

Context for a National Discussion

Elevating Community-Based Water Monitoring
in Canada

OTTAWA, ONTARIO - NOVEMBER 27-28, 2018



Convening Team

The discussion paper and the National Roundtable were convened by Living Lakes Canada, WWF-Canada and The Gordon Foundation. All three organizations engage with CBWM in different ways and are committed to advancing collaborative and evidence-based water stewardship across Canada.

The convening team thanks the roundtable participants for their willingness to share their work, knowledge and expertise with the Government of Canada. We would also like to thank Environment and Climate Change Canada (ECCC) and Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) for providing financial and in-kind support for this gathering and most importantly for their openness and willingness to work collaboratively towards achieving shared water stewardship objectives.

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Executive Summary

Our freshwater systems – the very foundation of healthy, productive societies – are being affected in unprecedented ways by increasingly complex environmental changes. Indigenous and non-Indigenous communities across the country understand this and are taking to their watersheds to collect much-needed information to track and respond to changes as they happen. This groundswell in **Community-Based Water Monitoring (CBWM)** is a powerful way to achieve effective water management and stewardship practices that are tailored for local conditions and capable of keeping pace with rapid environmental change.



Opportunity for the Government of Canada

The growth of CBWM programs across Canada presents an opportunity for the Government of Canada to simultaneously advance a number of its core priorities, including those articulated in the following documents:

- **Mandate letters** relating to climate change, environmental law reform and open science
- **Truth and Reconciliation Commission** recommendations, including those related to strengthening nation-to-nation relations
- **United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)**
- **Canada's 2030 Agenda** to meet the **United Nations Sustainable Development Goal #6** to ensure access to sustainable water management and sanitation for all

Importantly, the Government of Canada is already making significant investments in CBWM across the country through programming led by Environment and Climate Change Canada, the Department of Fisheries and Oceans, and Crown-Indigenous Relations and Northern Affairs Canada, among others. To make the most of these investments, efforts are needed to ensure programming across departments is well co-ordinated and effectively addresses community needs.

Draft Recommendations for the Government of Canada

The following draft recommendations for the Government of Canada aim to advance more strategic and sustained federal support for CBWM. These recommendations, developed collaboratively with diverse experts, including individuals with practical experience carrying out both Indigenous and non-Indigenous CBWM programs, were intended as a starting point for discussion at the National Roundtable on Community Based Water Monitoring held in Ottawa on November 27 and 28, 2018. **The aim of the roundtable was to revise, modify, add to, or remove from these recommendations based on the input of participants and outcomes of the collaborative discussion.**

Draft Recommendations for Discussion

1

Capacity-building

- Invest in partnership development
- Support knowledge co-production according to Indigenous protocols and policies

2

Effective Monitoring

- Where appropriate, participate in the co-design of strategic monitoring plans that fill critical data gaps while leveraging existing infrastructure or data collected under existing long-term monitoring programs
- Where desired and appropriate, support CBWM protocol design and review, as well as data analysis and interpretation
- Promote and support sharing of relevant protocols and equipment across CBWM programs within and between regions
- Support the development of standardized monitoring protocols, where appropriate

3

Regional and National Collaboration

- Be a part of the conversation: Participate in local, regional and national gatherings where CBWM organizations organically network, share ideas, and support one another
- Identify areas of overlapping interest to invest in strategic partnerships while avoiding forced collaboration

•

4

Data Management

- Extend “open by default” approach to federally-funded CBWM initiatives while upholding principles of data sovereignty as articulated by Indigenous nations
- Incubate and scale existing data management efforts
- Provide leadership on best practices and standards for managing data to promote interoperability

5

Data to Inform Decision-Making

- Coordinate federal support to strengthen CBWM through a cross-departmental CBWM strategy
- Better integrate CBWM data in decision-making at various levels (policy, planning and management)
- Promote knowledge sharing and best practices in government-funded research and science

6

Sustainable Funding

- Develop multi-year, core funding options
- Fund new and existing Indigenous Guardian Programs to improve Indigenous-Crown relationships and advance reconciliation through Indigenous-led programs
- Streamline and simplify federal funding processes
- Embed CBWM spending in federal water monitoring budgets



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Background

Freshwater systems are under increasing pressure from the impacts of climate change, development and other human-made stressors. There is, therefore, a need to focus on monitoring freshwater resources and aquatic ecosystems across Canada. To meet this growing need, there has been a proliferation of community-led efforts to generate critical data and information needed to understand, respond to, and plan for complex environmental challenges.

As a powerful means of achieving shared governance and sustainability objectives, **Community-Based Water Monitoring (CBWM)** is gaining momentum across Canada. To realize the full potential of this movement there is a need for strategic investment, collaboration and leadership across sectors, watersheds, and jurisdictional boundaries. This must include active integration of CBWM data into policy and decision-making.

About the Roundtable Discussion

Convened by The Gordon Foundation, Living Lakes Canada and WWF-Canada, the aim of the Roundtable Discussion was to support a collaborative dialogue around how the federal government can meaningfully and effectively engage with and support CBWM in Canada.

Key Objective: identify actionable steps the federal government can take to show leadership and support in advancing community-based monitoring of freshwater ecosystems in Canada.

ROUNDTABLE OBJECTIVE

The Roundtable discussion presented a valuable opportunity for a growing community of practitioners to come together for the following purposes:

- Highlight the expansive, diverse nature and network of CBWM programs across the country
- Identify how CBWM programs and governments can collaborate, including to fill existing knowledge and data gaps
- Identify strategic opportunities for federal investment in promoting and leveraging CBWM

While acknowledging the leadership and contributions of community-based monitoring for terrestrial and marine ecosystems, the focus of the roundtable discussion was on environmental monitoring of freshwater.



NATIONAL CBWM SURVEY

To better understand priorities for advancing CBWM in Canada, the organizers sent out a national survey to CBWM practitioners in the winter of 2017/2018. The survey results confirmed considerable appetite for a collaborative national discussion on the topic of federal support for CBWM, and informed the key themes addressed in this discussion paper. More information about the survey can be found on the Atlantic DataStream [website](#).

About this Paper

This discussion paper provides a brief overview of key areas where opportunities exist for the federal government to support CBWM. **This paper and the draft recommendations included in it have been intended as a starting point for discussion only** – the aim of the roundtable itself was to revise, modify, cut and add recommendations, based on the input of roundtable participants.

This discussion paper has been divided into the following key thematic areas of focus:

1. Capacity building
2. Effective monitoring
3. Regional and national collaboration
4. Data management
5. Data to inform decision making
6. Sustainable funding

Context for a National Discussion

Canada's commitment to environmental protection, reconciliation with Indigenous peoples, open data, and evidence-based decision making, along with a growing trend toward increased public engagement in environmental stewardship, presents a unique opportunity for the federal government to play a critical role in supporting and strengthening community-based water monitoring in Canada. However, without focused effort to build the capacity needed to sustain CBWM initiatives over the long-term as well as effective mechanisms to incorporate CBWM data into decision-making, there is a significant risk of wasting valuable resources and failing to mobilize the full potential of CBWM to support healthy communities and water in Canada.

Why Community-Based Water Monitoring?

Why should communities be the ones to monitor water? Communities are closest to their watersheds and well-placed to identify and track the issues affecting them. CBWM is significantly expanding the spatial and temporal scales of freshwater monitoring, contributing to a more comprehensive picture of freshwater health in Canada, and is helping to build new, mutually beneficial relationships in Canada's water governance landscape (Buytaert et al., 2014). Through diverse programs across the country, CBWM is playing a critical role in mobilizing energy, engagement and knowledge from the ground up to protect the freshwater ecosystems on which we, and all life, ultimately depend.



Figure 1. From data to policy and action through community-based monitoring. Image courtesy of The Gordon Foundation.

What do we mean by community-based water monitoring?

Community-Based Water Monitoring (CBWM), or citizen science, can be loosely defined as a “process where concerned citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track and respond to issues of common community concern” (Whitelaw, et al., p.410). CBWM is about all things water-related, such as monitoring quality, quantity and biodiversity in aquatic ecosystems. CBWM can be varied in its “nature and approach, ranging from volunteer monitoring programs to larger-scale, complex watershed management partnerships or councils” (Weston and Conrad, 2015, p. 1). In Indigenous contexts, CBWM further relates to Indigenous sovereignty and self-determination, and may be understood as “both a method for generating data useful for decision-making and an expression of governance itself, rooted in understandings of stewardship, kinship and responsibility” (Wilson, et al., 2018).

Indeed, despite recent iterations of CBWM, the concept is by no means new. From time immemorial, Indigenous peoples have maintained physical and spiritual connections to their lands marked by principles of community-based management. Though these connections have been affected by historic and ongoing legacies of colonialism, Indigenous peoples’ observations, laws, and ways of knowing continue to inform governance of Indigenous lands and territories. Today, many Indigenous-led CBWM programs are conducted by employees of Indigenous governments and organizations, which differs from volunteer-based approaches typical of other citizen science monitoring initiatives. While Indigenous-led CBWM efforts can include western scientific indicators and methods, this monitoring may take place within larger governance processes and programs (e.g. Guardian programs) that are grounded in and seek to revitalize Indigenous ways of knowing, laws, cultures, languages and sovereignty.

Water: Sharing Responsibilities

ALL LIFE DEPENDS ON WATER; WE HAVE A SHARED RESPONSIBILITY TO PROTECT IT.

For freshwater ecosystems, the watershed is widely recognized as the most appropriate scale for most water planning and management functions (Parkes 2010; CCME 2016). Based on natural pathways of water flow, watershed boundaries do not follow political boundaries. This poses challenges because the complex distribution of responsibilities for water across orders

of government can result in an overlap in jurisdiction and, in some cases, an accountability gap (Swain, Louttit and Hruddy, 2006). This fragmentation of responsibility also poses challenges for monitoring and data management that can lead to gaps in information and disconnection between data and decision-making.

Furthermore, prevailing approaches to water governance often exclude meaningful participation of Indigenous peoples, and systemic inequities constrain Indigenous peoples' access to water and ability to exercise inherent water rights and associated responsibilities (Craft, 2017; McGregor, 2014; Phare, 2009; Simms, 2016). Despite this, Indigenous peoples in Canada continue to assert their inherent rights and responsibilities to water, which flow from their relationships to their traditional territories and include the "power to make decisions, based upon [their] laws, customs, and traditional knowledge" (Phare, 2009, p. 46).

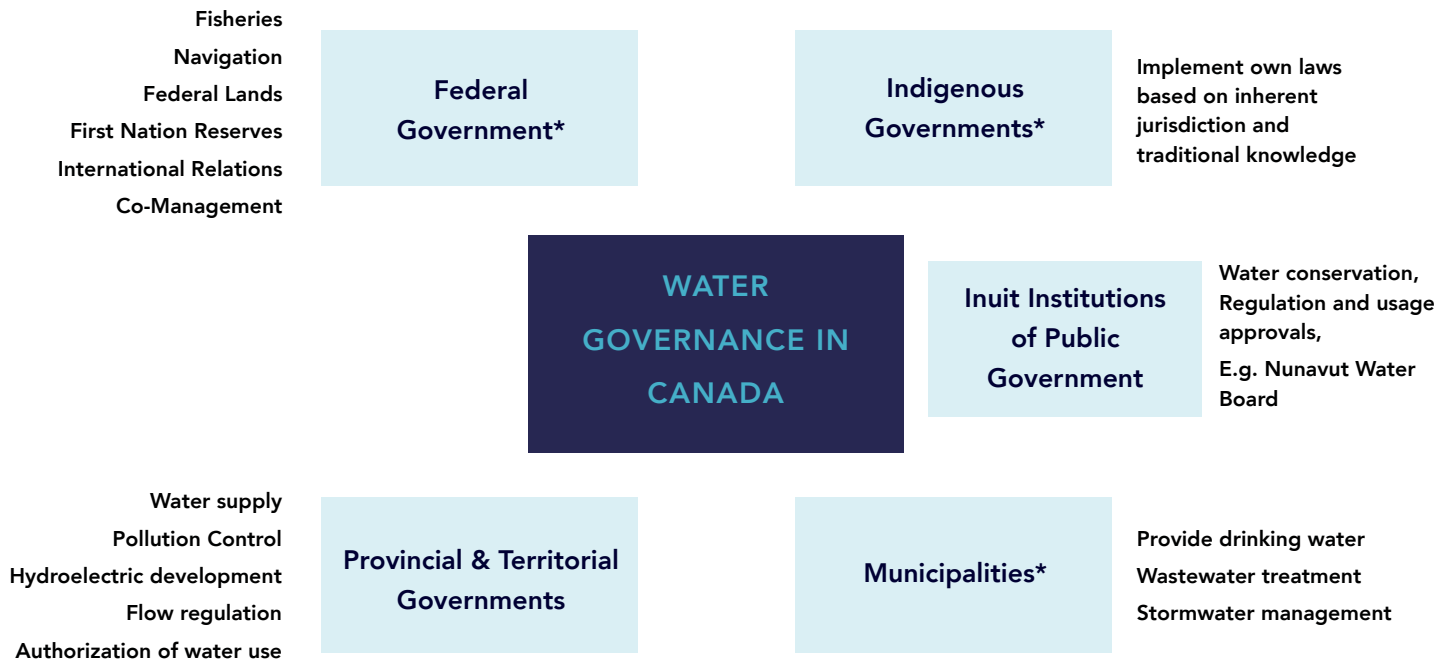


Figure 2. Governmental Responsibilities for Water

Current water governance in Canada is often described as a complex jurisdictional maze (Saunders and Wenig, 2007; Bakker and Cook, 2011). Under the Constitution Act (1867), responsibilities for various aspects of water law, policy, planning and management are shared among Indigenous peoples, municipal, provincial, territorial, and federal governments (see Figure 2).

Data Deficiencies

Limited availability of data and information about fresh water in Canada is a real and enduring barrier to making evidence-based decisions. As indicated in a 2010 audit by the Commissioner of the Environment and Sustainable Development, and echoed again in the WWF-Canada Watershed Reports of 2017, there is insufficient data collection and capacity within existing monitoring networks to fully understand long-term changes in water quality (WWF-Canada, 2017). These data gaps are a growing concern in the face of a rapidly warming climate, which is driving demand for robust and timely information needed to understand and adapt to more common and severe flood and drought, and to respond to increasingly complex threats to the health of freshwater resources and ecosystems.

A number of factors have led to this data deficiency. Some are more obvious, like persistent funding stress for long-term monitoring activities and the remoteness of many monitoring sites. Others, including a lack of co-ordination in monitoring efforts, poor communication among parties, and limited data sharing among government agencies, academia and other monitoring organizations may be more obscure but equally important. The wide range of protocols, indicators and metrics used to generate water quality data across watersheds further complicates integration of historical and newly acquired data to inform, for example, an understanding of cumulative effects on the state of freshwater resources and ecosystems.

“We need to step up, all of us – public sector, different levels of government, private partners – and ensure that the data so many people are collecting in so many different ways gets aligned, gets collated and gets shared.”

Prime Minister Trudeau, June 2017
WWF-Canada Healthy Waters Summit

The Legislative Landscape and Opportunity to Support CBWM

For the federal government, strategic support for CBWM is an opportunity to build on existing momentum and a foundation of collaborative water monitoring. Under the Canada Water Act (1985) the federal government has the mandate to work with the provinces and territories on joint water management. This mandate is implemented in part through shared monitoring agreements with the provinces and territories (though not all have agreements in place) and in areas of national concern such as the Great Lakes, the Mackenzie River Basin, St. Lawrence

River, and Lake Winnipeg watershed. As it relates to hydrometric monitoring (i.e. water levels and flows), the federal government has maintained a successful 27-year collaborative relationship with the provinces and territories, housing data in a central, accessible online database (National Hydrometric Network led by Environment and Climate Change Canada).

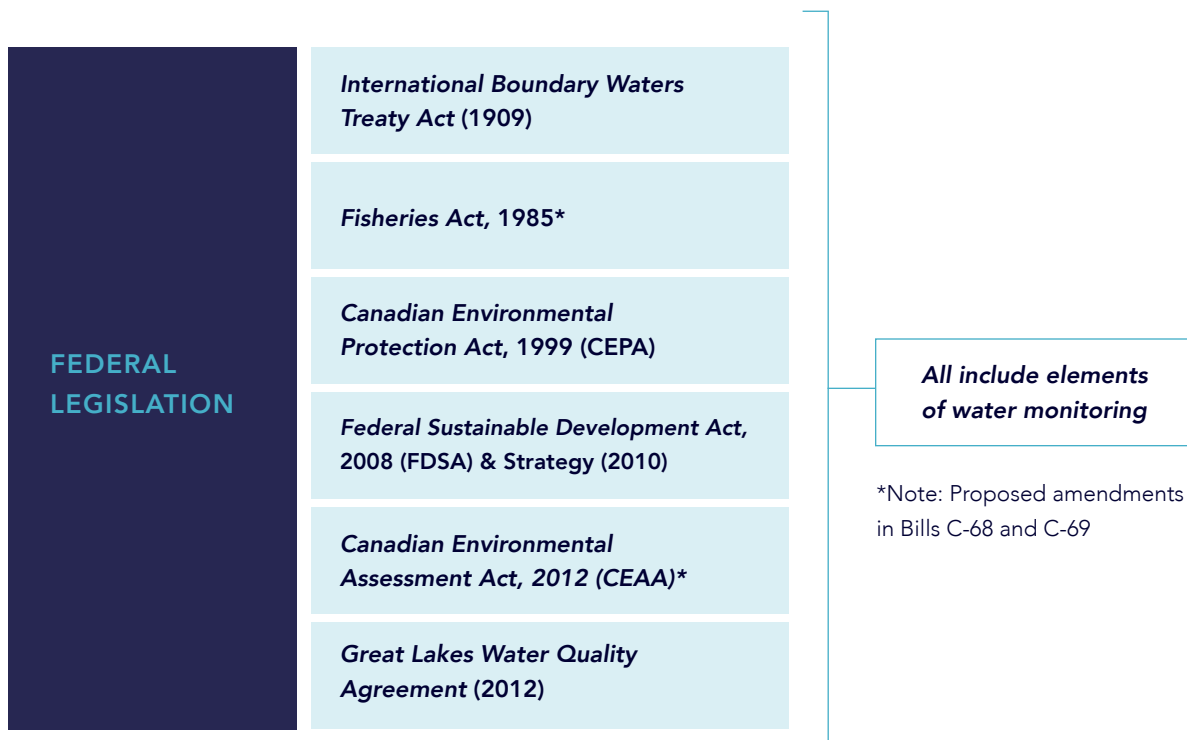


Figure 3. Federal Legislation Related to Water Management

A number of other federal laws also provide a basis for federal water monitoring (see Figure 3). Importantly, two Bills currently under review by the Senate will update the Fisheries Act (Bill C-68) and the Navigation Protection Act and environmental assessment legislation (Bill C-69) to require consideration of cumulative effects in decision making and establish a public registry to facilitate access to key information related to implementation of these laws. Implementation of these provisions would benefit greatly from the data and information developed through CBWM initiatives.

¹ Five federal-provincial agreements are active today between Canada and the following jurisdictions: Quebec (1983); British Columbia (1985); Manitoba (1988); New Brunswick (1988/1995); Newfoundland and Labrador (1986); and Prince Edward Island (1989) (Canada. Environment and Climate Change Canada, 2017).

Indigenous Water Governance

Indigenous peoples in Canada have always had laws and governance systems that protected water and waterways. Despite the impacts of colonialism, Indigenous peoples continue to sustain, reclaim, and revitalize these forms of governance, which may be diverse across communities and Nations. Recent policy shifts have implications for the recognition of Indigenous water rights, responsibility and jurisdiction. In 2016, the Government of Canada endorsed the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which is a comprehensive international instrument on Indigenous peoples' rights with implications for Indigenous water governance. More recently, the Principles Respecting the Government of Canada's Relationship with Indigenous Peoples marks a move to align federal policy with the provisions of UNDRIP, such as affirming self-determination and free, informed and prior consent (Canada. Department of Justice, 2018). While these policy moves express a political willingness, there remains much work to do to implement UNDRIP meaningfully with respect to fresh water issues (Askew et al., 2017).

Federal Support of CBWM

The benefits of collaborating with local monitoring groups have led governments at various levels to make considerable investments in CBWM. This has been accomplished through partnerships and support in the form of funding, training, equipment loans, data management, and project co-ordination. At the federal level, examples include long-standing programs such as the Canadian Aquatic Biomonitoring Network (CABIN) established through Environment and Climate Change Canada (ECCC), and the Aboriginal Aquatic Resource and Oceans Management Program (AAROM) housed at the Department of Fisheries and Oceans (DFO). The Northern Contaminants Program (NCP) is a long-standing example of collaborative monitoring conducted by northern communities and their partners at different levels of Indigenous and non-Indigenous government. At the federal government level, Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), Health Canada, ECCC and DFO are all involved in the NCP. The Nunavut, Northwest Territories, and Yukon territorial governments are also partners, as are Indigenous governments and organizations such as Inuit Tapiriit Kanatami (ITK), Inuit Circumpolar Council-Canada (ICC), Dene Nation and the Council of Yukon First Nations.



The federal government has also recently ramped up investments in monitoring through new and existing funding programs for which CBWM initiatives are eligible. Some notable examples include the following:

- **\$44.84 million over 4 years: Great Lakes Protection Initiative**
 - Administered through ECCC under Budget 2017's \$70.5 million allocation for freshwater protection: Swim Drink Fish received \$1.8 million for recreational water quality monitoring
- **\$31.4 million over 5 years: Indigenous Community-Based Climate Monitoring Program**
 - Announced in Budget 2017 and funded through CIRNAC
- **\$25 million over 5 years: Indigenous Guardians Programs Announced in Budget 2017**
 - Administered through Parks Canada. Funding will support the launch of a national Indigenous Guardians Network.

Additional examples are listed in the Appendix. It should be noted that while federal supports for CBWM are the focus of this discussion, many Indigenous Nations, municipalities, provinces and territories provide significant supports for CBWM through leadership, collaboration, and resourcing.

Community-based water monitoring helps the Government of Canada meet the following commitments and responsibilities:

1. Advance whole-of-government priorities such as climate change and open science, as articulated in ministerial mandate letters (Canada. Prime Minister's Office, n.d.).
2. Strengthen nation-to-nation relationships and implementation recommendations of the Truth and Reconciliation Commission (TRC) that relate to the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and protection of the environment.
3. Measure Canada's performance in meeting biodiversity goals and targets through Canadian Environmental Sustainability Indicators (CESI).
4. Achieve Canada's 2030 Agenda to meet the United Nations Sustainable Development Goal # 6, which seeks to ensure availability and sustainable management of water and sanitation for all.
5. Implement terms of collaborative federal/provincial/territorial/ bilateral agreements on water quality monitoring across jurisdictional boundaries.
6. Ensure that decisions are based on evidence and principles of open government, and that they serve the public's interest.
7. Play a unifying role in ensuring the health of freshwater in Canada for Canadians as mandated in the Canada Water Act (1970).

A group of seven people, four women and three men, are standing on a rocky riverbank. They are dressed in casual outdoor attire, including hats, sunglasses, and long-sleeved shirts. Some are holding fishing gear, like a net and a fishing rod. The background shows a dense forest of evergreen trees under a clear sky. The entire image has a dark blue overlay.

THEME 1

Capacity Building

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Overview

Capacity building has been identified as essential to the success of CBWM (Day and Litke, 1998; Conrad and Hilchey, 2010; Bellfield et al., 2015) and focuses on building the technical and institutional capacity to conduct monitoring that achieves identified objectives of a monitoring program, including the ability to collect high-quality data (CLEAR, n.d.; Bradshaw, 2003; Gouveia et al., 2004; Conrad and Daoust, 2007; Kearney et al., 2007; Conrad and Hilchey, 2010; Shelton, 2013; Danielsen et al., 2014; Buckland-Nicks, Castelden and Conrad, 2016; Jollymore et al., 2017; Herman-Mercer et al., 2018).

Challenges

The capacity- building challenges identified in this section apply to both Indigenous and non-Indigenous contexts. We acknowledge that Indigenous peoples face many more barriers as the result of ongoing and historical colonialism in Canada. There is a pressing need for a comprehensive analysis of the challenges and specific needs of Indigenous peoples related to CBWM. However, such an analysis is beyond the scope of this section.

SUSTAINABLE FUNDING

Sustainable funding is required to co-ordinate programs; train and retain qualified monitors; develop and maintain data management systems; support analysis, reporting and use of data; and retain institutional capacity, among other things (Carlson and Cohen, 2018; Conrad and Hilchey, 2011; Whitelaw et al., 2003.) The topic of funding is explored further in Section 6.

INSTITUTIONAL CAPACITY

A lack of sustained volunteer interest has been identified as one specific barrier to institutions conducting volunteer-based CBWM (Conrad and Daoust, 2007; Whitelaw et al., 2003). This may be influenced by several factors, including potential mismatches between volunteer interests and time, and monitoring program needs for engagement over the long-term. Likewise, complex or rigorous monitoring protocols such as the CABIN protocol; (see the case study at the end of this section) that require highly trained volunteers may be associated with costly certification programs that pose a financial barrier (Buckland-Nicks, Castleden and Conrad, 2016). For Indigenous governments and communities in particular, limits to institutional capacity mean being faced with the challenge of selecting priorities from among myriad pressing concerns.

POWER DYNAMICS

Mainstream approaches to capacity building tend to ignore the power dynamics that structure the context in which CBWM programs are being developed. Capacity building “ignores the fact that the very reason why some communities have difficulties in ‘developing’ is not their lack of capacity, but the structural, political and resource impediments in their way” (Kenny and Clark 2010, p. 8). Capacity building frequently fails to acknowledge the historic and ongoing effects of colonialism on Indigenous peoples in Canada associated with disruption of traditional laws, language and culture (Borrows, 2002; Napoleon, 2013). Mainstream approaches to capacity building have also ignored the need for non-Indigenous partners to build their capacity to work with Indigenous nations and within Indigenous territories, including increasing understanding of complex jurisdictional issues related to water governance, Indigenous ways of knowing and being, and traditional governance systems (Kotaska, 2013; Simms et al., 2016).

Opportunities

PARTNERSHIP DEVELOPMENT

Multi-stakeholder monitoring programs can increase the long-term organizational capacity and overall stability of CBWM programs by providing human and financial resources (Hunsberger, 2004). These partnerships can be used to leverage financial and other resources needed to support CBWM programs.

In Indigenous contexts, Indigenous-led bridging organizations have been key to building capacity for CBWM. These bridging organizations co-ordinate the efforts of multiple Indigenous governments, for example, Coastal First Nations or the Yukon River Inter-Tribal Watershed Council (YRITWC). At times, they also collaborate with external parties to leverage “networked capacity” while still acknowledging the authority of Indigenous governments to direct their own monitoring programs and engage in other self-determination activities that challenge current power dynamics. A good example of this is the international partnership model among Alaska Native Tribes and First Nations, the Yukon River Inter-Tribal Watershed Council (YRITWC), and the United States Geological Survey (USGS) (Wilson et al., 2018).

Opportunities exist for non-Indigenous groups to partner with and support Indigenous organizations that have monitoring programs to collect mutually beneficial data or collect data on a fee-for-service basis.

PROGRAM DESIGN THAT BALANCES SCIENTIFIC AND EDUCATIONAL GOALS

Where CBWM efforts are volunteer-based, integrated program designs that involve both adequate quality standards and engage volunteers are more apt to maximize resources and realize both scientific and educational goals, improving volunteer capacity and retention (Buckland-Nicks, Castleden and Conrad, 2016). To do this, programs must understand volunteer interests, motivation and skill level, and match monitoring design to this (Bliss et al., 2001; Whitelaw et al., 2003), while maintaining scientific credibility.

IN-KIND CONTRIBUTIONS

Non-monetary contributions are a valuable source of support for less-resourced CBWM groups. In-kind support may fall into the following areas:

- **Physical infrastructure**
 - Office space
 - Equipment such as monitoring kits, lab space, boat / car access
- **Technology**
 - Data management software
 - Access to servers and computers
- **Skills and time**
 - Volunteering
 - Training and technical expertise
 - Bookkeeping support
 - Fundraising including proposal writing
 - Networking (Weston and Conrad, 2015)

ENGAGING A KNOWLEDGE CO-PRODUCTION MODEL

Knowledge co-production conceptualizes capacity building in CBWM as a “mutual journey of discovery” (Kenny and Clarke, 2014, p. 10). Taking this concept further, community organizing emboldens leadership in communities to fight oppressive systems impeding their well-being (Kenny and Clarke, 2014, p. 18). In both non-Indigenous and Indigenous contexts, this means that capacity building should go beyond a narrow focus on technical capacity such as sampling protocols, and build institutional capacity for leadership, governance, and sustainability to maintain programs and use data in decision-making and other processes (Buckland-Nicks, Castleden and Conrad, 2016; Wilson, et al., 2018).

Draft Recommendations

The following actions can be taken by the federal government to build capacity for CBWM:

1. INVEST IN PARTNERSHIP DEVELOPMENT

- Develop partnerships with community institutions to conduct CBWM.
- In Indigenous monitoring contexts:
 - Develop partnerships with Indigenous bridging organizations to engage networked capacity (Wilson et al., 2018).
 - Focus capacity building efforts on developing partnerships that make Indigenous leadership and self-determination a high priority (Kotaska, 2013; Wilson et al., 2018). The federal government and other funders should be cautious about forcing unwanted or context-inappropriate partnerships.

2. SUPPORT KNOWLEDGE CO-PRODUCTION IN ACCORDANCE WITH INDIGENOUS PROTOCOLS AND POLICIES

- Create space for capacity building that is directed and led by Indigenous peoples for CBWM programs involving Indigenous peoples. To start:
 - Provide long-term funding for Indigenous Guardians and Indigenous-led CBWM programs
 - Include a mandate for federal water scientists and policymakers to recognize and make room for the role of ceremony and cultural connections to water and actively participating in these, where appropriate.
- Ensure that investment in CBWM in Indigenous contexts begins with acknowledging Indigenous self-determination and accounting for the broader political, economic, and jurisdictional challenges and inequities faced by Indigenous communities as a result of ongoing legacies of colonialism
- Challenge non-Indigenous partners to build their capacity to work with Indigenous peoples by genuinely investing in reconciliation and developing an improved understanding of Indigenous systems of knowledge, law, and governance.

Case Studies

ATLANTIC COASTAL ACTION PROGRAM (ACAP)

Between 1991 and 2009, ACAP was a federal government initiative operated by then Environment Canada. Its purpose was to help Atlantic Canadians restore and sustain local watersheds and adjacent coastal areas. Environment Canada and 15 ACAP groups (also known as the “ACAP family”) worked together to develop environmental management plans, build awareness of local environmental issues, and advance scientific research to inform restoration efforts for freshwater systems, estuaries and Atlantic harbours.

Studies of ACAP’s costs and benefits between 1997 and 2001 revealed that there were significant economic, social and ecological gains from the government’s investment. A shift in the funding model in 2009 from providing core-funding to project-based funding through the Atlantic Ecosystem Initiative (AEI) has had a significant negative impact on the capacity of individual CBWM organizations to continue their monitoring activities, particularly smaller, less resourced groups.

For more information, see McNeil, Rousseau, and Hildebrand (2006).

THE INDIGENOUS OBSERVATION NETWORK (ION)

Organized through a partnership model among Alaska Native Tribes and First Nations, the Yukon River Inter-Tribal Watershed Council (YRITWC), and the United States Geological Survey (USGS), ION is the largest international, Indigenous-led monitoring initiative combining Indigenous Knowledge (IK) and western science to research, sustain and protect the Yukon River Basin (YRB). Since the program began, more than 300 community members have been trained to conduct sampling and analysis of water quality data. Over 1500 samples have been collected at more than 50 sites covering the entire 2,300-mile reach of the Yukon River (Herman-Mercer, 2016).

Strong collaborative relationships ensure that technical and financial capacities are fairly distributed within the network. Importantly, Indigenous leadership in CBWM within the YRB has been essential in developing a program that is designed to meet desired outcomes for Indigenous water rights and co-governance.

For more information, see the Yukon River Inter-Tribal Watershed Council website:
<http://www.yritwc.org/science>.

THE COASTAL FIRST NATIONS REGIONAL MONITORING SYSTEM

Located in the North and Central Coasts of British Columbia, the Regional Monitoring System (RMS) was developed with the Coastal First Nations' Stewardship Offices and is administered by the Coastal Stewardship Network, a program of the Coastal First Nations-Great Bear Initiative. Guardian Watchmen play an important role in monitoring compliance with rules and regulations set out in ecosystem-based management plans and agreements such as the Marine Plan Partnership plans and Great Bear Rainforest Land Use Order, and are actively involved in education and outreach related to cultural and ecological values in the region. The water monitoring component of the RMS consists of stream surveys to collect water quality data, conduct salmon habitat assessments, and survey returning salmon to improve knowledge in priority watersheds.

With support from the Coastal Stewardship Network, member Nations of the RMS evaluate the system to ensure that it meets the changing needs of First Nations; keeps pace with advances in mobile technology; continues to collect data that will inform First Nations' land and marine use planning and management; and facilitates collaboration between Guardian Watchmen and non-Indigenous monitoring agencies (Kotaska, 2013).

The Coastal First Nations use a variety of sources of funding to support monitoring, including own-source revenue, government-to-government agreements, foundations, Coast Funds' conservation endowment, government funding programs, fee-for-service, and partnerships or agreements with academia, non-governmental organizations, government, and industry.

For more information, see the Coastal First Nations website:

<http://coastalfirstnations.ca/our-environment/programs/regional-monitoring-system/>

COLUMBIA BASIN WATERSHED NETWORK

Located in British Columbia's Columbia River Basin, Columbia Basin Watershed Network (CBWN) facilitates the sharing of knowledge and participates in water monitoring activities. The CBWN is led by a Board of Directors at the regional level and is publicly funded by the Columbia Basin Trust and key philanthropic granting sources. CBWN benefits from significant in-kind contributions from member groups and individuals.

CBWN promotes and supports collaboration at the sub-regional scale and works with members and partners to identify shared resource issues and to collaborate with partners to solve these at the Basin scale. As such, CBWN is well-placed to support and co-ordinate the efforts of sub-basin monitoring activities; to distribute knowledge; and to assist in the management of data through a regional Data Hub – a new initiative it is actively scoping.

For more information, see the Columbia Basin Watershed Network website: cbwn.ca



THEME 2

Effective Monitoring

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Overview

Despite the demonstrated benefits of CBWM, the credibility and utility of CBWM data has often been questioned. Data collected by CBWM programs may be viewed as inaccurate or of lesser quality given monitors' lack of traditional scientific training; such data may also be perceived as biased, if monitoring is motivated by specific citizen concerns. Data quality concerns may be further compounded by the short-term/stop-start nature of many CBWM programs. To address these concerns, CBWM programs can integrate the skills and experience of professional scientists with the commitment of trained community monitors (Kanu et al., 2016), matching tasks with the appropriate individuals and skills to leverage the unique capacity of all participants. Input from citizens and scientists alike drives an iterative program design that streamlines and simplifies data collection and interpretation to reduce error (Kosmala et al. 2016) and increase engagement.

CREDIBILITY OF CBWM DATA

Studies comparing water quality data collected by CBWM programs with those collected by professional scientists have found that statistical differences are not significant, and the data collected are of high quality (Shelton, 2013; Herman-Mercer et al., 2018). Diverse CBWM models exist and tailoring the approach of the program to desired objectives is key to ensuring that the data and information collected is fit for purpose. It should also be recognized that different knowledge systems have different methods and protocols for producing information that is considered valid within those systems.

PROGRAM DESIGN

CBWM program design should be driven by the questions and concerns at hand, which in turn determine the methods, indicators of interest and the appropriate temporal and spatial resolution of sampling activities (Kanu et al., 2016). Capacity and resources available will also influence program design and scope. More data is not always better, if it does not address the overarching goals of the monitoring program or the concerns of participants.

TRAINING, EQUIPMENT AND MONITORING PROTOCOLS

For western scientific monitoring, protocols and equipment should be standardized and supported by appropriate quality assurance/quality control (QA/QC) measures to ensure consistency and replicability of data collection. Opportunities to standardize protocols and simplify sampling equipment, based on participant experience, can reduce sampler error and increase efficiency, and ensure consistency among samples. Field audits are a necessary component of QA/QC, and also provide collaborative opportunities to refine and clarify



sampling protocols. Automated data entry and detailed metadata record-keeping enables participants to trace and evaluate unexpected results. Comparability of lab performance is evaluated as necessary, particularly when CBWM is being used to augment existing agency monitoring programs. Sharing monitoring outcomes in accessible formats that provide appropriate context allows volunteers to understand the impact of their participation, supports long-term engagement and reinforces the credibility and utility of citizen-generated data.

Once CBWM data is shared, it must be evaluated by data users for validity like any other scientific dataset – by review of the methods, QA/QC measures, associated metadata, and replicability, etc. As with data collected by professional scientists, statistical analyses can identify bias, systematic error, or outliers in the data so that they can be addressed (Kosmala et al. 2016).

Draft Recommendations

The federal government can take the following actions to encourage effective monitoring:

1. Where appropriate, participate in the co-design of strategic monitoring plans that fill critical data gaps while leveraging existing infrastructure or data collected under existing long-term monitoring programs:

- Assist communities in determining what, when, how, and where to sample in order to answer the questions at hand.
- Identify opportunities where existing research infrastructure (e.g., HYDAT stations) or long-term datasets can be used to identify data gaps where CBWM efforts will be most valuable.
- Earmark resources and departmental staff time to work collaboratively with CBWM groups (e.g., through peer-reviewing of jointly developed monitoring plans).

2. Where desired and appropriate, support CBWM protocol design and review, as well as data analysis and interpretation:

- Work with experienced CBWM practitioners to develop a CBWM program design toolkit or checklist.
- Provide support and participate in sampling and lab comparison studies to evaluate data comparability.
- Provide access to lab space or in-kind support for lab analyses, as commercial labs can be cost-prohibitive.

3. Promote and support sharing of relevant protocols and equipment across CBWM programs within and between regions:

- Support regional coordination among CBWM programs with common objectives.
- Identify and support opportunities for resource-sharing (e.g. monitoring equipment loans, data management expertise, analysis expertise).

4. Support the development of standardized monitoring protocols, where appropriate:

- Invest in collective efforts to standardize protocols, including best practices to ensure spatial, temporal, and methodological consistency.
- Following principles of open government, ensure protocols are openly shared and accessible.

Case Studies

LAKE WINNIPEG COMMUNITY-BASED MONITORING NETWORK

Located in the Lake Winnipeg watershed, Lake Winnipeg Community-Based Monitoring Network (LWCBMN) increases the spatial and temporal resolution of phosphorus monitoring. This network mobilizes citizens across the watershed to generate useful and credible water quality data to identify phosphorus hotspots: areas that contribute a disproportionately high phosphorus load to local waterways. LWCBMN volunteers follow scientifically-vetted sampling protocols that are compatible with provincial and federal water-quality monitoring initiatives, meaning LWCBMN data can be easily integrated into decision-making processes, and can guide the development of evidence-based policies and practices. LWCBMN is guided by the expertise of LWF's Science Advisory Council, composed of nationally recognized freshwater scientists from across the country.

Annual funding is received from multiple private and public foundations. Recently, the network received a four-year federal funding commitment from ECCC. LWCBMN data is currently being used to inform decision-making by watershed district managers, and has been acknowledged as increasing provincial capacity to target phosphorus load reductions and improve water quality across Manitoba.

For more information, see the Lake Winnipeg Community-Based Monitoring Network website: <http://www.lakewinnipegfoundation.org/lake-winnipeg-community-based-monitoring-network>

MIKISEW CREE FIRST NATION-COMMUNITY BASED MONITORING PROGRAM (MCFN-CBM)

Based in the Peace Athabasca Delta of northern Alberta, Mikisew Cree First Nation-Community Based Monitoring Program (MCFN-CBM) program uses scientific methods and local IK and wisdom passed down by Elders to watch, listen, understand and report on activities that may cause harm to their traditional lands and resources in the delta. The results of their studies are used to inform community members about the state of the traditional territory, to assist the leadership in establishment of Indigenous policies, and to inform consultation processes surrounding the impacts of resource development.

The programs measure water depth and navigation, water quality, ice thickness and snow depth, and CBM staff collaborate with other Indigenous, federal, provincial, territorial and University researchers in examining contaminants in wildlife and fish. MCFN CBM Guardians also respond to emergencies such as the October 2013 Obed spill.

For more information see the Mikisew Cree First Nation-Community Based Monitoring Program website: <http://mikisewgir.com/cbm/>



THEME 3

Regional & National Collaboration

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Overview

Countless watershed-focused monitoring organizations exist across Canada and many of these rely on robust partnerships among Indigenous and non-Indigenous CBWM participants and different levels of government. Examples of such partnerships are the PEI Watershed Alliance, the NWT-wide CBM Program, and the Indigenous Observation Network Case Studies. Despite successful examples of collaboration, many actors in the water monitoring and management landscape continue to operate in silos, focusing on one lake, beach or river without looking at the entire system. Regional collaboration more readily mobilizes knowledge within communities, enhances the inclusion of decision-makers, fosters peer-to-peer learning, and can leverage funding well beyond original investments (Weston and Conrad 2015, McNeil et al., 2006, Whitelaw et al. 2003).

Challenges

COMPLEX INTER-JURISDICTIONAL AND CROSS-SECTORAL RELATIONSHIPS

Organizations operating at the local and municipal level often face issues of concern that may fall under provincial, federal, Indigenous or even international jurisdiction. While many CBWM funding programs are administered by the federal government, the projects themselves may require multi-sectoral collaboration. This can lead to confusion over who does what. For example, when groups undertake a watershed connectivity project to improve fish passage or flow, provincial departments of transportation may be required for project approval, but DFO also has jurisdiction and responsibilities relating to fish habitat. Information about these responsibilities may be difficult for CBWM groups to access, or there may not be an obvious point person for groups to contact in each department.

ESTABLISHING TRUST AMONG ACTORS

Efforts towards collaboration must overcome existing mistrust among different groups. In Indigenous contexts, careful thought must go into ensuring that cultural knowledge and practices are respected in order to foster mutually respectful collaboration with Indigenous-led monitoring programs.

Opportunities

The federal government is well-placed to support strategic collaboration where it is appropriate, desired and brings value. Over the past few decades a number of federal funding programs have facilitated regional collaboration among CBWM initiatives such as the following:

- **Ecological Monitoring and Assessment Network (EMAN)** was a national citizen science program that was co-founded by Environment Canada and discontinued in 2010 (see the case study at the end of this section);
- **Atlantic Coastal Action Program (ACAP)** was operated by Environment Canada from the mid 90s to mid-2010. ACAP's model clearly demonstrated the environmental, economic, and social potential of a CBWM program (see the case study in Theme 1: Capacity Building). EC held annual gatherings of ACAP Directors, which led to strong program development and natural partnerships that exist to this day;
- **Atlantic Ecosystem Initiative (AEI)** provides funding through ECCC (2015-present). It encourages the inclusion of multiple types of partnerships in proposals;
- **Aboriginal Aquatics Resources and Oceans Management (AAROM)** organizations and the **Community Aquatic Monitoring Program (CAMP)** are ongoing programs run by DFO;
- **Great Lakes Protection Initiative:** Citizen Science Stream was announced in 2018 and will run until 2022. Funding will be allocated to programs that enhance public knowledge and awareness around Great Lakes water quality and ecosystem health;
- **Great Lakes Protection Initiative:** Indigenous stream has the aim of increasing Indigenous participation in restoration and monitoring efforts throughout the Great Lakes Region.

As federal interest in CBWM grows, it is imperative that federal department staff be empowered to actively engage with community-led initiatives. For example, the ACAP structure enabled regional ECCC staff or "EC Windows" to co-ordinate networking opportunities and facilitate cross-jurisdictional connections (Weston and Conrad, 2015). An international example is the New Jersey Department of Environmental Protection which has a Volunteer Monitoring Coordinator.

Several non-governmental organizations and networks are also actively facilitating regional collaboration in Canada. Organizations such as the Atlantic Water Network, the Lake Winnipeg Foundation, Swim Drink Fish, and the Coastal Stewardship Network support local CBWM efforts in their respective regions. "By joining wider networks and linking to other monitoring and scientific research initiatives, community members gain a sense of being a part of a wider collective, and gain access to new ideas and approaches that can improve techniques and lead to new discoveries" (Johnson et al., 2015 pg. 35).



Draft Recommendations

The federal government can take the following actions to promote regional and national collaboration:

1. Be a part of the conversation: Participate in local, regional and national gatherings where organizations organically network, share ideas, and support one another.

- Attend local and regional non-governmental CBWM gatherings and water management meetings to enhance federal awareness of the scope of CBWM work across watersheds and stay abreast of opportunities to collaborate;
- Invest staff time and resources in projects that are designed to bring local actors together to address practical issues of common concern.

2. Where desired and appropriate, support CBWM protocol design and review, as well as data analysis and interpretation:

- Support non-governmental organizations and platforms that are well-positioned to facilitate regional collaboration.
- Seek opportunities to co-design and manage water monitoring through mechanisms that promote cross-sectoral collaboration between environmental non-governmental organizations (ENGOS), multiple levels of government, Indigenous nations, academia, and industry (an ongoing example of this collaboration can be seen in the Columbia Basin Framework on Water Monitoring, see case study in Theme 1: Capacity Building).
- Avoid forced collaborations through funding programs where partnerships might not make sense.

Case Studies

ATLANTIC WATER NETWORK

The core mission of the Atlantic Water Network (AWN) is to build capacity among stewardship and watershed organizations by providing access to water monitoring and conservation resources such as standardized training via WET-Pro water monitoring kits, a secure and open access data hub (Atlantic DataStream), and the free use of an Environmental Monitoring Equipment Bank.

By sharing resources, AWN has contributed to the development of a standardized approach to water quality monitoring across Atlantic Canada through its online database, WET-Pro training and toolkit. AWN facilitates collaborative networking among member organizations and supports educational outreach efforts with the broader public. Importantly, AWN facilitates dialogue among relevant stakeholders about how to share water quality data and information products to facilitate uptake in decision-making. Collaboration with academic research has helped measure and communicate the credibility of CBWM data to other audiences (Shelton, 2013).

For more information see the Atlantic Water Network website: <http://atlwaternetwork.ca>

PRINCE EDWARD ISLAND WATERSHED ALLIANCE

Focusing on the Inland waters of Prince Edward Island, Prince Edward Island Watershed Alliance (PEIWA) supports the development of new and existing inland Watershed Groups in meeting their objectives to improve and protect the environmental quality of their watersheds. The Alliance serves as the main voice for all of the groups, which together account for water stewardship activities covering approximately 95% of the island. The provincial government of PEI provides multi-year core funding to members of the Alliance through a Watershed Management Fund (WMF). As well, PEIWA was successful in securing large-scale, multi-year funding from the federal government worth approximately \$2 million.

Brokered through the PEIWA, partnerships established with local farmers, woodlot owners, and community organizations have helped minimize the impacts of local industries on freshwater health. Often this involves tree and shrub plantings in the riparian zone, taking marginal lands out of crop production, and educating industries about provincial incentive programs (e.g., ALUS, NAPA, etc.). The Alliance has also been instrumental in the development of a Watershed Strategy and has provided input into recently drafted provincial legislation, the Water Act.

For more information see the Prince Edward Island Watershed Alliance website: <http://www.peiwatershedalliance.org>

Case Studies

ECOLOGICAL MONITORING AND ASSESSMENT NETWORK (EMAN)

No longer in operation, EMAN was funded by Environment Canada from 1994 to 2010. Operating at the national level, EMAN was a network of organizations involved in ecological monitoring in Canada to better detect, describe, and report on ecosystem changes. EMAN promoted the integration of long-term, multidisciplinary ecosystem research projects and their results across Canada, and helped to standardize protocols and contributed to making data accessible. Many conservation professionals and citizen scientists continue to monitor using these protocols.

During its existence, EMAN effectively demonstrated the importance of connecting different stakeholders, including citizen scientists, through their shared goal of monitoring ecosystem change across Canada using standardized protocols. EMAN also demonstrated the importance of secured funding and a leadership role through a Coordinating Office to strengthen the network. However, relying solely on a single source of funding, particularly government funding, is risky with budget cuts. A model with more distributed authority in terms of governance and funding would have increased the resiliency of the network.

For more information, see the archived ECCC website for EMAN:

<http://www.ec.gc.ca/faunescience-wildlifescience/default.asp?n=E19163B6-1>

ARCTICCONNEXION, POND INLET COMMUNITY-BASED WATER MONITORING

Located in Pond Inlet, Nunavut and working in adjacent watersheds, ARCTICConnexion's objectives are to implement a novel research framework based on community leadership, cultural relevance, and youth skills development for advancing scientifically rigorous water research capacity in Nunavut. Local watershed monitoring employs field- and satellite-based data to integrate various measures:

- climate (weather)
- landscape parameters (vegetation, soils, permafrost)
- hydrological conditions (stream flow, water level)
- water quality measures (DO, pH, conductivity, bacterial, benthic invertebrates)

Additionally, participatory mapping and traditional knowledge is used to guide the research locations and questions.

The program's focus on community-led research with scientific mentorship builds research capacity in a decolonizing and empowering spirit of truth and reconciliation. The program has seen progress in reframing the position of Inuit traditional knowledge and scientific knowledge in Arctic research settings and has already been successful in establishing community laboratory infrastructure in Arctic communities. The Project is expanding with water quality projects in the communities of Arviat, Baker Lake, and Taloyoak, Nunavut. **For more information, see the ARCTICConnexion website:**

<http://arcticconnexion.ca/project/pond-inlet/>

THEME 4

Data Management

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Overview

Among the most frequently cited motivations for collecting water quality data through CBWM is the hope that the information generated will inform water stewardship decisions and policy. And, while CBWM groups are collecting data that could be used in this way, it often doesn't reach decision-making tables (Weston and Conrad, 2015; Vines et al., 2014; Kanu et al., 2016). One of the barriers to this is the limited capacity and infrastructure that communities have to manage the data they collect (Pulsifer and McNeave, 2014; Michener, 2015). The end result is that when CBWM data is available, it is often scattered and inconsistent, making it difficult for communities and other end-users to interpret and use them for decision-making.

The impact of this is well-illustrated in the challenges WWF Canada encountered in producing its Watershed Health Assessments. This nation-wide assessment could not obtain sufficient data to calculate health scores for 65% of watersheds, despite the existence of comprehensive CBWM programs in some of these places. Though WWF did an extensive search for any data available, CBWM data was, quite literally, not on the map (WWF-Canada, 2017).

Challenges

The following challenges are common to CBWM data management:

- Data is stored in formats that are difficult to use in an analytical environment (such as in PDF or even paper format), not open (in formats that require the purchase of software), or difficult to aggregate with other datasets (i.e., "non-interoperable");
- Concerns exist about data sharing and how this impacts data security, ownership and control; this includes ensuring that data and its management can support decolonization efforts and avoid reintroducing colonial concepts and patterns.
- Data management infrastructure can be costly and cumbersome to develop and maintain. This is particularly true for groups seeking to adapt existing data management systems to new data models;
- There is a lack of financial and human resources to manage data once it is collected (Kanu et al., 2016).

Additional challenges, particularly relating to research and monitoring conducted by or with Indigenous communities, relate to processes around the treatment of sensitive data such as health data, or Indigenous knowledge about places with cultural or sacred significance (Johnson et al., 2015).



Opportunities

While communities do face real challenges managing their data, these are not intractable issues. Thanks to a combination of both technological advances and sociocultural shifts across disciplines and sectors, the data management issues of CBWM are arguably more solvable than they have ever been (Patterson et al., 2017; Cantor et al., 2018).

The advent of computer and web-based technologies alone presents tremendous opportunities to amplify the impacts of CBM initiatives. When datasets are well-managed, are available in formats that permit re-use, and when they are accompanied by detailed metadata (information that describes how, why and by whom the data were collected), there are considerable benefits including: protection against data loss; establishing baseline conditions; efficiency in research; and scaling up impacts from the community to a broader watershed or basin scale (DuBois as cited in Kanu et al., 2016, p.18).

Solutions to CBWM data management challenges do exist but navigating the vast landscape of tools, standards and platforms is a daunting challenge for both the data collectors who are seeking to manage and share data, as well as for the data users seeking to glean insights from that data to inform a complete picture of watershed health. This is where strategic support and leadership are needed from multiple partners including the federal government.

Data Management Principles

1. ETHICALLY OPEN ACCESS

Provide ethically open², accessible and understandable data. Open access datasets are distributed freely online without costs or other barriers (i.e. requiring login).

2. CLARITY ON INTELLECTUAL PROPERTY

Follow practices that support privacy, intellectual property rights, and sovereignty (Pulsifer and McNeave, 2014). It should be clear to contributors and end users who owns and has rights to data. Sustainability: Developing a data management plan that considers governance, financing, architecture, and long-term maintenance and operations can help ensure that data management practices are sustainable.

3. PERMANENT IDENTIFIER

Assigning permanent identifiers to datasets increases accessibility, enables clear citation, and identifies licensing terms, thus reducing chances of misuse. Digital Object Identifiers (DOIs) are the most common but others might include Uniform Resource Identifiers (URIs) and the Handle System (hdl).

4. DATA QUALITY

It is not always necessary to have access to high-quality data but rather to always know the quality of the data available. This can be achieved through use of robust documentation and metadata: the “who, what, where, when, and how of the data collection, or in other words, data about the data” (Pulsifer and McNeave, 2014)

5. STANDARDIZATION AND INTEROPERABILITY

Standardization ensures data is available in consistent, predictable, machine readable and internationally-recognized formats. This promotes “interoperability” in which an ecosystem of specialized hubs can connect in dynamic ways to match user needs and questions.

6. SUSTAINABILITY

Developing a data management plan that considers governance, financing, architecture, and long-term maintenance and operations can help ensure that data management practices are sustainable.

²Open data accounts for the need to appropriately manage the sensitive nature of some forms of data, such as health records. (Pulsifer et al., 2013)

Draft Recommendations

The federal government can help improve CBWM data management by taking the following actions:

1. Extend “open by default” approach to federally-funded CBWM while upholding principles of data sovereignty as articulated by Indigenous peoples.

- Lead by example by making the federal CABIN database open access.
- Extend the federal government’s “Open by Default” policy to the CBWM groups it supports by making open sharing of data a requirement of receiving federal funding (though note that exemptions should be made for any sensitive data or knowledge).
- Within Indigenous contexts, nation-to-nation relationships and principles of data sovereignty should be respected and implemented. The OCAP® principles³ (ownership, control, access and possession) set useful standards for how to conduct research with First Nations, including how to approach data management (First Nations Information Governance Centre, n.d.).

2. Incubate and scale existing data management efforts.

- Take stock of where CBWM data is currently housed and shared.
- Provide long-term support for existing independent data sharing platforms such as DataStream, CanWIN and Swim Guide so that they can serve the needs of CBWM groups.
- Encourage CBWM groups funded through federal programs to use existing platforms wherever possible rather than building new systems from scratch.

3. Build CBWM data management capacity.

- Tie CBWM funding to data management-related activities, that is, require that fundees provide a data management plan. This could include releasing final payment only once groups can demonstrate how and where data is being managed and, where appropriate, made open to the public.
- Support communities in developing data management expertise.
- Recognize that a data system includes social and organizational components such as policy, access models, legal and ethical dimensions and other facets related to the human context.
- Invest in “data rescue” by supporting initiatives to digitize and manage historical CBWM data.

4. Support the development of standardized monitoring protocols, where appropriate:

- Invest in collective efforts to standardize protocols, including best practices to ensure spatial, temporal, and methodological consistency.
- Following principles of open government, ensure protocols are openly shared and accessible.

³OCAP® is a registered trademark of the First Nations Information Governance Centre (FNIGC)

Case Studies

DATASTREAM

Currently operating in the Mackenzie River Basin, Atlantic Canada, and the Lake Winnipeg watershed, DataStream provides the infrastructure to support open sharing of water quality data across multiple monitoring programs and jurisdictions. Led by the Gordon Foundation at the national level, DataStream's regional partners include the Government of the Northwest Territories (GNWT) in the Mackenzie River Basin; the Atlantic Water Network (AWN) in Atlantic Canada; and the Lake Winnipeg Foundation in the Lake Winnipeg watershed. Data Stewards, or contributors, include watershed groups, Indigenous Guardian programs, governments and researchers.

DataStream employs a strong partnership model across regional hubs. All activities are carried out in collaboration with leading organizations across the country that are well-placed to effect change at the right levels. As well, DataStream is free and open for anyone to use. This approach has an embedded economy of scale, meaning that with each new iteration and improvement to the system, every monitoring organization, contributor, and user benefits.

For more information see the Gordon Foundation website: <http://gordonfoundation.ca/initiatives/datastream/>

CANADIAN WATERSHED INFORMATION NETWORK

Focused on the Lake Winnipeg Basin, the Canadian Watershed Information Network (CanWIN) is a web-based collaborative platform hosted at the University of Manitoba (UM) and supports research, education, management, policy and evidence-based decision-making about nutrient- and climate-related issues. CanWIN (formerly the Lake Winnipeg Basin Information Network) was created by Environment Canada as part of the Lake Winnipeg Basin Initiative under Canada's Action Plan on Clean Water and was transferred in 2012 to UM, where it benefits from a core funding model.

CanWIN currently hosts many different types of data, from community-based monitoring to historical and active research programs. CanWIN provides support to users on managing the complete data lifecycle, from project conception to data sharing. By working with multiple data managers, users and subject matter experts, CanWIN is working towards national and international standards for a common vocabulary and metadata, which increases the interoperability and therefore usability of the data. This harmonizing of disparate data and language enables users to ask new research questions by giving them the ability to analyze complex, multi-themed watershed issues across broad spatial and temporal extents.

For more information see the University of Manitoba website: lwbi.cc.umanitoba.ca

EXCHANGE FOR LOCAL OBSERVATIONS AND KNOWLEDGE OF THE ARCTIC

An international organization focused on the Arctic, Exchange for Local Observations and Knowledge of the Arctic (ELOKA) provides support to Indigenous organizations, communities, and researchers across a number of areas related to data management and use, while supporting communities in their efforts to attain data and information sovereignty in the Arctic. Primarily, ELOKA receives funding through the U.S. National Science Foundation to provide a range of data management support services.

ELOKA operates under the premise that meaningful knowledge exchange can only be achieved by linking physical networks, or technology, and human networks: community members, researchers, decision-makers, trainees, and others. ELOKA partners with Indigenous community members and representative organizations and networks all across the Arctic, from Canada and the U.S. to Greenland and Russia. ELOKA convenes workshops and events to facilitate exchange around themes related to data sovereignty, data management, and community-based observing.

In Canada, ELOKA provides data management support to community-based monitoring initiatives with the explicit goal of upholding Indigenous ownership and authority over Indigenous knowledge and data, for example, by following OCAP® principles across Canada and adhering to community-based research guidelines established in partnership with specific communities and research bodies such as the Natural Sciences and Engineering Research Council (NSERC), Social Sciences and Humanities Research Council (SSHRC), and Canadian Institutes of Health Research (CIHR) (Johnson et al., 2015).

For more information see the ELOKA website: <https://eloka-arctic.org>



THEME 5

Data to Inform Decision-Making

Overview

Community-based water monitoring is generating valuable information and engagement around freshwater issues from the ground up. But how can these efforts be mobilized to drive action on protecting and restoring the health of freshwater resources and ecosystems? Addressing this question requires an understanding of the end uses (and users) of CBWM data, and the types and format of information that are best suited to serve those uses and users.

Challenges

The following are common challenges encountered when applying CBWM data in decision-making:

- Confusion about the types of data needed by decision-makers and how the data are used makes it difficult for CBWM groups to ensure that their programs are relevant and reaching the right audiences. Many complex decision-making processes make it difficult to understand if, how and when CBWM data can plug in.
- Limited support and capacity for data analysis, interpretation, visualization and communication of CBWM data are limiting the translation of raw data into useable information and knowledge.
- There are perceived administrative and legal barriers to use of CBWM-generated data in government decision-making and a lack of overarching policies on integration of CBWM into decision-making.
- There is confusion around how to meaningfully and respectfully include IK in policy and other decision-making processes.

Opportunities

CBWM is already contributing critical data towards a shared knowledge base and better understanding of environmental change. It has the potential to serve a wide range of purposes, from the design and implementation of public awareness campaigns and tracking long-term trends in water quality, to specific decision-making processes such as policy development, planning, regulatory compliance, and stewardship programs. CBWM data also has potential for use at multiple, nested scales ranging from particular places, neighbourhoods and communities to watersheds, provinces and territories, Indigenous territories and across the country.

When the desired end use of the data is clear, appropriate protocols for data collection, management, interpretation, and communication can be chosen accordingly. Ethically open data supports data reuse, for example to answer different research questions or for different scales of analyses, while democratization of research and science can be further supported through methods and tools that support communication of information in formats that are accessible, culturally appropriate, and contextually useful (Kanu et al., 2016).

For CBWM initiatives led by or involving Indigenous peoples, sharing of information and knowledge should also respect and be guided by cultural protocols and other standards developed by Indigenous governments and organizations, such as the First Nations Principles of OCAP® (Johnson et al., 2015).

PUTTING KNOWLEDGE INTO ACTION

Research shows that community-led monitoring can increase the speed of decision-making at the local level. This is because community members are best placed to observe environmental change in real-time, are more motivated to guide management actions that affect them directly (Danielsen et al., 2014; Conrad and Hilchey, 2010), and are well-placed to assess the success of management actions taken to address problems or threats. Successful examples of knowledge mobilization through CBWM, such as the Canadian Shellfish Sanitation Program and the Northwest Territories-wide CBM Program case studies noted below, illustrate how programs that are designed specifically to incorporate CBWM can be effective in facilitating exchange of data and information, and make it easy for monitoring groups to see their observations applied to real-world issues.

The Canadian Aquatic Biomonitoring Network (CABIN) provides an example of putting CBWM data into action at the national level. Maintained by ECCC, the CABIN is a “network of networks” consisting of government organizations at all levels, Indigenous communities, academia, industry, and other NGOs. CABIN data is housed in a centralized ECCC database that is designed to enable data sharing. It is anchored by a nationally consistent training program, implemented and maintained in partnership with the Canadian River Institute, that provides the knowledge and skills required to conduct a biomonitoring program to consistent national standards. The “network of networks” approach amplifies the collection of information and allows for cost-effective, powerful data sharing to inform resource management decision making and support the assessment of cumulative effects.



FUTURE DIRECTIONS

There is also emerging work pointing to the potential of CBWM as a tool for asserting Indigenous sovereignty, jurisdiction, and authority in decision-making processes (Kotaska, 2013; Wilson et al., 2018). The Mikisew Cree development of an Aboriginal Extreme Flow concept for the Athabasca River is one example: “Data has been used to validate the concept of the Aboriginal Extreme Flow... and to constructively challenge aspects of Alberta’s Surface Water Quantity Management Framework, most notably the assumptions in their Aboriginal Navigation Index or ANI” (Mikisew Cree First Nation, 2016, p. 6).

Despite these successful case studies, a recent study suggests that Canada lags behind other countries when it comes to incorporating CBWM data into monitoring, legal, and regulatory frameworks governing water quality and quantity (University of Victoria Environmental Law Centre, 2018). Other jurisdictions, such as the United States and the European Union, have begun institutionalizing processes to facilitate the consideration of CBWM, and all types of citizen science, in decision-making processes. A number of federal laws and programs in the U.S. have intentionally built in opportunities for public participation in decision-making through monitoring and data sharing arrangements⁴. There is a significant opportunity for Canada’s federal government to draw on both successful domestic examples and global experience to strengthen policy frameworks and develop the supports needed to better connect CBWM data and programs to decision making.

⁴ This was set in motion by a 2015 memorandum issued by the President’s Office of Science and Technology Policy to the federal government, instructing various agencies to promote the use of citizen science data in government science and policy (Office of Science Technology and Policy, 2015).

Draft Recommendations

The federal government can help mobilize knowledge for action with the following actions.

1. Coordinate federal support to strengthen CBWM through a cross-departmental strategy:

- Champion a focus on CBWM at Canadian Council of Ministers of the Environment (CCME)
- Develop a cross-departmental strategy to support and leverage CBWM in Canada

2. Better integrate CBWM data in decision-making at various levels (policy, planning and management).

- Identify appropriate opportunities to write provisions for use of CBWM data into existing decision-making processes related to water management and policy (e.g. under the Fisheries Act, proposed Impact Assessment Act, Canadian Navigable Waters Act).
- Support regional/drainage basin scale CBWM data comparison, integration and analysis
- Provide clarity around acceptable thresholds for data quality (tied to specific intended uses).
- Support development of tools and approaches to help contextualize raw CBWM data.
- Track the ways in which government departments use CBWM data in decision-making and publicly report on these data uses (E.g., through use of DOIs).

3. Promote knowledge-sharing best practices in government-funded research and science.

- Promote development of tri-agency partnerships with CBWM initiatives and incentivize the use of citizen science data in water research through grant applications.
- Encourage academics to be involved in other forms of communication beyond peer-reviewed publications. Encourage recognition of the value of non-traditional outputs.
- Adopt the principles of transparency, openness and mindfulness regarding data stewardship and its reuse.
- Ensure that information and knowledge products derived from CBWM data for policy are first reported back to the community in a timely fashion.
- Work with the tri-agencies to reduce “embargo periods” in federally funded research involving CBWM partnerships and data.
- Respect Indigenous policies, standards and protocols relating to the use of Indigenous knowledge and data collected by and in Indigenous communities.

Case Studies

WWF-CANADA'S WATERSHED REPORTS

Through its Watershed Reports, WWF-Canada set out to create the first national picture of the health of and threats to Canada's freshwater. While WWF-Canada doesn't engage in monitoring, the Watershed Reports use data from as many monitoring organizations as possible. Watershed Reports take data and complex analysis to transform them to create a product that is easily transmissible and understood.

To create the Reports, WWF-Canada first consulted with leading freshwater scientists to develop an assessment framework. That framework was then used to produce reports on the health and threats to Canadian rivers. An interactive website was designed to publish the results, engage Canadians and raise awareness about the watersheds they live in.

This platform and project can give a voice to smaller monitoring groups and make them a part of national freshwater discussions. Often, groups operating on a smaller scale have nowhere to share their data, meaning it doesn't get used as much as it could. Watershed Reports gives them that option. Since its creation, Watershed Reports has been used by many individuals and organizations to advocate for infrastructure, water management and policy changes. Many organizations use the results as leverage to support their own work, or even use it to establish priorities.

For more information see the website for WWF-Canada's Watershed Reports:

<http://watershedreports.wwf.ca/#canada/by/threat-overall/profile>

SWIM DRINK FISH

A national initiative, Swim Drink Fish is a stewardship organization focused on blending science, law, education, and storytelling with technology, and works towards swimmable, drinkable, fishable water for everyone.

Swim Drink Fish's initiatives have different way of sharing knowledge, using digital communications technology to promote public access to information wherever and whenever people need it. Swim Drink Fish uses made-in-house apps and web platforms to communicate that information to the public.

Swim Drink Fish has demonstrated that there is demand for data sharing standards, especially in a field where monitoring practices are relatively well-established and consistent. The biggest challenge continues to be the clash between today's "open by default" mentality and the traditionally closed mentality of government and institutional data-holders. Whenever Swim Drink

Fish has struggled to deliver current water quality information to the public, it has been largely due to attitudes towards data sharing, rather than because of technical or financial barriers.

For more information see the Swim Drink Fish website: <http://www.swimdrinkfish.ca/>

CANADIAN SHELLFISH SANITATION PROGRAM

The Canadian Shellfish Sanitation Program (CSSP) is a federal food safety program jointly administered by the Canadian Food Inspection Agency (CFIA), DFO and ECCC. The goal of the CSSP is to protect Canadians from the health risks associated with the consumption of contaminated bivalve molluscan shellfish such as mussels, oysters and clams. Under the CSSP, ECCC's Shellfish Water Classification Program (SWCP) conducts surveys of bivalve molluscan shellfish growing areas for the purposes of classifying areas for harvesting of species.

The CSSP has several active partnerships with Indigenous communities in B.C. to collect marine water quality samples as an alternative service delivery option for the program, including with the Tsleil-Waututh Nation (TWN) in Indian Arm. On October 25, 2016, the TWN completed their first FSC harvest in 34 years with the collection of 17.9 kg of softshell clams!

For more information see the Canadian Shellfish Sanitation Program website:

<http://www.inspection.gc.ca/food/fish-and-seafood/shellfish-sanitation/eng/1299826806807/1299826912745>

NORTHWEST TERRITORIES CUMULATIVE IMPACTS MONITORING PROGRAM

Based in the Northwest Territories, the Cumulative Impacts Monitoring Program (CIMP) supports better resource management decision-making and the wise use of resources by furthering the understanding of cumulative impacts and environmental trends. Monitoring cumulative impacts is a constitutional obligation of the Sahtu, Gwich'in and Tłıch'ı comprehensive land claim agreements and a statutory requirement of Part 6 of the Mackenzie Valley Resource Management Act.

The program uses a partnership approach to achieve its objectives. Partners include Aboriginal governments, universities, industry, and federal and territorial government departments. A steering committee of First Nations, Inuvialuit, Métis, federal and territorial government representatives guide the program.

All NWT CIMP project results are available on the NWT Discovery Portal. Also, beginning in 2016, all data from currently funded NWT CIMP water quality projects is available on the Mackenzie DataStream.

For more information see the description of the Cumulative Impacts Monitoring Program on the GNWT website: <http://www.enr.gov.nt.ca/en/services/cumulative-impact-monitoring-program-nwt-cimp/about-us>



GRUPE D'ÉDUCATION ET D'ÉCOSURVEILLANCE DE L'EAU (EDUCATION AND WATER MONITORING ACTION GROUP)

Based in Québec, Prince-Edward Island and French communities in New Brunswick and Manitoba, la Groupe d'éducation et d'écosurveillance de l'eau (G3E) (Education and water monitoring action group) works towards the protection of aquatic ecosystems through the development of citizen science initiatives as well as educational and scientific tools useful for aquatic ecological monitoring. Having received initial support from ECCC's Biosphere and from a variety of different partners, G3E now ensures its finances through a variety of funds, from government to private.

Since 2000, over 50 000 young people and 50-plus organizations have participated in the projects, and more than 275 bodies of water have been studied and adopted. Annually, close to 3000 young people participate, over 50 bodies of water are monitored, and 35 organizations either participate or help with co-ordination. Having a team of regional co-ordinators has multiplied the impacts of the programs and increased G3E's reach. Outcomes of G3E's programs could not have been achieved without collaborating with a diverse group of external partners. Critical knowledge sharing and transfer is due in large part to this regional co-ordinating team as well as the openness of G3E and its partners to share their experiences and tools, allowing a greater number of citizens to participate in monitoring their waters

For more information see the G3E website: <http://www.g3e-ewag.ca/home.html>



THEME 6

Sustainable Funding

Overview

Community-based Water Monitoring (CBWM) is, by nature, a continuous process that yields many of its greatest benefits if performed consistently over long periods of time. Thus, sustained funding is key to achieving the full benefits of CBWM for communities and governments alike.

Indeed, some of Canada's most successful CBWM programs are not necessarily the ones with the most funds in a given year, but those with sustained funds year over year. This enables groups to build the capacity to not only be effective in their monitoring efforts but yield significant financial and non-financial benefits. For instance, through the Atlantic Coastal Action Program (ACAP), Environment Canada provided core funding to each of the ACAP groups (see the case study at the end of Theme 1: Capacity Building), who were then able to leverage these funds well beyond their original value to achieve greater social, economic and environmental outcomes. The financial benefits of ACAP are well documented.

Had Environment Canada conducted the same work using a traditional approach, with government offices and employees rather than a community-led approach, it would have had to spend 12 times as much money to derive similar benefits. ACAP's economic impact (GDP) was, in total, about 22 million dollars in direct and spin-off economic activity from 1997 to 2001, which far exceeds Environment Canada's six million-dollar investment (McNeil et al., 2006 pg. 373).

Beyond yielding a high economic return on investments, depending on the level of community ownership and participation, CBWM can generate a range of benefits by building on many different community values, as seen in Figure #.

Coastal Guardian Watchmen programs generate 10 to 1 annual return on investments

The Coastal Guardian Watchmen programs illustrate how much value can be derived from investments in community-led monitoring initiatives. The Coastal Guardian Watchmen programs operate under management agreements that respect the title and rights of First Nations in ancestral traditional territories and undertake the following activities consistent with CBWM:

- Gather data on the ecological health and community wellbeing;
- Compile and share data to inform decision-making, and
- Work with Coastal First Nations, provincial and federal governments to ensure coordinated and robust monitoring and enforcement of environmental management plans.

A costs and benefits analysis that examined both monetary (e.g., wages) and harder to measure non-monetary community values (e.g., cultural wellbeing, community capacity, governance authority, and taking care of territory, among others) found that Guardian Watchmen Programs generate a 10 to 1 annual return on investment (ROI) within the coastal First Nations that operate them. In other words, for every dollar invested, the Nation benefits 10 times that amount. For some programs, the First Nation can benefit from an annual ROI as high as 20 to 1. These contributions also extend beyond the First Nations that lead the programs, benefiting other coastal communities, government agencies, and the broader Canadian public. (EcoPlan International, 2016)

Challenges

CBWM groups frequently encounter the following challenges:

- **Short-term funding:** For CBWM programs that rely on governments to sustain their activities, the need for long-term core funding is often at odds with federal policy and budgetary timelines. Funding agencies both within and outside of governments rarely provide multi-year funding for monitoring, and when they do, the support will typically not extend beyond three years.
- **Project-based funding:** It is widely acknowledged that “without long-term, holistic, and sustainable financing for CBM, initiatives are constrained to the project level” (Bellfield et al., 2015, p. 153). Funding shortages, created by short-term or project-based funding models, have also been linked to poor data quality and fragmentation issues (Bliss et al., 2001; Conrad and Daoust, 2008). Unstable funding results in inconsistent monitoring activities and reduces the credibility and utility of CBWM data.
- **Eligible costs:** Tight restrictions on eligible costs on the part of different funders poses a significant challenge to CBWM groups tasked with covering all phases of a monitoring program from data collection and management to analysis, interpretation and reporting. Desire for tangible outcomes (as reported in metrics and before / after) detracts from funding for less easy to quantify outcomes such as social connection and knowledge sharing through water.

Opportunities

SHIFTING FUNDING MODELS

The financial and non-financial benefits of CBWM programs justify a shift towards multi-year or core funding models (Bonney et al., 2014; Conrad and Daoust, 2007; EcoPlan International, 2016). We echo Conrad and Hilchey’s findings, noting that “if relevant government agencies have the foresight to acknowledge the multiple benefits of CBM programs and want to link

their efforts to enhanced environmental management, they can make funding for CBM a priority” (2010, p. 282).

Some provincial and territorial governments are already championing inventive funding models that provide reliable, long-term resources for community-led monitoring and water stewardship initiatives. For instance, the Northwest Territories Community-Based Monitoring Program represents an example where the GNWT provided long-term funding to support CBWM. A plan and associated funding for CBWM is embedded in the NWT Water Strategy, indicating a formal recognition of its value in achieving shared water objectives. For more information about the NWT-Wide Community-Based Water Monitoring Program, see their website (<https://www.nwtwaterstewardship.ca/node/105>).

Efforts to shift from project-based to core funding models are also being tested by some federal government departments. Though the impacts have not yet been measured, CIRNAC has recently invested \$31.4 million over five years for the Indigenous Community-Based Climate Monitoring Program, signaling a shift away from project-based funding models. ECCC also recently awarded Swim Drink Fish \$1.8 million for CBWM in the Great Lakes, which includes establishment of monitoring hubs in three Indigenous communities (see case study in Theme 5: Mobilizing Knowledge for Action).

Adaptive and resourceful CBWM programs can thrive during periods of fiscal austerity and political change by leveraging the funds that are available, particularly when they are well-networked and have at least one permanent staff person. That said, as argued in a recent assessment of the Canada-wide CBWM landscape, “considering that CBM is often indirectly supporting the mandates of multiple levels of government responsible for water-related issues, governments should play a role in alleviating the financial, technical and logistical burdens associated with CBM” (Carlson and Cohen, 2018, p. 175).



Draft Recommendations

The federal government can help mobilize knowledge for action with the following actions.

1. Develop multi-year, core funding options.

- Develop multi-year, core funding for CBWM programs rather than project-based funding wherever possible.

2. Fund new and existing Indigenous Guardian Programs to improve Indigenous-Crown relationships and advance reconciliation through Indigenous-led programs

- Continue to provide long-term funding through initiatives like the Indigenous Community-Based Climate Monitoring Program, the Indigenous Guardians Program and the Aboriginal Aquatics Resources and Ocean Monitoring Program.

3. Streamline and simplify federal funding processes.

- Address tight turnaround times for funds granted and required spending that don't reflect the reality of monitoring timeframes.
- Adapt prescriptive funding models: recognize that the competitive funding landscape creates unequal opportunities and that some CBWM programs require additional resources and support (e.g., more rural or isolated sites requiring additional mileage allowances)
- Take a less restrictive approach to eligible expenses

4. Embed CBWM spending within federal water monitoring budgets

- Explore co-management approaches that embed long-term funding for CBWM within federal water management frameworks to combine efforts, achieve common goals, and avoid duplication.

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Appendix

Selected federal programs and funds relating to CBWM

A number of federal and provincial departments currently or have previously supported CBWM initiatives through funding programs, training, or the provision in-kind resources. Examples include but are not limited to the following:

ENVIRONMENT AND CLIMATE CHANGE CANADA

Community Aquatic Biomonitoring Network (CABIN)

Great Lakes Sustainability Fund

Lake Winnipeg Basin Stewardship Fund

Atlantic Ecosystems Initiative

Indigenous Guardians Fund

Gulf of Maine Initiative

St. Lawrence Action Plan

EcoAction Community Funding

Environmental Damages Fund

Great Lakes Protection Initiative

CROWN-INDIGENOUS RELATIONS AND NORTHERN AFFAIRS CANADA

Northern Contaminants Program

Indigenous Community-Based Climate Adaptation Monitoring Program

DEPARTMENT OF FISHERIES AND OCEANS

Aboriginal Aquatic Resource and Oceans Management Program (AAROM)

Community Aquatic Monitoring Program (CAMP) (cross-appointed with ECCC)

DFO Partnership Fund

Coastal Restoration Fund

RESEARCH GRANTING COUNCILS

Natural Sciences and Engineering Research Council

Social Sciences and Humanities Research Council

Canadian Institutes of Health Research

Canada First Research Excellence Fund - E.g., Global Water Futures Program

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