

Realizing the Potential of Community Based Monitoring in Assessing the Health of Our Waters

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Table of Contents

4..... INTRODUCTION

5..... BACKGROUND

7..... OPPORTUNITIES FOR COMMUNITY BASED MONITORING

8..... FIVE CORE CHALLENGES FOR CBM

9..... OVERCOMING THE CBM CHALLENGES: FIVE CASE STUDIES

9..... CASE STUDY 1 - Building a CBM Network for Lake Winnipeg: Connecting Scientists and Citizens

11..... CASE STUDY 2 - Mikisew Cree and Athabasca Chipewyan CBM Program: Empowering First Nations to be Part of Environmental Monitoring

13..... CASE STUDY 3 - The Lake Windermere Project: Challenges and Opportunities for Citizen Scientist Engagement

15..... CASE STUDY 4 - NWT Community-Based Water Quality Monitoring Program: Supporting Decision-Making at Multiple Levels

17..... CASE STUDY 5 - Mackenzie DataStream: Scaling-Up Community Monitoring Efforts Through Data Sharing

19..... CONCLUSION

Introduction

Canadians are united by water. On warm summer days, canoes dot our lakes near beaches where families swim, while joggers run next to rivers that course across the country connecting our communities and breathing life into our economies and environment. The health of our fresh water is vital to the places we play, the food we grow, the businesses we work for, and the well-being of the ecosystems supporting us all.

Canadians rank water as being our country's most important natural resource. As a nation we proudly embrace our favourite images of iconic wild rivers and unspoiled lakes. However, as the strain on our water multiplies – with more pollution entering our waterways, growing water demand from cities, industries and agriculture, and the impacts of a changing climate – our collective identity as a country full of clean and abundant flowing water is becoming a story of the past.

In order to prevent these collective pressures from overwhelming our freshwater heritage, we need to foresee problems before they emerge and take action to address or preferably avoid these increasingly urgent issues. Foreseeing these problems requires an ability to monitor, assess and understand freshwater health across the country.

This paper outlines the opportunity presented by a new wave of monitoring efforts that are being driven and led by communities. The paper includes five leading Canadian case studies of Community Based Monitoring that illuminate the challenges and opportunities associated with CBM. These examples, and similar efforts across Canada, are helping to inspire a new vision of how we can work together to pool our knowledge and better understand and protect the health of Canada's rivers, lakes and aquifers.



Background

A Patchwork of Knowledge on the State of Our Freshwater Health

Despite water's vital role in the Canadian fabric of life, we simply don't have a full picture of the health of our freshwater ecosystems. When we take a step back and look at the availability of freshwater data and how it is being used, what we see is an incomplete patchwork of knowledge on the state of Canada's freshwater health. This is exactly what happened when WWF-Canada took on the ambitious exercise of conducting a national assessment on the health of our major watersheds (*see text box*).

The Need to Pool Water Knowledge

A lack of data, information and knowledge doesn't suggest there is none, or that the problem is insurmountable. Across the country, water data is being collected by governments, industry, academic institutions and by communities. Unfortunately, data and information collected by these numerous organizations is often collected in a piecemeal way, using different approaches and standards, meaning it is difficult to compare or aggregate. In addition, much of this data and information is unavailable, in poorly maintained databases or considered unshareable for privacy reasons. In some cases, monitoring efforts are slowed as organizations struggle to find the resources to input data into databases, analyze the data or to make the information readily available.

The solution to this problem will need to be multi-faceted, focusing on two major themes: increasing the amount of data being collected, and making existing data more accessible. With respect to making data and information more accessible, there is a need to share and pool data from multiple sources. This is likely best done through data and information hubs at multiple levels (national, regional, local) that are able to provide credible and accessible data and information to inform good decisions at the appropriate scales (*figure 1, next page*). In addition, we will also need more new data, information and knowledge to fill the gaps. Gathering more data and information presents a significant challenge in an era of government cutbacks to water monitoring, the finite resources available to academic institutions, and private industry concerns around sharing data. In this realm of data collection, community based monitoring has become an increasingly important part of the solution.

The Potential of Community Based Monitoring

As water related threats arise in specific communities, or as citizens simply want to better understand and protect their home waters, community based monitoring (CBM) initiatives have emerged. Not all CBM initiatives are equal or occur for the same reason. Some CBM is carried out to inform better decisions and may involve collaborative partnerships with government agencies and academic institutions employing specific protocols. Other initiatives may be intended primarily as a citizen engagement tool with very little data kept long term or in any official manner.

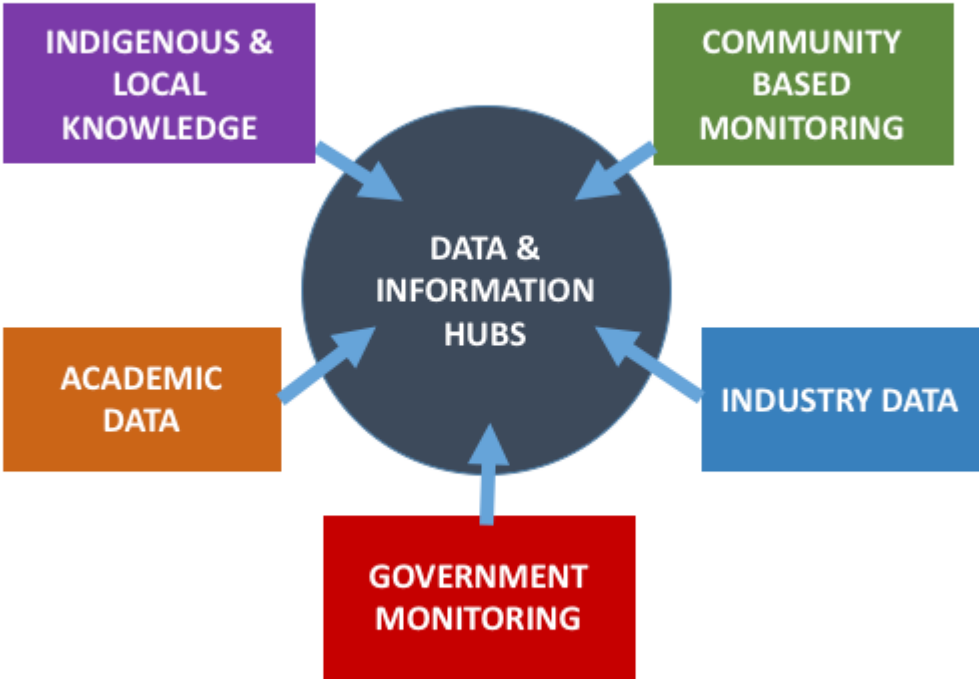
Assessing the Health of Our Waters: Critical Data Gaps

In 2011, WWF-Canada consulted with a number of leading freshwater scientists and developed a peer reviewed framework to assess the health of Canada's water and the threats they face. With this framework in hand, WWF-Canada set out to complete the first ever national assessment of the country's 25 major watersheds by 2017 (they have assessed 19 of 25 to date in its [Watershed Reports](#)). Through this process, WWF-Canada reached out to hundreds of organizations and government agencies to find the necessary data to conduct the assessments. It discovered that data just doesn't exist in many areas. There is also a frustrating amount of data that exists but isn't accessible, even when a direct request was made to the organization or agency holding it. Remarkably, even in Canada's most densely populated watershed – the Great Lakes basin – there isn't enough data to assess the health of the waters underpinning this region's well-being and economy. In fact, out of the 19 major watersheds assessed, 10 watersheds didn't have enough data to enable a health score to be assigned to them. In other words, for more than half of Canada's major watersheds, we have no idea how healthy or unhealthy they are.

While CBM initiatives span a wide spectrum, they are consistent insofar as they are all community-directed. That is, the data collection is initiated from the community and it is accessible to the community afterwards, no matter who is collecting the data. It is important to note that CBM can be informed by multiple knowledge systems, all of which have inherent value. For example, local knowledge, Indigenous knowledge and western knowledge all play an important role in helping us better understand the health of our waters.

There is significant potential for water data collected from CBM initiatives across the country to fill major gaps in knowledge, and to inform decisions at multiple scales. While there are certainly challenges to overcome, CBM presents a tremendous opportunity. Data is the building block for understanding the health of our waters nationally, and CBM represents an untapped source of high quality data.

Figure 1: Using data hubs to make data accessible



Opportunities for Community Based Monitoring

The Growth, and Growing Acceptance, of CBM

Although professional scientists and decision makers have raised concerns over the quality of citizen science data, ongoing refinement and an increased sophistication of many CBM efforts has resulted in a growing recognition nationally and internationally of the potential of CBM to fill our data needs, inform decision-makers, and engage and educate communities.

Today, community based monitoring is a data-driven movement that is gaining momentum and legitimacy as it moves to the next level through technological advancements, integration with policy making, and as a result of shared learnings and experience.



The Professionalization of CBM

Increased recognition of the value of citizen science has resulted in the development of best practices, shared learning and coordination of efforts. In recent years, organizations such as the Citizen Science Association, the European Citizen Science Association, and the Citizen Science Network Australia, were created to develop and support communities of practice around CBM and other forms of citizen science. These organizations are also working with governments to ensure that policy makers are supporting citizen science. For example, in 2014, the European Commission commissioned a White Paper on Citizen Science to make recommendations for improved integration of citizen science in European policy. And in 2015, the U.S. Whitehouse held a forum on citizen science and developed guidance and toolkits to help U.S. federal agencies manage and work with citizen science projects.

Five Core Challenges for CBM

If the goal of a CBM program is to contribute to data-driven decision-making, there are five common challenges that have been identified by CBM practitioners in Canada and internationally that need to be addressed. These are:

- 1. Ensuring Credible Data** - the legitimacy of CBM data is dependent on the quality of the information produced so it is important that data is collected and analyzed in ways that can be trusted and that respect and benefit the communities involved. Many factors go into ensuring high quality data. As outlined in the Lake Winnipeg case study (**Case Study #1**), the first step is to determine the most important parameters that need to be monitored and why. The parameters can then be matched with appropriate water monitoring protocols to ensure data collected is robust enough to be used in the short and long term. The data analysis process is also critical and must follow recognized, robust and consistent protocols and processes to ensure the data is reliable and useful to decision makers and available in a timely fashion.
- 2. Connecting Indigenous Traditional Knowledge & Western Science** - indigenous communities in Canada hold a wealth of traditional knowledge on water and environmental health. This knowledge is valuable and important for CBM in its own right, whether it is combined with other forms of knowledge or not. Increasingly, CBM programs are endeavoring to bring together traditional knowledge and western science to develop rich, robust and holistic programs that draw on the strengths of both forms of knowledge. Connecting traditional knowledge and western science as part of a CBM program can present a number of challenges. These include cultural differences in understanding and interpreting different forms of knowledge, the ability to translate this knowledge into decisions, as well as navigating the challenge of ensuring transparency while respecting cultural privacy. The Mikisew Cree and Athabasca Cree CBM program (**Case Study #2**) provides important insights and lessons for addressing these challenges.
- 3. Engaging and Motivating Citizens** – as demonstrated by the award-winning Lake Windermere project (**Case Study #3**), an effective CBM program depends on the active engagement of motivated citizen volunteers. Catalyzing and maintaining this level of engagement is no easy task and there are many challenges to overcome in the process of recruiting, engaging and training citizens properly, as well as ensuring program succession to support long term data requirements. It is also essential to ensure the volunteers are safe when they are doing monitoring, and that CBM organizations maintain sufficient liability insurance to cover unforeseen circumstances.
- 4. Informing Decision-Makers** - the connection between CBM and decision-making continues to present challenges. CBM programs that seek to inform decision-making must be designed to ensure that data is produced and translated in a way that can address key threats and support the needs and questions of decision-makers at different scales (including within the community). The CBM partnerships being formed between communities and the government in the Northwest Territories (**Case Study #4**) illustrate the potential for CBM data to make very significant contributions to decision-making at multiple levels.
- 5. Data Accessibility and Aggregation** - much data that is collected continues to be inaccessible or stored in formats that make it difficult to use. If data is not made available and accessible in a usable format, its usefulness for informing decisions and even local actions will be limited. Making decisions on a broader scale, such as an entire watershed or region, requires multiple sources of information to be aggregated and translated to have a complete picture of the health of a watershed or region. Increasing technological advancements and a growing trend towards open data are creating new opportunities for addressing these challenges. A new tool called Mackenzie Datastream (**Case Study #5**) embodies this trend and is at the forefront the possibilities of data accessibility and aggregation in Canada.

Overcoming the CBM Challenges: Five Case Studies

In Canada, we are fortunate to have some cutting-edge CBM programs that are tackling the five challenges outlined above. These programs are forming the basis of a growing community of practice for using CBM as a credible source of data to inform decision-making at multiple scales.

Five short case studies below illuminate how different CBM programs and innovations from across Canada are addressing these challenges and inspiring communities to take a real and meaningful role in producing data to support the protection and restoration of their waters.

Case Study 1 - Building a CBM Network for Lake Winnipeg: Connecting Scientists and Citizens

Overcoming the Challenge of Ensuring Credible Data - CBM initiatives for Lake Winnipeg have been supported by the Lake Winnipeg Foundation through their development of standardized scientific protocols and training for volunteers. As a result, an entire CBM network is being mobilized to collect high-quality data that is improving our collective understanding, and ability to manage, Lake Winnipeg, the world's tenth largest freshwater lake.

Understanding the impacts of phosphorous on lake health

Lake Winnipeg's watershed spans two countries, four provinces, four states, and over 100 Indigenous nations. A wide range of human activities across this landscape – an area 40 times larger than the lake itself – contribute excess phosphorus to the waterways that flow into Lake Winnipeg, ultimately accelerating the eutrophication of the lake and increasing the risk of potentially harmful algae blooms. The largest flows of phosphorous into Lake Winnipeg are during high water events such as spring melts, floods, and increasingly violent summer storms, which flush phosphorus present on the landscape into the lake.

In order to effectively manage these sources of phosphorus, and to evaluate the success of watershed policies designed to reduce phosphorus inputs, there is a need for robust data that identifies where, when and how phosphorus is entering Lake Winnipeg's tributaries.

Linking citizen volunteers with professional protocols

While government water sampling programs continue to suffer from reduced capacity, an emerging CBM network in Manitoba, co-ordinated by the Lake Winnipeg Foundation (LWF), aims to mobilize citizen volunteers to collect samples during and immediately after high-water events.

LWF has the benefit of a Science Advisory Council, which is comprised of nationally-recognized freshwater experts with connections to universities and provincial and federal water agencies. Advisory Council members have recognized the potential of citizen science and have provided their expertise to develop robust CBM data collection and analysis protocols that will support their own research interests, supplement long-term provincial data sets, and provide credible information to policy-makers.

Trained CBM partners collect and process water samples in the field, which are then shipped to a centralized lab for phosphorus analysis and data interpretation. This approach has the dual benefit of linking the capacity of citizen volunteers and their sampling efforts with professional protocols and analysis.

Developing credible CBM protocols

To support this groundswell of citizen volunteers, LWF's science advisors developed CBM protocols that will:

- 1. Generate credible data for the key parameter of interest in the Lake Winnipeg basin.** Phosphorus is the key driver in the growth of harmful algae blooms so rather than create protocols for a wide range of parameters, new CBM protocols were developed that test solely for total phosphorus. Focusing on phosphorus is not only more cost-effective, it will also provide the robust information that is necessary to design effective policy and management interventions.
- 2. Be tested by trusted and experienced partners.** In the 2016 pilot field season, Manitoba's Conservation Districts (the watershed-based organizations that manage land and water resources) are testing the sampling protocols and CBM network infrastructure. Challenges will then be addressed and resolved with a smaller number of experienced partners, before protocols are adopted by the wider CBM network.
- 3. Take advantage of existing field research infrastructure.** Sample sites for the 2016 season are located where existing hydrometric gauges provide regular measurement of stream flow, making it possible to calculate total phosphorus that enters Lake Winnipeg.
- 4. Be assessed for compatibility with other long-term data sets in the province.** LWF has partnered with the federal department of Fisheries, Oceans and the Canadian Coast Guard to test new lab protocols for phosphorus analysis. This research will compare results from lab protocols used by different agencies to identify and refine the CBM protocols to produce data that can supplement existing datasets.
- 5. Ensure data interpretation is shared back to CBM partners.** All partners participating in the CBM network are trained to use the scientific protocols developed for this network. Reciprocally, LWF's science advisors analyze and interpret CBM data and share it back to community partners, in person and online through the Lake Winnipeg Basin Information Network. This data sharing and interpretation improves understanding of how local efforts contribute to a larger pool of evidence that informs policy and management decisions.

In the 2016 pilot season, the emerging CBM network will produce a small but credible and relevant dataset documenting phosphorus loading during the spring melt at ten sampling sites in agro-Manitoba.

Building a robust CBM network to support water management and research

With credible data from the pilot sampling season, CBM partners will be able demonstrate the potential of the network as a vehicle to leverage the interests and expertise of both citizens and scientists in support of effective water management. In 2017 and subsequent years, Manitoba's CBM network will include more partners, provide training on refined protocols, and expand the number of sampling sites, their geographic distribution and the length of the sampling season. Ultimately, CBM data will be used by university researchers, provincial and federal agencies, land and water managers, and grassroots community groups to improve the health of Lake Winnipeg and its watershed.

Case Study 2 - Mikisew Cree and Athabasca Chipewyan CBM Program: Empowering First Nations to be Part of Environmental Monitoring

Overcoming the Challenge of Connecting Indigenous Traditional Knowledge & Western Science- The CBM program developed by the Mikisew Cree First Nation (MCFN) and Athabasca Chipewyan First Nation (ACFN) empowers the community to be part of environmental monitoring by including Indigenous Knowledge (IK) indicators, providing opportunities for the transfer of knowledge on the land between Elders and youth, and celebrating a knowledge system that is important to the community's culture, health and wellbeing.

Developing Indigenous Knowledge indicators to monitor environmental changes

In 2008, the Centre for Indigenous Environmental Resources (CIER) started working initially with the MCFN and later the ACFN to develop a CBM program to track water quality indicators and fish health, which later expanded to include navigation issues, muskrats and wild foods across the territory. This work continues today with the guidance of Bruce Maclean, a freshwater scientist and independent consultant. The CBM program was initiated because of various stresses on the environment (e.g., downstream impacts from oil sands, hydroelectric development) that MCFN and ACFN wanted to respond to. The first step in developing the program involved establishing a baseline of what the initial conditions were and then identifying a series of Indigenous Knowledge (IK) Indicators to monitor environmental changes over time. This process involved a series of interviews with active land users and Elders to discuss fish, animal and water health, then validated the IK Indicators with Elders and also transferred the knowledge associated with those Indicators to community monitors or 'Guardians'.

Challenges to incorporating IK indicators in the development of CBM

IK indicators value the knowledge of First Nations and add to the conversation about environmental changes. However, there have been two key challenges to incorporating IK indicators into the development and implementation of the CBM program.

- 1. Connecting across cultures** - The exercise of connecting Indigenous and non-Indigenous people to talk about both indigenous knowledge and western science indicators requires both curiosity from scientists and resources to support the time to listen, learn and understand. Maclean has found identifying interested individuals to create the space for MCFN and ACFN to communicate the value of using IK indicators alongside western science has been a challenge.
- 2. Sustainable funding to maintain capacity and continuity** - Secondly, one of the ongoing challenges of a CBM program is the long-term sustainable funding to maintain the internal staff and program continuity. Maclean has found it requires 60% of his time just to keep the CBM program funded and operational.

Applying innovative technology to support IK collection

Maclean is working with MCFN and ACFN to develop apps for collecting information and photographs on observations related to navigation routes, traditional use areas and health to track indicators of change. If funding is available, there could also be opportunities for providing land users with hand-held devices to collect similar data. To address the funding challenges, Maclean is exploring other funding models that could offer secured long-term funding for the MCFN and ACFN CBM program.

Lessons Learned for Including Indigenous Knowledge in CBM Initiatives

In the development of the MCFN and ACFN CBM programs, there were four key lessons that emerged.

1. It is important to be clear on the intention for why you are developing the CBM program and realistic about the funding you have to sustain it.
2. To be useful and pragmatic, start with IK indicators that you already have anecdotal data for, such as observing new insects or birds as an indicator for climate change. Collecting anecdotal stories and tracking over two decades becomes extremely powerful data for the community and complementary to western science climate change monitoring.
3. As part of establishing the program, it is important to determine who will maintain it and how it will be operated. Is it through the community school, local government, academic community, or is it run like a business? Involving the knowledge holders from the beginning of program development will allow the program to be owned and sustained by the community.
4. To overcome hesitation from western science to take IK indicators at face value, work to connect the IK indicator to a definitive western science indicator. For example, with increased phosphorus levels, Elders and land users will observe changes such as foamy scum and a change in the smell and colour of the water while scientists will collect water quality samples to check phosphorus levels. In this case, two different systems using different languages and techniques end up with the same result that the system is slowly eutrophying. Connecting these systems diplomatically creates the space for a new relationship between Indigenous and non-Indigenous people monitoring environmental change to expand and evolve.

Case Study 3 - The Lake Windermere Project: Challenges and Opportunities for Citizen Scientist Engagement

Overcoming the Challenge of Engaging and Motivating Citizens - The Lake Windermere Project has become a nationally recognized case study for community engagement in water quality monitoring and has become a template for lake management and CBM throughout the Kootenays, across the Columbia Basin in British Columbia, and beyond.

Responding to public concern

In 2005, results of a Lake-Use survey indicated widespread public concern about the sustainability of Lake Windermere. Respondents wanted information on maintaining septic systems while expressing concerns about boat traffic congestion, aquatic plant growth, shoreline and upland development, loss of native fish populations, water conservation and water quality. The Lake Windermere Project (LWP) was started in the same year as a proactive response to public concern and the demand for an ongoing, comprehensive water stewardship initiative.

The overall LWP goal was to protect and enhance the water quality of Lake Windermere through interagency co-operation, community based scientific water quality monitoring, and public education and engagement. From its inception, all levels of government, First Nations, community members, partner organizations and interagency participation were included. The Lake Windermere project was framed as a pilot to serve as a template for lake management and CBM throughout the Kootenays.

Determining monitoring objectives and parameters

The water quality objectives were based on a study commissioned by the Regional District of East Kootenay at the request of the Lake Windermere Project, which outlined past and future sampling locations, sampling frequency, sampling methods, protocols, trends and changes in water quality, and analysis criteria. To gain a watershed level of understanding of the health of the lake, water quality was monitored at three lake stations and on six tributaries of concern.

The monitoring program included a broad range of parameters such as water temperature, pH, conductivity, dissolved oxygen, turbidity, total sulphide, total nitrogen, ammonia, total dissolved phosphorus, E. Coli, nitrate, and total metals. A standard provincial government protocol was used for ambient water sampling and LWP co-ordinators were tested annually on their sampling technique.

Training the trainers

The initial training for a project coordinator to collect water samples was undertaken through in-kind support from government staff and also through workshops provided by the BC Lake Stewardship Society, which had developed a lake stewardship certification program and were able to analyze the data. The LWP coordinator was then qualified to train community volunteers and subsequent project coordinators. In the case of applying the CABIN protocol for tributary health monitoring, the LWP project coordinator was the only non-government certified trainer in Canada.

Engaging and motivating community volunteers

The LWP built a positive community profile due to publicity over a sister lake exchange with Lake Windermere in

England, local business support via a decal program, the re-instatement of the local lake regatta and regular articles in local media, and a designated municipal councillor as the LWP liaison, which all helped to establish a community stewardship ethic. This positive community profile significantly helped overcome the challenge of recruiting local volunteers for the duration of the project.

Key learnings

There is no one-size-fits-all approach with CBM since the citizen science is inextricably tied to its community circumstance. However, some key learnings were observed that have provided valuable guidance to other CBM programs in the region:

1. Adopting a standardized monitoring protocol provides higher quality data, engages and trains citizens in hands-on data collection, and allows for comparisons between monitoring initiatives and developing trends over time.
2. Creating strong, innovative partnerships within the community builds legitimacy, support, trust and maximizes the limited resources available for longer term commitments required for community-based monitoring.
3. Linking monitoring with decision-making and ensuring that decisions are made within known timelines, creates clear objectives and purposes for the data.
4. Communicating results clearly and concisely to the public builds interest and validates the work of the organization, enhancing volunteer recruitment.
5. Obtaining adequate funding was essential to ensure that the project could be delivered to its conclusion.

The legacy of the Lake Windermere Project

The Project received widespread recognition for its efforts. It was chosen as a federal best-practices example in community based ecological monitoring, won the prestigious Real Estate Foundation of BC Land Award, and received regional and provincial awards recognizing its advancement in conservation in the area. In the final year of the Lake Windermere Project, the components of water quality monitoring, education and outreach were handed over to the community under the direction of the Lake Windermere Ambassadors.

There is now a Columbia Basin Stewardship network, which supports CBM efforts in the Columbia Basin, and over 50 community based water monitoring groups, many of which have directly benefitted from the Lake Windermere Project template.

Case Study 4 - NWT Community-Based Water Quality Monitoring Program: Supporting Decision-Making at Multiple Levels

Overcoming the Challenge of Informing Decision-Makers - For CBM to influence decision-making, its need and purpose must be clearly conveyed and it must provide relevant and understandable information. Partners in the Northwest Territories (NWT)-Wide Community-Based Water Quality Monitoring Program have been working together to build capacity and increase the relevancy and accessibility of CBM data in multiple levels of decision-making.

Foundations of the NWT's Community Based Water Quality Monitoring Program

The NWT Water Strategy is a collaborative endeavour between Aboriginal, territorial, federal, and municipal governments, communities, non-government organizations and others. It guides NWT water stewardship and management. The Strategy's vision is to ensure that NWT waters remain "clean, abundant and productive for all time" and is founded on the importance of multiple forms of knowledge informing stewardship (e.g., traditional knowledge and scientific knowledge). During Strategy development, community and Aboriginal government partners expressed the desire to be actively involved in CBM.

The CBM program was developed with communities to address their questions about water quality, changes over time and impacts of stressors, such as upstream development and climate change. The CBM program includes 21 NWT communities working in partnership with government to monitor water quality at over 40 sites. The program supports the communities through training, technical support, water quality monitoring equipment and data analysis. The Government of the Northwest Territories (GNWT), currently plays a coordinating role in the overall program, and provides hands-on training to local monitors. This strengthens the quality of collected information, and supports capacity for long-term community-driven monitoring.

Challenges for decision-making based on CBM data

Decision-making occurs at multiple, nested scales: from individual land-users to community and regional governments; from territorial decisions to transboundary water management. CBM can inform decisions at all of these levels. Decision-making can take many forms, from influencing behaviours, policy changes, or supporting decisions about infrastructure.

Experience from the CBM program has identified two interrelated challenges around use of CBM data in decision-making:

1. **Relevancy** of information to decision-makers shapes uptake. Data collection needs to be tied to particular concerns and questions of decision-makers at multiple levels.
2. **Accessibility** of information shapes its use. It is critical that people who need and want data can access it in an easy and timely manner, to use it for decision-making. The ability to gather, analyze and communicate CBM data in a timely manner has been a challenge in the NWT, largely due to human resource capacity.

Ensuring relevancy at multiple scales of decision-making

The CBM program is guided by the questions of communities, which ensures the **relevancy** of information to community and regional Aboriginal government decision-making needs. Community partners are involved at all stages,

including selection of monitoring locations, undertaking the sampling and evaluating the program. For example, in two communities, CBM supported the assessment of drinking water sources and potential alternative locations. Participatory approaches foster community-level buy-in and trust in the data.

Though CBM is geared to local-level concerns, identifying linkages with other levels of decision-making increases the usefulness of CBM data. For example, the use of standardized protocols across communities supports the assessment of regional aquatic ecosystem health trends. This ensures data is relevant at both territorial and transboundary levels. With respect to transboundary waterways, CBM information will support implementation of bilateral water management agreements with upstream jurisdictions. This includes development and implementation of site-specific water quality objectives.

Ensuring accessibility through timely dissemination of information

Accessibility of data is critical for the CBM program. Meaningful and understandable information – framed and grounded within local experiences, values and knowledge – is more likely to be considered in decision-making. When CBM results are presented to community partners they are linked back to local monitoring questions and framed in local experiences. For example, comparing dissolved metals in water to what happens when sugar is stirred into tea (it dissolves and cannot be easily seen) makes results more relatable.

Community partners receive results before they are shared anywhere else and have full access to both raw and interpreted data. This information can be used in a wide range of situations, such as watershed planning, research and monitoring, and regulatory processes. One challenge is disseminating information in a timely manner. This is being addressed through an innovative partnership with the Gordon Foundation on the Mackenzie DataStream data management platform (see next case study). As additional partners from the Mackenzie River Basin contribute to DataStream, the ability to assess regional trends across the basin will increase, further enhancing the ability to use CBM data in decision-making.

² Available at: http://www.enr.gov.nt.ca/sites/default/files/strategies/nwt_water_stewardship_strategy.pdf

Case Study 5 - Mackenzie DataStream: Scaling-Up Community Monitoring Efforts Through Data Sharing

Overcoming the Challenge of Data Aggregation and Accessibility - CBM initiatives are cropping up throughout Canada's Mackenzie River Basin. Though these efforts vary depending on the community's chosen area of focus, they share a common challenge – that of managing, storing and disseminating large amounts of data. In response to this need, The Gordon Foundation, in partnership with the Government of Northwest Territories, has developed Mackenzie DataStream – an open source, open access tool for managing and sharing freshwater data.

Communities leading the charge on data collection for freshwater stewardship

The Mackenzie Basin is vast and the health of its waters is vital to the people who live within it. Like many places in Canada, there has been growing interest among Mackenzie Basin communities in playing an active role in freshwater stewardship. Understanding that you can't manage what you don't measure, communities have taken the lead in establishing monitoring programs. Among these initiatives, is the NWT-wide community-based monitoring program which includes 21 communities in the heart of the Mackenzie Basin (as described in the previous case study). Through these efforts, communities are generating baseline datasets, filling data gaps and beginning to answer fundamental questions about freshwater health in the Mackenzie Basin.

As the NWT-wide CBM program was being established in 2012, communities quickly recognized the need to manage and effectively disseminate the data they were collecting. This call from communities ultimately led to a unique collaboration between the Government of the Northwest Territories and The Gordon Foundation. The task, funded by the Gordon Foundation, was to build a web-based platform for CBM activities in NWT with the long-term objective of accommodating data from communities through all six jurisdictions in the Mackenzie Basin.

Mackenzie DataStream

Mackenzie DataStream is an open access platform for sharing water data in the Mackenzie River Basin. It currently contains data collected by 21 communities in the Northwest Territories since its soft launch in November 2015. Since the launch, there has been overwhelming interest from a range of data contributors who are interested in joining this collective commitment to open data. Though still early, the long-term vision of this project is to accommodate data from throughout the Mackenzie Basin. All partners share a willingness to ensure Mackenzie DataStream is long-lived, far reaching and impactful—ultimately fostering a collaborative drive towards evidence-based decision-making.

Keys to success:

- 1. Ethically open access** - Mackenzie DataStream employs an ethically open approach. This means that data are made available on an equal basis, fully, freely and openly in a timely way. Exemptions to this open data policy are allowed for ethical reasons (e.g. personal information is not identified). This framing has guided this project and addressed concerns data contributors may have related to the handling of sensitive information. Open access approaches allow for the full potential of datasets to be realized.
- 2. Decentralized model** - Mackenzie DataStream's data governance is largely decentralized. It is up to contributors to determine what data they are comfortable sharing openly. Data contributors also have the option of assigning their own disclaimers to datasets if need be. This disclaimer is specific to the contributor's dataset and will pop up when someone downloads the data. This gives Mackenzie DataStream the flexibility to accommodate a wide range of contributors and any specific restrictions they may need to assign to their data (e.g. non-commercial use).

- 3. Independence** - Being administered by a philanthropic organization and hosted on the Cloud means DataStream is independent from industry or government, and is well-positioned to accommodate data across jurisdictional, departmental and sectoral boundaries.
- 4. Using DOIs to assign credit and track downloads** - Mackenzie DataStream partners are exploring the possibility of assigning Digital Object Identifiers (DOIs) to credit data contributors for their work and allow them to track how and where their data are being used in publications. Though still under development, contributors including communities, academic researchers and government agencies have shown interest in this feature which is expected to encourage data submissions from new contributors.
- 5. Sustainability** - A key consideration throughout the design and development of Mackenzie DataStream was to ensure that it could continue to run with minimal human and financial input over the long term. Several aspects of Mackenzie DataStream will ensure it is sustained over the long term including the fact that it is open source (results in low costs to grow, modify and maintain); open access (reduces complexity of managing the site and thus the resources required); and cloud-based hosting (means no in-house investments into server maintenance. Annual hosting fees are greatly reduced through economies of scale inherent to cloud-based approaches.)

The Benefits of Using a Web-Based Open Access Platform for Data Sharing

The advent of computer and web-based technologies for data collection and aggregation 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. While still early in implementation, these benefits have already become very apparent to the partners and users of Mackenzie DataStream.

Conclusion

Community based monitoring provides a tremendous opportunity to harness the energy and resources in our own communities to address critical data, information and knowledge gaps in our country's understanding of fresh water and the health of our watersheds. Globally, and here in Canada, there is growing recognition of the potential of community based monitoring. The increasing sophistication of CBM is resulting in credible data, information and knowledge that can both respond to the needs of local communities and support decision making at multiple scales.

While there are a range of challenges that confront community based monitoring, the case studies in this paper show that organizations and communities across Canada are overcoming these challenges. In the process, they are generating new innovations and learnings that can foster and fuel a powerful network of community based monitors to help address the substantial data gaps that are preventing us from effectively managing the health of our waters.

To truly capitalize on the opportunity presented by CBM will require intention, network building, peer learning, funding and resources. However, the benefits for the health of our waters means this is an opportunity that we cannot afford to overlook, while the case studies demonstrate that this is an opportunity well within our reach.



