Item 10.3.2

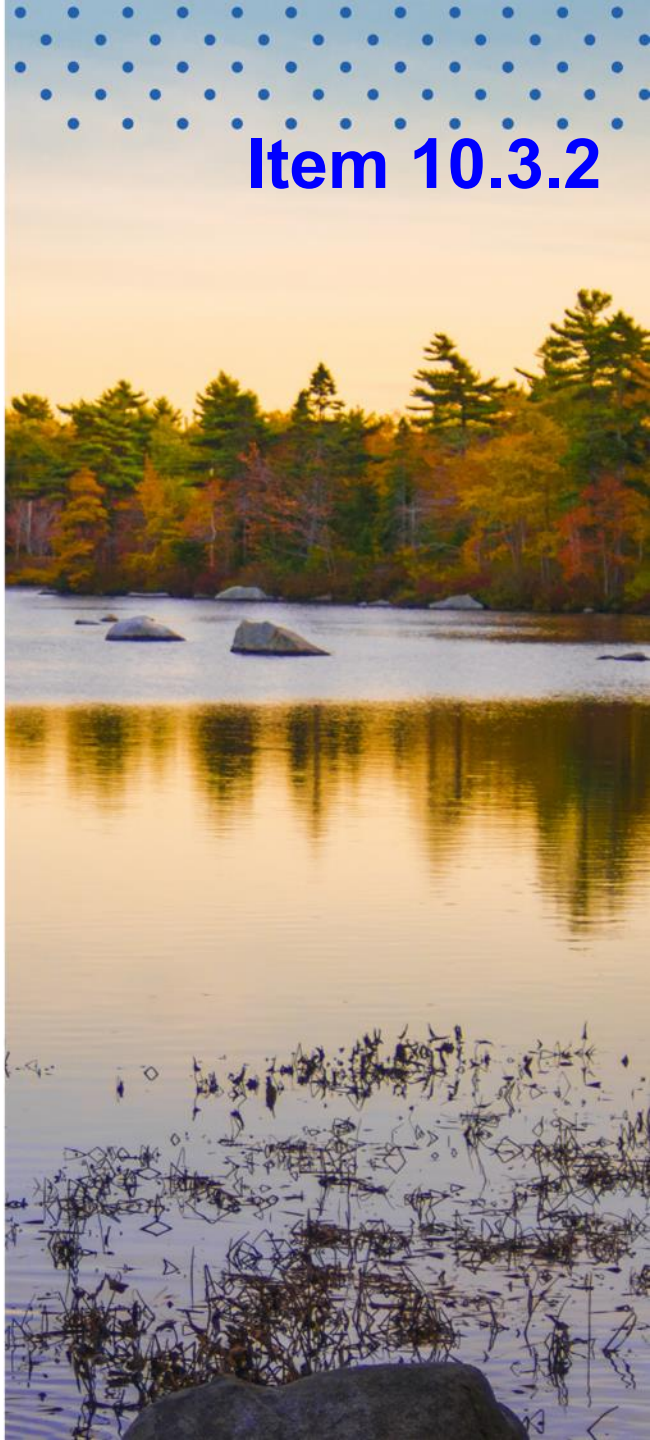
Halifax Water

Lake Recovery in Nova Scotia – Evidence for Occurrence

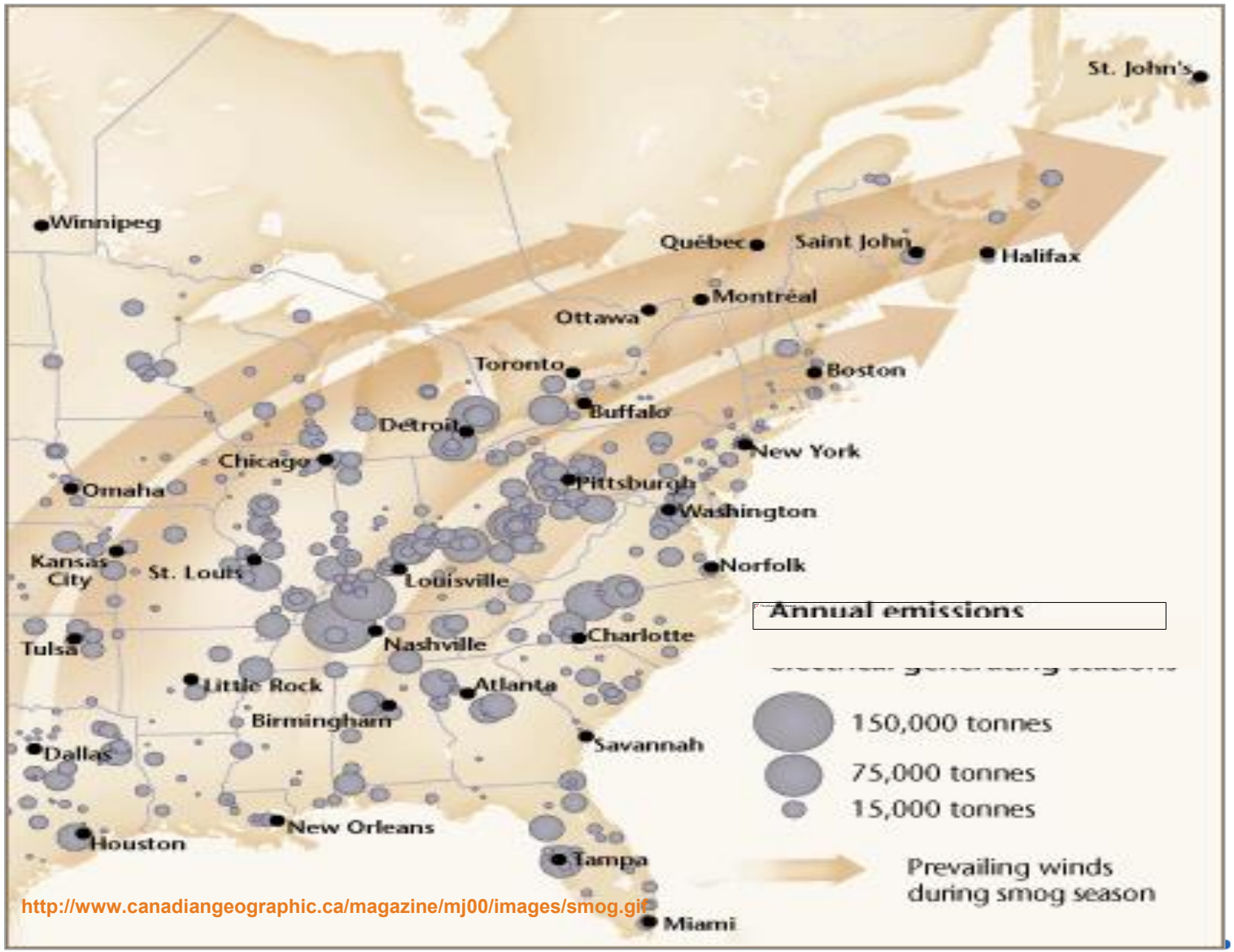
Presentation to Environment and Sustainability Committee

Carl Yates, General Manager
October 4, 2018

STRAIGHT from the SOURCE



Nova Scotia – The Tailpipe of North America

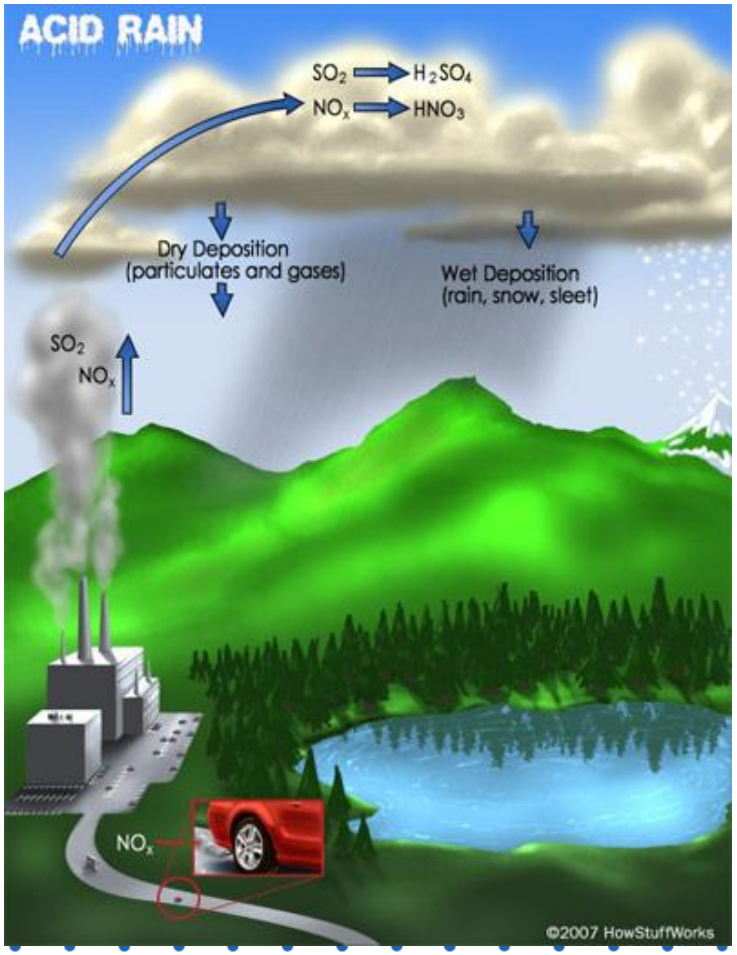


http://www.canadiangeographic.ca/magazine/mj00/images/smog.gif

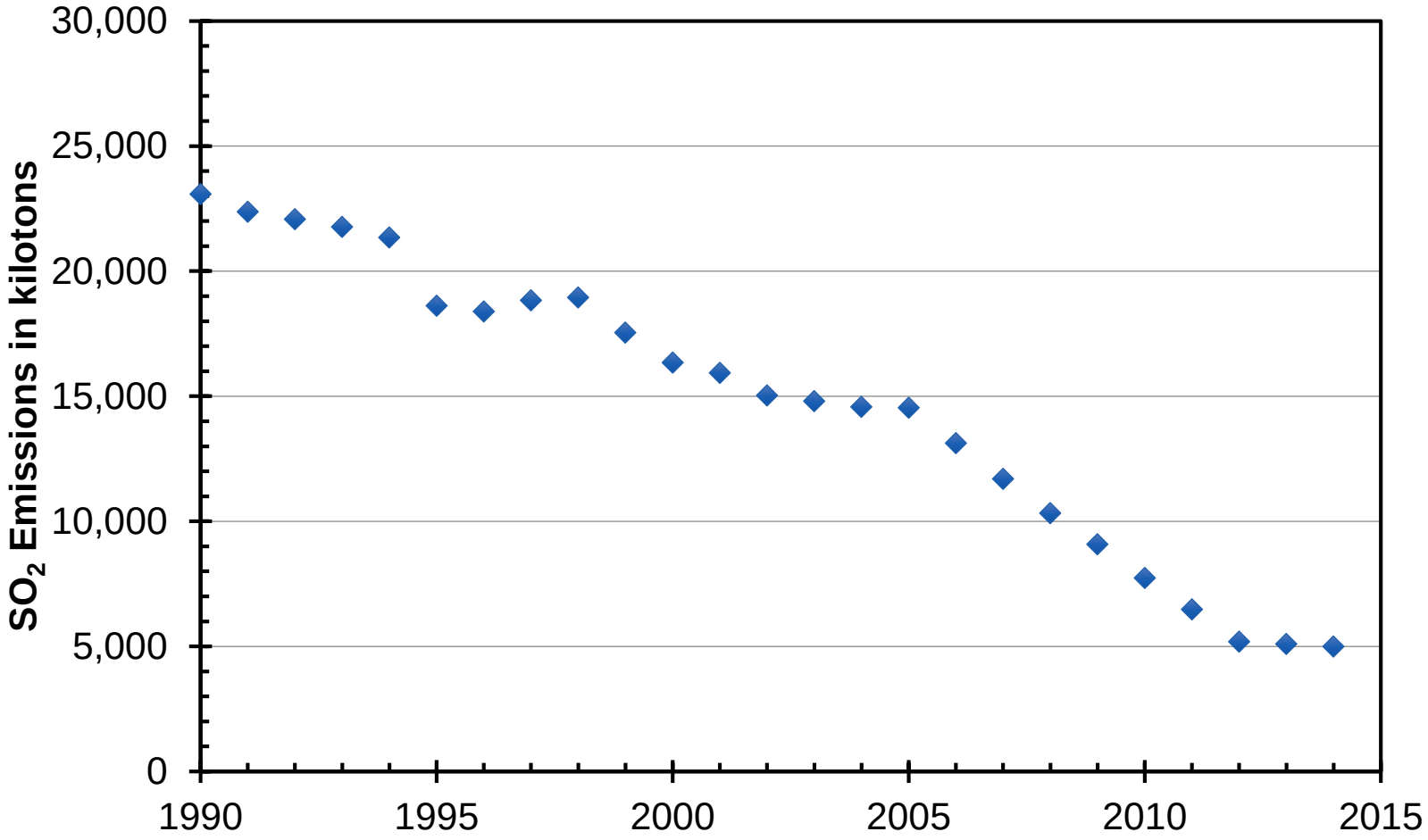
Sulphur Deposition and its Impact on NS Lakes

Changes in energy policy have significantly reduced SOx emissions in the atmosphere

- Stricter emission policies on SOx
- Less reliance on coal in US and abroad
  - ✓ Energy from Natural Gas, Wind

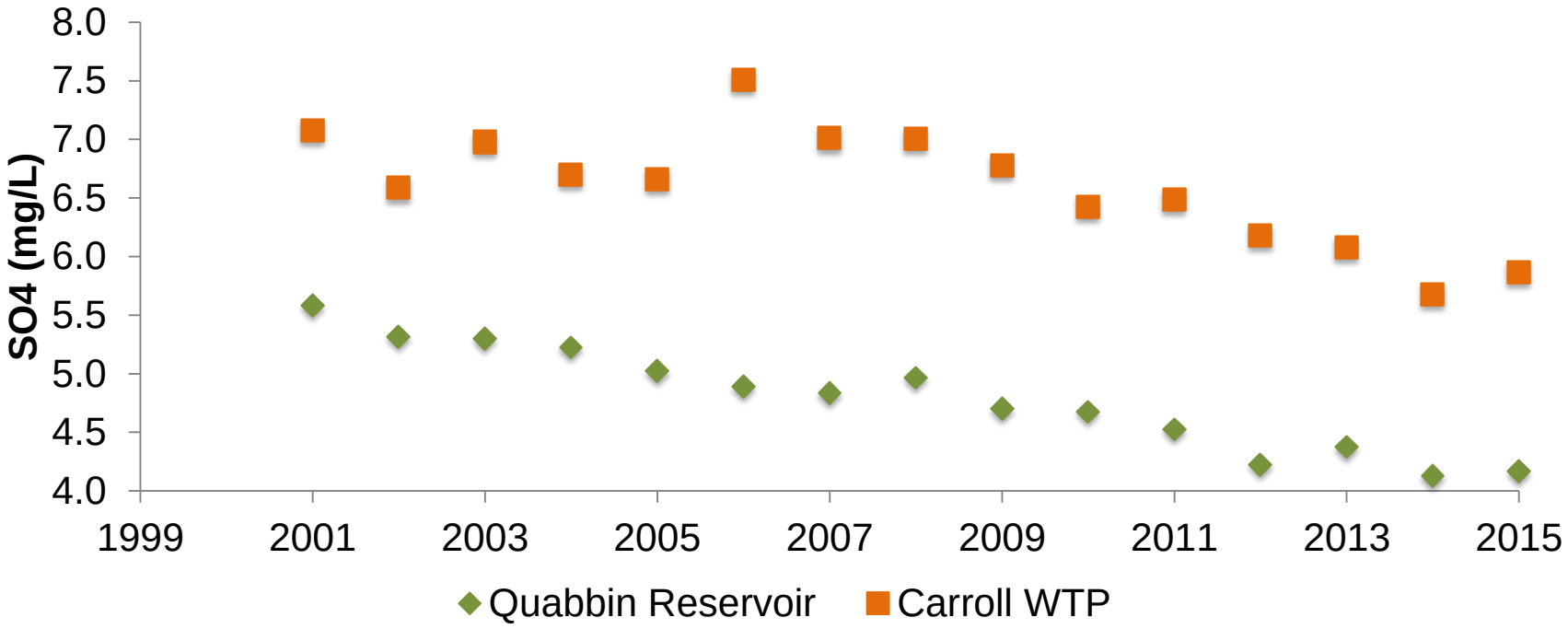


Sulphur Dioxide Emissions in United States

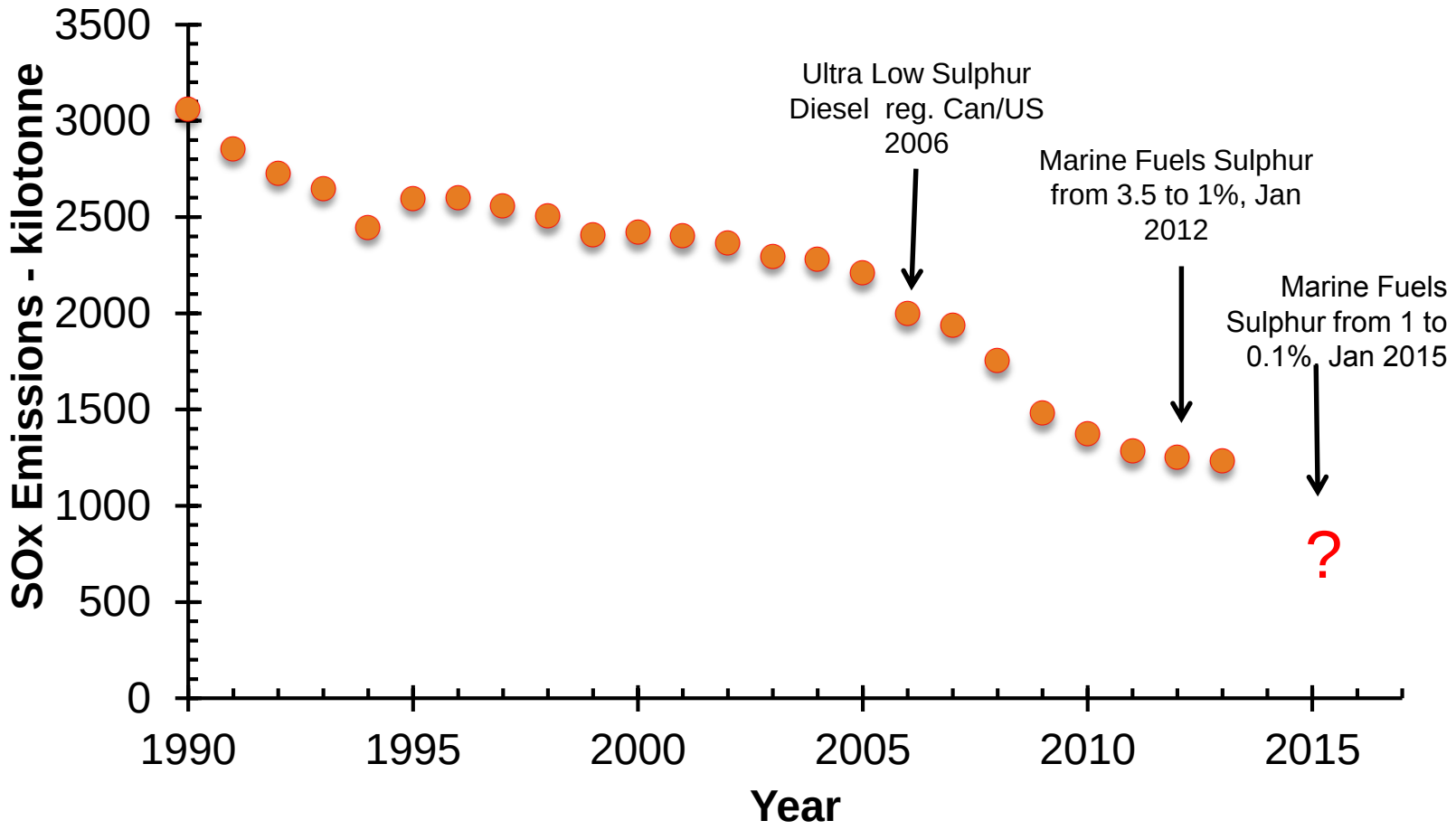


Source: *EPA National Emissions Inventory*

SO_4 Concentrations in Boston Water Supplies



Sulphur Oxide (SOx) Emissions in Canada



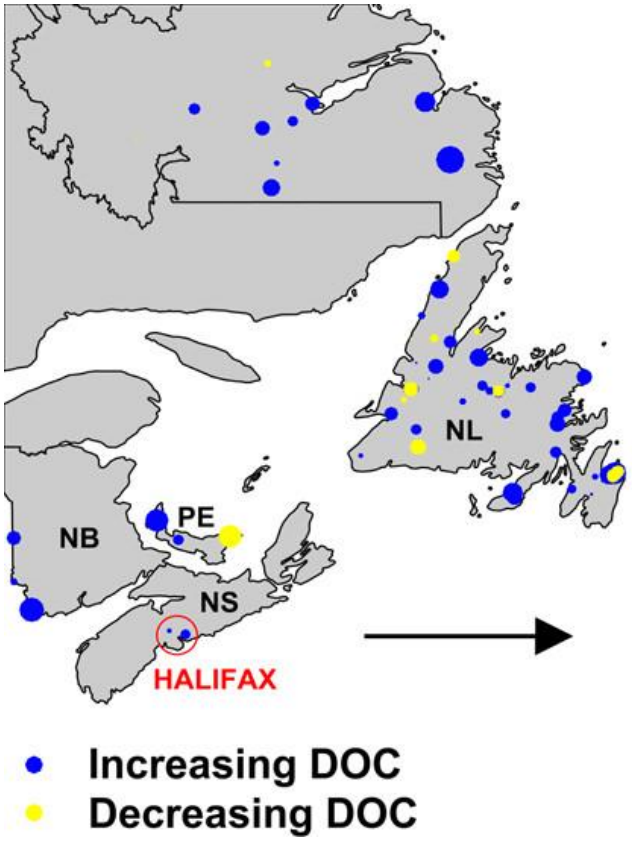
Source: *Environment Canada - http://www.ec.gc.ca/rnspa-naps/*

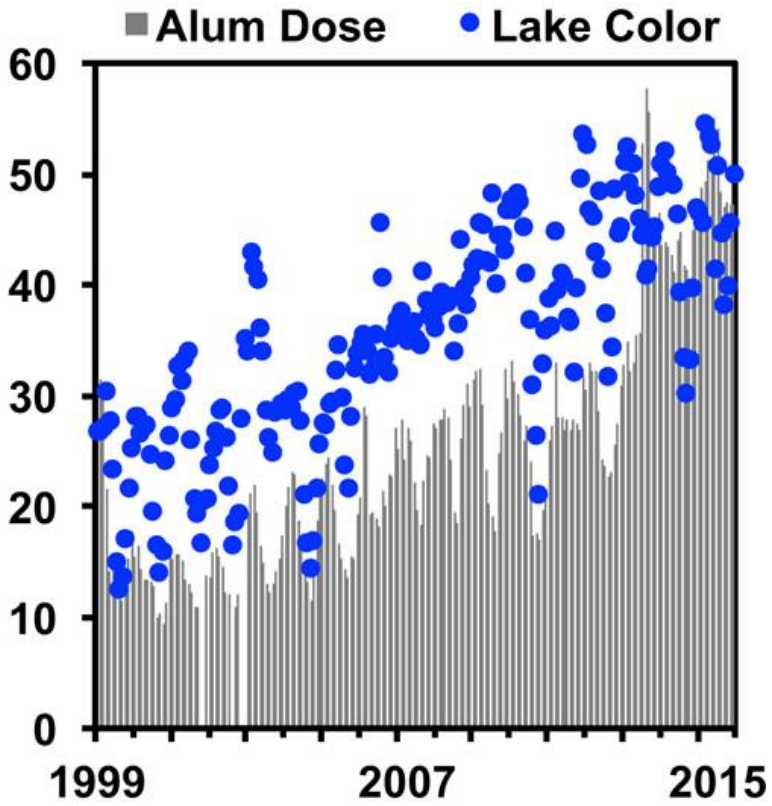
With Less SO_2 in the Atmosphere

What is Happening to Nova Scotia Lakes?

Research Motivation

NSERC Halifax Water Industrial Research Chair

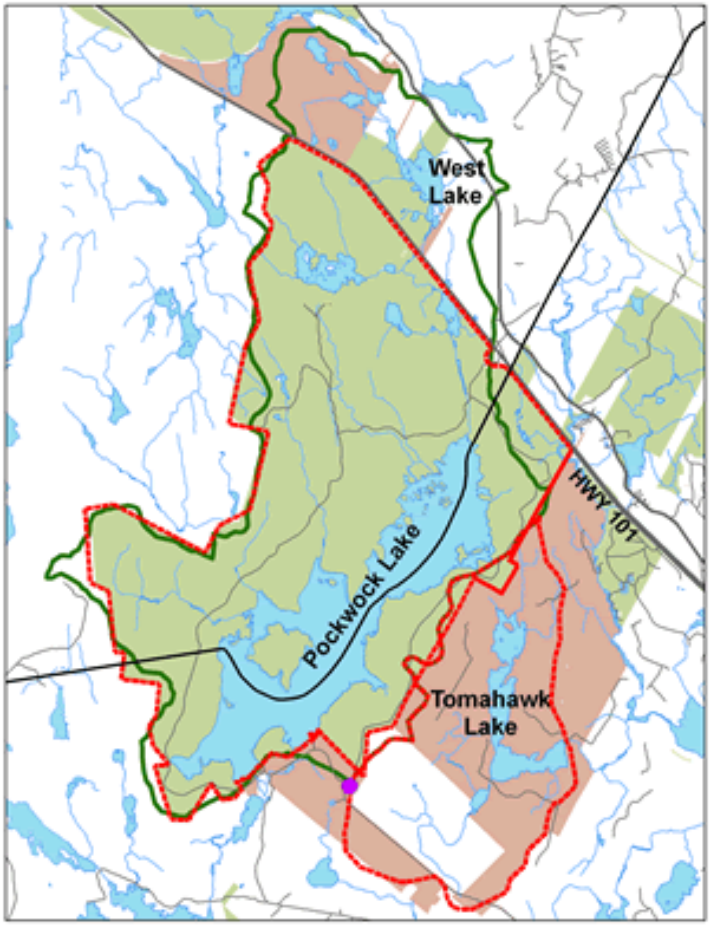




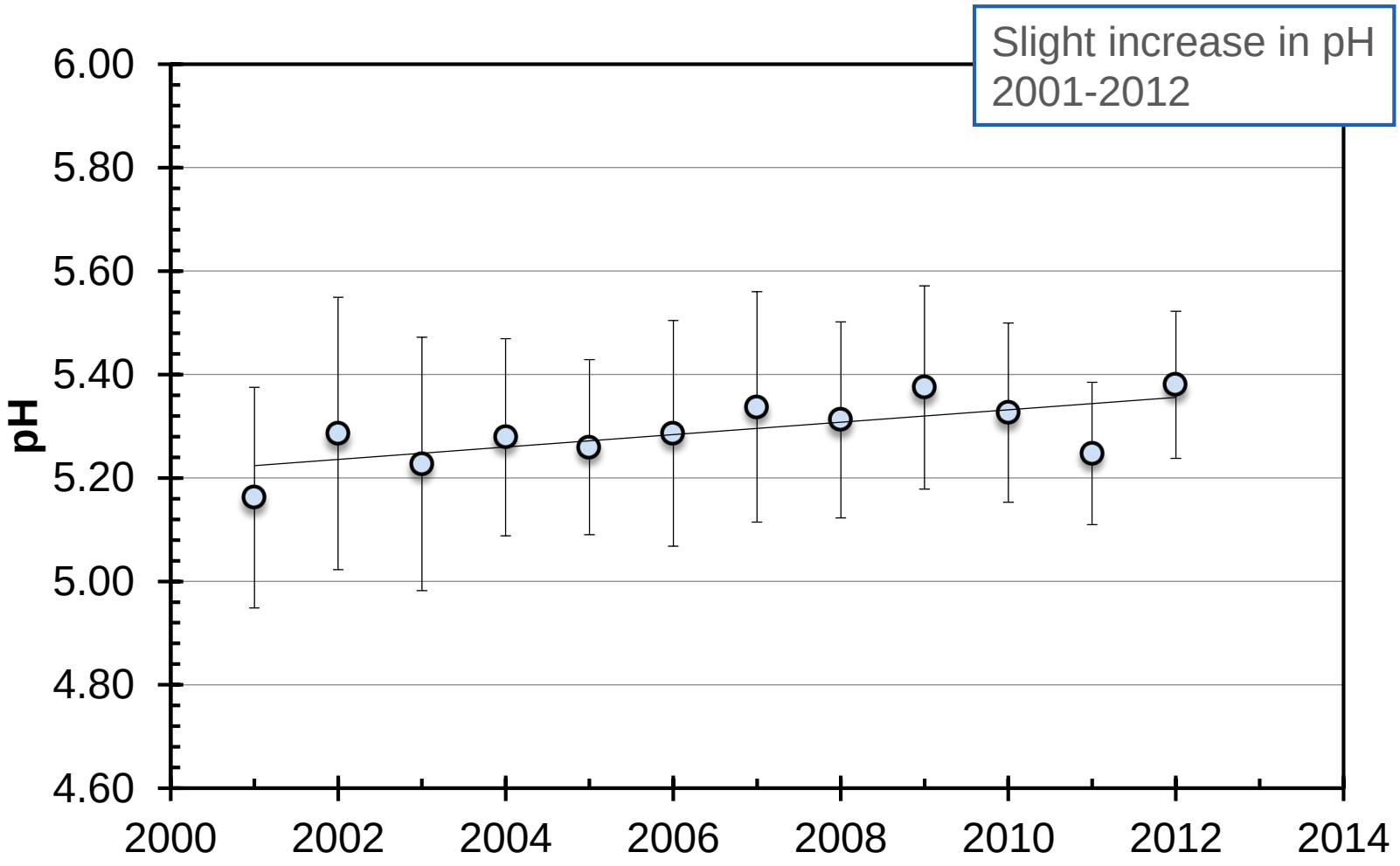
- Lake Recovery Through Reduced Sulfate Deposition: A New Paradigm for Drinking Water Treatment
- Lindsay E. Anderson, Wendy H. Krkošek, Amina K. Stoddart, Benjamin F. Trueman, and Graham A. Gagnon
- *Environmental Science & Technology* 2017 *51* (3), 1414-1422

Consider Pockwock Lake

Halifax Water Supply

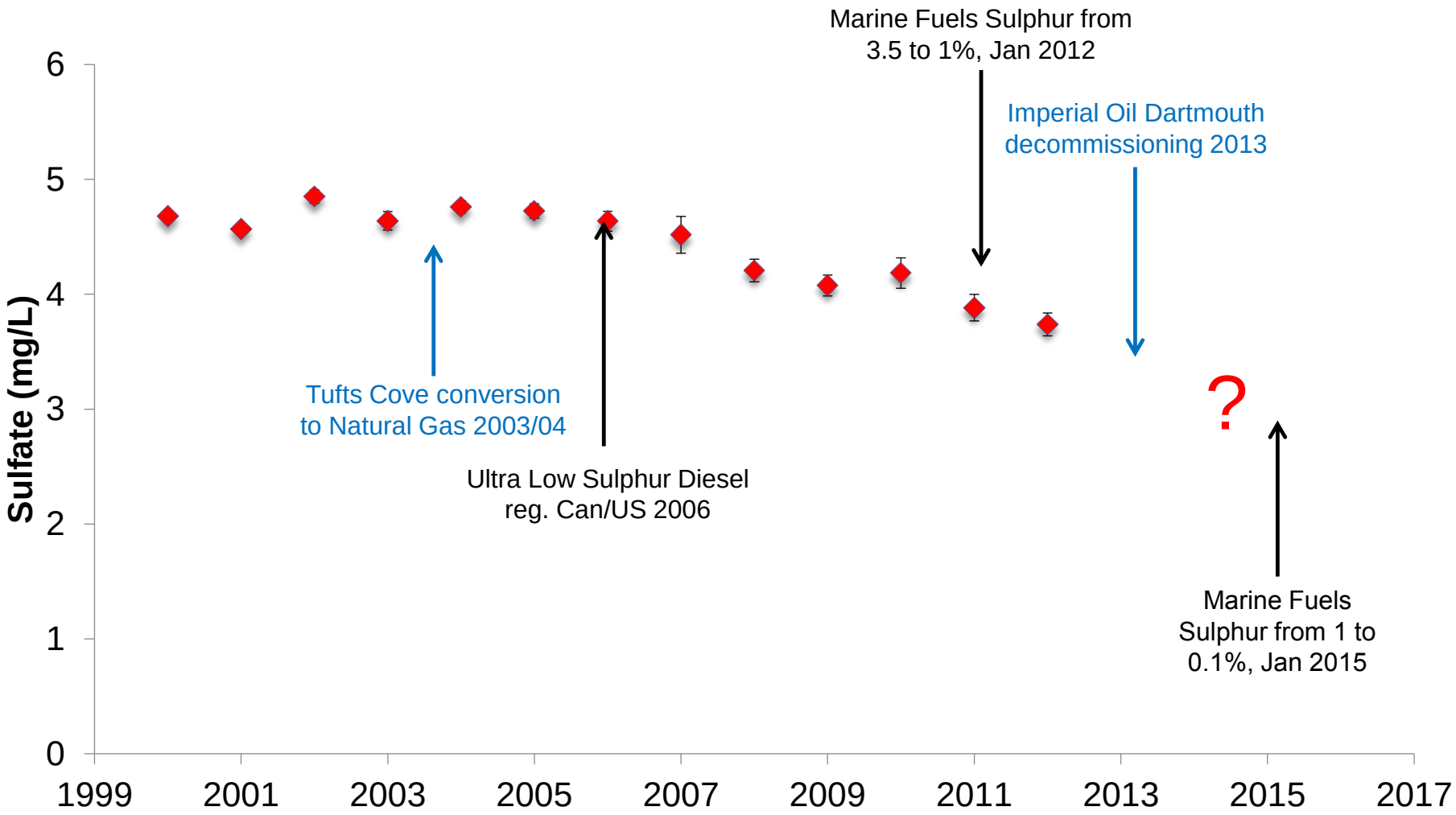


pH – Pockwock Lake



Source: *Environment Canada, Fresh Water Quality Monitoring Program*

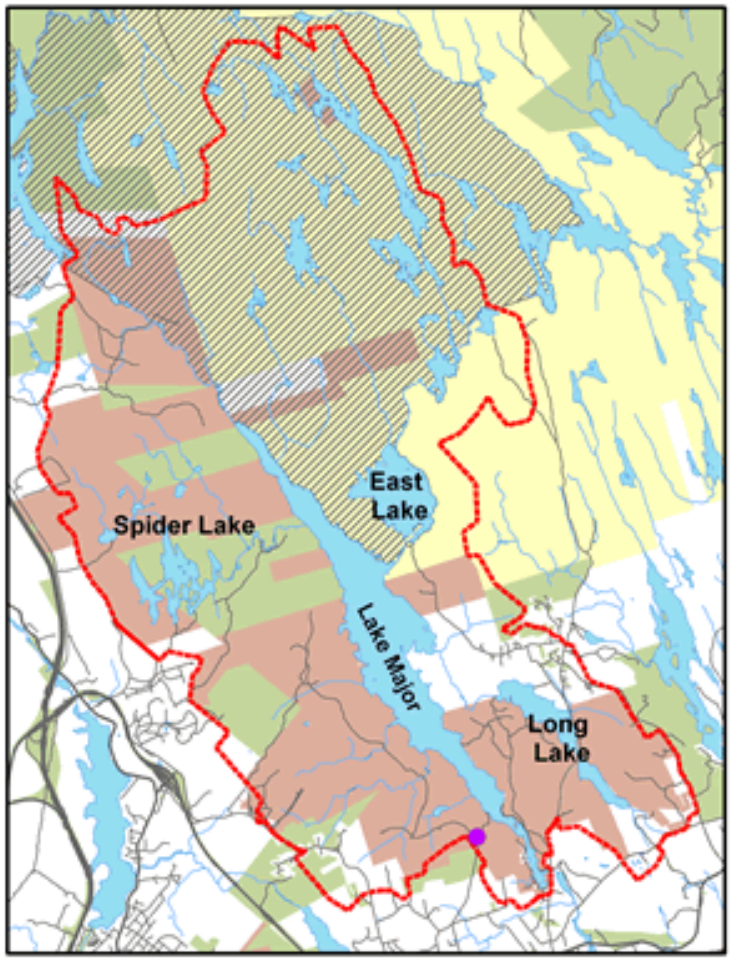
Sulfate in Pockwock Lake



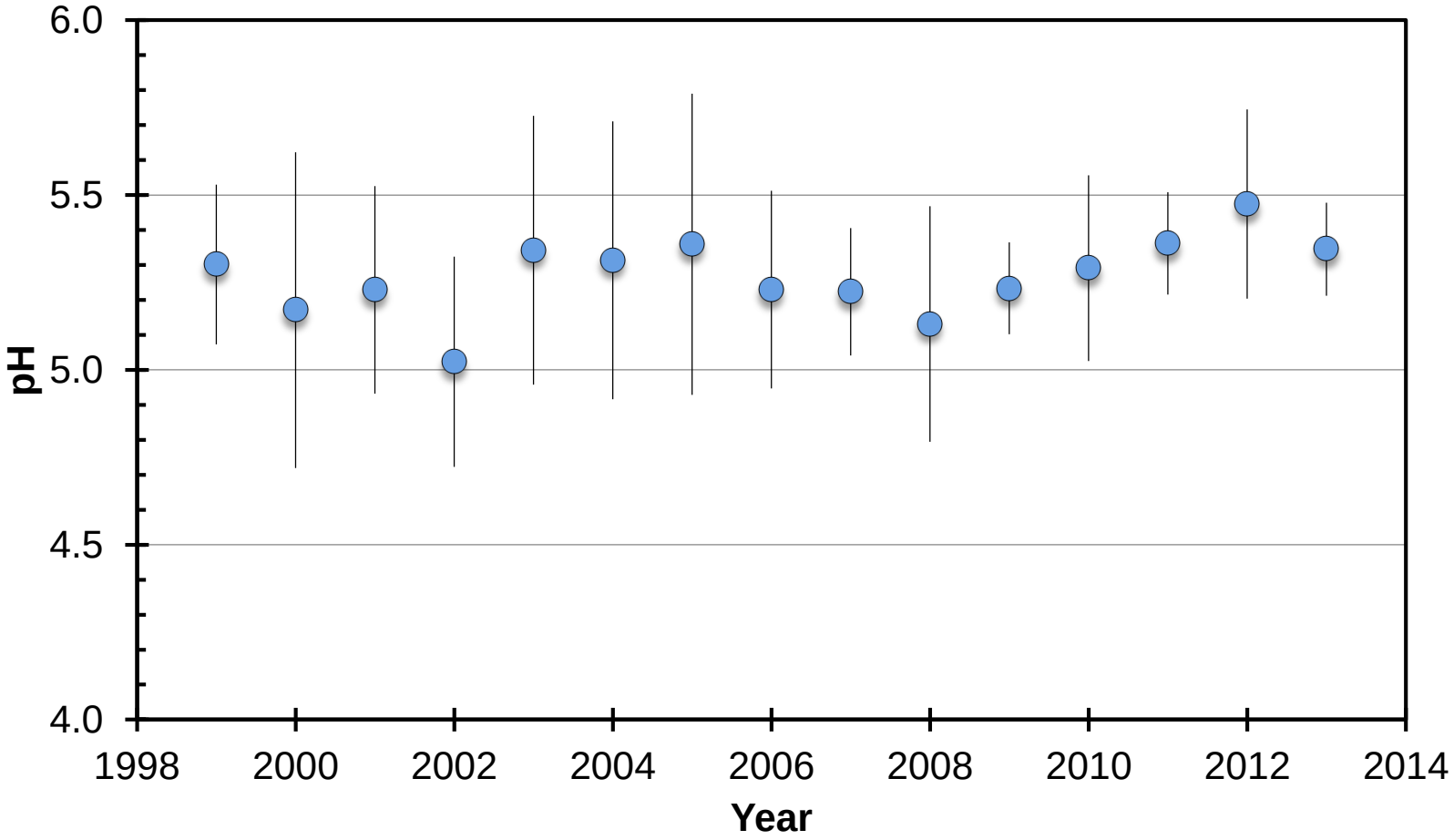
Source: *Environment Canada freshwater quality monitoring program*

Consider Lake Major

Dartmouth Water Supply



pH in Lake Major



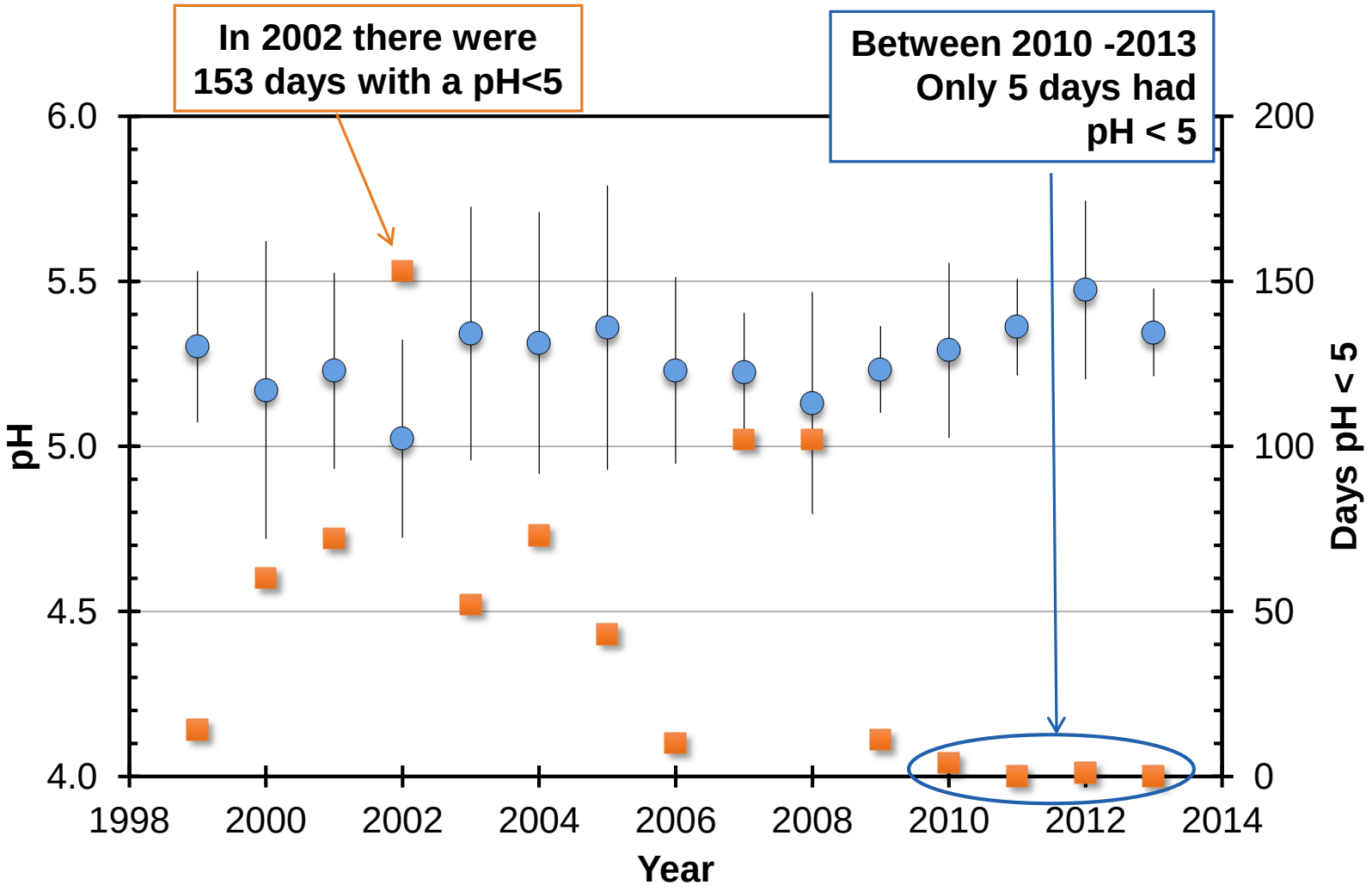
How Many Days Were Less Than pH 5?

Species	Scientific name	Atlantic Canada[a]
Atlantic Salmon	*Salmo salar*	4.8–5.5
Creek Chub	*Semotilus atromaculatus*	4.5–5.2
Lake Whitefish	*Coregonus clupeaformis*	≥4.9
Brook Trout	*Salvelinus fontinalis*	4.5–5.0
Brown Trout	*Salmo trutta*	≥4.5–5.5
White Perch	*Morone americana*	≥4.8
Nine-spine Stickleback	*Pungitius pungitius*	≥4.7
White Sucker	*Catostomus commersoni*	4.5–5.0
Brown Bullhead	*Ameiurus nebulosus*	4.5–4.7
Golden Shiner	*Notemigonus crysoleucas*	4.6–5.2
Banded Killifish	*Fundulus diaphanus*	≥ 4.6
Yellow Perch	*Perca flavescens*	4.1–4.8
American Eel	*Anguilla rostrata*	≥4.1
Common Shiner	*Luxilus cornutus*	≥5.7
Rainbow Trout	*Oncorhynchus mykiss*	5.5–6.0
Lake Trout	*Salvelinus namaycush*	4.8
Smallmouth Bass	*Micropterus dolomieui*	

Critical range of pH for fish species in Atlantic Canada

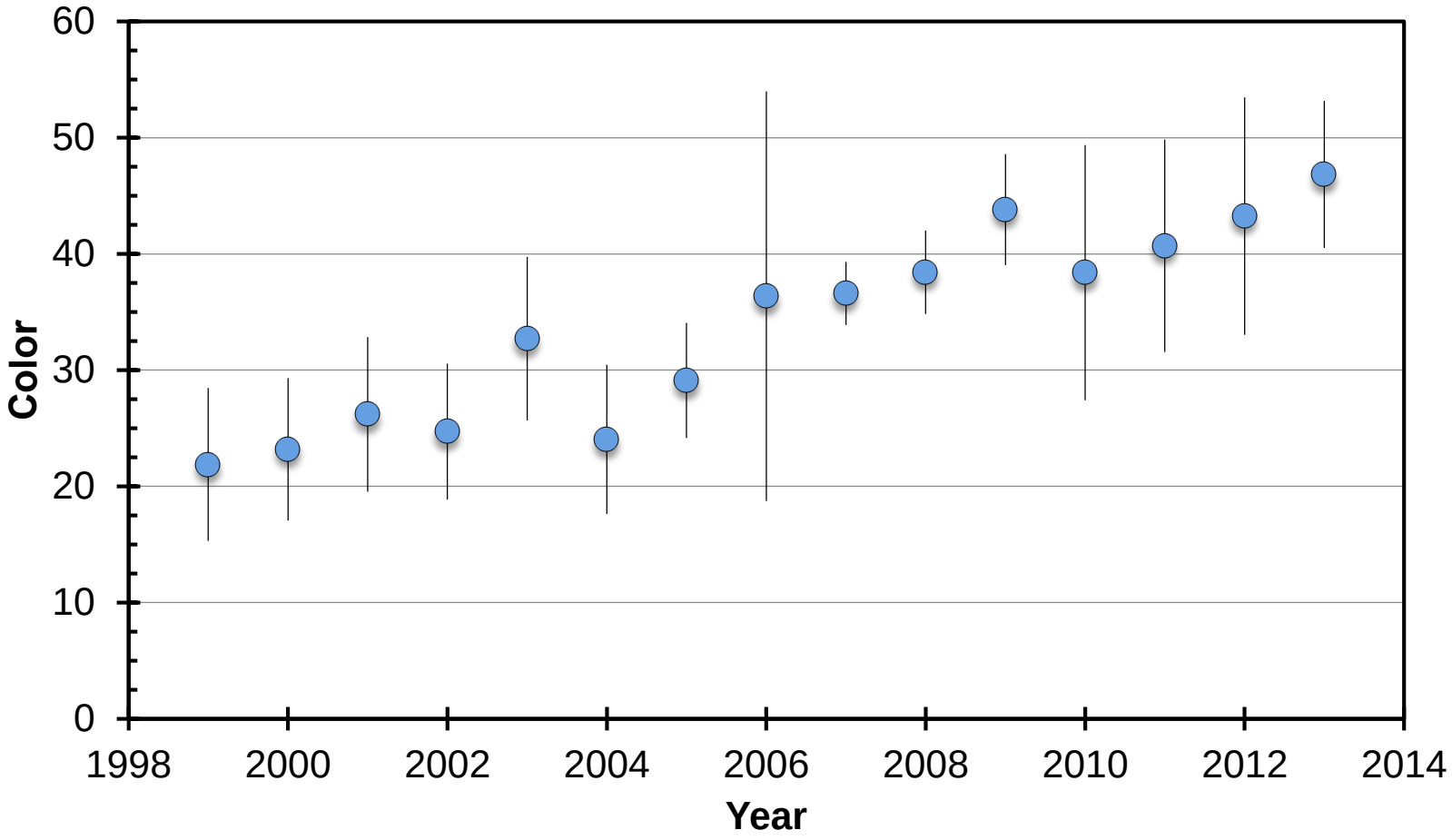
Source: *Lacoul et al. 2011*

Number of Days where pH < 5



Color in Lake Major

An Approximate Indicator of Organic Matter

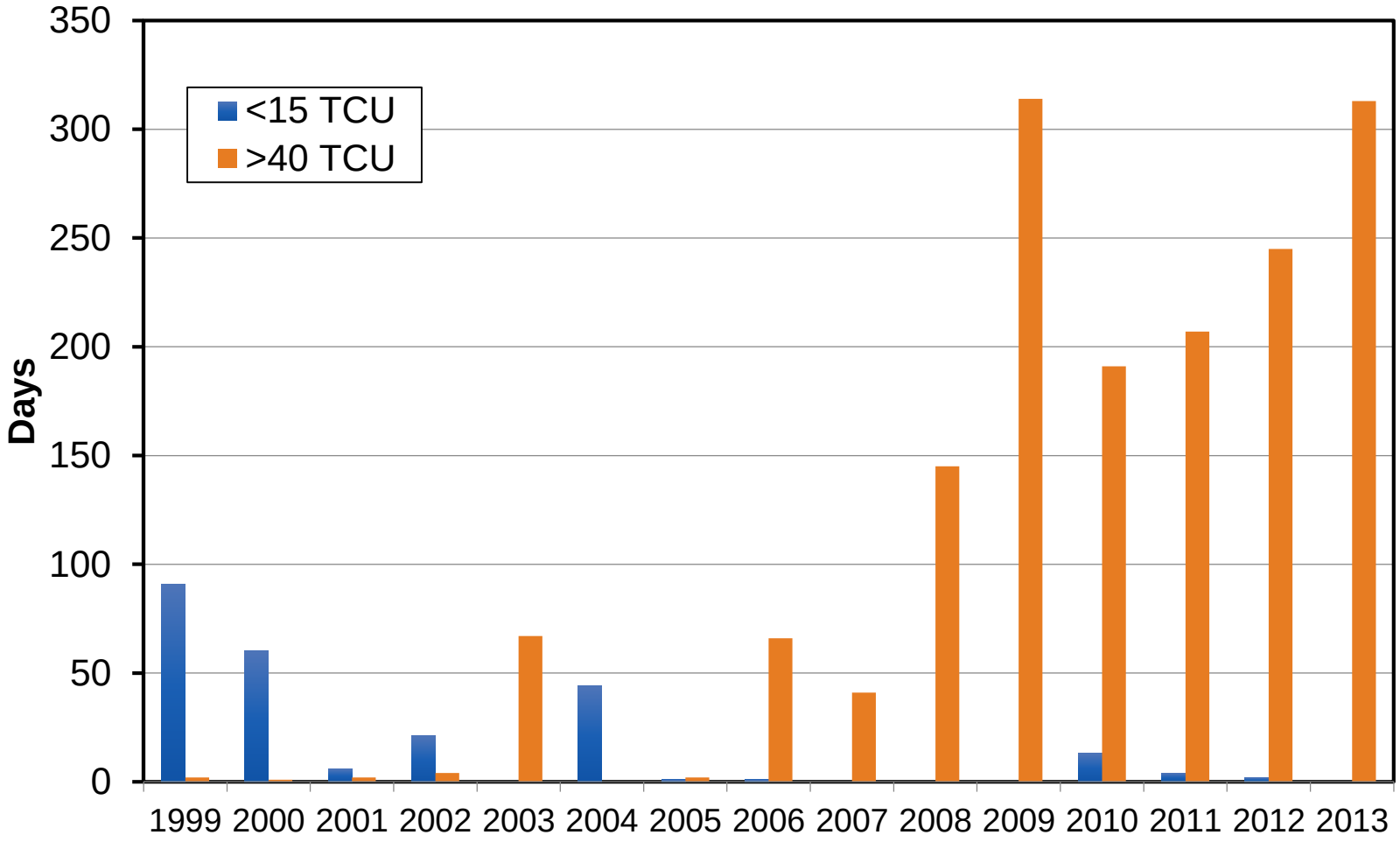


Color Analysis

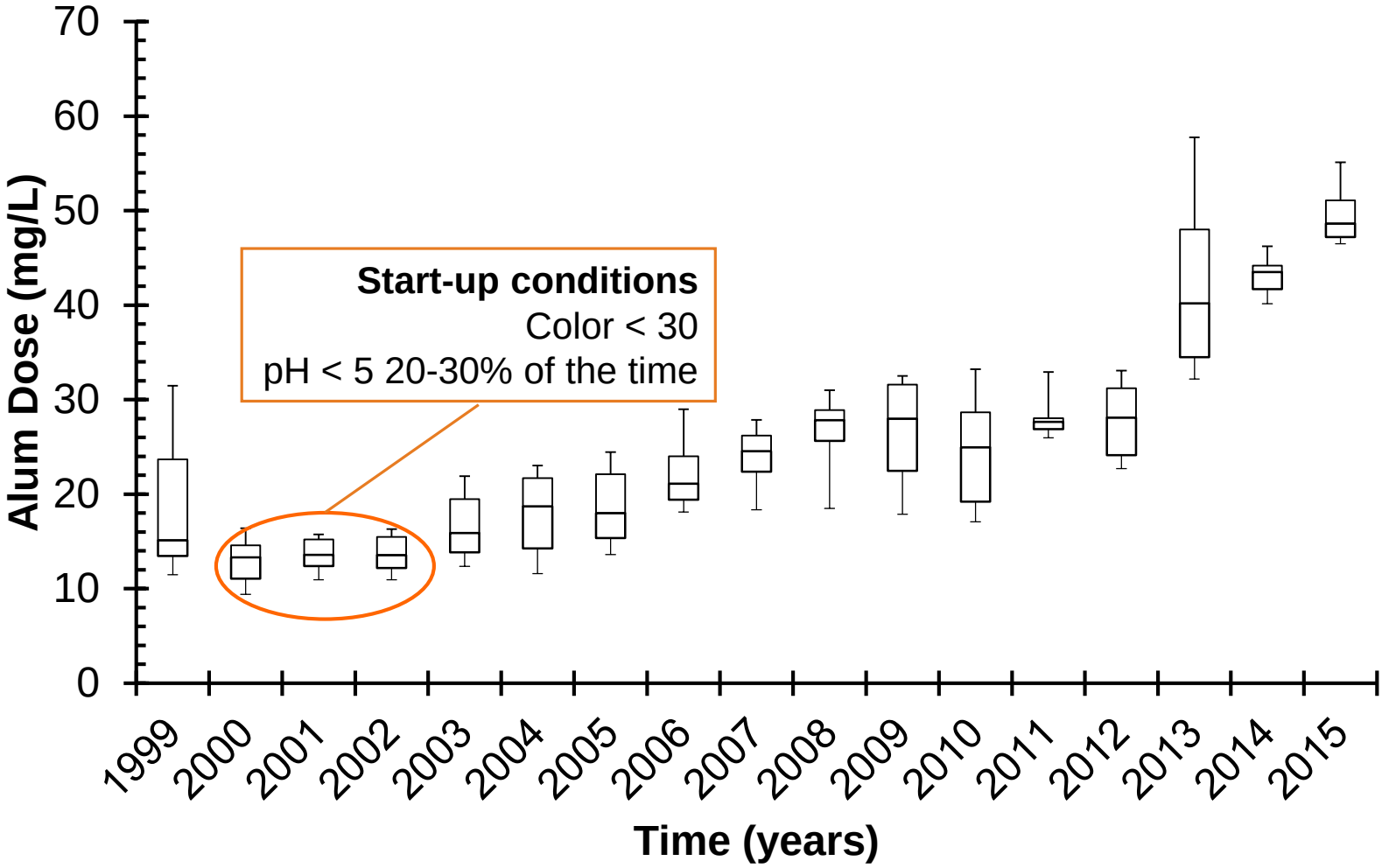
- Drinking water guideline for color is **15 TCU**
  - ✓Low color = low biological activity
- **40 TCU** or higher is often considered highly colored in drinking water

Image Source: *Stefan Löfgren, Swedish Department of Environment Assessment*

Lake Major - Color Analysis



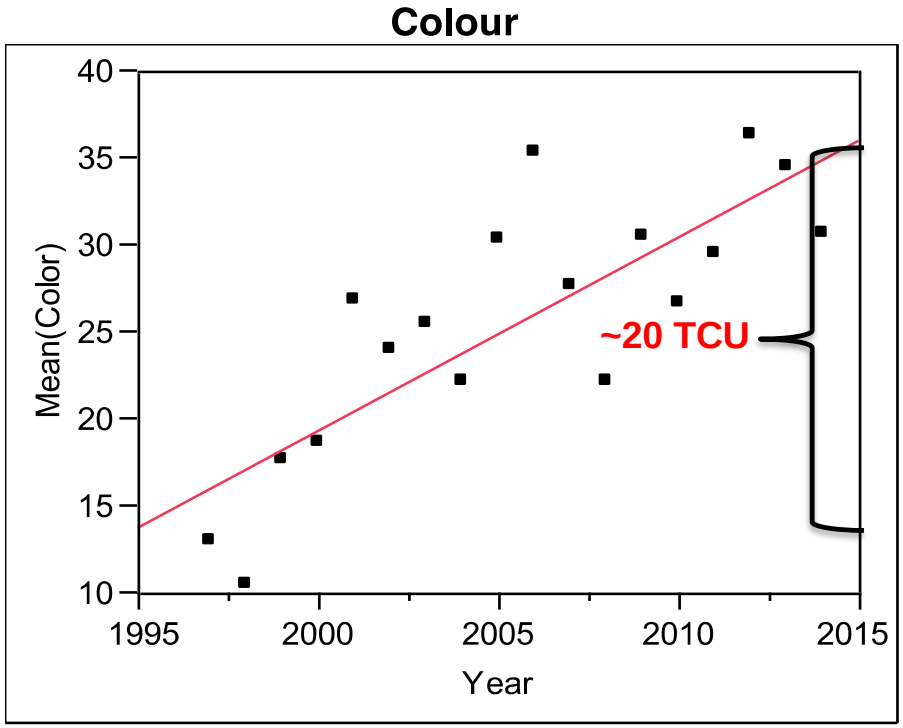
What Impact Has Color Had on Operations?

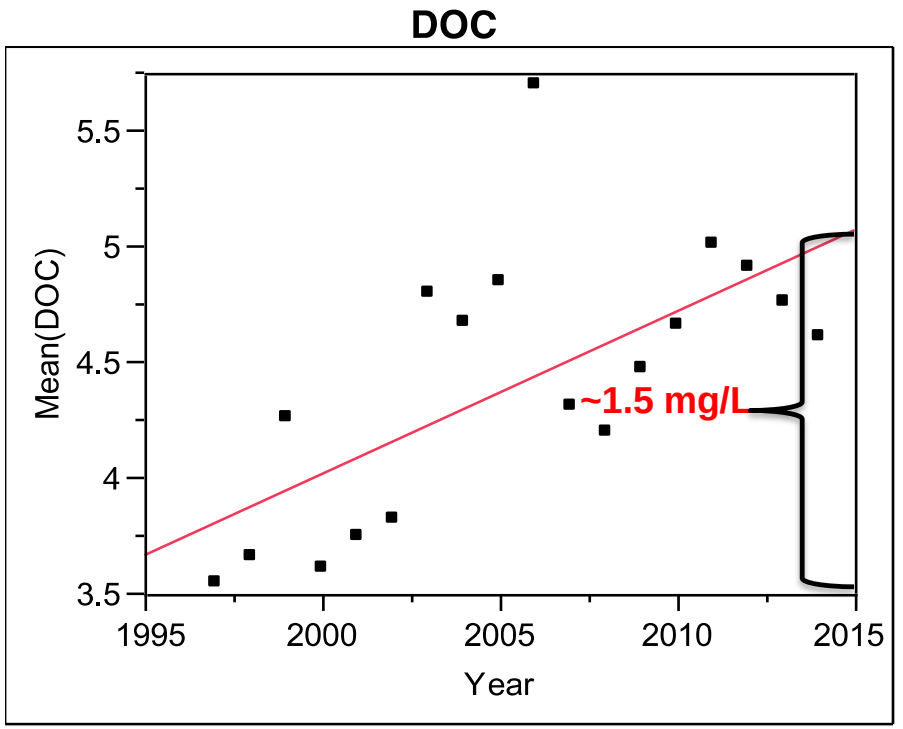


Elsewhere in NS

Lake George, King's County

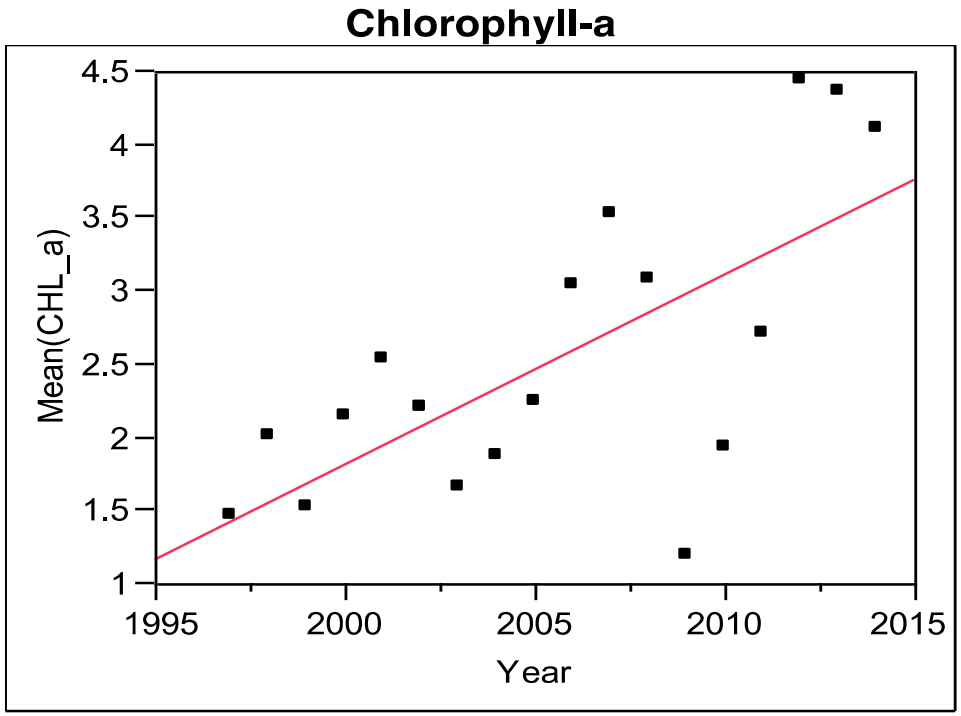
Lake George, NS

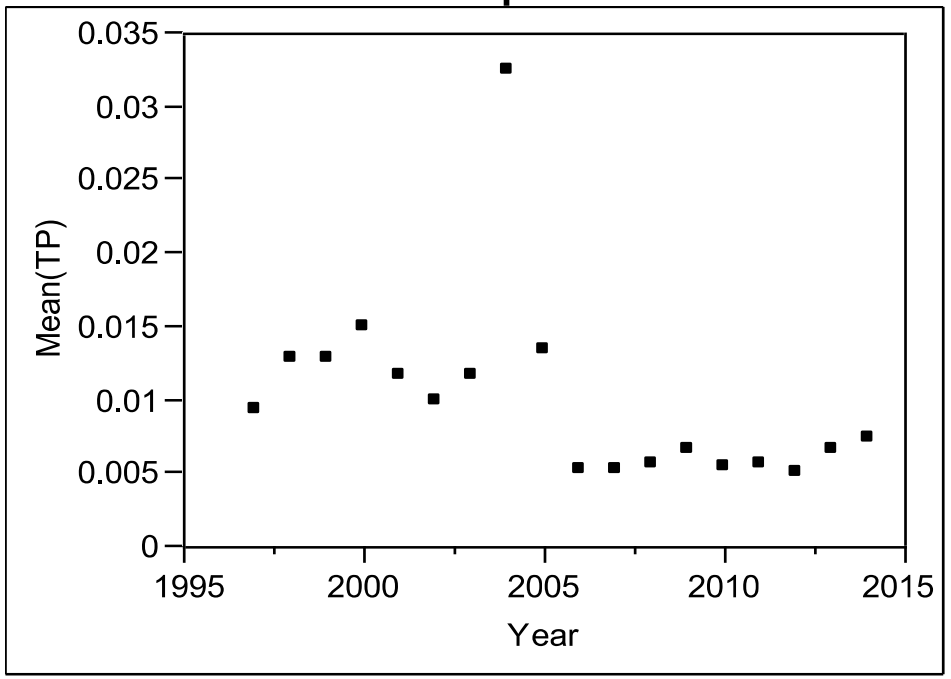




Source: *http://www.countyofkings.ca/residents/lakemon/archives.aspx*

Lake George, NS





Source: *http://www.countyofkings.ca/residents/lakemon/archives.aspx*

Other Consequences of Lake Recovery

Other Potential Consequences

Algal Blooms

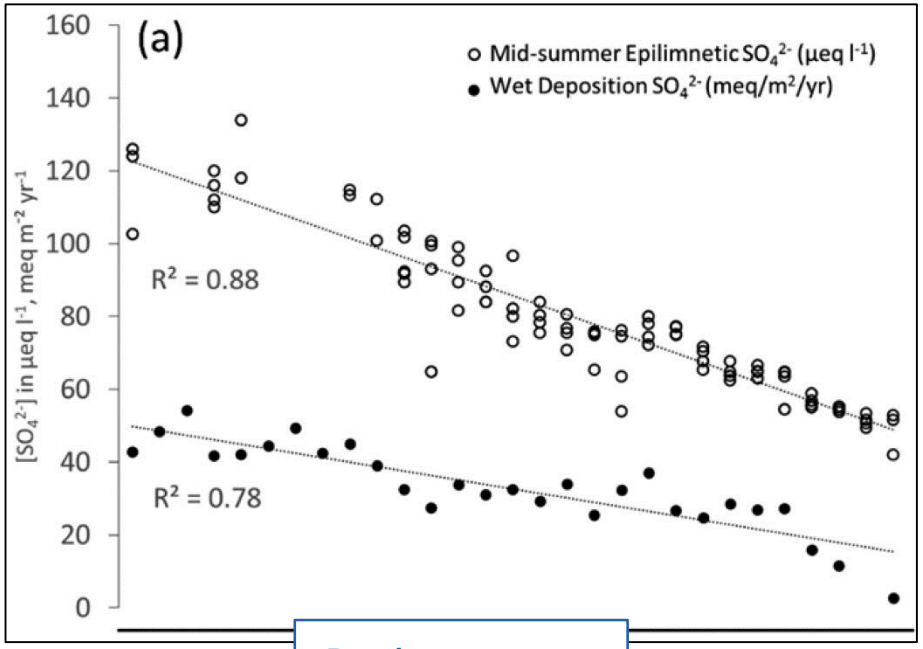
"Species richness of phytoplankton community is generally reduced by acidification in Atlantic Canada"

Source: *Lacoul et al. 2011. Environ. Reviews. 19: 429–460*

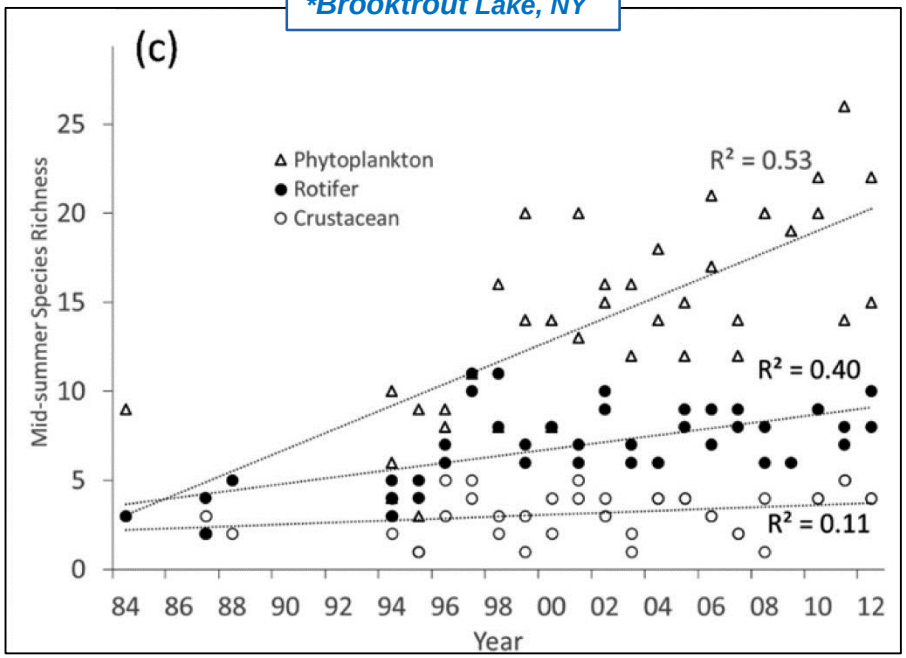
Lake Torment
Source: *CBC news, Aug 14, 2015*

Brooktrout Lake, NY

Photo Credit: *Dave Winkler, DFWI RPI 2015*



*Brooktrout Lake, NY



Decreased SOx …

Increased ***phytoplankton…***

Did this influence geosmin occurrence in Pockwock Lake?

Published In: *James W. Sutherland; et al Environ. Sci. Technol. 2015, 49, 2665-2674*

Lake Recovery Summary Thoughts

Water chemistry data is indicating a change in NS lake chemistry

- Closely linked to reduced sulphate deposition

Implications

- Need Innovation in Drinking Water Treatment
  - ✓ Currently experiencing process challenges
  - ✓ Plants were not designed for this type of water quality

Need to understand our watersheds

- ✓ Algal Blooms
- ✓ Taste and Odour Compounds
- ✓ Algal Toxins

Current Opportunities at Lake Major & Pockwock

- ✓ Optimization Studies

NSERC / Halifax Water Industrial Research Chair Acknowledgments

- Established in 2006 between Dr. Graham Gagnon at Dalhousie University and Halifax Water
- Chair renewal in 2011 added new partners; Luminultra, Mantech, CBCL Ltd., CBRM water Utility
- Chair renewal in 2016 added another partner; AGAT Laboratories
- Likely more partners to come

Water Research Foundation Tailored Collaboration Project Approved in February 2018

- A Decision Support Framework for Water Supply Plants Experiencing Lake Recovery.
- Project awarded to Hazen-Sawyer in June 2018.
- 4 day workshop in Halifax October 9-12, 2018.
- Additional participating utilities:
  - ✓ Tampa Bay Water, Mowhawk Valley Water District (NY), New York City(tentative).

Questions or Comments?