CONNECTING COMMUNITY-BASED WATER MONITORING

WITH ENVIRONMENTAL MANAGEMENT AND STEWARDSHIP IN CANADA

HEATHER CASTLEDEN, QUEEN'S UNIVERSITY

Research conducted 2014-2015

WEPGN
Water Economics, Policy and Governance Network

Canadian Water Network

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RESEARCH BACKGROUND

Data produced through water quality monitoring are important for evaluating the long-term health trends of watersheds and identifying water quality issues arising from human activities. This information can help environmental managers to understand environmental stresses, such as increasing nutrient runoff from farms, and adapt their programs, practices, and policies to manage the impacts on aquatic ecosystems. Professional and government scientists have been responsible for conducting scientific monitoring for the last several decades, but increasingly we are seeing community members becoming involved in monitoring their environment as citizen scientists.

Community-based water monitoring is a type of citizen science that involves the engagement of community volunteers and NGO staff in water quality monitoring. These activities are on the rise in Canada, partly due to declining capacity of municipal, provincial, and federal governments to conduct scientific monitoring and also increasing public interest in environmental conservation.[1] These monitoring programs can be run by NGOs, government, and academic institutions and may include a mixture of staff and volunteer involvement. Monitoring activities can include collecting water samples that get sent to accredited labs for analysis, using multi-probes to measure parameters such as pH and dissolved oxygen, and sampling aquatic invertebrates. In some cases, monitoring may also involve observations of ecological change in an area. The engagement of community volunteers or NGO staff in these activities helps to increase community awareness of local watershed issues in addition to increasing the geographic coverage of water quality information.[2,3] Studies have shown that volunteers can produce water quality data that is equal in quality to data collected by professionals when they have adequate training.[4,5] With these combined benefits, community-based water monitoring has the potential to inform environmental management and promote community-led environmental stewardship.

Alongside the benefits of community-based water monitoring, those involved can encounter challenges to collecting the data and connecting the information to relevant management or stewardship processes. For example, monitoring can be used to track the success of restoration projects, but yet many projects do not include it.[6] Moreover, there is limited funding available for either community-based water monitoring or government-led monitoring, and volunteer capacity to assist in sample collection can be sporadic.[7] On the whole, many government agencies and academics continue to doubt the accuracy of citizen-collected data and there is limited knowledge among NGOs and the public of the ways that their own monitoring information can be integrated into local, provincial, and federal government decision-making. When community-based water monitoring information is not trusted by professional environmental managers or used to guide their decisions, opportunities to apply these data are lost.

In order to understand the benefits and challenges of using community-based water monitoring to inform environmental management decisions and community-led stewardship activities (e.g. stream restoration), the research team explored the following questions:

1. What are the major socio-economic and political factors involved with connecting community-based water monitoring information to relevant governmental decision-making processes?
2. Does community-based water monitoring and related community-led stewardship activities benefit the health of aquatic ecosystems?

LINKING COMMUNITY-BASED WATER MONITORING WITH GOVERNMENTAL DECISION-MAKING

When community-based water monitoring information is shared with a government agency, the volunteers and NGO staff involved frequently do not know how the data are used or if the data influence management decisions or policy creation that affect their local watershed of concern. We wanted to identify cases of successful data sharing and integration with governmental decision-making in order to produce lessons learned for NGOs and governments engaged in these activities. We interviewed environmental NGO leaders and government representatives from four Canadian case studies (three of which are reported here) to better understand the factors involved in enabling the monitoring data to be successfully shared and used in governmental decision-making.

MEETING GOVERNMENT NEEDS, CAPACITY, AND COLLABORATION

We found that the monitoring information was most readily useful for governments when the government agencies and NGOs worked together to co-produce the water quality monitoring program, the program was supported by multiple government and private sources of funding, and government staff were involved in establishing quality control and volunteer training protocols. When this happened, provincial and federal levels of government used community-based data in the evaluation of long-term water quality trends, and for identifying hotspot issues that required further monitoring or management actions. In a municipal context, a community-based monitoring program was designed to inform regional land-use planning but direct use of community-based data did not occur. Monitoring information had an indirect influence on decision-making when it was used to inform the community about lake water quality and increase public support for a local government decision to extend a centralized sewer system.

CASE 1.

QUAMICHAN WATERSHED STEWARDSHIP SOCIETY (DUNCAN, BC): CITIZEN-COLLECTED DATA INFORMS PUBLIC AND BUILDS SUPPORT.

Quamichan Lake is a shallow, eutrophic lake that experiences annual algae blooms and fish kills partly resulting from nutrient runoff from surrounding residential and farm lands. The Quamichan Stewards have developed a simple water quality monitoring program with assistance from the provincial Ministry of Environment staff for assessing the condition of the Lake and the impact of various remediation techniques on water quality, such as fine bubble aeration. Local volunteers take regular measurements of secchi depth as well as temperature and dissolved oxygen using a multi-probe every summer, and water samples are collected by Ministry staff for assessing nutrient inputs. The volunteer- and Ministry-collected data were compiled into a Ministry report on lake water quality. The data were also sent to the BC Lakes Stewardship Society, which works in partnership with the Ministry of Environment and regularly shares reports on lake water quality. The program informs the Quamichan Stewards' watershed management planning process, which provides an overall strategy for improving water quality that includes public education and remediation. The Quamichan Stewards presented the compiled monitoring results, including nutrients analysis showing impacts from septic system outflows, to community members and gained their support for the local Municipality's decision to extend the centralized sewer system to lake landowners that used septic systems.

Many government staff and managers talked about the importance of being able to trust community-based data in order for them to directly use these data in their evaluation of water quality trends. An even higher level of confidence was required when using the data for law enforcement, which necessitated the use of government samples. It was also important that the data collected addressed an issue that was relevant to the government agency's mandate, for example stormwater quality in the case of a municipality. Involving government staff in the design phase of the monitoring program and training of NGO staff and volunteers in monitoring protocols helped to increase their confidence level in the data and ensured that the information was relevant.

"I would say it is necessary to have someone that has experience with the program, either myself or if it's someone else from [our department] who has experience with the program... or someone who has been trained by [our department staff] such as summer students, to be there and make sure the identification is correct".
(Research Participant)

Government staff provided training to volunteers for monitoring water quality in Englishman River

Both NGOs and governments were often challenged with attaining the funding and staff capacity necessary to support consistent, high quality community-based water monitoring programs. NGOs pieced together funding from multiple private and government project-level grants to conduct the work, but coordinators frequently brought up the need for core funding. In several cases, government agencies worked in partnership with regional-level NGOs to mobilize more resources. Collaboration helped each party to increase the resources available for monitoring by sharing equipment, staff, and local and scientific knowledge. Leaders in both governments and NGOs often engaged in reciprocal actions, such as sharing resources and providing feedback on results to volunteers, which helped to build trust between non-government and government parties.

Monitoring programs needed a certain standard of rigor and sufficient resources to be directly used by government staff and managers in their decision-making. An alternative to rigorous long-term monitoring is education-focused monitoring that is less intensive but also engages community volunteers with respect to learning about their watersheds. For example, another 'success' case was the Bedeque Bay Environmental Management Association's Adopt-A-River program (Emerald, PEI), which engages hundreds of kids in collecting basic information on aquatic health that informs their restoration projects. These programs contribute to a more informed citizenry, which helps when mobilizing a community around local watershed issues. Determining the goals of the program - that is, informing governmental management, public education, or both - is a key first step to ensuring program success.

CASE 2.

MID VANCOUVER ISLAND HABITAT ENHANCEMENT SOCIETY (MVIHES) (PARKSVILLE, BC): MULTIPLE PARTNERSHIPS AND THE REGIONAL DISTRICT OF NANAIMO WATERSHED MONITORING

MVIHES participates in the Regional District of Nanaimo's watershed monitoring program for the Englishman River, which is a drinking water source. The program is a partnership with the BC Ministry of Environment, a local forestry company, and several local watershed groups. The Regional District maintains multi-probes for monitoring variables such as turbidity and dissolved oxygen, and they work with the Ministry of Environment to hold regular training sessions for the volunteers that conduct the monitoring. The forestry company allows access to their lands for monitoring and funds the lab analysis. Ministry and Regional District staff maintain reciprocal relationships with volunteers to keep them engaged; this includes, for example, trouble-shooting obstacles to their involvement and providing monitoring results. The data are directly inputted to the Ministry's database for assessing water quality trends (including comparisons to BC Water Quality Guidelines) and the Regional District uses the data for land-use planning. In one instance, the program helped to identify leaky septic systems, which prompted the Regional District to write letters to landowners encouraging sewer system hook-up.

ASSESSING ECOSYSTEM BENEFITS OF WATERSHED STEWARDSHIP

Habitat restoration projects are carried out by environmental NGOs with the intention of benefiting aquatic ecosystems, but the impacts are not always certain. Citizen science, including community-based water and observational monitoring, has potential to be useful for identifying issues that could benefit from restoration as well as providing feedback on the impacts of restoration projects to aquatic health. We interviewed key staff from five environmental NGOs in Nova Scotia, Prince Edward Island, and New Brunswick that engaged in water quality monitoring and restoration projects to determine whether these projects benefited the ecosystem. Using photos from before, during, and after the restoration projects were conducted and information from the interviews, we contrasted these data with known indicators of restoration success (e.g., clear project goals and objectives, collection of baseline data, and documentation of the outcome).[8,6]

VISUAL VERSUS SCIENTIFIC ASSESSMENTS

We examined 15 projects representing a range of habitat restoration activities, including sediment control and riparian zone restoration, stream bank stabilization, and reconnecting fragmented stream habitat. These projects mostly addressed human-caused degradation and were often triggered through visual assessments, although two cases were triggered by water quality monitoring. The data collected through community-based water monitoring and before-and-after photographs of

restoration projects enabled us to identify how ecosystems responded to different types of restoration. In many cases, the restoration activities had positive impacts on ecosystem health that were visibly evident to the watershed groups and consistent with the literature on restoration. For example, it is well accepted that the removal of stream barriers can increase habitat connectivity, resulting in increased fish passage.[9,10] Only the projects that included scientific monitoring, however, could provide evidence for ecosystem health changes, such as changes in water temperature or dissolved oxygen levels.

Monitoring restoration projects before and after implementation is necessary to evaluate whether or not restoration is successful. However, research participants talked about many challenges to monitoring their projects and visual assessments were often more practical. Project-based funding for restoration activities often excludes scientific monitoring and so the costs are borne by the organization.

"...A lot of the funding we get for this type of project specify that it's for action; it's for environmental action, environmental improvement, but there is nothing provided to measure that improvement. So we very seldom have that opportunity, the funds, the capacity, to do before and after [monitoring] to actually evaluate the impacts of our projects."
(Research Participant)

Restoration projects are often limited to a smaller scale because of piecemeal approvals from private landowners that live along the watercourse of concern. It is inherently difficult to detect changes at a small scale with water quality monitoring even though improvements may be obvious visually. These challenges with both funding availability and scale limited the usefulness of water quality monitoring for evaluating the impacts of restoration on aquatic ecosystem health.

CASE 3.

CLEAN ANNAPOLIS RIVER PROJECT (CARP) (ANNAPOLIS ROYAL, NS): REMOVAL OF A DAM

A dam that was originally installed to make a drinking water reservoir became severely degraded and blocked a fish passage on a known salmon-bearing river in Nova Scotia. When the issue was brought to an environmental NGOs attention, they hired an environmental consultant to conduct a feasibility study, engage the local community, and conduct fish surveys. The results from these activities were favorable for dam removal, and so the NGO – CARP – along with consultants, the Department of Fisheries and Oceans, and Nova Scotia Environment worked together to create a plan for restoration. CARP staff monitored water quality indicators (pH, dissolved oxygen, macroinvertebrates, etc.) and used photo documentation two years before and after the dam was removed in 2011. Removal of the dam opened up 19.1 km of river habitat for fish. Water monitoring revealed increased dissolved oxygen, lower temperatures, and changes in macroinvertebrate communities, which indicated an overall improvement in habitat conditions for fish. This project was unique as funding was provided specifically for monitoring, and shows that when given the opportunity NGOs are capable of tracking improvements to ecosystems as a result of restoration.

Monitoring information and photographic evidence showed clear ecosystem benefits from the removal of a degraded dam in a salmon-bearing stream.

Culverts (A) were visually assessed to be impeding fish passage in the brook and culvert removal (B) restored habitat connectivity.

APPLICATIONS

This research provides a closer look at NGOs engaged in community-based water monitoring to help understand how we can connect the data they collect and the restoration work they engage in to meaningful governmental management actions and positive changes in watershed health. Here are some key recommendations for governments and NGOs when applying the results:

"Although restoration projects were successful in the mitigation or removal of targeted impacts, very few projects were capable of monitoring any changes within the aquatic environment resulting from restoration."

GOVERNMENTS:

- Sharing resources with NGOs for community-based water monitoring programs can help to build trust and increase shared capacity for monitoring. Partnerships with regional-level NGOs that support community-based water monitoring can enable government agencies to work with a wider base of groups.
- Integrating scientific monitoring into existing funding structures for restoration projects has the potential to increase NGO capacity for tracking restoration success.

ENVIRONMENTAL NGOS:

- Partnerships with relevant government departments can increase access to scientific expertise and resources for monitoring and can be facilitated through, for example, having governmental representation on an NGOs' Board of Directors and/or watershed management planning processes.
- Educational monitoring (or a blend with long-term rigorous monitoring) is a less resource intensive option that can increase public awareness of watershed issues.

Community-based water monitoring can be useful for increasing the breadth of information available on watershed health for environmental managers, increasing community engagement in watershed stewardship, and tracking restoration project success. We recommend that government agencies invest in partnerships with environmental NGOs through in-kind and funding support to achieve the multiple benefits associated with these activities for our society.

This research was recently published in Journal of Science Communication: Buckland-Nicks, A., Castleden, C., and Conrad, C. (2016). Aligning community-based water monitoring program designs with goals for enhanced environmental management. Journal of Science Communication, 15(3), p. 1-23.

The Water Economics, Policy and Governance Network's (WEPGN) overarching goal is to build knowledge and facilitate exchange between social science researchers and partners, thereby increasing the application of research to decision making and enhancing water's sustainable contribution to Canada's economy and society while protecting ecosystems. WEPGN was established with a SSHRC Partnership Grant. WEPGN's objectives are to:

- → Create a vibrant and multidisciplinary network of Partnerships amongst researchers, government agencies and community groups;
- → Provide Insight by mobilizing knowledge from social science perspectives to improve our understanding of water's role in Canadian society and economy;
- → Strengthen Connections by facilitating a multidirectional flow of knowledge amongst researchers and partners to promote more efficient and sustainable water management;
- → Provide high quality Training experiences for students and practitioners with interests in water policy decision-making and management.

This project by Castleden et al. contributes to each of the above objectives, and is a particularly strong example of a project providing high quality training experiences for students.

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