Successful Community-based Monitoring in Canada: Three Case Studies

Major Paper Submitted By

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FINAL READING APPROVAL

To the faculty of Rural Planning and Development in the School of Environmental Design and Rural Development.

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in its final form and have found that it meets the standards of the Rural Planning and Development M.Sc. program in all respects.

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Abstract

Public concern about the environment continues to rise in Canada, yet funding cuts to government monitoring programs have created difficulties for Canadian governments to adequately address this concern. Community-based ecological monitoring (CBEM) arose as a way to continue monitoring the environment in light of the reduced ability of the government to do so. While CBEM has been undertaken in Canada since the 1990s, successfully monitoring the environment and communicating monitoring results have continually challenged community groups. These challenges have been recognized by researchers who have proposed a number of methods to help CBEM groups achieve success including: obtaining adequate funding, adopting a standardized monitoring protocol, adopting a monitoring framework, selecting an appropriate monitoring approach, and linking monitoring data with decision-making. These recommendations for success are important for CBEM groups, but are rarely followed-up with additional field work to provide further evidence for their validity. In order to provide such evidence, three successful Canadian CBEM groups were identified by survey and studied in depth. The experiences of the Association for Canadian Educational Resources, the Lake Windermere Project, and the North Shore Streamkeepers offer support for the recommendations made in the literature. It is therefore concluded that, while the three monitoring groups examined achieved success differently, the methods recommended for attaining success identified in the literature are accurate.

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Project Background

The idea for this major research paper came from a research project, "Community Engagement for Adaptive Management in Environmental Assessment Follow-up", being undertaken by N.T.Yap Environmental Systems Analysts Limited on behalf of the Canadian Environmental Assessment Agency. The project aims to find institutional arrangements that allow community-gathered data to be used effectively in adaptive management decision-making in the context of Canadian environmental impact assessment follow-ups.

I became a researcher for this project under the supervision of Dr. John F. Devlin in the spring of 2009. It was clear from the outset that there was an opportunity to overlap my own graduate research with the research project I was undertaking with my employer. A marked advantage to this approach was the fact that I was able to study community-based monitoring organizations for the better part of a year before beginning to write my major research paper.

While community-based monitoring is by no means a new concept, it became apparent through my research that the entire field is to greater and lesser degrees shrouded in uncertainty. Researchers have tackled myriad issues such as volunteer motivations, linking monitoring with decision-making, monitoring protocols, monitoring frameworks, and others. Most make recommendations for community-based groups so that they can achieve success while navigating the many pitfalls of a community-based approach. These recommendations for success are important, but rarely are they followed-up with additional field work to provide supplementary evidence for their validity. In-depth case studies of successful community-based monitoring groups have the ability to corroborate or challenge these recommendations and in so doing add to

the corpus of knowledge on community-based monitoring. The following research paper undertakes to make such an addition.

The results of the research offer support for a number of recommendations made in community-based ecological monitoring literature. Obtaining adequate funding, adopting a standardized monitoring protocol, adopting a monitoring framework, selecting an appropriate monitoring approach, and linking monitoring data with decision-making—all recommended by researchers as ways to achieve monitoring success—are validated through case studies of three successful community-based monitoring groups.

Literature Review

Public awareness and concern about the environment has grown steadily since the 1960s. In response to this phenomenon, developed nations around the world established new ministries responsible for environmental protection at various levels of government (Savan *et al*. 2003). So it was in Canada: federal and provincial governments assumed the responsibility for monitoring and regulating the environment in light of mounting public concern.

Until recently, the Canadian government has continued to play a leading role in environmental protection. Yet, budget cuts in the late 1990s have significantly reduced the ability of the government to track and respond to issues of environmental concern (Canadian Institute for Environmental Law and Policy 1999, Whitelaw *et al.* 2003, Craig *et al.* 2003). In other words: while public concern about the environment continues to *increase*, there is a *decrease* in the ability of the government to address this concern (Conrad and Daoust 2008, Gayton 2003).

Community-based ecological monitoring (CBEM) arose as a measure to bridge this growing gap (Au *et al*. 2000, Sharpe *et al.* 2000). CBEM refers to the "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" (EMAN 2002).

The Benefits of a Community-based Approach to Monitoring

Though in its earlier years the value, effectiveness and reliability of CBEM were questioned (Heiman 1997), it is now accepted that a community-based approach to ecological monitoring can produce reliable and accurate data while bringing added benefits to communities (Carr 2004, Conrad 2006, Dyck 2007, EMAN 2002, Heiman 1997, Moyer *et al*. 2007, Pollock *et al.* 2003, Quinn and Dubois 2005).

While Heiman (1997) recognizes the limitations of a grassroots approach to environmental monitoring (an alternate term to CBEM), he nevertheless concludes that community members *can* gather reliable and accurate scientific data. This conclusion is also reached by Fore *et al*. (2001) who, after undertaking statistical analysis comparing volunteer and professional field samples of water quality, found no significant difference in the quality of the data collected. Because of this ability to produce reliable and accurate data, Heiman (1997) maintains that the "democratization of science" should be embraced. This early endorsement of CBEM is echoed in later literature.

Quinn and Dubois (2005) discuss a monitoring initiative collaboratively designed by community and ecological monitoring specialists and a group of Alberta ranching families. The

initiative, which used standard indicators to monitor ecological change over time, not only resulted in valuable data collection, but also empowered the families to take environmental stewardship into their own hands.

Others have highlighted the value of CBEM to communities. Dyck (2007) describes a college-based limnological CBEM initiative at Crazy Lake, Nunavut. From an administrative standpoint, the initiative drastically reduced cost and logistical constraints by using community youth. Equally as important, the initiative built trust in the research results within the community and led to a sense of accomplishment experienced by those who were involved.

In their proposal to use a community-based approach to monitor the Manitoba hog industry, Moyer *et al.* (2007) note that CBEM can not only help fill gaps in monitoring and address governance issues, but can also facilitate social learning, build trust within the community, and lead to greater social cohesion generally.

In his article *Why Do We All Need Community Science?* Carr (2004) offers a number of reasons why community science (yet another term for CBEM) is of value. CBEM can 1) rebuild community trust that has been lost in institutionalized science (as Dyck (2007) noted at Crazy Lake), 2) supplement traditional methods of data collection, 3) complement, extend, and refine scientific interpretation, 4) offer a low-cost and broader approach to conventional data collection, and 5) enable scientific questions asked by citizens to be answered.

Other benefits of CBEM abound in the literature. CBEM can 1) enhance community capacity and social capital, 2) help communities establish a desired vision for their community, 3) lead to a more inclusive decision-making process, 4) develop and extend social networks, 5) provide more data about the local environment to supplement that of external experts, 6) allow communities to respond to environmental change through adaptive management, 7) create a

sense of empowerment in the community, and 8) advance the concept and practice of sustainable development (Quinn and Dubois 2005, EMAN 2002, Pollock *et al.* 2003).

Overcoming the Challenges of a Community-based Approach to Monitoring

While a community-based approach to ecological monitoring can bring a number of benefits to multiple stakeholders, challenges and limitations of CBEM initiatives have also been recognized. These challenges include 1) data inaccuracy (Cuthill 2000, Craig *et al.* 2003, Engel and Voshell 2002); 2) volunteers losing interest in the project (Craig *et al*. 2003); 3) lack of participant objectivity (Stokes *et al*. 1990); 4) lack of funding (Craig *et al.* 2003, Hunsberger 2004); 5) a concern that governments will use community-based monitoring as an excuse to cut funding to current monitoring programs (Sharpe *et al*. 2000); 6) "datakleptomania", or collecting monitoring data without any real purpose or objective (Conrad and Daoust 2008); and 7) difficulties linking monitoring data with decision-makers (Bens 1994, Conrad 2006, Craig *et al*. 2003, EMAN 2002, Hunsberger 2004, Makhoul 2004, Milne *et al.* 2006).

These challenges and concerns about community-based monitoring are many, but there is a wealth of literature that proposes ways to resolve them. Proposed solutions include 1) positive feedback to volunteers on their roles, such as a volunteer recognition program, in order to maintain volunteer interest (Craig *et al*. 2003); 2) using skills assessment to match volunteers with tasks appropriate to their capabilities (Cuthill 2000); 3) establishing a method to deliver information to decision-makers to make monitoring data useful (Pollock and Whitelaw 2005); 4) obtaining ongoing and adequate funding to support the project (Yarnell and Gayton 2003); 5) involving experts in the design of monitoring initiatives to improve their monitoring

effectiveness (Yarnell and Gayton 2003); 6) developing partnerships with stakeholders to enhance capacity and link to decision-makers (Craig *et al.* 2003, Milne *et al.* 2006); 7) using monitoring protocols to ensure reliable data is collected (Conrad and Daoust 2008); and 8) training and supervising volunteers to ensure proper monitoring is undertaken (Au *et al.* 2000, Stokes *et al.* 1990).

The Importance of Linking Monitoring with Decision-Making

While the potential benefits of a community-based approach to ecological monitoring have been widely recognized, researchers have identified a number of necessary conditions to make monitoring more successful. One such condition is that monitoring should be formally linked to decision-makers (Bens 1994, Conrad 2006, Craig *et al*. 2003, EMAN 2002, Hunsberger 2004, Makhoul 2004, Milne *et al.* 2006). The absence of this important link can result in groups collecting data with no clear purpose or objectives (Conrad and Daoust 2008).

Craig *et al.* (2003) note in their consideration of monitoring activities undertaken at the Long Point World Biosphere Reserve that monitoring work undertaken there is not connected to decisions being made. For instance, two large-scale hog farms were approved near the source of drinking water for the Town of Simcoe without any consultation of monitoring information. Similarly, landscape fragmentation persists as rural and estate lot development continues to be approved without using monitoring data as a basis for decision-making. Craig *et al*. (2003) note that monitoring activities aren't meaningful when they are not consulted in decision-making.

Hunsberger (2004) considers the link between environmental monitoring and decision-making at length through three Canadian case studies (Comox, British Columbia; Hamilton,

Ontario; and Muskoka, Ontario). She notes that monitoring initiatives are not being used to their full potential. In her recommendations to improve CBEM activities, Hunsberger (2004) suggests that links be made with governments so that decision-makers will respond to monitoring information when they receive it.

Conrad (2006), in a similar way, notes that in Nova Scotia the information gathered through monitoring is not being used by decision-makers. She reveals a number of barriers that cause this disconnect, such as 1) lack of political will, 2) lack of staff time, 3) lack of available resources, 4) unequal level of commitment from CBEM groups and decision-makers, and 5) discrepancies in power and trust. These barriers can be overcome, she suggests, if CBEM initiatives adopt some simple guidelines such as researching political and educational strategies to understand how to influence decision-making as well as making monitoring information more usable and timely for decision-makers.

Other research has also suggested ways to bridge the divide between monitoring and decision-making. For instance, Milne *et al*. (2006) note that multi-party monitoring—the process which brings together community-level monitoring with governments and other interested parties—has the potential to link monitoring with decision-making. This is because multi-party monitoring brings together a monitoring group with other stakeholders (such as decision-makers) as equal partners and incorporates them into the process. Milne *et al.* (2006) further suggest that creating long-term records at a regional scale is necessary to inform policy decision about environmental change.

The issue of linking monitoring and decision-making was also recognized by the federal government, who began a long-term project seeking to address this issue (Makhoul 2004). The Canadian Community Monitoring Network, born from a pilot project of 31 monitoring initiatives

across Canada, was in a number of cases successful in achieving this goal. For instance, lichen monitoring data in Hamilton, Ontario describing the poor air quality in the city was recognized as an issue which required municipal attention and was subsequently incorporated into the city's Vison2020 plan (Makhoul 2004).

The Importance of Monitoring Protocols

In a similar way the importance of using a standardized protocol to gather monitoring data has also been recognized (Conrad and Daoust 2008, Fore *et al.* 2001, Engel and Voshell 2002, Hunsberger 2004, Makhoul 2004, Milne *et al.* 2006, Savan *et al.* 2003, Sullivan and Beveridge 2005).

Conrad and Daoust (2008) draw a direct line between monitoring protocols and the effective delivery of monitoring information to decision-makers. In a survey of various community-based organizations, they found that a staggering 73 percent did not use a monitoring protocol or consistent monitoring methods. Consequently, the data provided to decision-makers was less credible and less reliable. Their modified framework is in part intended to address this issue.

Hunsberger (2004) also draws a connection between standardized monitoring protocols and linking monitoring to decision-making. She notes that provincial and federal government agencies should be responsible for creating a protocol to be used by all monitoring organizations. This would lead to higher quality data and allow important data comparisons to be made between monitoring initiatives. Higher quality data and data comparisons have a greater potential to be used by decision-makers (this conclusion is also reached by Sullivan and Beveridge 2005).

Milne *et al*. (2006) also note that standard monitoring protocols are part of the solution in linking monitoring with decision-making.

We should, however, consider the cautions of Engel and Voshell (2002) who describe their experience with a popular American monitoring program, the Virginia *Save-Our-Streams* initiative. They found that volunteers were using a monitoring protocol, but one that had not undergone a validation study. The monitoring protocol was inappropriate for the type of monitoring being undertaken and it was only after undergoing a change as a result of a validation study that the monitoring protocol was effective in reliably assessing the condition of streams.

The Importance of Monitoring Frameworks

A framework for monitoring has also been recognized as an important component in the success of any CBEM initiative (Conrad and Daoust 2008, Craig *et al.* 2003, Pollock and Whitelaw 2005, Whitelaw *et al.* 2003). A monitoring framework is an attempt to remove the complexity from monitoring by "subdividing the entire design-process into separate components" (Vos *et al.* 2000, p. 318). Components often include what to measure and how, how to store and analyze monitoring data, and how to communicate results. This subdividing allows groups to address issues in the proper order and level of detail (Vos *et al.* 2000). We should note here the difference between a monitoring protocol—which is limited to what, where and how to monitor—and a monitoring framework—which is concerned with the entire monitoring process from data collection to the communication of results. Undoubtedly the most widespread framework (in literature coverage if not actual use) is the Canadian Community Monitoring Network (CCMN), a conceptual monitoring framework begun in the early 2000s.

Conceived and created by Environment Canada's Ecological Monitoring and Assessment Network's Coordinating Office, the CCMN was intended to coordinate existing monitoring initiatives, create a standardized monitoring protocol, and link monitoring activities to decision-making (Makhoul 2004, Whitelaw *et al.* 2003). The framework consists of two phases 1) developing the infrastructure necessary to launch CBEM activities in a community and 2) developing the tools to make the monitoring initiative successful (Whitelaw *et al.* 2003).

The framework was later evaluated by Pollock and Whitelaw (2005) after considering the progress of 31 CBEM pilot projects. They found that, while successful, the framework suffered certain inadequacies, such as inadequate attention to community diversity and lack of adaptability. The most successful initiatives of the 31 were those that were adaptive, had strong coordination, were meaningful to participants, had mechanisms for delivering monitoring information, and tried to achieve sustainability. Based on these conclusions, they propose a revised conceptual framework based on four dynamic themes 1) community mapping, 2) participant assessment, 3) capacity building, and 4) information delivery. Since its creation the CCMN has been used successfully by a number of initiatives (see Craig *et al.* 2003 and Makhoul 2004).

Others have also made modifications to the initial framework. Conrad and Daoust (2008), based on feedback from a number of community-based monitoring groups, note certain limitations of CBM systems, such as 1) monitoring information is still not being used by decision-makers, 2) there is lack of consistency in monitoring methods, and 3) the current CCMN framework would be more useful if it were functional instead of conceptual. They therefore propose a modified framework to address these limitations. Modifications to the framework include 1) the identification of all stakeholders at the beginning of the process, 2) an

assessment of available skills and resources, 3) the creation of a communication plan to provide information to decision-makers, and 4) the implementation of a three-tiered monitoring plan involving monitoring, analysis, and result communication.

Different Approaches to Community-based Ecological Monitoring

Four main approaches to community-based monitoring have been identified by researchers. The first is government-led CBM, or the "top-down" approach, initiated by the government and designed to complement the actions of scientific experts (Craig *et al*. 2003, Conrad and Daoust 2008). The second is interpretive CBM which attempts to educate citizens by getting them involved in a monitoring program (Craig *et al*. 2003, Conrad and Daoust 2008). The third is advocacy monitoring, also referred to as "bottom-up" monitoring, where concerned citizens address an existing local issue with the intent to force decision-makers into action (Craig *et al*. 2003, Conrad and Daoust 2008). Fourth and finally is the multi-party approach, which involves "all interested stakeholders—private landowners, individual citizens, representatives of civil society organizations, business, government, and others committed to the community" (Whitelaw *et al.* 2003, p. 411).

Cuthill (2000) describes the interpretive approach in the context of volunteer-based coastal monitoring programs. The interpretive approach, rooted in interpretive theory, aims to expand the goals of monitoring beyond data collection to a consideration of participant skills, knowledge, and motivations. Using "audience research", or research on the participants of a monitoring program, program designers are able to give volunteers tasks based on their skill levels (ensuring accurate and reliable data collection). Knowing the motivations of volunteers in

joining a monitoring group means that coordinators can try to satisfy volunteer motivations (leading to a stable and long-term volunteer base).

Fleming and Henkel (2001) describe a rapid appraisal approach to CBEM that falls outside the traditional four. They note that monitoring of natural resources is essential so that public agencies can make timely decisions. Yet, monitoring techniques have historically been hindered because they are 1) not adaptable to different ecological scales and 2) dependant on time-consuming, expensive, and often overly-detailed analysis. The rapid appraisal approach to community-based monitoring is cheap, fast, adaptable, and provides succinct and usable data. Their approach was used successfully by high school students to monitor a riparian system at a total cost of $15 per monitor.

Practitioners have noted several factors influencing the success or failure of different approaches to community monitoring. Conrad and Daoust (2008) note that advocacy monitoring, which is a unilateral approach, is often unsuccessful. This is likely due to the fact that monitoring groups end up monitoring a problem that has no comprehensive environmental law or policy to remediate it (Conrad and Daoust 2008). Conversely, the multi-party approach, a multi-tiered approach, is increasingly being accepted (Conrad and Daoust 2008). Milne *et al.* endorse this approach and note that it could potentially better link monitoring with decision-making.

Thesis Statement

The works surveyed above identify challenges for CBEM and suggest what can be done to achieve success. Five factors in particular stand out in the literature as key to achieving success. These are: 1) obtaining adequate funding, 2) using a monitoring protocol, 3) using a

monitoring framework, 4) adopting an appropriate monitoring approach, and 5) linking monitoring with decision-makers.

In-depth case studies of successful community-based monitoring groups have the ability to corroborate or challenge these success factors and in so doing provide valuable insight to CBEM groups while illustrating the potential planning applications of community-gathered data. Three Canadian community-based monitoring groups—the Association for Canadian Educational Resources (Mississauga, Ontario), the Lake Windermere Project (Invermere, British Columbia) and the North Shore Streamkeepers (North Vancouver, British Columbia)—are excellent candidates for case studies. All three are successful community-based monitoring initiatives that have overcome common monitoring challenges while achieving added benefits in their communities.

Methodology

In order to validate the factors which are thought to lead to CBEM success it is necessary to identify and study monitoring initiatives which are successful. While this is simple in concept, it proved to be a considerably lengthy process involving six steps: 1) establishing preliminary contact lists for the survey, 2) completing contact lists, 3) creating online surveys to send to the contact lists, 4) managing the survey responses, 5) selecting three groups for case study, and 6) undertaking field work for each case.

Establishing Contact Lists

This first phase in the research involved creating contact lists which would be used as a basis for eventual internet survey. Three contact lists were created for this purpose: 1) a list of all Canadian municipalities, 2) a list of comprehensive study or panel review environmental impact assessments (EIAs) within the past ten years, and 3) a list of organizations currently engaged in community-based ecological monitoring and management.

The contact list for Canadian municipalities was the first, and by far the longest, list created. The purpose of this list was to find out, through a general survey, which municipalities had active CBEM organizations. The list was compiled using information from municipal websites. As much contact information as possible was gathered from these sites and placed into a spreadsheet. The goal of the research was to obtain as many municipal electronic mailing addresses as possible to ensure a high response rate.

The contact list for comprehensive study or panel review environmental impact assessments (EIAs) within the past ten years was then compiled. This list was initially compiled using information from the Canadian Environmental Assessment Registry website (available from http://www.ceaa.gc.ca/050/index-eng.cfm). Again, all the contact information gathered was entered into a spreadsheet.

Finally, the contact list of organizations currently engaged in community-based environmental monitoring and management was compiled. This list was initially compiled using information gathered from the Citizen Science online directory of Canadian monitoring and management groups (now unavailable). The directory, at the time of the research, was no longer

being updated—however, it did provide an excellent research starting point. Once again, all available contact information was entered into a spreadsheet for future use.

Completing Contact Lists

The three contact lists compiled above were based on preliminary internet research. This research yielded good results, but there was a great deal of missing contact information from all three. For instance, the contact list for municipalities was taken from municipal websites; yet, a number of Canadian municipalities do not have websites. The lists were therefore completed as much as possible by telephone.

Developing Online Surveys

The next step in the research process was to create a survey tailored to each of the contact lists detailed above. The survey for Canadian municipalities, for instance, was designed to be very brief and simply determine whether or not organizations currently engaged in community-based environmental monitoring and management activities were present in a given municipality. If there were monitoring and management organizations, the survey asked for the name of the organization and contact information if possible.

The survey for community-based environmental monitoring and management organizations, on the other hand, was much more detailed and sought to determine specific information about the initiative such as the initiative's success in a number of predetermined

categories. The survey also inquired whether a given organization was aware of other monitoring or management organizations so that, through the "snowballing" effect, a large number of organizations could be identified.

After creating the initial version of the survey for community-based environmental monitoring and management organizations, trials of the survey were sent out to twenty organizations. These trials were intended to determine if the survey needed any modifications and asked suggestions on improving the survey. After these surveys were submitted, appropriate changes were made, and the surveys were ready to be sent to the contact lists.

The emails from the spreadsheets were then entered into three email lists (one for each survey type). As expected, a number of emails from each list were no longer valid. A new search was undertaken to try to find current email addresses, and the survey was eventually resent to these new addresses.

Managing Survey Responses

The next research step was managing the survey responses. This involved reading through the survey responses, sorting responses according to the perceived success of the initiative, and following-up on any suggested monitoring and management organizations. During this research phase profiles were created for the organizations which appeared to be successful. These organizations were followed-up with telephone interviews in order to enrich their profiles and help determine which monitoring and management organizations were the most successful. The profiles later became the basis for choosing the three case study organizations.

Selecting Three Cases

Once the profiles were completed a list of criteria (based on the literature review) was designed to help determine three of the most successful CBEM groups (see ANNEX 1). A seminal criterion for judging the success of each monitoring initiative was the group's self-identified or perceived success rating. This self-rating process helped highlight initiatives that should be further considered for case study.

The three cases were deliberately chosen from different areas of Canada to avoid any regional bias and to increase the diversity of the study. Similarly, different types of monitoring groups were chosen (tree monitoring, lake monitoring, and stream monitoring) to increase the applicability and diversity of the study.

A significant issue arose at this stage in the research process when a monitoring organization did not want to be studied. Their concerns were based on time commitments and an absence of funding for participation in the study. Eventually a replacement organization was chosen based on the aforementioned criteria, and the research was able to continue.

Field Work

The approach chosen for field work involved 1) travelling to the location of the monitoring program, 2) undertaking key informant interviews with as many people as possible involved with the program, and 3) undertaking and observing monitoring in the role of a volunteer. The length of field work varied between three and 10 days and took place in Mississauga, Ontario (the Association for Canadian Educational Resources); Invermere, British

Columbia (the Lake Windermere Project); and North Vancouver, British Columbia (the North Shore Streamkeepers).

The Association for Canadian Educational Resources, the Lake Windermere Project, and the North Shore Streamkeepers are briefly described below. Each description includes when monitoring activities started and why, what is monitored, what protocol is used for monitoring, and other important background information.

Case Studies

Association for Canadian Educational Resources

Alice Casselman single-handedly founded the Association for Canadian Educational Resources (ACER) in 1987. As the name suggests, ACER was originally designed as an educational program in order to get students outdoors. However, it was quickly realized that ACER could produce needed climate change data while continuing to engage students in outdoor activity. Tree monitoring was chosen to satisfy both data needs and the educational desires of the organization.

ACER's first project was to create three one-hectare monitoring plots along the Niagara Escarpment. These plots were accessible to teachers who could bring students to learn about climate change and the importance of tree monitoring. The idea for creating the plots came from the "Rio Conference" in Rio de Janeiro where the Smithsonian Tropical Research Institute was commissioned to develop a protocol to monitor forest biodiversity. This protocol was later brought to Canada to the Kejimkujic National Park in 1994, and was adopted by ACER in 1995.

Importantly, the protocol supported the concept of monitoring climate change through tree monitoring.

Since its first project, ACER has made significant additions to its programming. In 2002, ACER recognized that there was a need to "plant for climate change" in addition to teaching students about it. ACER therefore planted a one-hectare plot of trees (76 species, 2157 trees) in six mini-experiments of biodiversity in one field at the Humber Arboretum. The goal of this planting was not only to study biodiversity and monitor climate change but to create another educational outing for schools.

However, a number of schools experienced issues with funding and transportation to the plot which limited its use by students. In response to this, ACER created a program where schools could map their own schoolyards and inventory the trees in them using the same techniques used at the planting plots. Later, in response to requests from teachers, ACER helped a number of schools plant mini tree plots in their schoolyards. The "Planting for Change" program is increasing in popularity, and every year new schools are inquiring about the program.

ACER has also received a contract to lead a program called "Humber Youth Stewardship". This is an invasive species removal program in the City of Toronto. Once the invasive species are removed, ACER plants appropriate species in their place. This system allows ACER to conduct a complete tree inventory of each area.

ACER now uses the Smithsonian Protocol to monitor both mature and young trees in forests, test plots, standard plots, and schoolyards. Additionally, ACER monitoring data has been used in several publications. Based on its success, ACER has recently received a large transition grant to take the organization from its current size to the provincial scale.

The Lake Windermere Project

The impetus for the Lake Windermere Project (LWP) came from the 9th "Living Lakes" international conference held in the Columbia River area of British Columbia in 2004. The conference stimulated local interest in Lake Windermere, a widening of the Columbia River in Invermere, British Columbia. Heather Leschied, the project manager for the LWP, describes how

> "People started asking 'what's happening on Lake Windermere? What is the local environmental organization doing or what are local governments doing about that?' That's where the question first began: 'what's being done to protect the lake?' And at that time, nothing was being done" (personal communication, February 23, 2010).

Further motivation for creating the Lake Windermere Project can be found in the *Water Stewardship Workplan 2009-2010*, which details how

> "…it became apparent that development of second homes in the region was having significant impacts on the water quality and quantity of the Upper Columbia River, a river which provides water to 15 million downstream users. Lake Windermere has experienced a collapse in the burbot (Lota lota) fishery. Because burbot are a top predator, the health of their population is a good indication of the health of the ecosystem as a whole" (Leschied 2009).

These motivations led to the creation of the LWP in 2005, the purpose of which is to monitor the health of Lake Windermere and its tributaries and help determine if any remedial action is necessary.

The LWP started monitoring using the British Columbia Lake Stewardship Society (BCLSS) level 1 monitoring program in 2005 on Lake Windermere and two tributaries. Since the first year of the program, the LWP has added more monitoring sites—five more tributaries

and three water intake stations—and more monitoring programs, including the Canadian Aquatic Biomonitoring Network protocol. In addition to water quality monitoring, the LWP also monitors beach bacteriology on public beaches and undertakes boat counts as an indicator of recreational pressures on the lake.

The LWP has also been involved in partnership projects, such as the cosmetic pesticide ban in the District of Invermere with the Canadian Cancer Society, and the East Kootenay Integrated Lake Management Partnership, which resulted in the creation of the Windermere Lake Shoreline Management Guidelines for Fish and Wildlife.

LWP data has been used to compile several reports including the *Findings of the 2005 Lake Use Survey* document, which showed, based on a widespread survey in the Invermere area, that the community was concerned about the health of the lake and would be receptive toward a lake stewardship initiative.

Now in its fifth and final year, the Lake Windermere Project will be handed over to the Lake Windermere Ambassadors, a group of more than a dozen community leaders committed to ensuring the protection of the lake in perpetuity. The ambassadors will be responsible for raising funds and ensuring monitoring on the lake continues. Based on the success of the LWP, the project is now being franchised by its parent organization Wildsight as well as the Lake Winnipeg Foundation in order to support community-based water stewardship efforts on a broader scale.

The North Shore Streamkeepers

The North Shore Streamkeepers (NSSK) started in 1993 with the encouragement of environmental staff at the District of North Vancouver, who recognized the importance of local salmon-bearing streams, the impacts from urban development, and the community interest in local streams. Local groups were invited to send representatives and early members included the local fish and game club, salmonid enhancement groups, Girl Guides, and the Department of Fisheries and Oceans (DFO) Community Advisor.

Around the time the NSSK formed, the DFO began developing a training manual to help salmonid enhancement groups and other interested groups protect stream habitat. Groups had noticed that the salmon they carefully reared and released were exposed to many threats to habitat as well as pollution. The training manual (the Streamkeepers Handbook) was designed for volunteers based on commonly used scientific methods to assess watershed conditions, stream habitat, and water quality. The Handbook also discusses the development of plans and priorities for restoration and raising community awareness about the public's role in maintaining a healthy watershed. The training manual methods were based on commonly used scientific methods and stewardship models (including the Washington State "Adopt a Stream" program) which were reviewed by approximately 50 specialists and educators in British Columbia. DFO developed a database to capture the data provided by Streamkeeper groups around the province. Following the publication of the 1994 pilot manual, a more extensive version was released in 1996, followed by a training module for restoration work. It should be noted that the NSSK benefited greatly from the experience of several group members who had been involved in the development of the Streamkeepers Handbook.

Growth of capacity among volunteers was aided greatly by a support structure within the DFO. Community Advisors were in place within several regions of the province (approximately 15 in the early 1990s), providing technical advice and liaison with experts for many small scale salmon enhancement projects. DFO provided resources for writing the manual, training of trainers, database creation, and opportunities to spread the word about the program at Volunteer Workshops held every two years. DFO continues to support stream keeping and salmon enhancement projects, through the Community Advisors and the Pacific Streamkeepers Federation.

The NSSK differ from many monitoring organizations in a number of ways. First, the group is not a registered society, it is an informal group of volunteers who come together to monitor North Vancouver streams. Second, the group has no central office and no staff. Third, the NSSK have no consistent funding.

Despite these differences, the NSSK have been a success for the past 17 years. Through their membership with the Pacific Streamkeepers Federation, the NSSK have a presence on a number of boards including the Pacific Salmon Foundation, the Salmon Enhancement Advisory Board, the Marine Conservation Caucus, and the Stewardship Council of British Columbia. The group has been asked to give input into a number of municipal documents, such as the Parks Master Plan and the Official Community Plan, and has published a comprehensive water quality monitoring report on MacKay Creek.

The group undertakes water quality monitoring, salmonid monitoring, and visual monitoring of North Vancouver streams. In addition, the NSSK have been involved in a number of salmonid enhancement projects, clean-up projects, and invasive plant removal projects in North Vancouver.

Having briefly described ACER, the LWP, and the NSSK, we can move to a consideration of how each has achieved a number of conditions that have been identified as factors contributing to monitoring success. These factors are: obtaining adequate funding, adopting a standardized monitoring protocol, adopting a monitoring framework, selecting an appropriate monitoring approach, and linking monitoring data with decision-making.

Validating Proposed Success Factors

Funding

Adequate funding has been recognized both as necessary for the success of community-based monitoring groups and as a major challenge for them (Bliss *et al.* 2001, Craig *et al.* 2003, O'Rourke and Macy 2003, Hunsberger 2004,). Each CBEM group studied was able to overcome the challenge of funding, but interestingly, each has done so in a different way.

The Association for Canadian Educational Resources had a flow-through budget of $200,000 in 2009. This impressive figure comes from a stable base of repeat funders. The Trillium Foundation, Environment Canada's EcoAction Community Funding Program, TD Friends of the Environment, Shell, and the International Society of Arboriculture are but a few of ACER's repeat funders. This impressive list of recurring funders provides stability for the organization and has been achieved in a number of ways.

First, ACER proposes realistic and achievable project deliverables which they have always either met or surpassed. Discussions with funders revealed that this is a key factor in making granting decisions to non-governmental organizations (NGOs). Second, one funder noted that, because of ACER's ability to leverage support from others when a grant is received,

they have built a reputation of "doing more with less" (personal communication, September 22, 2009). This ability to use most grants as "seed money" has impressed funding agencies and has facilitated the formation of long-term funding relationships. Third, funders noted that ACER actively promotes their programs to other NGOs. This raised the profile of a number of funding agencies and has been recognized by funders.

Interestingly, ACER is entirely project-driven. In partnership with the University of Waterloo's cooperative education program, ACER has been able to obtain a student intern and an additional summer student has been hired. However, ACER does not have—and never has had—any full time staff. This means that the vast majority of funding goes directly to ACER projects. This has no doubt contributed to the organization's prolific list of programs. Alice Casselman, ACER's founder and executive president, noted that project-driven NGOs are usually unsustainable. Yet ACER has been monitoring since 1987.

This ability to push the majority of funds toward projects while neglecting full-time staff positions has been made possible because of Alice Casselman. Alice, a retired teacher, works full-time for ACER without pay. Alice's pro bono work has maximized funding to ACER projects without sacrificing funding to staff. It is clear that having the benefit of a full-time staff person without the need to pay them has contributed to ACER's efficient use of funding and therefore partly to the organization's success. Alice described how "there's...no permanent staff on salary. There's an honorarium here or there and there's minimal bookkeeping and webmastering is token, so we're talking about a pretty lean and mean machine." (personal communication, September 22, 2009).

Realistically, relying on volunteer staff is problematic. It creates obvious administrative difficulties. If a staff person left, who would replace them? If the organization only has one full-

time staff member, who would recruit the new staff member? Such problems could threaten the continuity of the organization altogether (how can an organization continue to function without its only full-time staff member?) This approach of maximizing funding for projects should therefore be approached cautiously by monitoring groups, but not written off completely; while this situation may not be seen as ideal, it is difficult to argue with ACER's impressive lifespan and results.

The Lake Windermere Project has an annual budget of roughly $130,000 and also boasts a stable funding base. Major consistent funders include Environment Canada's EcoAction Community Funding Program, the Columbia Basin Trust, the Columbia Real Estate Foundation, and the District of Invermere. In order to obtain consistent funding, the LWP took a number of steps.

First, the LWP identified a concrete project end (5 years from its creation), after which time the project will be handed over to the Lake Windermere Ambassadors, a group of community leaders dedicated to the perpetual protection of the lake. Funders noted that this concrete timeline, as opposed to a project of indeterminate length, was appealing. Second, the LWP established itself as a credible organization in the community before they applied for major funding. LWP funders noted that they are more likely to support projects that are already supported by the community. Third, the LWP has always proposed realistic deliverables which they have consistently met.

While the LWP has a full-time paid staff member, perhaps the most significant funding difference with ACER is that local government is one of the project's major funders. The District of Invermere (DOI) has been a partner in the project from its beginning, and not only provides funding but significant in-kind support to the group, including office space and a boat

for water monitoring activities on the lake. This ongoing relationship with the DOI has been a considerable benefit for the LWP because not only has it resulted in increased LWP funding but it has also brought LWP data to the attention of municipal government. This relationship between the LWP and the DOI has blossomed beyond a funding relationship and the LWP has now undertaken a number of partner projects with the district.

In sharp contrast to ACER and the Lake Windermere Project, The North Shore Streamkeepers have no consistent funding. At first glance it might seem that this would be detrimental to a monitoring group, but funding has never been an issue for the NSSK. Part of the reason for this is because the NSSK do not have an office or any paid staff, which means costs are drastically reduced. The Streamkeepers Handbook (the NSSK monitoring protocol) is available online for free from the Department of Fisheries and Oceans, and what little monitoring equipment is needed has rarely required replacement.

This does not mean that the NSSK do not seek funding. Rather, they have adopted a strategy of only seeking funding for specific projects instead of pursuing a consistent budget. This project-oriented funding strategy has not significantly hindered the productivity of the group. For instance, an Environment Canada EcoAction grant for $30,000 was obtained to complete a two-year water quality study on MacKay Creek, and a grant for a film about MacKay Creek has also been received.

While a project-oriented funding strategy has been successful for the NSSK, there are several disadvantages to their approach. First, a lack of full-time staff creates extra administrative duties for volunteers. It also means there is no consistently available contact for people that need to get in touch with the organization, thereby limiting the community's access to the group. Second, lack of office space means that there is no physical location for obtaining

information on the group and their results, which also limits community access. Evidence from the NSSK illustrates that such a funding approach is feasible, but its limitations should not be overlooked by monitoring organizations choosing a funding strategy.

What we should take from this discussion is that adequate funding is necessary to achieve success in community-based monitoring, but many different approaches can be taken to achieve funding success. A more traditional reliance on granting agencies, as in the ACER case, is certainly effective, but we should not overlook creative funding strategies like the LWP's municipal relationship or the NSSK's project-oriented approach. We should also note the importance of listening to the needs of funders in order to increase the chances of success with funding appeals and applications.

Monitoring Protocols

Like adequate funding, the importance of using a standardized protocol to gather monitoring data has also been recognized as a factor in CBEM success (Conrad and Daoust 2008, Fore *et al.* 2001, Engel and Voshell 2002, Hunsberger 2004, Makhoul 2004, Milne *et al.* 2006, Savan *et al.* 2003, Sullivan and Beveridge 2005). Lack of a standardized monitoring protocol can make monitoring data less credible in the eyes of decision-makers (Conrad and Daoust 2008). The Association for Canadian Educational Resources, the Lake Windermere Project, and the North Shore Streamkeepers all boast robust standardized protocols for data collection.

ACER adopted the Smithsonian Protocol—developed by the Smithsonian Tropical Research Institute—following the adoption of the protocol in Canada's Kejimkujic National Park

in 1994. The protocol was designed in order to monitor biodiversity in forest plots. In brief, the protocol involves dividing a one-hectare plot into 25 sub-plots of 20 meters by 20 meters. Trees are then measured from the first plot to the last in a series of clockwise inward-rotating circles. Depending on the maturity of the tree, measurements are taken for total height, diameter, crown width and depth, root collar size, and bud length (see ANNEX 3). The protocol was a perfect fit for ACER because it supports the concept of monitoring climate change through tree monitoring. ACER also chose the Smithsonian Protocol because it is an international protocol. Sadia Butt, a previous intern for ACER, described how the Smithsonian Protocol is "a solid protocol, it's internationally accepted, it's scientific, it's peer-reviewed" (personal communication, September 23, 2009). Because the data is internationally accepted, it can be used on a global scale. Alice Casselman noted that "climate change is a *global* not a *local* problem" (personal communication, September 22, 2009).

In part because of its scientifically defensible standardized protocol, ACER data has been used in a number of significant publications on climate change, such as *Climate Change and Biodiversity in the Americas* (Fenech *et al.* 2008), *Climate Change and Wildlife* (Pollock 2002), and *Human Health in a Changing Climate: a Canadian Assessment of Vulnerabilities and Adaptive Capacity* (Séguin and Berry 2008).

The Lake Windermere Project uses two primary standardized protocols for water monitoring. First, the LWP uses a British Columbia Lake Stewardship Society monitoring protocol. This provincial-level protocol allows standardization of lake water monitoring within the province. Data collected from Lake Windermere and tributaries includes turbidity, dissolved oxygen, pH, and conductivity (see ANNEX 3). The LWP has also recently adopted the Canadian Aquatic Biomonitoring Network (CABIN) protocol, a national protocol which

promotes "inter-agency collaboration and data-sharing to achieve consistent and comparable reporting on freshwater quality and aquatic ecosystem conditions in Canada" (CABIN 2010). CABIN is a more intensive protocol which includes turbidity, dissolved oxygen, pH, and conductivity as well as invertebrate sampling and descriptions of the substrate (see ANNEX 3). Because the LWP uses these standardized protocols, they have been able to provide useful data to Environment Canada and others about the quality of water in Lake Windermere.

The LWP uses another standardized protocol for monitoring bacteriology on several of Lake Windermere's public beaches. Water samples are collected from beaches and tested for fecal coliform and E. coli (see ANNEX 3). This data is used by the British Columbia Interior Health Authority to assess the health of the beaches. If data shows high bacteria levels at beaches (which has yet to happen), the Interior Health Authority can take reactive measures such as posting beach warnings or closing beaches altogether.

Boat monitoring is also undertaken by the LWP. A standardized protocol has been created by the LWP to accurately assess the number and type of boats on Lake Windermere at a given time (see ANNEX 3). While many volunteers found the boat counts to be tedious work, this form of monitoring clearly shows the high recreational pressures on the lake: one count found 225 boats on the lake at one time. This data is not yet directly linked with decision-makers, but it is possible that it will be used in the future to help assess the effects of recreational pressure on Lake Windermere.

The North Shore Streamkeepers use the Streamkeepers Handbook protocol. The Handbook is a comprehensive guide to stream stewardship and includes specific protocols for activities such as water quality monitoring and fish monitoring. Data collection correspondingly ranges from turbidity, dissolved oxygen, pH, and conductivity to measurements of juvenile fish

(see ANNEX 3). The monitoring data is provided to the City of North Vancouver, the District of North Vancouver, and the DFO. Data is used by the DFO, for instance, in assessing whether proposed projects will be detrimental to local fish habitat.

These cases illustrate that standard monitoring protocols are indeed important to the success of a community-based monitoring initiative. Through the use of provincial, national, or international protocols, standardized monitoring data is made more accessible to decision-makers and is seen as more credible. Data obtained through community-based ecological monitoring programs can in this way be used to fulfill a number of important functions, such as updating provincial water quality objectives (the LWP) or in discussions about the effects of climate change on human health (ACER).

Monitoring Frameworks

Monitoring frameworks, like protocols, have also been recognized as an important component in the success of any CBEM initiative (Conrad and Daoust 2008, Craig *et al.* 2003, Pollock and Whitelaw 2005, Whitelaw *et al.* 2003). Vos *et al.* (2000) note that a well-designed monitoring program requires a systematic framework in order to avoid gathering data without purpose. As mentioned above, the Canadian Community Monitoring Network (CCMN) model for community-based monitoring has garnered the most attention and refinements. Recently the CCMN model has been expanded and refined into a functional model by Conrad and Daoust (2008). Their new monitoring framework proposes four steps: 1) the identification of stakeholders, 2) the identification of skills and resource, 3) the creation of a communication plan,

and 4) the creation of a monitoring plan. While none of the three cases examined here has formally adopted this monitoring framework, each has undertaken similar steps.

Identification of Stakeholders.

The Association for Canadian Educational Resources identified stakeholders early on and has been adding others ever since. Environment Canada was approached from the beginning as the primary candidate for receiving data and continues to use ACER data in trying to understand climate change. Since ACER is structured around education, schools were approached as well as individual educators in order to create a curriculum program that could be used by teachers. Many other stakeholders were also identified—business people, individual citizens, and other environmental organizations. ACER has lasting partnerships with the Niagara Escarpment Commission, the City of Toronto, the Humber Arboretum, Environmental Education Ontario, and others.

The Lake Windermere Project also undertook stakeholder identification at the outset. The LWP identified as many stakeholders as possible and invited them to participate in the program. Stakeholders identified included local governments (the District of Invermere and the Regional District of East Kootenay), the local Chamber of Commerce, the British Columbia Ministry of the Environment, the British Columbia Interior Health Authority, and community members, all of whom have become partners in the LWP.

Like ACER and the LWP, the North Shore Streamkeepers identified stakeholders at the beginning of the monitoring project. With the help of the District of North Vancouver, the NSSK brought together numerous stakeholders including the local fish and game club, salmonid

enhancement groups, Girl Guides, the the Department of Fisheries and Oceans through the local Community Advisor, and citizens. Many of these stakeholders continue to work with the NSSK.

Identification of Skills and Resources.

ACER, as discussed in the funding section, has easily managed to identify and capitalize on outside monetary resources. Technical expertise has also been identified, most notably ACER's technical advisory team, who inform the organization on what trees are most appropriate to plant in a particular area. Internal resources have also been identified in the form of a monitoring "champion". Champion identification, or identifying an individual that will lead the initiative, increases the chance that monitoring groups will "enjoy longevity" (Conrad and Daoust 2008, p. 363). While never formally identified, it is clear from field experience that ACER has a champion. When asked why ACER was successful, Sid Baller, Superintendent of the Humber Arboretum, replied "it's like asking why is a circle round. It's kind of a tautology. *Because of Alice*. I mean, she has enough energy and drive for any 5 people that you'll meet. And she may take a licking but she keeps on ticking. She goes like an Energizer bunny that just goes on and on. And she's persistent, and she's determined, and she has a vision, and she's not a shy, bashful person. So put all those together" (personal communication, September 23, 2009).

In part because of the multi-party approach taken by the LWP, the identification of outside resources was easily achieved. The LWP has been extremely successful in securing a stable funding base and in-kind support from a number of sources. Scientific expertise is also close at hand from planners in local government, the British Columbia Ministry of the Environment, and the British Columbia Interior Health Authority. As with ACER, the LWP

never formally identified a champion, but it is evident that the organization is championed by a particularly motivated individual. When asked why the LWP was successful, a recurring response was the "hard work and dedication of Heather", referring to the LWP's project manager Heather Leschied. A confidential interviewee noted that "if [the LWP] didn't have her we wouldn't have gotten past first base" (personal communication, March 2, 2010).

Given the unique funding approach taken by the NSSK, resource identification was not undertaken during the initial formation of the group, but has been undertaken in the interim as deemed necessary. Technical expertise is provided by the DFO Community Advisors as well as municipal staff when it is needed. Technical advice is also available within the group as a number of volunteers were involved with the creation of the Streamkeepers Handbook.

Creation of a Communication Plan.

The creation of a communication plan was undertaken by ACER from the beginning. As mentioned above, ACER approached Environment Canada, the intended audience for the data, to ensure monitoring data would be used. The Smithsonian Protocol was adopted to suit both the ACER's goal to monitor climate change and Environment Canada's information needs.

The LWP also created a communication plan. Goals and objectives of monitoring were established, water quality data relevant to both local and provincial governments were identified, and protocols were chosen to meet information needs.

A communication plan was also produced by the NSSK. The plan included setting their monitoring goals and objectives, identifying what data would be relevant to decision-makers (both the DFO and municipal governments), and choosing the Streamkeepers Handbook as their monitoring protocol.

Creation of a Monitoring Plan.

A monitoring plan was also produced by ACER. This plan involves undertaking tree monitoring with volunteers, inputting the data into spreadsheets, analyzing the data, and sending the data to Environment Canada. Communication with stakeholders and the public is done primarily by way of newsletters, academic posters (for instance the *Biological Threats to Biodiversity* poster), and reports (such as the *Humber Youth Stewardship Project Final Report Summer 2008*). ACER also erects booths at popular events to increase their exposure and communicate their message to the public. ACER's website is used in order to inform the public about ACER projects and share information about the organization.

The LWP has created and implemented an effective monitoring plan as well, comprising monitoring, results analysis, and result communication. Monitoring is undertaken by the LWP on Lake Windermere and selected tributaries, results are sent to various bodies for analysis, and analyzed results are communicated with other stakeholders and the public. Several methods of data communication are used by the LWP including annual reports (the *Lake Windermere Project 2009 Report*), website updates and newspaper articles. The LWP is particularly prolific in the local media: in 2009 alone 45 articles written both by and about the LWP appeared in local media. These articles are used to seek funding, ask for volunteers, advertise events, outline new projects and describe findings. Articles are also used to inform the community about water conservation strategies, the importance of properly maintained septic systems, the drawbacks of retaining walls on the foreshore, and other pertinent issues regarding the lake. This constant communication with the public means that the community knows what is happening with the lake and what they can do to minimize their impacts.

The LWP is also involved with a number of events on the lake. For instance, the LWP is involved in an annual shoreline clean-up. The LWP conducts the "yellow fish program" to teach people about non-point source pollution and how pollution enters Lake Windermere through storm drains. The project also hosts a Water Wonders workshop at the annual Lakeside Hang-gliding and Para-gliding event to teach people about water conservation and pollution. By hosting popular events and putting up booths at events which already draw a crowd (such as the Lakeside Paragliding event), the LWP has been able to educate many people about the lake and the need to protect it.

The NSSK monitoring plan includes volunteer monitoring of streams, sending out data to be analyzed, and communicating the results to decision-makers and the public through a variety of media. The NSSK communicate with the public through various forms of literature: they have created brochures about their group which are sent out to the community, and they distribute a newsletter about MacKay Creek to roughly 1000 community residents. Other resources have also been created such as "My Nature Journal" to engage children and get them interested in stream preservation.

Perhaps the most impressive aspect of the North Shore Streamkeepers, however, is their proliferation of events. In 2008 alone the NSSK held 1) four invasive plant removal events on MacKay Creek, 2) two invasive plant removal events on Hastings Creek, 3) plantings on Lower MacKay Creek, 4) the Coho Walk event, 5) Rivers Day, 6) Gumboots and Goats, and 7) an annual MacKay Creek clean-up. These events are designed to raise awareness about the urban streams in North Vancouver and get the community interested in preserving them.

One event which has been of particular success is the Community Art Project conceived and designed by NSSK volunteer Ron den Daas. This huge event included puppet shows, bands,

free pizza, a blessing by the First Nations, and appearances by the acting mayors. The culmination of the project was a mural painted by participants on a municipal washroom beside MacKay Creek in Heywood Park (NSSK are in discussions with the municipality to turn the washroom into a fully functional hatchery). The washroom has historically been a constant target for vandalism, but only very minor incidents have occurred since the painting of the mural. A short documentary was also funded based on the event (available at http://www.youtube.com/watch?v=XbJhIrgXvIU). Further funding has now been received to make a longer film about MacKay Creek.

Our discussion above indicates that a monitoring framework is an important tool in obtaining community-based monitoring success, even if frameworks are not formalized. It is clear too that the proposed functional framework by Conrad and Daoust (2008) is supported by the systematic steps that successful community-based groups have taken. Importantly, all three groups examined emphasized communication with the public. While public communication is not the primary purpose of monitoring groups, it is clear that creative communication is important in engaging the public and raising the profile of community-based organizations.

Adopting a Monitoring Approach

Choosing an appropriate monitoring approach has also been identified as a factor which can contribute to the success of a monitoring initiative. Four main approaches to community-based monitoring have been identified by researchers: 1) government-led monitoring, 2) interpretive monitoring, 3) advocacy monitoring, and 4) multi-party monitoring. Researchers have noted that advocacy monitoring is more likely to fail whereas multi-party monitoring shows

increasing promise (Conrad and Daoust 2008). Interestingly, all three successful community-based groups studied used a multi-party approach.

The Association for Canadian Educational Resources, as we have seen, identified stakeholders from the beginning and invited them to be part of the organization in various capacities. By bringing relevant parties into the process from the outset, ACER not only ensured that the organization better represented the interests of the community but also created a positive relationship with decision-makers. Alice Casselman, ACER executive president, described how "that's the secret of this stuff—community monitoring—is long term building of trust and rapport" (personal communication, September 21, 2009).

The Lake Windermere Project also undertook a multi-party approach to monitoring. Bringing local government, businesses, organizations, and citizens into the organization created legitimacy for the group in the community. Engaging the business community has been a particular success of the LWP. The LWP approached business leaders diplomatically, listened to their concerns, and brought them into the process from the outset. Often building partnerships with business is difficult for environmental groups who view business as the cause of many environmental issues. A business owner in Invermere described how "environmentalists often draw a distinction between businessmen and environmentalists, but in reality this distinction does not always exist." Making this distinction can jeopardize relationships with business. The LWP was able to bring businesses on board by pitching the business benefits of keeping Lake Windermere healthy, and maintained a relationship with them through open and honest communication. As in the case of ACER, the multi-party approach also created a positive relationship with decision-makers, who were pleased to be part of the process from the start.

The North Shore Streamkeepers adopted a multi-party approach as well. In this case, the government led the process of bringing the parties together, but the project remained volunteer, and not government, led. Positive relationships with government resulting from this approach have given the NSSK special privileges with government including the opportunity to privately comment on the ecology section of the upcoming Community Development Plan for North Vancouver.

This brief consideration of monitoring approaches taken by successful community-based initiatives suggests that a multi-party approach is conducive to the success of a monitoring group. The multi-party approach can create legitimacy for a monitoring group in a community and help link monitoring with decision-makers by creating positive relationships with them.

Linking Monitoring with Decision-making

Another factor contributing to monitoring success is creating a link between monitoring and decision-making (Bens 1994, Conrad 2006, Craig *et al*. 2003, EMAN 2002, Hunsberger 2004, Makhoul 2004, Milne *et al.* 2006). While linking monitoring with decision-making continues to challenge many groups, the organizations studied have managed to successfully link their data with both decision-makers and planning processes.

The Association for Canadian Educational Resource has produced valuable climate change data which has been provided to Environment Canada. As we have seen, this data has influenced health policy in Canada as well as climate change policy both in Canada and internationally.

While ACER does not provide monitoring data to municipal government, the group nevertheless maintains a link with the City of Toronto. ACER runs the Humber Youth Stewardship Program for the City which removes invasive species and plants appropriate indigenous species in their place.

ACER data has received little attention beyond Environment Canada, yet the potential to influence decisions at municipal and provincial levels is high. For instance, if ACER data showed that small woodlots are significant in curbing climate change, government incentive programs could be tailored to woodlot owners. Alice Casselman, ACER's executive president, described that the links to government were already made, and "[the government] will want [the data] sooner or later" (personal communication, September 23, 2009).

The LWP has also successfully linked monitoring data with the planning process and decision-makers. This achievement can be directly correlated to positive relationships fostered early on between the LWP and government. The LWP has links with the District of Invermere (DOI), the Regional District of East Kootenay (RDEK), the British Columbia Interior Health Authority, and the British Columbia Ministry of Environment (MOE).

The MOE is using monitoring data from the LWP in order to update water quality objectives for Lake Windermere. The purpose of these objectives is to determine the water quality status of the lake and guide the approval of permits. Based on the data obtained from the LWP, new water quality objectives will be put in place on the lake along with an attainment program for reaching them.

Monitoring data is also being gathered for the Interior Health Authority. The LWP collects bacteriology samples from several beaches on Lake Windermere and the Authority pays the lab fees to have the samples analyzed. While the quality of beaches has never required a

posted warning or closure, this link to Interior Health could result in provincial decisions based on LWP data.

The Lake Windermere Project partnership with the RDEK is somewhat different. In this case, monitoring data from the LWP is not used directly. However, the LWP is an active partner in the East Kootenay Integrated Lake Management Plan, which has developed the Windermere Lake Shoreline Management Guidelines for Fish and Wildlife. These guidelines are intended to direct the development processes in the local municipalities away from sensitive areas on the lake to preserve the lake's ecological integrity. The guidelines, based on scientific evidence, take the guesswork out of planning where development should or should not go on the lake.

The LWP also has a link with the DOI. No decisions have yet been made by the DOI based on Lake Windermere Project data. However, a report is currently being jointly compiled by the DOI and the Regional District of East Kootenay based on five years of LWP data entitled "The Lake Windermere Management Plan". This plan is intended to guide the "long-term management of the lake and direct local government planning for the lake and shoreline. It will consider and integrate the environmental, anthropogenic, cultural, and biological factors and values associated with Lake Windermere" (Leschied and Purden 2009, p. 4). The DOI mayor and planner have both suggested that, based on the results of the Lake Management Plan, new by-laws could be enacted in the DOI as well as new restrictions regarding what is allowed on the lake.

Like the Lake Windermere Project, the NSSK have successfully linked monitoring data with the planning process and decision-makers. The NSSK have active links with Environment Canada, the Department of Fisheries and Oceans (DFO), the District of North Vancouver (DNV), and the City of North Vancouver.

The North Shore Streamkeepers provide monitoring data to both the DNV and the City of North Vancouver to be used in making urban planning decisions. For instance, data gathered by the NSSK has been used by the DNV in developing an Integrated Stormwater Management Plan. Similarly, information from MacKay Creek has been used by the City of North Vancouver in the creation of the Parks Master Plan. A special consultation session has also been arranged specifically for the NSSK to comment on the ecology section of the Official Community Plan revisions.

The NSSK also maintain a relationship with the DFO through the Community Advisor Program. Data gathered from salmon monitoring is used by the DFO to assess the health of salmonid population in urban rivers in North Vancouver. Due to low salmon populations, the DFO has in the past given permits for the NSSK to relocate fish and release fish into North Vancouver streams.

Environment Canada has also found NSSK monitoring data useful. Through the EcoAction fund, the *Water Quality and Watershed Health of Mackay Creek 2007-2009 Study* was conducted to determine the health of this urban stream. The study helped determine that the stream was being jeopardized and led to remedial actions being recommended to the municipality (these are being reviewed but have not yet been implemented).

Without the link to decision-makers, the uses of monitoring data can be limited. But, as we can see from these examples, when monitoring data is linked with decision-makers it can lead to positive change in communities.

While the examples provided above show success in linking monitoring with decision-making, difficulties still remain. ACER, for instance, has yet to link monitoring data with local government, despite the fact that the City of Toronto's council voted unanimously to approve the

Climate Change, Clean Air & Sustainable Energy Action Plan. The LWP's final report is intended to help guide the development process around Lake Windermere, but discussions with local council and staff revealed a number of reservations about the actual influence of the document. NSSK data is being used to update the integrated storm drain management plan for the District of North Vancouver, but it is unclear how the data will be used and what its influence will be. These few examples indicate that even when monitoring is linked with decision-makers, the work of community-based groups is not over. Groups should strive to continually improve both the delivery of their monitoring data and their relationships with data recipients in order that their monitoring data is used widely by decision-makers.

Conclusions

Literature on community-based ecological monitoring identifies challenges for monitoring groups and suggests what can be done to achieve success. Obtaining adequate funding, adopting a monitoring protocol, using a monitoring framework, adopting an appropriate monitoring approach, and linking monitoring with decision-makers are all considered factors that can lead to the success of a monitoring initiative. Our in-depth case studies have in large part offered further support for the importance of these factors.

Our discussion on funding showed that adequate funding is indeed important in achieving success in community-based monitoring. However, we noted too that adequate funding is relative, and there are a number of different ways by which funding can be sought. The North Shore Streamkeeper's longevity coupled with a lack of consistent funding are proof of this. We also saw in the case of the Association for Canadian Educational Resources that funding could be maximized for monitoring projects through the use of volunteer staff—as opposed to only

volunteer monitors—something which is not often seen in community-based groups. This non-traditional approach is no doubt challenging, but it is difficult to argue with both ACER's permanence and success.

Our cases also illustrated that standard monitoring protocols are important to the success of a community-based monitoring initiative. Through the use of provincial, national, or international protocols, standardized monitoring data is made more accessible to decision-makers and is seen as more credible. In part because of defensible scientific protocols, data obtained through these monitoring programs has been used to fulfill a number of important functions, such as updating provincial water quality objectives (the Lake Windermere Project) or in discussions about the effects of climate change on human health (the Association for Canadian Educational Resources).

A monitoring framework is also an important tool in obtaining community-based monitoring success. Monitoring frameworks give groups a clear direction and allow a systematic approach to monitoring. All of the monitoring organizations examined informally adopted a monitoring framework similar to that of Conrad and Daoust (2008) and this can be considered a factor in their success. The proposed functional framework by Conrad and Daoust (2008) is therefore supported by what successful community-based groups have done. We should recognize, however, that there is merit to a non-formalized framework and community-based groups clearly have the ability to intuitively work through a framework without ever formally adopting one. Our cases also illustrated that, even though communication with the public is not the primary concern of monitoring groups, it is nevertheless important in engaging the public and raising the profile of community-based organizations.

Monitoring approaches also appear important in achieving success. We have seen that a multi-party approach yields benefits including creating legitimacy for the program in the community and helping link monitoring groups with decision-makers. It also reaffirms that positive relationships with stakeholders can be more effective than antagonistic relationships.

Linking monitoring data with decision-makers, likely the most frequently discussed issue in monitoring literature, is also clearly important. As we have seen from our examples, when monitoring data is used by decision-makers it can lead to positive change in communities. Yet improvements can still be made. Community-based groups should therefore continually strive to improve their links and relationships with decision-makers.

Planning Applications

Budget cuts have significantly reduced the ability of the government to track and respond to issues of environmental concern. But community-based ecological monitoring groups clearly have the ability to undertake monitoring in greater detail than government at low-cost while bringing added benefits to communities.

Community-gathered data can be exceptionally useful in informing the planning process. The creation of lakeshore development guidelines (the Lake Windermere Project), updating storm drain management plans (the North Shore Streamkeepers), and quantifying the effects of climate change on human health (the Association for Canadian Educational Resources) are but a few of the potential planning applications of community-gathered data. What is needed is increased recognition of this fact and a willingness from both community groups and planning

professionals to work together. If this relationship can be formed there is a greater possibility of achieving positive environmental change in Canadian communities.

Opportunities for Further Study

The field of community-based monitoring, still shrouded in uncertainty, has many more avenues which need to be explored. For instance, we have concluded that linking monitoring data with decision-makers is important to achieving success, but *how* should this link be achieved? How can community groups market data to decision-makers? What can decision-makers do to be more receptive to community-gathered data? Similarly, we noted that monitoring frameworks can increase the success of community-based groups, but are formal frameworks more efficient than informal ones? Should there be standardization among monitoring frameworks for CBEM organizations in Canada? These questions and others present opportunities for further study and ultimately the betterment of many community-based ecological monitoring groups and the communities they seek to serve.

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ANNEX 1 – Evaluation Template for CBEM Organizations

Rating

Comments

Criteria Checklist

What type of monitoring is undertaken?	
Where is the monitoring site located?	
How big is the initiative (number of volunteers)?	
How long has the initiative been going on?	
How successful do members of the initiative think it has been?	
Does the monitoring initiative use a standardized protocol?	
Does the initiative provide monitoring data to decision-makers?	
Is the data provided to decision-makers used?	
Has the monitoring data influenced: 1. Policy decision?	
2. Decisions of government agencies?	
3. The behaviour of firms?	
4. Community members?	
5. Specific actions?	
Does the initiative: 1. Use CBM data to complement conventional science?	
2. Enable environmental questions of citizens to be answered?	
3. Increase community capacity?	
4. Increase social capital?	
5. Help the community establish a desired environmental vision to guide	

their actions?	
6. Develop and extend social networks?	
7. Allow the community to respond to environmental change through adaptive management?	
8. Create a sense of empowerment in the community?	
9. Advance the concept and practice of sustainable development in the community?	
Is the initiative hindered by any of the following challenges: 1. Data inaccuracy?	
2. Volunteers losing interest in the project?	
3. Lack of participant objectivity?	
4. Lack of funding?	
5. Data fragmentation?	
Has the initiative tried to overcome any of its challenges?	
If so, was it successful in this attempt?	

ANNEX 2 – Key Informant Interviews

Association for Canadian Educational Resources

Total interviews conducted: 13

Alice Casselman, ACER Executive President
Philip Medeiros, ACER co-op student
Jason Noronha, ACER intern
Debbie Leon, ACER volunteer
Sid Baller, Superintendent, Humber Arboretum
Sadia Butt, ACER volunteer and previously ACER intern
Salem Werdyana, ACER board member
Doug Haine, ACER volunteer and previously ACER board member
Madeline Webb, ACER volunteer
Troy Dettwiler, co-supervisor of the Humber Youth Stewardship Program and ACER volunteer
Confidential Interviewee 1, EcoAction Community Funding Program Project Officer
Confidential Interviewee 2, ACER volunteer
Confidential Interviewee 3, previously an ACER intern

Lake Windermere Project

Total interviews conducted: 24

Heather Leschied, Lake Windermere Project Manager
Alison Neufeld, Air/Water Quality Technician, British Columbia Ministry of Environment
Arnor Larson, LWP volunteer
Chris Prosser, Chief Administrative Officer, District of Invermere
Dave Lazzarino, Reporter, Invermere Valley Echo
Gerry Taft, Mayor, District of Invermere
Ian Dewey, LWP volunteer
John Pitcher, LWP volunteer of the year 2008
Amanda Fedrigo, LWP Program Coordinator
Marion Stotts, LWP volunteer
Nory Esteban, LWP volunteer
Ron Clark, Branch President, Wildsight Invermere
Rory Hromadnik, Planner, District of Invermere
Tim Pringle, Real Estate Foundation of British Columbia
Confidential Interviewee 1, local business owner
Confidential Interviewee 2, Fisheries and Oceans Canada employee
Confidential Interviewee 3, LWP ambassador and funder
Confidential Interviewee 4, Columbia Basin Watershed Network employee
Confidential Interviewee 5, Wildsight employee
Confidential Interviewee 6, LWP partner
Confidential Interviewee 7, LWP volunteer

Confidential Interviewee 8, Environmental Monitoring Scientist, Environment Canada
Confidential Interviewee 9, Global Nature Fund employee
Confidential Interviewee 10, elected official from the Regional District of East Kootenay

North Shore Streamkeepers

Total interviews conducted: 8

Karen Munro, NSSK Program Coordinator
Bob Parrot, NSSK volunteer
Caroline Jackson, Environmental Coordinator, City of North Vancouver
Doug Hayman, NSSK volunteer
Ron den Daas, NSS volunteer
Sandie Hollick-Kenyon, Community Advisor, Department of Fisheries and Oceans
Confidential Interviewee 1, District of North Vancouver Councillor
Confidential Interviewee 2, Department of Fisheries and Oceans contractor

TOTAL INTERVIEWS CONDUCTED: 45

ANNEX 3 – Data Collection

Association for Canadian Educational Resources

What is monitored?	What data is collected?
Established trees (>1.3m in height)	Diameter at breast height Crown width and depth Total height
New trees (<1.3m in height)	Root collar Crown diameter Bud length Total height

Lake Windermere Project

What is monitored?	What data is collected?
Beach bacteriology	Fecal coliform samples E. coli samples
Boats on Lake Windermere	Number of boats Location of boats Types of boats Water conditions (calm to white caps)
Water quality (Lake Windermere and tributaries)	Location Weather conditions Water conditions (calm to white caps) Water conditions Colour Odor Water transparency Dissolved oxygen levels pH levels Water conductivity Water temperature
Water quality (Canadian Aquatic Biomonitoring Network)	Geographical description Surrounding land use Dominant surrounding land use Location Reach data Habitat types Canopy coverage Macrophyte coverage Riparian vegetation Dominant riparian vegetation Periphyton coverage Benthic invertebrate samples Air temperature Water chemistry Water temperature pH level Specific conductance Dissolved oxygen Turbidity Total phosphorous Major ions and nitrogen Channel data Slope Width Depth Velocity Substrate data Size Embeddedness

North Shore Streamkeepers

What is monitored?	What data is collected?
Stream habitat	Location Time Weather conditions Water conditions Turbidity Temperature Bankfull channel width and depth Wetted channel width and depth Stream discharge Measurement of survey site Length Upstream survey boundary Downstream survey boundary Habitat quality Streambed material Embeddedness Instream cover Percent pool habitat Off channel habitat Bank stability Length of bank with no vegetation Overhead canopy Riparian zone Additional features Type Description Location Adjacent land use Water quality concerns
Water quality	Location Time Weather conditions Bankfull channel width and depth Wetted channel width and depth Water conditions Turbidity Temperature Dissolved oxygen pH levels
Invertebrates (water quality)	Location Time Weather conditions Bankfull channel width and depth Wetted channel width and depth

	Water conditions Turbidity Temperature Invertebrates Category (pollution intolerant, somewhat pollution tolerant, pollution tolerant) Number counted Number of taxa Abundance Density Diversity
Juvenile fish	Weather conditions Water conditions Turbidity Temperature Stream condition (% Bankfull) Air temperature Upstream boundary Downstream boundary Trap number Bait used Time set Time retrieved Species Length (in mm)
Spawning fish	Weather conditions Water conditions Turbidity Temperature Stream condition (% Bankfull) # of live fish # of dead fish % new fish # of new fish # of prespawning deaths % active spawners Total spawners Spawning start, peak, and end date Fish distribution Habitat problems