Halifax Water

What's Old is New Again

2016 Clean and Safe Drinking Water
Gander, Newfoundland

Carl Yates, General Manager

March 22, 2016

Providing world-class services for our customers and our environment

Presentation Overview

- **Part I: Lead**
  - Lead in the news
  - Regulatory climate
  - Recent research outcomes
  - Halifax Water's corrosion control and lead service line replacement strategy
- **Part II: Changing source water quality**
  - Lake recovery in Atlantic Canada
  - Implications of changing source water quality

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Part I: Lead

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Flint Michigan

- In an effort to save money, Flint Michigan changed water supplies in 2014
- The outcome was significant corrosion and lead exposure

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How Has Flint in the News Affected Halifax?

- Canadian Water Network project quoted in several articles
- Dr. Gagnon from Dalhousie gave an interview on CBC Main Street more specific to lead in Atlantic Canada.
- Halifax Water has had a slight increase in customer inquiries

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Regulatory Framework

- **Health Canada**
  - Proposed Change: MAC 10µg/L to 5µg/L

- **US: National Drinking Water Advisory Council (NDWAC) / EPA**
  - Lead and Copper Rule under review
  - Long-term plan for removal of all lead service lines
  - Discontinue sampling to measure corrosion control

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Halifax Water Lead Programs

- **Residential Sampling Program**
  - Residential monitoring program – Annually in August
  - Results reporting and advised course of action
- **Distribution Monitoring Program**
  - Monthly distribution system monitoring
  - Quarterly distribution system coupon monitoring
- **Lead Service Line (LSL) Program**
  - LSL replacements
  - LSL monitoring program
  - Public outreach and education initiatives

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Residential Monitoring Program

Two Tier Sampling Protocol

LSL Service Sampling Procedure

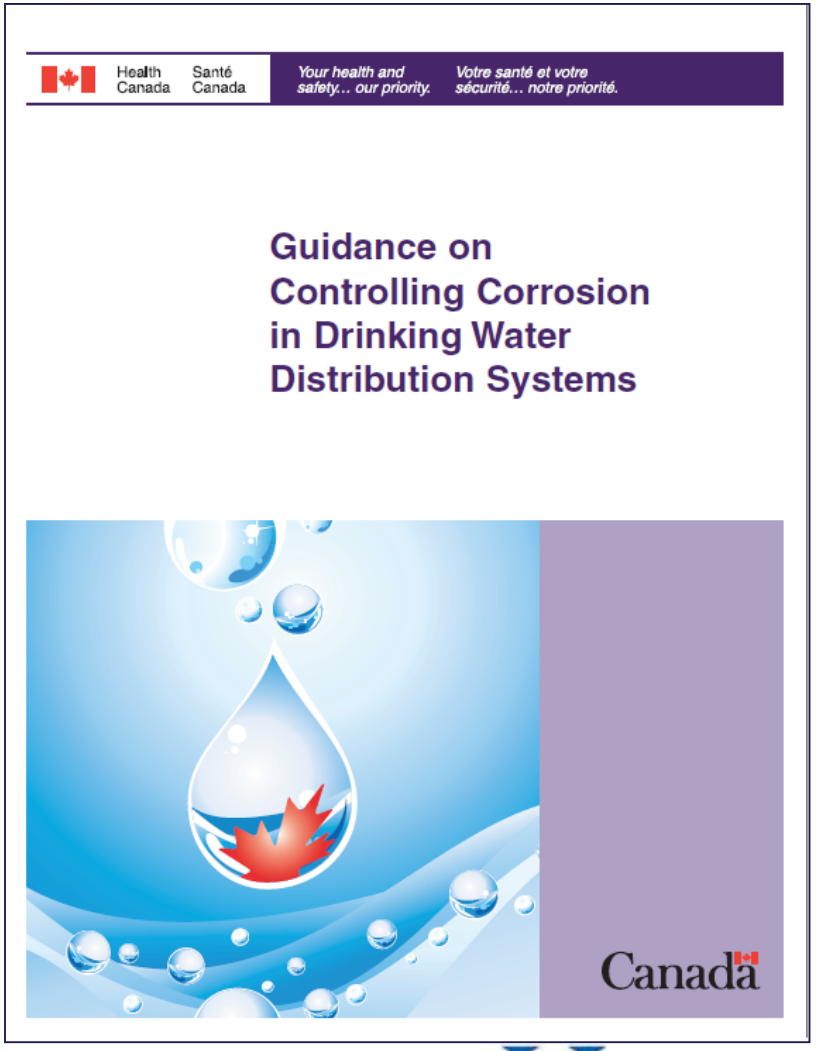
4 x 1-L after 6 hour stagnation
1-L after flushing

Copper Service Sampling Procedure

1-L after 6 hour stagnation
1-L after flushing

Target Sample Pool:

100, once per year



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Customer Results Reporting and Recommendations

- **Results Letters Sent to Customers**
  - Report total Pb and Cu for each litre sampled
  - Resample, if necessary
- **Corrective Actions Advised if Lead >10µg/L**
  - Draw cold tap water for cooking and drinking
  - Flush > 6 hrs. stagnation
  - Periodically remove and clean all faucet aerators
  - If pregnant, breastfeeding or have children under the age of six, consider using a household water filter (NSF certified)
  - Boiling water will NOT remove lead!
- **Recommend LSL Replacement**

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Challenges in Adopting a Residential Monitoring Program

- **Recruitment of Volunteers**
  - Many old homes converted to multi-unit residences
  - Elderly home owners not interested
  - Conflicts with vacation time
  - Agreeable but no follow through

- **Quality Control During Sampling**
  - Insufficient stagnation time
  - Insufficient flush time (as evident in results)
    - ✓ Standardized to 5 minutes

Corrosion Control & Distribution System Monitoring

- **Corrosion Control**
  - Zinc orthophosphate currently dosed at 0.5 mg/L PO_4 , leaves ~0.15 mg/L PO_4 residual

- **Monitoring Program**
  - Monthly sampling for pH, PO4, Zn, Mn, Fe, alkalinity, turbidity in distribution system
  - Quarterly analysis of corrosion rates of steel, copper and lead coupons [six sites in distribution systems]

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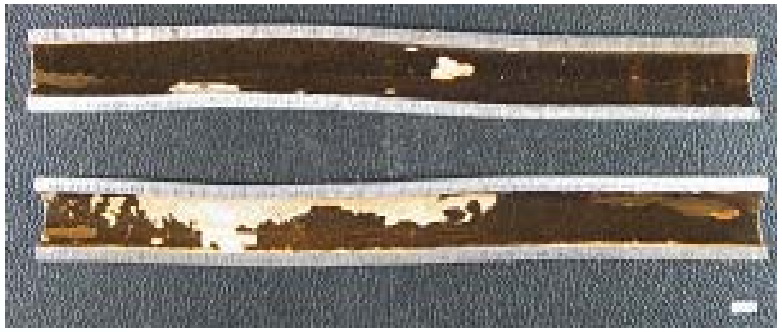
Review of Corrosion Control Program (2015)

- **Recommendations from Independent Consultant Review of Corrosion Program:**
  - ↑ Orthophosphate dose (0.5 mg/L) → ***1.8 - 3.6 mg/l (as PO_4)***
  - ↑ Increase pH (7.2 - 7.4) → ***8.0 to 8.5***
  - Change product from zinc ortho-polyphosphate to zinc orthophosphate
    - ✓ Polyphosphates are used for iron and manganese sequestration but can result in lead release.

Corrosion of a Lead Service Line Recovered from the Distribution System



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Corrosion Inhibitor Changeover

- **In response to corrosion review and research with Dalhousie University, Halifax Water changed the product:**
  - 2005 – Zinc ortho-polyphosphate (75 ortho:25 poly blend) with 30% active ingredient
  - 2015 - Zinc-orthophosphate (100 ortho:0 poly) with 55% active ingredient
  - Maintained dose of 0.5 mg/L as PO_4 but for the same cost as prior chemical, can double the dose.
- **Monitoring Results**
  - No significant changes to trends from past years due to product changeover

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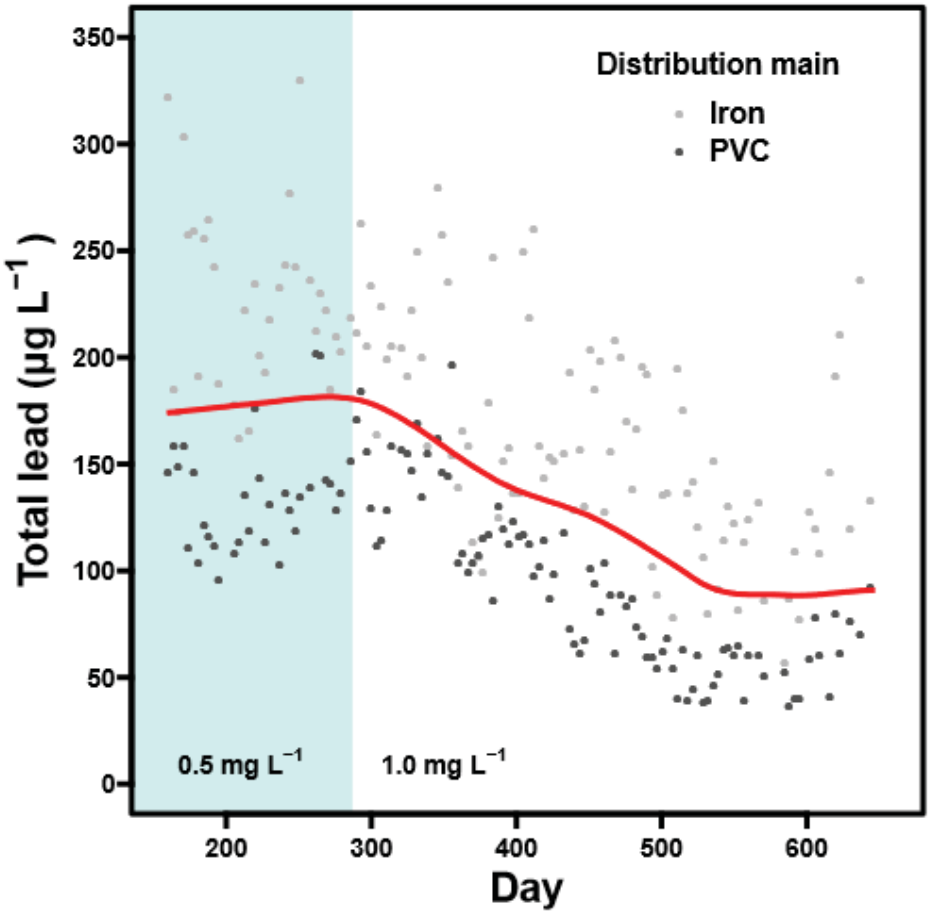
Increasing Phosphate Dose

- **Research with Dalhousie University shows decrease in lead with a doubling of phosphate dose from 0.5 to 1.0 mg/L**
- **Implementing a Bi-monthly Sampling Program:**
  - 30 homes with either a partial or full lead service line
  - Start in April, double the dose in June
  - Monitor long term impact of an increase in dose.



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Lead Service Line (LSL) Program

- **Current Policy of Lead Service Replacement:**
  - Following a private replacement
  - When there is a planned or sudden disturbance of the water main or public portion of the service line:
    - ✓ When there is a leak in the public portion of the service line.
    - ✓ When there is a water main renewal project occurring on the street.

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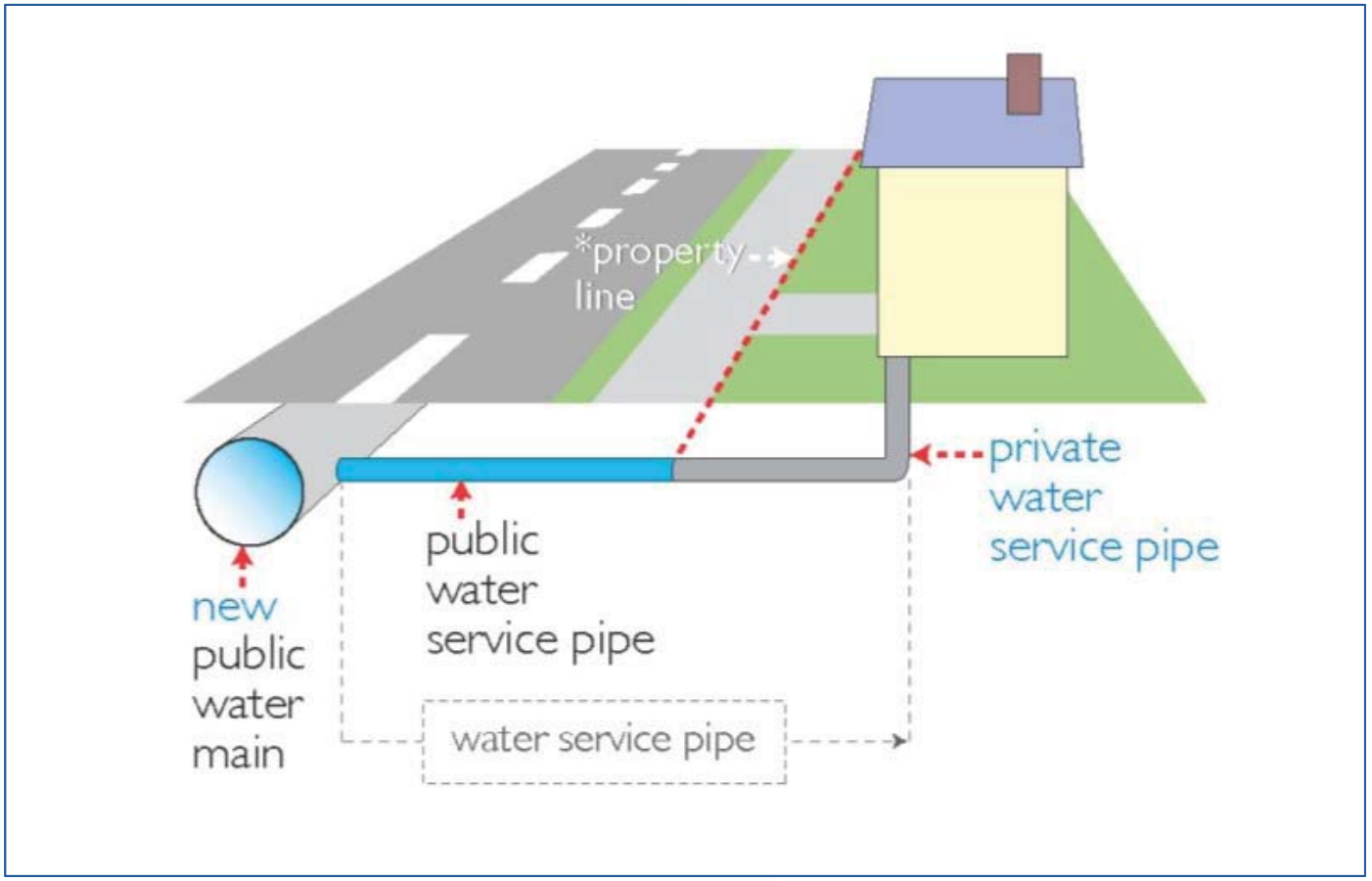
Service Schematic



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Lead Service Line Replacement

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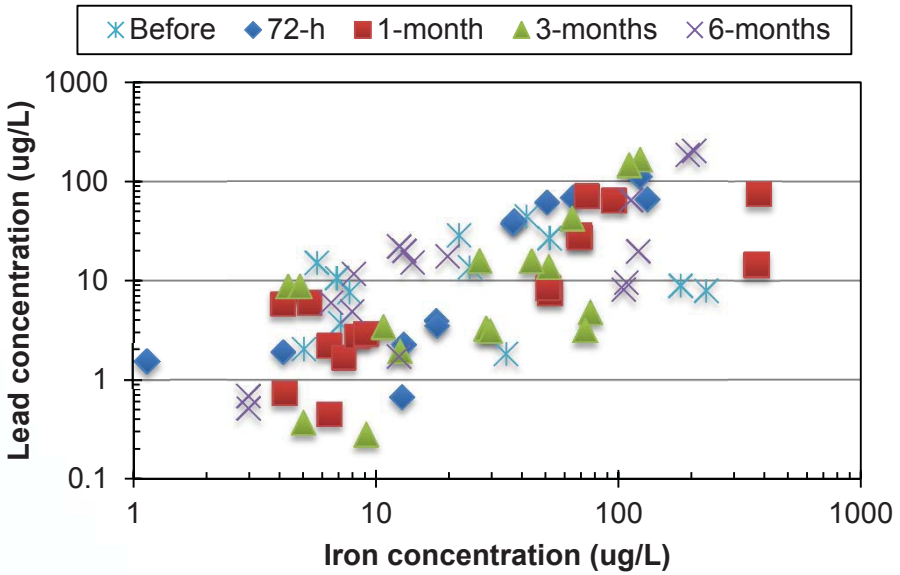
Lead Service Line (LSL) Program

- **Outreach Initiatives:**
  - Pre and Post Construction LSL Replacement Information to Residents
  - LSL Replacement Sampling Program
  - Customer Results Reporting
  - Residential Program
  - Publications: Watertalk, Stewardship Report, Website

What Research at Dalhousie University has Told Us About LSLs

- **Partial LSLs can lead to increased lead**
  - In 2012, Halifax Water stopped doing partial replacements unless it is a water main renewal and material will already be disturbed.
- **Link between increased lead and unlined cast iron water mains**



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AWWA Distribution & Plant Operations Division Best Paper 2014

Camara et al | http://dx.doi.org/10.5942/jawwa.2013.105.0102
Journal - American Water Works Association
PEER-REVIEWED

Role of the water main in lead service line replacement: A utility case study

ELIMAN CAMARA,[1] KRYSTA R. MONTREUIL,[2] ALISHA K. KNOWLES,[3] AND GRAHAM A. GAGNON[4]

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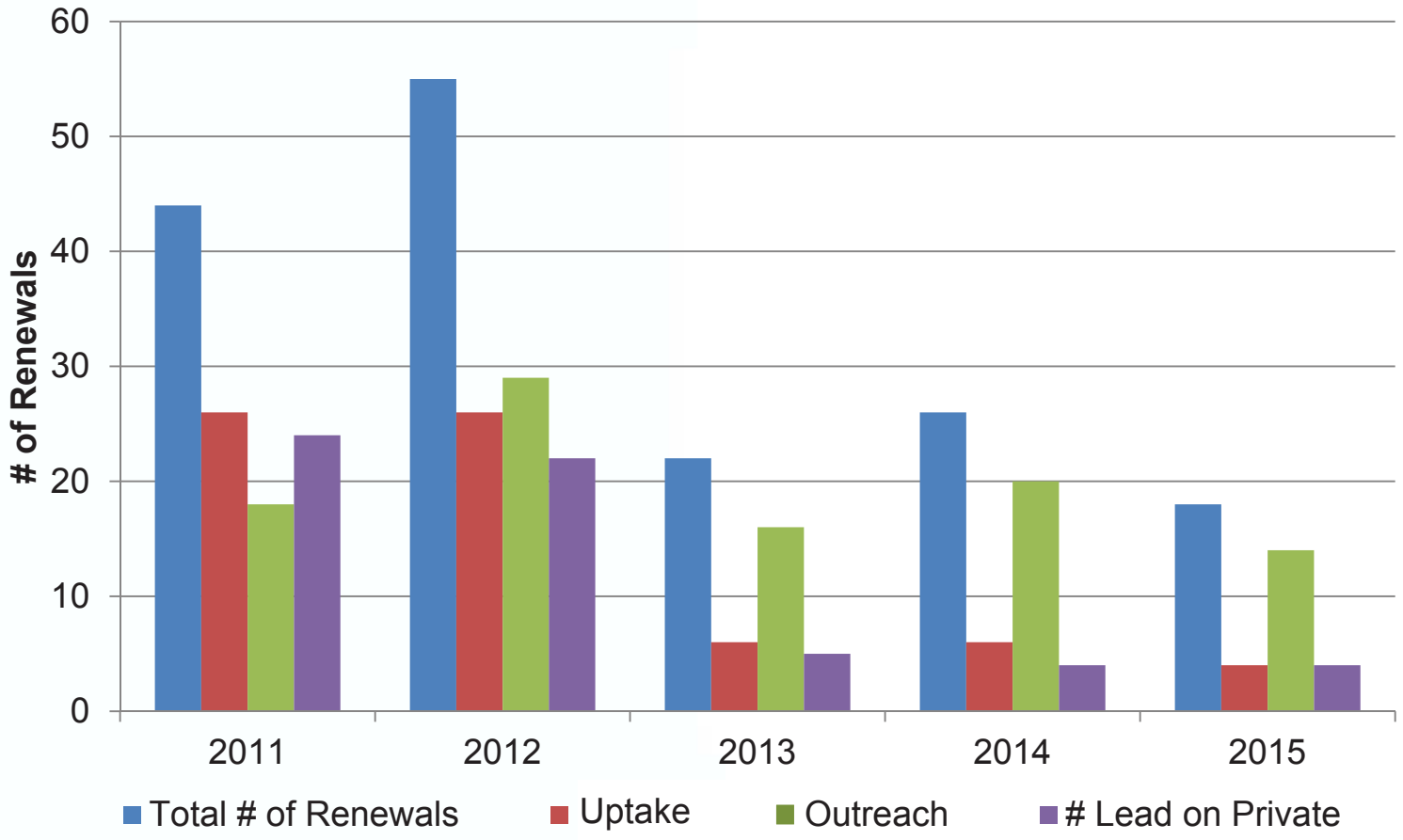
LSL Replacement Program Statistics



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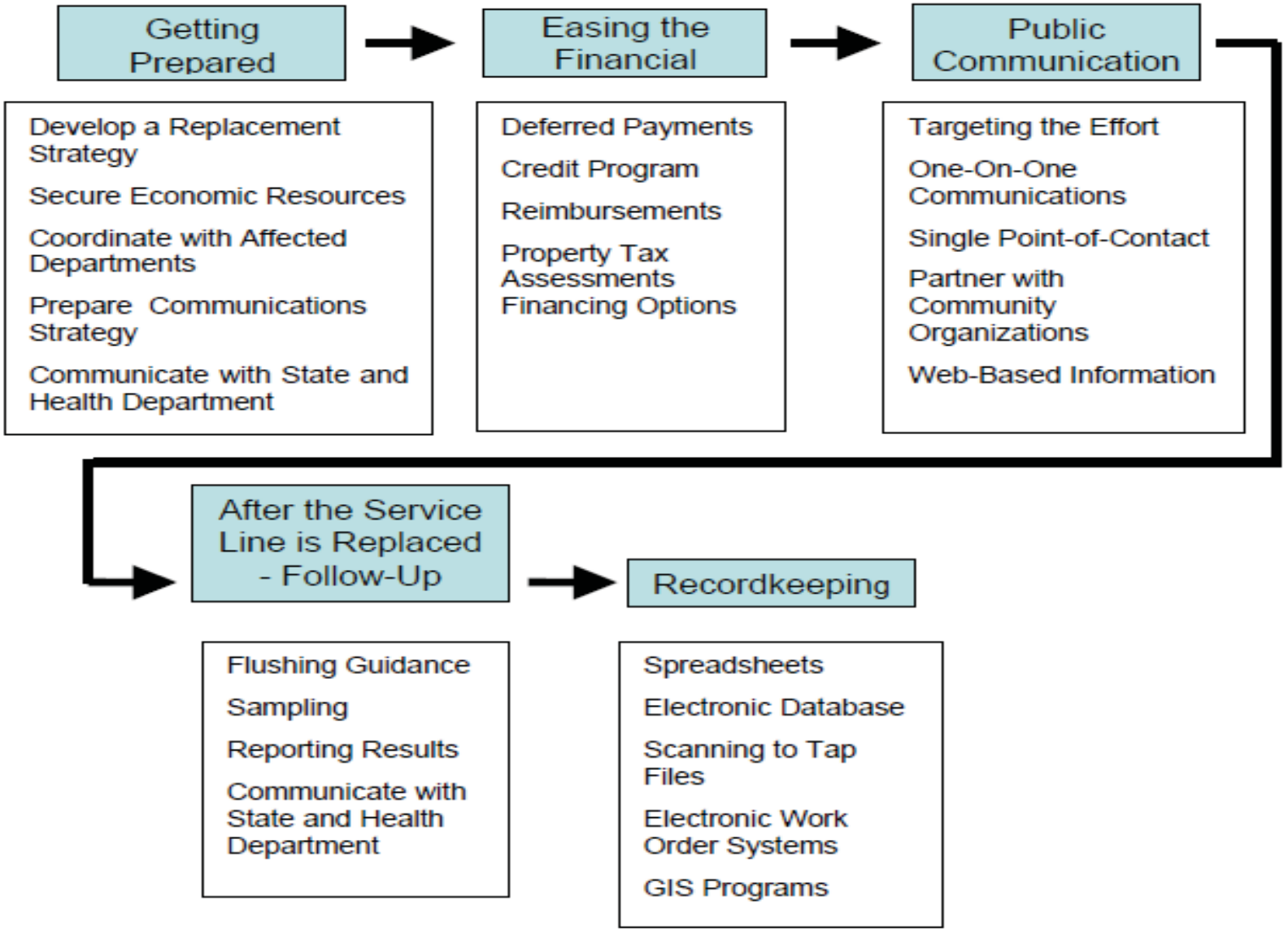
AWWA Elements of a Strategy for Complete LSL Replacement



Updating Halifax Water's LSL Replacement Strategy: FACTORS

- **Targeted Replacement**
  - Sensitive populations (school, child care facilities)
  - Sites with elevated levels
  - Known lead challenges (concentrated LSL areas, unlined cast iron mains, dead ends/low flow)
  - Return to coordinating with HRM capital work, coordinate with wastewater capital work
- **Capital Commitment: Certain % Replacement Annually**

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Updating Halifax Water's LSL Replacement Strategy: FACTORS

- **Changing Current System Maintenance Priorities**
- **Quality of Utility Records (historical and updates)**
  - Procedures to identify service line composition
  - AMI Project - information Opportunity
- **Private Uptake Limitations**
  - Cost
  - Inconvenience
  - Disruptive Nature

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Strategies for Customer Buy-In for Private Replacement

- **Thorough Preparation**
- **Financial Incentives**
  - low income deferred payments, credits to offset cost, low-interest loans, betterment charge
- **Effective Communication**
- **Follow-Up Interactions**
- **Efficient Recordkeeping**

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Communication Strategy

- **One-on-One Contact – Projected High Success Rate, but No Solutions Offered**
- **Include MOH and NSE in Communication**
  - Customer confidence, credibility and open the lines of communication on this topic
- **Partner with Community Based Organizations**
  - Outreach expertise for public health messaging
- **Targeted Outreach:**
  - High risk groups, high density lead neighbourhoods, homes with known lead lines or elevated results
- **Mass Media**
- **Written Correspondence**

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Part II: Lake Recovery in Nova Scotia – Evidence for occurrence

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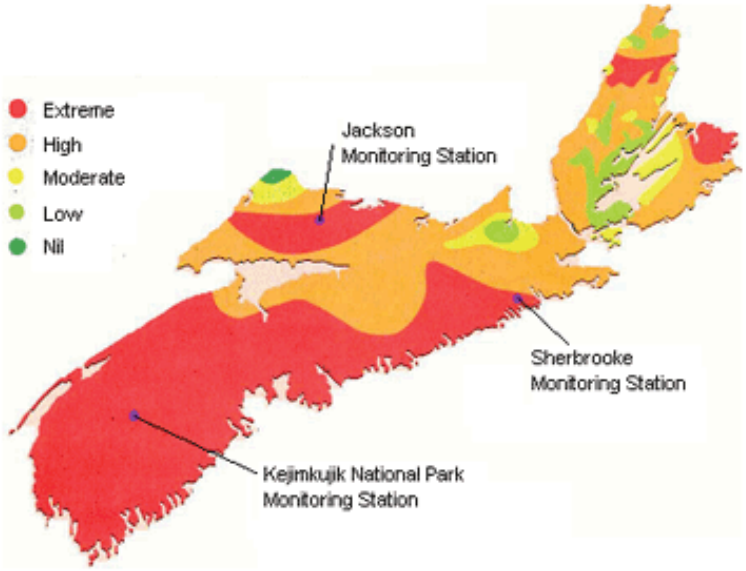
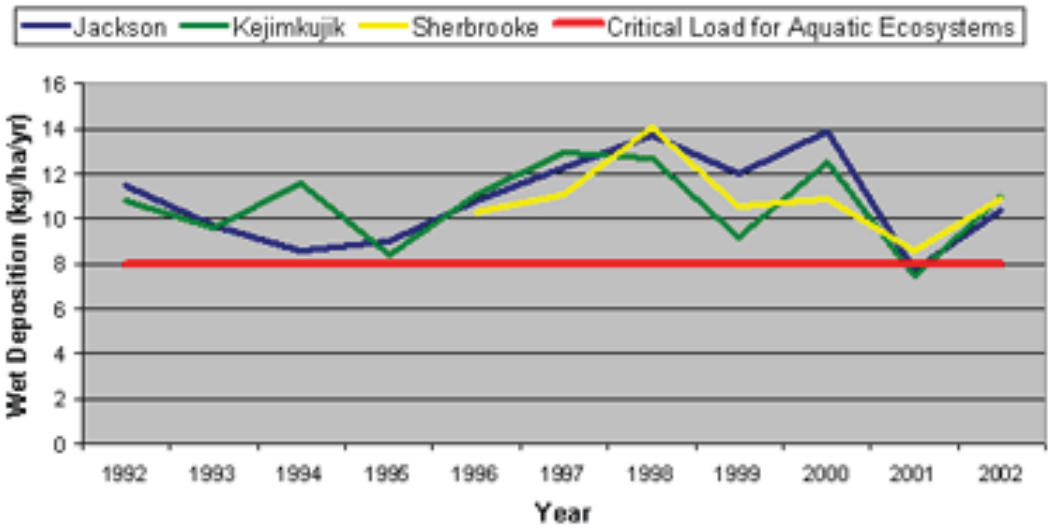
Acid Rain Impacts to Nova Scotia Lakes



- Map of Nova Scotia showing sensitivity of lakes to acidification (Source: The State of the Nova Scotia Environment, July 1998)

Source: *https://www.novascotia.ca/nse/air/acidrain.asp*



- Wet sulphate deposition measured at three stations in Nova Scotia against the critical load for lakes in the province

(Data source: NAtChem database)

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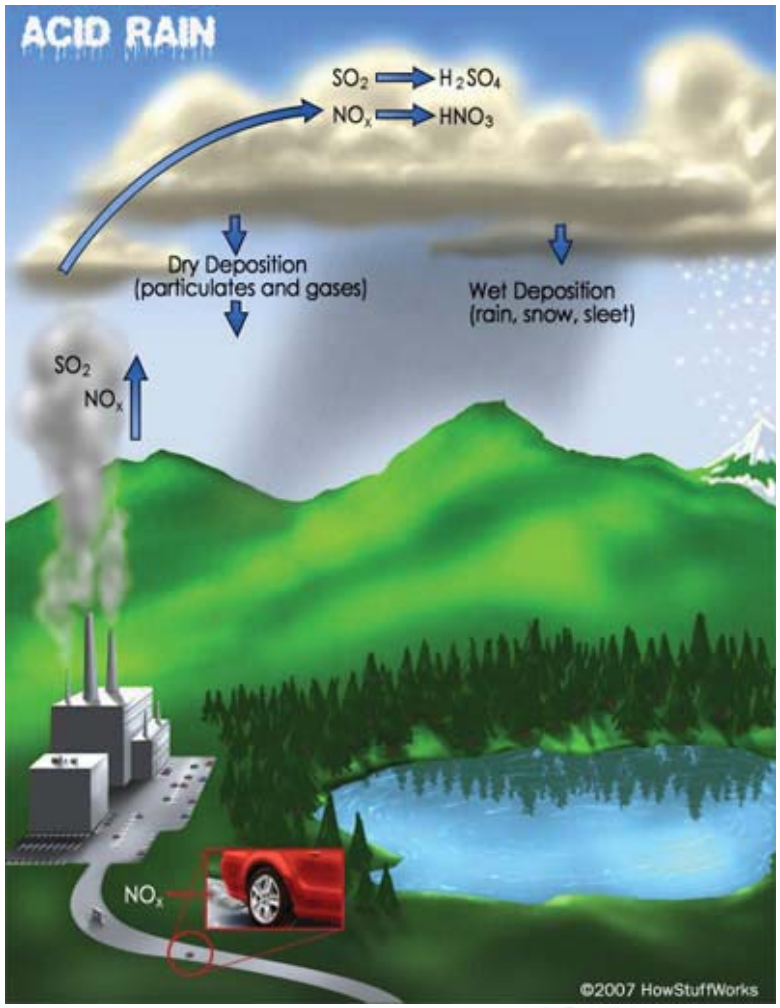
Sulphur Deposition and its Impact on NS Lakes

- **Changes in energy policy has 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



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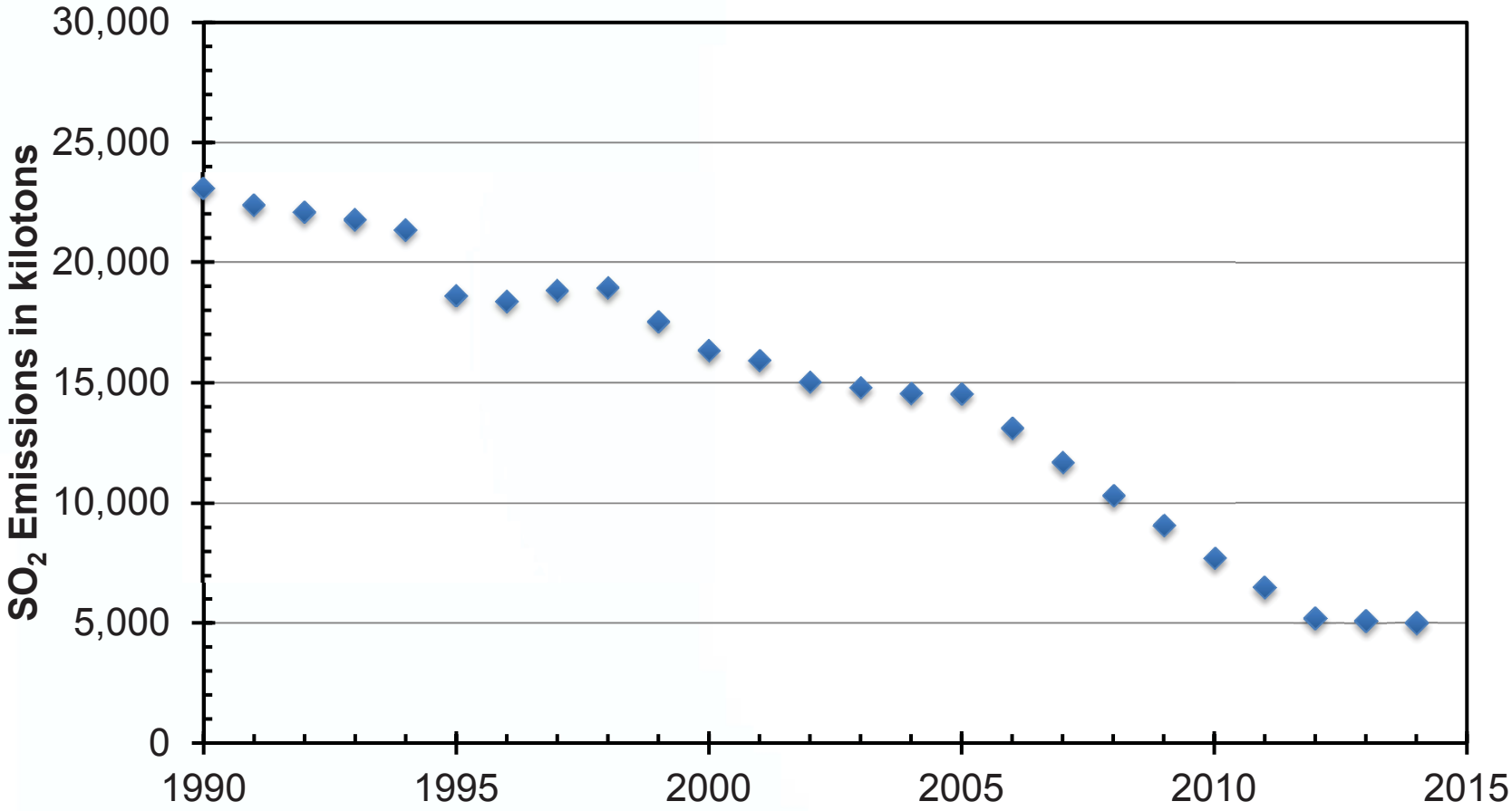
Sulphur Dioxide Emissions in United States



Source: *EPA National Emissions Inventory*

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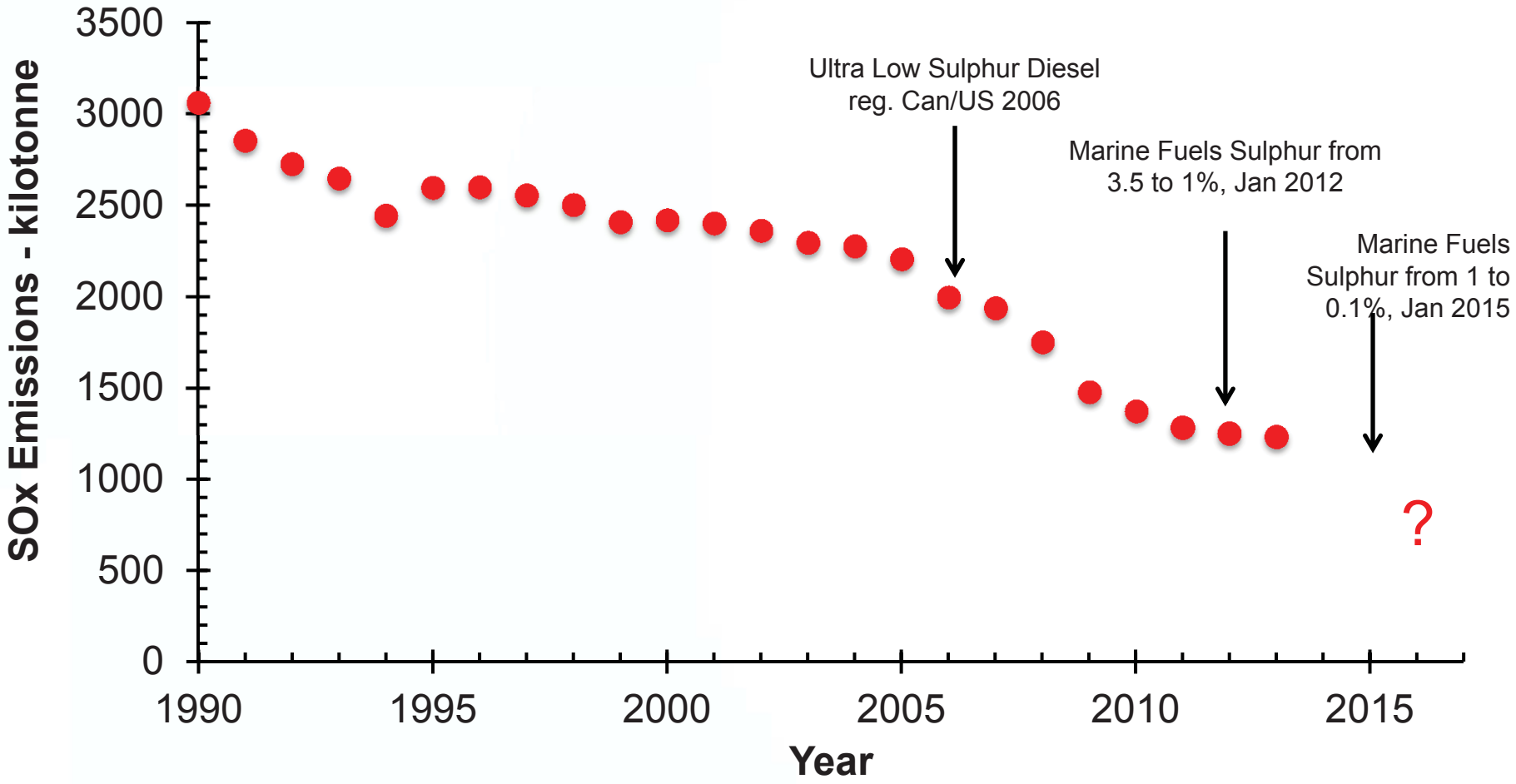
Sulphur Oxide (SOx) Emissions in Canada



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

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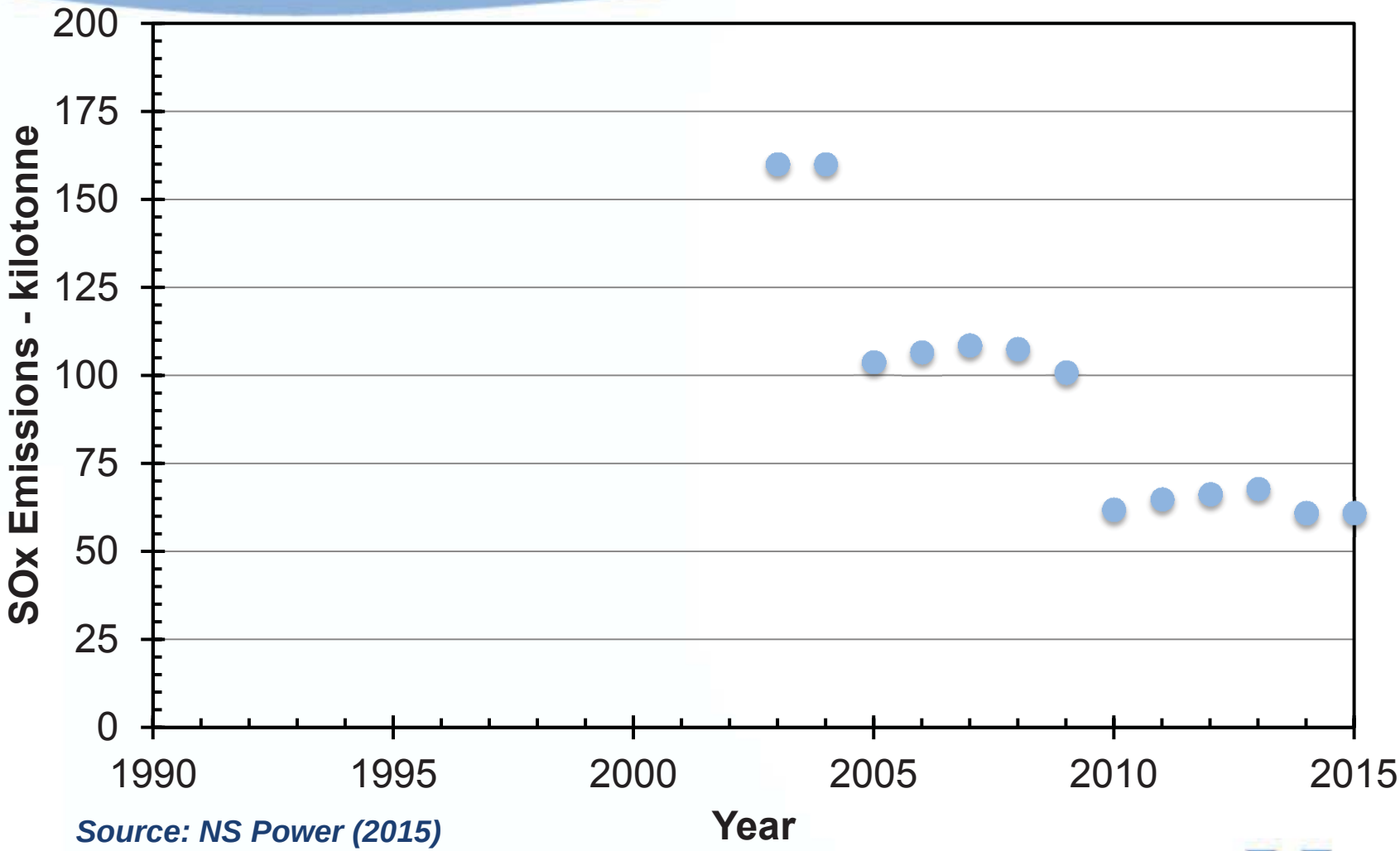
Sulphur Oxide (SOx) Emissions in Nova Scotia



Source: NS Power (2015)

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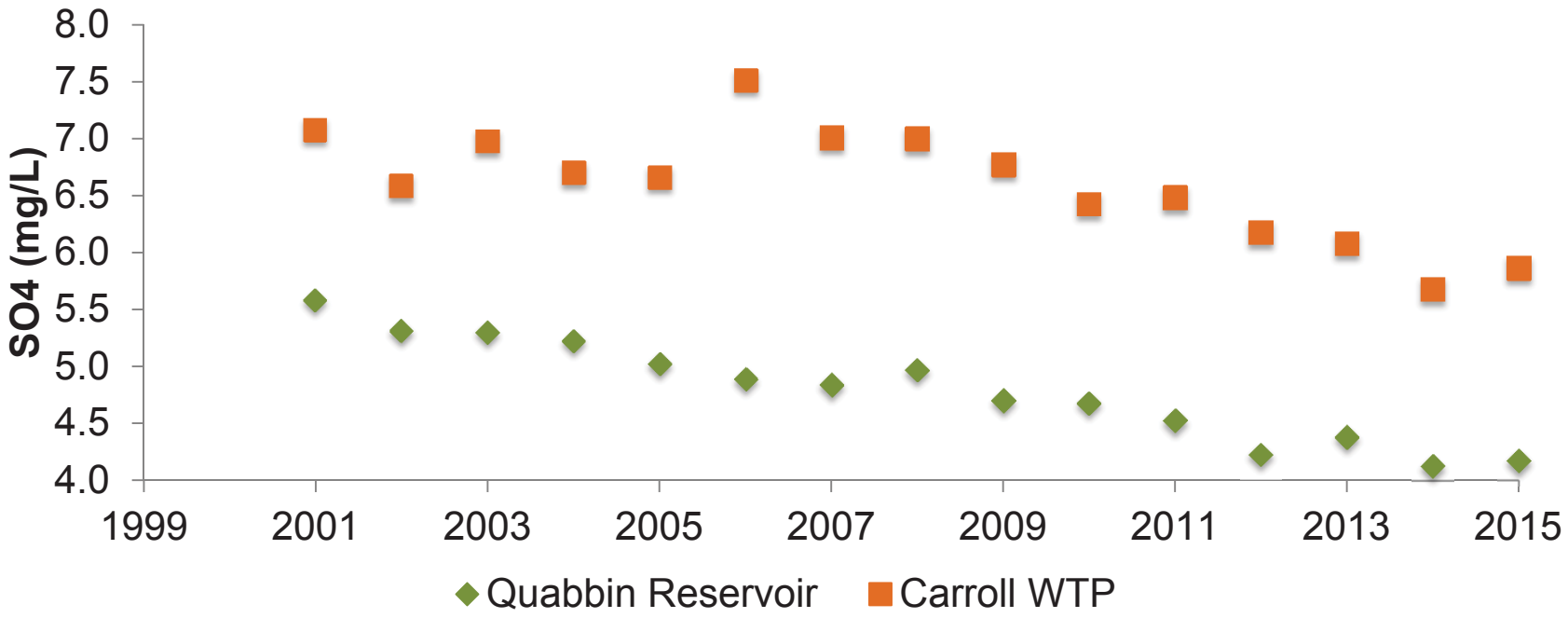
With Less SO_2 in the Atmosphere

Is it Possible for Lakes to "Recover"?

SO_4 Concentrations in Boston Water Supplies



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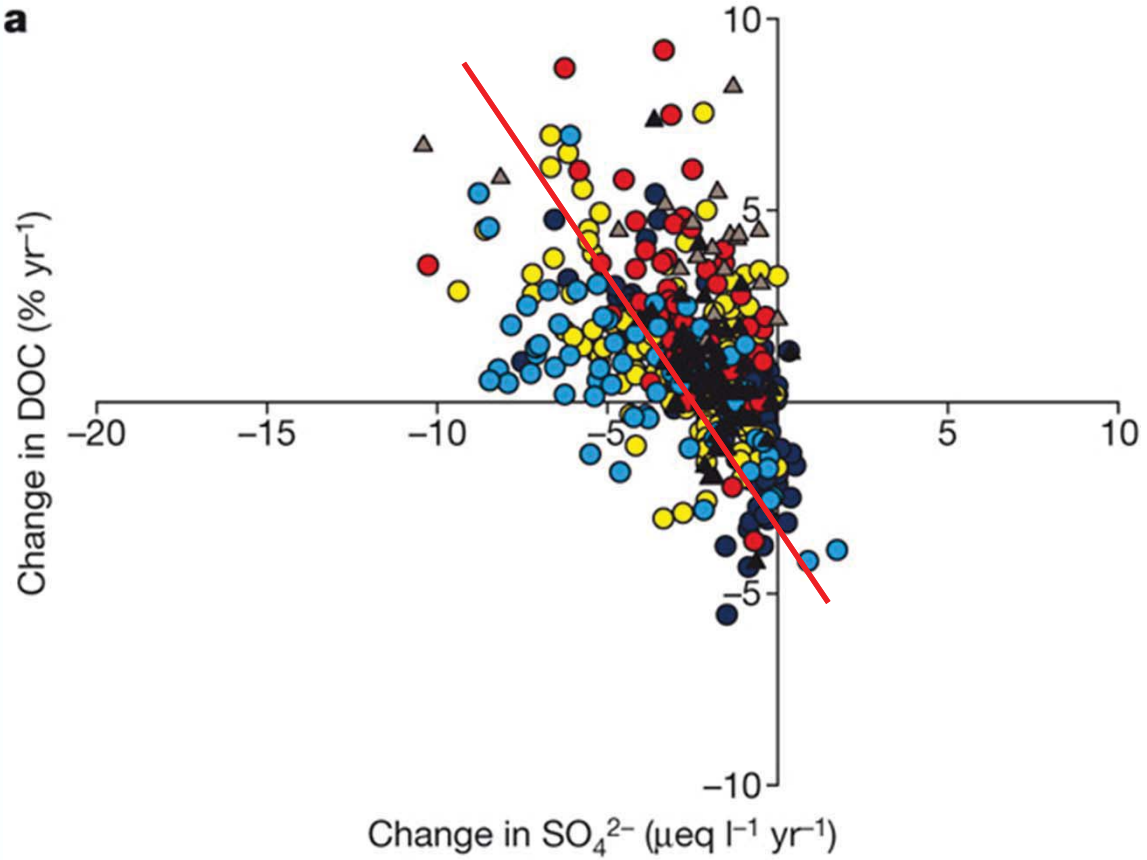
Decreased Atmospheric SOx … Increased Lake DOC



Source: *Monteith et al. 2007 Nature 450(22): 537-541*

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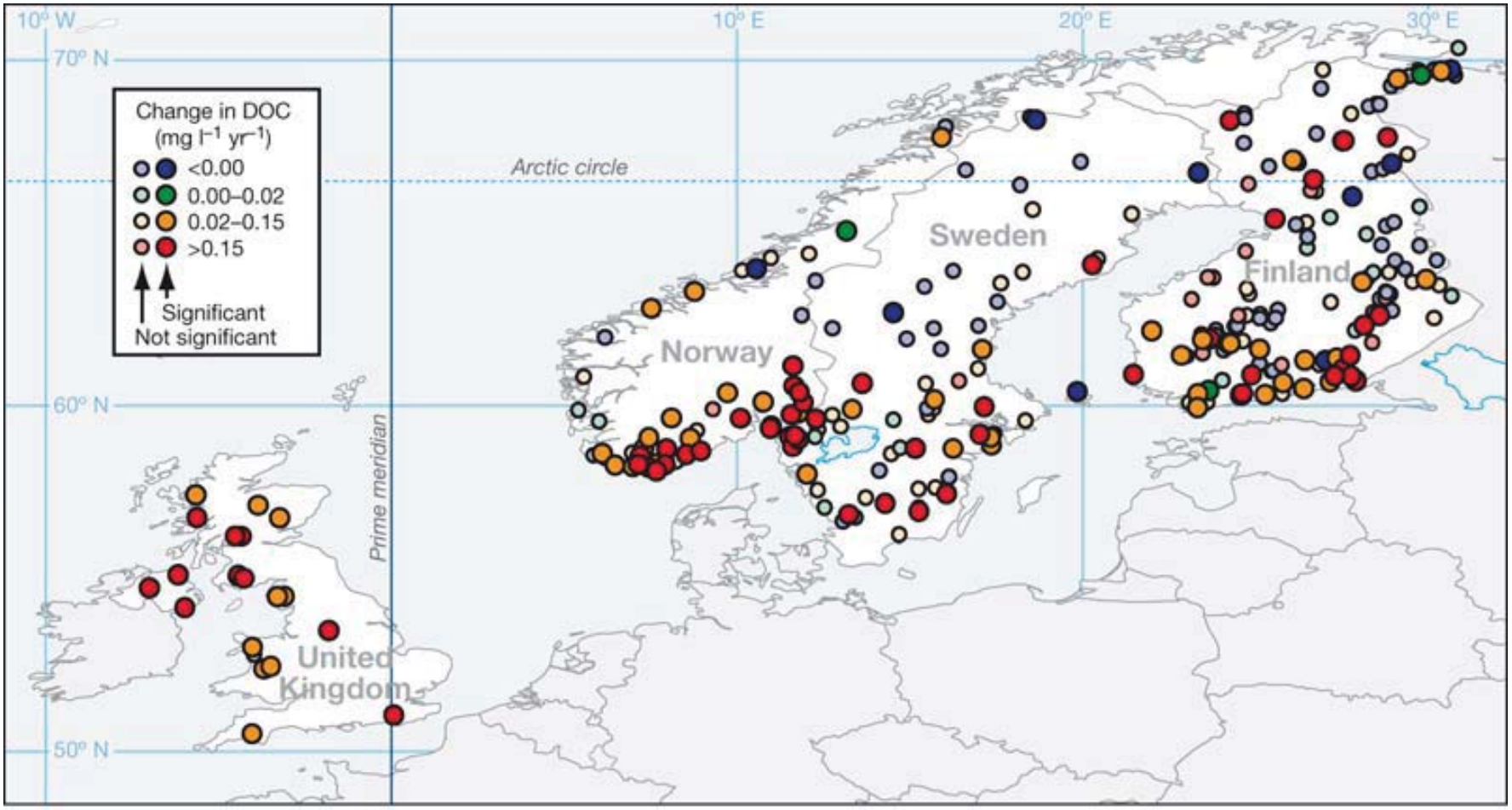
UK and Scandinavian Utilities are Realizing This New Reality



Source: *Monteith et al. 2007 Nature 450(22): 537-541*

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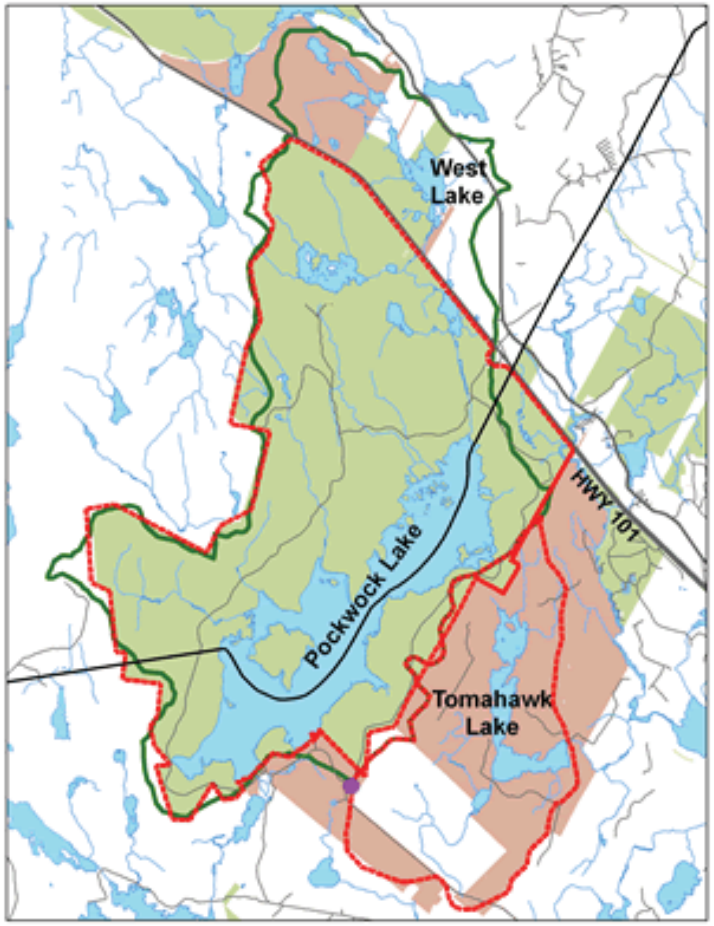
With Less SO_2 in the Atmosphere

What is Happening to Nova Scotia Lakes?

Consider Pockwock Lake

Halifax Water Supply Plant



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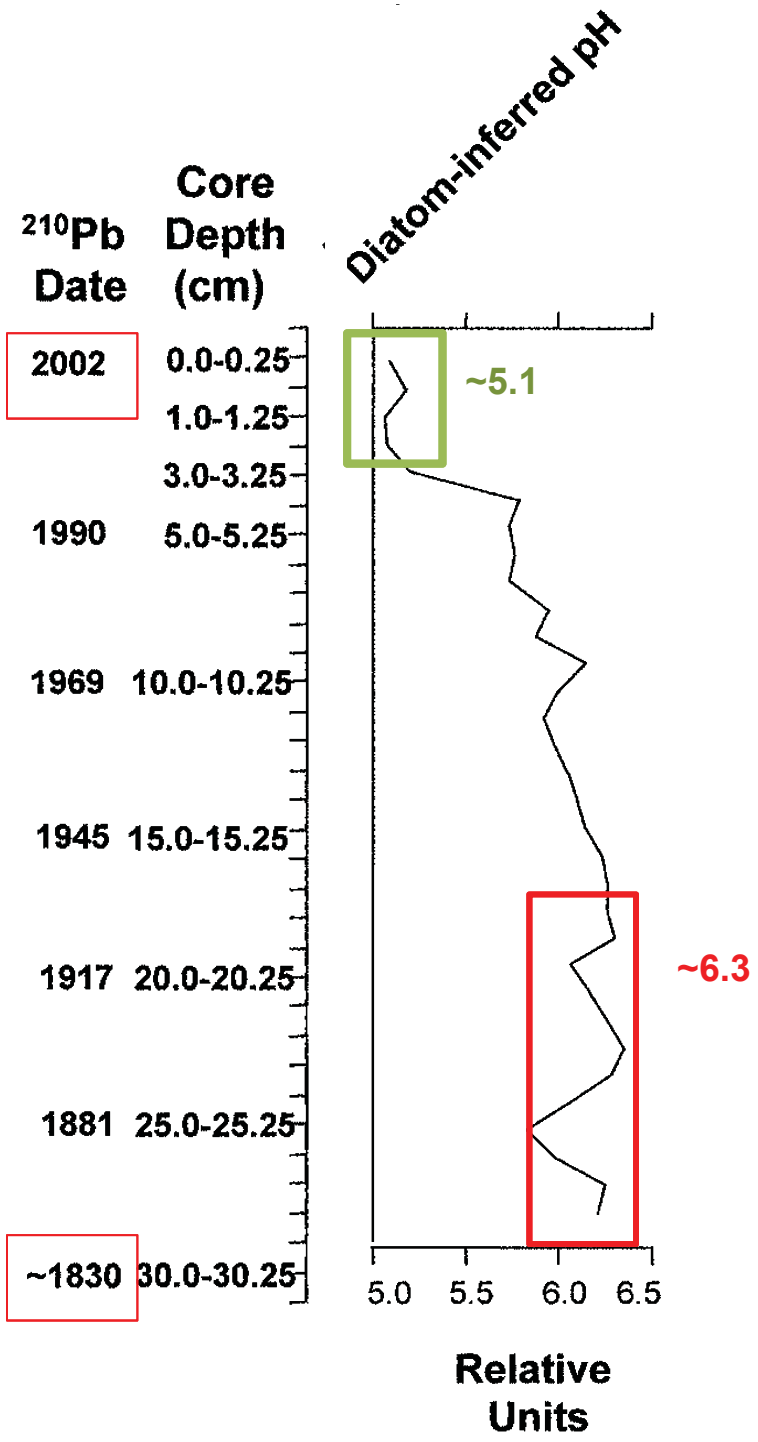
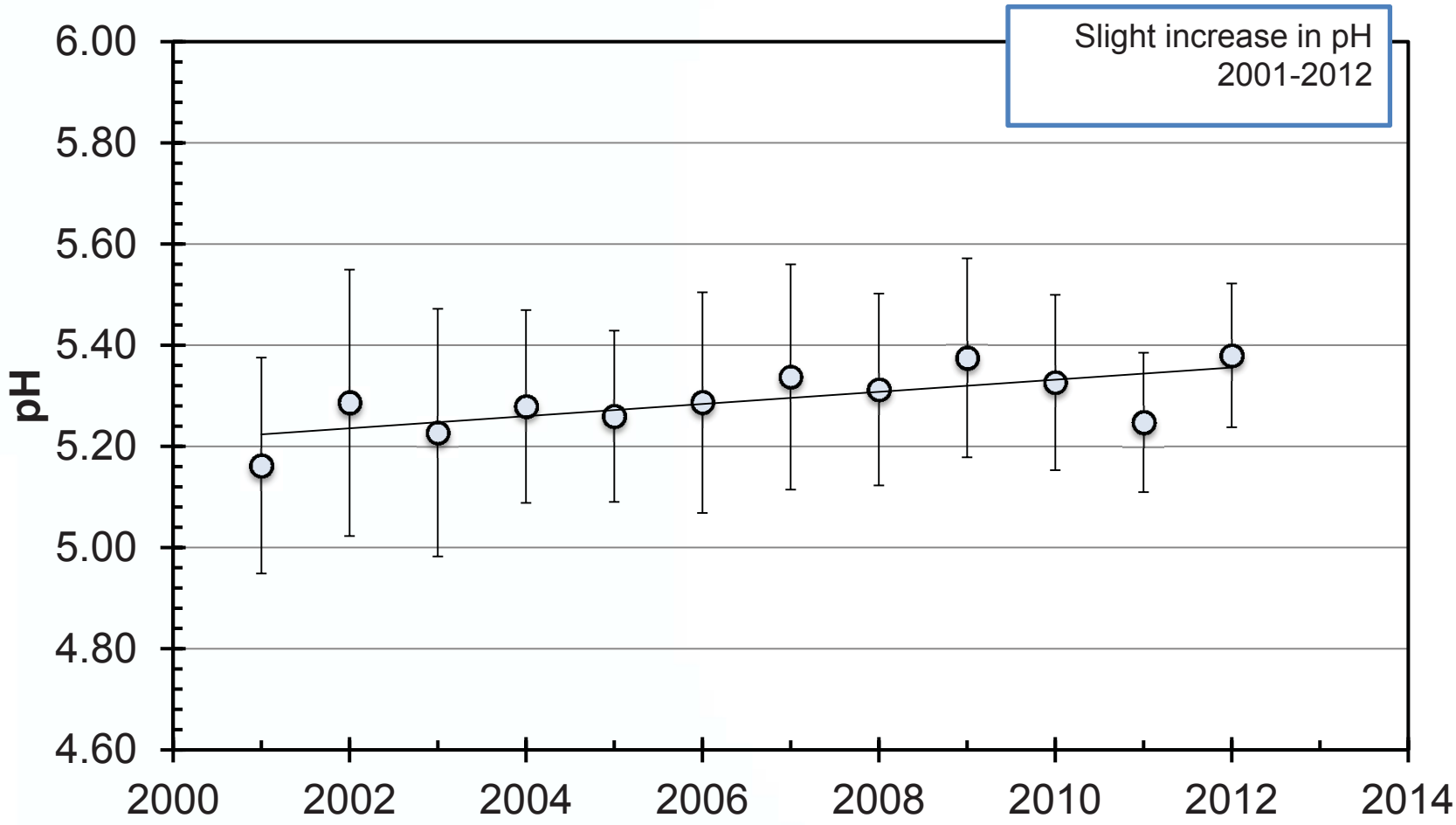
Sediment Core Samples

- Research led by John Smol's group at Queens University
- Sediment core at Pockwock Lake
- 3 Distinct Regions in Core…
  - **Before ~1940**, Pockwock Lake had a diatom-inferred **pH ~6.3**
  - With the onset of acidification (**1940-1992**), diatom-inferred lake water **pH decreased to ~5.8**
  - Second (**post ~1992**) acidification event resulted in **pH of 5.1** (low DOC era)



Source:
Tropea et al. 2007 Lake & Reservoir Mgt 23: 279-286.

pH – Pockwock Lake



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

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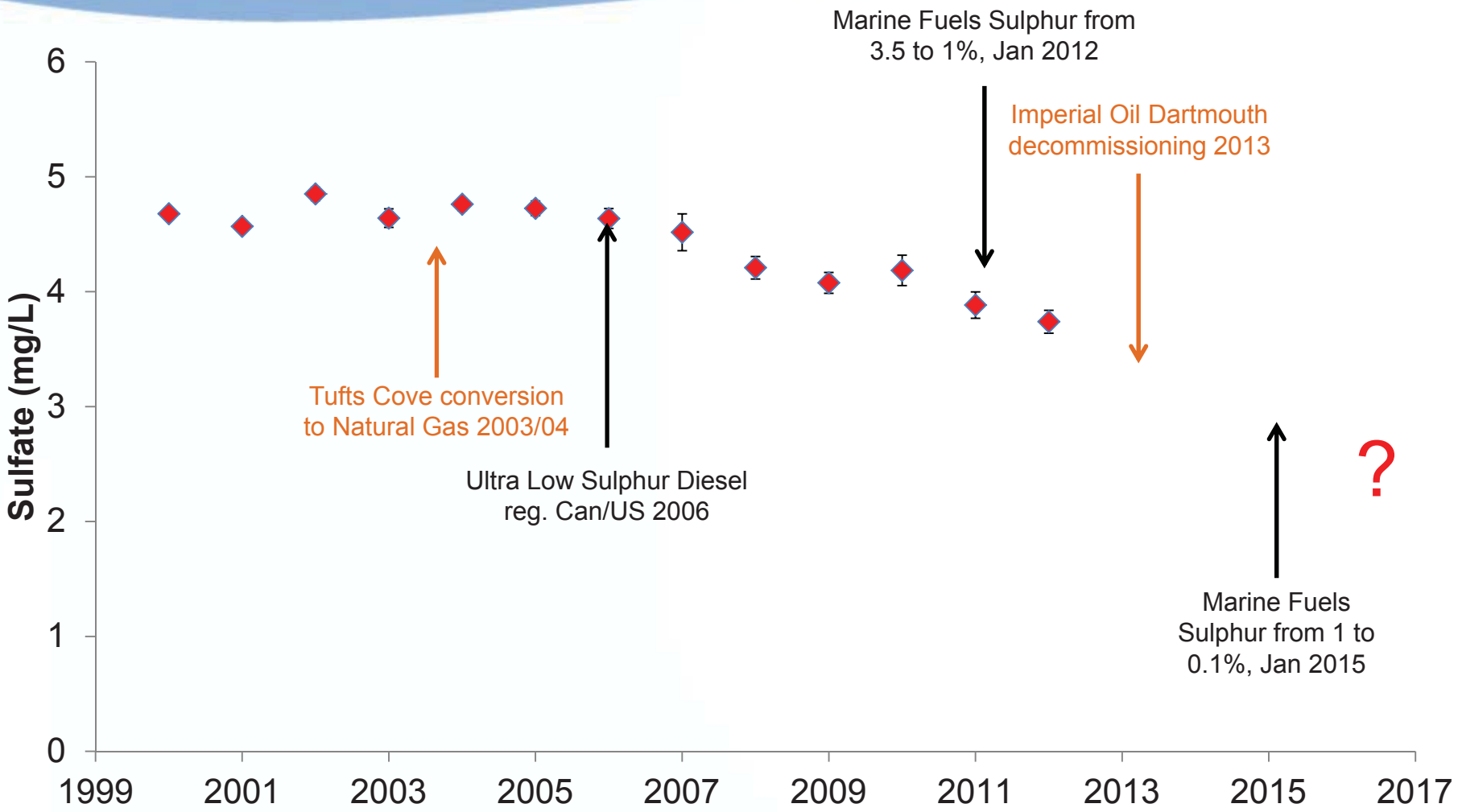
Sulfate in Pockwock Lake



Source: *Environment Canada freshwater quality monitoring program*

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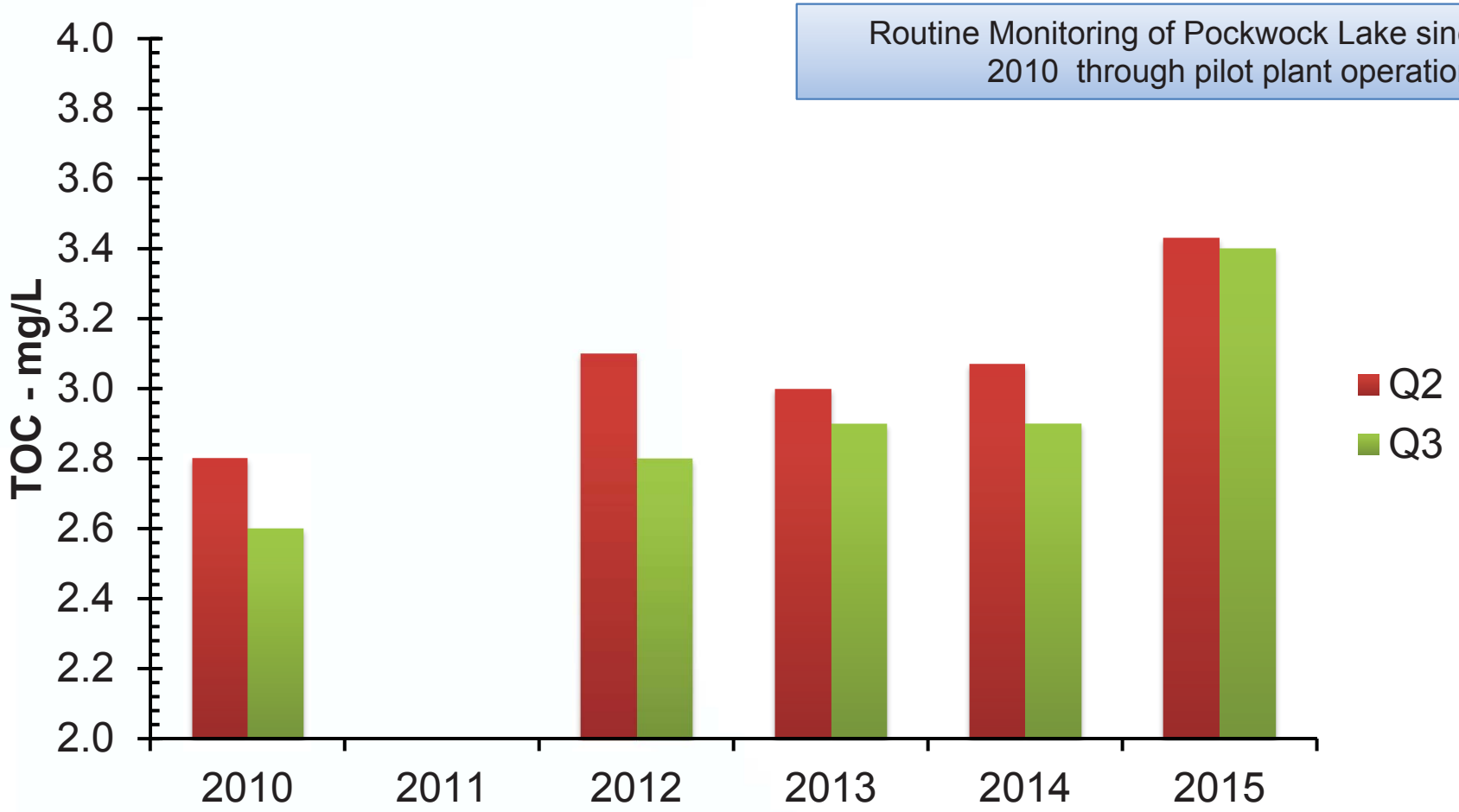
TOC – Pockwock Lake

Warmer Months (April-Sept)

Routine Monitoring of Pockwock Lake since 2010 through pilot plant operations



Data from NSERC/Halifax Water Industrial Research Chair

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TOC – Pockwock Lake

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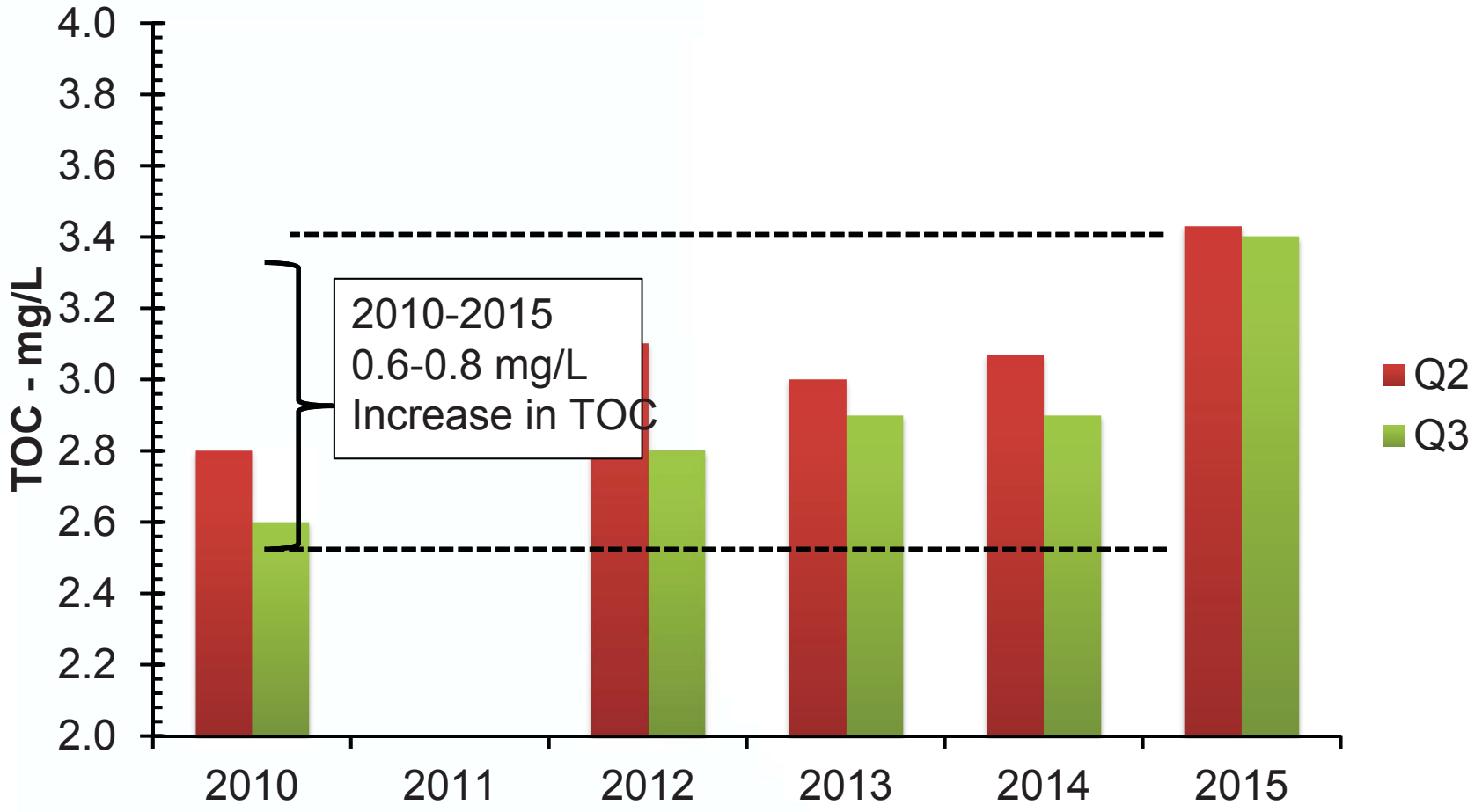

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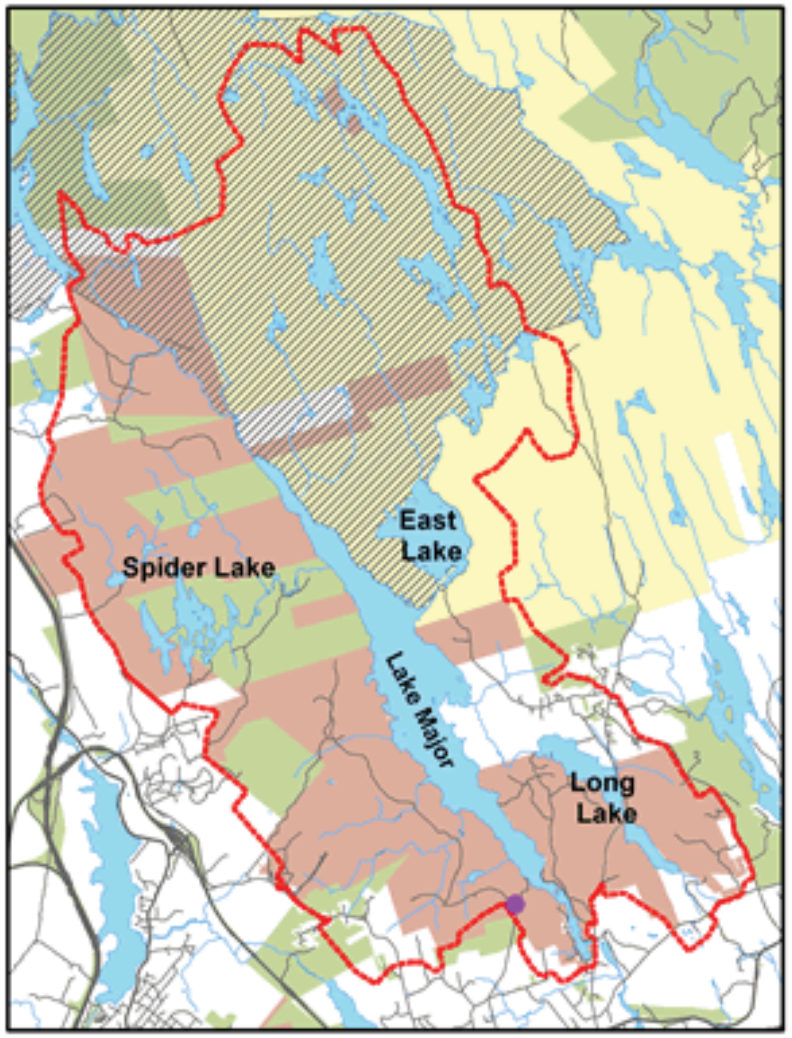
Consider Lake Major

Dartmouth Water Supply



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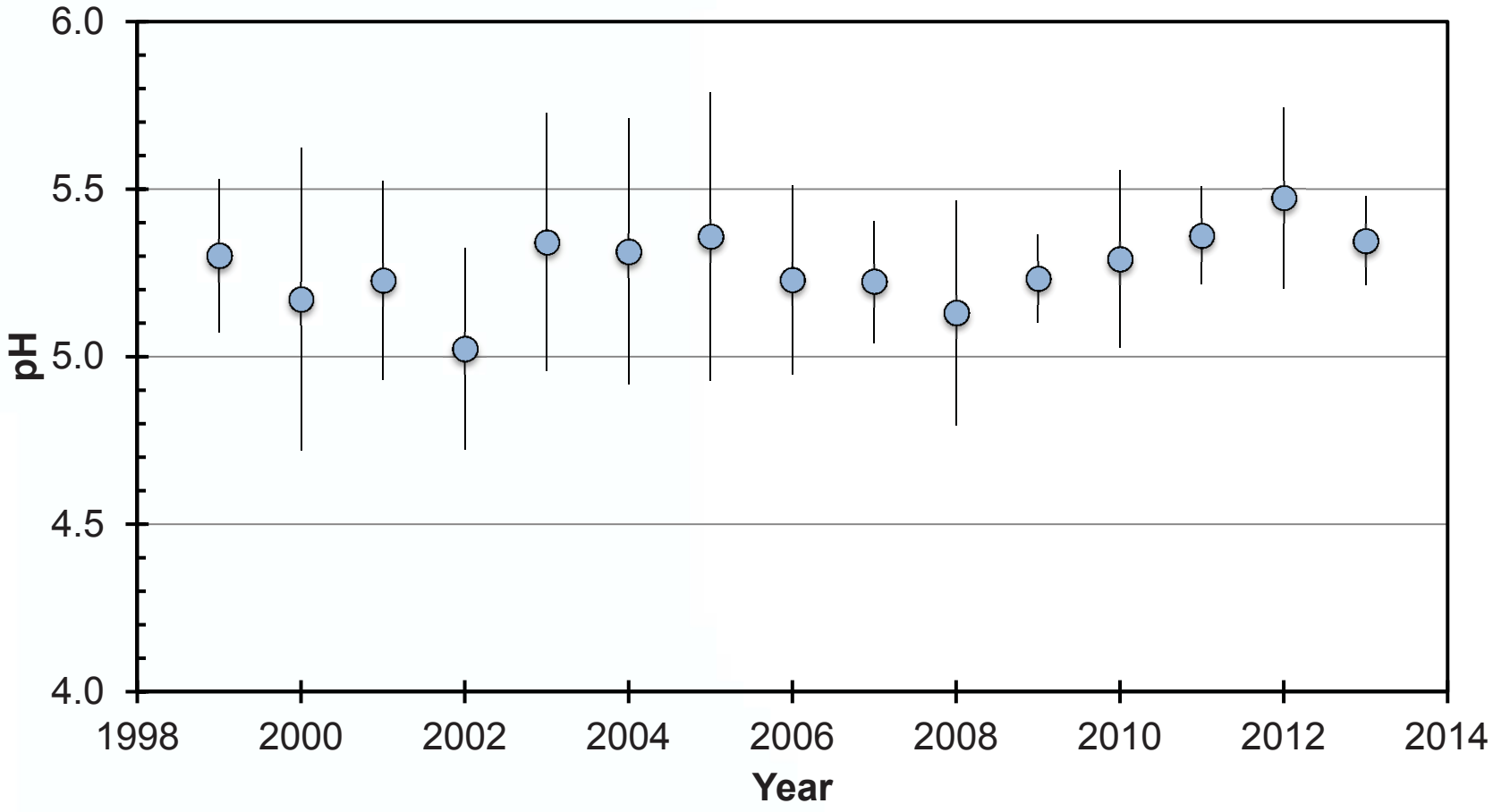
pH in Lake Major



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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*

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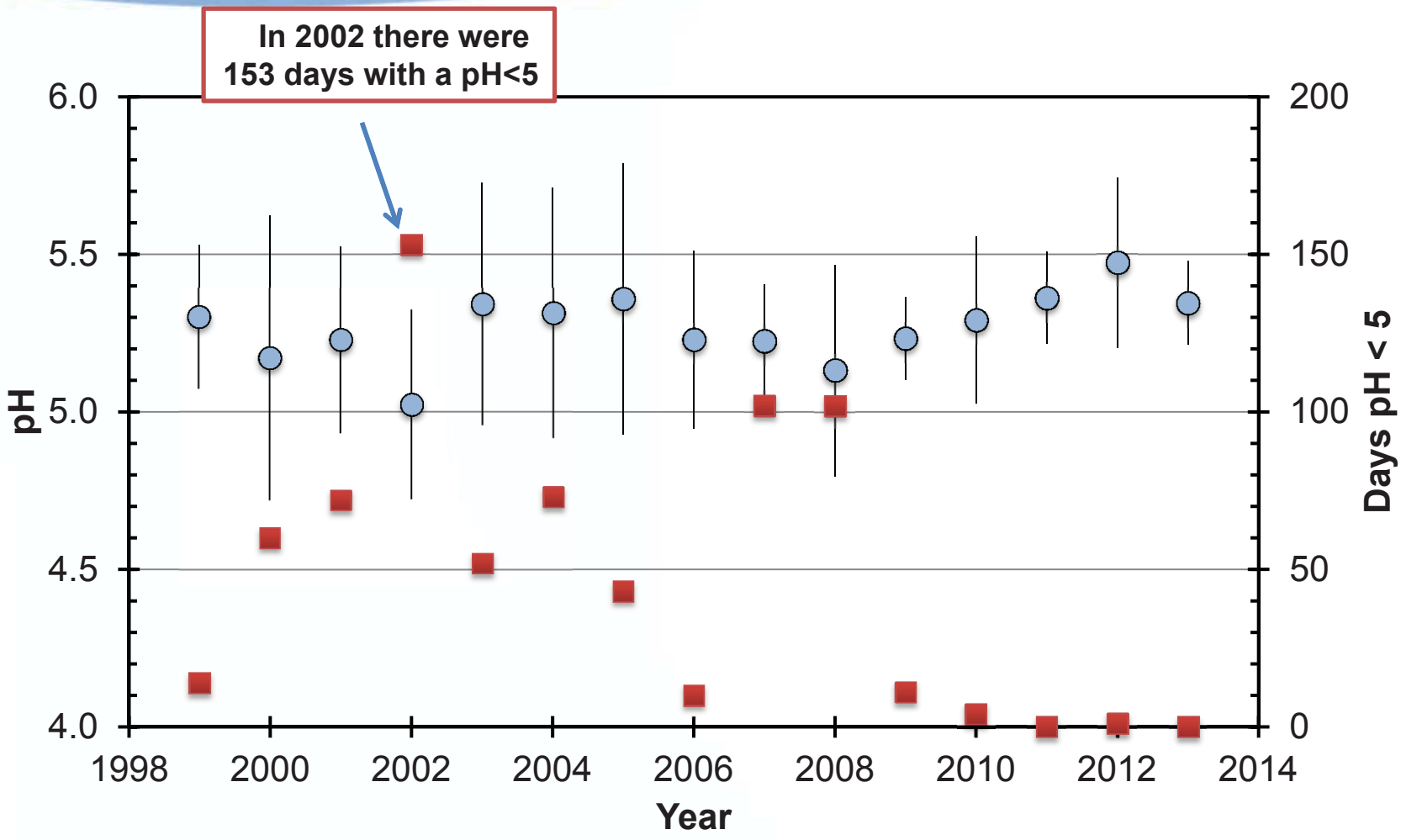
Number of Days Where pH < 5



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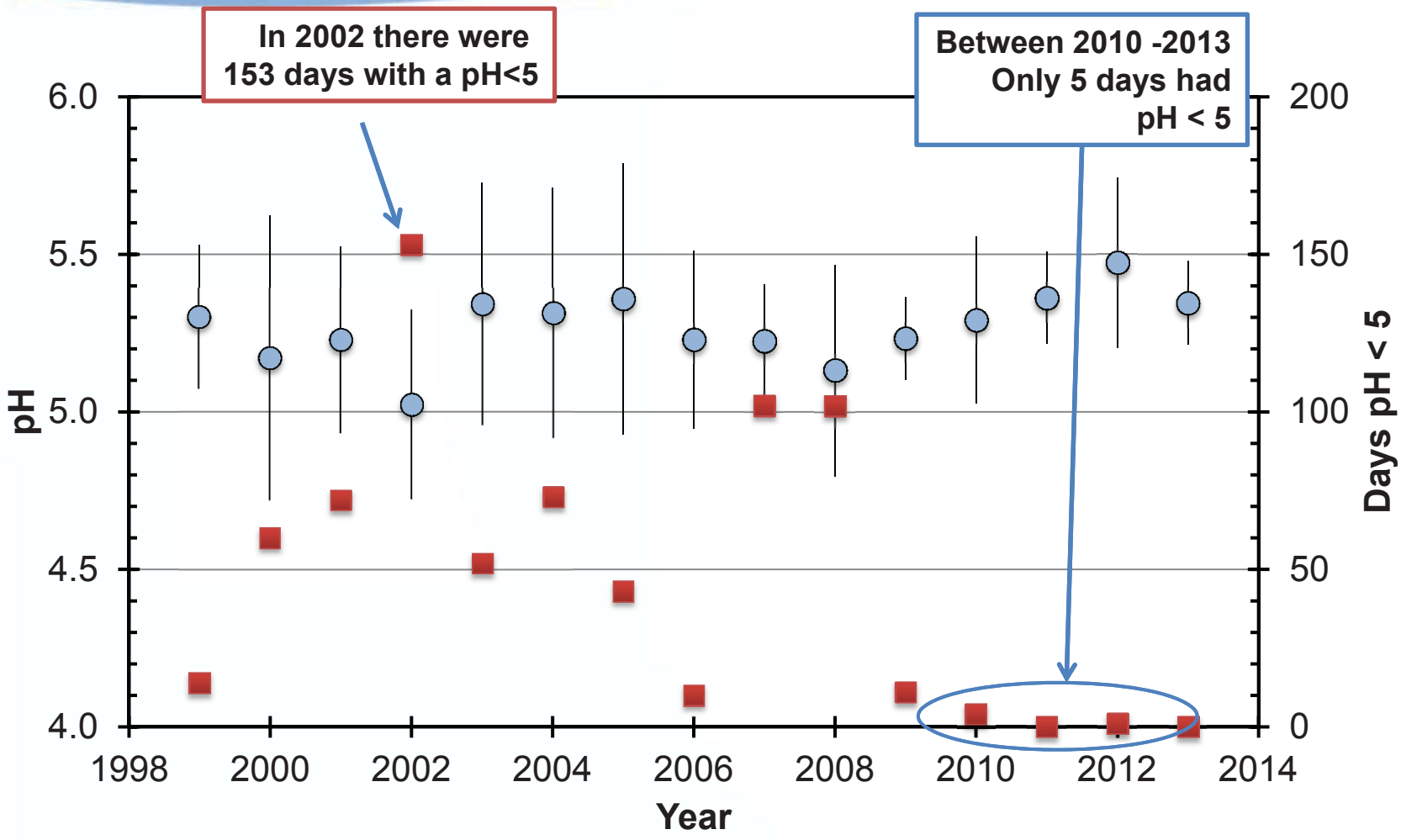
Number of Days where pH < 5



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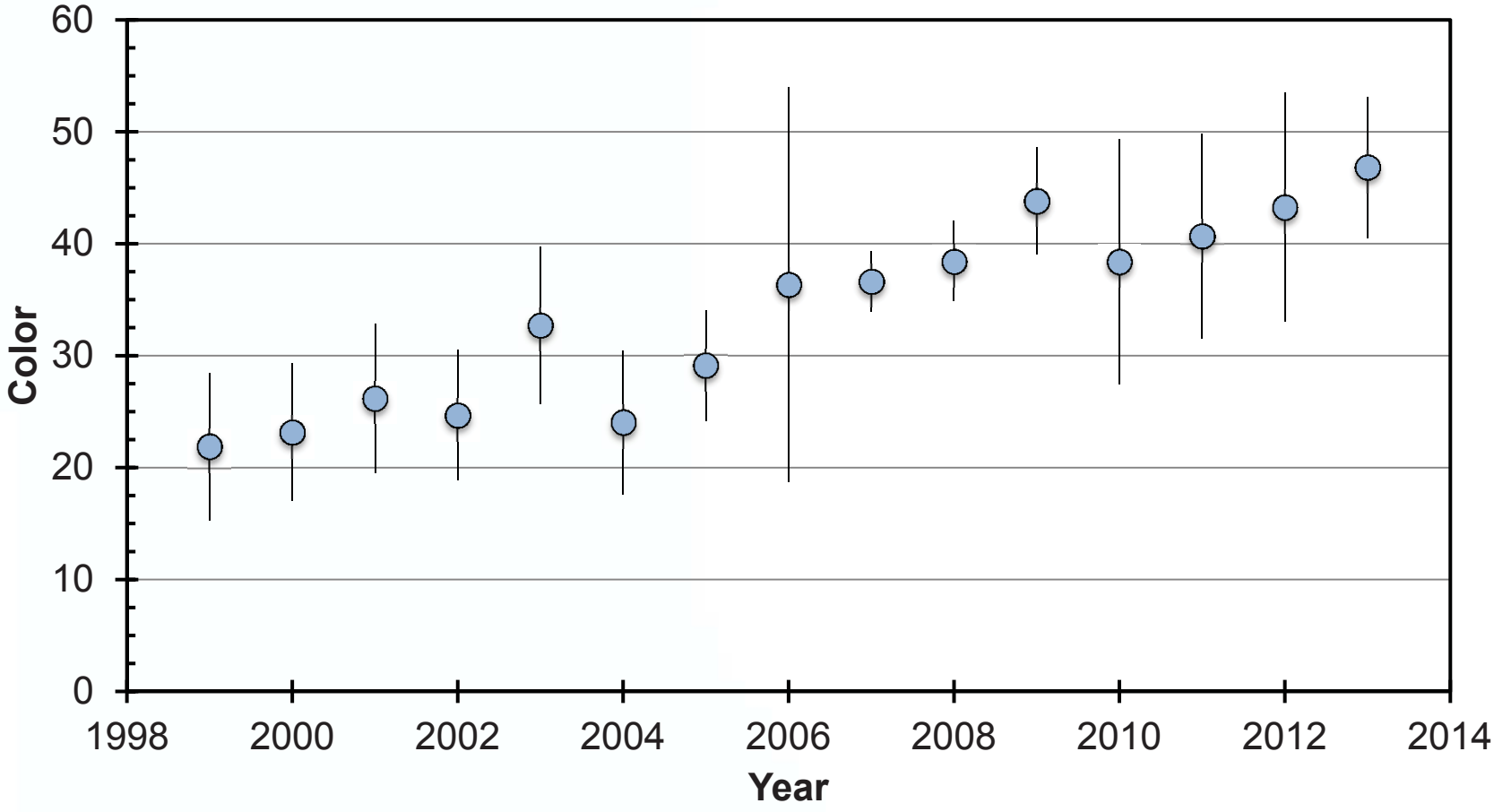
Color in Lake Major

An Approximate Indicator of Organic Matter



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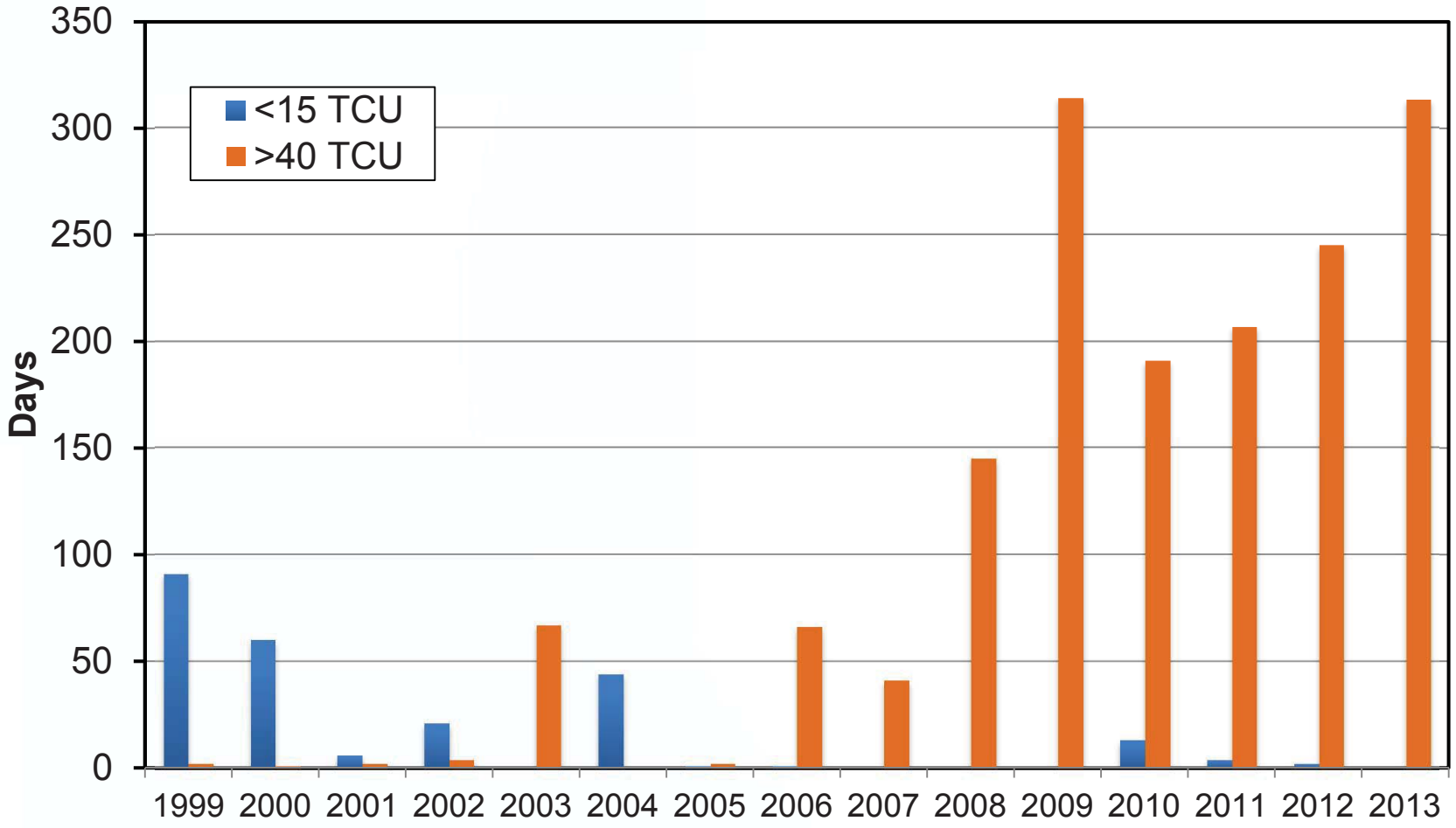
Color Analysis

- **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



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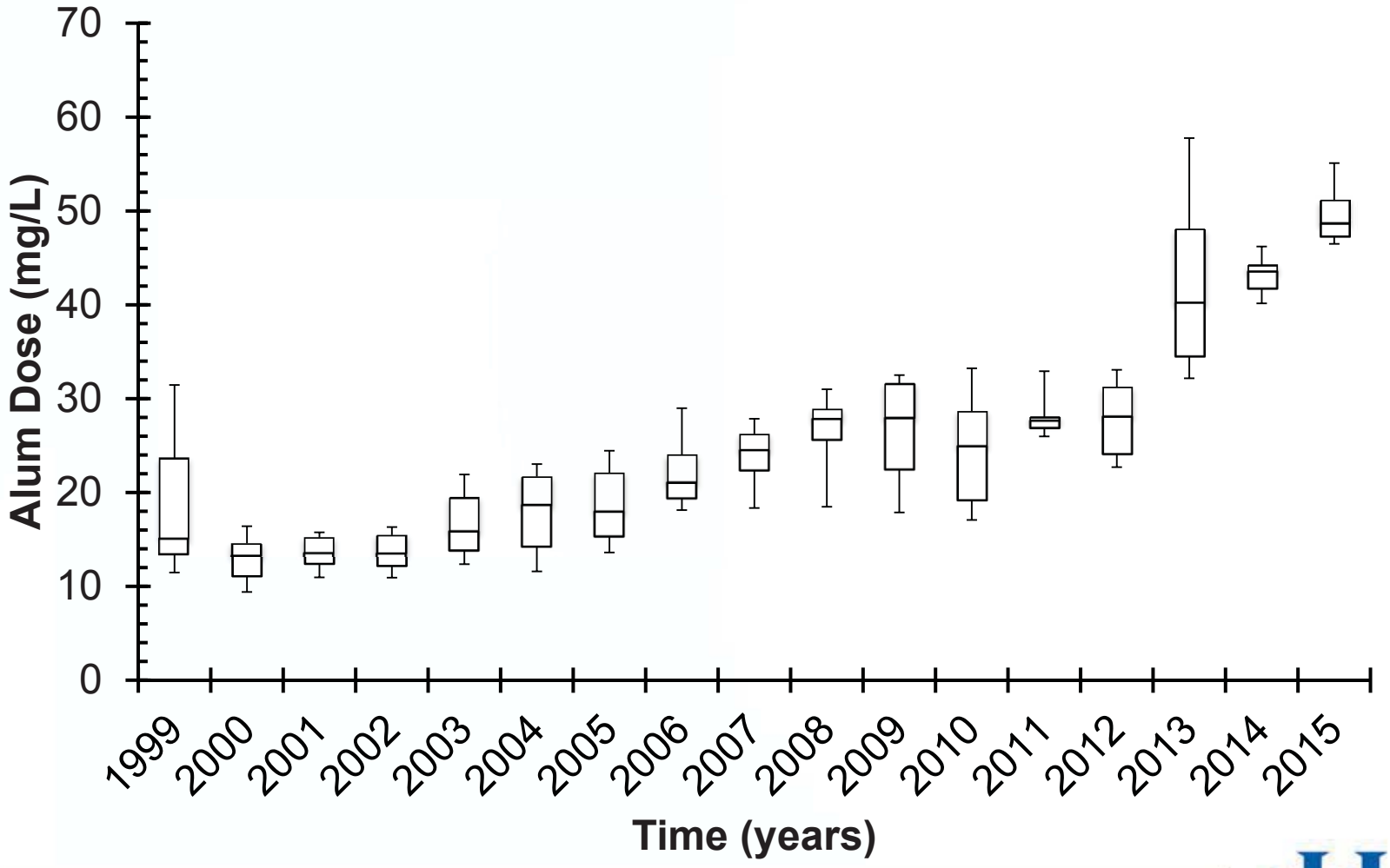
What Impact Has Color Had on Operations?



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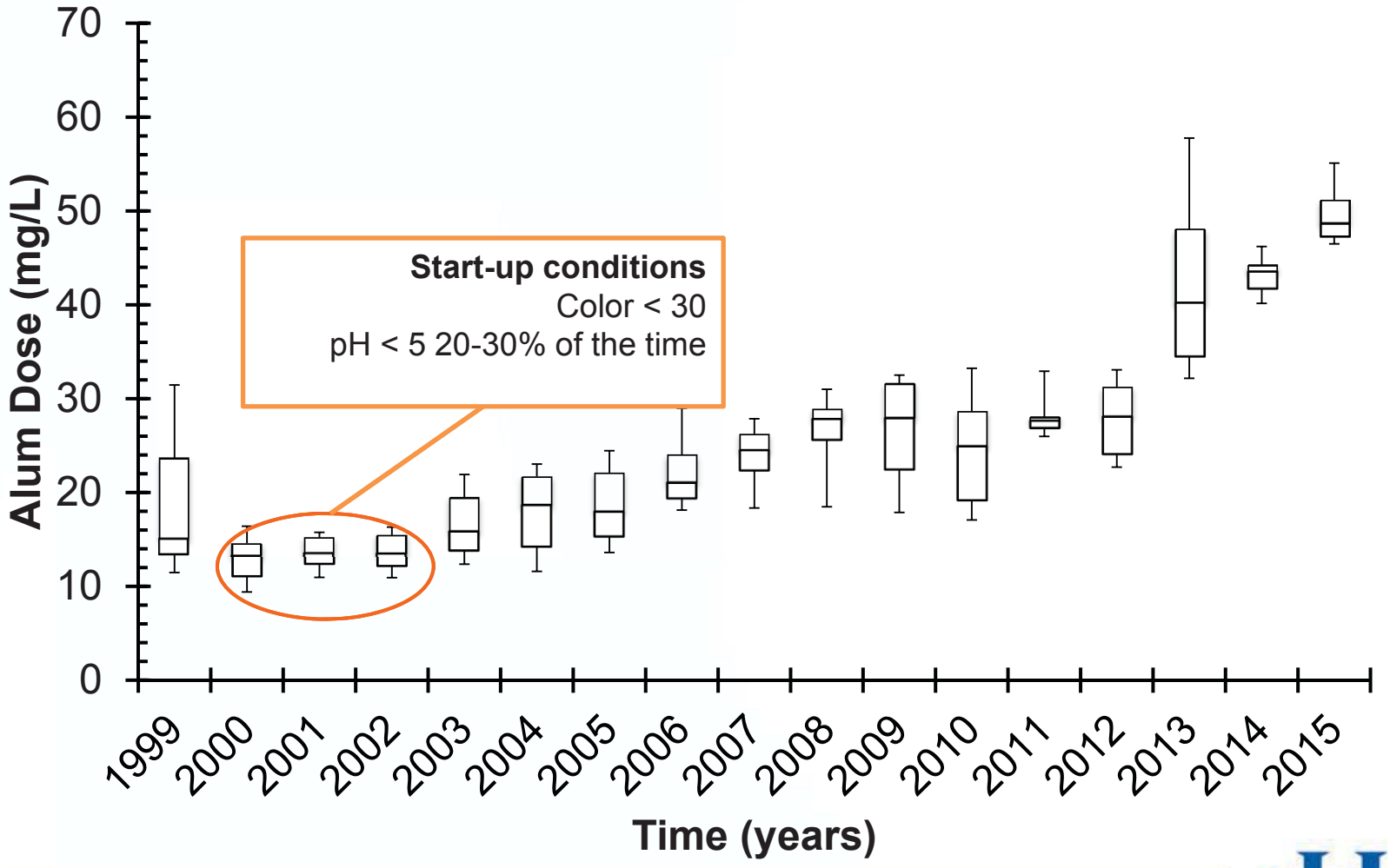

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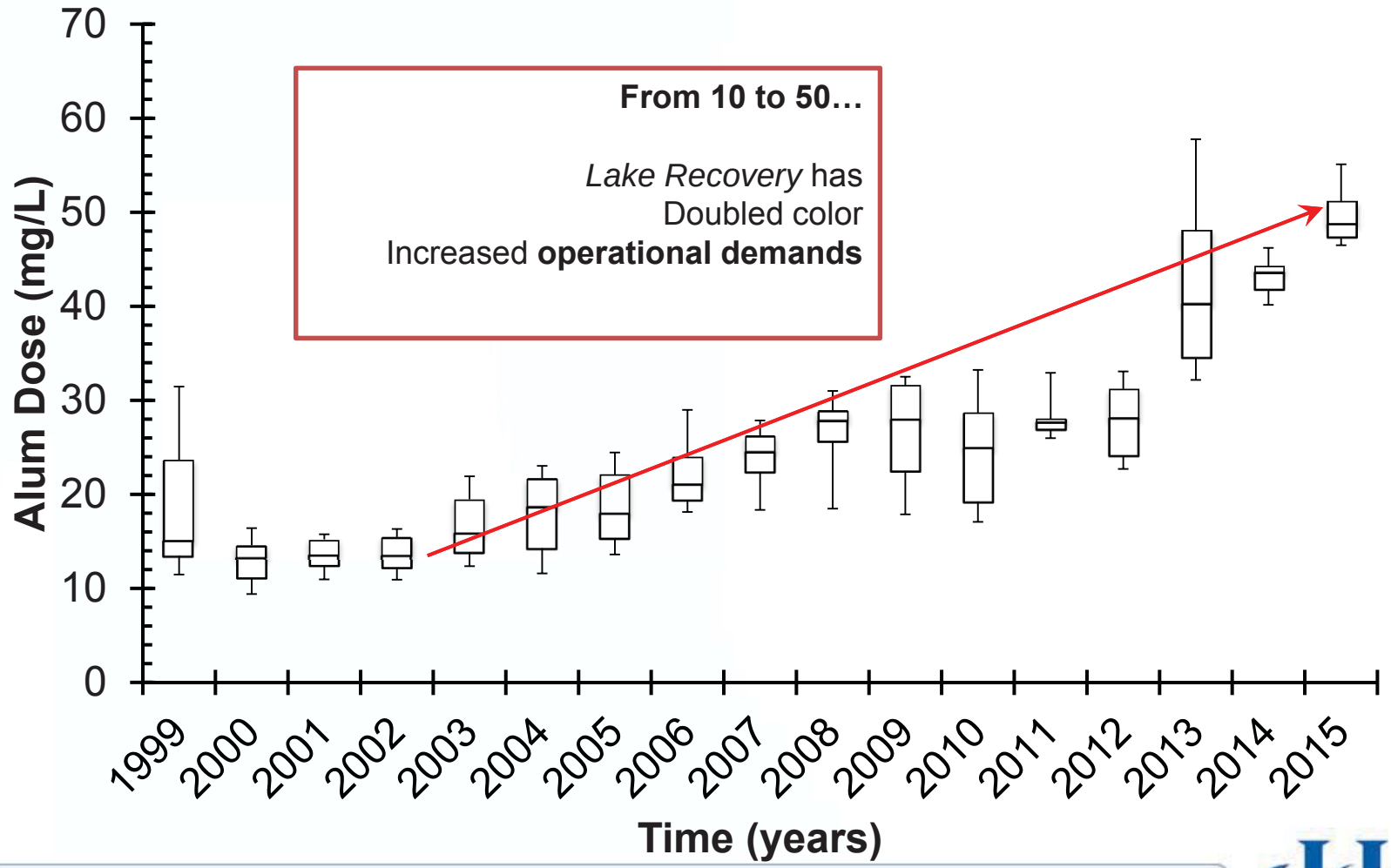
What Impact Has Color Had on Operations?



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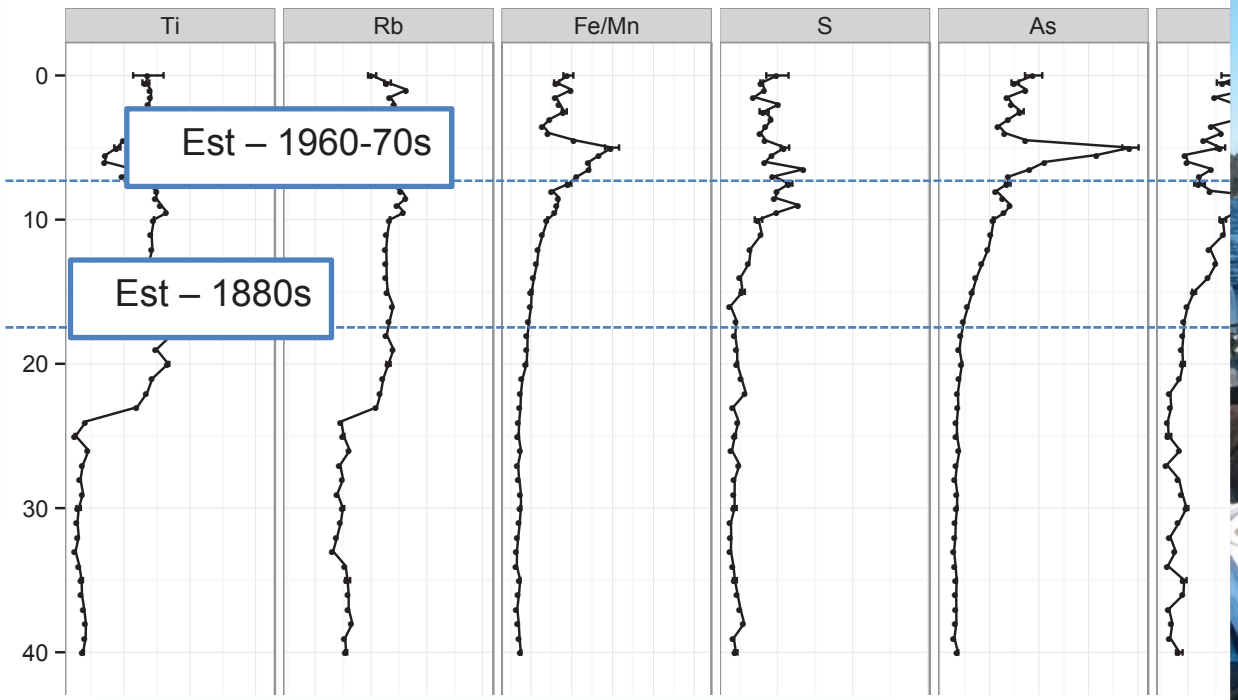
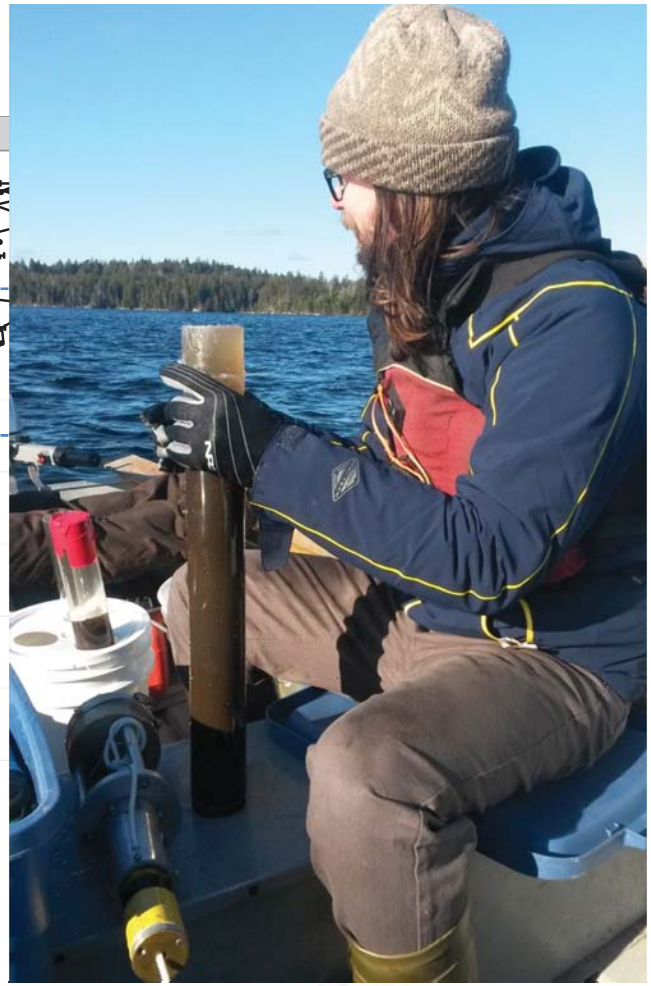
On-Going Sediment Research

Dr. Ian Spooner, Acadia University





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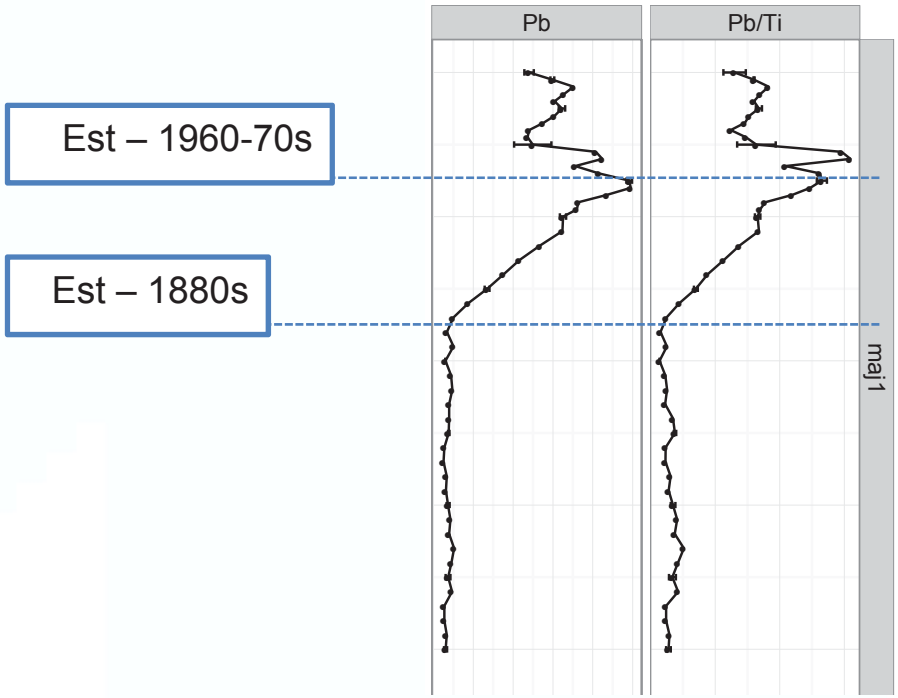
On-Going Sediment Research

Atmospheric deposition is reflected in the Sediment



1922 – Lead (Pb) was introduced to gasoline

1970 – Nixon introduced Clean Air Act – Pb controls introduced

1990 – Clean Air Act amended to ban Pb in gasoline

2008 – Pb emission standards reduced by EPA (coal plants are a key target)

2015 – Ontario bans electricity from coal

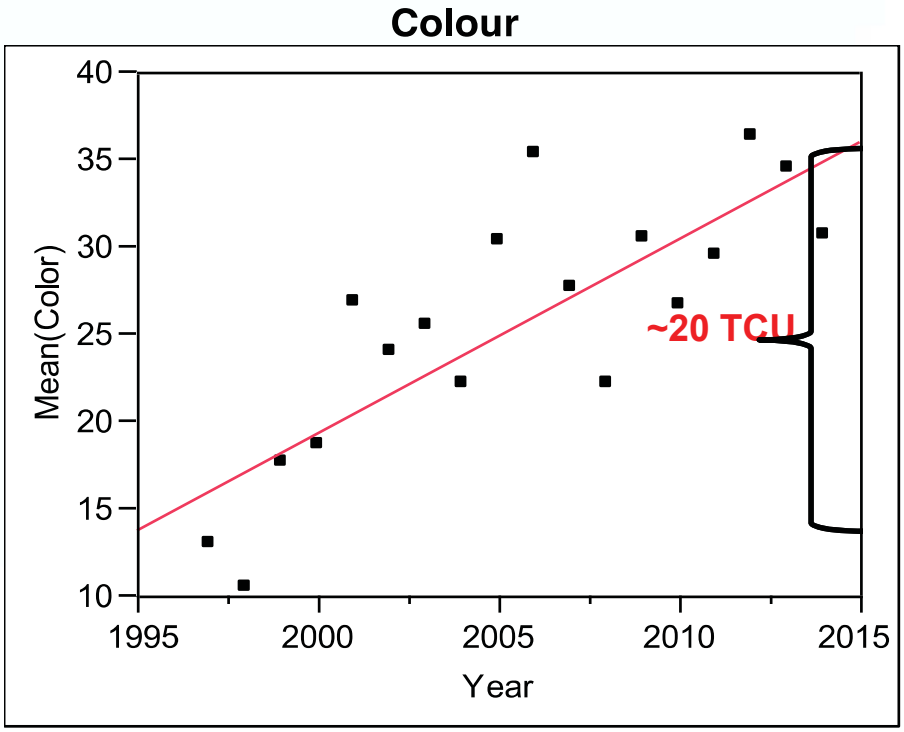
Halifax Water

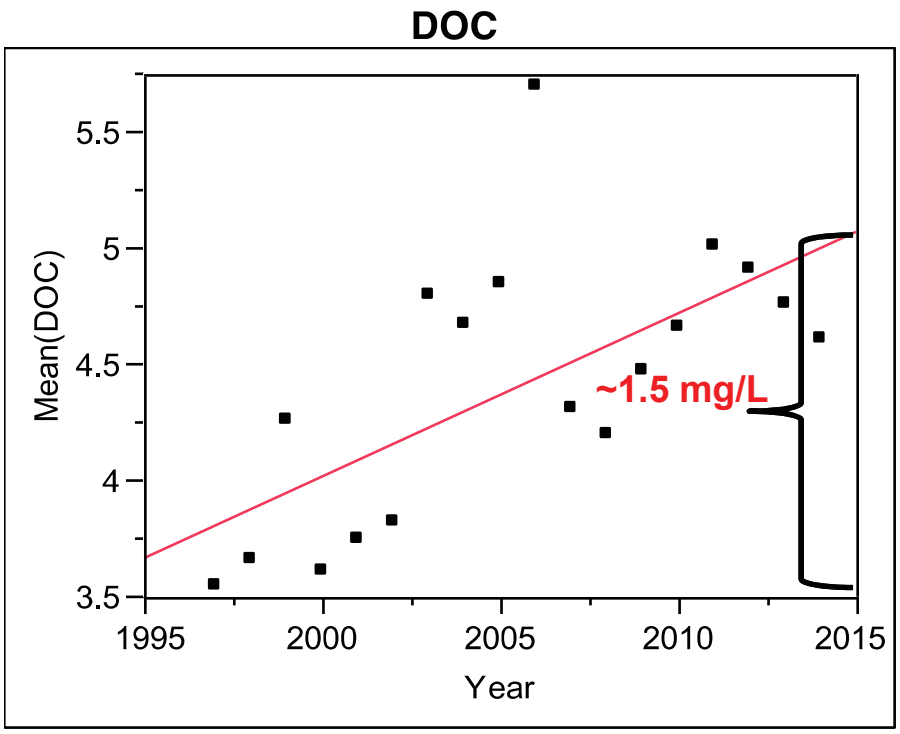
Elsewhere in NS… Lake George

King's County

Halifax Water

Lake George, NS

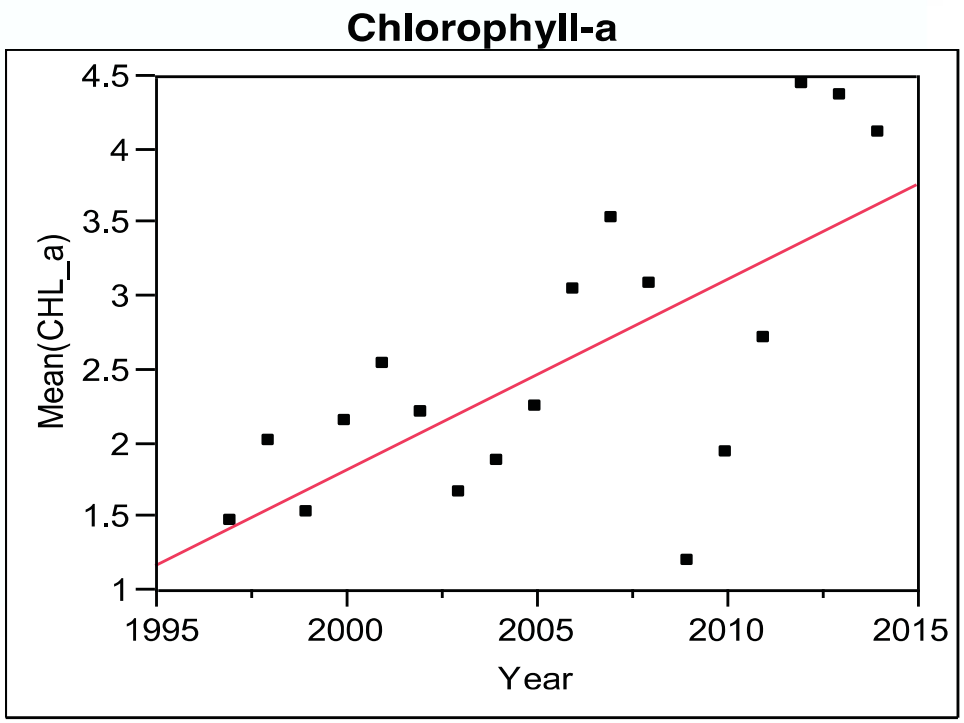


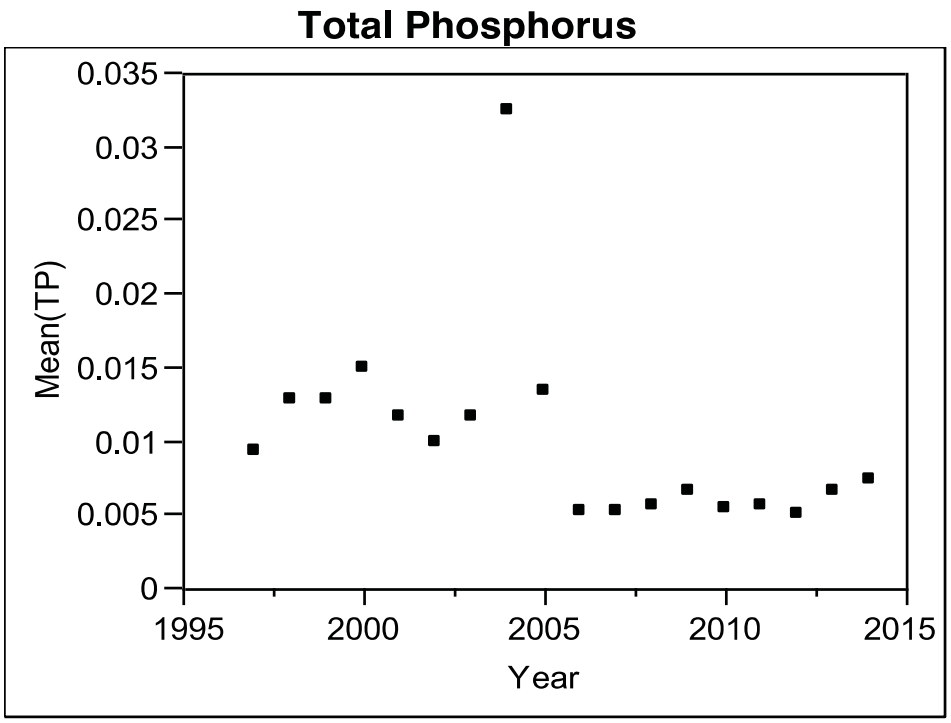


Source: *http://www.countyofkings.ca/residents/lakemon/archives.aspx*

Halifax Water

Lake George, NS





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

Halifax Water

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*

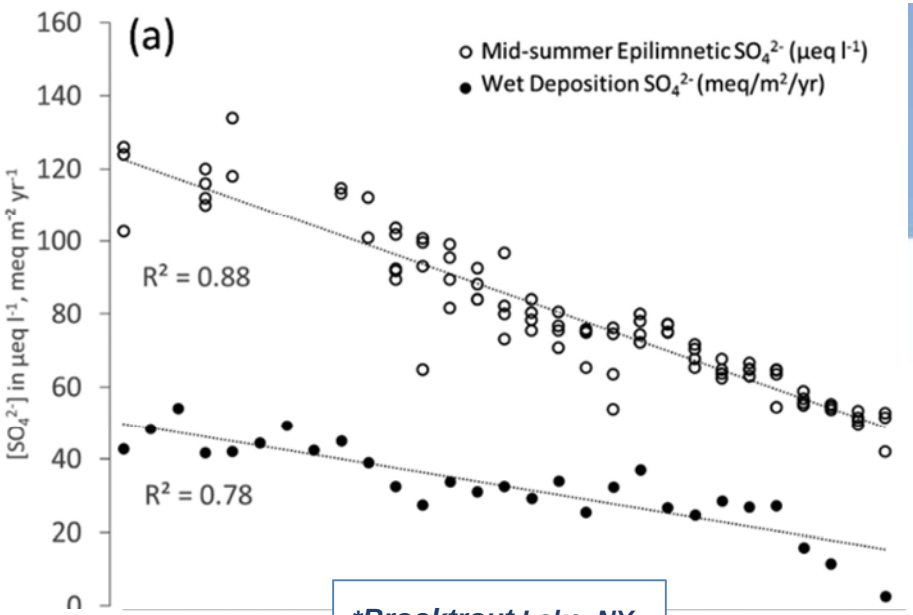
Lake Torment
Source: *CBC news, Aug 14, 2015*

Halifax Water

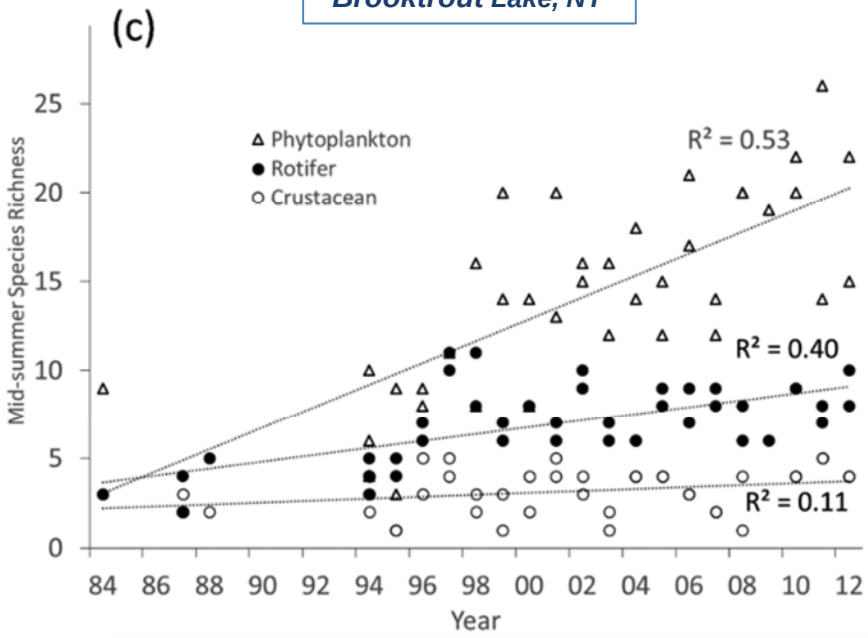
Brooktrout Lake, NY

Photo credit: Dave Winkler, DFWI RPI 2015.

Halifax Water



*Brooktrout Lake, NY



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

Decreased SOx …

Increased ***phytoplankton…***

Did this influence geosmin occurrence in Pockwock Lake??

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 Opportunity at Lake Major**
    - ✓ 2015 Optimization Study

Halifax Water

NSERC Industrial Chair in Drinking Water Treatment

- **Established in 2006 between Dr. Graham Gagnon at Dalhousie University and Halifax Water**

- **Chair renewal in 2011 added new partners:**

Halifax Water

Questions or Comments?