Ministry of the Environment, Conservation and Parks

Mining the value from our long-term water quality monitoring network in Ontario

Georgina Kaltenecker

November 19, 2019

Latornell Conservation Symposium

Ontario

Outline

- Importance of monitoring
- The Provincial Water Quality Monitoring Network (PWQMN)
- Mining the value, a.k.a. case studies in applications of PWQMN data
- Need for continued monitoring

Importance of monitoring

Importance of water quality monitoring

"The overall objective of water quality monitoring programs is to **inform Canadians about the suitability of water for various beneficial uses** in both the spatial and temporal domains."

"Water quality monitoring is **one of the most important components in environmental management of aquatic ecosystems**."

"Monitoring of water quality in Canada **provides water managers with the necessary information for sustainable water resources management** and provides insight into complex dynamic environmental processes. Reliable, consistent and appropriate information is necessary to understand Canada's water resources."

Canadian Council of Ministers of the Environment. (2015). *Guidance manual for optimizing water quality monitoring program design*

Importance of long-term monitoring

"The only way to figure out what is happening to our planet is to measure it, and this means tracking changes decade after decade and poring over the records." (Keeling, 2008)

MacDonald et al. (2008) state that long-term monitoring is needed:

- to determine when human activities are adversely affecting water quality conditions
- to determine when management intervention is required
- and to evaluate efficacy of management actions

Keeling, R.F. (2008). Recording Earth's vital signs. *Science, 319*, 1771-1772

MacDonald, D.D., Clark, M.J.R., Whitfield, P.H., & Wong, M.P. (2008). Designing monitoring programs for water quality based on experience in Canada I. Theory and Framework. *Trends in Analytical Chemistry, 28(2)*, 204-213.

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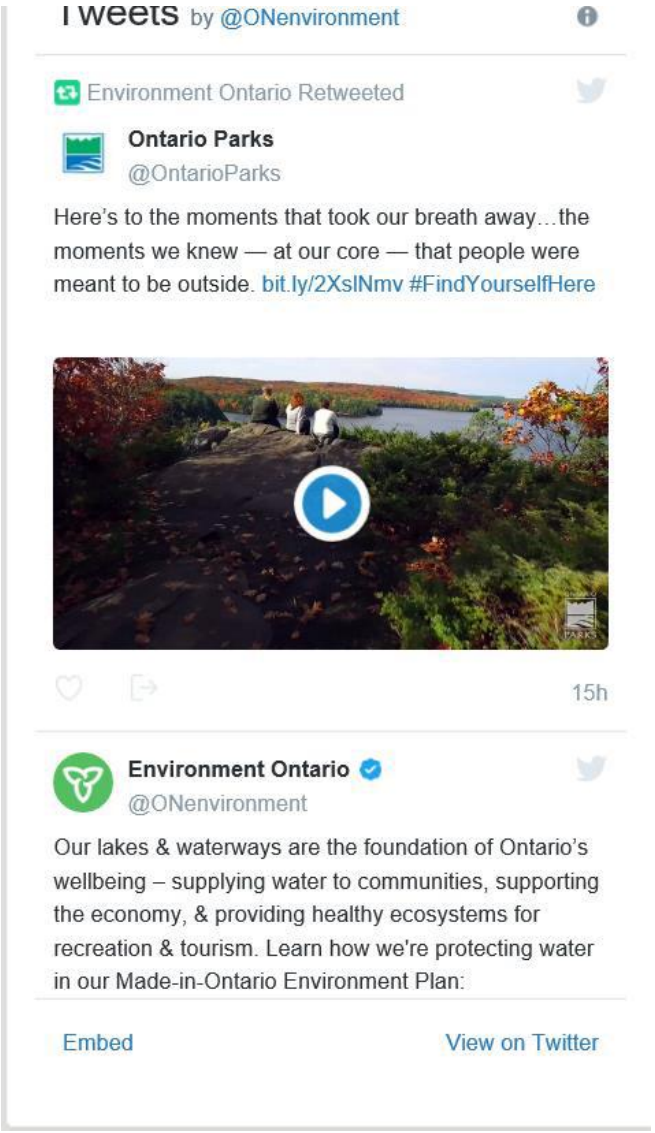
The value to us…

"Water quality affects people through numerous pathways, from drinking water to recreation to commercial fisheries"

"There are [also] nonuse values such as the intrinsic value of intact food webs or the cultural values associated with the existence of species or habitats that are difficult to quantify using economic tools…estimates suggest that these nonuse values make up a significant portion of total value"

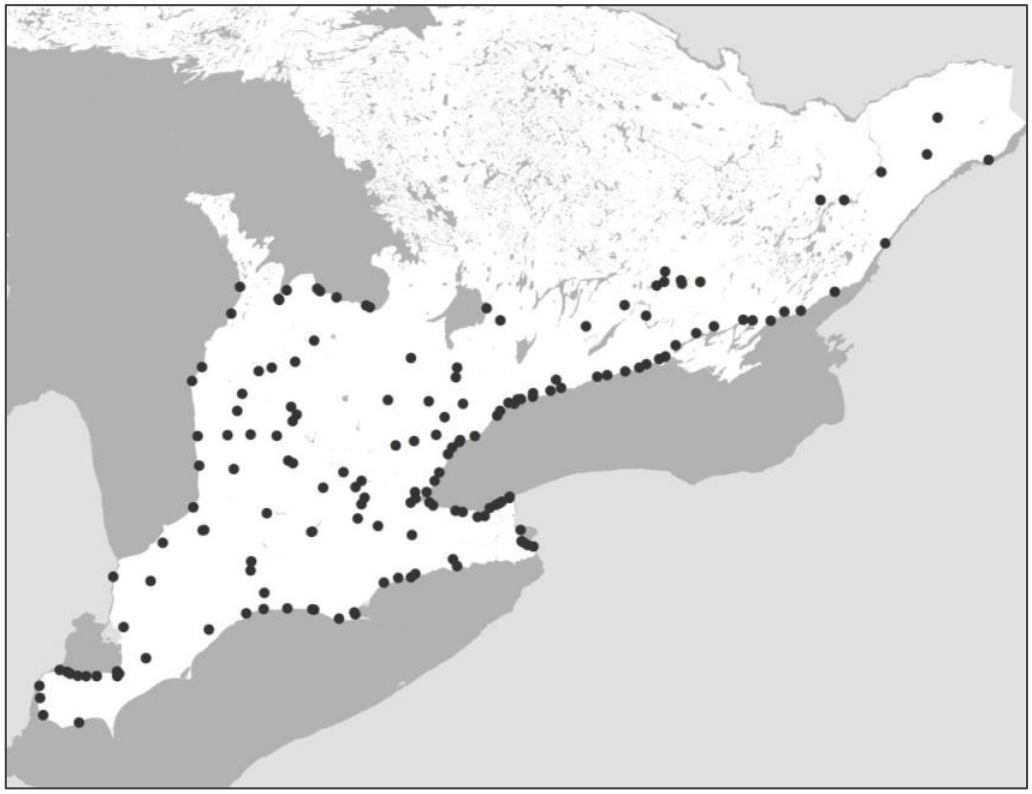


Keeler B.L., Polasky, S., Brauman, K.A., Johnson, K.A.,Finlay, J.C., O'Neill, A., Kovacs, K., Dalzell, B. (2012). Linking water quality and well-being for improved assessment and valuation of ecosystem services. *The Proceedings of the National Academy of Sciences, 109(45)*, 18619-18624

The Provincial Water Quality Monitoring Network (PWQMN) in Ontario

PWQMN - then

- The PWQMN began in July 1964 under the Ontario Water Resources Commission in collaboration with five Conservation Authorities
- The network began with 89 monitored streams and grew to 200 stations by the end of its first year
- Within the first two years, the number of participating Conservation Authorities had grown to 11



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INTRODUCTION

The data presented in this publication is part of a program which is designed to provide a near continuous record of basic water quality information at specific points on rivers and lakes in Ontario. This data is being made available to all those who need such information in their work and are directly concerned with the quality of surface water in Southern Ontario.

The water quality monitoring program includes routine collection of water samples at specific locations from key rivers and lakes and analysis for various constituents which are primarily of concern from a water use point of view.

Sampling stations were selected at points considered reasonably representative of the general condition of the body of water. As it is of great importance to relate quality data with flow conditions, the sampling stations were located, where practicable, in the vicinity of recording gauging stations maintained by the Department of Northern Affairs and National Resources. In addition, a program was initiated for the installation of staff gauges near sampling stations where no recording gauging stations exist. At the end of the 1965 water year, nine staff gauges had been installed by the Division of Water Resources.

Analysis of samples included some or all of the following parameters: Total coliforms, biochemical oxygen demand, solids (total, suspended, and dissolved), turbidity phosphorus (total and soluble), nitrogen (free ammonia, total Kjeldahl, nitrite, and nitrate), chlorides, hardness, alkalinity, pH, iron, phenol, dissolved oxygen, alkyl benzene sulfonate, and conductivity.

The water quality monitoring program was started in July 1964 with 89 streams. By the end of the 1964-65 water year (September 30th, 1965), the program was expanded to include a total of 156 rivers and 210 sampling stations.

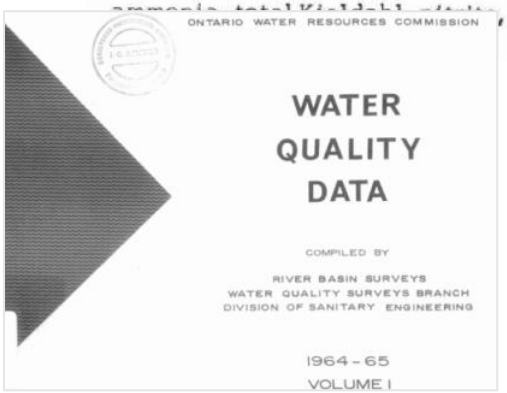
The Commission initiated co-operative water quality studies with the Conservation Authorities in Ontario.

The following Conservation Authorities participated in the collection of water samples in 1964-65 water year:

Credit Valley Conservation Authority
Halton Region Conservation Authority
Maitland Valley Conservation Authority
Moira River Conservation Authority
Spencer Creek Conservation Authority

The drainage basins in Southern and Eastern Ontario contributing to the Great Lakes and the St. Lawrence River are shown in the figures following this introduction.

This initial publication of water quality data covers heavy water use areas in the Southern and Eastern parts of the Province. Subsequent annual publications will include quality data on streams in the Northern parts of the province.



From the archives:
First report on PWQMN water quality data

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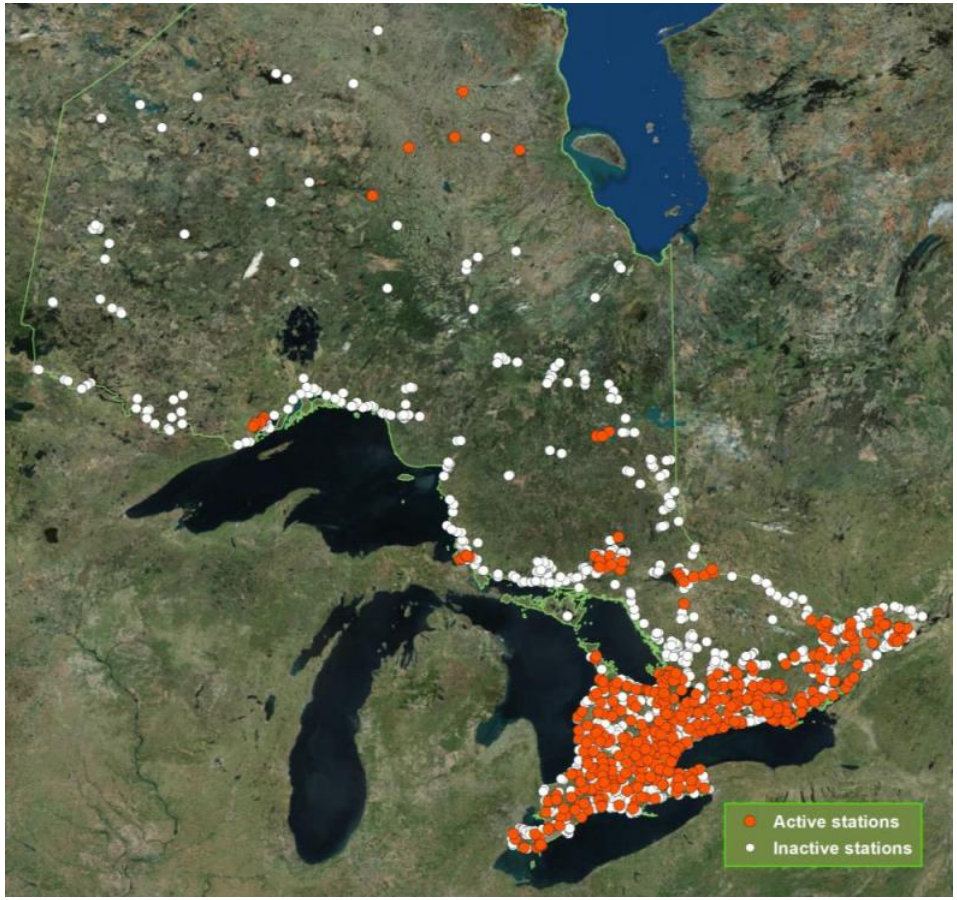
PWQMN - now



- Over 2,000 locations have been monitored in Ontario
  - Of which, 437 are currently active
- 38 partner agencies including conservation authorities, Severn Sound Environmental Association, Water Survey Canada
- > 3,000 samples collected annually across the province
- Limited winter sampling introduced 3 years ago
- Continuous sensors deployed at a few sites

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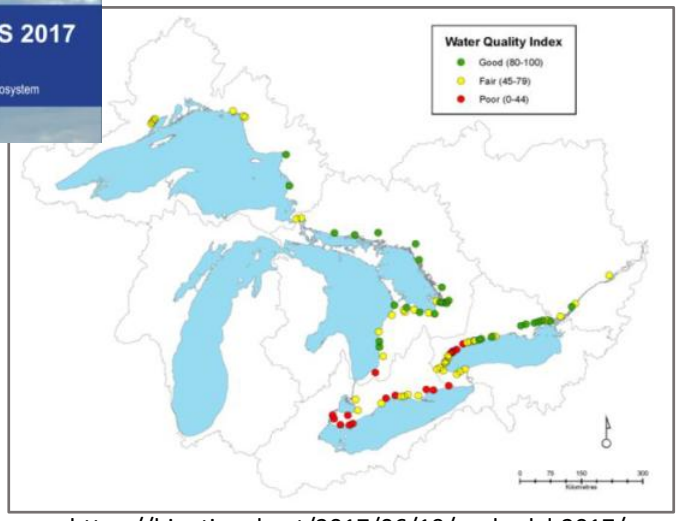
Mining the value

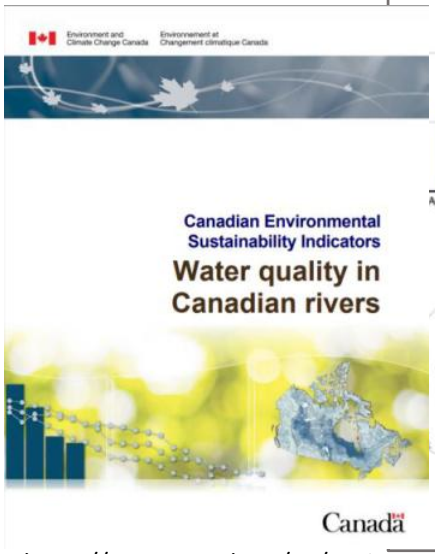
Quality of our water resources – rivers and streams

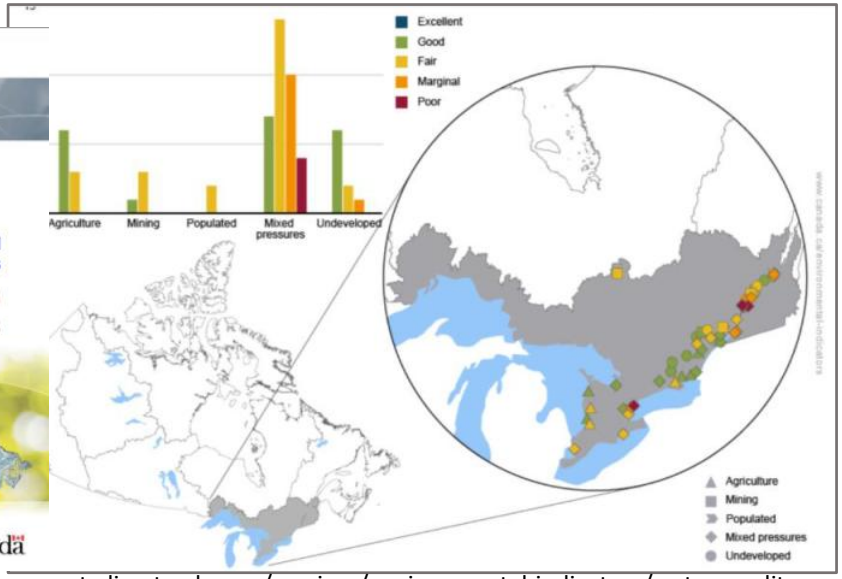
"The overall objective of water quality monitoring programs is to inform Canadians about the suitability of water for various beneficial uses in both the spatial and temporal domains… Canadians want to know if their water is clean and safe to use (i.e., is it swimable, fishable?)…" CCME 2006

Water Quality Index (WQI) for Ontario tributaries to the Great Lakes



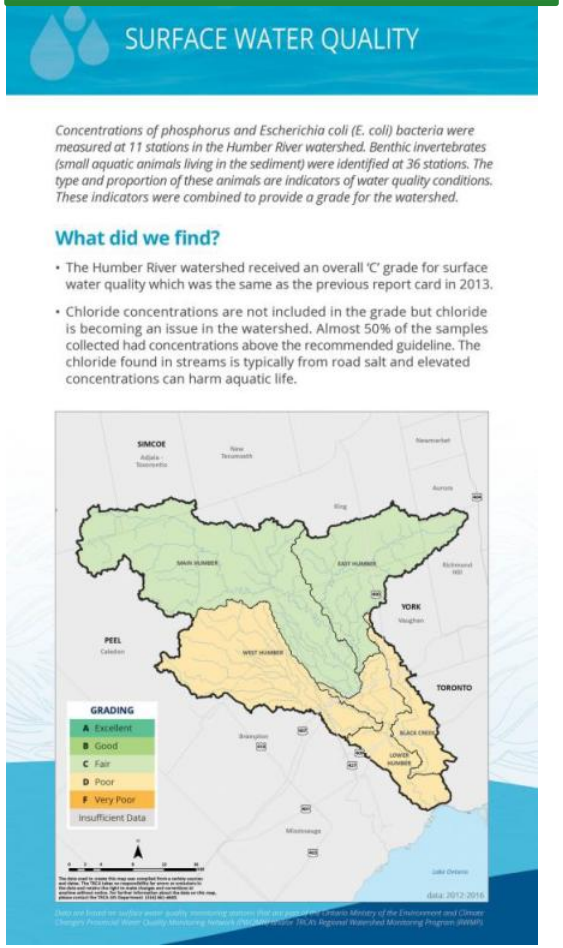
https://binational.net/2017/06/19/sogl-edgl-2017/





https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/water-quality-canadian-rivers.html

Humber River Watershed Report Card 2018
Toronto and Region Conservation Authority



https://reportcard.trca.ca/watershed-report-cards/humber-river/#surface-water

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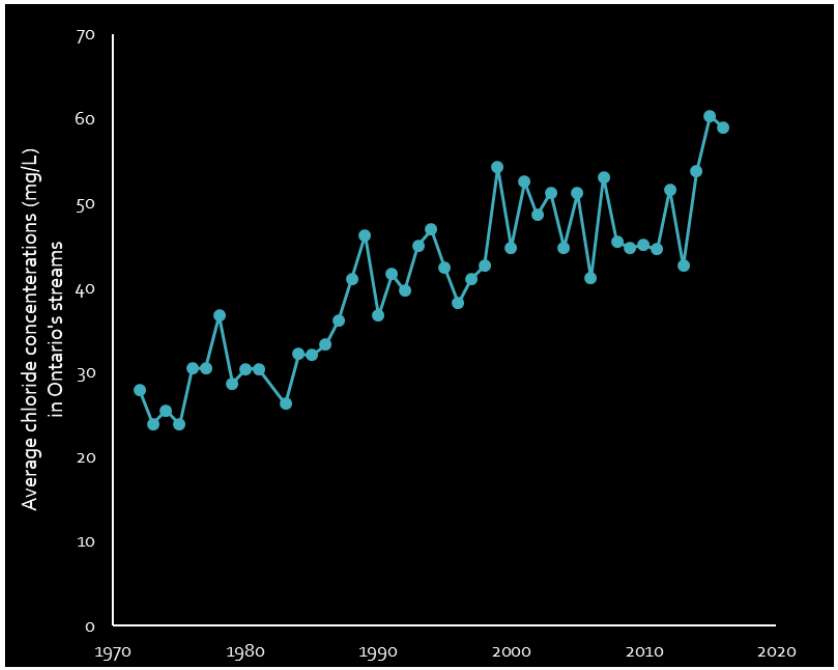
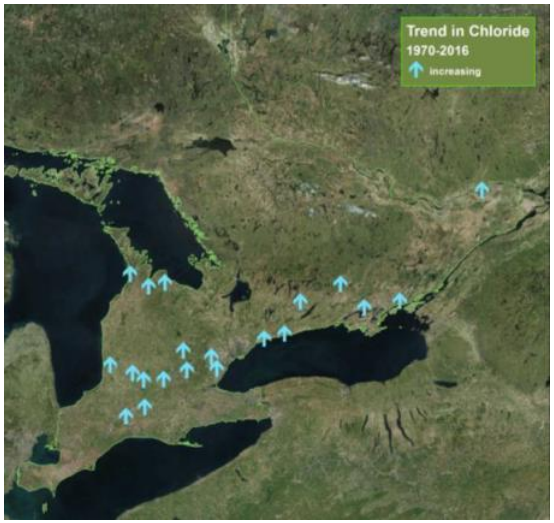
“Is it getting better or worse?”

“Canadians want to know if … water quality is getting better or worse (i.e., trends).” CCME 2006



Updated from Water Quality in Ontario Report (2010)



Latornell Conservation Symposium 2017


Contents lists available at SciVerse ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Warm season chloride concentrations in stream habitats of freshwater mussel species at risk

Aaron K. Todd*, M. Georgina Kaltenecker


Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Increasing nitrate concentrations in streams draining into Lake Ontario

M. Catherine Eimers *, Shaun A. Watmough


Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Long-term decline in stream total phosphorus concentrations: A pervasive pattern in all watershed types in Ontario

Katie L. Stammler [a,*], William D. Taylor [a], Mohamed N. Mohamed [b]

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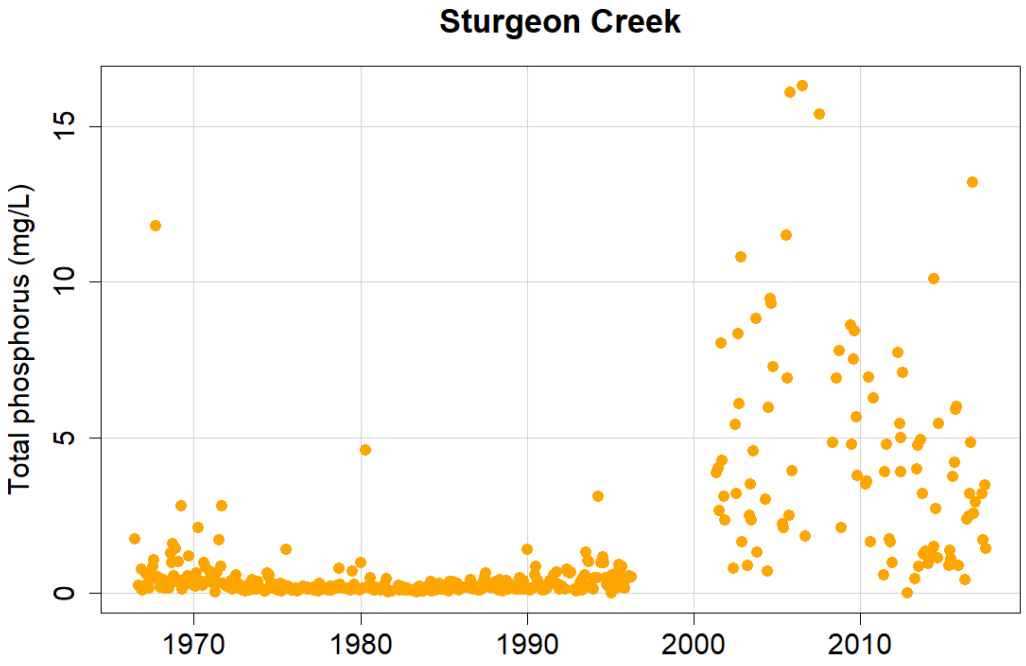
Identifying issues and need for action/additional monitoring



- Long term monitoring was instrumental in highlighting issue at Sturgeon Creek
- Prompted intensive monitoring study to determine source of increased nutrients
  - greenhouses

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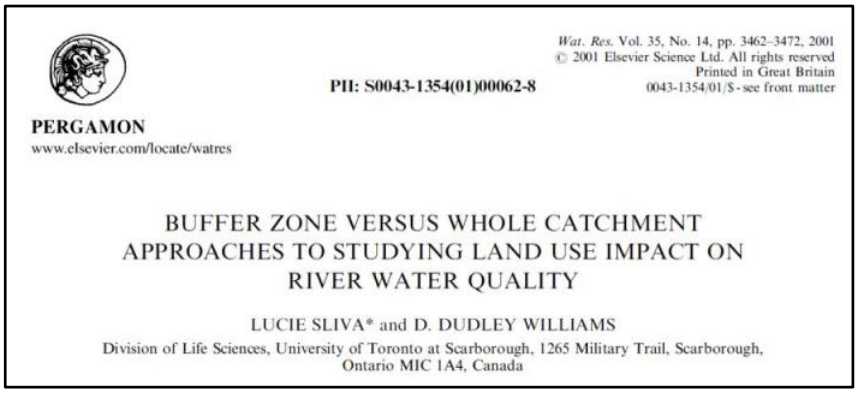
Landscape – water quality link



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0043-1354/01/$ - see front matter

BUFFER ZONE VERSUS WHOLE CATCHMENT APPROACHES TO STUDYING LAND USE IMPACT ON RIVER WATER QUALITY

LUCIE SLIVA* and D. DUDLEY WILLIAMS
Division of Life Sciences, University of Toronto at Scarborough, 1265 Military Trail, Scarborough, Ontario MIC 1A4, Canada

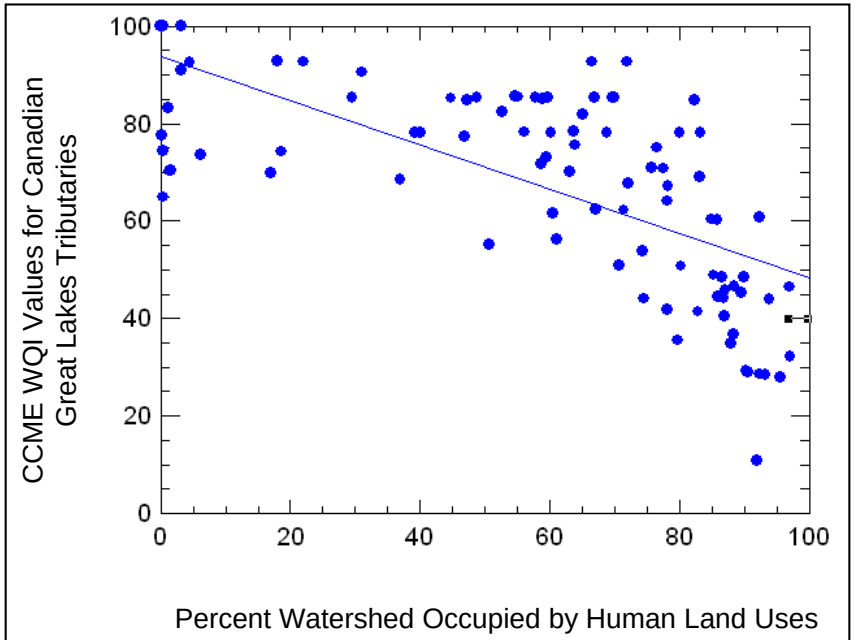
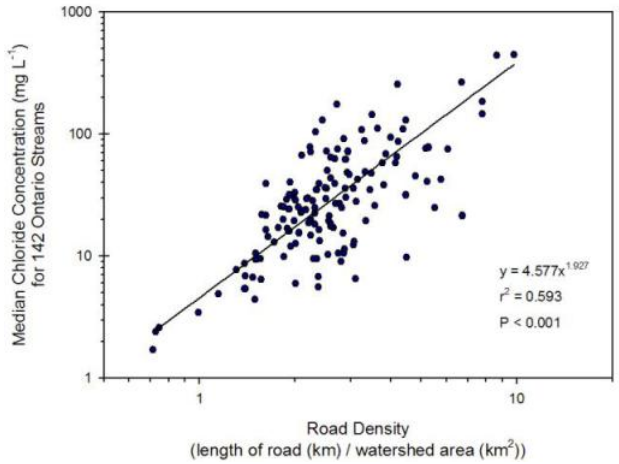


Figure 3. CCME Water Quality Index (WQI) values for Canadian Great Lakes tributaries (n=92) versus percent watershed occupied by human land uses.

State of the Great Lakes 2017 Report

https://binational.net/2017/06/19/sogl-edgl-2017/

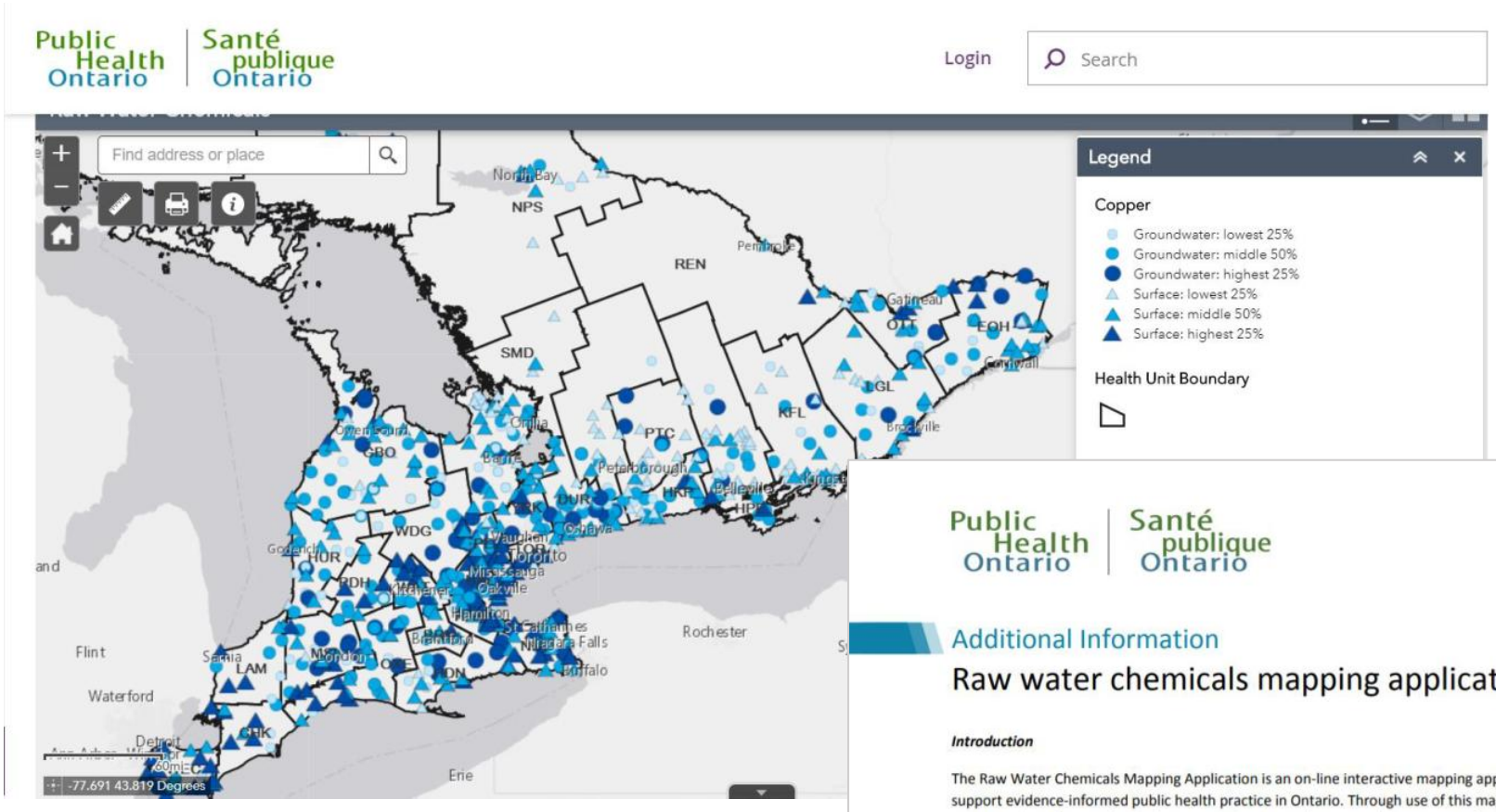
Median Chloride Concentration versus Road Density (2004-2008)



Todd, A.T., & Kaltenecker, M.G. (2012). Warm-season chloride concentrations in stream habitats of freshwater mussel species at risk. *Environmental Pollution, 171,* 199-206

Ontario

Informing small drinking water systems risk assessments



https://www.publichealthontario.ca/en/data-and-analysis/commonly-used-products/maps/raw-water-chemicals

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Monitoring – policy link

Journal of Great Lakes Research 42 (2016) 1151–1165

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Total and soluble reactive phosphorus loadings to Lake Erie
A detailed accounting by year, basin, country, and tributary

Matthew J. Maccoux [a,*], Alice Dove [b], Sean M. Backus [b], David M. Dolan [c,1]

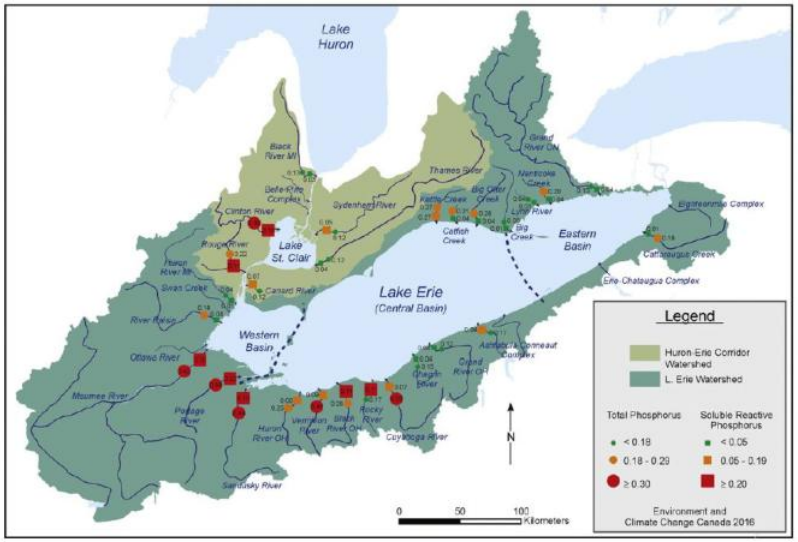

Fig. 7. Mean flow-weighted mean concentrations (mg/L) for total phosphorus (2003–2013) and soluble reactive phosphorus (2009–2013) in Lake Erie tributaries.

Great Lakes Water Quality Agreement

Protocol Amending the Agreement Between Canada and the United States of America on Great Lakes Water Quality, 1978, as Amended on October 16, 1983, and on November 18, 1987

Signed September 7, 2012
Entered into force February 12, 2013

Canada

ANNEX 4

NUTRIENTS

A. Purpose

The purpose of this Annex is to contribute to the achievement of the General and Specific Objectives of this Agreement by coordinating binational actions to manage phosphorus concentrations and loadings, and other nutrients if warranted, in the Waters of the Great Lakes.

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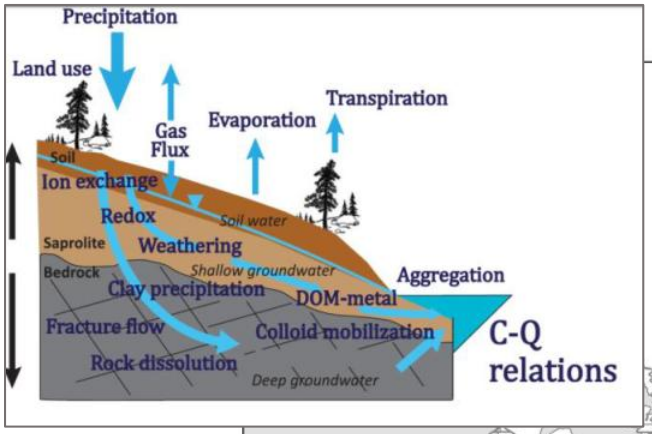
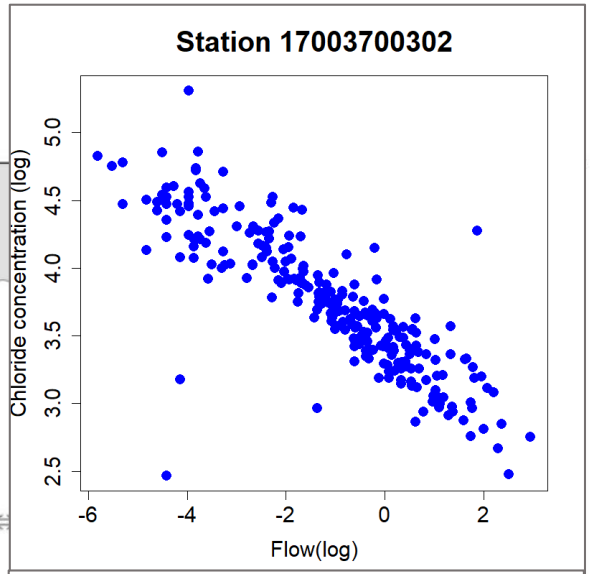
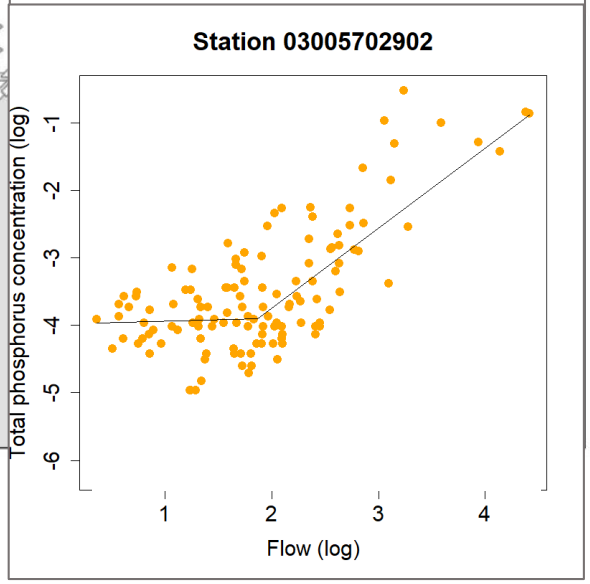
Understanding patterns in concentration-discharge (c-q) relationships*



Chorover et al., 2017





- Important for understanding magnitude & timing of concentrations -> climate change
- Important to understand if the nature of the c-q relationship changes at a certain flow threshold

* Research underway in collaboration with George Arhonditsis & Carl Mitchell, University of Toronto - Scarborough

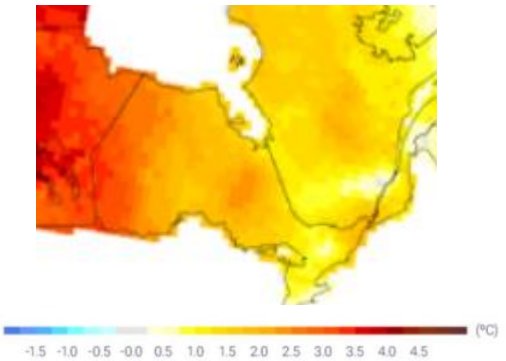
Ontario

Need for continued long-term monitoring

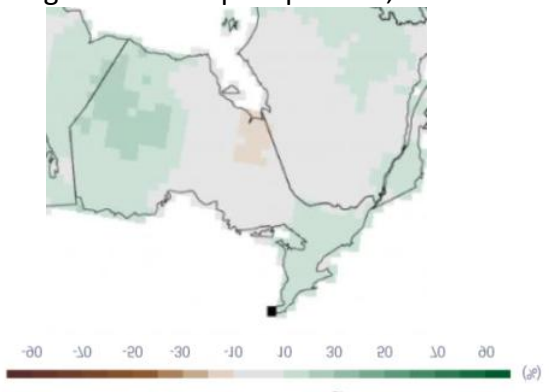
Why do we need continued, broad-scale (provincial), long-term water quality monitoring?

- Never underestimate the value of consistent monitoring over long time periods
- Uncertainty regarding future changes to water quality given:
  - Increasing human activities in watersheds
  - Changing climate
  - The complex interrelationships of water quality trends
- Continued long-term monitoring is crucial for understanding these changes and to inform management
- Need dedicated resources and collaborations to make it happen

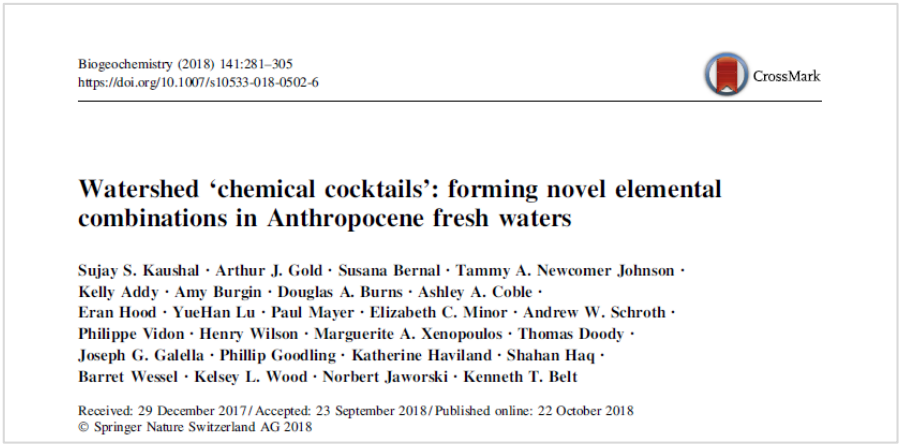
Trends in seasonal temperatures - winter



Changes in annual precipitation, 1948–2012



https://changingclimate.ca/CCCR2019/



Biogeochemistry (2018) 141:281–305
https://doi.org/10.1007/s10533-018-0502-6

CrossMark

Watershed 'chemical cocktails': forming novel elemental combinations in Anthropocene fresh waters

Sujay S. Kaushal · Arthur J. Gold · Susana Bernal · Tammy A. Newcomer Johnson · Kelly Addy · Amy Burgin · Douglas A. Burns · Ashley A. Coble · Eran Hood · YueHan Lu · Paul Mayer · Elizabeth C. Minor · Andrew W. Schroth · Philippe Vidon · Henry Wilson · Marguerite A. Xenopoulos · Thomas Doody · Joseph G. Galella · Phillip Goodling · Katherine Haviland · Shahan Haq · Barret Wessel · Kelsey L. Wood · Norbert Jaworski · Kenneth T. Belt

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George Arhonditsis, University of Toronto - Scarborough

Hugh Geurts, Ministry of the Environment, Conservation and Parks

Thank you!

You can never step in the same river twice - Heraclitus