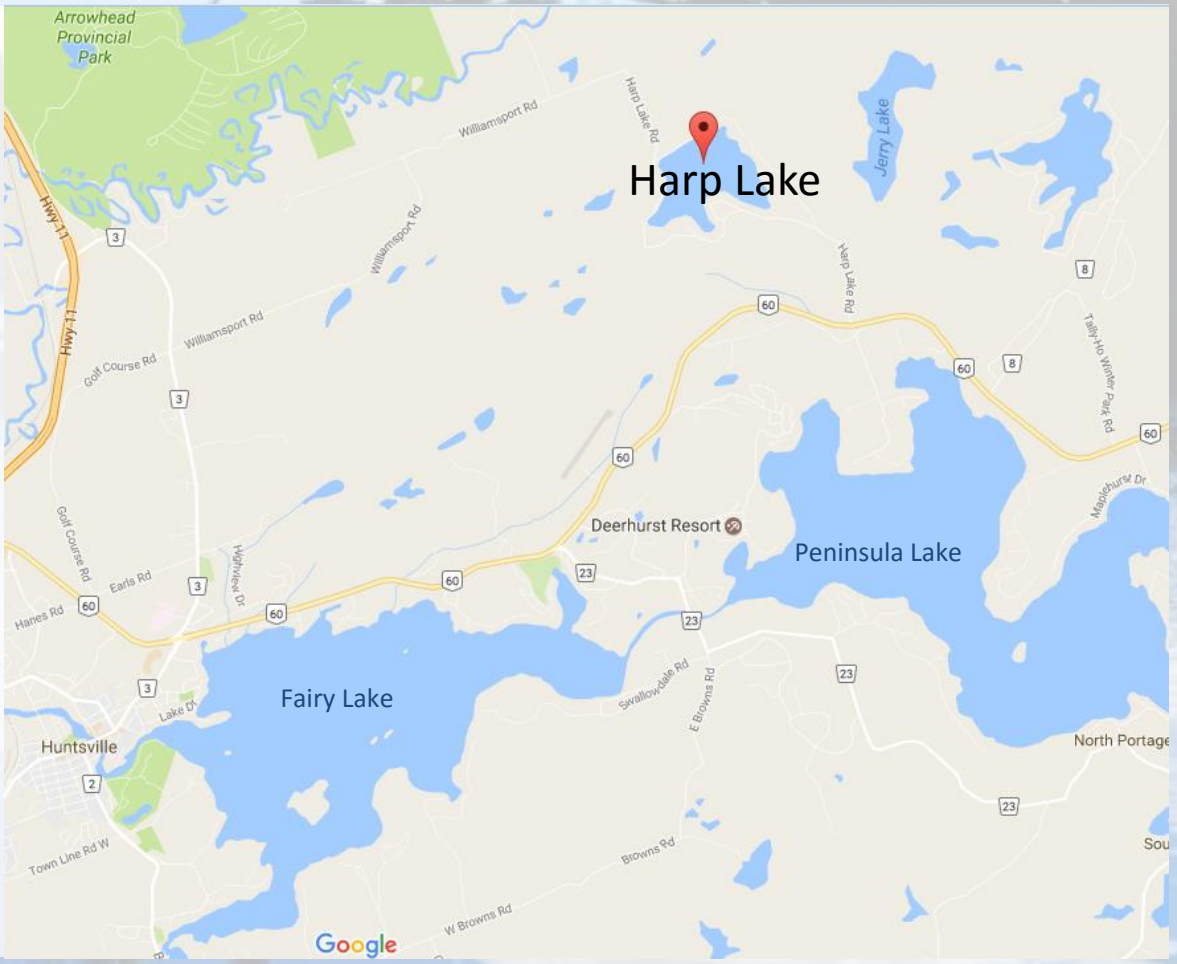
CHIRONOMIDS

DIATOMS

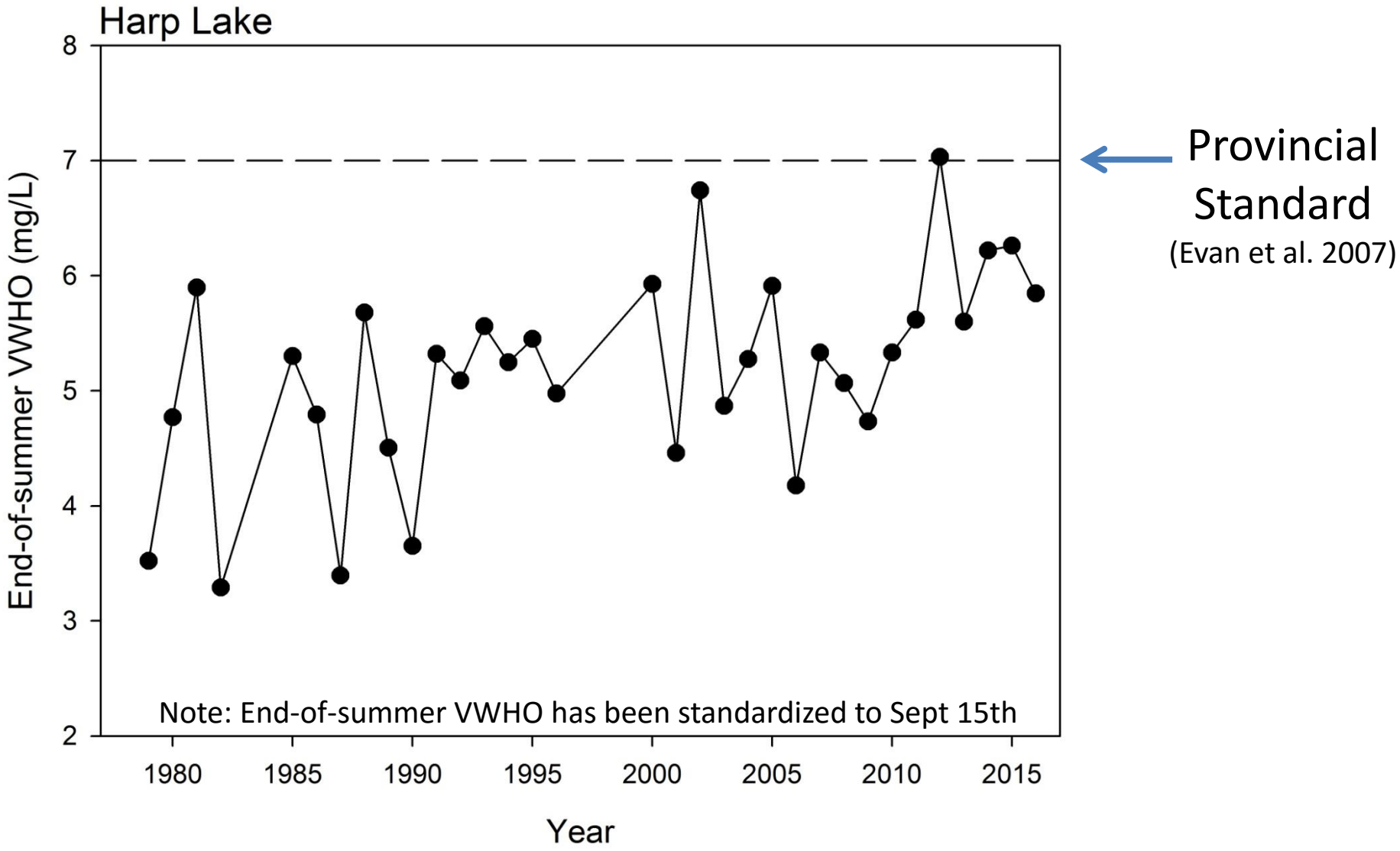


Harp Lake

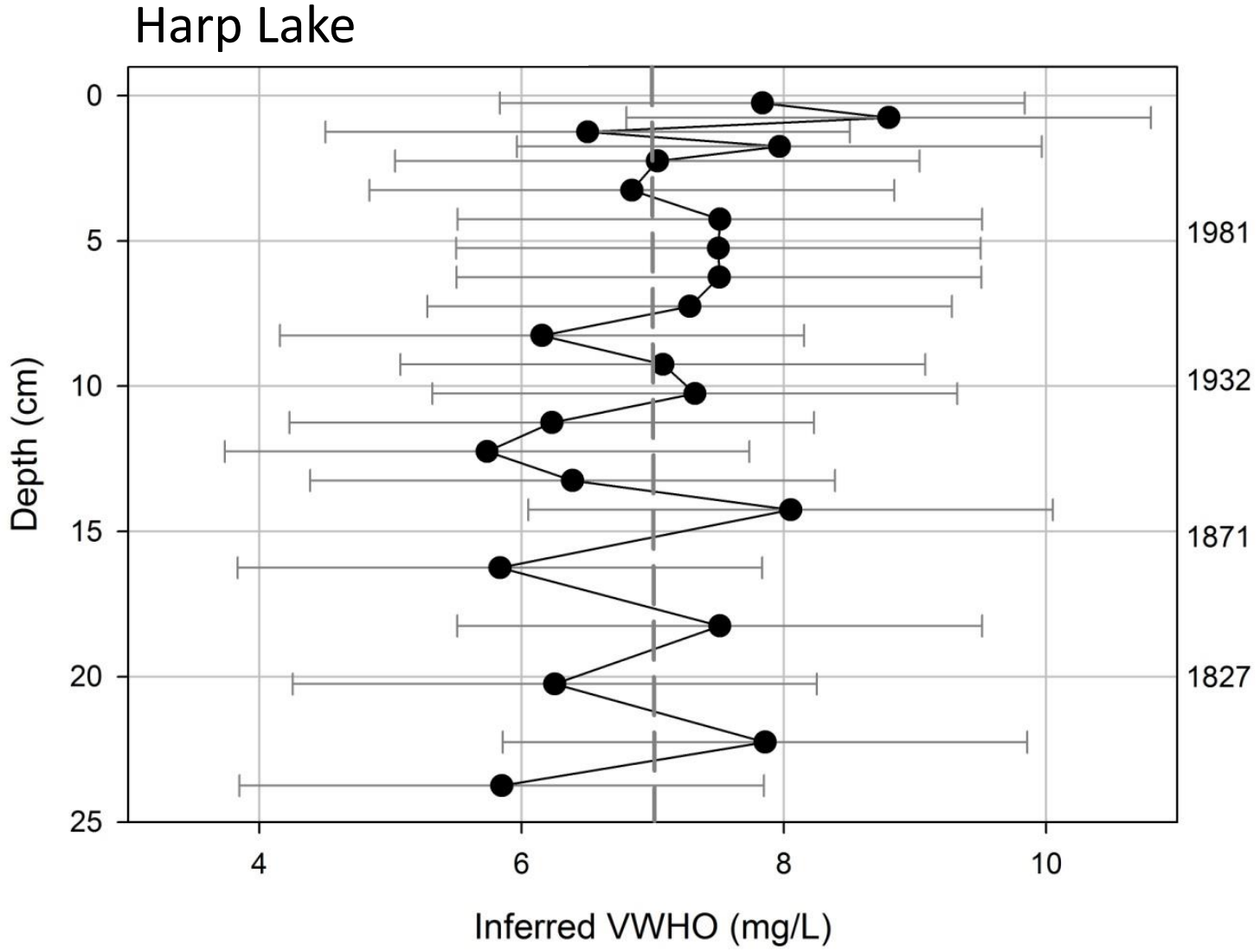
- Stocked to support the recreational Lake Trout fishery
- Monitored bi-weekly since the late-1970s
- Low nutrient, deep lake (max depth 37.5 m)



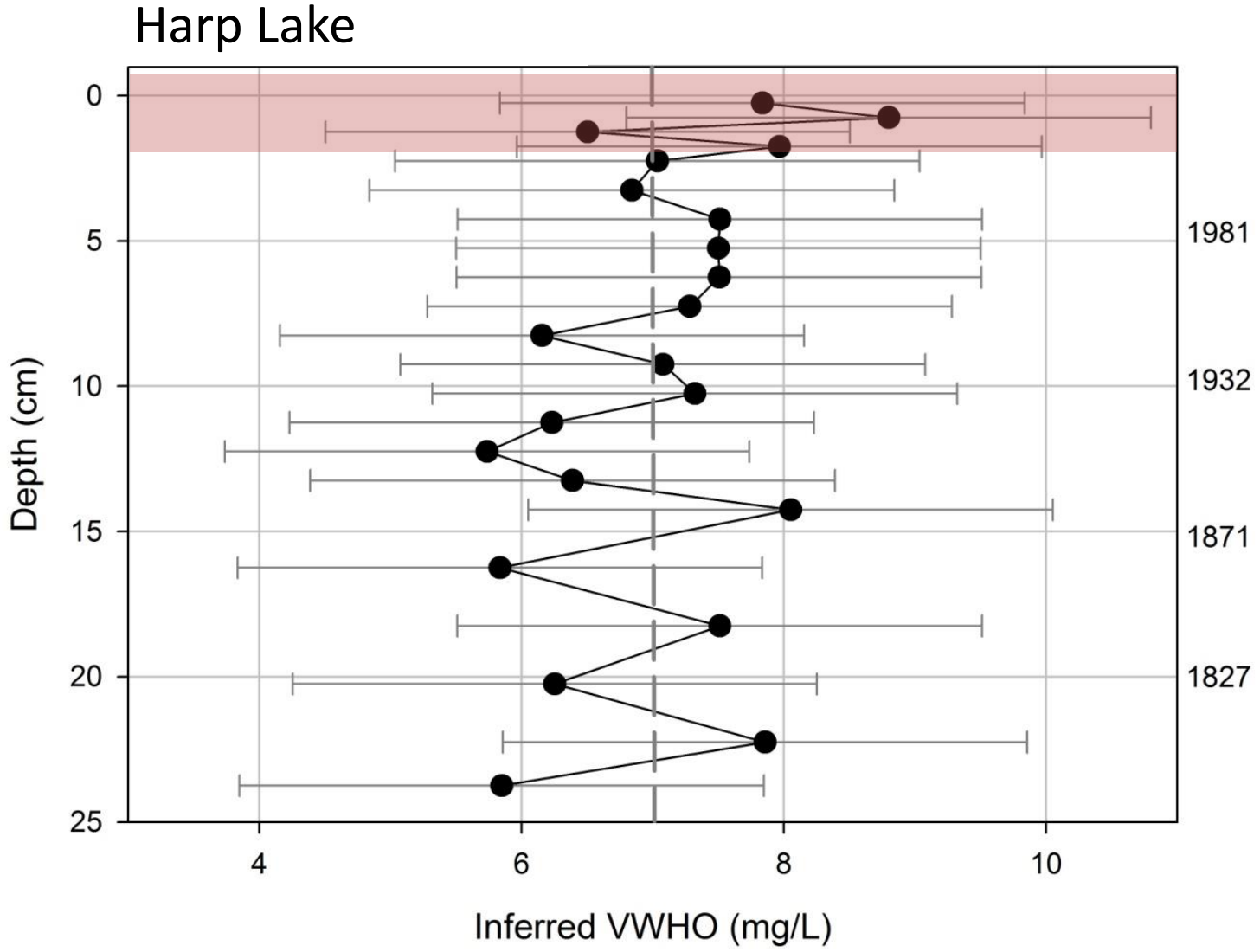
End-of-summer Bottom Water Oxygen



Chironomid Oxygen Reconstruction



Chironomid Oxygen Reconstruction



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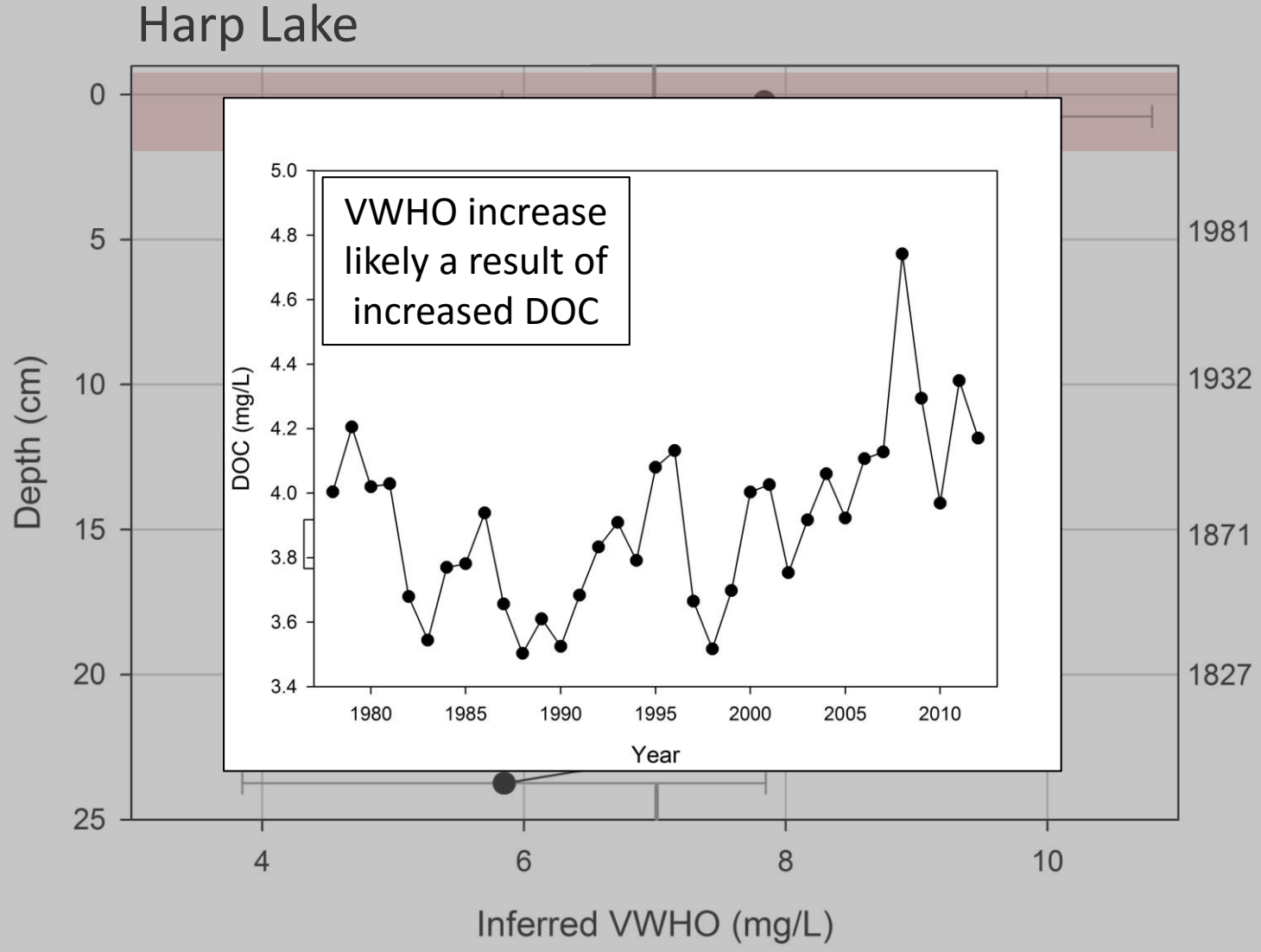
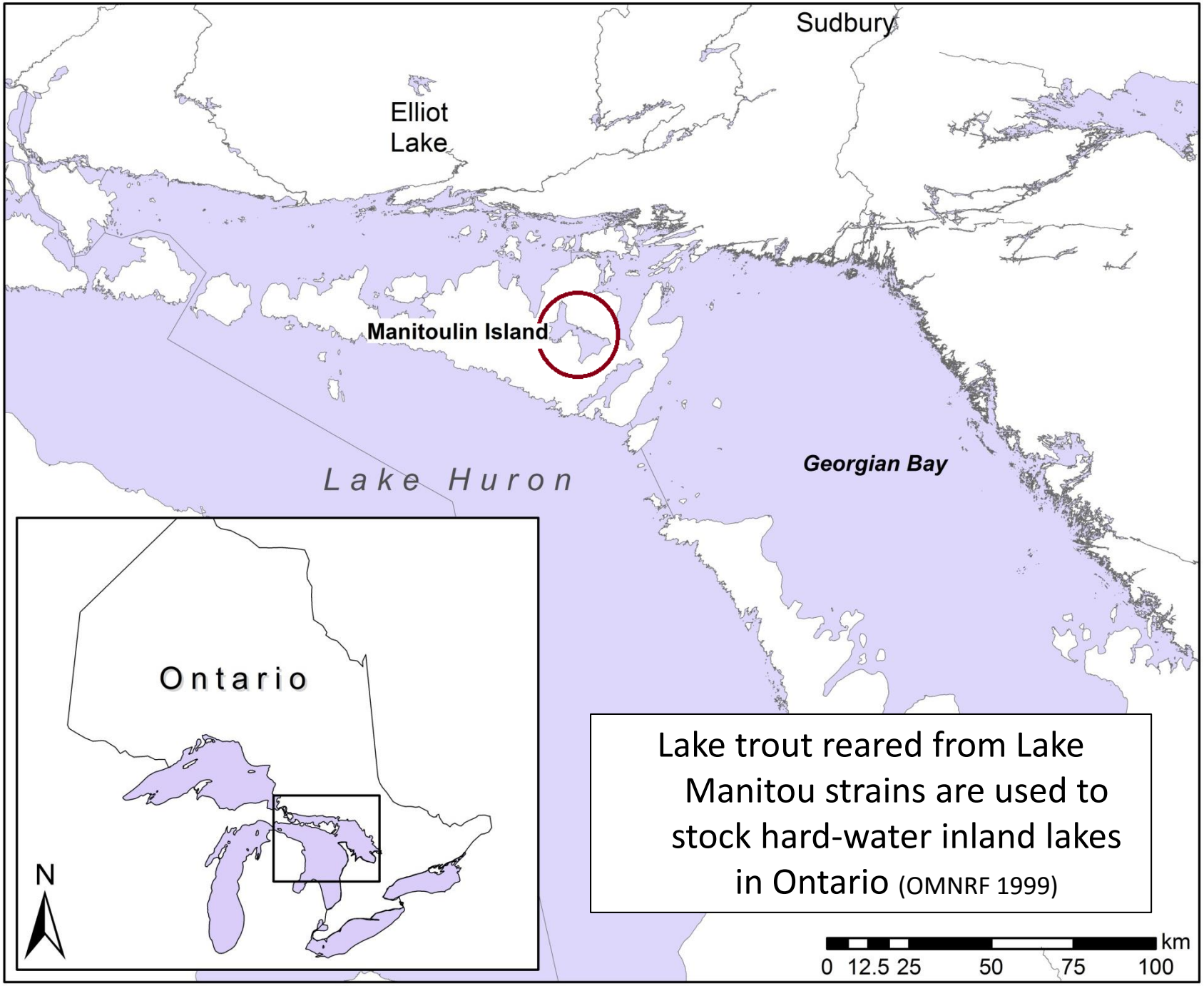
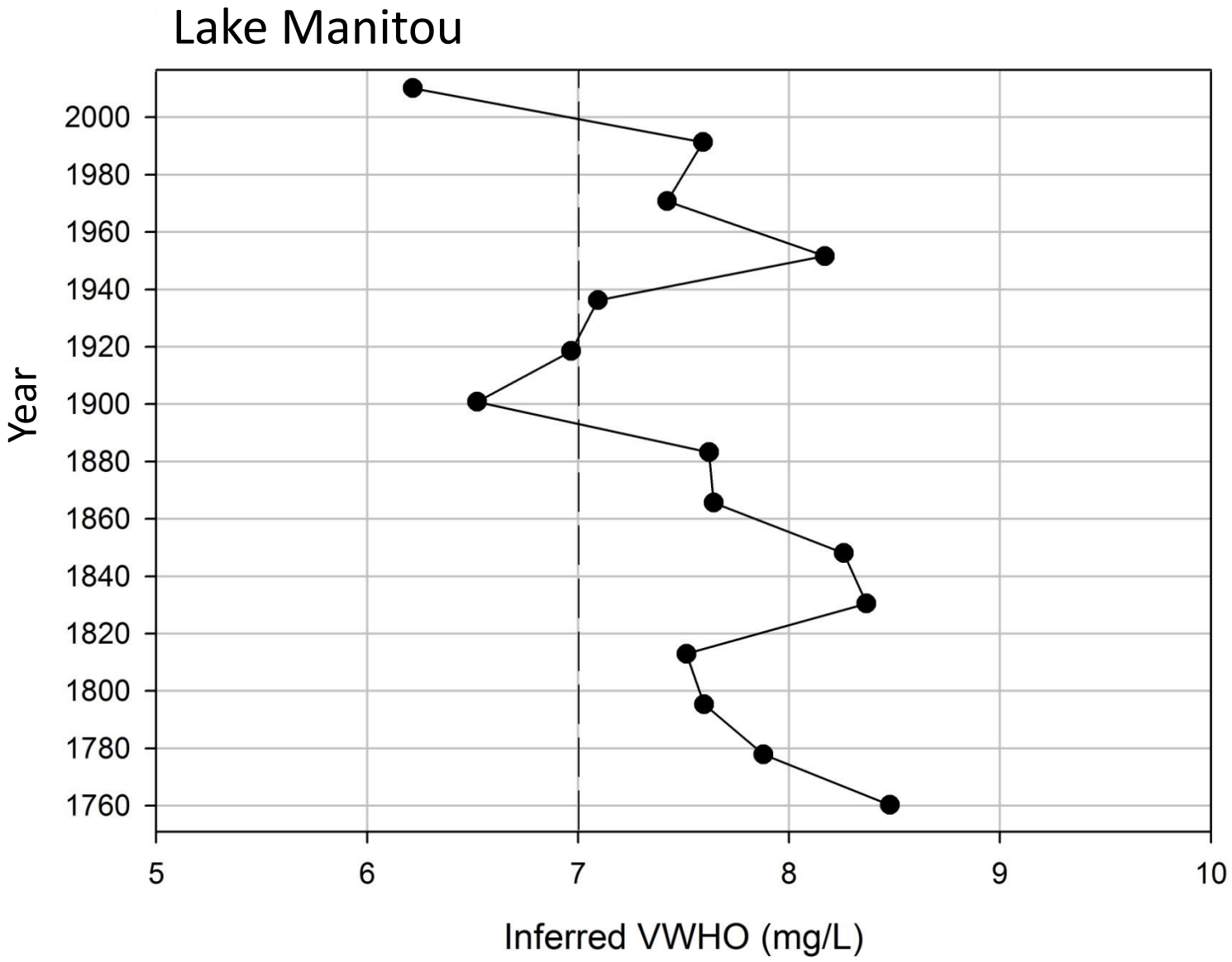



Sudbury
Elliot Lake
Manitoulin Island
Georgian Bay
Lake Huron
Ontario
N
Lake trout reared from Lake Manitou strains are used to stock hard-water inland lakes in Ontario (OMNRF 1999)
km
0 12.5 25 50 75 100

Chironomid Oxygen Reconstruction



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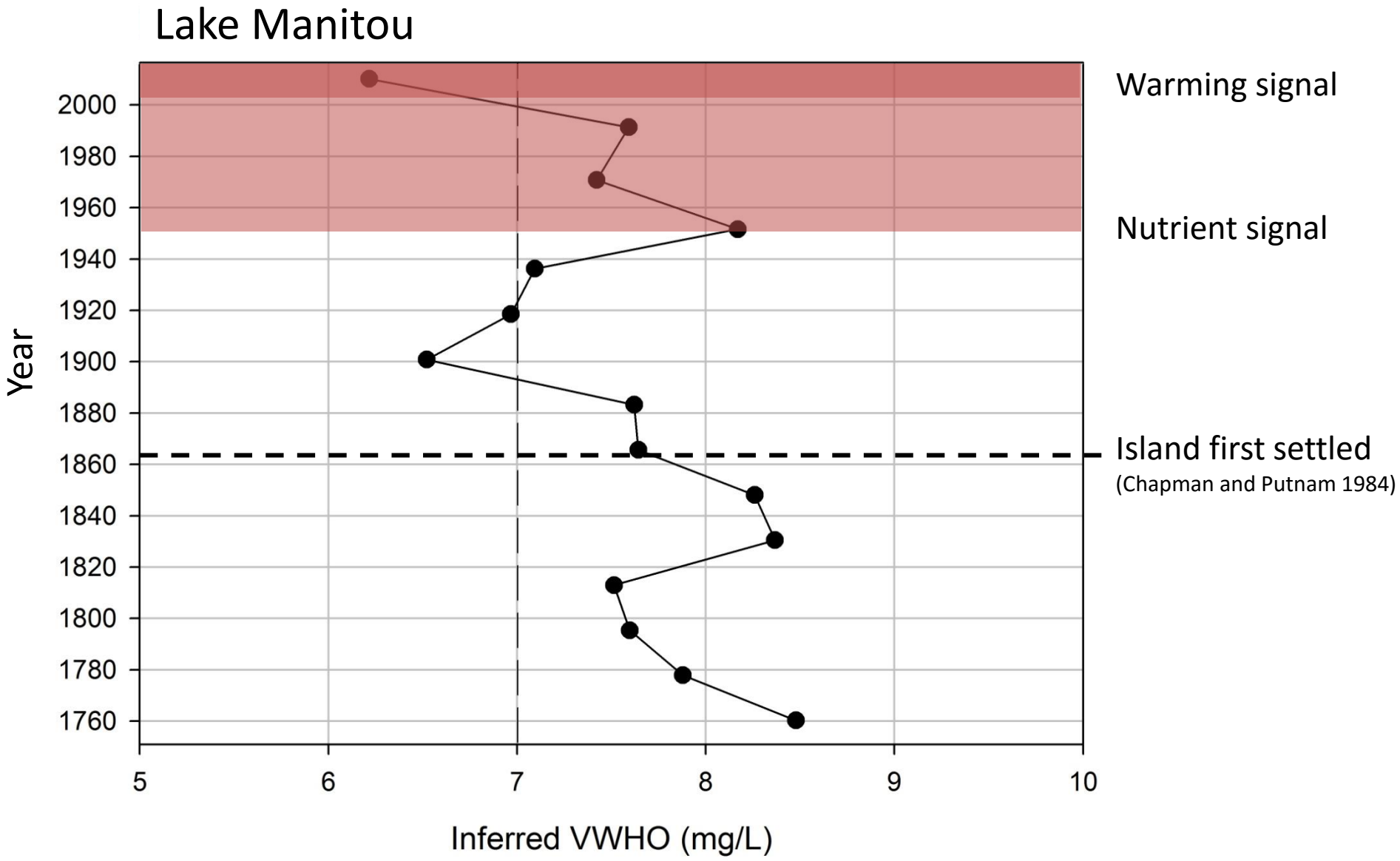

Next Steps

Lake sediment archives can provide useful information about how and why Lake Trout lake are changing

Understanding the past

Modeling the present

Forecasting the future

Develop and calibrate models on a common set of study lakes

Apply models to lakes of interest

Develop a new toolset for lake and resource managers

Thank you!

- Liz Favot and the staff from the Blue Jay Creek Hatchery
- NSERC
- Environment Canada
- Ontario Ministry of the Environment and Climate Change
- Ontario Ministry of Natural Resources and Forestry
- Federation of Ontario Cottagers' Associations

Ontario

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CRSNG

FOCA
Federation of Ontario Cottagers' Associations

Environment Canada