Community Engagement for Adaptive Management in Environmental Assessment Follow-up

Final Report

John F. Devlin
N.T. Yap Environmental Systems Analysts Limited

25 March 2011

Catalogue No. En106-99/2011E-PDF
ISBN 978-1-100-18565-1

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGEMENTS

We wish to thank the 10 organizations who generously agreed to participate in this research project: the North Shore Streamkeepers, the Lake Windermere Project (LWP), the Prairie Nest Records Scheme, the Association for Canadian Educational Resources (ACER), Adopt-A-Pond / Frog Watch, Project FeederWatch, H_2O Chelsea, SurVol Benthos, the Community Aquatic Monitoring Program (CAMP), and the Clean Annapolis River Project (CARP).

Many staff and volunteers from the 10 organizations and from the agencies working with them have given generously of their time to assist in the preparation of this report. We thank you all for your time, your contributions, and your ongoing work.

We would also like to acknowledge the able graduate students who conducted the interviews and assisted with editing the manuscript: Tristan Lefler, Monika Korzun, Émanuèle Lapierre-Fortin, Caron Smith, and Kailea MacGillivray.

Finally, we wish to acknowledge the thorough and penetrating comments from two anonymous reviewers who have helped to significantly improve the analysis and presentation.

EXECUTIVE SUMMARY

The *Canadian Environmental Assessment Act* (the Act) recognizes that unanticipated adverse environmental effects may arise during the implementation of projects. For that reason, the Act requires the design and implementation of follow-up programs for all projects assessed by comprehensive study or panel review, and requires that such a program be considered for projects assessed by screening. The Act also ties follow-up programs to the concept of adaptive management of environmental effects. In 2008, the Canadian Environmental Assessment Agency (the Agency) included "adaptive management" as one of its research priority themes. Our research project set out to assess the potential for community-based environmental monitoring (CBEM) to play a role in environmental assessment (EA) follow-up programs designed with the goal of adaptive management. It was assumed that CBEM could be useful to EA follow-up because adaptive management requires a continuous stream of relevant information to support management decisions. Our research set out to assess whether CBEM could reliably provide such information.

The research first undertook an extensive review of the scholarly and grey literature on CBEM. Then, the researchers prepared online surveys to elicit responses from key personnel in municipalities and environmental organizations. They also surveyed projects that had gone through comprehensive studies or panel reviews. They invited 1,725 municipalities, 273 environmental organizations, and 139 projects in total, to respond to the online survey. Unfortunately, the response rates were extremely low. After two rounds of invitations, they had received only 21 responses from municipalities, 36 responses from CBEM organizations, and 5 responses from projects. Nevertheless, we determined that we had identified a sufficient number of organizations to move on to the selection of cases for the 10 in-depth case studies that would form the main data collection effort. Our researchers contacted candidate groups by telephone and e-mail and selected the 10 CBEM groups we judged to be most successful. Researchers made field visits to 9 of the 10 groups, which allowed them to collect additional documentation and conduct face-to-face interviews with staff and volunteers. The on-site research materials include 92 recorded interviews and 14 e-mail exchanges with key informants.

For each case study, we developed a short history of the organization. The questions posed to each group covered the basic scale of their monitoring effort, the types of monitoring and types of data that they collected, as well as the data collection techniques and the protocols, guidelines, and kits that they used. In addition, they asked about data quality and consistency, how the data were reported, who received and used the data, and how their data could be made more useful. The final interviews explored how the data influenced the group's decision making; what challenges they faced in working with volunteers, including how they recruited volunteers, why people volunteered for their organization, and how they trained the ones selected.

This study demonstrates that there is a well-established and diverse body of literature on CBEM and an active practice of CBEM in Canada. The groups were collecting data on: water quality; benthic macro invertebrates; biodiversity; birds; fish; amphibians; and

trees. Each group made use of published protocols developed by technical experts. The groups reported a variety of concerns with data quality which they believed required attention but could be improved with additional resources. Data were used by a variety of government agencies at municipal, provincial, and federal levels. All 10 cases had some form of link with either a national or a provincial government program, or with a municipality or university. The data collected had been used in a variety of ways, but the link to decision making was irregular. The groups offered significant insight into the challenges of working with volunteers from a wide range of social groups and ages. Some groups have mobilized hundreds of people to work on special events, but most rely on a relatively small core group of volunteers for the collection and processing of data. Importantly, each group stressed the need to train their volunteers and to provide regular encouragement to keep volunteers involved in their group activities. Funding was a challenge for most groups, but not for all.

Our research team applied these insights to the development of a framework for introducing CBEM into EA follow-up programs. The framework outlines five steps:

1. Identify environmental components to be monitored through CBEM
2. Identify existing community groups with experience in monitoring those components.
3. Establish a follow-up monitoring and management unit with representation from the appropriate stakeholders, including monitoring groups
4. Establish monitoring protocols for each indicator or set of indicators
5. Establish an environmental auditing procedure and an audit reporting schedule

Although the Act does not require the establishment of a follow-up monitoring and management unit, such units would help to bridge the gap between data collection and decision making. The “management” dimension of the unit’s mandate would make explicit its role as a catalyst for adaptive management. There has been limited experience with such units in Canada. Although the existing literature suggests that achieving adaptive management through follow-up monitoring and management units would be a challenge, we conclude in this report that, if responsible authorities provide support, we could expect better outcomes.

At the end of this report, we provide some suggestions for further research on community involvement in EA follow-up, on the impact that long-term projects could have on communities, on monitoring for socioeconomic data, and on regional variations in the relations between government programs and community groups.

Overall, our research supports the view that community based environmental monitoring can provide usable knowledge that could support adaptive management of projects during both their implementation and their decommissioning stages. This report contains a rich repository of experiences, approaches, and contacts for the CBEM groups involved. These will be a resource for responsible authorities, proponents, and other community groups seeking to establish CBEM for EA follow-up.

1. INTRODUCTION

The *Canadian Environmental Assessment Act* (the Act) recognizes that unanticipated adverse environmental effects may arise during project implementation. For that reason, it requires that the design and implementation of a follow-up program for all projects be assessed by comprehensive study or panel review; it also requires that such a program be considered for projects assessed by screening. In addition, the Act ties follow-up programs to the concept of adaptive management of environmental effects. In 2008, the Canadian Environmental Assessment Agency (the Agency) included "adaptive management" as one of its research priority themes.

In March 2009, the Agency issued an operational policy statement entitled *Adaptive Management Measures under the Canadian Environmental Assessment Act.* It presented the following definition of adaptive management:

> "In general, adaptive management is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. Adaptive management provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project."(CEAA, 2009)

This report describes research conducted to assess the potential for community-based environmental monitoring (CBEM) to play a role in environmental assessment follow-up programs designed with the goal of adaptive management. CBEM is relevant to follow-up and adaptive management in environmental assessment because those activities require a continuous stream of relevant information to support management decisions. CBEM can provide such information and can therefore support adaptive management, provided that the data are in a form that a project's proponents and responsible authorities will use as decision inputs

This report has the following six sections: in Section 2, we discuss the potential relevance of CBEM to the *Canadian Environmental Assessment Act* and EA follow-up; in Section 3, we review the methodology used for the study; in Section 4, we present the results of the literature review and case studies; in Section 5, we discuss the implications for EA practice; in Section 6, we offer a brief conclusion; and in Section 7, we suggest some areas for further research arising from our study.

2. RELEVANCE OF CBEM TO EA FOLLOW-UP AND ADAPTIVE MANAGEMENT

A follow-up program is defined in the Act as a program for (a) verifying the accuracy of the environmental assessment of a project and (b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project (CEAA, 2010 §2). The Act also states that "the results of follow-up programs may be used for implementing adaptive management measures or for improving the quality of future environmental assessments" (CEAA, 2010 §38:5).

The importance of adaptive management for EA follow-up has been asserted by many EA specialists over the past decade (Storey and Noble, 2004; Noble and Storey, 2005; Marshall et al., 2005), and EA analysts have consistently argued that communities can be engaged in adaptive management processes (Arts et al., 2001; Morrison-Saunders et al. 2003; Hunsberger et al., 2003).

This integration of adaptation with community engagement reflects the widely held belief that more participatory processes in EA can provide opportunities for transformative learning and for debates over values and ethics throughout the project implementation process (Dale and Lane, 1994; Webler, Kastenholz, and Renn, 1995; Leeuwis, 2000; Sinclair and Diduck, 2001; van der Sluijs, 2002; Fitzpatrick and Sinclair, 2003; Wilkins, 2003; Ryu et al., 2004; Hunsberger et al., 2005; Connelly and Richardson, 2005; Kearney et al., 2005; Richardson, 2005; O'Faircheallaigh, 2010).

Analysts have argued that community participation can improve EA with respect to indigenous knowledge (Stevenson, 1996; Berkes et al., 2001; Paci et al., 2002; Baker and McLelland, 2003), sensitivity to cultural heritage (Bond et al., 2004; O'Faircheallaigh, 2007) and community values (Cardinal and Day, 1998; WVES, 2001; Devlin and Yap, 2002; O'Faircheallaigh, 2006)

The CBEM programs discussed in this report can assist in the collection of data useful for assessing the accuracy of environmental assessments, assessing the effectiveness of mitigation measures, developing adaptive management measures, and improving the quality of future environmental assessments.

Providing a typology of environmental indicators and data collection techniques that have been proven in practice will contribute to the planning of more effective follow-up programs. The research results will be of interest to staff of the Agency and responsible authorities, EA practitioners, proponents, members of the public, and policy-makers focused on creating an enabling environment for effective adaptive management through community-based EA follow-up.

3. RESEARCH METHODS

The researchers first undertook an extensive review of the scholarly and grey (institutional and Internet) literature on community-based environmental monitoring. They then sought to identify communities that have successfully generated data and influenced decision making through monitoring.

They developed three contact lists: one for Canadian municipalities; one for comprehensive studies or panel reviews conducted within the past 10 years; and one for organizations currently engaged in community-based ecological monitoring and management.

To compile the contact list for Canadian municipalities, they used the information on municipal websites. The contact list for comprehensive studies and panel reviews was compiled from information on the Canadian Environmental Assessment Registry website (http://www.ceaa.gc.ca/050/index-eng.cfm). The contact list of organizations currently engaged in community-based environmental monitoring and management was compiled from information in the Citizen Science online directory of Canadian monitoring and management groups. Although the directory was no longer being updated, it did provide an excellent starting point for the research.

The above efforts yielded good results, but all three lists lacked specific contact information on key personnel. Additional telephone work was, therefore, necessary to fill in those gaps.

Developing the Online Surveys

Three online surveys were developed, one for each contact group category.

In the survey for Canadian municipalities, respondents were asked whether any organizations engaged in community-based environmental monitoring and management activities were currently active in their municipality. If the answer was positive, they were asked for the names of the relevant organizations and key personnel to contact.

In the survey for projects that had undergone comprehensive study or panel review, respondents were asked to identify community organizations that had been involved in follow-up activity related to the project.

In the survey for community-based environmental monitoring organizations, our research team took a more detailed approach. They sought specific information from each organization on the nature of the initiatives undertaken and the degree of success achieved. They also asked for information about other CBEM organizations in order to create a “snowballing” effect and maximize the number

of organizations identified. They tested the first version of their detailed survey on twenty of these organizations and then made appropriate modifications to create the final survey.

The next step was to send invitations to all contacts identified on the three lists, requesting that they respond online to the survey.

As expected, a number of e-mail addresses on each contact list were no longer valid, as evidenced by “bounce-back” messages. A new search was undertaken to identify current e-mail addresses, and the survey invitation was sent to these new addresses.

In total, 1,725 municipalities, 273 environmental organizations, and 139 projects were invited to respond to the online survey. Because first response rates were very low, we sent a second round of invitations. Our final tally was 21 responses from municipalities, 36 responses from CBEM organizations, and 5 responses from projects.

Since the objective of our survey was to identify active organizations, not to generate statistical data, we determined after two rounds of invitations, that we had identified enough responsive organizations and that further, more detailed research could be conducted directly with them. First, we created profiles for the organizations that appeared to have experienced some success, and contacted them by telephone or e-mail to further fill out their profiles.

Selecting Cases

Once the profiles were completed, we designed a list of criteria (based on the literature review) to identify the 10 most successful CBEM groups. A key criterion for judging the success of each monitoring initiative was the group’s own perception of its success. We asked them to describe specific situations in which their initiative was successful. We then further explored whether they believed their community-based monitoring had made a difference by influencing policy decisions, the decisions of government agencies, the behaviour of firms, the behaviour of community members, and whether it had influenced specific actions such as the remediation of a chemical spill. Finally, they were asked to rate whether their success was low, moderate, or high. This self-rating process helped highlight the group’s initiatives that should be considered for further study.

Cases applying to different types of monitoring activities (tree monitoring, lake monitoring, stream monitoring, biodiversity monitoring) that had been conducted in various parts of Canada were chosen to maximize the diversity and range of applicability of the study.

Members of the research team conducted field visits and on-site, face-to-face interviews for 9 of the 10 groups. The remaining case study, the Prairie Nest Records Scheme, was conducted through telephone interviews. For each of the

10 case studies, we reviewed documents and websites, recorded 92 interviews, and received responses to 14 questionnaires from, or through e-mail exchanges with, key informants who were unavailable for interviews.

For each of the 10 case studies, we developed a short history of the organization to understand how the monitoring started and then how it evolved; we asked them to describe the scale of the monitoring effort, the sources of funding, and the number of volunteers active in the programs.

Each group described the types of monitoring; the types of data collected; their data collection techniques, protocols, guidelines, and kits used; any issues with data quality and consistency and how the data were reported; who received and used the data; and if their information was not used, why not; and how could the data be made more useful. We also asked the groups to describe how the data influenced decision making, citing both general and specific examples. We further questioned them to explore the challenges of working with volunteers — How are volunteers recruited? Why do they volunteer? How are they trained?

4. RESEARCH FINDINGS

Community-based environmental monitoring (CBEM) refers to a "process where concerned citizens, government agencies, industry, academia, community groups, and local institutions collaborate to monitor, track, and respond to issues of common community concern" (EMAN 2002). CBEM expanded in the early 2000s as a supplement to government monitoring programs (Au et al., 2000; Sharpe et al., 2000).

In this section, we provide an overview of the literature on CBEM as well as our observations drawn from the 10 case studies. In addition, we address some issues identified in the literature — the types of monitoring data collected, the quality of monitoring data, the protocols used, how the data are reported and used, the structure of CBEM organizations, working with volunteers, funding, the challenges for CBEM groups, and the relationship between CBEM and adaptive management.

Types of Monitoring Data Collected

The types of monitoring that we have identified in the literature and our case studies cover several categories: water quality, benthic macro invertebrates, birds, fish, amphibians, trees, biodiversity, and industry. These are organized into several major groups. There is some inevitable overlap between categories.

Water Quality

Water quality monitoring was the most prevalent type of monitoring in the literature we reviewed and in the case studies. Dyck (2007) describes limnological water monitoring undertaken at Crazy Lake, Nunavut. Engel and Voshell (2002) studied the Virginia branch of the American Save-Our-Streams program. Lawe and Wells (2005) describe how a community-based water monitoring program was created to assess the cumulative effects of oil sands projects on the Mikisew Cree First Nation's water resources. Sullivan and Beveridge (2005) describe a study of 14 Atlantic Coastal Action Program sites, all of which are water monitoring initiatives.

Sharpe et al. (2000) describe an Ontario-based monitoring program, Citizens' Environment Watch, whose success in discovering water quality problems had good results in two situations: improved municipal sewage infrastructure to the tune of $11 million at the Collingwood Harbour; and a commitment by the City of Hamilton to clean-up the Rennie Street dump site.

Six of our case studies had a water quality monitoring aspect: North Shore Streamkeepers, the Lake Windermere Project, H_2O Chelsea; SurVol Benthos, CAMP, and CARP. Water quality indicators for which data were collected included: fecal coliform bacteria, nutrients, conductivity, water temperature, dissolved oxygen, anions, chlorophyll, nitrate, chloride, sulphate, pH,

conductivity, total suspended solids, total dissolved solids, water temperature, salinity, colour and transparency, cover of plants and algae, and benthic macro invertebrate populations. In most cases, volunteers take the water samples to labs for analysis.

Benthic Macro Invertebrates (BMIs)

Populations of benthic macro invertebrates can tell a great deal about the condition of a given body of water. Firehock and West (1995) note that analysts began using organisms as indicators in the late 1970s. Although they tried using a number of different organisms before accepting benthic macro invertebrates, the success of using them to determine water quality has continued up to the present. Fore, Paulson and O'Laughlin (2001) describe how volunteers use benthic macro invertebrates to measure stream quality. Of our case studies, the North Shore Streamkeepers, the Lake Windermere Project, and SurVol Benthos in Quebec use BMIs to monitor the quality of river water; the CAMP program in the Maritimes use BMIs to monitor the quality of water in coastal estuaries. The techniques used are virtually the same in both cases. Volunteers gather samples of BMIs on site by stroking a net on the bottom of the river or estuary. They then sort and store their samples.

Birds and Mammals as Indicators of Water Quality

In ways similar to the use of benthic macro invertebrates, birds and mammals have also been used to monitor water quality. Ely (2002) describes how a survey by volunteers of dead birds and mammals on beaches was used to determine the quality of ocean water conditions offshore. The successes of such initiatives include the discovery of an oil spill, indicated by a sharp increase in bird/mammal deaths on the shores, which led to a $4 million remediation project. None of our case studies employed bird and mammal data in this way.

Biodiversity Monitoring

Biodiversity monitoring may be achieved through the monitoring of many flora and fauna groups. Monitoring programs that involve First Nations have a particular focus on biodiversity, using observations of plants and animals: berries, caribou, wolves, fish, and other animals (Berkes et al., 2001; Åutsÿl K'e Dene First Nation, 2002; Arctic Borderlands Ecological Knowledge Society, 2008). The benthic macro invertebrates offer one form of biodiversity monitoring, and several more are discussed below.

Bird Monitoring

Fischer (1996) describes the Coyote Creek Riparian Station, where volunteers monitor neotropical birds in Alviso, California. Bird Studies Canada is a nation-wide organization with numerous monitoring initiatives, from studies of nocturnal owls to surveys of backyard feeder birds. Project FeederWatch is one such initiative of Bird Studies Canada. FeederWatch volunteers monitor the

distribution and abundance of more than 100 bird species through regular bird counts by volunteers at backyard feeders. The survey is conducted each winter, starting on the second Saturday of November and running for 21 weeks through the first Friday of April.

Fish Monitoring

Pattengill-Semmens and Semmens (2003) describe the REEF Fish Survey Project based in Florida. REEF asks regular snorkellers and divers to report what they see in the water, using a standardized census method. This has resulted in a large body of data that can be used to assess the health of the marine ecosystem. In Canada, Berkes, Kislalioglu, and Fast (2007) relate how indigenous fishers can "read" wildlife health through abundance patterns. Traditional ecological knowledge of monitoring fish can accurately assess the health of an ecosystem. One of our cases, the North Shore Streamkeepers of North Vancouver, BC, is specifically devoted to monitoring fish through smolt trapping and measuring. Another group, the CAMP volunteers, documents fish and crustacean populations. In Nova Scotia, the CARP organization also has a fish monitoring program, although that was not the focus of the case study included in Appendix 10.

Amphibian Monitoring

The Adopt-A-Pond program is an example of the monitoring of amphibian populations. Volunteers listen for calls and make visual observations in order to identify population trends and learn about the range and distribution of frogs and toads. The volunteers record date, time, location description, habitat type, temperature, and weather conditions, the type of frog or toad seen or heard, and the abundance of calls. Volunteers can mail in paper copies of the data, but they are encouraged to submit results online where possible.

Tree Monitoring

Ely (2000) describes the Illinois Forest Watch program, which comprises over 600 volunteers who measure tree trunks, note plants on the forest floor, count shrubs, and assess the forest canopy on a standardized plot. The monitoring data are used to assess trends in the Illinois forest ecosystems. Our ACER case study focuses on tree monitoring by volunteers who collect data on trunk diameter, crown width and depth, total height, root collar, and bud length in various settings, including forests, test plots, standard plots, and schoolyards.

Can CBEM Generate Data of Acceptable Quality?

Concern about the quality of data collected by non-experts is a recurring theme in the CBEM literature, but it is now widely accepted that monitoring by volunteers can produce reliable and accurate data. Fore, Paulsen, and O'Laughlin (2001) compared volunteer and professional field samples of water

quality and found no significant difference between them. Savan, Morgan, and Gore (2003) found that Citizens' Environment Watch in Toronto was able to make a significant contribution to environmental education and stewardship because it shifted from chemical to biological indicators, which were more easily identified by community monitors. O'Neill, McKim, and Rainer (1995) argue that monitoring protocols can achieve technical and scientific credibility if they are generated in consultation with academic specialists. Heiman (1997) maintains that CBEM should be embraced because the organizations involved are able to produce reliable and accurate data. Sullivan and Beveridge (2005) concluded that participants in the Atlantic Coastal Action Program (ACAP) needed more standardized protocols and parameters to increase their capacity to share data with other participants and external stakeholders.

In our case studies, all groups were using one or more protocols to standardize the data gathered and improve consistency in reporting. Table 1 sets out the organizations and the protocols they have used.

Table 1: Protocols and Documents Used by CBEM Groups

CBEM Group	Protocol or Protocol Document
North Shore Streamkeepers	The Streamkeepers Handbook
Lake Windermere Project (Wildsight)	Lake Windermere Water Sampling Protocol Lake Windermere Bacteriology Sampling Protocol Canadian Aquatic Biomonitoring Network (CABIN) protocols Boat Count Protocol
Prairie Nest Records	Prairie Nest Records Scheme Handbook Prairie Nest Records Scheme Card and Coding Book
Association for Canadian Educational Resources (ACER)	Smithsonian Tropical Research Institute, Protocol Documents,
Adopt-A-Pond / Frog Watch	Amphibians of Ontario Identifier Guide Amphibians of Ontario poster (hard copy) Frog and Toad Calls of Ontario (CD)
Project FeederWatch	FeederWatch Instructions
H_2O Chelsea	Lake Sampling Protocols Stream Sampling Protocols Static Level Protocols
SurVol Benthos	Guide du volontaire Guide d'identification des principaux macroinvertébrés benthiques d'eau douce du Québec
Community Aquatic Monitoring Program (CAMP)	CAMP Protocols (see appendices in this document)
Clean Annapolis River Project (CARP)	River Guardians Manual River Guardians Data Handling Procedures
Sources: Appendices; where available web links to the protocol documents have been embedded.	

Development of Protocols

The development of protocols requires support from and should be first vetted by technical experts. The cautions of Engel and Voshell (2002) should be noted. They 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 undertaken a validation study. The monitoring protocol was inappropriate for the type of monitoring being undertaken, and it was only after a validation study led to a change in the monitoring protocol that they became effective in reliably assessing the condition of streams. Loperfido, Beyer, Just, and Schnoor (2010) found some error and bias in volunteer water quality measurements in Iowa, but they suggest that this knowledge means that regulators can incorporate volunteer water quality data into planning the total maximum daily load or in reporting state water quality. Researchers argue that CBEM cannot, and should not, replace conventional science (Carr, 2004; Moyer et al., 2007). Rather, it should supplement expert data, which maximizes the usefulness of the data while continuing to provide the many benefits described above.

Data Quality Issues

Only two of our case study groups were not at all concerned about data quality. For the North Shore Streamkeepers, community advisors from the Department of Fisheries and Oceans (DFO) are present at sampling times, and no issues in data quality or consistency are reported. The Prairie Nest Records Scheme has no data quality concerns. Most of the volunteers are birders who are familiar with nesting habits. SurVol Benthos reports 95 to 96 percent accuracy in the identification of benthic macro invertebrates, which is considered acceptable.

The other seven cases had some concerns about quality. The Lake Windermere Project has some problems with the temperature control of samples during transportation by bus. The Adopt-A-Pond program reports some concerns with misidentification of amphibians. Project FeederWatch relies on large numbers of observers to control misidentification of species. H_2O Chelsea has a number of quality assurance / quality control protocols that help to pick up skewed values. But not all errors can be detected and budgets do not allow for re-sampling.

The CAMP program, which collects data on fish and crustacean populations, reports net snagging, abundant plant debris, and very large numbers of fish but has no issue with identifying fish or crustaceans. The presence of DFO staff during the monitoring helps resolve these issues. Freezing of water samples during transport, questions of absolute and relative measures of data, potential insignificance of water samples that are not filtered, and discrepancies in approaches between data analysis locations have been other problems. CAMP volunteers perform quality assurance checks by recounting the results obtained

by community groups, and they have found very high agreement. CARP reported that sometimes volunteers do not gather all the necessary data. For example, volunteers are asked to take samples after rainfall, but many volunteers admitted that they do not do so. Such problems help to underline the importance of support from specialists, of sample checking, and of periodic confirmation of results.

Data reporting and recipients

The case studies reveal a variety of strategies for data reporting and a significant overlap in approaches. The major reporting strategies are hard-copy reports to data users, submission of spreadsheet files, and data storage on websites. Annual reports, newsletters, brochures, information kits, and survey results are prepared and released to the public. Sometimes, these documents are also posted on websites.

The range of data recipients is also subject to significant repetition across the groups. Federal, provincial, and municipal agencies, group members, other interested organizations, and the general public are all recipients of the data gathered.

Data use

The range of applications of the data collected by the organizations included in our case studies includes: storm water management plans for North Vancouver, the definition of new water quality objectives for Lake Windermere, wildlife conservation programs in Alberta, questioning of subdivision development in Ontario, creation of a lake buffer zone and a water treatment plant in Chelsea, and updating of the Etchemin Watershed Master Plan in Quebec.

Prairie Nest Records data have been used by the Alberta Conservation Association, the Canadian Wildlife Service, and the Alberta Sustainable Resource Development, Fish and Wildlife Division. Data collected by the Association for Canadian Educational Resources (ACER) were used by Environment Canada to prepare a poster for the Symposium on Climate Change and Biodiversity in the Americas, Panama City, Panama, in 2008. CAMP data are used by several groups at the DFO and CAMP staff helped provide the baseline data on species-at-risk for a 2009 report. The information was used to help determine the impact of development projects on fish habitat, and it was helpful in monitoring the spread of green crab, an aquatic invasive species.

Data from CARP helped to identify the source of rising e-coli levels in the Annapolis River, by identifying the municipal sewer septic plant as the problem. Subsequently, changes were made to improve its performance. CARP also identified the runoff into the river from the Greenwood Air Force Base of its cleaning chemicals, fuels, and anti-freeze. As a result, the base has introduced a better drainage management system.

Many academic studies have made use of data supplied by ACER and FeederWatch. Graduate students have used data from H_2O Chelsea and CAMP in their theses.

Organizational Structures

One of our research goals was to identify the structures of successful CBEM organizations, with the hope that these would suggest organizational structures that could be used in follow-up programs. From the successful case studies we have examined, the outstanding features were the linkages between CBEM groups and government agencies or programs. All 10 cases have some form of link with either a national or a provincial government program, or with a municipality or university. These relationships are set out in Table 2.

Table 2: Community-Based environmental Management (CBEM) Partners

CBEM Program	Partners
North Shore Streamkeepers	Department of Fisheries and Oceans Pacific Streamkeepers Federation
Lake Windermere Project (Wildsight)	BC Ministry of Environment Regional District of East Kootenay
Prairie Nest Records	Bird Studies Canada, Project Nest Watch Federation of Alberta Naturalists
Association for Canadian Educational Resources (ACER)	Environment Canada
Adopt-A-Pond / FrogWatch	Toronto Zoo Frog Watch, National Wildlife Research Centre, Environment Canada
Project FeederWatch	Bird Studies Canada
H_2O Chelsea	Municipality of Chelsea University of Ottawa, Institute for the Environment
SurVol Benthos	Direction du suivi de l'état de l'environnement (DSEE) of the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP)
Community Aquatic Monitoring Program (CAMP)	Fisheries and Oceans Canada
Clean Annapolis River Project (CARP)	Environment Canada's Atlantic Coastal Action Program (ACAP)
Source: Appendices	

However, neither the literature nor our case studies have offered examples of multi-stakeholder institutions in which the co-management of data collection and decision making is ongoing. The information is collected by volunteers, recorded by CBEM groups, then released to others. In our case studies, success was judged on the basis of the data collected rather than on the collectors' participation in decision making. Most groups report that this division of labour

leads to a failure to use relevant data for the purposes of adaptive management. Thus, there is no clear message about the internal organization of the CBEM groups themselves.

Working with Volunteers

Volunteers come from the full range of social groups. There does seem to be some weighting towards retired persons. CARP reports an early recruitment of retired teachers, scientists, and doctors. For Prairie Nest Records, the people who volunteer are usually seasoned birders, and many come from Canadian Wildlife Service staff. Typical ACER volunteers include gardeners, retired teachers, people interested in forestry or landscaping, new Canadians looking for field experience, youth looking for community service hours, horticultural and gardening club members, and Sierra Club members.

At its inception, Adopt-A-Pond targeted school children, and the program continues to collaborate with educational institutions. Now, they focus on students from schools that have a special environmental mandate, retired persons, the Boy Scouts, naturalist clubs, and cottage and boating communities. Project FeederWatch volunteers include people of all skills and backgrounds, school children, families, individuals, retired people, youth groups, nature centres, bird clubs and recently even residents of a long-term care facility. H_2O Chelsea has had youth volunteers from the Chelsea Youth Summer Co-op and students from the University of Ottawa monitoring and, in turn, receiving the data for their own research. For SurVol Benthos, many volunteers are hikers and fly fishers, regular users of the watershed ecosystem. CAMP relies on a variety of local community groups.

Volunteer Numbers

The number of volunteers involved in each of the 10 case studies varies widely. SurVol Benthos works with from 2 to 4 volunteers to collect samples. CARP reports from 8 to10 volunteers; H_2O Chelsea 10 to 20 volunteers; the North Shore Streamkeepers work with 10 to 25 regular volunteers per year. But the number of volunteer can swell to 100 people for some events. Prairie Nest Records receives reports from about 30 nest-watchers. The Lake Windermere Project has 40 volunteers. CAMP reported 117 volunteers in 2009. ACER reports about 300 volunteers. Project FeederWatch could provide only North American data and reported 15,000 feeder watchers. There appears to be no clear constraints of scale on CBEM volunteer activities.

Volunteer Recruitment

Recruitment of volunteers is achieved through the North Shore Streamkeepers website, bulletin board postings at their meeting place, and ads in the events section of the local paper. They maintain an e-mail list and go to other people's events to advertise. The Lake Windermere Project recruits through advertisements in the local newspaper. Some recruitment is done by word of

mouth, and the newsletter of the host organization is also a vehicle. Prairie Nest Records volunteers are recruited through the network of clubs that make up the Federation of Alberta Naturalists (FAN). FAN organizes a variety of festivals and conferences and produces flyers and advertising materials for distribution at these events.

ACER organizes recruitment drives primarily at “green” organization gatherings, at conferences for educators, at symposia, annual meetings, and events of other environmental groups, where they distribute informational materials. Individuals can sign up to volunteer or to receive further information. Adopt-A-Pond targets groups, and sends them information. The Toronto Zoo organizes outreach programs, and representatives attend fairs and workshops to distribute information. They also use the Internet, advertise through partner organizations, and advertise in newspapers and other media . SurVol Benthos recruits among colleagues and people from the board, and through ads in the newspapers; it relies heavily on social networks and word-of-mouth to recruit people. For CAMP, volunteer recruitment is carried out by partner community groups. For CARP, the volunteers have not changed much over time, and little effort has been made to recruit volunteers because in the beginning, most volunteers joined through personal contacts.

Volunteer Motivations

Most CBEM groups report that volunteers want to be outdoors, to learn about the environment, and to make a contribution to environmental protection. For the Lake Windermere Project, the volunteers are motivated by the chance to learn about their lake and experience the lake from the monitoring boat. Some want to be part of the perceived success of the project. For ACER, the reasons for volunteering include an interest in working with children, learning about Canadian vegetation, getting field experience, supporting ACER’s work on climate change, and obtaining community service hours. Project FeederWatch attracts volunteers who want to learn about winter birds and about bird populations, to interact with others who share their interest, and some want to contribute to science and to help with conservation.

H_2O Chelsea volunteers appreciate the hands-on experience in water resource research; care about the quality of water near their homes; and enjoy a sense of community togetherness in facing environmental issues. SurVol Benthos reports volunteers have many motivations — curiosity, the desire to be involved in environment-related programs, an attachment to the organization; others want to gain volunteer experience to add to their CVs, to learn more about fly fishing, or to raise awareness of water issues. Volunteers for CARP want to care for the river; they believe that the data they collect has scientific value and that they are making a positive difference.

Volunteer Training

CBEM does require training of volunteers (O'Neill et al., 1995). Lynch and Aupers (2005) stressed the potential of community-based social marketing as a means of raising the overall environmental literacy of stakeholders. For indigenous communities, increased technical capacities can reduce dependency on non-indigenous experts and consultants (O'Faircheallaigh, 2007).

In the 10 groups profiled, training takes several forms, but is relatively "light." For the North Shore Streamkeepers, there is a "train the trainers" course at Capilano College. The trainees complete all the modules in the *Streamkeepers Handbook* and submit a detailed report. Their successful completion of training means that they can advertise in their community and train others. Standard training lasts two days. The Department of Fisheries and Oceans also provides some training. For the Lake Windermere Project, training is undertaken primarily on an individual basis. Experienced trainers go through the protocol and what to expect before the volunteer(s) leave the office. So far (2006, 2009), there have been two official training days where the entire day is dedicated to training volunteers.

ACER offers a training package and hands-on training, whether in the forest, on a planted plot, or in someone's yard. For school-based training, ACER representatives show classes how to weed, measure, or mulch. For two years, ACER held a three-day training course for teachers, but the funding for this program has run out — the cost for training, trees, mulch, and equipment amounted to $20,000 per school. The Adopt-A-Pond program distributes a Frog Watch-Ontario package, which includes a frog and toad identifier guide, a poster, a CD of the frog and toad calls, and a Frog Watch-Ontario data sheet. The frog-watcher needs to learn frog calls either from the website or from the CD of frog calls. For the FeederWatch program, volunteers receive an instruction booklet, a colour poster of feeder birds, a bird watching calendar, tally sheets, and data booklet of forms and return envelopes. But they do not receive specific training.

H_2O Chelsea volunteers receive training in simple sampling, the use of monitoring equipment, and safety precautions. When the sampling kits are provided, the instructor explains the equipment in the kits, reads through the sampling protocols with them, distributes the maps, and explains the reporting procedures. The volunteers, grouped in teams, are instructed in how to get to their sites and learn about the sampling schedule.

SurVol Benthos has provided training each May since 2006. The training program is designed to improve volunteers' knowledge about biological monitoring, about the implementation of the SVB program and the identification of benthic macro invertebrates. In addition, instructors explain various aspects of the program in detail and provide practical workshops in the field and in the laboratory.

CAMP provides a one-hour presentation, which includes background information on the program and the methodology, an introduction to the equipment, instruction on how to use the data collection sheets, and an identification review of the species. The practical aspect of the presentation covers training in the use of equipment, in sampling techniques, the identification of fish, crustaceans, and plant species, and includes an on-site data collection session. Volunteers receive an identification guide on fish, crustaceans, and plant species.

CARP provides one day of training for volunteers every year, and many volunteers go back each year to refresh their memories. They also receive a handbook for their reference.

Funding

Community-based organizations can provide environmental monitoring data at a relatively low cost (Craig et al., 2003; Moyer et al., 2007), but an ongoing flow of resources is needed to support volunteer work and to ensure sustainability.

The case studies in our report exemplify a wide range of funding levels and arrangements. The North Shore Streamkeepers do not have consistent funding, but they have received a grant from Environment Canada of about $30,000 that supported the study on the Water Quality and Watershed Health of Mackay Creek 2007–2009. Over the years, the organization has received funding from: the Community Fund of DFO; private donations; and the EcoAction Community Funding Program of Environment Canada.

The budget for the Lake Windermere Project (LWP) has been roughly $130,000 a year. The four largest and most consistent funders are the Eco-Action fund, the Columbia Basin Trust, the Columbia Real Estate Foundation, and the District of Invermere. Other funders include individual property owners, businesses, Columbia Valley Community Foundation, Lake Windermere Lions Club, TD Friends of the Environment, RBC Bluewater, and the Regional District of East Kootenay. In-kind expert advice and support has also been provided by Wildsight and LWP partners(MOE, Interior Health, DFO, planners).

For Prairie Nest Records, funding comes from the general Federation of Alberta Naturalists budget for which the biggest funder is the Alberta government. The program currently has a low overhead, but it is estimated that PNRS needs about $30,000 to $40,000 a year along with dedicated staff to operate effectively. It is not getting this attention at the moment.

The funds flowing through ACER in 2008 were roughly $200,000. Funding has been project-driven and the repeat funders for ACER include Trillium Foundation, EcoAction, TD Friends of the Environment, Shell, and the International Society of Arboriculture. Two years ago, ACER received a grant of $100,000 (over 18 months) to allow them to expand into a provincially driven and supported organization with full-time staff.

Project FeederWatch is largely self-sustaining because most of its budget comes from participant fees. The cost to participate in the program is $15 in the US and $35 in Canada. These fees pay for website maintenance, the database system, the data analysis, participant support and kits, the printing of materials, data dissemination, and a year-end report.

H_2O Chelsea has acquired over $397,000 in funding from Fonds d'action québécois pour le développement durable; the North American Fund for Environmental Cooperation; the Municipality of Chelsea; the Walter and Duncan Gordon Foundation; and Environment Canada's Ecological Monitoring and Assessment Network. Because the program is now run by the Municipality of Chelsea, the municipality funds the program entirely. The program does continue to receive in-kind donations from various sources.

SurVol Benthos has received funding from a number of sources — Québec Action Fund for Sustainable Development, the Biosphere of Environment Canada, the City of Québec, the Ministry of Employment and Social Solidarity, the Regional Environment Council of the National Capital Region, Shell Canada Limited, and Environment Canada. But details on amounts were not available.

CAMP receives funding from the Department of Fisheries and Oceans annually (roughly $25,000) which supports hiring summer students and renting vehicles. DFO purchases all the equipment and provides expertise and training to the local community groups.

CARP’s Annapolis River Guardians program was first funded by the Environmental Partners Fund of Environment Canada. Other organizations have also provided financial support: Farmer’s Cooperative Dairy Ltd., Nova Scotia Power, Investors Group, Collaboration of Community Foundation for the Gulf of Maine, Atlantic Coastal Action Program (ACAP), Acadia Center of Estuarine Research and the Nova Scotia Department of Environment. Details on amounts were not available.

It is clear from these experiences that successful CBEM requires a funding base that can support some staff, volunteer training, kits, information dissemination and general organizational functioning. CBEM is relatively inexpensive but not costless.

Other Benefits of CBEM

The collection of useful data at low cost is not the only benefit of CBEM. Carr (2004) suggests that CBEM can rebuild community trust that has been lost in commercialized science. Quinn and Dubois (2005) discuss a monitoring initiative collaboratively designed by ecological monitoring specialists and a group of Alberta ranching families. The initiative resulted in valuable data collection, which empowered the families to take environmental stewardship into their own hands.

Dyck (2007) describes a college-based limnological CBEM initiative at Crazy Lake, Nunavut, which reduced cost and logistical constraints by using community youth. 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, Fitzpatrick, and Diduck (2007) note that CBEM can not only help fill gaps in monitoring and address governance issues but also facilitate social learning, build trust within the community, and lead to greater social cohesion generally.

CBEM can enhance community capacity and social capital, help communities establish a desired vision, lead to a more inclusive decision-making process, develop and extend social networks, provide more data about the local environment to supplement that of external experts, create a sense of empowerment in the community, and advance the concept and practice of sustainable development (EMAN, 2002; Pollock et al., 2003; Pollock and Whitelaw, 2005).

Other Challenges for CBEM Groups

Experiences with CBEM have identified a variety of problems that should be recognized. For example, Craig, Whitelaw, Robinson, and Jongerden (2003) suggest that there might be competition among CBEM groups with overlapping mandates. Lack of funding can lead to overstretched volunteers and burnout (Quinn and Dubois, 2005). But funding dependence can also distort community agendas (O'Neill et al., 1995) and competition for funding can generate intergroup conflict (Craig et al., 2003).

Does CBEM necessarily lead to adaptive environmental management? Despite the evidence that CBEM can generate data usable for adaptive environmental management, there is also ample evidence that CBEM does not necessarily lead to effective adaptive management. Lane and Corbett (2005) suggest that “localism” has been a disadvantage for indigenous communities in Australia. Sullivan and Beveridge (2005) observed that the Atlantic Coastal Action Program (ACAP) had limited influence on decision-makers. Conrad (2006) noted that CBEM groups in Nova Scotia had little influence on decisions regarding the management of their watersheds.

The link between monitoring and decision making can fail for informational, attitudinal or institutional reasons. Failures may be “informational” when monitoring data are inadequate or incomplete, analysis of the available monitoring data is limited, or the results of such analysis are contradictory or inconclusive. Failures are “attitudinal” when decision-makers choose not to use monitoring data that is available. Failures are “institutional” when the organization fails to put into place the appropriate structures and procedures, for example, mechanisms for the effective dissemination of information (Elzinga, Salzer, and Willoughby, 1998; O'Donnell and Galat, 2008), and developing monitoring

initiatives without linking to management and policy-making processes (Conrad, 2006).

These barriers can be overcome. The evidence presented above demonstrates that the data generated through CBEM can be of sufficient quality. At the same time, attitudinal and institutional barriers can be overcome. The Act requires that follow-up programs be designed by responsible authorities and information on their results be made public. If community-based monitoring were to be integrated into follow-up programs, there would be continuous attention from the public involved in the monitoring to use the data for adaptive management purposes.

Organizing Communities for Monitoring

Five main approaches to community mobilization for CBEM 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.
>
> The second is interpretive CBM, which attempts to educate citizens by getting them involved in a monitoring program (Cuthill, 2000; Conrad and Daoust, 2008).
>
> The third is advocacy monitoring, or "bottom-up" monitoring, where concerned citizens address an existing local issue with the intent of forcing decision-makers into action (Craig et al., 2003).
>
> Fourth 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).
>
> Fleming and Henkel (2001) describe a fifth, a rapid appraisal approach to CBEM, which 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.

The case studies undertaken for this report fall into the first and fourth category and several represent a transformation of top-down to a more multi-party approach.

The next section discusses how an EA follow-up program might integrate CBEM as an approach to data collection and adaptive management. The recommendations adopt the multi-party approach to CBEM.

5. IMPLICATIONS FOR EA FOLLOW-UP PROGRAMS

In Section 4, we have demonstrated that communities can be effectively mobilized for environmental monitoring and that community-based organizations and their volunteers can collect data of acceptable quality, but that a number of conditions must be met in order to achieve these results.

- Data quality requires the development of protocols for CBEM vetted by and with support from technical experts.
- CBEM groups should be organizationally linked to supportive government agencies or programs. The division of labour between data collection and decision making leaves a gap that must be bridged for purposes of adaptive management.
- The recruitment, mobilization, and training of volunteers require ongoing attention.
- Successful CBEM requires a funding base that can support some staff, volunteer training, kits, information dissemination and general organizational functioning.

In Section 5, we consider the implications of these findings for the development of EA follow-up programs that could support adaptive management.

Framework for Introducing CBEM into EA Follow-up

The Framework refers to the steps that should be followed to develop a community-based environmental monitoring system. The most widespread framework in Canada has been the Canadian Community Monitoring Network (CCMN), a conceptual monitoring framework conceived by Environment Canada's Ecological Monitoring and Assessment Network's Coordinating Office (Whitelaw et al., 2003). Since its creation, the CCMN has been used successfully by a number of initiatives (Craig et al., 2003; Makhoul, 2004). The CCMN framework was evaluated by Pollock and Whitelaw (2005), and they propose a revised monitoring framework which gives attention to community mapping, participant assessment, capacity building, and information delivery. Conrad and Daoust (2008) have more recently proposed a monitoring framework, which included:

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 — monitoring, analysis, and communication of results.

Drawing on these studies and the experiences of the 10 case studies, we propose the following general CBEM framework to guide the creation of systems

in support of adaptive management in EA follow-up. The proposed follow-up program framework has five steps:

1. Identify environmental components to be monitored through CBEM.
2. Identify existing community groups with experience in monitoring those components.
3. Establish a follow-up monitoring and management unit with representation from the appropriate stakeholders, including monitoring groups.
4. Establish monitoring protocols for each indicator or set of indicators.
5. Establish an environmental auditing procedure and an audit reporting schedule.

These five steps are elaborated below:

1. **Identify environmental components to be monitored through CBEM.**

   The environmental management plans approved during EA processes identify key environmental components that require monitoring. Although not all environmental components will be open to volunteer monitoring, we can identify those that can be monitored through CBEM, and develop a program for them. We can identify such components during the design of the environmental management plan, and formally include them in the follow-up program approved by the responsible authority.

2. **Identify existing community groups with experience in monitoring those components.**

   For the components identified as open to CBEM, a search should be conducted for groups already engaged in CBEM on those components. These groups can be invited to participate in a consultation process to consider their potential involvement in the EA follow-up program. Many such groups will already have identified themselves during the EA process through attendance at hearings or the submission of briefs.

   Where community groups do not already exist, proponents should invite key environmental groups in the community, or identify external community groups with appropriate experience and invite them to participate in a consultation process intended to create the appropriate CBEM groups for the EA follow-up program. In addition, federal and provincial government agencies engaged in environmental monitoring can be approached for assistance in identifying CBEM groups with the appropriate experience.

3. **Establish a follow-up monitoring and management unit with representation from the appropriate stakeholders including representatives of CBEM groups.**

On the basis of the consultation (under 2 above) a Follow-up Monitoring and Management Unit can be established for each EA follow-up program. This will be a multi-party unit with representation from the proponent, the responsible authority, the community, and the community-monitoring groups who will conduct data collection.

The Follow-up Monitoring and Management Unit will be an independent body. It will have responsibility for the collection and reporting of data, for the auditing of the environmental management plan, and for making recommendations about adaptive management using incoming data on the valued environmental components or unanticipated effects of the project. This unit should have responsibility for the monitoring and management of all environmental components, not just those allocated to community-based monitoring.

Current examples of units that manifest some of these features are the Independent Environmental Monitoring Agency for the Ekati Diamond Mine (Ross et al., 2004); the Snap Lake Environmental Monitoring Agency (SLEMA, 2009); and the Environmental Monitoring Advisory Board for the Diavik Project (EMAB, 2010).

4. **Establish a monitoring protocol for each indicator or set of indicators.**

   The Follow-up Monitoring and Management Unit would establish monitoring protocols for each indicator or set of indicators identified in the environmental management plan, and would ensure the collection of appropriate data. Our research report has demonstrated that there are many sources for off-the-shelf protocols. The unit would select or develop protocols in cooperation with experts who are able to attest to their validity and to the reliability of the data that would be collected. The unit would identify the training requirements for community members. Requirements for organization of capacity development exercises or expert consultations would be communicated to the proponent and the responsible authority.

5. **Establish an environmental auditing procedure and audit reporting schedule.**

   The Follow-up Monitoring and Management Unit would audit the relationship between the environmental management plan and the environmental outcomes. Regular reports incorporating data collected by CBEM groups and supplemented by necessary special studies would be prepared for the proponent, the responsible authority, and the public. The Follow-up Monitoring and Management Unit would establish an appropriate schedule for data reporting and for the release of data to the public.

Where monitoring shows that the effects and impact on the environment are not compliant with the environmental management plan or where unanticipated environmental impacts have been observed, the Follow-up Monitoring and Management Unit would make recommendations for appropriate remediation, which they would report to the proponent, the responsible authority, and the public

Discussion

These five steps represent a minimal framework for the incorporation of CBEM into EA follow-up. Substantial elaboration of each step would be required to adapt these steps to the specific conditions of each project.

The establishment of a Follow-up Monitoring and Management Unit is not a requirement of the Act. The purpose of establishing a Follow-up Monitoring and Management Unit with the mandate for environmental auditing and reporting is to establish a unit with an independent mandate that reports simultaneously to the proponent, responsible authorities, and the public. A recurring failure noted in the literature and in case studies on CBEM is the gap between data collection and decision making. We suggest that a Follow-up Monitoring and Management Unit would bridge that gap. The “management” dimension of the unit’s mandate would make explicit its role as a catalyst for adaptive management.

Previous Experience with Follow-up Committees

Follow-up committees with some of the features of the Follow-up Monitoring and Management Units recommended here have been created in the past. The few empirical studies of such committees do not offer strong evidence that follow-up committees necessarily lead to adaptive management practices.

Bush (1990) examined eight cases of community involvement in EA follow-up in Alberta and noted: (a) ineffectiveness of committees; (b) poorly designed management structures; (c) slow and inefficient processes; (d) difficulties in dealing with more than one issue at a time; and (e) lack of political will in sustaining the committees.

Gagnon, Lepage, Gauthier, Cote, Champagne, Miller, and Simard (2000) investigated 10 EIA follow-up committees in Quebec. They found that the committees were inadequately equipped to fulfill their mandates. There was no standard organizational structure and there was a need for a legal framework for the committees as well as rules and procedures, expertise, external relationships and change management. A skilled leader, an information base, a mandate, basic operating rules, combined lay and expert knowledge, funding, training, and links to outside networks were all needed.

Lavallée and André (2005) reviewed EA social impact follow-up in Quebec since 1980, and noted that the limited effectiveness of follow-up programs. Noble and

Birk (2011) suggest that follow-up under negotiated agreements in Canada's uranium industry has improved community–industry relations, but has done little to support effects-based management. There is, they suggest, a need to ensure that monitoring results are useful for, and integrated with, regulatory-based monitoring and project impact management practices.

On a more positive note, the independent monitoring agencies created for mining projects in the Northwest Territories do suggest that such institutions can function successfully as autonomous institutions when they are explicitly created and supported as part of the environmental management plan (Ross, 2004; Macharia, 2005). But those committees may still fall short of their public outreach and informational mandates (SENES Consultants Limited, 2009).

On balance, these studies suggest that achieving adaptive management through Follow-up Monitoring and Management Units will be a challenge. The success of such units will depend upon the support given to them by proponents and by responsible authorities. Community engagement and multi-party institutions cannot replace the enforcement function that must remain the responsibility of governmental representatives. If responsible authorities take up the problems reported by Follow-up Monitoring and Management Units and if they insist that proponents respond to those problems, then continuous adaptive management can be achieved. But if responsible authorities do not hold proponents to account for identified and documented negative impacts or non-compliance with environmental management plans, then the work of the units will not contribute effectively to adaptive management.

6. CONCLUSION

This report on research study has demonstrated that there is a well-established and diverse body of literature on CBEM and an active practice of CBEM in Canada. It has demonstrated the viability of a community-based approach to environmental monitoring, some of the different types of critical environmental values that have been monitored by communities, the importance of using monitoring protocols and examples of such protocols, and the challenges of linking monitoring to decision making.

Our study is in no way comprehensive in itself, although it provides an overview of the substantial body of literature now available on community-based monitoring and the hundreds of organizations involved in Canada alone. Above all, the study's broad overview of community monitoring in practice has provided the basis for some concrete suggestions for how it can be integrated into formal follow-up programs. Our case studies demonstrate that community based environmental monitoring can provide usable knowledge to support adaptive management of projects during the implementation and decommissioning stages.

We will not repeat here the recommendations already outlined in Section 6. We end simply by recommending that we use the evidence that CBEM can make a contribution to successful EA follow-up as the basis for the development of a program by the Agency to increase the use of volunteer monitoring in Canada. At a minimum, project proponents should be encouraged to make it an integral part of their environmental management plans.

But we feel that environmental management plans that do not include the creation of a multi-party Follow-up Monitoring and Management Unit to operate for the duration of the project should be viewed as inadequate. Responsible authorities, and most particularly the Agency, should make Follow-up Monitoring and Management Units a standard feature. The establishment of such units is consistent with the spirit of the Act which recognizes that the results of follow-up programs may be used for implementing adaptive management measures (CEAA §38 (5)). It is also consistent with the mandate of the Agency, which is to ensure an opportunity for timely public participation in the environmental assessment process (CEAA §62 (g)).

Community-based environmental monitoring will provide an ongoing opportunity for public participation throughout the life of each EA follow-up program.

7. AREAS FOR FUTURE RESEARCH

Community Involvement in EA Follow-Up

By now, sufficient information should have been gained in designing and implementing follow-up programs to start assessing their effectiveness, particularly in respect to the adaptive management of adverse environmental effects. Community involvement in follow-up programs is not required under the Act, so it's likely that only a few follow-up programs currently involve significant community participation. But a general review of the functioning of follow-up programs would assist the Agency in further efforts to design effective follow-up that would include community participation as an integral program component. Studies of the three environmental monitoring agencies established for diamond mines in the Northwest Territories (Diavik, Ekati, and Snap Lake) would be particularly relevant.

Project Impact on Communities

As part of a general program of research on follow-up, it would be useful to conduct studies of communities affected by projects during the project implementation as well as after the decommissioning — even if those projects have not initiated a formal follow-up program. The thousands of projects that have passed through the federal EA system could provide useful insights into the kinds of issues that arise between communities and proponents during the implementation and decommissioning of projects. It would be useful to include not only Canadian cases but also comparable international cases.

Community-Based Monitoring and Socio-Economic Data

The literature on CBEM and the cases reviewed for this study have not included community-based monitoring of social and economic impacts, which are not currently addressed by the Act. This would be an important line of research if future amendments to the Act broadened it to include such impacts, as is the case for most provincial EA legislation. If that were the case, further research would be required to identify techniques and protocols for the collection of socio-economic data. The community-based monitoring approaches discussed in this report could presumably be extended to such considerations.

Regional Variations of National Programs

Several of the cases examined in this report related to local initiatives supported by national programs. Their success was, in part, a function of the strength of the national program support they received. It is likely that there will be variation in the success achieved by various local initiatives falling under the same national program. Comparative studies of those variations would bring to light additional specific factors that contribute to those local success stories.

Appendices

APPENDIX 1

NORTH SHORE STREAMKEEPERS

North Vancouver, British Columbia

History of the Organization

The North Shore Streamkeepers (NSSK) began when a number of salmon enhancement projects were being advised by staff from the Department of Fisheries and Oceans (DFO). They realized that simply releasing the fry and hoping for the best was not sufficient, and that it was important to protect the streams to ensure the protection of the fish. This realization led to the creation of *The Streamkeepers Handbook* by the DFO in 1995. More groups were formed after its publication and the DFO realized that training would also be necessary. The Pacific Streamkeepers Federation (PSkF) was formed to facilitate both the training and information-sharing between existing Streamkeeper groups.

The NSSK, now one of the members of the Pacific Streamkeepers Federation, began when an Environment Officer at the district of North Vancouver working on environmental protection bylaw became interested in a community approach. He brought a number of people together and started an "Adopt-a-Stream" program, based on an American model. After a few meetings, he handed the group over to Karen Munro, who has been the NSSK coordinator since 1993.

When the NSSK was formed, there was simply an interest in stream monitoring. But when a culvert was observed which was preventing fish on Hastings Creek from swimming upstream (thereby limiting spawning habitat), the NSSK decided to try to make it passable. This led to the installation of a fish ladder. When the fish ladder was completed, NSSK began undertaking spawner surveys to determine whether the fish ladder had been successful. NSSK has also undertaken a number of park enhancements (Princess Park, Heywood Park) to increase bank cover and thereby reduce erosion and access to the water by dogs and humans who may jeopardize fish habitat. In the 1990s a community salvage nursery was created with the DFO to reduce the cost of buying plants and trees for enhancement, but this nursery is no longer in operation.

More recent projects include Ron den Daas's community art project, an all-day event that was made into a video — there is now a contract for a full-length movie based on the NSSK group). The event included puppet shows, bands, free pizza, a blessing by the First Nations, and appearances by the acting mayors. Bob Gelling, a member of NSSK, has also started his own personal monitoring program. He goes to city hall every week and gets all the building permits. He visits their sites and reports to city hall if anything is out of order (e.g., improperly covered silt which would go directly into the storm drain and then into the stream).

Types of Monitoring

Three types of monitoring are conducted by NSSK: fish monitoring (smolt trapping and measuring); visual monitoring of streams (they walk the bank and note/report any issues); and water quality monitoring.

Data Collecting Techniques

The numerous protocols used by the NSSK can be found in *The Streamkeepers Handbook and Modules*. It provides modules for surveys of stream habitat water quality; stream invertebrates; salmonid spawners; as well as protocols for storm drain marking; stream cleanup; streamside planting; streamside fencing; the "observe, record, report" system; community awareness; juvenile fish trapping and identification. Information for planning habitat restoration or monitoring of the success or effectiveness of restoration is also gathered. The Department of Fisheries and Oceans gave money to The Pacific Streamkeepers Federation to make kits for groups, including essentials such as shovels and nets. This equipment is still in use.

Data Quality Issues

Because the DFO community advisors are present at sampling times, there are no issues in data quality or consistency

Data Reporting

The NSSK has produced the Water Quality and Watershed Health of Mackay Creek 2007–2009 Study and have produced a number of brochures mailed out to the community. Data are reported in the Streamkeepers Database, which is organized through the Pacific Streamkeepers Federation. Data are also reported through the DFO Community Advisors to the DFO, or directly to the Municipality. The Mackay Creek watershed study was reported to Environment Canada. Some information is also stored on the NSSK website.

Data are distributed to the DFO, the District of North Vancouver, the City of North Vancouver, granting agencies such as the Pacific Salmon Foundation, Evergreen Canada, and Environment Canada. The data are available to the provincial Ministry of Environment but, typically over the past 10 years, there has been limited engagement with the province.

Data Use

We found several examples of NSSK data being used in decision making. Streamkeepers provide information on local streams to the Municipality to use in decisions about urban development. Some information will be used in developing Integrated Stormwater Management Plans for watersheds in the District of North Vancouver. Information about MacKay Creek contributed to the Master Plan for City of North Vancouver Parks. Reports on environmental infractions such as fish kills, illegal dumping, and practices for erosion and sediment control on

construction sites are often followed up by DFO, Environment Canada, or the Municipality. Salmonid monitoring data are used by DFO to assess fish habitat. Water quality monitoring data on Mackay Creek are used by Environment Canada.

NSSK provided input to municipal tree bylaw revisions and streamside protection bylaw. NSSK also has attended public meetings, talked to and sent written comment to staff and council. NSSK has been invited to participate in revising the Official Community Plan. High turbidity during rainstorms indicated a gap in district erosion and sediment control bylaws that apply to the construction phase for buildings, but this problem occurred on a landscaping job when enough soil washed down storm drains to the creek to allow the water in 5 km of creek to run brown for several hours. High fecal coliform levels documented at one site over the course of one year suggested a break in the sewer line, and this information was passed on to the district.

Sometimes NSSK doesn't follow-up on the data collected. Sometimes the agency is not interested enough (e.g., the municipality might go ahead and approve a development closer to the stream than NSSK would like to see). *The Streamkeepers Handbook* actually provides a very robust, scientifically defensible way of collecting data on the stream and watershed but improvements could be made in communicating results.

Organizational Structure

The North Shore Streamkeepers have a limited formal organizational structure. They are not a registered society. The do, however, have formal positions within the group such as treasurer, secretary, coordinator, and watershed coordinator.

Working with Volunteers

The NSSK works with 10 to 25 regular volunteers per year. But the number of volunteers can swell to 100 people, depending on the event. The consistent volunteer base is composed of retirees. Volunteers are recruited through the NSSK website; bulletin board postings at their meeting place (donated in-kind by the District of North Vancouver); and ads in the event section of the local paper. The NSSK maintains an e-mail list and goes to other people's events to advertise.

Capilano College offers the "train the trainers" course. The trainers had to go out and do all the modules in *The Streamkeepers Handbook* and submit a detailed report. They could then advertise in their community and train individuals. Standard training lasts two days. NSSK pays half the cost for the weekend training (about $50). Training is also undertaken by DFO and facilitated by PSKF. There seems to be no problem with training. DFO advisors are readily available if there are issues.

Funding
NSSK has never needed extensive funds and therefore has never applied for consistent funding (i.e., they have no fixed budget). They have applied for grants for specific projects such as the grant from Environment Canada (~$30,000) that led to the Water Quality and Watershed Health of Mackay Creek 2007–2009. Funding has been received over the years from: DFO's Community Fund; private donations; and Environment Canada's Eco Action fund. The province has had limited involvement in Streamkeeper organizations, whether in funding or in providing support.

Successes
The interviewees identified several NSSK successes. These included increased awareness about urban streams in North Vancouver and the need to protect and rehabilitate them; increased environmental literacy in North Vancouver generally; increased salmonid spawning and return to local streams; a positive change in attitude and behaviour in certain groups in the community; a decrease in invasive species in public spaces through removal programs; more educated conservation-minded individuals; and the government has more information on smaller streams that it does not have the capacity to monitor itself.

Reasons for Success
The reasons for success identified by interviewees included a tremendous dedication to the preservation and enhancement of the riparian environment; a simple but sound organizational structure; a solid membership base; a willingness to be "vocal"; a grassroots organization with strong links to the community; passionate and dedicated members; a two pronged approach to monitoring: education and scientific data collection; an exciting and dynamic process; support from the municipality; and ongoing contact with the Department of Fisheries and Oceans.

Suggestions for Improvement
The Program Coordinator suggested two areas for improvement: First, to add a mechanism for changing responsibilities by having organizational positions with fixed terms of office. This would keep things fresher and provide new volunteers with a greater sense of involvement. Second, she suggested that the group maintain a formal membership list to achieve greater continuity over time because members come and go and the NSSK has no formal registration process.

Interviews (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

Sources

North Shore Streamkeepers Web Site: http://www.nssk.ca
Pacific Streamkeepers Federation website: http://www.pskf.ca/index.html
The Pacific Streamkeepers Federation, *The Streamkeepers Handbook* Available online: http://www.pskf.ca/publications/Handbook%20and%20Modules.pdf

APPENDIX 2

LAKE WINDERMERE PROJECT (WILDSIGHT)

History of the Project

A Global Nature Fund “Living Lakes” international conference was held in 2004 (the 9th conference) in the Columbia River area. Wildsight (formally the East Kootenay Environmental Society) was present at the conference as the Canadian partner in the Living Lakes program. After the conference people from Lake Windermere started asking what was happening with the lake. What was the local environmental organization doing? What were local governments doing? “That’s where the question first began — What’s being done to protect the lake? And at that time, nothing was being done” (Leschied interview). The 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 had experienced a collapse in the burbot (Lota lota) fishery. Because burbot are a top predator, the health of their population was a good indication of the health of the ecosystem as a whole.

In the first year of the Lake Windermere Project (LWP) a consulting company was retained by the Regional District of East Kootenay (RDEK) to review, summarize, and consolidate existing water quality literature on Lake Windermere and provide recommendations for future sampling. It was intended that these sampling recommendations be integrated with the project called Healthy Water for Healthy Communities – Lake Windermere (HWHC), which was spearheaded by Wildsight.

In addition, the British Columbia Ministry of Environment (MOE), Interior Health Authority, and other partners made suggestions about how to structure a monitoring program for Lake Windermere.

The Lake Windermere Project (LWP) began fully in 2005 when it was awarded an Eco-Action grant in the amount of $100,000 spread over three years. The LWP was designed to incorporate four components: science, outreach, restoration, and communication. The project was to continue for 5 years, then be handed over to the Lake Windermere Ambassadors, a group of volunteers who intend to continue the work.

In 2005, the LWP became a Level 1 monitoring program of the BC Lake Stewardship Society (BCLSS), which began monitoring on Lake Windermere and 2 of its tributaries.
In 2007, the LWP entered the East Kootenay Integrated Lake Management Partnership (EKILMP) and began winter monitoring at 3 new water intake stations. In 2008 monitoring began on 5 new tributaries to Lake Windermere. In

2009, benthic macroinvertebrate monitoring began using the Canadian Aquatic Biomonitoring Network (CABIN) protocols. During 2010, the Lake Management Plan for Invermere is being drafted based on data collected since 2005, and preparations began to transfer the LWP to the Ambassadors.

Types of Monitoring

Four categories of monitoring are conducted by the LWP and each monitoring activity has its own protocol: water quality monitoring (Lake Windermere Water Sampling Protocol); beach bacteriology sampling (Lake Windermere Bacteriology Sampling Protocol); benthic macro invertebrate sampling (CABIN Field Sheet 2009 Revised); and boat counts (Boat Count Protocol).

Guidelines and instructions for monitoring are all incorporated into the protocols and each protocol requires a different monitoring kit. A manual was being compiled by the LWP at the time of the field visit. This will guide the Ambassadors when they take over the project

Data Collection Techniques

Volunteers travel to a site, gather data using the kits provided to them, and send the water samples to the lab when finished monitoring.

Data Quality Issues

There are some data quality concerns. The water quality samples have to be shipped via Greyhound. Because the samples are time-sensitive (i.e. they must be analyzed within a certain time frame) sometimes they are not analyzed in time and need to be re-sampled. During the summer shipping is sometimes a problem as water quality samples need to be maintained at a certain temperature. If the temperature is exceeded a new sample must be taken. Since all monitoring samples go to government agencies there may sometimes be a problem that the LWP does not even hear about.

Data Reporting

LWP has released numerous newsletters, brochures, and surveys. A 2005 Lake Use Survey Report was compiled near the beginning of the project. An annual report is also compiled which is the main communication vehicle to the public and is available online.

Samples and data are sent to the MOE and Interior Health who compile their own reports. General reports are released to the public and there is a hope to have data on the website in the future. Data are received by the Ministry of the Environment, the District of Invermere Council, Interior Health Department, and the Regional District of East Kootenay.

The culmination of the project will be the Lake Management Plan scheduled for completion in the fall of 2010 which is being compiled by MOE staff. It has been

proposed that the plan be mailed to the public but this decision was still pending at the time of writing.

Data Use

Water quality monitoring data has been used by the MOE to update their Water Quality Objectives (WQOs) for the lake. The WQOs help protect the most sensitive areas of the lake (fish, wildlife, drinking water). Prior to the LWP the last WQOs were completed in 1985. An Attainment Program will be created based on the current WQOs

Bacteria sampling is undertaken at 3 public beaches for the Interior Health Authority. Bacteriology samples are used by Interior Health to monitor beach conditions. So far, the data have not led to any remedial actions (no beach closures have been necessary and drinking water quality has not fallen below provincial threshold. Water quality data has also been used by a private firm in designing a new drinking water intake.

However, there has been shoreline mapping of sensitive areas used to guide municipal planners in development approval and LWP data have contributed to a temporary municipal moratorium on foreshore development of marinas and dock. LWP data supported a cosmetic pesticide ban in partnership with the Canadian Cancer Society. Other results of the monitoring will come from the forthcoming Lake Management Plan (LMP) to be released in late 2010 which will include all the data collected since 2005.

Working with Volunteers

Roughly 40 volunteers per year have logged over 400 hours of volunteer time and this does not include the huge turnout at events like the shoreline cleanup. Volunteers undertake water sampling on the lake, water sampling on tributaries, boat counts, the organization of events, and beach cleanup.

Retired people who form the volunteer base are recruited through advertisements in the local newspaper, the *Invermere Valley Echo*. A reporter from the *Echo* who used to be an LWP volunteer has written numerous articles. Some recruitment is made by word of mouth and some people want to volunteer in groups. The Wildsight newsletters, another advertising vehicle, reach a broader audience.

Volunteering offers people the chance to learn about their lake and volunteers gain a different perspective because they get to go out in the monitoring boat. They learn about the environment. Many enjoy being outside. Some see the LWP as a success and they want to be part of it. Some are retired and are looking for something to do. Some volunteers have applied the training from the LWP to their own lake.

Training of Volunteers

Training of volunteers is undertaken on an individual basis primarily on site, either on the tributary shore or on a boat. They review the protocols and what to expect before leaving the office. There have also been two official training days so far (2006, 2009), where the entire day is dedicated to training volunteers. Training is considered to be effective and LWP personnel are always on site in case any questions or issues arise.

Funding

The budget for the LWP has been roughly $130,000 a year. From this amount, between $15,000 and $20,000 goes towards water quality monitoring. This budget covers two part-time staff, lab fees (which are a major expense), communications (such as brochure design and printing), and website maintenance, equipment, and the costs of other events.

The funds are provided most consistently by four organizations: Eco-Action Fund provided the initial 3-year grant; the Columbia Basin Trust, the Columbia Real Estate Foundation, and the District of Invermere have provided funding every year. Other funders include individual property owners, businesses, the Columbia Valley Community Foundation, the Lake Windermere Lions Club, the TD Friends of the Environment, the RBC Bluewater, and the Regional District of East Kootenay. In-kind support has been provided by Wildsight and expert advice and support have been provided by LWP partners (MOE, Interior Health, DFO, planners).

Structure of the Organization

Wildsight Invermere is a local branch of regional organization, Wildsight. The Lake Windermere Project (LWP) is operated as a project of Wildsight Invermere.

Successes

The main successes of the LWP as identified by interviewees include: widespread credibility in the community; widespread buy-in from various sectors including business, government, and the general public; and useful partnerships with local government, business, homeowners, and media. The LWP has created a common basis for discussing the health of the lake and has helped bring multiple interest groups to the table and uniting them to address a common goal. The LWP continues to spend time building trust both within the community and with government.

The LWP has educated the public about Lake Windermere and the need to protect it and has raised awareness about the danger of overdevelopment on water supply and habitat and has affected the attitudes of people on the lake, most notably the younger generation. The project has helped people take ownership over their lake and created a general stewardship ethic in the

community. The project has created a community pride and ethic for conservation and management of the lake

Reasons for Success

Interviewees identified many reasons for these successes: the hard work and dedication of Heather Leschied, the Program Coordinator; the importance of Lake Windermere to the community because it is what brings many residents and the recreationists to the area; and the community-based and community-driven, bottom up, character of the organization which engages both the permanent and the transient population.

The project has maintained constant communication with the public and their partners and has maintained a consistent message. LWP undertakes extensive public outreach programs (articles in the paper, events, door-to-doors, newsletters, annual reports). The project is supported by the local government and by the community. The LWP is conducted professionally and receives ample and consistent funding from a diversity of sources. The staff are strong personalities, skilled and knowledgeable in their field.

It is also important that the LWP has taken a more moderate stance than the more political and radical parent organization, Wildsight. Initially there were concerns in the community about the controversial nature of some of Wildsight's previous projects. To gain more community support, the project was designed as a partnership with partners such as the District of Invermere (DOI), RDEK, MOE, Interior Health and the local Chamber of Commerce. Wildsight serves as a facilitator to the project through various forms of support.

The LWP has managed to bring stakeholders into the discussion instead of antagonizing them. It has fostered positive relationships with stakeholders instead of pursuing a more radical advocacy role. There has been extensive LWP networking to achieve support from a broad range of partners and they have used a collaborative approach. Everyone involved with the LWP has both a professional and personal interest in the project

The LWP consulted with non-profit groups that deal exclusively with water, limnologists, other experts, and MOE to get a sense of what a good monitoring program would look like. LWP is adaptive and changes as is necessary. LWP accepted small, tangible gains instead of trying to immediately fix the troubles the lake was facing and tackles issues positively (what can we do?) instead of negatively (what can't be done any more). It was the first unified lake water monitoring program in the area and it relies on established and respected protocols

Conclusion

When asked what she would do if starting to build the project from scratch, the Project Coordinator offered the following observations. She would have created a

Terms of Reference (TOR) for the partners involved in the project. While there was an informal agreement and many of the partners have been able to fulfill their commitments, it would have been beneficial to have a document to refer back to year to year. She suggested that the project has been lucky that none of the key contacts/partners have left their positions, however, if that had been the case, the TOR would have been an introductory piece for their replacement. She also suggested that the project has been lucky to have had the opportunity to change the work plan based on new information and requests from the community. The project has not been bound to goals laid out in the beginning. It has been flexible and allowed to evolve. In other words the project has been allowed to pursue a program of adaptive management.

Interviews

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 Interview 1, local business owner
Confidential Interview 2, Fisheries and Oceans Canada employee
Confidential Interview 3, LWP ambassador and funder
Confidential Interview 4, Columbia Basin Watershed Network employee
Confidential Interview 5, Wildsight employee
Confidential Interview 6, LWP partner
Confidential Interview 7, LWP volunteer
Confidential Interview 8, Environmental Monitoring Scientist, Environment Canada
Confidential Interview 9, Global Nature Fund employee
Confidential Interview 10, elected official from the Regional District of East Kootenay

Sources

Canadian Aquatic Biomonitoring Network (CABIN) website:< http://www.ec.gc.ca/rcba-cabin/default.asp?lang=En&n=72AD8D96-1>

Lake Windermere Water Sampling Protocol (n.d.), 2 pp. Lake Windermere Project.

Lake Windermere Bacteriology Sampling Protocol (n.d.), 1 p. Lake Windermere Project.

CABIN Training Field Sheet, (n.d.), 6 pp. Available online at: http://www.ec.gc.ca/rcba-cabin/74876ADD-8158-49CD-94E3-FC21D5A2C2E7/CABIN%20field%20sheet%202009.pdf

Lake Windermere Boat Count Protocol (n.d.), 2 pp. Lake Windermere Project.

Leschied, H. (2009). Water Stewardship Work Plan 2009–2010. Lake Windermere Project.

Wildsight Web site: http:/www.wildsight.ca/

"Wildsight's Lake Windermere Project Goes International," April 18, 2008. Available online at: http://www.wildsight.ca/news/263

APPENDIX 3

PRAIRIE NEST RECORDS SCHEME (PNRS)

History of the Organization

The regional branch of Bird Studies Canada, with its national program entitled Project NestWatch, has coordinators for every region in Canada and has undertaken records schemes for the past 40 years in the Maritimes, Newfoundland and Labrador, Quebec, Ontario, and Saskatchewan.

Nest monitoring started as a way to understand bird populations and to act as an early detector of environmental change. The goals of Project NestWatch are listed on their website:

- Involve amateur bird watchers, naturalists, and young people in studies related to birds;
- Gather long-term data on bird populations throughout Canada;
- Inform the general public of existing nest record schemes across Canada;
- Provide direct feedback to project participants and the general public regarding bird population trends.

Types of Monitoring

Through the data gathered on nests, it is possible to monitor changes in clutch size, nesting success, and predation rates over time, and to relate these changes to such long-term modifications in habitat or climate as global warming. It is also possible to evaluate the impact of predators on nesting success and document basic breeding biology such as nesting habitat, nest site selection, incubation period, and re-nesting. As a national monitoring program, Project NestWatch is able to document the breeding distribution of birds in Canada.

Data Collection Techniques

The Prairie Nest Records Scheme Card and Coding Book outline the data to be collected. Nest monitoring seeks data on species type, number of eggs, live and dead young in the nest, nest site, nest type, exposure, slope, nest hole direction, and nest height. Volunteers travel to nesting sites and record what they observe. The volunteers submit data on recording cards. For examples see the Prairie Nest Records Scheme Handbook, pp.18 and 21.

Data Quality Issues

The data quality is considered to be good because most of the long-term volunteers are birders who are familiar with bird nesting habits.

Data Reporting

The data are gathered by Bird Studies Canada and the Federation of Alberta Naturalists, who roll all the data into the Natural History Database (NHDB), which now contains observational records for birds throughout Alberta. Basic searches in this database for Alberta bird species can be accessed through the Federation of Alberta Naturalists (FAN) website (http://naturealberta.ca/alberta-natural-history/bird-projects/the-alberta-bird-atlas-project) More detailed data can be obtained on request. People request general data from Alberta Naturalists (not just PNRS data). There are hundreds of information requests each year.

Data Use

Some examples of data requests follow:

The Alberta Conservation Association used data regarding bird species that occur in the Milk River Basin Project area to identify key areas of interest within the basin pertaining to wildlife in order to focus conservation efforts on these areas.

Canadian Wildlife Service used data to guide efforts in targeting areas for stewardship activities and monitoring of Loggerhead Shrikes. The National Recovery Team for the Western Loggerhead Shrike used the data for compiling occurrences and nesting of Loggerhead Shrikes throughout the Canadian prairies.

The Alberta Sustainable Resource Development, Fish and Wildlife Division used data in a scoping project linked to the Southern Headwaters at Risk Project (SHARP), a project led by Alberta Fish and Wildlife. The project was designed to conserve a suite of species at risk in the mountains and foothills comprising the headwaters of the Oldman River System. The aim of the project was to develop a multi-species model to identify high value areas or “hot spots” for species at risk and to work with key stakeholders to implement some form of protection or management to ensure the long-term sustainability of the species.

The Alberta Natural Heritage Information Centre requested data in order to verify the nesting records they had collected for Caspian Terns on Lake Athabasca. Woodlands Forest Management Inc. submitted a data request for the area near Cochrane, Alberta. They used the data to compile biophysical information on the area. The information being collected was for one aspect of a land use bylaw that Woodlands Forest Management was preparing for the Jamieson Road Tourism and Recreation Land Use Policy Review. The data were used as part of a background review on the site’s natural resources, to be included in a report. “It is intended that the FAN information may provide increased credibility to our own review and conclusions.”- Bruce Nielsen

Not all data requests come from researchers and scientists. There are many recreational birders in the province who are interested in the information

collected about Alberta's bird species. Many of these birders are able to access the information they want through the online NHDB available on the FAN web site. For those that require more specific information, a data request is required.

FAN is exploring the development of a web-based process to allow birders ease in entering their data from various bird inventory processes that include Christmas Bird counts, May species counts, check list surveys, Prairie Nest Record Scheme Surveys, industry surveys associated with EIA's, government management surveys and the public using the FAN bird checklist. FAN has committed to maintain and upgrade the system as required. FAN continues to explore opportunities to enhance the database which includes expanding it to include additional floral and fauna elements. Funding support for this activity is generated through the bi-yearly operating of a casino, administration fees charged for data access, and member donations. Data is provided free to educational institutions.

Organizational Structure

The Prairie Nest Records Scheme is jointly coordinated by the Manitoba Museum, the Royal Saskatchewan Museum, and the Federation of Alberta Naturalists and operated in cooperation with the Canadian Wildlife Service and Bird Studies Canada. The Provincial Museum of Alberta acts as the final repository for the Alberta cards (data records).

Working with Volunteers

Roughly 30 individuals submit data each year. All reports are done by people who use the data. The people who volunteer are generally older and seasoned birders. Many come from Canadian Wildlife Service staff, and consequently are usually trained people capable of collecting reliable data.

Volunteers are recruited through the network of clubs that make up the Federation of Alberta Naturalists (FAN), which organizes a variety of festivals and conferences and produces flyers and advertising materials.

Volunteers can receive formal training available at office or can go out with a seasoned birder

Funding

The Federation of Alberta Naturalists has not sought specific funding for their PNRS program. Funding comes from the general budget for which the biggest funder is the Alberta government. The program currently has a low overhead but it's not meeting its potential in the province. It is estimated that PNRS needs between $30,000 and $40,000 a year with dedicated staff to operate effectively, but it's not getting this attention at the moment.

Suggestions for Improvement

In addition to the need for greater funding the program could be improved through greater outreach efforts by the coordinators. The program also needs a project champion within the provincial government. The program also requires a more effective mobilization of volunteers. This type of monitoring does not appeal to people who find it somewhat tedious. Even normal birders do not find it an interesting activity.

Interviews (3)

Philip Penner, Executive Director, Nature Alberta
Confidential Interview 1 (volunteer)
Confidential Interview 2 (volunteer)

Sources

Dale, B.C., A. Hingston, G. Sutter, and G. Hanke (editors). 2003. Prairie Nest Records Scheme Handbook. PNRS, Edmonton, Alberta. Available online at: <http://fanweb.ca/projects-and-programs/prairies-nest-records-scheme-pnrs/PNRS_Handbook.pdf/at_download/file>

Prairie Nest Records Scheme:
<http://fanweb.ca/projects-and-programs/prairies-nest-records-scheme-pnrs>

Prairie Nest Records Scheme Coding Card
<http://fanweb.ca/projects-and-programs/prairies-nest-records-scheme-pnrs/PNRS_Coding_Card_8.5x14.pdf/at_download/file>

Prairie Nest Records Scheme Nest Card
<http://fanweb.ca/projects-and-programs/prairies-nest-records-scheme-pnrs/PNRS_Card.pdf/at_download/file>

APPENDIX 4

ASSOCIATION FOR CANADIAN EDUCATIONAL RESOURCES (ACER)

History of the Organization

Founded in 1987, the Association for Canadian Educational Resources (ACER) was a response to the limited availability of resources for teachers wishing to incorporate learning outdoors or in science labs. ACER's first project, the Niagara Escarpment Biosphere Reserve (NEBRS), established three 1-ha monitoring plots along Ontario's Niagara Escarpment in partnership with the Niagara Escarpment Commission. The plots were designed for teaching about climate change and tree monitoring. The idea was initiated at the Rio Conference in 1992, when the Smithsonian Institution was commissioned to develop a protocol for monitoring forest biodiversity and climate change. This protocol was brought to Canada in 1994 to the Kejimkujic National Park in Nova Scotia. After training by Environment Canada, ACER adopted the protocol in 1995. ACER is the only community-based, long-term monitoring network that gathers and manages the data. ACER applies the same protocol in a schoolyard, a forest, a planting plot, and a stewardship recovery program.

Around 2002, the association realized that they could "plant for climate change" as well as teach students about it. Through the Plant, Measure, and Mulch project (now shortened to Measure and Mulch) volunteers planted 1 hectare of trees (76 species, 2,157 individual trees) in six biodiversity mini-experiments in one field hosted at the Humber Arboretum. Unfortunately, limited funding, inclement weather, and other variables meant that few schools got involved; consequently, ACER moved on to create another program for schools — mapping their own playgrounds and taking an inventory of the trees in them, using the same techniques designed for the planting plots. They wrote manuals and developed a 3-day training course for interested teachers.

When teachers expressed the wish to plant trees in their school yards, ACER developed a program called "Planting for Change" in which the teachers and students, with support from ACER, planted 15 trees on small plots. ACER's technical advisory team recommended that five types of trees be planted, including accompanying native shrubs. In 2008, ACER received a new contract to lead a program, Humber Youth Stewardship, which aims to remove invasive species according to a protocol initiated by the City of Toronto. Once the invasive species are eliminated, ACER plants appropriate species in their place. Simultaneously, ACER conducts complete tree inventories.

In 2009 ACER received a large "transition" grant to expand to the provincial scale. The funding also allowed ACER to pay the salary of the first permanent office staff member — an executive director.

Types of Monitoring

ACER monitors trees for size in various settings — forests, test plots, standard plots, and schoolyards. Table 3 lists the main indicators for which data are collected.

Data Collection Techniques

In terms of measurement guidelines, ACER added new descriptors to the somewhat bare bones format of the Smithsonian protocol — crown width and depth, compass bearing for height-taking, and different methods of measurement for small and large trees. ACER purposely chose the framework of an international protocol rather than a local or provincial one so that the data could be compared with that of other nations to understand the issue of climate change on a global scale.

ACER divides 1-ha plots into 5 m x 5 m grids and asks its monitors to start in one corner of the plot and number trees through 2 m swaths in concentric circles. Monitors fill in data sheets, which are then entered into an Excel spreadsheet. Initial data are used as a benchmark inventory, and the new data collected help them determine which species are flourishing, which species are dying, and why.

Table 3; ACER Indicators

What is monitored?	What data are 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

The kit used for tree monitoring by ACER is the Biobag kit, which includes: aprons, measuring tapes, tree gauges, diameter tapes, winter tree bark ID key sets, sample data and field sheets, clinometers, compasses, flagging tape roll, permanent markers, safety glasses, hammers, sample numbered tags, sample zinc coated siding nails, side signs, quadrant divider ropes, “Go Global!” manuals and “Why Monitor?” DVDs. ACER also provides protocol documentation (Hayward and Casselman, 1997; Reynolds and Casselman, 1997; Wilson, 1999; and Karsh et al., 2002) and some site-specific manuals (Putnam, 1997, 1998a, 1998b, 2001).

Data Quality Issues

The quality of the data is highly dependent on the quality of the training and supervision. ACER strives to use the simplest tools possible to get the most accurate results. The data sheets are designed to try to minimize incomplete and incorrect information. Data management can be a challenge, considering the

high turnover in staffing and volunteers. ACER initially used FileMaker Pro software, then transitioned to MySQL; however, the group's lack of a high-speed Internet connection meant an eventual switch to Excel spreadsheets. Now the data can be easily shared and manipulated by multiple users.

Data Reporting

Environment Canada, as the primary user of ACER raw data in Excel files, sometimes suggests sites measurement sites. Data reporting is a fairly new process for ACER. Until recently, they had focused their effort on setting up plots and training people for data collection. They also compile data in progress reports submitted for grants. More recently, their have produced a series of reports from their co-op projects.

Data Use

ACER data has been used at a number of conferences, in academic posters, and in research papers, as noted in the following list:

> Panama Statement, from the Climate Change and Biodiversity Symposium in the Americas, Panama City, Panama, February 2008
>
> Environment Canada. 2008. Poster prepared for Climate Change and Biodiversity in the Americas Symposium, Panama City, Panama, Feb. 25–29, 2008. Adaptation and Impacts Division, Environment Canada. Available online at: http://www.canada-biodiversity.ca/pdfs/case_14.pdf
>
> Fenech, A., MacIver, D., and Dallmeier, F. eds. (2008). Climate Change and Biodiversity in the Americas. Environment Canada. Toronto, Ontario, Canada, 366p.
>
> Pollock, S. (2002). Climate Change and Wildlife. Environment Canada. Toronto, Ontario, Canada.
>
> Séguin, J. and Berry, P. (2008). Human Health in a Changing Climate: a Canadian Assessment of Vulnerabilities and Adaptive Capacity. Health Canada. Ottawa, Ontario, Canada.

ACER has the potential to inform policy, particularly with relation to climate change. For instance, if there is government recognition that small woodlots are important in slowing climate change, the taxes may be lowered on woodlots to encourage people to grow trees.

Organizational Structure

ACER is an incorporated not-for-profit organization whose members are leaders in education, media and business. The Executive President, Alice Casselman, is the only full-time staff member of the organization at present and is supported by

a Board of Directors. A volunteer network of community groups, educators and scientists supports ACER programming. An advisory board monitors project funds.

Working with Volunteers

Roughly 300 volunteers visit the Humber Arboretum each year. The “Planting for Change” program involves 2-3 classes of 30 people on each of 6 plots. Others visit the Humber Arboretum to volunteer on Saturdays.

Typical ACER volunteers include: gardeners, retired teachers, people interested in forestry or landscaping, new Canadians looking for field experience, youth looking for community service hours, horticultural and gardening club members, and Sierra Club members.

Recruitment is undertaken primarily at events hosted by others, such as “green” organization gatherings, conferences for educators, symposia, annual meetings and events of other environmental groups. Informational materials are distributed and individuals are able to sign up for volunteering or to receive further information.

Reasons for volunteering are quite diverse and include: working with children, being outdoors, doing something with a purpose, learning about Canadian vegetation, getting field experience, supporting ACER’s work on climate change, and obtaining community service hours.

ACER offers a “training package” and hands-on training in the forest, on a planted plot, or in someone’s yard. For school-based training, ACER representatives show classes how to weed, measure, or mulch. For two years ACER held a three-day training course for teachers but funding for this program has run out, with the cost for training, trees, mulch, and equipment being up to $20,000 per school.

Funding

The funds flowing through ACER in 2008 were roughly $200,000. Funding has been project driven and until recently has not allowed for hiring full-time staff. Although writing applications and reports is extremely time consuming, repeat funders for ACER include: Trillium Foundation, Eco Action, TD Friends of the Environment, Shell, and the International Society of Arboriculture.

Two years ago, ACER received a grant of $100,000 (over 18 months) to allow them to expand into a provincially driven and supported organization. This will allow them to have full time staff and hire a branding company.

Successes

The monitoring undertaken by ACER was intended to allow non-scientists to “get their hands on a tree, get their head around climate change, and get their heart behind doing something about climate change” (Casselman interview). ACER successfully engages a wide range of community members, including new Canadians interested in Canadian forestry and climate change. There is increasing interest among teachers every year. ACER has been invited to the Panama Conference by Environment Canada to train scientists to measure trees as a way to understand climate change. ACER has maintained a long-term and stable member base and has a number of repeat funders who have expressed a desire to continue to do business with the organization.

Reasons for Success

The dedication of ACER founder Alice Casselman has been cited as a key reason for success. Enthusiastic and dedicated people have driven ACER and programming has been designed by educators in order to ensure interest and curriculum-compatibility.

ACER has excellent reciprocal relations with their partners, such as the Humber Arboretum and Environment Canada. Funders describe good deliverables and surpassed expectations. ACER has an excellent network of professionals available for consultation and has established connections with decision and policy-makers, which they sustain through reliable data provision. Because they are separate from the government ACER has been able to continue projects even when government funding is reduced.

Suggestions for Improvement

ACER has always been project-oriented and has struggled because of a lack of infrastructure funds. Donated office space or collaboration with another “green” organization would alleviate pressure in this area. Meanwhile, infrastructure support should be requested as part of grant applications. At least one full-time staff is necessary in order to maintain continuity and efficiency. Seeking larger grants and partnerships with corporations interested in enhancing their environmental image may be useful. Marketing and branding should be included in budgets so that the organization, when the time comes, will be ready to expand.

Interviews (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 Interview 1, EcoAction Community Funding Program Project Officer
Confidential Interview 2, ACER volunteer
Confidential Interview 3, previously an ACER intern

Sources

ACER website: <http://www.acer-acre.org/index.html>

Casselman, A., Berry, A., Hain, D., Fergusson, A. et al.(2002) *Solar UV in our World*. Downsview, ON: Environment Canada, 2002.

Gillespie, M. and Butt, S. (2008). Niagara Peninsula Project. Association for Canadian Educational Resources.

Hayward, S. and A. Casselman. (1997) TreeWatch LTM (One Tree At A Time). Mississauga, ON: ACER, 1997.

Humber Youth Stewardship Project. (2008) West Humber Community Forest. Association for Canadian Educational Resources.

Karsh, Marianne,et al. (2002) Plant It! Planting protocol- one hectare biodiversity plots Mississauga, ON: ACER, 2002.

Putnam, R.G. (1997) Royal Botanical Gardens site manual. Mississauga, ON: ACER

Putnam, R.G. (1998a) Short Hills site manual. Mississauga, ON: ACER.

Putnam, R.G. (1998b) Albion Hills site manual. Mississauga, ON: ACER.

Putnam, R.G. (2001) Humber Arboretum site manual. Mississauga, ON: ACER.

Reynolds, J. and A. Casselman. (1997) WormWatch LTM Mississauga, ON: ACER.

Smithsonian Tropical Research Institute, Protocol Documents, <http://www.ctfs.si.edu/group/Carbon/Protocol+Documents>

Why Monitor? (2007) DVD. Association for Canadian Educational Resources.

Weiler, J. (2009). *Niagara Escarpment Project.* Association for Canadian Educational Resources.

Wilson, Audrey E.(1999) BirdWatch LTM Mississauga, ON:ACER, 1999.

APPENDIX 5

ADOPT-A-POND / FROG WATCH ONTARIO

History of the Organization

The Adopt-A-Pond program was developed in 1991 by an amphibian conservation group at the Toronto Zoo. The idea for the program arose in 1989 at the 1st Congress of Herpetology in England. Several scholars from around the world were noticing the disappearance of various frogs, toads, and salamanders. It was decided “to establish a task force of the International Union for the Conservation of Nature to determine the extent and the nature of the problem” (Interview 2). A decision was made to form a program to educate the public about the importance of amphibians and wetlands, and to gather data so that changes could be tracked over time.

Bob Johnson, Curator of Reptiles and Amphibians at the Toronto Zoo, decided the Zoo would be an appropriate avenue through which to establish the program, particularly as it was already partaking in some research on amphibians and conservation. The monitoring of frog and toad activity was not the initial program goal but rather there was a focus on educating school children about wetlands, amphibians and frog and toad calls. Monitoring emerged later. The program encouraged students to listen to frog calls and write down what they heard. Recognizing the need to have data about frogs and toads in Ontario, Johnson encouraged people to sign up for the frog watching program, listen to tapes, make observations, record results and mail them to Adopt-A-Pond. He later helped to develop a program for anyone wanting to learn frog calls through a 1-800 number where one could listen to specific frog calls.

Johnson began discussions of citizen-science with an Environment Canada representative interested in establishing a citizen-based environmental monitoring program. Through a one-year trial partnership beginning in 2000 with Environment Canada and with funding from the Ecological Monitoring and Assessment Network (EMAN), Adopt-A-Pond developed its geographical referencing capacity. When volunteers input data into the system, they also input their postal code, allowing for further geographical analysis. Adopt-A-Pond became the provincial representative for Frog Watch Ontario and an advocate for public involvement in data collection.

Types of Monitoring

Adopt-A-Pond engages volunteers in the monitoring of frog and toad activity, including listening for calls and making visual observations in order to track climate change, identify population trends, and learn about the range and distribution of frogs and toads.

Data Collection Techniques

Once registered, volunteers are encouraged to find a location where they wish to observe the activity of frogs then to go out during the spring and summer and listen at the specified location for fifteen minutes, three times a week and submit the collected data on the Frog Watch website. Volunteers are encouraged to observe during the evening or dusk, as the frogs are most active and vocal at that time.

The volunteers are to record the following data: date, time, location description, habitat type, temperature and weather conditions, the type of frog or toads seen or heard and the abundance of calls. The following scale of frog activity is provided on a pamphlet that volunteers receive upon registration: 0 – no frogs or toads seen or heard; 1 – frog or toad seen but not heard; 3 – some individuals can be counted, others calls overlapping; 4 – full chorus, calls continuous and overlapping. While some volunteers mail in paper copies of the data, they are encouraged to submit results online where possible.

Data Quality Issues

One advantage of a citizen- or community-based monitoring program is the large amount of data that can be obtained. On the other hand, the majority of the volunteers are not scientists and there is no way to monitor their observations. The most common error in data collection is misidentification. In cases where more than one person in the same region reports having seen an uncommon frog for that region, the data is left in the system. In situations that appear very unlikely, the volunteer is contacted in order to determine whether data should be counted or not. For the few cases that are left out of the database, these are set aside and future data is monitored in case similar situations arise again. Data quality is analyzed case by case by the national, not the provincial, coordinator. Volunteers typically become more accurate and efficient with practice and because the monitoring process is rather simple, data quality issues are not often a concern.

Data Reporting

All information is available on the Adopt-A-Pond website, which also makes available the latest Frog Watch Ontario summaries. Summaries include maps of where observations took place, and report the number of observers, locations and observations. The common and scientific names of the observed frogs are listed. The first call and last call observed in the year are also included. The summary also includes cumulative data on the number of observations made since 1998, as in Table 4.

Table 4: Adopt-A-Pond – Observers, Locations and Observations by Year

	2007	2008	2009
Number of Observers	473	527	575
Number of Locations	704	773	840
Number of Observations	8,718	10,389	11,882

Source: Adopt-A-Pond files
Note: The results presented here are cumulative. Data prior to 2007 was not retained.

Obtaining some hard-copy resources requires contacting the program directly. Full sized posters, wetland curriculum resources and a program newsletter, the Amphibian Voice, are also available to subscribers. Data is also distributed through organized events, including a variety of workshops and the Spring Toad Festival, which celebrates the breeding rituals of the toad.

Data Use

All data received via phone, fax, email and online is stored at the Natural Heritage Information Centre (NHIC). National and provincial Frog Watch branches, Environment Canada and Nature Canada, also receive data. The data obtained via the program contributes to other scientific databases on frogs in Ontario. However, there currently is no direct link between the data gathered by frog watchers and decision makers.

Those wanting access to the data must register online with Frog Watch Canada. There is currently no built-in ability to track how the data is used or for what purpose. Some researchers, however, do volunteer updates on their use of the data. Recently, a researcher from the University of Toronto requested the data for her research on the impacts of salt on roads. Communities in Atlantic Canada have used the data for various ecological monitoring programs.

Individual volunteers sometimes make use of the data as well. One volunteer became concerned about the decreased flow and contamination of the pond in her backyard when she heard of plans to build a subdivision in the area. She took the case to City Hall, using collected data to illustrate how many different species were present in the area. She gained the support of her community and the plans for the subdivision were stopped with the developers' experts acknowledging that their studies were inappropriate.

Some volunteers indicated that they share their data with other environmental organizations, and that their children have used the data and Adopt-A-Pond resources for class presentations and school fairs. The Adopt-A-Pond website claims about 2000 schools in Ontario follow the curriculum provided through the program.

Organizational Structure

FrogWatch Ontario is a partnership between Adopt-A-Pond, Environment Canada's Ecological Monitoring and Assessment Network (EMAN), and the Natural Heritage Information Centre (NHIC). The provincial coordinators of FrogWatch have biannual teleconferences and there is regular contact between the national and provincial coordinators. Johnson emphasizes that Adopt-A-Pond has been around almost twice as long as FrogWatch and so there is a desire to maintain some autonomy along with the benefits of the partnership.

Working with Volunteers

At its inception, Adopt-A-Pond targeted school children as their main audience, providing them with educational resources and encouraging them to monitor frog and toad activity. Although the program continues to collaborate with educational institutions, they now focus on marketing towards schools with a special environmental mandate, retired persons, the Boy Scouts, naturalist clubs and cottage and boating communities.

Targeted groups are sent information or contacted directly in order to inform them of the program. The Zoo also organizes outreach programs and representatives attend fairs and workshops to distribute information. The Internet, advertisement through partner organizations, newspaper advertising and other media remain key channels for volunteer recruitment as well.

Most volunteers become involved because they enjoy the outdoors, have a passion for frogs, and are interested in examining levels of frog activity. They believe that monitoring is essential for environment conservation. Most volunteers observe about three times a week. Some go beyond observation and help frogs and toads cross roads or participate in local protests.

Although some volunteers suggest that the monitoring process requires more rigour, others appreciate its simplicity. The balance of providing rigorous, scientific data and maintaining community involvement is taken into consideration by the marketing strategy.

Training Volunteers

Volunteers receive a FrogWatch Ontario package, which includes a frog and toad identifier guide, a poster, a CD of the frog and toad calls and a FrogWatch-Ontario data sheet. The frog watcher needs to learn frog calls using the website or frog call CD. The identifier guide and poster provide a coloured picture of the frogs or toads, the common and scientific names, a brief description of their appearance and common places where they can be found, a range of their size and a description of their call. The identifier also outlined which frogs are endangered or threatened. Volunteers report finding the training tools to be user friendly and very practical.

Funding

Additional information on program funding was not obtained for this case study.

Successes

The Adopt-A-Pond program successfully involves citizens in environmental monitoring through frog and toad observation. Through volunteer involvement, the program is able to collect a wide range and depth of data that is distributed widely and put to a variety of uses, all aimed at improving conservation. In terms of its youth programming, Adopt-A-Pond is educating young people and preparing them for lifetimes of environmental action and stewardship.

Reasons for Success

Collaboration with a number of dedicated partner institutions and enthusiastic volunteers have been the basis for program success. In terms of data collection capabilities, volunteer dedication and its appreciation have been key. Adopt-A-Pond sends annual results, thank-you notes and certificates of participation as a way to show their appreciation to volunteers. The program also organizes an appreciation day for volunteers once a year.

Suggestions for Improvement

One volunteer claims he has been questioned by home owners and police because they found it suspicious that he parked his vehicle on the side of the road and walked around at night. As such, some type of identification showing affiliation with Adopt-A-Pond may be beneficial. Continued promotion and marketing of the program and the data that is gathered by FrogWatch is encouraged so it can become a more widely used body of information.

Some see the lack of employment of the data by decision makers as a flaw of the program. Updated database resources may make the data more accessible and useable in decision-making processes.

Adopt-A-Pond and FrogWatch at the national level are considering updating the data gathering process. They are considering asking volunteers to record additional variables and requiring volunteers to observe in the evening, when frogs are vocally active.

Interviews (6)

Julia Phillips, Adopt-A-Pond (FrogWatch Ontario) Coordinator at the Toronto Zoo
Bob Johnson, Curator of Reptiles and Amphibians at the Toronto Zoo
Louisette Lanteigne, Volunteer from Waterloo
Lynda McLeod, Volunteer from Ajax
Emily S. Damstra, Volunteer from Kitchener
Steve Racey, Volunteer from Elmira

Johanne Ranger, National FrogWatch Coordinator, National Wildlife Research Centre, Environment Canada

Questionnaires (6)

After we sent an e-mail to the volunteers of the Adopt-A-Pond program, some volunteers agreed to respond to questions via e-mail. A short, open-ended questionnaire was distributed and the volunteers sent back the responses electronically. The following volunteers responded:

Nadine Vouriot
John Cree
Darcie McKelvey
Angie Van Puyenbroeck
Alex Angus
Jan Mitton

Sources

Adopt-A-Pond website:
http://www.torontozoo.com/AdoptAPond/

Amphibian Voice (newsletter of the Adopt-A-Pond program), Available online at http://www.torontozoo.com/adoptapond/newsletter/index.html

Environment Canada, Frog Watch,
http://ec.gc.ca/education/default.asp?lang=En&n=02C8BE53-1

APPENDIX 6

PROJECT FEEDERWATCH

History

Project FeederWatch began initially in Ontario in the mid-1970s through Canada's Long Point Bird Observatory. Dr. Erica Dunn established the Ontario Bird Feeder Survey in 1976. The survey ran successfully for 10 years with more than 500 participants. Long Point approached the Cornell Lab of Ornithology to expand the program across North America using the Ontario data and methodology as a starting point. FeederWatchers now represent every state in the U.S. (except Hawaii) and most provinces in Canada. In the past 13 years, the number of citizens involved in FeederWatch has grown to more than 15,000. FeederWatch now connects thousands of bird enthusiasts across the United States and Canada. In 1997 the Canadian Nature Federation and Audubon Society joined as PFW partners.

Types of Monitoring

Project FeederWatch seeks to involve birdwatchers in serious ornithological study; gathering long-term data on winter bird populations; detecting population declines or expansions; tracking the movements of species; identifying habitat features that attract bird populations; and providing direct feedback to project participants and the general public regarding bird population trends.

The survey of North American Birds takes place for 21 weeks between November and April each year. FeederWatch volunteers record the bird species that visit feeders. Volunteers also report rare, sick, or unusual birds. Records of weather and count site conditions are also documented. PFW surveys birds in backyards, nature centres, and community areas. Because PFW counts individual species seen several times and throughout the winter, PFW data is extremely useful for detecting and explaining gradual changes in winter ranges of many species.

Data Collection Techniques

Volunteers are provided with an instruction booklet; a colour poster of feeder birds; a bird watching calendar; tally sheets; data booklet forms (paper version); and return envelopes. The research kits are mailed out in October for the coming winter season. Volunteers first select a feeder watch site (often their backyard) and they choose their feeder watch count days. They then collect the feeder watch data on those days each week and report their data. The bird counts must be done the exact same way to ensure its use in scientific research using tally sheets. Participants must have a valid ID number and be registered for the season to enter and access the data entry section of the website**.** In 1997, online

data entry became available. Volunteers may watch the same sites for many years.

Data Quality Issues

In some regions, particularly in parts of the west, the limited number of participants makes it difficult to follow population changes. Some volunteers may tend to look for and report exceptional numbers and types of birds while not providing complete reports on more common species. Data from a single location or a short-term study can be misleading unless there is comparable data from other areas and other years. But bird counts, whether small or large, are needed for scientific validation. Errors made while entering data can be corrected. There may be issues with limited staff available to provide technical assistance, during peak times. To address issues relating to identification and counts, an automated system asks confirmation of an entry if a report on a species or count is not normally reported by participants in that region.

Data Reporting

The collected data are reported in a variety of formats. There are Regional Roundup Reports that indicate trends and highlights by year. Bird Watch Canada and World Bird Watch put out quarterly issues. The *Winter Bird Highlights* is an annual publication. Bird Studies Canada produces an annual report.

PFW information and results are regularly published in scientific journals; regional birding, garden and nature newsletters; national magazines such as *Audubon*, *Birds World*, *Bird Watchers Digest*, *Birds & Bloom*; and newspapers. The website provides a newsletter and a data trend feature. All feeder watchers can see bird population charts, bird trend graphs, and bird distribution maps. There is an annual *Winter Birds Highlights* publication that is available online which is also the FeederWatch Annual Report.

Data Use

Data from FeederWatchers have helped scientists learn about changes in the distribution and abundance of feeder birds over time; expansions and contractions in their winter ranges; the spread of disease through bird populations; and the kinds of habitats and foods that attract birds.

FeederWatch data from Florida showed that the winter population of the Painted Bunting declined steadily since the 1980s. This information, combined with complementary data from the Breeding Bird Survey led the Florida Game and Fresh Water Fish Commission to begin a systematic monitoring program of bunting populations so they could learn how to protect them.

The FeederWatch website provides many scientific papers that have been written using PFW data. Papers have covered a wide range of topics including: spatial and temporal variation in winter abundance of resident birds; evening

grosbeak populations; competition between house finches and house sparrows; declines of chickadees and corvids as a possible impact of West Nile virus; population cycles in the varied thrush; migration of common redpolls; mycoplasmal conjunctivitis among birds; and spreading of other infectious diseases; predation of birds at feeders; and bird mortality from striking residential windows. These papers have appeared in publications such as *American Birds*, *Canadian Journal of Zoology*, *Ecography*, *Ecology*, *Journal of Emerging Infectious Diseases*, *Journal of Field Ornithology*, *Journal of Wildlife Disease*, *Ontario Birds*, *Proceedings of the National Academy of Sciences of the USA*, *Science Education*, and *The Condor*.

Organizational Structure

FeederWatch is a cooperative research and education project of the Cornell Lab of Ornithology, Bird Studies Canada, the National Audubon Society, and the Canadian Nature Federation. PFW is administered jointly in the US by Cornell and in Canada by Bird Studies Canada. The Headquarters for Bird Studies Canada is in Port Rowan, Ontario, with regional offices in British Columbia, Quebec, and the Atlantic Provinces. There are 15 PFW regions in North America.

Working with Volunteers

PFW uses both volunteers and temporary personnel alongside a scientific team and leaders. PFW volunteers comprise people of all skills and backgrounds, children, families, individuals, class rooms, retired people, youth groups, nature centres, bird clubs, and recently a long-term care facility in the US. Students and seasonal temporary staff process data forms, conduct correspondence via the mail, review comments, and review photos sent in from across North America. In its first 19 seasons, volunteers contributed 1.1 million checklists. Volunteers also help with computer programming and web design.

Volunteer participation usually starts at the membership office. Participants may join at any time of year. People volunteer because they want to contribute to science and are concerned about conservation of North American feeder birds. Participation in the program gives them an opportunity to hear what other participants are experiencing and saying. Seventy of the 2000 feeder watchers in Canada have been monitoring their feeders since 1987.

The program offers minimal volunteer training. The kits are simple and easy to understand and PFW “ambassadors” help with new volunteers. There is also online support. There are additional feeder watch support materials such as information on sick or unusual birds, Frequently Asked Questions, e-mail discussion groups, online access to technical support, and field guides that can be downloaded and are easy to read. The website provides online support, counting instructions, count days, weather data, and a flagging system to help catch data entry errors. There are features to view and manage each volunteer’s data, report rate, sick and unusual birds, and an e-mail discussion group and examples.

Funding

PFW is largely self sustaining, with most of its budget coming from participant fees; it would not exist without the financial support of participants. The cost to participate in the program is $15 in the US and $35 in Canada. Participant fees pay for website maintenance, database system, data analysis, participant support and kits, printing of materials, data dissemination, and a year-end report entitled “Winter Bird Highlights.” There are several government foundation and corporate sponsors and donors to Bird Studies Canada. There are also individual donors.

Interviews (8)

Patrick (New Brunswick Volunteer)
April (British Columbia Volunteer)
Hugh (Ontario Board Member)
Martin (Ontario Volunteer)
Kerry (Ontario Administrator for PFW)
Janet (New Brunswick Volunteer)
Gord (Ontario Volunteer)
Rob (Ontario Volunteer)

Sources

Bird Studies Canada website: http://www.bsc-eoc.org/

Cornell Lab of Ornithology website:
https://secure3.birds.cornell.edu/NetCommunity/SSLPage.aspx?pid=1696

Project FeederWatch website (Canada):
http://www.bsc-eoc.org/volunteer/pfw/index.jsp?targetpg=index&lang=en

Project FeederWatch scientific papers:
http://www.birds.cornell.edu/pfw/News/ScientificPapers.htm

APPENDIX 7

H_2O CHELSEA

History of the Organization

In keeping with the municipality's history of environmental initiatives, the H_2O Chelsea program was developed in 2003 as a precautionary measure, using a monitoring program developed by professors and graduate students from the University of Ottawa. The initial idea stemmed from an NGO, Action Chelsea for the Respect of the Environment (ACRE), which sought to engage the local community in water issues, because Chelsea is on a well system.

The municipality of Chelsea was receptive to the notion of monitoring water quality and developed the program with the notion that, if it proved successful, the municipality would adopt the program as their own. The municipality did adopt the program as their own in 2008. Following the transfer, some of the sampling parameters and some of the monitoring sites were cut. As such, while boosting the chances of program longevity, some parameters and sites were sacrificed in the process. At the same time, growth and expansion beyond the current scale are no longer priorities of the program.

The objectives of the program are: 1) to provide municipal decision-makers with current information on the state of ground and surface-water quality and quantity that they can use to inform their decision making; 2). to generate a spatially explicit baseline water quality/quantity electronic database that can be used for scientific research on the impacts of human activities on Chelsea's water resources, and that also can be integrated with existing monitoring networks at provincial and federal levels; and 3) to provide residents, public institutions, and businesses with the opportunity to participate in water monitoring and stewardship in their own community. As a result of all the program's efforts and successes, the Municipality of Chelsea was awarded the Sustainable Community Award' in 2006 by the Federation of Canadian Municipalities ' for the H_2O Chelsea project.

Types of Monitoring

H_2O Chelsea uses a three-tiered approach to monitor surface and groundwater quantity and quality, and partakes in the three community based monitoring programs outlined below. In these programs, H_2O Chelsea acts as a facilitator between the community and laboratories. By testing through the program, the community pays lower prices for testing through subsidized and group rates.

Static Level Program: Monitoring static levels in wells indicates fluctuation in the surrounding groundwater levels. Tracking these levels over time provides information about whether water tables are rising, falling or staying the same.

The program consists of two parts: the Intensive Static Program and the Volunteer Static Program. For at-risk areas, a static-level coordinated has been employed to monitor well-water levels. Meanwhile, the volunteer program recruits community members to monitor their own wells or those of neighbours.

Lake Programs: The program monitors the water quality of Beamish, Kingsmere, and Meech Lakes once per month. The samples are returned to the municipality after data collection and are transferred to various laboratories for analysis. The lake program analyzes bacteria, nutrients, conductivity, temperature and dissolved oxygen, anions, chlorophyll, and Secchi depth.

Stream Programs: Stream monitoring is done from May to October. There are 38 stations monitored in total, along the Meech, Chelsea, Fortune, and Hayworth creeks. The stations are monitored five times during the sampling season. The samples are returned to the municipality and the samples are transferred to various laboratories for analysis. The Stream Program analyzes bacteria, nutrients, cations, total suspended solids, water temperature, and weather.

Lake and stream programs monitor the quality and quantity parameters of local lakes and streams to determine what effects human activity and natural events are having on the health of these lakes and creeks, locate areas at risk, and develop conservation and mitigation strategies.

Data Collection Techniques

Lake sampling equipment used by the program includes a dissolved oxygen/temperature metre, a Secchi disk, and a pH/TDS/electrical conductivity meter. The sampling kits for the monitoring wells include bottles, instructions, and forms. The Van Dorn sampler can collect water samples at specific depths and multi-probe meters enable one to collect field measurements of parameters such as electrical conductivity, pH, total dissolved solids, temperature, and dissolved oxygen. Creek sampling equipment consists solely of water bottles for the water samples. Lake sampling requires access to a boat and related safety equipment. Either a rowboat or a canoe is, in fact, preferred for smaller lakes. Stream monitors receive their kits during the training session. Lake monitors pick up the kits on Friday, do the monitoring on Sunday, and return the kits on Monday. The lake monitoring kits are more expensive, so there are fewer of them.

Monitoring one of the lake sites takes 2 to 3 volunteers between 10 and 40 minutes, once a month. Monitoring one H_2O Chelsea stream site takes one volunteer between 5 and 10 minutes, also once a month.

Data Quality Issues

The program has a number of Quality Assurance/Quality Control protocols to run on the data in order to pick up skewed values. Most issues are with the nature of sampling. Not all errors can be detected, however, and in some cases it is necessary to go back and refer to the raw data when issues arise in the annual

analysis. Generally, mistakes in data are easily spotted and can be simply removed or included in the sample. Field notes may explain why a sample was skewed and these explanations can be noted with the data. Budgets do not allow for re-sampling, but the simplicity of the monitoring process generally does not result in data quality issues.

Data Reporting

The residents of Chelsea receive the results and other relevant information about water quality and quantity through information kits sent to every household and business, a program for water conservation in schools, and information available on the program's and municipality's websites. The group also provides information stands at local events, publishes updates in municipal and local newspapers, makes public presentations, including at annual general meetings (open to the public), Municipal Council meetings, and Lake Association meetings. Volunteers receive copies of the data.

Data Use

The use of groundwater data is limited because it is confidential. The lake and stream data is public so that is used more often.

The monitoring of the lake and the data gathered from the lake encouraged one of the volunteers interviewed to submit a (successful) proposal into Environment Canada in 2008 to build a buffer zone around the lake. The program was also able to supply baseline data to a PhD student testing a well-sealing method. In Farm Point, the north part of Chelsea, the data suggested that something was happening to the creeks. It turned out that there was a problem with the septic systems. In response, a water treatment system was established.

The program does not impact decision making at the provincial and federal levels because the H_2O Chelsea data are not used beyond the municipal level. For example, Chelsea developed a unique program that is put in place when there is a proposal to build new houses. This program stemmed directly from the H_2O Chelsea well-monitoring. The municipality seriously considers the recommendations that are produced in the annual reports. They also do all they can to implement these recommendations (Interview #5).

Organizational Structure

H_2O Chelsea is a partnership program between the Municipality of Chelsea and the University of Ottawa's Institute of Environment and Action Chelsea for the Respect of the Environment (ACRE). ACRE is a non-for-profit, non-governmental organization incorporated in Quebec in 2000 with a mission to promote the protection and understanding of ecological integrity in the area. Collaboration between the University of Ottawa and ACRE has helped Chelsea not only to develop a well-designed and executed program but also to apply for funding.

Working with Volunteers

Some volunteers were initially hesitant to become involved for fear of impact on future decision making, particularly regarding property sales. As confidence grew, the program reached a plateau of volunteers and now continues to recruit, but only minimally.

Since the start of the lake and stream-monitoring program, the program has welcomed between 10 and 20 volunteers each year. Numbers have decreased since the beginning, because water quality has improved and stabilized; as a result, enthusiasm has waned somewhat. There are also fewer sampling sites now, which means fewer volunteers are needed. Those who do volunteer are dedicated and return to the program, a contrast with the former large numbers of short-term volunteers leading to a high turnover rate.

The program takes advantage of Chelsea's Youth Summer Co-op, where they sometimes hire a few students for sites that have little or no volunteers. In the past, University of Ottawa students have done monitoring and, in turn, received the data for their own research.

Volunteers benefit from hands-on experience in water resource research, contributing to issues they care about and which often impact the water near their homes, the opportunity to be outdoors, and community togetherness when facing environmental issues.

Training of Volunteers

H_2O Chelsea volunteers receive relatively simple sampling training, including the use of monitoring equipment and safety precautions. Sampling kits are given out to stream sampling volunteers, and the equipment in the kits is explained. The sampling protocols are read through, maps are distributed, and reporting procedures explained. Teams are instructed in how to get to their sites, and the sampling schedule is discussed. When asked whether the volunteer training techniques have been useful, all those who participated in this study claimed there was no problem with the training sessions and that the monitoring is easy to do.

Funding

To date, H_2O Chelsea has acquired over $397,000 in funding, including $150,000 from the Fonds d'action québécois pour le développement durable (2004–2005), $40,000 from the North American Fund for Environmental Cooperation (2003–2004), $100,000 from the Municipality of Chelsea ($20,000 a year from 2003 to 2007), $70,000 from the CLD des Collines de l'Outaouais'(2006–2007), $25,000 from the Walter and Duncan Gordon Foundation (2006), and $12,000 from Environment Canada's Ecological Monitoring and Assessment Network (2006). Because the program is now run by the Municipality of Chelsea, it is the

municipality that funds the program entirely. The program does continue to receive in-kind donations from various sources, including ACRE and the University of Ottawa.

Successes

The Chelsea H_2O program has had a direct impact on municipal decision making; for example, the government action taken when the presence of cattle led to the deterioration of a Meech creek.

Another illustration of the program's success is the fact that H_2O Chelsea is becoming the model for a water-monitoring program. Other municipalities in the area are adopting the program. Mayors have been enthusiastic, despite the hesitance of some municipal employees who question the availability of resources and expertise. Chelsea coordinators are confident that, with time, others will discover the ease and simplicity of the program.

Reasons for Success

In-kind donations such as volunteer hours, services and scientific equipment provided by volunteers, the University of Ottawa, ACRE members and local businesses are very important to the success of the program. In addition, because it is a smaller community, Chelsea can make water its priority, whereas bigger cities might prioritize other services, such as transportation.

Suggestions for Improvement

Some feel the provincial and federal government, in addition to providing funding, should take a more active leadership role through assistance in developing protocols, working with the equipment and analyzing the data. One volunteer mentioned that the annual reports are sometimes a little confusing. He wants to know simply whether the lake he monitors and lives near is in good condition. It is sometimes difficult to find a simple answer among all the scientific analysis. As such, the program may be improved through more user-friendly reports.

Interviews (5)

Isabelle Pitre – H_2O Chelsea Coordinator
Murray Esselmont – Lake Monitoring Volunteer
Stephan Moresoli – Creek Monitoring Volunteer2
Scott Findlay – Science Director
Patrick Henry – Former H_2O Chelsea Coordinator

Questionnaires (1)

Charles Lacombe – Lake Monitoring Volunteer

Sources

H_20 Chelsea website: http://www.h2ochelsea.ca/

Lake Sampling Protocols: The how-to document that details the lake sampling process.

Lake Depths and Analytes: Chart that demonstrates what samples are taken and at what depths.

Lake Data Sheet: The sheet our volunteers use to record information during their sampling outings.

Beaufort Sky and Wind Codes: Chart that provides codes for weather observations

Stream Sampling Protocols: The 'how to' document that details the stream sampling

Stream Data Sheet: The sheet our volunteers use to record data and observations during their sampling outings.

Beaufort Sky and Wind Codes Chart: The chart provides codes for weather observations.

Static Level Protocols: Steps to follow for sampling.

Static Data Sheet #1: Bilingual form used to record static level sampling data during the first measurement of the season.

Static Data Sheet #2: Bilingual form used to record static level sampling data for the rest of the season.

APPENDIX 8

SURVOL BENTHOS

History of the Organization

The SurVol Benthos program is a Quebec initiative created by two organizations. The first is the Groupe d'éducation et d'écosurveillance de l'eau (G3E) or the Education and Water Monitoring Action Group. This group was known as the Comité de Valorisation de la rivière Beauport (CVRB) until July 2009, and some of its documentation still refers to the CVRB. The second initiating group is the Direction du suivi de l'état de l'environnement (DSEE) or State of the Environment Directorate of the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP) or the Ministry of Sustainable Development, Environment, and Parks. The SVB program is aimed at organizations wanting to evaluate the health of their water. SVB is coordinated by the G3E group and works mostly through Comités de Bassins Versants (Watershed Committees) from around the province, who work with volunteers to undertake the monitoring.

This case study is based on the SurVol Benthos program as it has been implemented by the Comité de Bassin de la Rivière Etchemin (CBE). CBE is located in Saint-Anselme, in the Etchemins Municipalité Régionale de Compté (MRC). The Etchemin River flows into the St. Lawrence River at Lévis, Quebec. CBE was founded in 1999 to respond to the degrading water quality of river. Its mission is to promote and supervise the implementation of sustainable and integrated watershed management across the watershed of the Etchemin River (CBE, 2010).

At the provincial level, the idea for SurVol Benthos started in 2002 when the CVRB (now G3E) realized that there was a demand by adults to expand on the school-based monitoring program, *J'adopte un Cours d'Eau* (Adopt-a-River). They met with the MDDEP to see if data from that program could be used, and they found out the methodology was not strict enough. CVRB (now G3E) and MDDEP worked closely together to create a new program, with the NGO making sure the developing methodology was workable for volunteers and the Ministry building tools (identification keys and manuals) in French (Gagnon, personal communication, 03/05/10; Pelletier, personal communication,10/05/10).

The Comité de Bassin de L'Etchemin (CBE) was one of the first two watershed committees to be approached by CVRB (now G3E) to pilot the new program and specifically its new training and field support arms, in 2005 (CBE, 2010). The CBE at the time monitored one station near Saint-Lazare on the Abénaquis river. As this was a station previously monitored by the MDDEP, the goal of the exercise was to see if volunteers could obtain comparable results. The exercise was successful (Rouillard, personal communication, 04/05/10). Then, the CBE

spoke to three other watershed committees and worked with CVRB and MDDEP to obtain a funding grant from Fonds d'action québécois pour le développement durable (FAQDD). The response was positive. The first public training with an exam leading to certification was then held jointly by CVRB and MDDEP with two groups of 15 in Québec City, including representatives from CBE.

SurVol Benthos was intended to educate and inform volunteers and their community on the protection of rivers and riparian ecosystems; to support sustainable development and the protection of natural habitats and the riparian ecosystem; to enable participating organizations to access a high quality, simple, and inexpensive methodology to evaluate the health of aquatic ecosystems; and to collect reliable data on the health of small streams in Quebec and make it available to the public as well as to scientists and policy-makers (CVRB, 2006).

Types of Monitoring

The SurVol Benthos program monitors benthic macro invertebrates (BMIs) as well as the quality of the shoreline and the quality of the habitat.

Data Collection Techniques

Once a year in the fall, volunteers go into the river at designated stations and gather a sample of BMIs by stroking a net 20 times on the bottom of the river. The BMIs are dislodged by rubbing the rocks upstream. During this stage, CBE staff support volunteers in completing information sheets on the habitat and drawing the shoreline. They then perform an initial cleaning of the sample. Large debris is removed to reduce the size of the sample and avoid damaging BMIs during transport, The samples are then sorted and stored. In the laboratory, a more comprehensive clean-up of the sample is done to remove more debris and coarse material and eliminate alcohol.

Over the winter, volunteers work on identifying the BMIs . Splitting reduces the number of BMIs by randomly selecting a portion of the sample. Using a stereomicroscope, volunteers have to count a minimum of 200 BMIs for the sample to be valid. Volunteers use identification keys to identify BMIs. The data reported covers up to the family taxonomic level using the *Guide d'Identification*. A calculated index, the Indice de surveillance volontaire du benthos (ISVB), is the ultimate result. The ISVB is a weighted average of six indicators taken from the volunteers' inventory sheet and consists of a number out of 100. A score below 50 is considered poor, 50–64.9 is marginal, 65–80 is sub-optimal and over 80 is optimal. There is also an index for the quality of the shoreline and one for the quality of the habitat, based on worksheets filled by volunteers in the field. Table 5 depicts the ISVB in stations monitored by CBE from 2004 to 2008, and shows the improving condition of the Abénaquis river station.

Table 5: ISVB results for stations monitored by CBE from 2004–2008

Station	Year			
	2004	2005	2006	2008
ETS01	88.53	n.a.	n.a.	n.a.
ABEN01	84.28	91.47	92.60	n.a.
BRAS02	n.a.	n.a.	n.a.	69.56
BRAS03	n.a.	n.a.	n.a.	66.47
BRAS 04	n.a.	n.a.	n.a.	66.75

Two reference stations with good conditions were sampled originally (ETS01 and ABEN01).e There was no sampling in 2007 because the Executive Director was on maternity leave. Also, because funding for the Le Bras Amont Project came late in 2007, monitoring focused on stations along the Bras river (BRAS02, BRAS03 and BRAS04) whose water quality is significantly lower than other stations. In 2008, CBE worked on stations in the Bras river, and in 2009, they worked on two stations— one in the Pénin River and one in the Alassis River. It takes, on average, about 35 hours of overall coordination for the SVB program, as well as one week of work for each station (Brochu, personal communication, 04/05/10).

Several tools and documents for the use of partner organizations and volunteers are available. These include a Volunteer Guide and a general identification key of freshwater benthic macro invertebrates (see Sources for a more complete list of documents and links).

CBE has purchased the SVB Kit available for sale from G3E. It includes a box, 2 Bogorov sorting trays, 2 divided Petri dishes, 6 pipettes, 2 flexible clamps, 2 hard clips, 6 yellow pots, 2 washing bottles, 50 vials, 2 vials racks. 50 vial labels, Nalgene Paper, a pair of yellow gloves, a bucket and sieve, and a thermometer and its protector. The CBE also had to separately purchase nets (mesh 500 micron), a disposable plastic pipette, coliplates, and fishing boots, and announce to volunteers that they should wear comfortable, warm, and waterproof clothing and footwear(G3E, nd). The use of a microscope is essential for SVB. CBE is contemplating buying its own, but is at the moment renting an equipped facility (with sinks, etc.) from CÉGEP de Lévis-Lauzon for about three weeks a year. This arrangement is not fully satisfactory as this year the CBE almost didn't get access to the labs (Gravel, personal communication, 04/05/10).

Data Quality Issues

At the G3E level, it is accepted that volunteers can collect reliable data. There is a 95 to 96 percent rate of successful organism identification by watershed committees. There have been a few issues with the identification of ephemeroptera, which are the most difficult order to identify. As a result, G3E

and MDDEP have focused their training and support on that order. Also, sometimes volunteers may have difficulty identifying certain types of insects, especially the small transparent ones that are hard to see. Once again, with in-lab support offered to partners, this situation has been corrected. Materials have also been adjusted to facilitate sorting.

It has also been difficult to schedule all the people involved (staff from G3E and CBE plus volunteers) to always ensure on-the-ground support. This difficulty is exacerbated by the fact that one cannot sample for a week after heavy rains. This has been addressed by allowing organizations like CBE to become more and more autonomous over time (Gagnon, personal communication, 03/05/10).

At the Ministry level, no issues with the data quality and consistency have yet been identified. This could be because the program is still in its development phase, and most partners are asked to use reference stations, that is, stations in which they don't think the habitat is negatively affected. This is also due to the big emphasis put on quality control, through the validation of samples by CVRB. This has resulted in the ISVB and the Ministry's scientific index being highly comparable (Pelletier, personal communication, 10/05/10).

Data Reporting

CBE sends in the various working sheets to G3E along with all their samples. A certified person adds their signature to indicate that the methodology was followed correctly. Internet working sheets linked to a web portal are under development. Because of its scientific accuracy and the uniform character of the methodology, data collected are transmitted to the Direction du suivi de l'état de l'environnement (DSEE) of the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP). This community-based monitoring will help research on reference stations and allow shedding light on certain regional issues (CVRB, 2006). Collaboration with the MDDEP has been exemplary given the good fit between the mandates of MDDEP, CVRB and CBE; the Minister in fact came to the launch of SVB (Pedneau, pers comm., 09/04/10). Data is also used by watershed committees such as CBE.

Data Use

CBE will be using the ISVB obtained from SVB in writing the Water Master Plan for the Alassis watershed, on which they have just gained jurisdiction, and in updating the Etchemin Watershed Master Plan. They have also used it for a report on water quality and predict it will be used in proposals for projects in certain areas of the watershed. MDDEP also uses that data in their yearly report on BMIs. The SVB is of great benefit to the Ministry, which monitors stations across Québec itself, but sees its database expanded greatly through the work of SVB partners.

The data hasn't been extensively nor externally used given that the program is still in its early stages. Data is not publically available yet, but it is used for

monitoring and raising “red flags”. The close collaboration between the different partners – CBE, G3E and MDDEP – allows for synergies to occur. For example, CBE was once asked by MDDEP to monitor one of the stations in Le Bras, because of concerns over water quality. Elsewhere in the province, especially in the Matapédia watershed in Bas St-Laurent, the SVB methodology was used by researchers to tackle the problem of proliferation of the *Didymosphenia geminate* algae.

It is deemed too early for data to have influenced decision making in CBE; once they use more stations, it could have more influence, which is what is hoped for (Pelletier, personal communication., 10/05/10). Ultimately, reports on data collected are viewed as a management tool (Pedneau, pers comm., 09/04/10). It could be more used for yearly water monitoring, to demonstrate negative impacts of certain landscaping activities and pollution to put pressure to correct the situation, and to measure and underline the improvements in water quality or habitat after applying certain measures such as shoreline stabilization, etc. (CVRB, 2006).

The G3E (2010) is optimistic that, given the high interest in the program by watershed committees and its growing number of participants, more and more streams will be monitored across the province and knowledge on health of small streams will be greatly improved. The impact of the data goes with the extent of its diffusion. At the moment the CBE talks about BMIs in presentations to community and school groups and wishes to use it more to encourage behavioural change among agriculturalists.

Organizational Structure

CBE has a staff of five people: two certified staff members, and a third staff member who has taken the CVRB training. CBE has an average of about 3 volunteers per year for SVB, some of them choosing to work in the field and/or in the lab (Gravel, personal communication, 04/05/10). Staff and volunteers share the work for SVB; volunteers are involved in the hands-on aspects of the program (sample collection, filling out habitat description worksheets) and in the sorting and identification of BMIs, and the staff organizing logistics around field and lab timing, double-checks BMI identification and sends in inventory sheets and samples to G3E. The CBE is active in several projects in addition to Sur Vol Benthos. Other projects include a signage project to physically indicate the boundaries of the watershed, a water sanitation project in the Le Bras river surrounded by agricultural land, and Escouades Lacs, a research project to solve the issue of cyanobacteria through landscaping of the banks around the Etchemin Lake.

Working with Volunteers

The vision in 2006 was for watershed committees to recruit volunteers and have them do all the sampling and lab identification with support from a trained person, perhaps one of the staff or volunteers who had taken the annual three-day free

training offered jointly by CVRB and MDDEP and had passed the exam. It was soon found that the best way to maintain the program was with a small number of volunteers (2 to 4), and to keep the program flexible. As such, formal demands on volunteer management by G3E onto watershed committees were kept to a minimum so that each watershed committee can use the program to suit its needs (Gagnon, personal communication, 03/05/10). As such, CBE has consistently been using an average of 3 volunteers per year for SVB. The CBE chooses to work with volunteers because they want to increase involvement and interest in water quality issues. Having the public see firsthand the state of their shorelines and what species are in their streams raises public awareness and sense of responsibility.

There are many reasons why volunteers volunteer. “[F]or some, it’s curiosity, the desire to be involved in environment-related programs, an attachment to the organization... it’s often people who are already aware, have an interest for streams and nature and they want to get involved” (Gagnon interview). Some do it to get a volunteer experience on their CVs, some because they are fly-fishers and want to learn more about their sport, some because they want to know more about how water quality is determined, some live or know people who live near the station and want to raise awareness on those issues. All believe in the cause and want to learn and improve the situation. Some also want to encourage the organization because they know it’s difficult to recruit volunteers. CBE adapts their program to let the volunteers engage in the aspects that are of most interest to them.

Volunteers are recruited in many ways: sometimes they are colleagues from CBE in another sector, people from the board, people recruited through ads in the newspapers, or retired people. CBE sends a lot of email and relies heavily on their social networks and word of mouth to recruit people, as it is not always easy given the low population in the watershed.

Advantages of working with volunteers include the pleasant dynamic, the time saved on sorting BMIs, having free labour and meeting very passionate, nature-loving people. Some disadvantages are that it sometimes takes more time, work and coordination, it is hard to make schedules match and it sometimes requires more supervision because of the highly specialized nature of BMI identification.

Training of Volunteers

Annual training has been given each May since 2006. It is designed to improve knowledge about biological monitoring, on the implementation of the SVB program and identification of BMIs. In addition, various aspects of the program are explained in detail and practical workshops in the field and laboratory are given. Attention is paid to the identification of BMIs due to its level of difficulty and importance. At the end of this training, participants can pass a certification exam on their identification skills (G3E, 2010). MDDEP also encourages permanent

staff to undertake the training. At CBE, certified individuals work closely with volunteers to share their knowledge, and Jonathan Pedneau from G3E comes yearly to give a more in-depth training to CBE volunteers on site in Saint-Anselme.

Volunteers are very satisfied with the training they receive. They say it is simple enough that even someone with no background in biology can do well. There are big pictures on slides of BMIs, which makes it easier to make identifications. Trainers and CBE staff were described as approachable, very welcoming, passionate, and good pedagogically. Volunteers didn't feel like they were forced to do anything and felt free to ask many questions, on such things as the usefulness of the program and its weight in influencing decision making.

Funding

As a provincial program SurVol Benthos has a number of partners who provide informational, logistical and financial support. The main partners are set out in Table 6.

Table 6: SurVol Benthos Partners

Partner	Type of Partnership
Ministry of Sustainable Development, Environment and Parks (MDDEP)	Developed the program with the CVRB and offered scientific support and logistics
Québec Action Fund for Sustainable Development (FAQDD)	Financial support (through Actions for sustainable development program)
The Biosphere of Environment Canada	Educational and financial partner of the project.
City of Québec	Financial support
Ministry of Employment and Social Solidarity	Financial support through Career Focus Program
Regional Environment Council – National Capital Region	Financial support through Objective: Career of Ministry of Human Resources and Skills Development Canada
Shell Canada Limited	Financial support through the Environmental Fund Shell
Environment Canada	Financial support
Source: CVRB, 2006	

The funding has allowed G3E to offer its services to CBE for free up to now. CBE still incurs costs for running the program, mostly in the form of staff time. It doesn't have external grants for that, and as such the money is taken from its regular operating budget.

Conclusion

Staff expressed the belief that BMI monitoring generally is an underused tool in Quebec; there is a focus on the physicochemical analysis and the biological aspect is left aside. People need to understand the importance of it as a tool and the relevance of developing bio-criteria for water quality. There has been some shift of perception in ministries, companies, municipalities, and there is now a broader range of indicators that are used to measure water quality. It would also be useful for the MDDEP to publish summaries for each watershed, especially because community-based monitoring makes it possible to raise the public's environmental awareness. Hopefully, this will come in the near future. It would also be helpful to have a sharing session with all watershed committees involved to exchange information and best practices on the implementation of SVB. It was also stressed that for new programs it will be important to consider from the outset how the program will finance itself.

Volunteers suggested how important it is to keep the program as simple as possible to facilitate volunteer recruitment and to be flexible about the tasks volunteers are asked to perform. Training, coupled with validation to ensure the accuracy of the data, was considered particularly useful. An online volunteer database was suggested to allow volunteers to work with different committees according to their availability. It would be good to have more volunteers, in small groups, to allow them to develop a network. For example, it would be nice to work with other families. Involving students from CÉGEPs might encourage them to get involved with watershed committees back home. Improved communications and networking might involve more residents of the shoreline as volunteers. Giving volunteers something like a participation certificate to take home would also raise the CBE's profile and support expansion of the program.

Interviews (8)

Matthew Audet, Volunteer
Véronique Brochu, Technician at CBE and Volunteer
Éric Gagnon, Biologist and SVB Coordinator at G3E
Steve Gamache, Environment Assistant at CBE and Volunteer
Véronique Gravel, Biologist at CBE
Héloïse Hotton, Volunteer
Lyne Pelletier, Biologist at MDDEP
Carole Rouillard, Executive Director at CBE

E-mail Communication (1)

Jonathan Pedneau, Biologist at G3E

Sources

CBE, Comité de Bassin de la Rivière Etchemin website: <http://www.cbetchemin.qc.ca/>.

CBE, Comité de Bassin de la Rivière Etchemin. 2010. Son Histoire, Retrieved May 14th, 2010, from: <http://www.cbetchemin.qc.ca/index.php?option=com_content&view=article&id=55&Itemid=59>.

CVRB, Comité de valorisation de la rivière Beauport. 2006. SurVol Benthos : Guide du Volontaire. (Volunteer Guide) Retrieved May 14, 2010, from: <www.cvrb.qc.ca/documents/doc_final_volontaires.pdf>.

G3E. Groupe d'éducation et d'écosurveillance de l'eau (nd). Bon de commande. ,(Scientific material price list). Retrieved May 14, 2010, from: www.pjse.ca/documents/benthos/bondecommande_SURVOL2009.pdf

G3E, Groupe d'éducation et d'écosurveillance de l'eau. 2010. SurVol Benthos : Bilan 2006-2008. Rapport présenté au ministère du Développement durable, de l'Environnement et des Parcs. January. Québec City, Québec.

Les Etchemins (map) Retrieved May 16, 2010, from: <http://fr.wikipedia.org/wiki/Les_Etchemins>.

Les Etchemins Watershed (map). Retrieved May 16, 2010, from: <http://www.cbetchemin.qc.ca/index.php?option=com_content&view=article&id=48&Itemid=2>.

MOISAN, J. et L. PELLETIER. 2008. Guide de surveillance biologique basée sur les macroinvertébrés benthiques d'eau douce du Québec – Cours d'eau peu profonds à substrat grossier, 2008. Direction du suivi de l'état de l'environnement, ministère du Développement durable, de l'Environnement et des Parcs. Retrieved May 16, 2010, from:<http://www.mddep.gouv.qc.ca/eau/eco_aqua/macroinvertebre/surveillance/benthiques.pdf>.

APPENDIX 9

COMMUNITY AQUATIC MONITORING PROGRAM (CAMP)

History of the Organization

In 2003, various sections from Stewardship and Environmental Science in the Department of Fisheries and Oceans (DFO) Gulf Region and from the Oceans and Science Branch collaborated to develop a monitoring program that would assess the health and productivity of estuaries and coastal shorelines across the southern Gulf of St. Lawrence. The new program, Community Aquatic Monitoring Program(CAMP), was to satisfy Canada's Oceans Strategy (2002).

CAMP began as a pilot program to raise awareness about the estuaries and coastal areas in the southern Gulf of St. Lawrence (sGSL), and to collect baseline data on coastal species and develop indicators of environmental health. By 2007, the program included various monitoring sites along the Gulf of St. Lawrence from northeastern New Brunswick to Mabou, Nova Scotia, and to Prince Edward Island. CAMP works with local communities throughout the Gulf region to help them monitor the health [of and?] productivity of local water ecosystems. CAMP provides baseline data necessary in monitoring and assessing changes in the estuaries, identifying causes, and developing remedies for the negative impacts.

CAMP promotes stewardship, public awareness and partnership with local communities to "establish marine environmental quality guidelines, objectives and criteria respecting estuaries, coastal waters and marine waters."

The primary goal of the program is to test the hypothesis that there is a relationship between the state of an estuary or shoreline and the diversity and abundance of finfish and crustacean species that inhabit the shoreline. In other words, estuaries that have been tarnished by human activity may have fewer species or fewer individuals of certain species or more of other species than an undisturbed estuary.

CAMP was officially launched in 2004. During its pilot phase, the program had four monitoring sites: both Lameque Bay and Shediac Bay estuary in New Brunswick, Antigonish Harbour in Nova Scotia, and Basin Head in Prince Edward Island (PEI). In 2004, the number of sites increased to 24 and by 2009, the number of sites had increased to 35. Roland Cormier, one of the CAMP directors, would like to increase the number of sites to match the number of estuaries in the southern part of the Gulf of St. Lawrence.

Types of Monitoring

CAMP aims to provide local communities and environmental groups with a practical set of tools and methods for monitoring estuaries and for understanding

their local water ecosystem. The information gathered can then be used to make necessary decisions regarding the estuary.

Data Collection Techniques

From May through to September, staff and volunteers collect daytime data on estuaries. They sample six stations per month around their designated site or an entire estuary. All species of finfish, crabs, and shrimp are collected, identified, counted, separated into young and adults, and then released. Habitat data such as water temperature, salinity, dissolved oxygen, cover of plants and algae and substrate grain size, moisture content, and organic content are also collected.

CAMP uses monitoring programs that were established by the DFO. This helps to maintain a scientific standard for the monitoring of watersheds throughout the Gulf Region. Every site utilizes the same sampling methodology and protocols. Monitoring materials include seines, fish tubs, clipboards, identification guides, dip nets, multi-function meters, quadrants, garden trowels, Ziploc bags, data sheets, water bottles, sampling permits and small coolers.

The fish, crustaceans, and invertebrates are caught during daytime using a 30 x 2m beach seine to sample an area of water measuring 225m^2. The methods employed help to collect the following information and data: fish and crustacean species and numbers, water temperature, salinity, dissolved oxygen and nutrient concentration, general aquatic vegetation profiles, sediment, water samples, and mycrophytes.

Once a year, in the month of September, samples of substrate are also taken to measure grain size distribution, percentage of moisture content, and percentage of organic content.

Data Quality Issues

The three stages of the data collection process that entail the most problems occur during beach seining: net snagging, abundant plant debris, and very large numbers of fish. For the most part, the identification of fish or crustaceans is not an issue. The volunteers are trained in proper identification and receive the CAMP identification guide. In instances of confusion, additional training, identification guides and the presence of DFO staff during the monitoring help resolve these issues.

Additional problems faced by CAMP have included the freezing of water samples during transport, questions of absolute and relative measures of data, potential insignificance of water samples that are not filtered, and discrepancies in approaches between data analysis locations.

CAMP has developed a variety of strategies for dealing with issues as they arise. Additionally, because CAMP is concerned with data quality, they performed a

quality assurance check by recounting the results obtained by community groups for a particular sample. There was a very high agreement.

Data Reporting

The results of the 2003 pilot phase of CAMP were published as a Master's thesis in 2006. Annual reports are published summarizing results. Annual reports are available for the years 2004, 2005, 2006, and 2007. These reports are made available on the website. Coordinators of the local community groups also received hard copies of the annual reports.

Over the years, many working materials have been prepared to help the program evolve. The working materials include an identification guide on fauna (fish, crab, and shrimp), an SAV dichotomy key, and a document describing the life history of each species.

Since 2007, raw data have been entered into a website called Smart Watershed and Coastal Communities Portal that is maintained by the Collectivité Ingénieuse de la Péninsule Acadienne (CIPA). Once the data are entered into the portal, the information is made available to the coordinators of the local community groups. All the coordinators have access to all the raw data from all community groups.

Data Use

Community groups use the CAMP data as baseline information about their estuaries and coastal shorelines. Some include the data in their monthly newsletters, make the data available to other partners, and incorporate the data in other projects. Within the DFO itself, the CAMP data are used by the species-at-risk (SAR) group, the habitat group, the oceans group, as well as the science group. CAMP data helped provide the baseline data on SAR for a 2009 report, specifically the data on young striped bass. The data were also used to help determine the impact of development projects on fish habitat, and to monitor the spread of green crab, an aquatic invasive species (AIS).

The data received from the local estuaries is shared with universities and government agencies. Researchers perform various types of analyses on the data including nutrient analyses, organic loading assessments and helps them better understand the changes in the aquatic community. CAMP staff, the Southern Gulf of St. Lawrence Coalition on Sustainability (the "Coalition") and some local coordinators met in March 2010 to address the question: Can CAMP be used to infer the ecological health of bays and estuaries in the southern Gulf of St. Lawrence? A final document was produced as a result of the meetings and was presented to the Canadian Science Review.

It is hoped that CAMP data will be used for more effective decision making in the short term, particularly at the local level. In addition, there is the suggestion that in the near future scientific reports may be produced from CAMP data.

Organizational Structure

DFO scientists coordinate data acquisition. DFO staff also provide training, in-kind material support in the form of nets and meters, and in-depth analysis of the data. Local efforts and volunteer recruitment are carried out by partner community groups.

Working with Volunteers

In 2009, there were 29 local community groups partaking in CAMP monitoring. In total, 117 individual volunteers worked for CAMP. In some cases, local communities monitored more than one site and two community groups worked together to monitor one site. Volunteers participate in field sampling, data collection and transfer to DFO. For beach seining, five volunteers are ideal. With fewer volunteers, counting and recording is difficult and with more volunteers, some simply become observers.

For volunteers, the benefits include learning about species and estuaries, spending time outdoors, having the opportunity to gather data in the coastal environment, participating in the community and involvement in important issues, and the possibility of securing future funding for their local community groups.

Training of Volunteers

CAMP combines both theoretical and practical aspects in their training of volunteers. The theory aspect is covered in a one-hour presentation, which includes information about the background of CAMP, the methodology, an introduction to the equipment, how to use the data collection sheets, and a review of the identification of species. The practical aspect of the presentation covers training in the use of equipment, sampling techniques, and identification of fish, crustaceans, and plant species and involves an on-site data collection session. Volunteers are also given an identification guide of fish, crustaceans, and plant species. Feedback on training processes has been largely positive.

Funding

CAMP receives funding annually from the Oceans division of DFO . DFO funding ($25,000 annually) is also provided to the Coalition to carry out various projects for CAMP, such as hiring summer students and renting vehicles. DFO purchases all the equipment and provides expertise and training to the local community groups. In 2007 and 2008, the Coalition gave the community groups an honorarium: $250 each in 2007, $1,000 each in 2008 and $2,000 for those sampling two sites. Due to lack of funds, honorariums were not distributed in 2009.

Successes

CAMP is a great example of a government agency, in this case the DFO, working in partnership with the local community. This relationship has increased public

awareness of and outreach for developing stewardship of local resources. In 2004, they trained almost 50 individuals, including high school and university students, retirees, and youth from the general public who are volunteering with CAMP.

Volunteers gain knowledge about their local estuaries and come to realize their importance to their local communities while participating in a monitoring process that otherwise they would not have been able to.

Reasons for Success

The reasons for success include the enthusiasm and dedication of local community groups and volunteers, a systematic monitoring approach and DFO participation on site, and strong ongoing partnerships and support from the within the DFO, the Coalition, and several others.

Suggestions for Improvement

Some interviewees feel that the community-based aspect of the program has not been fully reached and requires greater emphasis. At the same time, there is a need to ensure that community groups have strong coordinators and are well-established so that the monitoring does not fall upon the DFO staff, and that the community-based nature is maintained. There is a concern regarding the visibility of the program in local communities. Volunteers want community leaders to be more involved in the program and to recognize its importance. They want more media attention for the program and more presentations within the community.

Interviews (10)

Simon Courtenay – Science Director
Marie-Hélène Thériault – CAMP Head Coordinator, DFO
Shauna Barrington – Coordinator for Mabou Harbour Coastal Management Planning Committee
Roland Cormier – CAMP Director, DFO
Jack McNeil – NS Coordinator (Antigonish)
Roland Chiasson – Education and Outreach Coordinator, Cape Jourimain Nature Centre
Blayne Peters – Coordinator for Elsipogtog First Nation
Joseph Clair – ATK Technician, Volunteer for Elsipogtog
Randy G. Power – PIE Coordinator (Charlottetown)
Chantal Gagnon – Southern Gulf of St. Lawrence Coalition on Sustainability

Questionnaires (5)

Fred Cheverie – Coordinator for Souris & Area Branch PEI Wildlife Federation
Brenda Kelly – Coordinator for Bathurst Sustainable Development
Edward Sampson – Coordinator for North Colchester River Restoration Association
Alice Power – Coordinator for Friends of the Pugwash Estuary

Sabine Dietz – Volunteer for Cape Jourimain Nature Centre

Sources

CAMP, Community Aquatic Monitoring Program website: http://www.glf.dfo-mpo.gc.ca/e0006182

Thériault, Marie-Hélène and Simon Courtenay. 2010. The Community Aquatic Monitoring Program (CAMP): Information Document for science review, March 17-18, 2010. Mimeograph.

Weldon, J., S. Courtenay, and D. Garbary. 2009. The Community Aquatic Monitoring Program (CAMP) for measuring Marine Environmental Health in Coastal Waters of the southern Gulf of St. Lawrence: 2007 Overview. Canadian Technical Report of Fisheries and Aquatic Sciences 2825, viii + 47 p.

APPENDIX 10

CLEAN ANNAPOLIS RIVER PROJECT (CARP)

History of the Organization

CARP was established in 1990 as a charitable, community-based, non-governmental organization. Its main objective is to work with communities and local organizations to educate, restore, and conserve the marine and freshwater ecosystems of the Annapolis River Watershed. The Annapolis River Watershed is the third largest watershed in Nova Scotia, covering 2,000 km^2. Two events encouraged the development of CARP: the rejection of the Annapolis River as a heritage river site, and the scientific community's recognition of Annapolis River as a location for an innovative environmental management initiative.

CARP seeks to continually assess and improve the ecological integrity of the Annapolis River by increasing local knowledge of the watershed, particularly among decision-makers. It also facilitates collaboration among stakeholders and seeks to incorporate the local community in the restoration and conservation of the watershed. CARP has been engaged in 31 projects covering areas such as environmental monitoring, climate change, habitat conservation, energy conservation, pollution prevention and environmental education. There are several projects under the environmental monitoring category including monitoring of invasive fish species, invasive alien plants; and striped bass populations. The most important monitoring program and the one that is the focus of this case study is the Annapolis River Guardians.

Types of Monitoring

Established in 1992, the Annapolis River Guardians program provides an overview of the river's health and helps identify any problems in the Annapolis River watershed by:

- developing and undertaking a regular observation system, which will provide early warning signs of threats to the watershed.
- providing a long-term record of the watershed's ecological health.
- developing a community interest in the Annapolis River and community stewardship.
- developing a knowledgeable group of people who will help restore and protect the watershed.

Data Collection Techniques

Since 1992, over 100 volunteers have been trained in quality monitoring techniques, over 50 sites throughout the watershed have been monitored and over 3,500 water samples have been taken. Seven sites have been monitored annually since the beginning of the program. Sampling occurs 9 months out of

the year. No data gathering takes place between January and March. Although the data gathering process has changed over time, the following have been measured since the start of the program: fecal coliform bacteria, dissolved oxygen, air and water temperature and weather conditions. Some other elements that have been measured periodically include: nitrate, chlorophyll, chloride, sulphate, pH, conductivity, total dissolved solids, salinity, total suspended solids, colour and transparency. The data is analyzed every year and compiled into two reports: the Annapolis Watershed Report Card and the Annapolis River Annual Water Quality Monitoring Report.

Evaluation of water quality involves measurement of a number of variables using data collection and interpretation techniques that are simple and easy to understand. CARP has selected a number of specific sampling sites that span the entire watershed of the Annapolis River. Currently, there are 8 sites, which is the average number of sites that has been monitored since 2004. These sites are located near bridges and were chosen partly on the basis of their potential for providing the most useful information, and partly for their ease of access and sampling. The sampling is done every second Sunday during the designated sampling period.

Analysis of monitoring data collected

Evaluation of water quality involves sampling a body of water using a number of parameters (Table 7). The parameters chosen for this program have been selected partly on the basis of their relative importance in determining overall water quality and partly on their ease of measurement. They require a minimal amount of time for both field and laboratory analysis. The types of data that are collected by the River Guardians include: physical factors such as water temperature and water clarity, water chemistry (pH and dissolved oxygen), biology (coliform bacteria), and general observations on weather conditions.

Table 7: Water Quality Data Gathered by CARP Volunteers

Parameter	Technique
Weather Conditions	General Observation
Water Temperature	Thermometer
Water Clarity	
Suspended Particulate Matter	Filtration/Gravimetric
Colour	Visual Observation
pH	pH Probe
Dissolved Oxygen	Winkler Titration
Fecal Coliform Bacteria	Membrane Filtration

The equipment necessary for gathering the data in the field includes: the Techniques Manual; clipboard and field data sheets; pencils; a 1-litre plastic sample bottle; a 100-ml sterile sample bottle; a dissolved oxygen sample bottle;

reagent 1 powder; reagent 2 powder; thermometer; water sampler or bucket and rope; pH meter; scissors or pocket knife; and a backpack to carry the equipment to the field.

In addition to gathering samples, the volunteers partake in analysis. The volunteers are given a small laboratory kit for their homes where the samples are analyzed. The *River Guardians Manual* details the procedures involved in collecting and processing samples. It also provides some background information on the importance of each water quality parameter and some guidelines to help interpret results.

Data Quality Issues

The CARP staff believes that its protocols for gathering data are simple and do not require a scientific background. Many of the volunteers are experienced and are highly familiar with the protocols. Volunteers can refer to the River Guardian manual if they have questions or doubts. Many volunteers also mention that the support of the scientific director is very important. The only issue cited was the inconsistency in some data because some volunteers do not gather all the necessary data. For example, volunteers are asked to take samples after rainfall. Many volunteers admitted that they do not do so.

Data Reporting

CARP has produced The Annapolis Watershed Report Card since 2004 and the Annapolis River Annual Water Quality Monitoring Report since 2002. Both are available on the CARP website. The Report Cards include the variables measured, the status of the measurement, comments about the measure, trends of the measure since 1992, the Water Quality Index, and an introduction to the program, to watersheds and suggestions.

The Monitoring Report is highly detailed and is also produced every year. This report expands on the information that is found in the Report Card. Each variable or measure is described in detail along with a comprehensive description of the monitoring results. These reports are also available in the office and are sent to volunteers individually.

The data collected is made available to the university, to local, provincial and federal government agencies, and to other interested groups. Each participant receives a monthly summary of the data collected at all the sites being monitored. This means that each participant can compare conditions at their site with all other sites. The science coordinator meets with the municipal government every month to review the results. They have also met with various fishing groups and associations and presented the results to them.

Data Use

There are two specific cases where the data produced by the River Guardians directly influenced decision making. The first involved the septic tank program. Many septic tanks were leaking, which had an impact on the river and its e-coli levels. CARP was able to identify that the problem originated from the municipal sewer septic plant, and changes were made to improve performance. The second case involved the Greenwood Air Force Base where there was runoff of cleaning chemicals, fuels, and anti-freeze into the river. CARP was involved in lobbying for a change. As a result, the base has introduced a better drainage management system.

Organizational Structure

CARP has a board of directors that governs the program, establishes CARP policy and operating boundaries, and approves all CARP projects. The Board consists of 15 volunteers who are chosen annually. The volunteers come from various regions and from different occupations. An executive is also elected to facilitate the entire process. Over time, the Board of Directors has not changed much and most of the members have remained in the same roles.

Working with Volunteers

Because CARP has had, on average over the past few years, about 8 monitoring sites there are 8 to 10 volunteer positions for River Guardians. The CARP volunteers have not changed much over time. As a result, there has not been a great effort made to recruit volunteers. In the beginning, it was mostly word of mouth that helped find volunteers, particularly among older members of the community, including retired teachers, scientists, and doctors. Volunteers are motivated by an enjoyment of outdoor activities, wanting to care for the river, trust in CARP, and the knowledge that the data they are collecting has scientific value and that they are making a positive difference.

Training of Volunteers

The group offers one day of training for volunteers every year. Many of the volunteers go back to refresh their memories. Both volunteers and CARP staff believe the training has been successful. After the training, volunteers felt confident to perform the tests at home. The volunteers are also given a handbook as a reference. Many volunteers call the executive director or the science director and ask minor questions throughout the year. This is not a reflection of poor training, but rather the personal and open relationship that CARP has with its volunteers.

Funding

The Annapolis River Guardians group was first funded by the Environmental Partners Fund of Environment Canada. Over time, organizations such as Farmers Cooperative Dairy Ltd., Nova Scotia Power, Investors Group,

Collaboration of Community Foundations for the Gulf of Maine, Atlantic Coastal Action Program (ACAP), Acadia Centre of Estuarine Research, and the Nova Scotia Department of Environment have helped financially maintain the project. The Science Advisory Group that includes East Coast Aquatics, the Department of Fisheries and Oceans, the NS Department of Environment, and the Acadia Centre for Estuarine Research also helps with the study design and methodology and the analysis of the results. Funding has been made available partly because of the realization that extensive and consistent long-term monitoring is essential to realistically evaluate water quality trends, and that if left solely to government agencies, the cost would be prohibitive. As a result, regulatory agencies are encouraging the public to take greater responsibility.

Successes

Some of the successes of the water quality monitoring program include: over 300 volunteers trained in water quality monitoring; protection of about 570,000 m^2 riparian habitat; collection of over 1,950 water samples; restoration of nearly 630,000 m^2 of aquatic habitats; and participation in construction of about 100 hectares of wetlands.

Many of those interviewed believe that the work of CARP is having a great impact in the community. It has increased local awareness by educating people about the ecosystems in the region. Many volunteers are proud of the fact that they are gathering scientific data. The organization is now relied upon as a source of local water information.

Other successes include: twenty years of community-based water quality monitoring; participation of 14 farms in greenhouse gas reduction projects; protection of salt marshes; local businesses actively preventing watershed damage and pollution; homeowners actively participating in sewage management and water and energy conservation; and signing of over 20 farm stewardship agreements.

Reasons for Success

Many attribute CARP's success to the people that work at the organization. The longstanding executive director has built contacts locally, regionally, provincially, and nationally. CARP believes their strong partnerships are essential to the success of the projects and of the organization as a whole.

Suggestions for Improvement

Some believe the data produced by River Guardians is not being used to its full potential. One of the main challenges is limited funding. However, many believe the government could provide more prompt, non-financial support to organizations like CARP. In addition, some of the CARP staff feel that they have been left to take care of the water issues while the community simply assumes

CARP will inform them if something is wrong. Community members should recognize that the organization needs volunteers to be successful.

Interviews (10)

Stephen Hawboldt – Executive director
Andy Sharpe – Science coordinator
Doug Parker – Volunteer
Ron Jones – Volunteer
Murray Freeman – Volunteer
Levi Cliché – Environmental Home Assessor
Tami Parks – Volunteer
Sondra Brehaut – Watercourse Technician
Susan Lane – Office Manager
Matthew Guy – Volunteer

Questionnaire (1)

Claire Diggins - Volunteer

Sources

Annapolis River Guardians website: http://www.annapolisriver.ca/riverguardians.php

CARP, Clean Annapolis River Project website: http://www.annapolisriver.ca/

CARP, Clean Annapolis River Project. Annapolis River 2009: Annual Water Quality Monitoring Report. Prepared by: Jeffrey Glenen and Andy Sharpe, January 2010. Retrieved June 12, 2010, from: http://www.annapolisriver.ca/downloads/Annapolis_River_Guardians_2009.pdf.

CARP, Clean Annapolis River Project. River Guardians Data Handling Procedures, May 2007. Mimeograph.

CARP, Clean Annapolis River Project. River Guardians Manual, April 2000. Mimeograph.

CARP, Clean Annapolis River Project. Strategic Planning 2009. Final Report May 15, 2009. Annapolis Royal, Nova Scotia. Mimeograph.

REFERENCES

Arctic Borderlands Ecological Knowledge Society. 2008. Arctic Borderlands Ecological Knowledge Co-op, Community Reports 2006–2007. Available online at: <http://taiga.net/coop/>.

Arts, J., P. Caldwell, and A. Morrison-Saunders. 2001. EIA follow-up – Environmental impact assessment follow-up: Good practice and future directions – Findings from a workshop at the IAIA 2000 conference [Electronic version]. *Impact Assessment and Project Appraisal*, 19*(3), 175-185.*

Au, J., P. Bagchi, B. Chen, R. Martine, S.A. Dudley and G.J. Sorger. 2000, Methodology for public monitoring of total coliforms, Escherichia coli and toxicity in waterways by Canadian high school students, Journal of Environmental Management, 58, 213-230.

Åutsÿl K'e Dene First Nation. 2002. Traditional Knowledge in the Kache Tué Study Region: Phase Three – Towards a Comprehensive Environmental Monitoring Program in the Kakinÿne Region, Final Report. Yellowknife: West Kitikmeot Slave Study Society. Retrieved July 7, 2008, from http://www.nwtwildlife.com/WKSS/PDF/TradEcoKacheTueFinal2002.pdf.

Baker, D.C., and J.N. McLelland. 2003. "Evaluating the Effectiveness of British Columbia's Environmental Assessment Process for First Nations' Participation in Mining Development." *Environmental Impact Assessment Review*, 23, 581–603.

Berkes, F., J. Mathias, M. Kislalioglu, and H. Fast. 2001. "The Canadian Arctic and the Oceans Act: The Development of Participatory Environmental Research and Management." *Ocean & Coastal Management*, 44, 451–469.

Berkes, F., M. Kislalioglu, and H. Fast. 2007. "Collaborative Integrated Management in Canada's North: The Role of Local and Traditional Knowledge and Community-Based Monitoring." *Coastal Management*, 35, 143–162.

Bond, A, L. Langstaff, R. Baxter, H. G. Wallentinus, J. Kofoed, K. Lisitzin, and S. Lundstrom. 2004. "Dealing with cultural heritage aspect of environmental impact assessment in Europe." *Impact Assessment and Project Appraisal*, 22(1) March, pages 37–47.

Bush, M. 1990. "Public Participation in Resource Development after Project Approval." A background paper prepared for the Canadian Environmental Research Council.

Canadian Environmental Assessment Agency (CEAA). 2009. *Operational Policy Statement, Adaptive Management Measures under the Canadian Environmental Assessment Act.* Minister of Public Works and Government Services Canada, Ottawa, Catalogue No.: 978-1-100-12062-1.

Canadian Environmental Assessment Act. 2010. S.C. 1992. c. 37 (Consolidation to August 2010).

Cardinal, D., and J.C. Day. 1998. “Embracing Value and Uncertainty in Environmental Management and Planning: A Heuristic Model.” *Environments*, 25:2/3, 110–125.

Carr, A.J.L. 2004. Why Do We All Need Community Science? *Society and Natural Resources* 17:841-849.

Connelly, S., and T. Richardson. 2005. "Value-Driven SEA: Time for an Environmental Justice Perspective?" *Environmental Impact Assessment Review*, 25: 391–409.

Conrad, C. 2006. “Towards Meaningful Community-Based Ecological Monitoring in Nova Scotia: Where we [are] versus where we would like to be” in *Environments Journal* 34(1): 25–36.

Conrad, C. T., and T. Daoust. 2008. "Community-Based Monitoring Frameworks: Increasing the Effectiveness of Environmental Stewardship." *Environmental Management*, 41(3): 358–366.

Craig, B., G. Whitelaw, J. Robinson, and P. Jongerden. 2003. Community-based Ecosystem Monitoring: A tool for developing and promoting ecosystem-based management and decision making in the Long Point World Biosphere Reserve. Proceedings of the Fifth Science and Management of Protected Areas Association Conference [Web Page]. URL: http://www.sampaa.org/PDF/ch4/4.4.pdf [2006].

Cuthill, M. 2000. An Interpretive Approach to Developing Volunteer-based Coastal Monitoring Programs. Local Environment 5(2): 127-137.

Dale, A. P., and M. B. Lane. 1994. “Strategic Perspectives Analysis: A Procedure for Participatory and Political SIA.” *Society and Natural Resources*, 7:3, 253–267.

Devlin, J., and N. T. Yap. 2002. *Public Participation in Environmental Assessment, CIDA and the Canadian Environmental Assessment Act: A Handbook.* Guelph: Prepared for the Canadian International Development Agency, under contract with YESA Guelph, ON., 82 pp.

Dyck, M. (2007). “Community Monitoring of Environmental Change: College-Based Limnological Studies at Crazy Lake (Tasirluk), Nunavut.” *Arctic 60* (1): 55-61.

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. *Measuring and Monitoring Plant Populations*. Denver, CO: Bureau of Land Management. BLM Technical Reference 1730–1.

Ely, E. 2000. Tallying trees: Illinois volunteers monitor forests. *Volunteer Monitor* 12(2):21.

Ely, E. 2002. Dead birds do tell tales. *Volunteer Monitor* 14(1):10–22.

Ecological Monitoring and Assessment Network Coordinating Office. (EMAN) 2002. *Improving local decision-making through community based monitoring: toward a Canadian Community Monitoring Network*. Ottawa: Environment Canada. 24 p. Available at: www.ccmn.ca.

Engel, S., and J. Voshell. 2002. Volunteer biological monitoring: Can it accurately assess the ecological condition of streams? *American Entomologist 48*: 164–177.

Environmental Monitoring Advisory Board (EMAB). 2010. *Annual Report 2009–2010*. Available online URL: <http://www.emab.ca/pdfs/EMABAnnualRepot2010.pdf>.

Firehock, K., and J. West. 1995. "A brief history of volunteer biological water monitoring using macroinvertebrates." *The North American Bethological Society* 14(1): 187-202.

Fischer, C. 1996. Monitoring the monitors: Bird banders track data quality. *Volunteer Monitor* 8(2):9–11.

Fitzpatrick, P., and A.J. Sinclair. 2003. "Learning Through Public Involvement in Assessment Hearings." *Journal of Environmental Management*, 67, 161–174.

Fleming, B., and D. Henkel. 2001. Community-based ecological monitoring: A rapid appraisal approach. *Journal of the American Planning Association* 67:456-466.

Fore, L.S., K. Paulsen, and K. O'Laughlin. 2001. Assessing the performance of volunteers in monitoring streams. *Freshwater Biology* 46(1):109–123.

Gagnon, C., L. Lepage, M. Gauthier, G. Côté, P. Champagne, F. Miller, and L. Simard. 2000. "Analysis and Evaluation of the Operations of Ten Environmental Assessment Follow-up Committees in Quebec: Exploratory Research." Prepared for the Research and Development Monograph Series. URL: http://www.ceaa.gc.ca/default.asp?lang=En&n=C398606D-1 Extracted 23 May 2007.

Heiman, M. K. 1997. Science by the people: Grassroots environmental monitoring and the debate over scientific expertise. *Journal of Planning Education and Research*: 291-299.

Hunsberger, C., R. Gibson, and S. Wismer. 2003. Increasing Citizen Participation In Sustainability-Centred Environmental Assessment Follow-Up: Lessons from Citizen Monitoring, Traditional Ecological Knowledge, and Sustainable Livelihood Initiatives. With case studies by Carol Hunsberger, Tyler Shaw, and Thalia Santisteban. CEAA Research and Development Monograph Series, 2003, Catalog No. En105-3/31-2005E-HTML

Hunsberger, C. A, R. B. Gibson, and S. K Wismer. 2005. "Citizen Involvement in Sustainability-Centred Environmental Assessment Follow-Up." *Environmental Impact Assessment Review*, 25, no. 6, August: 609–27.

Kearney, John, F. Berkes, A. Charles, E. Pinkerton, and M. Wiber. 2005. “The Role of Participatory Governance and Community-Based Management in Integrated Coastal and Ocean Management in Canada,” *Coastal Management*, 35:1, 79–104.

Lane, M. B. and T. Corbett. 2005. “The Tyranny of Localism: Indigenous participation in community-based environmental management.” *Journal of Environmental Policy & Planning, 7*(2), 141–159.

Lavallée, L., and P. André. 2005. Social impact follow-up in Quebec, Canada: 25 years of environmental impact assessment practice [Electronic version]. *Impact Assessment and Project Appraisal*, *23*(3), 241–245.

Lawe, L. B. and J. Wells. 2005. Cumulative effects assessment and EIA follow-up: a proposed community-based monitoring program in the Oil Sands Region, northeastern Alberta. Impact Assessment and Project Appraisal 23(3): 205-209.

Leeuwis, C. 2000. “Reconceptualizing Participation for Sustainable Rural Development: Towards a Negotiation Approach.” *Development and Change* Vol.31, pp. 931–959.

Loperfido, J. V., P. Beyer, C. L. Just, and J. L. Schnoor. 2010. Uses and Biases of Volunteer Water Quality Data. *Environmental Science & Technology, 2010*, 44 (19), pp. 7193–7199: June 11, 2010.

Lynch, M., and W. Aupers. 2005. "Tri Community Watershed Initiative Towns of Black Diamond, Turner Valley and Okotoks, Alberta: Promoting Sustainable Behaviour in Watersheds and Communities." M. Doyle and M. Lynch, eds., *Linking Ecological Monitoring to Decision-Making at Community and Landscape Scales*. Ottawa: The Ecological Monitoring & Assessment Network, Environment Canada. 13–19. Retrieved July 7, 2008, from URL: <http://emanrese.ca/eman/reports/publications/2005/camesa/CAMESA.pdf>.

Macharia, S. N. 2005. A Framework for Best Practice Environmental Impact Assessment Follow-Up: A Case Study of the Ekati Diamond Mine, Canada. M.A. Thesis, University of Saskatchewan. Retrieved July 23, 2008, from URL: <http://library2.usask.ca/theses/available/etd-05192005-093452/unrestricted/sarah_macharia.pdf>.

Makhoul, A. 2004. *The Canadian Community Monitoring Network*. Ottawa: Caledon Institute of Social Policy.

Marshall, R., J. Arts, and A. Morrison-Saunders. 2005. Principles for EIA Follow-Up: International principles for best practice EIA follow-up [Electronic version]. *Impact Assessment and Project Appraisal*, *23*(3), 175–181.

Morrison-Saunders, A., J. Baker, and J. Arts. 2003. EIA follow-up Lessons from practice – Towards successful follow-up [Electronic version]. *Impact Assessment and Project Appraisal*, *21*(1), 43–56.

Moyer, J., P. Fitzpatrick, and A. Diduck. 2007. Toward Community-Based Monitoring in the Hog Industry in Manitoba. Manitoba Clean Environment Commission, Winnipeg MB. Retrieved July 7, 2008, from URL: <http://www.cecmanitoba.ca/resource/Hearings/22/WSUB-101.pdf>.

Noble, B., and K. Storey. 2005. “Towards increasing the utility of follow-up in Canadian EIA” [Electronic version]. *Environmental Impact Assessment Review*, *25*, 163-180.

Noble, B., and J. Birk. 2011. “Comfort monitoring? Environmental assessment follow-up under community-industry negotiated environmental agreements.” *Environmental Impact Assessment Review,* 31, 17–24.

O'Donnell, T. K., and D. L. Galat. 2008. Evaluating success criteria and project monitoring in river enhancement within an adaptive management framework [Electronic version]. *Environmental Management*, 41(1), 90–105.

O'Faircheallaigh, C. 2006. *Environmental Agreements in Canada: Aboriginal Participation, EIA Follow-up and Environmental Management of Major Projects*. Calgary AB: Canadian Institute of Resources Law.

O'Faircheallaigh, C. 2007. Environmental agreements, EIA follow-up and aboriginal participation in environmental management: The Canadian experience. *Environmental Impact Assessment Review*, *27*(4), 319–342.

O'Faircheallaigh, C. 2010. Public participation and environmental impact assessment: Purposes, implications, and lessons for public policy making. *Environmental Impact Assessment Review*, 30(1), 19–27.

O’Neill, H.J., M. McKim, and R. Rainer. 1995. Community-based water quality monitoring. T. Herman, S. Bondrup-Nielsen, J. H. Martin Willison and N.W.P. Munro, eds. *Ecosystem Monitoring and Protected Areas, Proceedings of the Second International Conference on Science and the Management of Protected Areas,* Dalhousie University, Halifax, NS. Wolfville, NS: Science and Management of Protected Areas Association, Centre for Wildlife and Conservation Biology, Acadia University. 447–453.

Paci, C., A. Tobin and P. Robb. 2002. “Reconsidering the Canadian Environmental Impact Assessment Act: A Place for Traditional Environmental Knowledge.” *Environmental Impact Assessment Review,* 22, 111–127.

Pattengill-Semmens P and B. Semmens. 2003. Conservation and management applications of the REEF volunteer fish monitoring program. *Environmental Monitoring and Assessment* 81:43–50

Pollock, S. *Climate Change and Wildlife*. Toronto: Environment Canada, 2002.

Pollock, R., G. Whitelaw, and D. Atkinson. 2003. *Linking Community Based Ecosystem Monitoring to Local Decision Making and Policy Development on Sustainability*, final research report for the Canadian Nature Federation

and the Ecological Monitoring and Assessment Network Coordinating Office, Environment Canada, pp. 96.

Pollock, R. M., and G. S. Whitelaw. 2005. "Community-Based Monitoring in Support of Local Sustainability." *Local Environment. 10*(3): 211–228.

Quinn, M.S., and J. E. Dubois. 2005. Community-Based Monitoring: Engaging and Empowering Alberta Ranchers. *USDA Forest Service Proceedings RMRSP-36. April 13*. Washington, D.C: USDA Forest Service. Retrieved July 9, 2008, from URL: http://www.fs.fed.us/rm/pubs/rmrs_p036/rmrs_p036_212_218.pdf

Richardson, T. 2005. "Environmental Assessment and Planning Theory: Four Short Stories About Power, Multiple Rationality, and Ethics." *Environmental Impact Assessment Review*, 25: 341–65.

Ross, B. 2004. The Independent Environmental Watchdog: A Canadian Experiment in EIA Follow-Up. In A. Morrison-Saunders & J. Arts, eds., *Assessing Impact: Handbook of EIA and SEA Follow-Up* pp. 178–92. London: Earthscan.

Ryu, J., J. D. Walmsley, P. Slinn, and S. Harashina. 2004. "The Role of Environmental Non-Governmental Organizations in the Environmental Impact Assessment Process in Japan." *Impact Assessment & Project Appraisal*, 22, no. 4, December: 283–93.

Savan, E., A. J. Morgan, and C. Gore. 2003. “Volunteer Environmental Monitoring and the Role of the Universities: The Case of Citizens’ Environment Watch.” *Environmental Management* 31(5): 561–568.

SENES Consultants Limited. 2009. *Final Report: External review of the independent environmental monitoring agency*. Yellowknife NT: Independent Environmental Monitoring Agency.

Sharpe, T., B. Savan, and N. Amott. 2000.“Testing the waters.” *Alternatives* 26: 30–33.

Sinclair, A. J., and A. P. Diduck. 2001. “Public Involvement in EA in Canada: A transformative learning perspective.” *Environmental Impact Assessment Review*, 21, 113–136.

Snap Lake Environmental Monitoring Agency (SLEMA). 2009. *2008–2009 Annual Report.* Available online at URL: http://www.slema.ca/documents/SLEMA/Review/2009/2008%20Annual%20Report%20-%20Working%20copy%20with%20financials%20(PDF).pdf

Stevenson, M. 1996. “Indigenous Knowledge in Environmental Assessment.” *Arctic* 49:3, 278–91.

Storey, K., and B. Noble. 2004. *Increasing the Utility of Follow-Up in Canadian Environmental Assessment: A Review of Requirements, Concepts and Experience.* January, CEAA Research and Development Monograph

Series, 2004. Catalog No. En105-3/92-2004E-HTML, ISBN 0-662-38452-0.

Sullivan D., and Beveridge, M. 2005. Ecological Monitoring and Reporting: A Survey of the Atlantic Coastal Action Program. Annapolis Royal, Nova Scotia: Clean Annapolis River Project. Retrieved July 11, 2008, from URL: <http://atlantic-web1.ns.ec.gc.ca/community/acap/D2574285-342D-4DB5-A4B2-58E53C13B719/ecological_monitoring_e.pdf>.

Taccogna, G., and K. Munro, eds. 1995. *The Streamkeepers Handbook: A Practical Guide to Stream and Wetland Care*. Salmonid Enhancement Program, Dept. Fisheries and Oceans, Vancouver, BC.

van der Sluijs, J.P. 2002. “A Way Out of the Credibility Crisis of Models Used in Integrated Environmental Assessment.” *Futures*, 34, 133–146.

Webler, T., H. Kastenholz, and O. Renn. 1995. “Public Participation in Impact Assessment: A Social Learning Perspective.” *Environmental Impact Assessment Review*, 15, 443–463.

Whitelaw, G., H. Vaughan, B. Craig, and D. Atkinson. 2003. "Establishing the Canadian Community Monitoring Network." *Environmental Monitoring and Assessment.* 88(1-3): 409–418.

Wilkins, H. 2003. "The Need for Subjectivity in EIA: Discourse as a Tool for Sustainable Development." *Environmental Impact Assessment Review*, 23: 401–14.

Winds and Voices Environmental Services (WVES). 2001. *Determining Significance of Environmental Effects: An Aboriginal Perspective*. Research and Development Monograph Series, 2000. Ottawa, Canada: Canadian Environmental Assessment Agency.