Connecting water monitoring and management in the lower Grand River and nearshore Lake Erie

October 25, 2019

Presentation to: Water & Wastewater Projects and Compliance, Haldimand County

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GLOBAL WATER FUTURES SOLUTIONS TO WATER THREATS IN AN ERA OF GLOBAL CHANGE

the water INSTITUTE University of Waterloo

Canadian Rivers Institute

About me

- **Hons. Bachelor of Environmental Studies** – thesis in conservation ecology
- **Master of Environmental Studies** – thesis explored the impact of youth in Canada
- Currently in final year of **PhD** in Social and Ecological Sustainability (Water specialization)
- **Principal**, TRIECO Research & Consulting – stormwater management and sustainability (especially Sustainable Development Goals)
- **Director of Training and Consulting**, Synergy Sustainability and Development Group

Overview

1. Introduction to the research (context and goals)

2. Current ongoing monitoring in the study area (why this work is needed)

3. Research approach (method and summary results)

4. Discussion (what is the vision?)

Keep in mind…

Is this something Haldimand County (specifically, your unit) is interested in engaging with?

- If so, in what capacity?
- If not, what changes would be needed to engage with Haldimand County/your unit?

1. INTRODUCTION TO THE RESEARCH

Context and purpose

Context

- **National/International**
  - Resurfacing algae (and other) issues in the Great Lakes
  - Canadian monitoring starting to require cumulative effects (Canadian Water Network/CWRC)
  - *Also*: Sustainable Development Goals and the New Decade for Water
- **Global Water Futures – a nationwide research initiative**
  - In 2017: 18 universities and colleges, including: University of Saskatchewan (host), University of Waterloo, McMaster University, Laurier University
  - Canada First Excellence Research Fund - $77.84 million (Sep 2016); *total funding $143.67 m*
  - Global Water Futures > User-centered solutions ('Pillar 3') > UW > Lake Futures
  - Three years Canadian context, four years international implications

Introduction to my research

- **Challenge**: Fragmented, uncoordinated monitoring; guided by Western Science, community views often excluded; multiple jurisdictions (responsibility in the Grand River/Lake Erie estuary is often unclear)

- **Goal**: Propose a water monitoring framework for the interface (estuary) of the Grand River and Lake Erie that:
  - considers cumulative effects
  - is co-created by diverse stakeholders and rightsholders
  - recognizes diverse perspectives and multiple forms of knowledge and/or knowledge creation
  - connects monitoring to management and decision making (and aligns with other frameworks)

Other challenges

- Previous conflicting interests have led to failure of management and resistance to policy changes

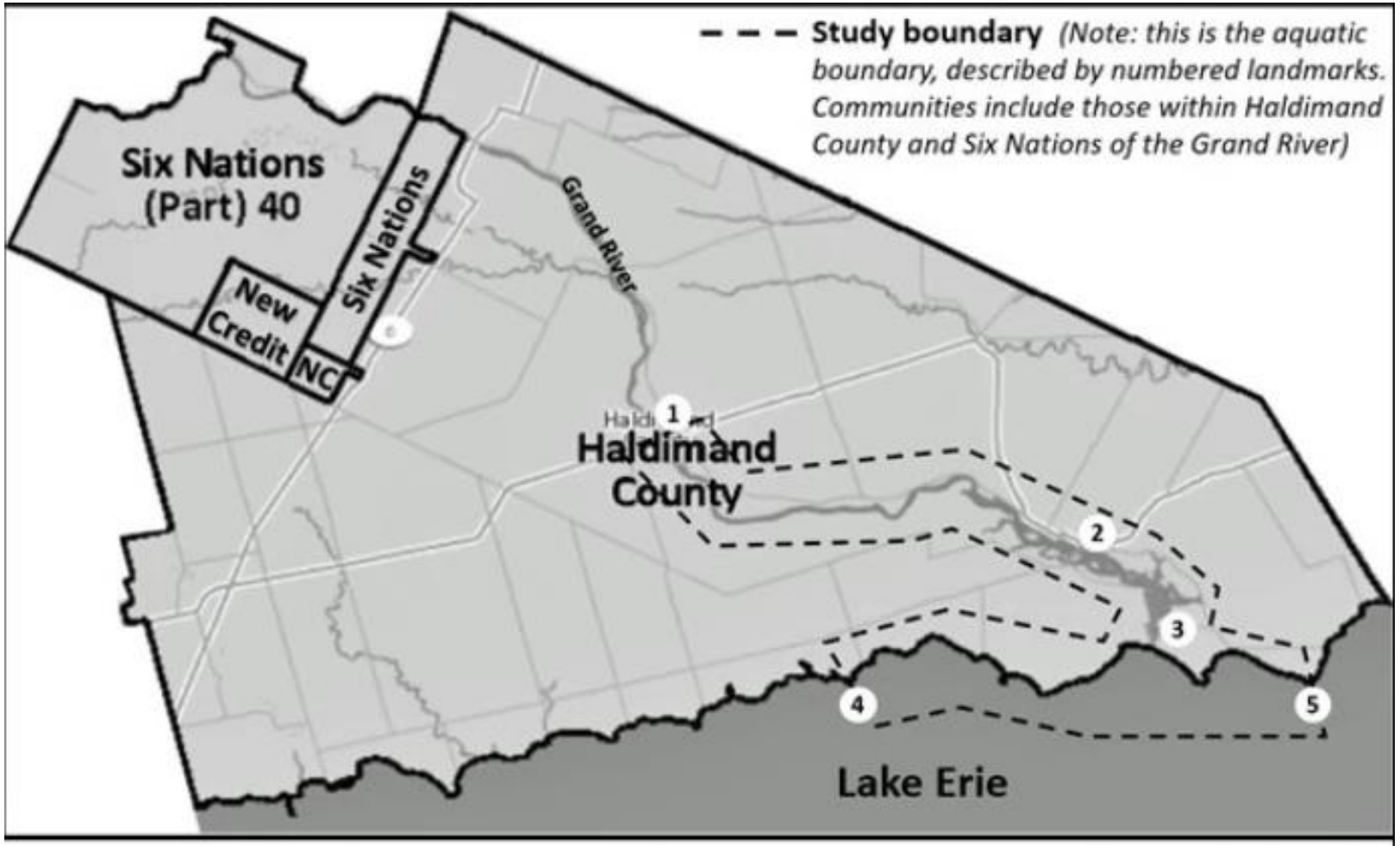
- Challenges connecting monitoring and management include:
  - Anticipating needs, cross-disciplinary communication, and applying research/science (e.g., translating monitoring into action)
  - Equalizing risk tolerances and standardizing priorities
  - Willingness to act or change

About cumulative effects

- **Cumulative Effects (CE)**:
  - Collecting, accruing, and/or combined changes
  - Experienced at the same time in the same social-ecological system/area
  - Caused by past, present and (in the case of prediction) reasonably foreseeable future actions, both natural and human

- **Cumulative Effects Monitoring**: process of measuring and interpreting accumulating change/CE relative to established limits.
  - Often followed by predicting future CE
  - Goal is to act – prevent, understand and respond to (undesired) change

Study area



1 Talbot Rd/ON-3 (Village of Cayuga)
2 Town of Dunnville
3 Village of Port Maitland
4 Evan's Point (South Cayuga)
5 Mohawk Point

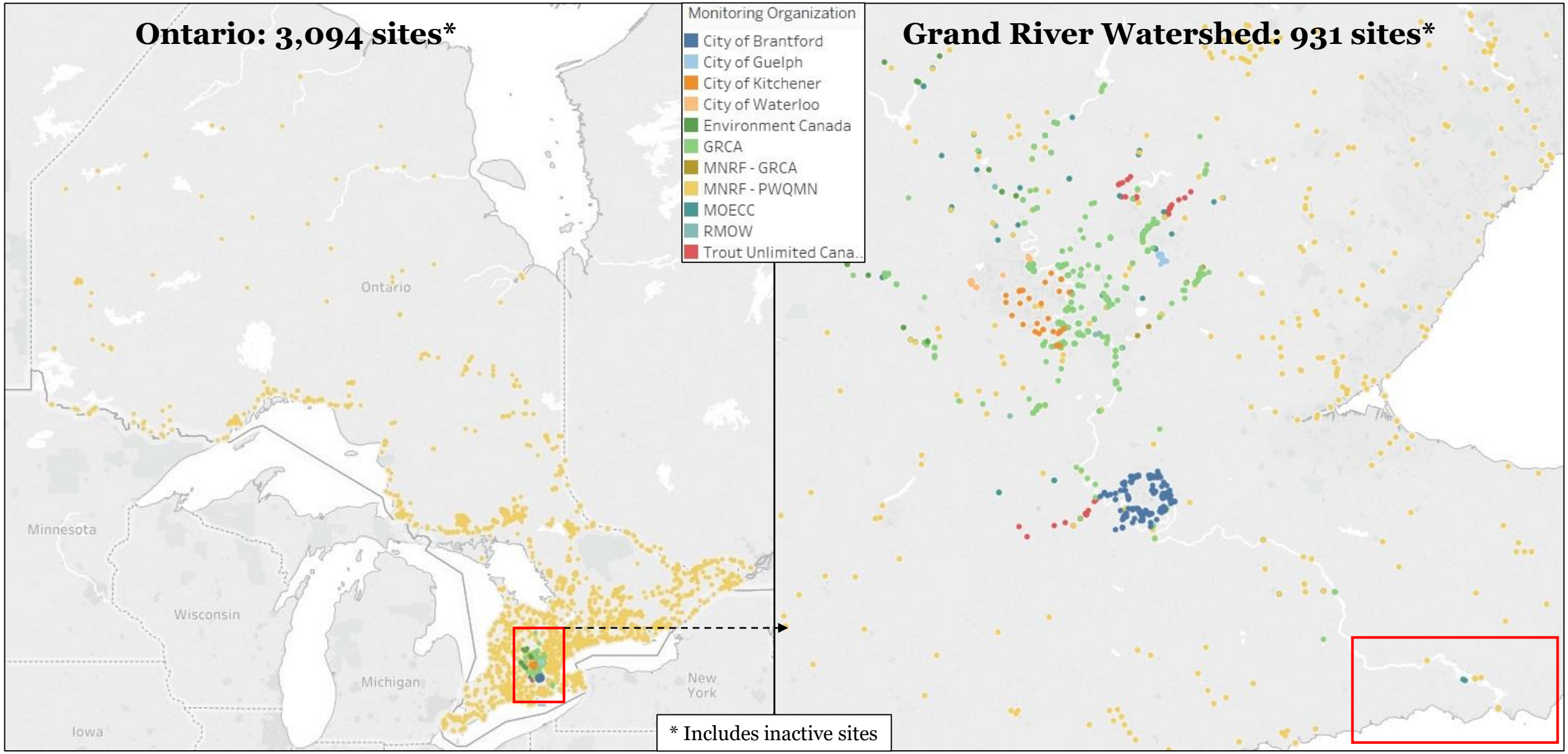
Grand River:
Cayuga to Lake Erie

Nearshore Lake Erie:
Evan's Point to Mohawk Point, out to the 10m bathymetry line

2. CURRENT ONGOING MONITORING

Why should we pay attention?

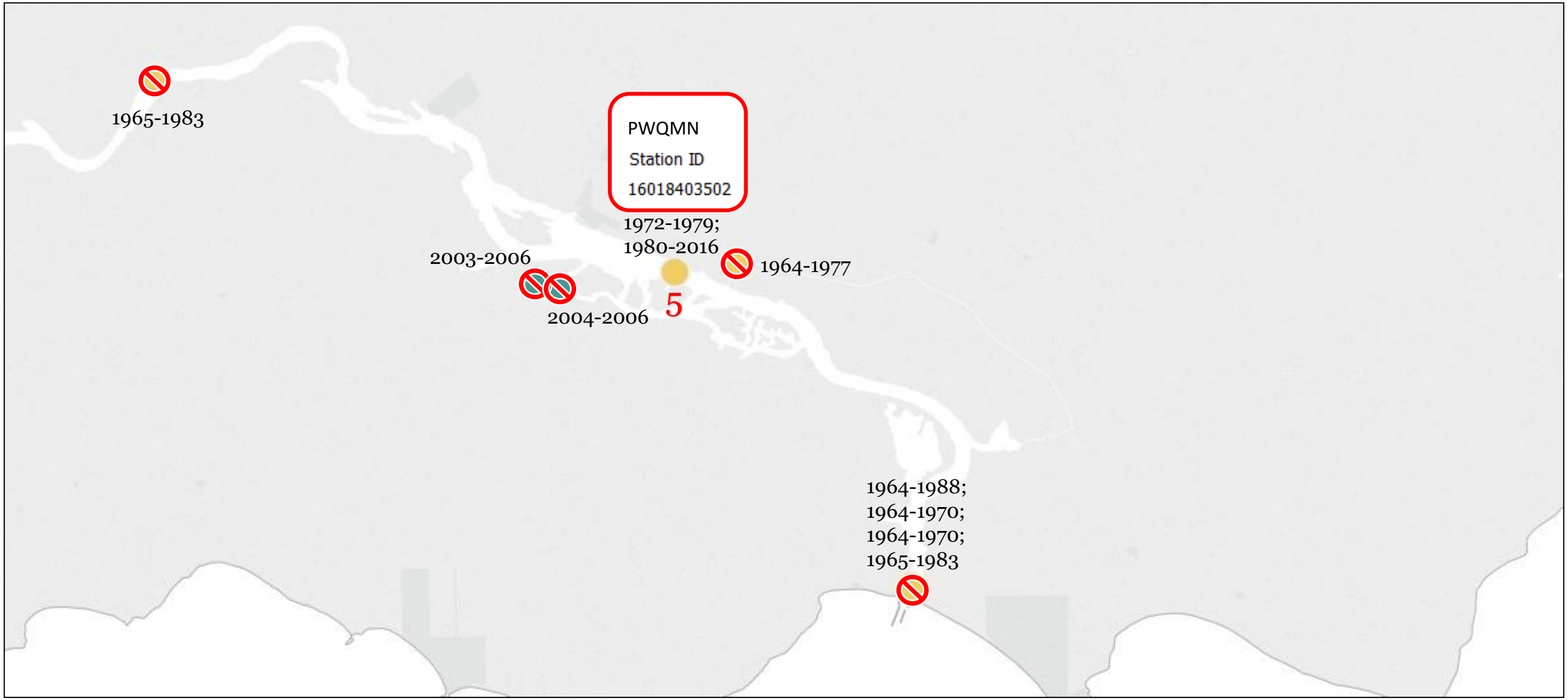
Grand River Monitoring – PWQMN and GRCA (1964-2016)



* Includes inactive sites

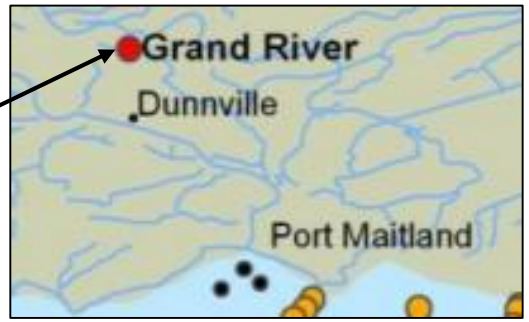
Monitoring in the GEI – Grand River portion (10 sites total)

Monitoring in the GEI – Grand River portion (1 site active)



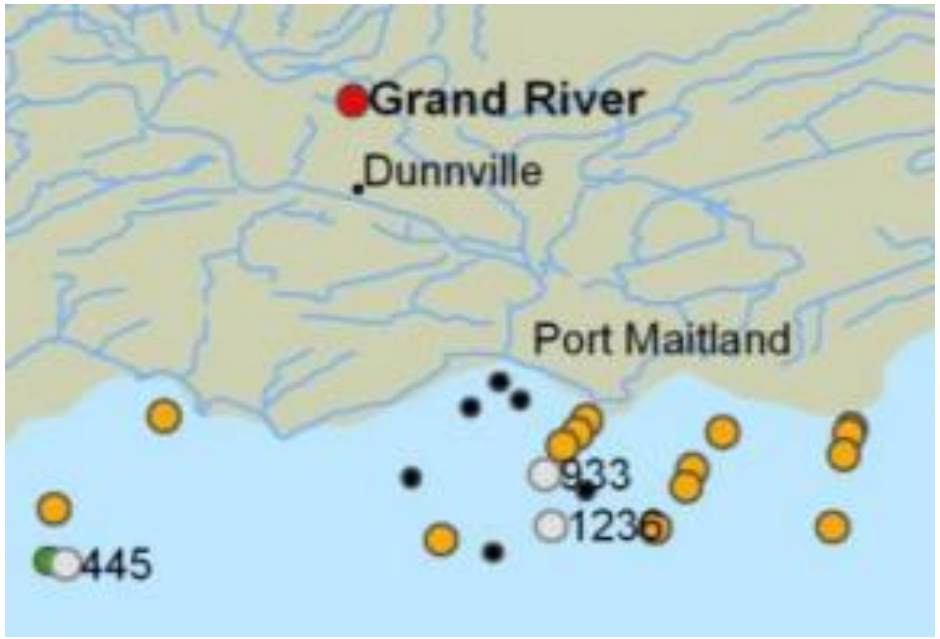
Parameters currently measured in the study area

- Site 5 at the Dover Rd./R.R. 3 bridge (Dunnville, 1980-2016)
  - 43 parameters: alkalinity, aluminium, ammonium, barium, beryllium, bismuth, cadmium, calcium, chloride, chromium, cobalt, conductivity, copper, dissolved oxygen, hardness, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, nitrates, nitrite, nitrogen, pH, phenolics, phosphate, phosphorus, potassium, residue, silver, sodium, stream condition, strontium, temperature (water), tin, titanium, uranium, vanadium, zinc, zirconium
- One station upstream at Haldimand Norfolk R.R. 9 (York, 1977-2016)
  - 16 parameters: ammonium, chloride, conductivity, dissolved oxygen, nitrates, nitrite, nitrogen, pH, phosphate, phosphorus, residue, temperature (water)
  - PWQMN at York St (Stn # 16018409202)?



Lake Erie monitoring – Great Lakes Nutrient Initiative (GLNI)

- Water quality (every 8 hours) – 10 parameters
  - Secchi depth, Photosynthetic Active Radiation (PAR), silica, fluoride, chloride, sulphate, nitrogen (multiple forms), phosphorous (multiple forms), TSS/turbidity, Chlorophyll *a*, particulate organic carbon and particulate organic nitrogen
- Mussel community and *Cladophora*
  - Biomass and P tissue concentration
- Hydrodynamics
  - Water movement



Sampling Activity

- Tributary Loading
- Nearshore Water Quality and Biology - Primary
- Nearshore Water Quality and Biology - Secondary
- Moorings for Hydrodynamics
- Surveillance/Connecting Channel Sites 2012

Dove, A., Backus, S., and Richardson, V. 2013. *Water Quality Monitoring for Lake Erie and the Great Lakes Nutrient Initiative (GLNI) 2011-2016*. http://www.lemn.org/LEMN2013-Files/Theme1/Dove_LEMN2013.pdf

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3. RESEARCH APPROACH

Method and summary results

Approach and timeline

Ongoing: document/literature review and participant observation

1. Exploratory study (Jan-Aug 2016) – **complete**
   - A new Criteria-based Ranking process for selecting and/or prioritizing indicators was developed and tested.
   - It is a helpful and efficient approach for standardising indicator selection and incorporating diverse perspectives.

Approach and timeline

2. Monitoring review (Sep 2018-Aug 2019) – **complete**

- **Done well (all programs)**: Western knowledge frameworks are used.
- **Done poorly (1 program)**: Roles are clear; Community based monitoring; Funding provided for community.
- **Conclusions**:
  - Monitoring is generally technically sound, but socially disconnected.
  - Design and implementation should be more coordinated and inclusive of diverse views and needs.

Approach and timeline

3. Key informant interviews (Oct 2018-Nov 2019) – **in progress**

- Monitoring and decision making are not well connected. Institutional barriers (and approaches to address these) exist.
- Optimized partnerships and coordinated collaboration (increased capacity, decreased redundancy) are imperative.
- Multiple forms of inquiry (e.g., approaches to analysis, integrating Indigenous knowledge) and reporting should be applied to monitoring data.
- Few examples of monitoring programs considerate of cumulative effects exist.

Approach and timeline

4. Public engagement

- Great Art for Great Lakes (Jun-Oct 2019) – **in progress (analysis)**
- Six Nations traveling arts exhibit (Aug 2019-Apr 2020) – **in progress**

5. CE mini-study (Nov 2019-May 2020) – **not started**

- How can current data be used to assess cumulative effects?

6. Synthesis workshop (May 2020) – **in progress**

- You're invited!

BLUEPRINT

EMPOWERING CANADIANS THROUGH SUSTAINABLE DEVELOPMENT

NOVEMBER 2018

Elaine Ho
Jeremy Runnalls

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

Method Article

Criteria-based ranking (CBR): A comprehensive process for selecting and prioritizing monitoring indicators

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ABSTRACT

Resources allocated to natural resource management often fluctuate, requiring the types and numbers of parameters used in monitoring programs (e.g., indicators of ecosystem health) to be frequently reassessed. Conventional approaches to selecting monitoring indicators are often biased and non-inclusive. A new Criteria-based Ranking (CBR) process for selecting and/or prioritizing indicators was tested in the Muskoka River Watershed (Ontario, Canada). The CBR process is based on two environmental assessment tools, Simple Weighted and Leopold matrices. It incorporates environmental components and criteria for assessing each indicator, which generate a score per indicator. The process tested in this study was concluded to be an effective way to prioritize and/or select environmental monitoring indicators. A different set of indicators emerged when a common set of criteria was used to assess monitoring indicators. Benefits of the CBR process include:

- Standardization of indicator selection process with less bias and lower cost (e.g., time and human resources).
- Indicators that are representative of the community and more relevant for decision-making (e.g., more resilient to socio-political change).
- Adaptability: (1) to other goals, e.g., selecting from a list of Valued Ecosystem Components (VECs), and (2) to any context through localized scoring criteria. Easily integrated into existing practice.

ARTICLE INFO

Method name: Criteria-based ranking (CBR) process (for indicator selection/prioritization)
Keywords: Valued ecosystem components (VECs), Indicators, Monitoring, Watershed monitoring, Water monitoring, Indicator selection process
Article history: Received 16 August 2018; Accepted 6 October 2018; Available online 23 October 2018

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

Original Articles

Assessing current monitoring indicators and reporting for cumulative effects integration: A case study in Muskoka, Ontario, Canada

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ARTICLE INFO

Keywords:
Social-ecological resilience
Climate change
Cumulative effects
Monitoring indicators
Watershed monitoring
Watershed reporting

ABSTRACT

Climate is changing at an unprecedented rate with impacts being felt in social and ecological systems around the world. Opportunities for building climate resilience of the social-ecological system surrounding freshwater areas are assessed using the aquatic monitoring and reporting programs of Muskoka River Watershed (Ontario, Canada) as a case study. A three-step study design was used: establishment of a knowledge baseline (i.e., what has been done), confirmation of the baseline to ensure perspectives that emerged were inclusive of multiple stakeholders (i.e., broadly applicable) and an exploratory workshop to disseminate recommendations and discuss implementation with key stakeholders. Two themes are discussed: the strengthening of watershed-scale monitoring approaches, and improved communication with stakeholders (e.g., through 'state of the watershed' reporting). This study offers an evaluation of watershed-scale aquatic monitoring and reporting and provides concrete examples from the case study. We test a new process for refining, selecting, or prioritizing indicators for aquatic monitoring. Cumulative effects assessment and monitoring (CEAM) is considered as the suggested monitoring approach at a watershed-scale. Recommendations for developing CEAM in the Muskoka River Watershed include considerations for selection of monitoring indicators, consistent communication of indicators, and implementing a metadatabase. Ways to enhance education of, and engagement with, local stakeholders through improved 'state of the watershed' report cards are highlighted. Resilience is strengthened by addressing two goals in the case study: engaging with the community and improving knowledge of stressor-effect relationships in the watershed via stronger aquatic monitoring.

1. Introduction

Resilience of communities to environmental changes is increasingly a priority as cumulative impacts and changes in climate are becoming increasingly visible (Armitage et al., 2017; Iebel et al., 2006). Climate change threatens resilience in many ways, affecting resource development, causing more frequent devastating storm events (e.g., flooding, fires, drought), interrupting biogeochemical cycles, and increasing the spread of vector-borne diseases (IPCC, 2013). The 100 Resilient Cities global network, pioneered by the Rockefeller Foundation, describes many examples of communities that are focusing on building climate resilience in their economies, communities, and environments, which demonstrates the growing global interest in resilience in general (100 Resilient Cities, 2017). Arguably, the foundation of (climate) resilient communities is the use of monitoring programs (e.g., monitoring the environment as well as policy outcomes) that inform and increase capacity to implement relevant strategies. Without monitoring programs, decision makers, managers, and local communities would not understand what changes are likely to occur, the implications of these changes or the effectiveness of management measures.

The main objectives of environmental monitoring programs, including monitoring of water and watersheds, are to assess current states, identify change (Anderson et al., 2003), predict risks from potential effects (Brack et al., 2009), and to inform a management

Abbreviations: CE, cumulative effects; CEA, cumulative effects assessment; CEAM, cumulative effects assessment and monitoring(/management); COSIA, Canada's Oil Sands Innovation Alliance; CWN, Canadian Water Network; CWRC (or, CWN-CWRC), Canadian Watershed Research Consortium; DMM, District Municipality of Muskoka; HLW, healthy land and water (program – http://hlw.org.au); MWC, Muskoka Watershed Council; THREATS, The Healthy River Ecosystem AssessmenT System, a software by Greenland Group of Companies (consulting firms that focus on civil environmental alternative energy and software engineering, as well as landscape architecture); VEC(s), valued ecosystem component(s); WISKI, water information systems, a software by KISTERS (an international company which specializes in the development of data management software

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1470-160X/

- And more at www.GrandErieStudy.ca

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Keep in mind…

- High-level **goal**: develop a water monitoring and management framework for the interface (estuary) of the Grand River and Lake Erie

- What are **your thoughts** on the general direction and approach of the research?

- How can we best **collaborate**?

4. DISCUSSION

What is the vision?

Elaine's early thoughts

- The 'framework' might be a **project/issues-based network of partners**
  - Safeguards from political, economic and social changes and challenges
- Haldimand county is a key player; would a **leadership** role be feasible?
- GRCA is an important partner; might be a **convener**
- Universities and community groups are also important partners; could fill gaps in **capacity and mandate**… may contribute to the following:
  - Collection and interpretation of data
  - Generating management-relevant information
  - Communicating to authorities, stakeholders and/or rightsholders

The question…

Is this something Haldimand County (specifically, your unit) is interested in engaging with?

- If so, in what capacity?
- If not, what changes would be needed in order to engage with Haldimand County/your unit?

Thank you for your time and feedback!

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Study website: www.GrandErieStudy.ca

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ADDITIONAL SLIDES 1

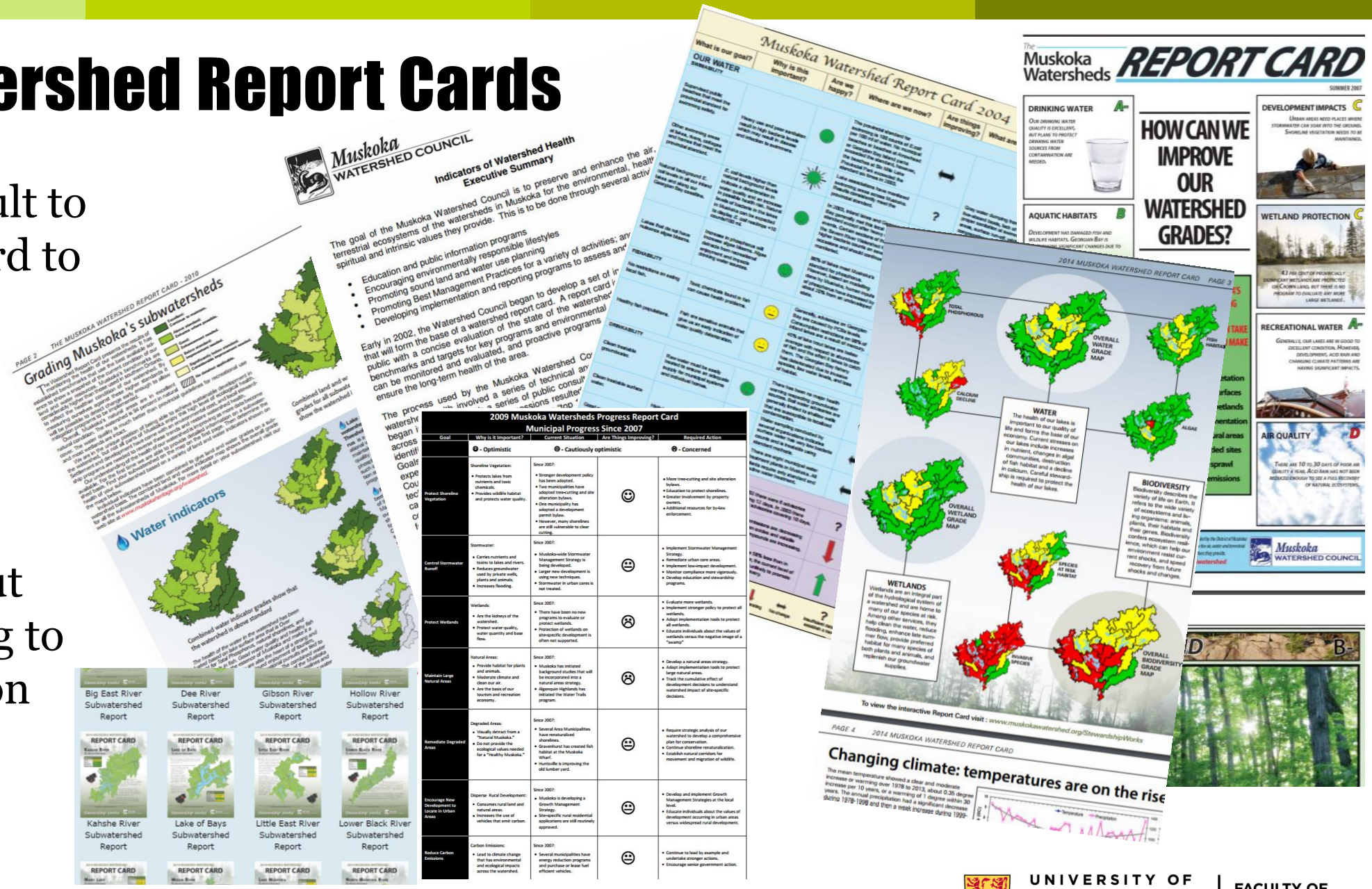
The exploratory study (2 parts)

Muskoka River Watershed

- **Study goals**
  - **Part 1**: Improve communication in watershed report cards via a review of the program
  - **Part 2**: Address inconsistency of monitoring indicators at a workshop with the Muskoka Watershed Council
- **Example indicators**: phosphorous, calcium, *E.coli*, dissolved organic matter, species composition, road salt runoff, amount of recreational and industrial development, etc.

Part 1: Watershed Report Cards

- Trends difficult to infer from card to card
- Background reports more consistent, but overwhelming to average person



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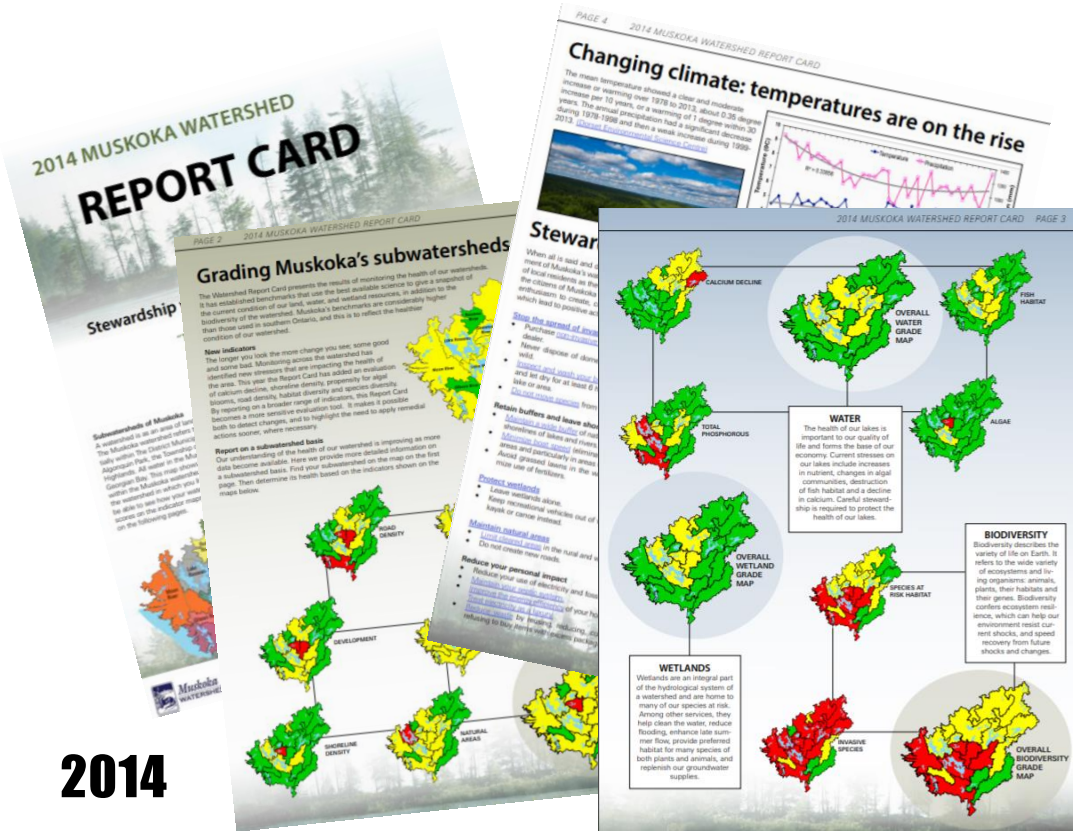
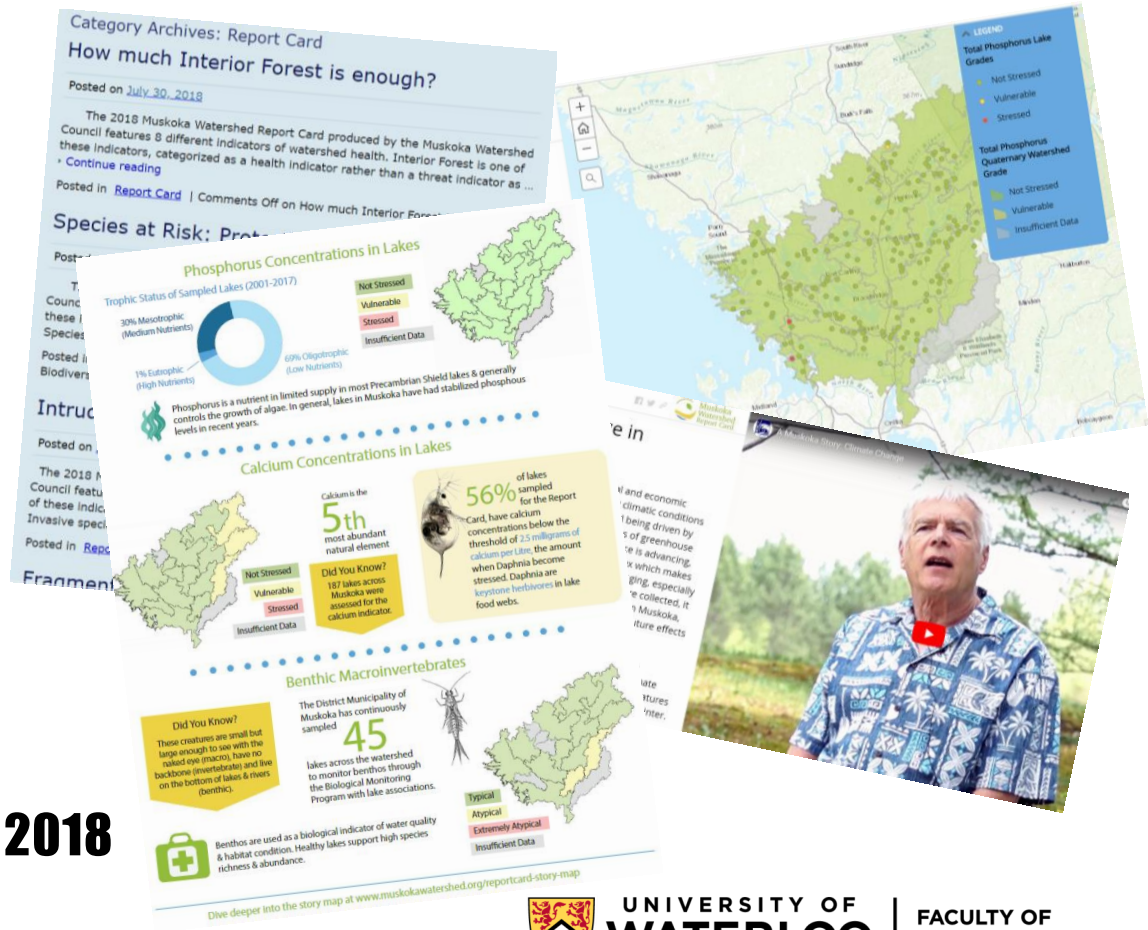
Part 1 outcome

- Reporting was transformed (more accessible)



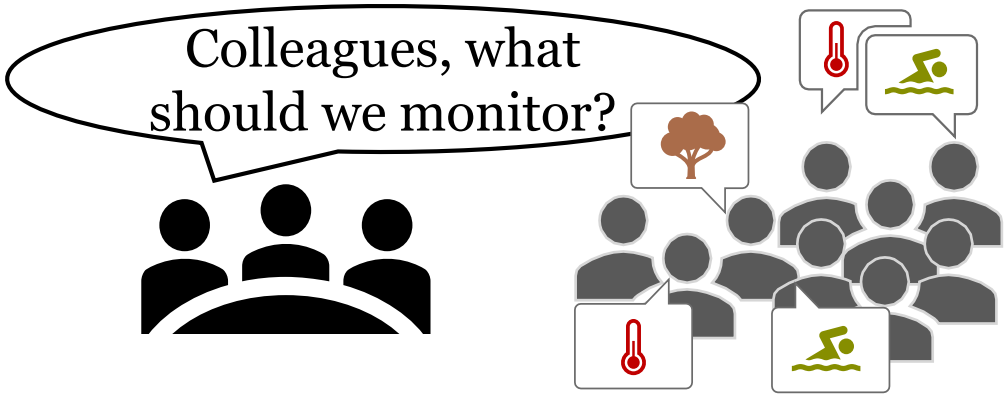
2014



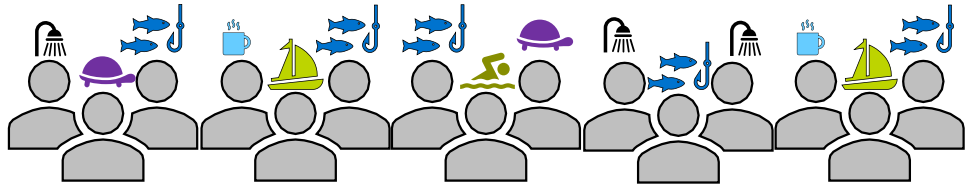
2018

Part 2: monitoring indicator selection/prioritization

- Criteria-based ranking method was developed and tested



...Outside the group of water managers, many values are excluded.



Examples of criteria

Importance to self	Ease of measuring (tools)	Level of control over change
Importance to ecosystem	Ease of monitoring (process)	Magnitude of undesired impact

Part 2 task

- Reduce a list of 6 monitoring indicators (5 existing, 1 new) to a list of 5
  - Existing indicators: Secchi Depth, Algae, Calcium, Land Use, Wetland cover
  - New indicator (related to new goal of incorporating action on climate change into reporting): carbon footprint

- SurveyMonkey was used: each response rated on a scale of 0 (least agreement) to 5 (strongest agreement)

Part 2 criteria

- I would include this indicator in the Report Card
- This indicator is measurable given reasonably expected resources
- We have control over changes to this indicator
- We have effective mechanisms for correcting CURRENT unwanted changes to this indicator
- We have effective mechanisms for correcting FUTURE unwanted changes to this indicator
- Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.
- This indicator is important to me

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)						
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)						
We have control over changes to this indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator						
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

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I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)						
This indicator is measurable given reasonably expected resources (to people, funds, time…)						
We have control over changes to t indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator						
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Before new method:

"We all know this will make the list"

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)	17	31	23	33	32	27
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)	33	22	25	30	25	20
We have control over changes to this indicator	18	20	18	27	24	23
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator	16	19	16	25	19	20
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator	20	21	17	27	21	20
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.	22	31	27	31	28	30
This indicator is important to me	24	31	25	34	31	28

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)	150	154	151	207	180	168
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)						
We have control over changes to this indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator						
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)						
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)						
We have control over changes to this indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator	6	4	5	1	2	3
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Main results

- **Monitoring indicators**: fewer, easily understood, consistent units,
  - Purposeful: geared towards use of results (triggers, goals, locally-connected)
  - Stakeholders must agree on what and how to measure
- **Explicit roles at the start**: monitoring and decision makers - purpose, goals, needs, capacity, outcomes, and protocols for issue response.
- **Time lags**: address discrepancy between monitoring (science), communication (to public and decision makers), and response.
- **Co-creation** of the monitoring framework is needed.
  - Meaningful stakeholder engagement and consideration of stakeholder perception must be improved, from the start and throughout the process.

ADDITIONAL SLIDES

Monitoring review

Method

- Nine programs were evaluated (using 22 criteria):

1. Blair Creek Subwatershed monitoring program (led by the GRCA)
2. Canada's Environmental Effects Monitoring Program (led by the Government of Canada, legislated under the Fisheries Act for Canadian metal mines and pulp and paper mills)
3. Grand River Watershed monitoring program (led by the GRCA)
4. Muskoka River Watershed monitoring program (led by the District Municipality of Muskoka – Ontario, Canada)
5. Slave Watershed Environmental Effects Program (led by the Slave River and Delta Partnership – Northwest Territories, Canada)

Method

- Nine programs were evaluated (using 22 criteria):

6. Healthy Land and Waters program (independent organization – South East Queensland, Australia)

7. Provincial (Stream) Water Quality Monitoring Program (led by the Ontario Ministry of Environment, Conservation and Parks – Ontario, Canada)

8. Statistics Canada Sustainable Development Goals Data Hub (led by the Government of Canada, includes targets under Goal 6 for clean water and sanitation)

9. The Brisbane Declaration and Global Action Agenda on Environmental Flows (2018; created and revised at the 10th and 20th International Riversymposium and International Environmental Flows Conference, respectively – Brisbane, Australia but global in scope/application)

What was done well?

1. Western knowledge (score 100%, 9 programs)
2. Collaboration and/or partnerships (score 89%, 9 programs)
3. Stakeholder-driven indicators (score 89%, 9 programs)
4. Short-term continuous data (score 83%, 8 programs)
5. Indicators measured are reported on (score 72%, 7 programs)
6. Easily-understood reporting (score 72%, 9 programs)
7. Parameters shared and/or explained (score 72%, 9 programs)

Recommendations: what should be maintained?

- Multiple durations of science-based data

- Collaboration, but with more diverse and representative groups of stakeholders and rights-holders

- High standard of accessibility and transparency by providing contact information *and* understandable explanations of monitoring processes and parameters

What was done poorly?

1. Funding provided to community (score 17%, 2 programs)
2. Community-based monitoring (score 17%, 2 programs)
3. Indigenous knowledge recognized (score 22%, 3 programs)
4. Roles are clear (score 28%, 4 programs)
5. Multiple reporting formats (score 33%, 3 programs)
6. Database or metadatabase available (score 33%, 4 programs)

Recommendations: what should be improved?

- Recognition of multiple worldviews, with a concerted effort to recognize Indigenous Knowledge or ways of knowing
- Use of multiple reporting formats to enhance accessibility and, thus, usability of monitoring data
- Clarity of roles for monitoring and management to support collaboration and coordination efforts
- Combined use of water quality, quantity and biomonitoring monitoring data in a whole-watershed approach
- Linkages between monitoring, management and decision-making

ADDITIONAL SLIDES

Early results from key informant interviews and participant observation (CWRA workshop)

Early results – Key Informant Interviews

- Collaboration is generally well-practiced (but not with diverse, representative groups); coordination severely lacking

- Relationship between evidence-producers and decision-makers needs addressing (trust-building and shared spaces, NOT about inclusivity)

- Bureaucratic chain of command impedes access to decision-makers (without access, other influence is needed – 'leverage points')

Results – CWRA Workshop

- Defining boundaries of management systems problematic – we deal only with who and what is within (e.g., the watershed), but people and stressors outside it influence cumulative effects observed within
- Of the many experienced practitioners and researchers in the room, none had ever done a stakeholder mapping and analysis exercise (except three of the speakers) → implications on effective engagement
- Critical to recognizing and surpassing multiple worldviews; the models we apply determine defined roles, possibilities, and limitations