2003

Community-based Ecosystem Monitoring in British Columbia

A Survey and Recommendations for Extension

FORREX SERIES 13

Forest Research Extension Partnership
FORREX
Supporting Sustainable Natural Resource Management Decisions

Community-based Ecosytem Monitoring in British Columbia

A Survey and Recommendations for Extension

Patrick Yarnell and Donald V. Gayton

Forest Research Extension Partnership
FORREX
Supporting Sustainable Natural Resource Management Decisions

National Library of Canada Cataloguing in Publication Data

Yarnell, Patrick, 1969-
Community-based ecosystem monitoring in British Columbia [electronic resource] : a survey and recommendations for extension / Patrick Yarnell and Donald V. Gayton.

(FORREX series ; 13)
Includes bibliographical references.
Type of computer file: PDF.
Issued also in print format.
System requirements: Adobe Acrobat Reader.
ISBN 1-894822-19-6

1. Environmental monitoring—British Columbia—Citizen participation. 2. Environmental protection—British Columbia—Citizen participation. 3. Ecosystem management—British Columbia—Citizen participation. I. Gayton, Don, 1946- II. FORREX. III. Title. IV. Series: FORREX series (On-line) ; 13.

QH77.C3Y37 2003a 363.7'063'09711 C2003-905830-1

For more information about FORREX, visit: ***www.forrex.org***

This report is published by:

FORREX
Suite 702, 235–1st Avenue
Kamloops, BC V2C 3J4

This FORREX publication is supported in part by the Province of British Columbia through Forestry Innovation Investment.

FOREWORD

The concept of involving citizen groups in the collection of long-term ecological baseline data is a relatively new idea for British Columbia. Currently, the demand for these data is on the increase, while the financial capacity and human resources of the traditional agencies collecting ecological data appears to be in long-term decline. As community-based ecosystem monitoring has become a partial solution to this dilemma in other jurisdictions, the Board of Directors of FORREX–Forest Research Extension Partnership felt it was appropriate to conduct a preliminary investigation, with recommendations on a potential extension role for the Partnership.

Patrick Yarnell, an environmental planning and management consultant from Vancouver, had the right combination of knowledge and expertise for the project, and was contracted in the fall of 2001 to research and write a preliminary report to submit to the Board. This is the final report, after editorial review and comment. Although some of the information and recommendations are specific to FORREX, the Board felt there was sufficient interest in community-based ecosystem monitoring to make this report available to a wider audience.

Funds to support this project came from the Province of British Columbia.

Please refer questions or comments to:

Don Gayton
Ecosystem Management Specialist, FORREX–Forest Research Extension Partnership
don.gayton@forrex.org

Citation—
Yarnell P. and D.V. Gayton, 2003. Community-based ecosystem monitoring in British Columbia: A survey and recommendations for extension. FORREX–Forest Research Extension Partnership, Kamloops, B.C. FORREX Series 13.

ABSTRACT

Community-based ecosystem monitoring (CBEM) is a process whereby non-government organizations (NGOs), community groups, or individuals participate in long-term monitoring of selected species, habitats, or ecosystem processes with the ultimate goal of improving management of ecosystems and natural resources. With a focus on North America, and a particular emphasis on CBEM issues and institutions that are relevant to British Columbia, this exploratory study provides a review of the published literature, the "grey literature" of government agencies and NGOs, and information available on the Internet from these organizations. It also presents information obtained through interviews with practitioners of community-based ecosystem monitoring, including academics, NGO directors and staff, environmental consultants, and government agency staff. The concepts involved in community-based ecosystem monitoring are broadly examined and examples of existing approaches discussed. The report concludes with recommendations on the potential roles that FORREX could play as an extension organization seeking to improve the use of citizen-collected ecological data.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Community-based ecosystem monitoring (CBEM) is a process whereby non-government organizations (NGOs), community groups, or individuals participate in long-term monitoring of selected species, habitats, or ecosystem processes. Monitoring programs may involve any number or combination of partners, including governments, universities or colleges, various NGOs, and volunteers. The ultimate goal of CBEM is improved management of our ecosystems and natural resources. Community-based ecosystem monitoring is a relatively new concept in North America, arising from an increasing level of environmental interest and concern among the public, coupled with dwindling resources in those government agencies traditionally charged with ecosystem management.

As a non-profit organization committed to developing, applying, and sharing knowledge about natural resource management, FORREX–Forest Research Extension Partnership is exploring its potential role in improving how science-based data collected by non-governmental organizations or citizens' groups is used to inform decision making in natural resource management (see Appendix 1 for background on FORREX). The intent of this exploratory study is to broadly examine the concepts involved and to raise ideas, open doors, and generate options for improving adaptive ecosystem management using community-based ecosystem monitoring. The focus is on North America, with particular emphasis on issues and institutions that are relevant to British Columbia.

In Section 2, we briefly explain our assumptions and the methods used to gather information for this report. In Section 3, we define and discuss community-based ecosystem monitoring and related concepts. We also present the benefits and limitations of CBEM and examine different types of monitoring. Section 4 is based on interviews with practitioners and includes examples of existing approaches to community-based inventory and monitoring. Section 5 builds on the findings of the literature review and interviews and identifies potential roles that FORREX could play as an extension organization seeking to improve the use of citizen-collected ecological data. Section 6 offers some conclusions and outlines four recommendations on the actions FORREX could pursue over the next 1–3 years to define its role in community-based ecosystem monitoring.

2 METHODS

2.1 Assumptions

We approached this research with the belief that biological diversity and ecological complexity have intrinsic value and are inherently positive, and that the extinction of species is negative (Lackey 2001). We also believed that without inventory and monitoring, good management could not exist, except by accident. Furthermore, we recognized a trend in the decline of financial and human resources within the government agencies that are responsible for natural resource management and environmental protection, particularly at the provincial level.

Therefore, in preparing this report we assumed that:

- human disturbance of the environment (i.e., resource extraction, land development, pollution) will continue to intensify, thereby increasing the stresses on our ecosystems;
- the public is becoming progressively more aware of environmental and natural resource issues;
- ecosystem monitoring provides basic information that is essential for sound decision making about land use and conservation; and
- the capacity of government researchers to effectively monitor a sufficient number of ecological parameters is limited, and the use of NGO and citizen resources could complement government capabilities.

2.2 Literature Review and Interviews

We reviewed the published literature in conservation biology and related fields, the "grey literature" of government agencies and NGOs, and information available on the Internet from these organizations. We also undertook a series of informal interviews with practitioners of community-based ecosystem monitoring. A survey of practitioners began at the end of October 2001 with a request for information that was delivered by e-mail (Appendix 2). This was intended to provoke thought and identify additional contacts. The request was circulated to approximately 30 individuals who represented NGOs, government, consultants, and academics. Based on responses to this initial request and the review of literature, follow-up interviews were conducted by telephone with several of these individuals, as well as with contacts they identified and others who were identified through the review of material on the Internet. The telephone interviews focused on the existing projects of NGOs, the challenges of volunteer-based programs, and the potential role that FORREX might play in supporting community-based ecosystem monitoring.

3 LITERATURE REVIEW

3.1 Overview

Community-based ecosystem monitoring is a relatively new area of interest in ecosystem management. Although amateur naturalists have been a source of ecological information for many years, the use of volunteer-collected data has typically taken place in an ad hoc manner. Until recently, standardization of community-based ecological data within the context of science-based adaptive management has received little attention. Over the past several decades, citizens have become more concerned about the environment and environmental NGOs have proliferated. As these NGOs evolve and become more complex with increased scientific and political capacity, interest continues to build in networking, in affecting change to protect ecosystems, and in taking a hands-on approach. Indeed, since the mid-1990s, several community-based and volunteer monitoring programs have been established across Canada.

The literature on community-based stewardship tends to focus on environmental education and awareness-raising activities, such as the posting of habitat signage and conducting clean-ups, or on conservation initiatives for private lands. However, in the past few years researchers have started to bridge the gaps between scientists and volunteers. This is being accomplished by:

- defining characteristics of successful CBEM programs,
- evaluating the reliability of volunteer-collected ecological data, and
- developing standardized, pan-Canadian monitoring protocols (Bliss *et al.* 2001; Craig and Vaughan 2001; Fore *et al.* 2001; Rosenau and Angelo 2001).

3.1.1 Biodiversity and Ecosystem Management

Two of the fundamental rationales for CBEM are the protection of biodiversity and the provision of data in support of ecosystem management. Internationally, the importance of national strategies for conserving biological diversity has been bolstered and guided by the United Nations' Convention on Biological Diversity, which was adopted at the 1992 Earth Summit held in Rio de Janeiro, Brazil. Since the mid-1990s, the field of "ecosystem management" was introduced (Grumbine 1994) and has been very active with many publications (e.g., see *Saving Nature's Legacy: Protecting and Restoring Biodiversity* [Noss and Cooperrider 1994]). Arguably, the concept of ecosystem management has existed since at least the 1930s, as what Aldo Leopold called the "land ethic." However, in the past

decade this concept has been discussed regularly in the context of linking science, law, policy, and management with the goal of protecting biological diversity (Campbell 2000).

Although Canada created its Ecological Monitoring and Assessment Network (EMAN) in 1994 and developed a national biodiversity strategy in 1995, several important aspects of Canadian conservation policy pre-date the Earth Summit. For instance, the modern notion of sustainability (i.e., leaving the environment unimpaired for future generations) appeared in the first National Parks Act in 1930, and ecological integrity was introduced as a guiding principle for park management in 1979 and made a legal priority in 1988 (Panel on the Ecological Integrity of Canada's National Parks 2000). But while the notions of ecosystem management and ecological integrity have been incorporated into Canadian policies and even laws, their application nationally and provincially has faltered because these concepts have been employed inconsistently by managers (B.C. Parks Legacy Panel 1999; Campbell 2000; Panel on the Ecological Integrity of Canada's National Parks 2000).

3.1.2 Government Policies

Virtually every government agency with responsibilities in wildlife management, land management, or environmental protection now has policies that embrace stewardship, ecosystem management, and the conservation of biodiversity. To support these policies, agencies have management objectives for protecting sensitive habitat and preserving environmental quality. Furthermore, these policies and objectives often promote the role of the public in decision making. Given this reality, it is a worthwhile pursuit, if not a necessity, to involve the public in the collection of science-based data for the purposes of monitoring our ecosystems.

3.1.3 The Role of Community-based Ecosystem Monitoring in Adaptive Ecosystem Management

Monitoring generates the information that managers need to make decisions, and it is therefore an essential element in adaptive management. Monitoring allows scientists to detect trends that may serve as an early warning of impending changes, and therefore it provides scientists and decision makers with a predictive tool. For example, ecological monitoring of lake acidification helped to identify long-range transport of pollutants as a problem. Partly due to the public's faith in the multi-scale, long-term data, these monitoring results played a role in subsequent negotiations with the United States to reduce sulphur dioxide emissions (Stabb 2000). In addition, monitoring provided data to develop models used in building scenarios with positive or negative outcomes (Lindenmayer 1999; Kappelle 2000).

Integrated Ecosystem Monitoring To provide the high-quality information necessary to improve management decisions and to maximize learning, monitoring needs to be well designed and executed (Landres 1995; Martell 1999). Monitoring goals should be established with adequate knowledge of past, current, and potential future conditions of the ecosystem in question (Noss 1999; Kay *et al.* 2001). Indeed, good monitoring, with explicit goals, should have the same rigorous standards as ecological research.

However, Martell (1996, 1999) cautions that scientific rigour and a focus on the ecological system should not marginalize lay perspectives. Scientific, social, and bureaucratic demands are not easily disentangled, and societal and economic systems should be considered along with ecological systems (Martell 1999; Kay et al. 2001). "Good science" alone will not necessarily command legitimacy for an ecosystem monitoring program. For example, the controversy surrounding the Department of Fisheries and Oceans, the Newfoundland Inshore Fisheries Association, and northern cod stocks showed that a technocratic approach, which relies on science to reduce uncertainty and to solve problems, failed to

resolve the policy conflict (Martell 1996). Community-based ecosystem monitoring programs must be carefully placed into the local cultural and economic context, while at the same time respecting the scientific integrity of the actual monitoring. Monitoring of local social and economic trends also fits under the CBEM umbrella. Indeed, local groups that undertake to monitor both ecological and socio-economic parameters may find some unexpected relationships between the two.

Adaptive Ecosystem Monitoring Evaluations of resource management efforts have consistently identified monitoring (and the financial resources to conduct monitoring) as a shortfall in the conservation of biodiversity, and have concluded that closer relationships between scientists, managers, and NGOs would strengthen ecosystem management. However, the recognition that monitoring is a critical part of a thorough management cycle is not new. Monitoring (or "checking") has been a principle of good management for more than 100 years and has been re-introduced several times in various disciplines (Yarnell 1999).

The concept of adaptive management embodies the idea of interlocked management cycles—"Plan–Do–Check–Act" (Yarnell 1999; Bliss *et al.* 2001; Kay *et al.* 2001) and was introduced into ecology in the late 1970s (see Holling 1978). For example, Boyle (1998) presents a comparison of conventional versus adaptive approaches to ecosystem management and monitoring. The information generated from ecosystem monitoring is the cog that turns the wheel of adaptive ecosystem management (Figure 1). Data collected from CBEM programs can supply suitable information to identify probable changes in ecosystem

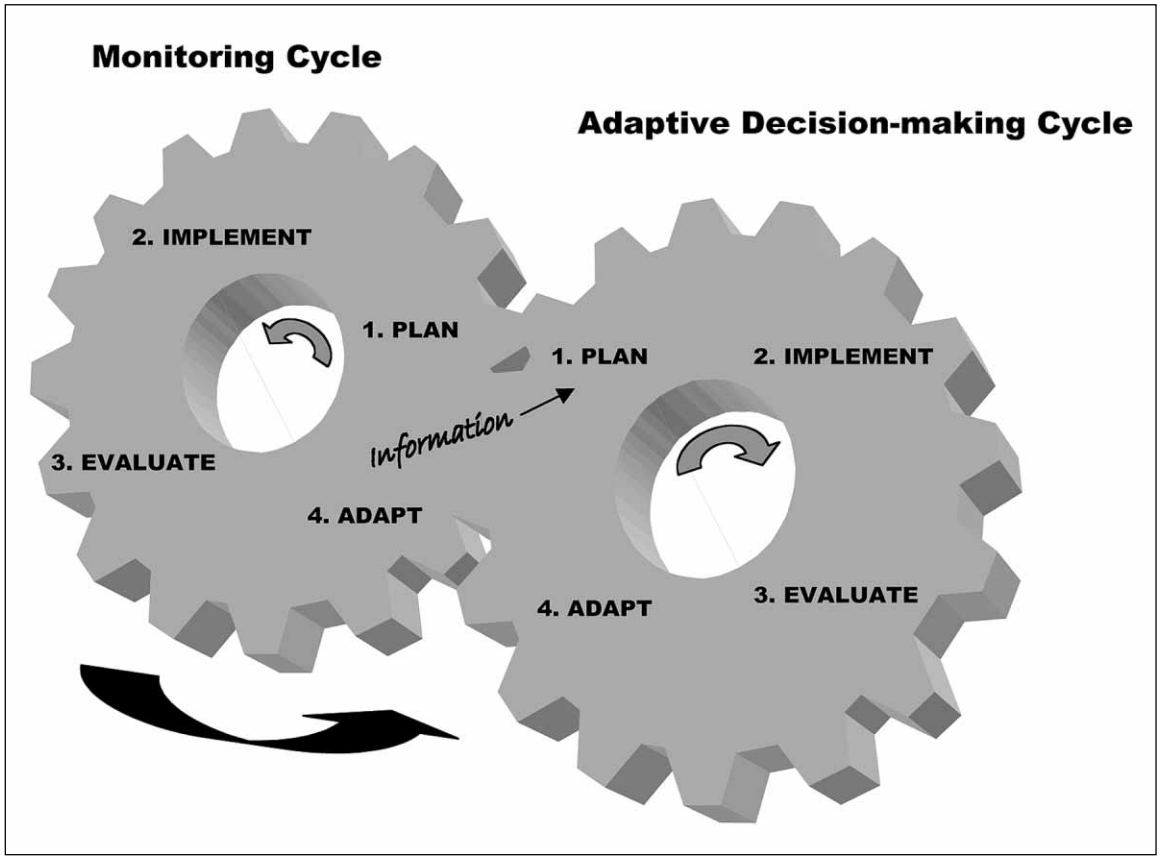

FIGURE 1 Monitoring generates the information flow (probable changes in ecosystem conditions) that feeds the policy direction and leads to responsive priority setting in an adaptive ecosystem approach (after Bliss et al. 2001).

conditions (Craig and Vaughan 2001). Monitoring results provided in a co-ordinated and timely way supply a steady flow of information that then informs policy development and priority setting.

The monitoring cycle itself is also an iterative, or adaptive, cycle (Figure 2). In practice, no clear distinction exists among the cycle's different elements (e.g., between the planning and implementing elements), and some elements may need to be revisited more frequently than others.

3.1.4 The Role of Community-based Groups

The role of citizens in ecosystem monitoring is a simple extension of the need for good, science-based information to guide decisions about natural resource management. It is natural and sensible to consider this option, given that:

- the body of resource management professionals, however large, is limited as to where and how often it can undertake monitoring;
- the public desire for responsible management of all aspects of our ecosystems is growing; and
- the public (i.e., concerned citizens, amateur naturalists, or trained advocates) is interested in helping to collect ecological information.

One needs only to look at the long lists of names associated with some of the existing volunteer-based monitoring programs to understand the energy that volunteers have to offer (e.g., see the report on the first year of Bird Studies Canada's BC Coastal Waterbirds Survey at ***www.bsc-eoc.org/regional/bccws99-00.html***). In fact, not only are citizen volunteers interested, but they possess a personal connection with the landscape and a sense of ownership that makes community members ideal candidates to watch for changes (Fore *et al.* 2001; Rosenau and Angelo 2001).

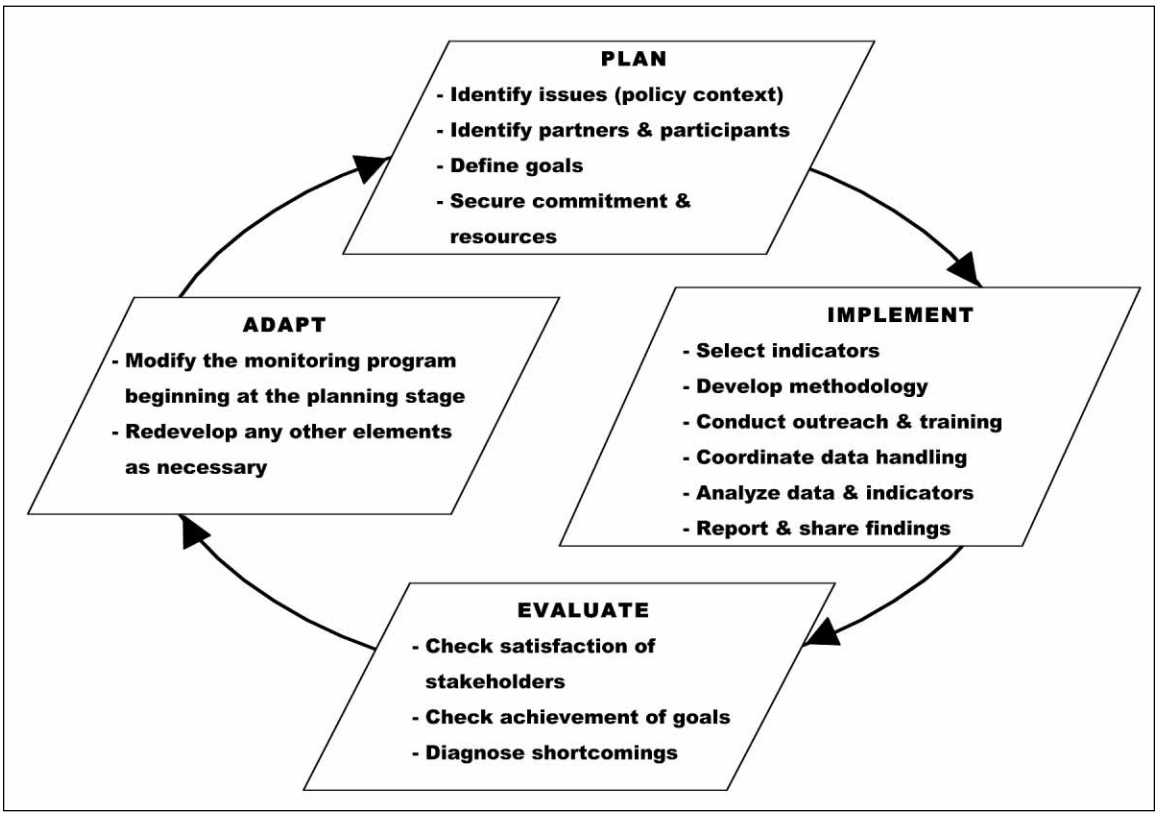

FIGURE 2 The monitoring cycle and its elements (after Boyle 1998; Yarnell 1999; Bliss et al. 2001).

3.2 Definitions and Context

3.2.1 Ecosystems

Many science-based agencies and organizations have their own detailed criteria for defining ecosystems. In simple terms, an ecosystem is a functional unit of plants, animals, micro-organisms, and their physical surroundings. Humans interact with (and often dramatically affect) other species, the soil, air, and water; they are, therefore, considered as part of ecosystems. An "ecosystem" is not a fixed entity that a person can see or touch as a whole. Instead, ecosystems are context-specific—they cannot be delimited without a science or policy context (Lackey 2001). The scale or size of an ecosystem is defined by the issue-at-hand.

3.2.2 Ecosystem Management

Ecosystem management is a modern paradigm for linking science, law, and policy to manage our environment, or our development, in a holistic way. Grumbine (1994) offers the following working definition:

> *ecosystem management integrates scientific knowledge of ecological relationships with a complex socio-political and values framework toward the general goal of protecting native ecosystem integrity over the long term (1994:31).*

Some consider that in conventional ecosystem management the societal system dominates the ecological system, and that too much focus is placed on predicting and controlling rather than learning and adapting (Boyle 1998; Martell 1999). Boyle (1998) stresses the importance of an adaptive ecosystem approach where "societal and ecological systems are seen as co-evolving entities."

3.2.3 Ecosystem Monitoring

Monitoring is a structured, repeatable process of observing and recording (measuring) something over time, ideally for a specified purpose. Monitoring is also an essential component of an iterative management cycle. It follows then that ecosystem monitoring measures (over time and for a purpose) some parameter of the ecosystem, such as species abundance and distribution or water quality. The important distinction between monitoring and inventory is the long-term commitment of monitoring and the importance of goal-setting; monitoring is also part of an adaptive decision-making cycle (Landres 1995; Boyle 1998; Lindenmayer 1999; Noss 1999; Bliss *et al.* 2001). Inventory can be thought of as a wide-angle snapshot; monitoring, on the other hand, is a narrowly-focussed movie, or series of movies.

3.2.4 Community-based Ecosystem Monitoring

Typically, scientists or technicians who work for government agencies responsible for natural resources management carry out ecosystem monitoring, sometimes in conjunction with scientists at academic institutions or research agencies. Community-based ecosystem monitoring, on the other hand, is: "... a range of observation and measurement activities involving participation by community members and designed to learn about ecological and social factors affecting a community" (Bliss *et al.* 2001:143).

Community-based ecosystem monitoring often involves the participation of community members who would not normally have a formal role in ecosystem monitoring. Community members may become involved in ecosystem monitoring as a hobby, as concerned citizens, or through recreation organizations, learning institutions, or non-governmental organizations with a community or environmental focus.

Increasingly, it is recognized that NGOs and citizen volunteers are capable of providing useful science-based information to help government agencies manage the environment (Fore *et al.* 2001; Rosenau and Angelo 2001). Many government programs for wildlife and habitat management now recommend or actively seek assistance from NGOs, property owners, and volunteers. See, for example, materials such as British Columbia's Wildlife at Risk brochure series (***http://wlapwww.gov.bc.ca/wld/list.htm***) and recent education and outreach efforts by the Canadian Endangered Species Conservation Council and other multi-agency coalitions (Agriculture and Agri-Food Canada *et al.* 2000; B.C. Ministry of Environment, Lands and Parks 2001; Canadian Endangered Species Conservation Council 2001).

3.3 Types of Community-based Ecosystem Monitoring

Although community-based ecosystem monitoring generally refers to "ongoing measurement of ecological parameters with the participation of community members," such monitoring can be driven by numerous factors, organized in various ways, and used for diverse purposes. Different types of monitoring include:

- baseline and inventory monitoring, which provides snapshots of population numbers and/or areal extent;
- implementation (compliance) monitoring, which determines whether an action has been undertaken;
- condition and trend monitoring, which tracks a particular ecosystem element or process over time;
- effectiveness (compliance) monitoring, which assesses whether given goals were achieved; and
- validation monitoring, which tests scientific hypotheses (Bliss *et al.* 2001).

Bliss *et al.* (2001) conclude that NGOs and volunteers typically participate in (in order of complexity): baseline monitoring, inventory monitoring, implementation monitoring, and effectiveness monitoring. Baseline "monitoring" is a static assessment (or inventory) of current conditions, and is only the first step towards a monitoring program. Verification monitoring, also known as "monitoring-by-experiment" (Lindenmayer 1999), is normally carried out on a large scale by academics and resource professionals. There are exceptions to this, however, where the potential inaccuracies of volunteer data collection are offset by amassing large numbers of individual data sets.

3.3.1 Inventory Monitoring versus Compliance Monitoring

Community-based ecosystem monitoring is goal-oriented, structured (with a standardized protocol), and designed to be repeated over time. Of the types of monitoring mentioned above, inventory monitoring—assessing how conditions have changed over time (compared to the baseline)—will likely represent most community-based efforts. Compliance (implementation or effectiveness) monitoring implies that citizens measure ecological parameters against actions or outcomes most likely established by government regulations, guidelines, or objectives. Compliance monitoring, therefore, has potential to be political. In addition, community-based inventory monitoring will likely embrace non-economic and rare or endangered species, while community-based compliance monitoring will likely revolve around issues related to forestry, fishing, and water.

In general, community-based ecosystem monitoring can be thought of as measuring the changes in conditions over time of selected ecological parameters. Frequently these parameters relate to a threatened species or sensitive habitat. However, all variations of science-based community ecosystem monitoring share common principles, and each has the potential to help society achieve better natural resource management. This improved management is achieved through continually generating and adding new ecological information to the adaptive decision-making cycle (Figure 1).

3.3.2 Social Parameters

Modern definitions of ecosystems and community-based ecosystem monitoring programs include reference to social factors. A successful ecosystem monitoring program should consider how ecological parameters are nested within the social and economic systems, and community-based ecosystem monitoring should help us learn about social factors affecting a community (Bliss *et al.* 2001; J.J. Kay, Professor, Environment and Resources Studies, University of Waterloo, pers. comm., December 20, 2001). However, should a CBEM program necessarily measure social parameters?

Often, human activity is already accounted for by measuring "purely" ecological parameters. This is true if the context of the CBEM program acknowledges the human dimension of environmental problems (e.g., observing butterfly populations because of concerns about pesticide use). The data collected may be ecological (butterfly presence), but the human dimensions (social acceptance of pesticides, economic dependence on pesticides) can be introduced into the data analyses and reporting of results. For example, knowledge of threats to an ecosystem may provide essential background information that justifies the project (e.g., has the quantity, type, area, or timing of pesticide use changed relative to a monitoring site?). However, social and economic information need not be collected as part of the *fieldwork* of a volunteer-based ecosystem monitoring program for the following reasons:

- Conservation-minded volunteers are likely more interested in nature-based work (counting butterflies) than in paper work (analyzing agricultural records); and
- Social and economic data may be available through other sources, such as Statistics Canada (census data), Human Resources and Development Canada, or other government agencies, industry associations, or chambers of commerce.

Furthermore, as Bliss *et al.* (2001) point out, problems that communities face are neither strictly social nor strictly environmental, but are extraordinarily complex. Thus, environmental issues are addressed most effectively by multiparty monitoring. Different social groups (e.g., residents, workers, and bureaucrats; young people; poor people; etc.) are affected differently by environmental change. Consequently, it is highly desirable to achieve diverse participation in planning a CBEM program (Martell 1998; 1999; Bliss *et al.* 2001; Rosenau and Angelo 2001). Diverse participation is one way of accounting for different social and economic factors in the design and interpretation of a CBEM program. Therefore, community-based ecosystem monitoring should involve "place-based science" and the monitoring program should be designed as a "collaborative learning system" (J.J. Kay, pers. comm.), while maintaining the scientific integrity of the monitoring methodology.

Recently, environmental reporting by government agencies, NGOs, and corporations has included the use of ecological, social, and economic data to provide a complete picture of pressures and trends. Proper synthesis and reporting from a CBEM program should therefore convert "ecological data" into "environmental, social, and economic information" (J.J. Kay, pers. comm.). Often referred to as "sustainability reporting" or the "triple bottom line," this reporting highlights indicators that reflect ecological, social, and economic criteria. Excellent examples, which include commentary on data relevancy and acquisition, are emerging in British Columbia (see Fraser Basin Council 2001; BC Hydro 2001, Fraser River Estuary Management Program 2001).

Community-based ecosystem monitoring programs can account for social factors by including:

- a well-researched project justification,
- diverse participation in planning, and
- reporting that includes social and economic factors.

In the same way that a CBEM program needs scientific support from specialists to ensure that the indicators are valid, the sampling methodology is sound, and the data are comparable, the program

should have the support of social analysts. These experts can place the environmental factors in context, especially when program results are synthesized and reported. With these supporting conditions met, it is appropriate for the on-the-ground component of a CBEM program to focus solely on ecological conditions.

3.4 Designing a Community-based Ecosystem Monitoring Project: The Role of Government and Other Organizations

Considerations about the roles of government and other organizations will affect the design of a community-based ecosystem monitoring project. For instance, CBEM projects can range from an NGO-led program that is independent of government research and not integrated with other monitoring programs, to a government-led program linked with government scientists that is part of a larger program. Any of these types of CBEM could be appropriate, depending on the program's objectives (Bliss *et al.* 2001).

A community-based ecosystem monitoring program may be carried out either independently of government scientists, or in collaboration with them. However, considering that a major interest in citizen and NGO monitoring is to fill existing or anticipated "monitoring shortfalls" and to provide data that will help influence land-use decisions, at some stage government agencies should be able to access (and trust) the data. Therefore, if community-generated data will be used to inform decision making, monitoring must occur in collaboration with the government or special efforts must be taken to control the quality of the data and then make it available. Researchers have persistently recommended stronger links between scientists and managers to improve ecosystem monitoring. Likewise, those now studying community-based ecosystem monitoring recommend that community-based programs be carried out in close association with relevant government agencies (Bliss *et al.* 2001; Fore *et al.* 2001; Rosenau and Angelo 2001).

A monitoring program could be initiated and led by:

- an NGO or citizens' group seeking to collect and share data, either for advocacy or research; or
- a government agency seeking to engage the public, either for the sake of public involvement or because it needs assistance with data collection.

Other potential partners in initiating, designing, managing, or even leading a CBEM effort include funding organizations, universities or community colleges, and extension organizations. Funding organizations (e.g., corporations, foundations, or NGOs such as the Columbia Basin Trust) have the opportunity to stipulate or screen how CBEM projects will be carried out. An organization with a high level of awareness about scientific methodologies, long-term commitment, and the capacity to manage and share information will more likely fund projects that fill information gaps and inform adaptive decision making (K. Gosal, Community Liaison, Columbia Basin Trust, pers. comm., January 23, 2002).

Universities and colleges are frequently involved in CBEM projects, but often operate as silent partners. In some cases, monitoring programs were initiated by academics with student involvement and depended heavily on the academic institution's support (i.e., the University of Toronto's Citizens' Environment Watch and the B.C. Institute of Technology's Burnaby Lake System Project). In other cases, universities or colleges provided behind-the-scenes support in data management. Many of these arrangements were likely negotiated between the academic institution and either a government agency or an NGO, and were extensions of previous working relationships or personal and professional connections between the different organizations.

An NGO that attempts to start a new CBEM project should ensure its proposed program is relevant and appropriate to the mandates and resources of potential funders and supporters. If connections can be made with dedicated people at a learning institution, such a partnership is an ideal framework for a CBEM program. As well as access to human, financial, and material resources, a university or college can

lend the program additional credibility and stability (B. Savan, Co-founder of Citizens' Environment Watch and Adjunct Professor of Planning and Geography, Innis College, University of Toronto, pers. comm., January 24, 2002).

A successful CBEM program needs to garner the support and interest of everyone involved to obtain adequate financial and technical resources, to efficiently and effectively share information with others, and to attract committed volunteers. Extension organizations, such as FORREX–Forest Research Extension Partnership, the Sonoran Institute, or the South Okanagan–Similkameen Conservation Program, can raise awareness about the value of partnerships, and educate various partners or stakeholders in building a common understanding about program priorities, design, co-operation, and knowledge sharing (C. Stark, Canadian Program Associate, Yellowstone-to-Yukon Community Stewardship Project, pers. comm., January 22, 2002).

3.5 Motivations for Community-based Ecosystem Monitoring

Although the different types of community-based ecosystem monitoring share the same principles, an analysis of the various ways of monitoring and the reasons for monitoring is necessary to gain a richer understanding of the subject. To successfully engage the public, a government must understand the motivations of volunteers; to provide quality data, volunteers must understand the requirements of a structured monitoring program; and, to facilitate the sharing of knowledge, an extension organization must understand the relationships and gaps between the needs of decision makers, NGOs, and volunteers.

Community-based ecosystem monitoring tends to be driven by:

- a concern for special places (or features, habitats, or species);
- a desire to address an environmental or community problem or threat; or
- a desire to foster awareness and contribute to planning (Bliss *et al.* 2001).

Citizen participants will likely have different motivations than government or academic researchers, and these motivating factors may affect a monitoring program. For instance, community-based ecosystem monitoring is generally conducted in response to a perceived need for information or as a tool for reducing conflicts and building constructive relationships. Using these two objectives (information collection or relationship building) as a starting point, Table 1 presents monitoring issues and some possible tendencies of a resultant monitoring program. Note that for both these objectives, the government is considered as a user of the data and NGOs take the leadership role.

The "tendencies" outlined in Table 1 are generalizations only. They are not intended to suggest that all community-based monitoring conducted with the "primary motivation" of data collection is simple, reactive, and short term. Indeed, all monitoring programs, by definition, share the goal of collecting data. By highlighting some of the issues related to CBEM, this table is intended to provoke thought regarding some of the potential risks of monitoring, which may be driven by a need for information in response to a perceived crisis and based on concern.

3.6 Benefits and Successes of Community-based Ecosystem Monitoring

Community-based ecosystem monitoring employs the energy, knowledge, and commitment of local volunteers to gather scientific information on ecological conditions thereby expanding the capacity of government agencies and government's ability to make informed management decisions. It also builds an element of public participation into decision making. The participation of community members can facilitate partnerships with other organizations, gain acceptance by the community, and put pressure on managers and decision makers (see *Shorebirds and Sunbathers* opposite).

From the perspective of government, the ability of community-based projects to build partnerships is an important one. In addition to the human resources that NGOs and community groups offer, these

TABLE 1 *Generalized tendencies of community-based ecosystem monitoring efforts designed primarily for information collection or relationship building*

	Primary Objective	
Theme	**Collect data**	**Build awareness/trust**
Focus	Outcome/decision	Process/buy-in
Benefit	Protection	Stewardship
Strategy	Tactics	Ethics
Participation	Special interest	Multiparty
Relationships	Adversarial	Co-operative
Perspectives	Limited	Diverse
Values	Narrow	Inclusive
Motivation	Reactive	Proactive
Temporal	Shorter term	Longer term
Spatial	Specific/special	Variable
Organization	Simple	Complex
Management	More static	More systematic
Government	As user/judge	As user/partner
Design	Independent	Collaborative
Integration	Stand-alone	Existing program
Leadership	Citizens' group or NGO	Government or NGO

Shorebirds and Sunbathers, Presqu'ile Provincial Park, Ontario

As a result of good science about the relationship between fat reserves and the reproductive success of shorebirds, and shorebird surveys that involved volunteers and investigated shorebird food supplies, a community-based group was able to influence management practices at a popular beach. Sunbathers and migrating shorebirds both used the beach, and to encourage recreation for the humans, drifts of plant matter were cleaned up from the beach. However, it turned out that the untidy plant matter held a cache of invertebrates on which the shorebirds depended for food. As a result of regular shorebird (and human) monitoring carried out by skilled volunteers, and co-operation between the community-based conservation organization and the staff of the provincial park, the beach has a new management plan. Despite some pressure to keep the beach "clean," the new plan has a timing window for raking that balances migrations and peak sunbathing season. The shorebird-friendly policy also allows the park's superintendent to completely close the beach to people should weather force thousands of shorebirds to stay grounded.

The community-based group is associated with the area's designation as an Important Bird Area (IBA) and funding for the volunteer monitoring came from IBA's Community Action Fund. The IBA is an international program (Birdlife International) based on international habitat criteria, but guided by local objectives. The Canadian Nature Federation and Bird Studies Canada are responsible for delivering the IBA program in Canada.

— From Stabb 2001

groups may gain access to funding for which a government agency would not be eligible (even though the money may technically come from that or another government department). Many NGOs and community groups include a fund-raising component in their organization and work to secure funding from private grants and foundations (Rosenau and Angelo 2001; B. Craig, Network Science Advisor, Ecological Monitoring and Assessment Network Coordinating Office, pers. comm., December 18, 2001).

From the perspective of the community participants, ecosystem monitoring gives a new level of meaning to their observations, helps raise awareness of environmental policy issues, and, perhaps most importantly, maintains a level of connectivity between people and their natural environments (West Coast Environmental Law 2000; Rosenau and Angelo 2001; Stabb 2001) (see *Herons and Habitat*, opposite).

From the perspective of the public, one advantage of community-based ecosystem monitoring can be improved access to information. For instance, the United States government reported rainfall pH levels every 2 years, whereas the volunteer-based Citizens Acid Rain Network, organized by the National Audubon Society, reported its results locally and nationally on a monthly basis (International Wildlife 1988). More recently, a component of Trent University's (Peterborough, Ont.) Monitoring Acid Rain Youth Program ("Maryp") emphasizes the importance of reaching the public with information by working effectively with the media (Monitoring Acid Rain Youth Program, no date).

In their study of the role of public groups in stream protection, Rosenau and Angelo (2001) assessed the positive aspects of stewardship or advocacy groups participating in some components of habitat management. These benefits are listed in Table 2.

TABLE 2 *Potential benefits of stewardship or advocacy group participation in ecosystem management (from Rosenau and Angelo 2001:24)*

• Volunteers have time and energy where agencies may not have the resources to undertake a particular task
• Local knowledge may not be available to agencies, but can be obtained from individuals in the community
• Community-based groups may have a sense of ownership that stimulates them "to go the extra mile" in collecting information
• Public groups can gain access to additional money
• Public groups may have a passion for the resource that paid agency professionals may not have

3.7 Characteristics of a Successful Stewardship Group

Assessing the positive and negative aspects of using public groups in ecosystem management provides insight into how community-based organizations should design their monitoring efforts. In their study of the participation of public stewardship and advocacy groups in the protection of fish habitat, Rosenau and Angelo (2001) profiled three groups: the Alouette River Management Society (ARMS), the Pitt River and Area Watershed Network (PRAWN), and the Burnaby Lake System Project (BLSP). Both ARMS and the BLSP have a monitoring component in their work. The BLSP project is somewhat unique—it does not rely as heavily on citizen volunteers, but is guided by faculty and students at the B.C. Institute of Technology and works closely with the local government (City of Burnaby) (R. Gunn, Instructor, B.C. Institute of Technology's Fish, Wildlife and Recreation Program and Co-ordinator of the Burnaby Lake System Project, pers. comm., December 19, 2001). These groups have different mandates and motivations, and therefore have some specific characteristics, interests, and tactics. Table 3 presents a summary of the elements that appeared to make these groups successful.

Herons and Habitat, Saltspring Island, B.C.

A heronry is where heron's live. McFadden Creek on Saltspring Island is where lots of herons live: 138 nests were counted in November 2000 compared to 70 nests in 1992. There are only 8000 herons left from Alaska to California. A community-based group has been using volunteers to help monitor water bird populations around Saltspring Island for over 7 years. With the help of partners, this group has seen the heronry designated an Important Bird Area and has lobbied to get a 1000-m buffer zone around the heronry. The 1000-m siting requirement for development will help keep an unfragmented canopy of vegetation to protect the heronry from eagle predation.

The Waterbird Watch Collective co-ordinates the monitoring, and the Wild Bird Trust and the Islands Trust Fund supported the protection of the heronry by purchasing the land. West Coast Environmental Law has helped identify legal options to protect the site.

— From West Coast Environmental Law 2000

TABLE 3 *Characteristics of successful community-based stewardship or advocacy groups (after Rosenau and Angelo 2001)*

- History of concern in the community and community support
- Focus on primary issue (or place, feature, or species) or message
- Strong, articulate leadership and passionate, committed members
- Strong organizational capacity to co-ordinate resources and people
- Connections with federal, provincial, and local governments at the technical, management, and political level
- Connections with the media, learning institutions, First Nations, other NGOs, or industry to provide required leverage or resources
- Skill at securing funding
- Inclusion of a broad cross-section of people and interests

3.8 Limitations and Challenges of Community-based Ecosystem Monitoring

All types of monitoring require a long-term plan. The main reason why ecosystem monitoring remains highly topical, but poorly implemented, is that existing arrangements fail to offer adequate long-term financial, political, institutional, logistical, and intellectual commitment (Walters 1997; Lindenmayer 1999; Drever 2000). Rosenau and Angelo take the position that "government institutions, frameworks, and agencies at all levels in British Columbia are no longer capable of protecting and restoring [ecosystems] on their own" (2001:3), and envision the active involvement of public groups and NGOs as a solution to stemming the loss of habitat. However, the challenges of securing long-term commitments, which have plagued large-scale government efforts, are also relevant to community-based ecosystem monitoring.

The political environment of a region can present challenges for community-based projects. Some government scientists do not believe that lay groups should be involved in the collection of scientific data (Fore *et al.* 2001). Indeed, government agency staff are employed by the Crown to provide professional management services, and ecosystem management is the legally designated task of government's

environmental agencies (Rosenau and Angelo 2001). Disagreements between government and public groups can also extend to money. In times of government cut-backs, agency staff may be more protective of their funds and their responsibilities.

Social conditions can also affect the success of community-based monitoring. British Columbia has effectively been trading the natural value of habitat and species for the opportunity to exploit other resources (timber, land, hydro power, fur, tourism, and recreation) (Rosenau and Angelo 2001). The opportunity costs of conservation are often perceived as too high with a resulting loss of biodiversity and ecosystem services (e.g., clean water) (Balvanera *et al.* 2001). This can affect community-based ecosystem monitoring (especially in small, rural communities) if the conservation-oriented objectives of the program are perceived to threaten the livelihood of other community residents who are "just trying to make a living" (Rosenau and Angelo 2001). Therefore, in addition to the logistical, institutional commitments, a heightened awareness of trade-offs is required and greater incentives provided for conservation.

In their study of the role of public groups in protecting urban streams, Rosenau and Angelo (2001) assessed the potential limitations of stewardship or advocacy group participation in some components of ecosystem management. Table 4 presents a summary of these potential limitations.

In summary, to build a successful CBEM program and contribute to decision making, NGOs and public groups need to understand these potential limitations. If a group is aware of the characteristics of successful organizations and the challenges of conducting ecosystem monitoring, community-based programs will build support in their communities and provide quality information as an adjunct to government (Bliss *et al.* 2001; Rosenau and Angelo 2001). In addition, the literature we reviewed on the success of CBEM programs agrees that they are most effective when guided by experienced researchers and government agencies (Fore *et al.* 2001, Rosenau and Angelo 2001, Stabb 2001). Although government cut-backs have been a major factor in the creation of some CBEM programs, many groups involved explicitly state that their intention is not to replace the monitoring role of government agencies (e.g., see Citizens' Environment Watch Web site: ***www.utoronto.ca/envstudy/cew/cew.htm***).

TABLE 4 *Potential limitations of stewardship or advocacy group participation in ecosystem management (after Rosenau and Angelo 2001)*

• Information from non-professional lay people can be poorly collected and collated or lost because of an absence of qualified personnel
• Information that has already been collected by agencies may be inadvertently re-collected because of poor communication among groups
• Programs may be incorrectly implemented and have negative environmental impacts
• Activities undertaken by community groups may be of low ecological effectiveness or low management priority
• Money redirected to public groups through layers of bureaucracy may see its potential effectiveness diluted by losses to administration
• Money that is provided to community groups can reduce the total dollars available for paid agency professionals to undertake work

4 EXPERIENCES IN COMMUNITY-BASED ECOSYSTEM MONITORING

According to our review of the academic, popular, and Internet literature, the best-known Canadian volunteer-based ecosystem monitoring programs are those with a specific focus and national breadth, and are organized by partnerships that include the federal government. For example, the birding community has a rich history of volunteerism and community involvement. Across the country, "Christmas Bird Counts" have been organized for over a century. Recent developments in British Columbia include:

- habitat management and monitoring conducted by stewardship groups, particularly for salmon-bearing streams; and
- compliance monitoring conducted by advocacy groups who are concerned by the failure of government agencies and corporations to uphold environmental regulations, especially surrounding forestry operations.

Conservancy or "land trust" groups are also active in protecting sensitive habitat on private lands through acquisition or other means (i.e., covenants or easements).

Each of these monitoring programs or organizations involves different groups of players, diverse dynamics, and unique experiences. The following sections survey the experience of several types of organizations and their distinctive perspectives on the needs and challenges of community-based ecosystem monitoring.

4.1 National Monitoring Programs: The Ecosystem Monitoring and Assessment Network

The Ecosystem Monitoring and Assessment Network (EMAN: ***www.eman-rese.ca/eman/***) represents a national-level ecosystem monitoring program that draws on government, academic, and private-sector scientists, and NGOs and volunteers to assist with data collection. A government institution, this network was founded in 1994 in response to Environment Canada's 1990 Green Plan. The network connects researchers to create an early warning system for the environment—it provides timely information to decision makers, informs the public, and answers ecological questions. EMAN is administered from the Canadian Centre for Inland Waters in Burlington, Ontario, but is essentially a "franchise" operation that gives a national identity to existing ecological research programs and embraces the role of communities and volunteers (Stabb 2000). EMAN has over 140 partner organizations and collects data from over 100 case study sites across the country (Environment Canada 2000a). In British Columbia, EMAN has been criticized for being understaffed and "Ottawa-centric," and hence limited in its ability to deal with relatively small monitoring projects (K. Martin, Centre for Applied Conservation Biology and Professor in the Department of Forest Sciences, University of British Columbia, pers. comm., January 24, 2002).

4.1.1 Early Warning Science

The "early warning system" that involves NGOs, public groups, and citizen volunteers is a relatively new dimension of the Ecosystem Monitoring and Assessment Network. To ease the demand of tracking environmental change across the country, EMAN needs volunteers to contribute data, and needs to focus on indicator species or "standardized ecosystem monitoring protocols." The network assembled a list of 1770 monitoring variables, tested their responses to 12 environmental stressors (i.e., endocrine disrupters, invasive species, carbon cycle/climate change, UV-B radiation, habitat fragmentation, transportation corridors, acid rain, DDT, eutrophication, ground-level ozone, pulp and paper mill effluent, and groundwater contamination), and selected a suite of 22 "core monitoring variables" (Craig and Vaughan 2001).

As an example, scientists have identified frogs (for a variety of biological reasons) as a species that is sensitive to environmental stressors (e.g., climate change and contamination) and that can indicate changes in several of the monitoring variables; scientists have also observed that frog populations have declined even in relatively pristine areas. As a result, EMAN set out to standardize and expand frog monitoring initiatives that already existed in several provinces. They piloted FrogWatch in Ontario, with the Metro Toronto Zoo, and enlisted the help of the non-profit Canadian Nature Federation to initiate its national, volunteer-based FrogWatch program (B. Craig, pers. comm.). The Canadian Nature Federation, in turn, was able to find the corporate sponsorship needed to produce communication materials and help inaugurate EMAN's flagship program. FrogWatch, launched in the spring of 2000, provides valuable information on species diversity.

Monitoring of biological indicators (as opposed to chemical analyses that can be measured against standards) is a more holistic assessment of the ecosystem and is useful for addressing non-point sources of pollution. The monitoring of indicators, such as lichen or worms, is relatively labour intensive, and the local knowledge possessed by community-based volunteers can make the program more efficient and consistent. With proper training, volunteers provide reliable data that informs government research or even government investigations and enforcement actions (B. Savan, pers. comm.).

4.1.2 Partnerships

The FrogWatch program has also been picked up in British Columbia where it is managed by the Biodiversity and Wildlife Branch of the Ministry of Water, Land and Air Protection with the support of EMAN, the Habitat Conservation Trust Fund, and the Conservation Data Centre. Through EMAN's communication materials, volunteers receive basic scientific background (e.g., the ecological rationale for interest in a particular species), instruction on a standardized national monitoring protocol to ensure that data are comparable, and direction on how to geographically reference and report their observations.

The Ecosystem Monitoring and Assessment Network and the Canadian Nature Federation have similar partnerships and programs for WormWatch (with Agriculture and Agri-Food Canada) and IceWatch (with the Meteorological Service of Canada and Laval University). They are also developing programs for PlantWatch (with the University of Alberta's Devonian Botanic Garden) and LichenWatch (Environment Canada 2000a; Craig and Vaughan 2001). The Canadian Nature Federation's Web site and newsletter (formerly dedicated only to FrogWatch) serve these national, volunteer-based data collection programs (see ***www.cnf.ca/naturewatch/index.html***). The Federation distributes its *Nature Canada* magazine and newsletters to over 30 000 members a year; therefore, the partnership with the Canadian Nature Federation allows EMAN to communicate more easily with its audience of concerned citizens. This communication is important to raise awareness about the programs, to recruit volunteers, and to disseminate information gathered by the programs (B. Craig, pers. comm.).

4.1.3 Canadian Community Monitoring Network

In January 2002, EMAN and its NGO partner, the Canadian Nature Federation, were accepting proposals from prospective regional co-ordinators for their latest community-based ecosystem monitoring initiative, the Canadian Community Monitoring Network (***www.ccmn.ca***). During this initiative's pilot year (March 2002–2003), 30–40 communities were engaged in a CBEM network. The program's goal is to increase the capacity of communities to carry out ecosystem monitoring and to provide science-based information for local environmental policy. The objective is to test and refine approaches for application to other communities across Canada. The growth of EMAN's CBEM programs since it launched FrogWatch less than 3 years ago is testimony to the timeliness of this research.

4.2 Provincial Ecosystem Management in British Columbia: The Conservation Data Centre

Many provincial ministries and departments have environmental protection as their mandate, or at least an important part of their mandate (e.g., B.C. Ministry of Water, Land and Air Protection, including that ministry's Biodiversity and Wildlife Branch and BC Parks; Land and Water British Columbia; and the B.C. Ministry of Forests). The Conservation Data Centre (CDC: ***http://srmwww.gov.bc.ca/cdc/index.htm***) is a program of the B.C. Ministry of Sustainable Resource Management's Terrestrial Information Branch. It has a specific role in collecting, managing (mapping), and distributing information about rare organisms and ecosystems in British Columbia, and handles data related to inventories of sensitive ecosystems. The CDC is also part of an international network of such centres through the Association for Biodiversity Information.

The CDC maintains a Biological and Conservation Data System of occurrence records, and produces reports of the occurrence and rarity (global and provincial) of species. To ensure data comparability, species are classified and ranked using recognized classification schemes. The centre's professional staff identify information needs, conduct terrestrial ecosystem mapping, review data, and contribute to inventory methodologies and reports on sensitive ecosystem initiatives. The staff also advise people on methods of collecting data for submission to the centre's database and on ways to interpret data received from the centre. However, the ability of staff to carry out these functions depends on their relative priority and sufficient funding (J. Kirkby, Conservation Science Ecologist, BC Conservation Data Centre, pers. comm., December 2001). The Ministry also has data forms and offers training on inventory techniques for non-rare species that are recorded for the Species Inventory Project.

Non-government scientists and amateur naturalists also contribute data to the CDC. Although no formal, concerted efforts have been made to engage specific groups, interested individuals or groups are encouraged to submit their data by using standardized observation forms so that their observations are easily fed into the central database. In addition, contributors are asked to follow standard practices for the collection of inventory data. The multi-agency Resource Inventory Committee (RIC) established the standards and guidelines for inventory fieldwork, and colleges offer continuing education programs on applying the methodologies (J. Kirkby, pers. comm.). With ongoing government cutbacks, it is anticipated that the centre will have limited funds to conduct inventories and field verification. Therefore, the importance of submissions from volunteers will increase. For instance, the information collected by EMAN projects, including its volunteer-based NatureWatch programs, is incorporated into CDC databases (B. Craig, pers. comm.).

Another change in data collection, and environmental management in general, has been the transfer of increased responsibility to local governments and to project proponents or benefactors. As a result, the CDC is working more closely with developers who may not use formal criteria for collecting or interpreting ecological data. Although the CDC tries to make active use of any data it receives, there is a hesitancy to include non-government or "one-off" data in CDC products because of concerns about reliability. As more NGOs, private citizens, and developers become involved in collecting inventory data, it becomes more important to promote the use of standardized collection methodologies and observation forms. Otherwise, considerable volumes of inventory data may be deemed untrustworthy and, although the work may be valid, the time and money of these independent sources may ultimately be wasted (J. Kirkby, pers. comm.).

4.2.1 Wildlife at Risk

The Biodiversity and Wildlife Branch of B.C. Ministry of Water, Land and Air Protection (formerly the Ministry of Environment, Lands and Parks) has produced a series of information brochures to highlight

species at risk across British Columbia (see ***http://wlapwww.gov.bc.ca/wld/list.htm***). These brochures explain the pressures that have placed species at risk, evaluate the status of the species, describe its biology and habitat, and outline the steps necessary to improve the species' survival. Monitoring has been recommended to assess the status of these species and help the CDC fill information gaps; however, provincial agencies do not have the resources to undertake the monitoring for all species at risk and have had limited success with agency-led, volunteer-based programs (R. Cannings, Consulting Biologist, pers. comm., December 2001).

Traditionally, government agencies have conducted scientific research and management, and relatively recently have made attempts at community outreach and participation. On the other hand, many NGOs in the education and environmental communities have specialized in volunteer and community participation for years. Government scientists and agencies may not have an adequate understanding, or perhaps trust, of the effort required to maintain a successful community-based project in the long run. In addition, they do not have adequate, stable financial and human resources dedicated to the support of volunteer-based programs (A. Casselman, President, Association for Canadian Educational Resources, pers. comm., December 2001; R. Cannings, pers. comm.).

4.3 Bird Programs: Bird Studies Canada

Birdwatching is alive and well in Canada. Bird Studies Canada (BSC) is a non-profit conservation organization that directs the energy of volunteer birdwatchers to scientific observations. For example, the Canadian Lakes Loon Survey is volunteer-based program that monitors the breeding success of loons on about 800 lakes across Canada (Environment Canada 2000b). This survey does not require specialized birding skills, and builds on previous long-term monitoring related to acidification of lakes. It is supported by Environment Canada and administered by Bird Studies Canada (R. Cannings, pers. comm.). Another example is the Christmas Bird Count that has taken place since 1900. This program now involves over 50 000 birders in 1800 locations across North and Latin America. Previously administered by the U.S. National Audubon Society, the BSC has recently taken over administration of its Canadian component (see ***www.bsc-eoc.org/bscmain.html***). Other national programs directed by the BSC include the Canadian Migration Monitoring Network and Project FeederWatch.

The BSC establishes monitoring and data entry procedures for all of these programs and uses volunteer-collected, science-based data to help detect trends in bird populations and their habitats. A national science council guides and oversees the BSC's scientist–co-ordinated programs. This ensures that the sampling protocols are sound, the data forms complete, and the information collected fulfils the programs' objectives. In addition, the BSC works in partnership with other science-based organizations, including the Canadian Wildlife Service. This ensures that the data fill important information gaps; it also takes advantage of areas of mutual interest between BSC and its partners, government agencies, and the interests of potential volunteers (S. Hazlitt, Co-ordinator, B.C. Coastal Waterbird Survey, Bird Studies Canada, pers. comm., December 2001).

Bird Studies Canada also operates programs at a regional level. Although BSC has operated in Ontario for 50 years, its British Columbia programs are relatively new. For example, the British Columbia Coastal Waterbird Survey began in 1999, and is carried out in partnership with the Canadian Wildlife Service; and, the Nocturnal Owl Survey began in 2000 with the support of the Vancouver Foundation, the B.C. Federation of Ornithologists, and the Habitat Conservation Trust Fund. The water bird survey is based on monthly observations and the owl surveying is done on an annual basis (***www.bsc-eoc.org/regional/bcprograms.html***). To date, BSC's efforts have been focused on the Coast, but informal feedback from birders suggests that additional resources and programs for volunteers are needed in the Interior (S. Hazlitt, pers. comm.).

For both British Columbia programs, BSC recruits and informs the volunteers. The volunteers monitor their designated site or route and report their observations according to standardized survey protocol. For the Coastal Bird Survey and other BSC programs, skilled volunteers are required to differentiate between species in the field. Volunteers either are known to BSC through an informal network of skilled birders, or are known amongst themselves as knowledgeable birders. The BSC is frank about its needs and provides training resources to volunteers; however, volunteers that move dramatically along a learning curve (i.e., adding species that they are able to identify) may skew a survey's results. To handle such issues, the results of one volunteer are compared to the results of the same volunteer over time and emerging trends of positive observations are compiled; therefore, a volunteer's inability to identify a given species would not count as absence of that species. The results are reviewed by BSC staff and, should problems arise, each survey's co-ordinator is available to check the results with volunteers and answer any questions they may have (R. Cannings, pers. comm.).

4.3.1 Volunteer Management and Retention

The bird count programs, with their long history, provide valuable experience on which to build other community-based ecosystem monitoring programs. For instance, although governments may perceive that volunteer labour is "free," BSC's experience has shown that effective program management requires sufficient staff resources to deal with the volunteers, manage data, secure funding, and generate information products. Without the necessary financial and technical support, and feedback mechanisms, volunteer-based monitoring programs are unlikely to last (R. Cannings, pers. comm.; S. Hazlitt, pers. comm.).

Bird Studies Canada also acknowledges the increased awareness of the role played by volunteers, especially given the limited resources of all levels of government—and this raises concerns about the demands placed on the volunteer workforce. For example, the people interested in counting birds may be the same people who are interested in counting frogs or collecting water samples. Enough volunteers must be available in the long term to justify the start-up costs of a new monitoring program (e.g., defining sampling protocols, designing data forms, and producing brochures and booklets). Another important aspect of monitoring program management is, therefore, volunteer retention, which involves the provision of adequate contact and support. To maintain the interest of volunteers, and possibly funders, the production of short-term educational or advocacy products may be necessary, as several years of data collection may pass before trends in species populations are noticeable (S. Hazlitt, pers. comm.; B. Savan, pers. comm.).

4.4 Stewardship Groups

Numerous stewardship groups, mostly involved with water (i.e., water quality, riparian habitat, or stream and fish protection), actively help to manage or restore specific streams, lakes, or watersheds. Next to birds, water is an area of strong public interest and participation. A study 1995 by the U.S. Geological Survey cited over 500 volunteer groups occupied in water-quality monitoring; in Washington State alone 11 000 volunteers are involved in surface water monitoring and protection (Fore *et al.* 2001). Many of stewardship groups in Canada were established and increased their capacity to collect science-based data with the support of government programs such as the federal Department of Fisheries and Oceans' Habitat Conservation and Stewardship program (Rosenau and Angelo 2001).

4.4.1 Federations and Alliances

Stewardship groups range from small citizens' groups that spring up in response to a local threat, to large naturalist clubs with long histories and well-defined organizational structures. Co-ordinating

bodies exist in British Columbia that support and track the province's various types of environmental and stewardship groups. Examples include: the Federation of BC Naturalists, the Pacific Streamkeepers Federation, the British Columbia Lake Stewardship Society, the British Columbia Watershed Stewardship Alliance, Networking BC Rivers, the BC Wildlife Federation, and Wetland Keepers. Each group or club that is affiliated with these federations, societies, and alliances represents a community-based group of volunteers that may be interested in participating in ecosystem monitoring. In fact, many of these groups may already conduct volunteer monitoring as part of their stewardship activities.

4.4.2 Streamkeepers

Planned by the federal Department of Fisheries and Oceans (DFO) in 1993 and funded through the Fraser River Action Plan, Pacific Streamkeepers Federation started in 1995 and has become a model for community-based environmental activism. The Streamkeepers program uses scientifically sound techniques described in plain language and has provided training to hundreds of volunteers across the province. Streamkeepers continues to work closely with DFO and community colleges (e.g., Capilano College) to provide training to volunteers so that they can assess, monitor, and protect their local streams. The training is standardized for all groups, based on DFO protocols outlined in its *Streamkeepers Handbook and Modules*. The Pacific Streamkeepers Federation provides support by connecting groups with trainers, supplying streamkeeper's kits, and facilitating communication between various streamkeeper groups and with other community-based stewardship groups (see ***www.pskf.ca/***).

4.4.3 Lake Stewardship Groups

Part of a larger network called the North American Lake Management Society, the British Columbia Lake Stewardship Society was established in 1997 after several conferences and 2 years of start-up work funded by the Habitat Conservation Trust Fund. Similar to the Pacific Streamkeepers Federation, the B.C. Lake Stewardship Society promotes local stewardship, facilitates monitoring workshops, maintains information resources, co-ordinates events, and aids communication between the different stewardship groups and their interaction with government and industry. The program has also partnered with academic institutions (e.g., University of Northern British Columbia) to offer lakekeepers workshops on lake processes and field sampling. Typically, the stewardship groups promote environmental awareness of local issues that affect water quality and conduct water quality testing overseen by professional biologists (see ***www.nalms.org/bclss***). See *Eagle Eyes* (opposite) for information about a similar stewardship program.

4.5 Advocacy Groups and Compliance Monitoring

4.5.1 Stewardship versus Advocacy

Unlike stewardship and naturalist groups that help care for certain areas, advocacy groups pressure governments to manage resources with diligence and to produce progressive new policies that meet the needs of environmental protection. While some overlap exists between stewardship and advocacy activities, many environmental organizations are much stronger in one activity than the other. Many community-based groups focus on stewardship to the exclusion of advocacy, perhaps because advocacy work demands the time and energy required to understand science, policy, and the political process (Rosenau and Angelo 2001). Examples of advocacy groups in British Columbia include: the Sierra Legal Defence Fund, West Coast Environmental Law, the David Suzuki Foundation, the Environmental Mining Council of British Columbia, the Canadian Centre for Policy Alternatives, the East Kootenay Environmental Society, the Valhalla Wilderness Society, the Granby Wilderness Society, the Canadian Parks and Wilderness Society, the Western Canada Wilderness Committee, Ecotrust, and the Outdoor Recreation Council of British Columbia.

Eagle Eyes: Wildlife Tree Stewardship, Vancouver Island, B.C.

In the summer of 2000, the Federation of BC Naturalists secured funding for a program called Wildlife Tree Stewardship (***www.naturalist.bc.ca/***). This project has grown from an eagle-focused program near Comox and Nanaimo to a more structured multi-species wildlife tree project throughout the southeastern end of Vancouver Island. The program is funded by EcoAction, a program of Environment Canada that funds community-based environmental projects (***www.ec.gc.ca/ecoaction/index_e.html***). This funding allowed the Federation to take the critical step of hiring a biologist to co-ordinate the stewardship project.

The Federation's partners include BC Hydro, Environment Canada, and the B.C. Ministry of Water, Land and Air Protection. Agency officials helped the Federation deliver training to over 100 stewards and the data collected is entered into provincial and federal databases. A goal of this project is to protect habitat by establishing approximately 70 conservation agreements with private landowners. In addition, the project has identified a need for better scientific information on the foraging habits of herons, and hopes to contribute to that research (R. Speller, Federation of BC Naturalists, pers. comm., December 2001).

Although many advocacy groups may not conduct monitoring, they can be an important resource for community-based monitoring groups and, in some cases, a source of funding. Advocacy groups are also well connected to government personnel and knowledgeable about the most recent directions of government policy. Some businesses with progressive environmental and social policies, such as VanCity Credit Union, Mountain Equipment Co-op, and BC Hydro, may also play a supportive role for stewardship groups. Corporate sponsorship is important to the Nature Watch programs of the EMAN and the CNF (e.g., Petro Canada and Imperial Oil).

4.5.2 Forest Watch

Forest Watch originated in Vermont in 1994 as an action-oriented voice for wildlife, wilderness, and backcountry recreation, dedicated to saving and re-creating wild forest. One of its goals is: "to mobilize citizens and other groups to watch over and report on forest conditions and practices" (Forest Watch 2001). Now many states and provinces have Forest Watch groups, frequently supported by a network of environmental NGOs. Global Forest Watch, a worldwide initiative of the World Resources Institute, was formed in 1997 and by 2006 it will have expanded its coverage from four countries to 25 (see ***www.globalforestwatch.org***). Forest Watch of BC is a founding member of Global Forest Watch.

In British Columbia, Forest Watch started as a project of the Sierra Defence Legal Fund and several partners. Forest Watch of BC began training volunteers in 1996 and provided the structure, training, support, and resources necessary for local people to deal with local forestry problems. Forest Watch of BC documented forest conditions to ensure the long-term sustainability of forests and forest communities; it did this by facilitating an "on-the-ground" network of trained people who monitored forestry planning and practices across the province. Therefore, its volunteers were trained in compliance monitoring, tended to monitor sites as "one-offs" (i.e., not long-term, repeated visits), and the program was increasingly concerned with the planning process as well as the practices. The program attempted some ecological monitoring, but had concerns about the expense and sophistication of this type of monitoring. However, with adequate support, community-based ecosystem monitoring is a possible extension of Forest Watch of BC's program. In addition, Forest Watch of BC and its partners produced tools such as

maps and checklists that could be useful to environmental NGOs (A. O'Carroll, Director, Forest Watch of British Columbia, pers. comm., January 2002).[1]

In Ontario, the Wildlands League, also in co-operation with the Sierra Defence Legal Fund, has conducted forest audits for several years using its own staff. These audits are designed to measure the effectiveness of certain unambiguous requirements of forest practices regulations (e.g., riparian leave strips, stream crossings, and reserves for non-timber values). Currently, through the Ontario Environmental Network and other organizations including First Nations, the Wildlands League is soliciting advice on developing its forest audits into community-based projects (C. Henschel, Director, Forest Program, Wildlands League, pers. comm., December 2001).

From the perspective of community-based ecosystem monitoring, Forest Watch programs tend to focus on measuring the effectiveness of forest practices, rather than monitoring ecosystem conditions. These programs are also politically charged and carried out in opposition to government policies, rather than designed in concert with government agencies. However, as Forest Watch of BC grew and gained recognition, its meetings were attended by staff of government environmental agencies and representatives of industry associations (Sierra Defence Legal Fund 2000).

4.5.3 Adopt-a-Cutblock

The "adopt-a-cutblock" strategy has been put forward as a way to shift the Forest Watch approach towards monitoring ecological conditions (C. Steeger, Pandion Consulting, pers. comm., December 2001). It would match volunteers with a certain location—a section of logging road or a cutblock—and train them to identify features such as wildlife trees. This approach is similar to the Federation of BC Naturalists' Wildlife Tree Stewardship project and FrogWatch Ontario's program known as "Adopt-A-Pond," which matches volunteers with specific wetland sites (see ***www.torontozoo.com/adoptapond/***). This strategy has also used by the Association for Canadian Educational Resources in Ontario. This NGO encourages individuals, groups, or businesses to "adopt-a-quadrat" for community-based monitoring within forest biodiversity plots which the organization has established (A. Casselman, pers. comm.). BC Parks offers organizations, such as Scouts Canada or sporting clubs, the opportunity to adopt a park (BC Parks 2000).

Similar to existing community-based ecosystem monitoring programs, adopt-a-cutblock would require a co-ordinating body to support the volunteers and to design sampling protocols, schedules, and data forms. Ideally, an adopt-a-cutblock program would be created in co-operation with government agencies (e.g., B.C. Ministry of Forests, B.C. Ministry of Water, Land, and Air Protection), forest companies, and local naturalist clubs. To be successful, its emphasis should be on achieving common goals rather than compliance monitoring (C. Steeger, pers. comm.).

4.5.4 Park Watch

Park Watch, an initiative of the Canadian Parks and Wilderness Society (CPAWS), was designed to raise and maintain awareness about threats and management issues related to protected areas throughout British Columbia. Park Watch performs a networking and educational role, and does not include the monitoring of ecological parameters or compliance issues. However, within this existing network is both the interest and potential to develop a more on-the-ground approach. CPAWS is concerned about duplicating the efforts of other NGOs, but sees the value in examining the potential of on-the-ground

[1] In 2003, Forest Watch of British Columbia announced the closure of its office and its merger with partner Global Forest Watch Canada. See ***www.forestwatchbc.org/main.html*** for details.

monitoring programs. CPAWS and the Sierra Legal Defense Fund are already discussing the possibility of a joint project related to buffer zones around parks (E. Riccius, Park Watch Co-ordinator, Canadian Parks and Wilderness Society, pers. comm., December 2001).

Park agencies often have their own Park Watch programs that involve the public in park management. "Friends of" groups are a type of stewardship group associated with parks. Given their personal connection with the area, their local knowledge, and level of commitment, these groups could take part in ecosystem monitoring. The Park Watch Program of BC Parks is part of its Conservation Steward Program for volunteers. Park Watch promises to provide training to conservation-minded volunteers; volunteers will then observe and report on visitor behaviour, as well as natural and cultural features. The information collected by Park Watch volunteers will help inform the agency's annual management plans (see ***http://wlapwww.gov.bc.ca/bcparks/involve/volstew.htm***).

The Greater Vancouver Regional District's successful Park Partners program involves volunteers who are always keen to take part in new initiatives. Recognizing the enthusiasm of its 1000 volunteers and the quality of their work (e.g., monitoring evasive species), park staff created a data management framework to structure the collected information. This framework is essential to make effective use of the data (R. Gunn, pers. comm.; H. Wornell, Park Planner, Greater Vancouver Regional District, pers. comm., November 2001).

A deeper investigation into park–volunteer relations would almost certainly reveal some unique opportunities and models for successful community-based ecosystem monitoring. However, a defensive or antagonistic relationship may exist between the agencies and the advocacy groups that critique them. Both sides need to work towards a clear understanding that ultimately they share the same goals (E. Riccius, pers. comm.).

4.6 Conservancy Organizations

Non-profit organizations that protect biodiversity by acquiring private lands have proliferated over the past several decades and range from huge worldwide conservancies to local land trusts. The Nature Conservancy, established in the United States in 1951, could be considered the parent of this movement. Sometimes these organizations acquire the property outright by purchase or by donation; at other times, they partner with community, business, or other groups and negotiate various legal agreements (i.e., conservation covenants) with the property owners. In either case, the organizations have a perpetual responsibility for, and access to, the properties (B. Turner, Land Conservancy of British Columbia, pers. comm., December 2001).

Major conservancy groups in British Columbia include: the Land Conservancy of British Columbia, which has regional offices throughout the province; Nature Trust of British Columbia, and Nature Conservancy of Canada. The mandate of these organizations is typically to: "preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive" (see ***http://nature.org/aboutus/***). Some of the valley bottom and riparian habitat properties with which they work in British Columbia are especially important because many of these areas are privately owned. Requirements for inventory and compliance monitoring are built into the covenant agreements. However, each land trust has developed slightly different procedures for collecting, storing, and sharing data, and only recently are the Conservation Data Centre, the Land Conservancy, and others beginning to work towards standardized, comparable methodologies (J. Kirkby, pers. comm.; B. Turner, pers. comm.).

In British Columbia, approximately 17 conservancies and land trusts receive support and co-ordination services from the Land Trust Alliance of British Columbia (***http://landtrustalliance.bc.ca/***) and the Stewardship Centre for British Columbia (***www.stewardshipcentre.bc.ca***). These organizations provide

extensive information resources through their Web sites, as well as consulting, workshop, and facilitation services. Recently, with government and NGO funding, they published *On the Ground: A Volunteer's Guide to Monitoring Stewardship Agreements* (Banighen 2001).

Typically, wardens employed by a conservancy undertake monitoring and enforcement visits to the property. They monitor the condition of the property against a baseline report and according to the covenant agreement. However, this performance monitoring is not designed as scientific data collection to track ecological changes (B. Turner, pers. comm.).

The Land Conservancy of BC and similar organizations depend on volunteers and offer various programs to provide them with on-the-ground conservation experience. For example, the Land Conservancy offers working holidays at a few of its properties. The holidays may involve inventory work or the removal of exotic species; these undertakings may entail a monitoring component, but no long-term, structured plan exists for volunteer-based ecosystem monitoring. However, most conservancies and land trusts are well connected with other environmental NGOs and agencies such as the Conservation Data Centre. They also rely on personal relationships to identify information gaps and to obtain advice (B. Turner, pers. comm.).

4.6.1 Private Stewardship

A similar approach, though not aimed at gaining protective control over property, involves educating private landowners about the natural value of their holdings. This stewardship approach may be employed around protected areas to build community acceptance and create a voluntary "buffer zone" (Yarnell 1997). It is also used by stewardship organizations that are devoted to community-based economic strategies, growth strategies, and land-use planning. The goal of community stewardship is an inclusive planning process that does not polarize communities and results in lasting strategies for ecological sustainability and economic growth. For example, the Sonoran Institute, based in the western United States, works with ranchers, local government, and conservation groups to provide tools for planning, training, restoration, and information sharing. Exercises to develop strategic vision in some of the Sonoran Institute's programs have led to community interest in monitoring and environmental reporting (see ***www.sonoran.org/front.html***). Establishing a close working relationship with the Sonoran Institute and similar extension organizations, partnerships, funding organizations, or advocacy groups may be an effective way to identify such interest and develop appropriate extension or education materials (C. Stark, Canadian Program Associate, Yellowstone-to-Yukon Community Stewardship Project, pers. comm., January 2002).

4.7 Co-ordination of Community-based Ecosystem Monitoring Programs

In addition to the many stewardship, advocacy, and conservancy organizations that undertake or could include monitoring among their activities, a few NGOs in Ontario specialize in facilitating science-based volunteer monitoring projects, including Citizen's Environment Watch and the Association for Canadian Educational Resources.

4.7.1 Citizens' Environment Watch

Based in Toronto, the Citizens' Environment Watch (CEW) was established in 1996 because of concerns about government cutbacks affecting environmental monitoring programs. The group's primary focus is collecting data on air and water quality to identify communities' environmental quality issues. The CEW also conducts outreach and education programs that promote involvement of the community in hands-on projects that will initiate positive environmental change. So, as well as helping communities monitor

air and water quality, the CEW also educates young people and gives volunteers the opportunity to work with academics, NGOs, and government scientists and managers.

Citizens' Environment Watch partnerships include close ties to universities. The organization is affiliated with Innis College at the University of Toronto, where one of its founders is a faculty member in planning and geography. In addition, York University's Centre for Applied Sustainability handles online data management for CEW programs and Trent University in Peterborough is helping to develop new peer-reviewed protocols for monitoring lichen as an indicator of air quality. For establishing monitoring protocols, the CEW also works closely with the Toronto and Region Conservation Authority and EMAN (see Scharpe 2001; ***www.utoronto.ca/envstudy/cew/cew.htm***).

4.7.2 Association for Canadian Educational Resources

The Association for Canadian Educational Resources (ACER) is another Ontario-based NGO that specializes in facilitating science-based ecosystem monitoring at the community level. Following international research protocols for biodiversity monitoring established by the Smithsonian Institution's Monitoring and Assessment of Biodiversity (SIMAB) program (Smithsonian Institution 2003), ACER has set up a network of long-term biodiversity monitoring plots that focus on forest health. This network stemmed from the lack of a standardized approach to forest monitoring among different agencies, and the desire to involve public groups and citizen volunteers in community-based ecosystem monitoring. ACER has established pairs of standard, permanent research plots on lands where long-term ownership is secure, such as educational institutions, conservation authorities, or parks. These plots meet the international protocol of 1 ha (100 m × 100 m) in size and are divided into 25 quadrats measuring 20 × 20 m. Trained volunteers use one of the plot pairs and professional researchers use the other (A. Casselman, pers. comm.; see ***www.acer-acre.org***). The SIMAB methodology, and modifications of it, is also applied by EMAN and its partners on their long-term research plots (B. Craig, pers. comm.).

As well as conducting the standard SIMAB biodiversity measures (i.e., recording species and measuring diameter-at-breast-height for trees larger than 4 cm in temperate regions), the trained volunteers can apply other monitoring protocols such as recording bloom times or identifying worm species. Although ACER had some problems on its early sites with the accuracy of surveying the plots and quadrats, it currently has about 20 sites at various stages of development. Many of the plots are relatively new and within their first cycle of data collection. In addition, many of the plots that are reserved for "scientists-in-residence" are not yet matched with scientists. Data from the program are self-audited by the volunteers or their organization and subject to external review before they are accepted by ACER. ACER then makes the data available to EMAN and other government agencies or academic researchers. ACER is diligent about data quality and external review because the program needs to establish itself as a credible way of doing "real science" with non-scientists (typically school children or naturalist clubs). ACER also wants to maintain its volunteer base, so it protects data quality to ensure that volunteers are not exposed to negative feedback. A recent, high-profile initiative of ACER is its partnership with the Humber Arboretum in Toronto (A. Casselman, pers. comm.).

5 LESSONS LEARNED

5.1 Summary

The literature review revealed that government agencies, NGOs, academics, and citizens share a general belief that community-based ecosystem management can extend government's capacity to protect the environment and conserve biodiversity. In community-based ecosystem monitoring, community members generally participate in measuring the changes in ecological conditions over time to help fill information gaps and contribute to adaptive decision making in ecosystem management. However, our research also revealed that "community-based ecosystem monitoring" can assume many forms, depending on the issues involved and the co-ordinating organization.

Three important characteristics of successful community-based ecosystem monitoring surfaced:

- They were designed in collaboration with government researchers.
- They were inclusive, involving a diverse group of participants at all stages.
- They possessed the resources to support the needs of volunteers and to manage the data that are generated.

Our discussion of existing community-based ecosystem monitoring programs explored different types of monitoring efforts. Depending on a project's scale, monitoring programs involved a combination of players: government departments, such as EMAN, the Canadian Wildlife Service, or local government; large NGOs, such as the Canadian Nature Federation, Bird Studies Canada, or the Pacific Streamkeepers Federation; various academic institutions involved in research, data management, or teaching; and, smaller groups, such as stewardship groups, naturalist clubs, scout or school groups, and individual citizens. Most programs have linkages with outside entities, such as the Conservation Data Centre or with universities and colleges, which assist with training volunteers and managing data. The programs' required funding came from a combination of government programs, private foundations, and corporate sponsorship. Finally, some programs are connected with advocacy groups, such as West Coast Environmental Law, or conservancies to apply tools for protecting sensitive ecosystems.

The main message offered by the non-government organizations interviewed is that volunteer-based programs are not free! They advised that adequate support for volunteers is essential to ensure thorough training and control over data quality, and to provide a positive experience for volunteers. Volunteers and volunteer-based programs are unlikely to last very long if the volunteers feel that their information is not appreciated and is not integrated into the decision-making process. This situation may arise because of poor data management or poor reporting and extension by the co-ordinating organization, or because decision makers in the government choose to ignore the community-generated information.

To manage the risk of alienating volunteers and ensure effective use of the collected information, the co-ordinating NGO needs recognition and acceptance by the relevant agency, whether it is EMAN or the local planning authority. The co-ordinating organization also needs to generate and distribute information through Web sites, newsletters, and media campaigns to provide feedback in the short term. It is also advisable to host meetings and invite volunteers to conferences.

To get quality output from community-based ecosystem monitoring, the monitoring plan (e.g., issue identification, participation, goals, methodologies) should be scientifically valid and relevant to existing policy. To get good input for a community-based program, the volunteers must be motivated through high-quality experiences (e.g., receive challenging training, unique experiences, clear channels of support, tangible results). However, no internationally accepted or pan-Canadian protocols exist to ensure a standard level of care in supporting volunteer efforts.

5.2 Defining a Role for FORREX–Forest Research Extension Partnership

Given the wide array of emerging initiatives in community-based ecosystem monitoring, how does a research extension NGO like FORREX define a role for itself? "Gradually" is probably the best answer. Consulting with government agencies to identify information gaps, engaging a broad range of participants, and securing the necessary funding and other supportive resources all take time. After seed money was obtained, many successful stewardship programs in Canada and British Columbia typically took 2–3 years to be developed and officially launched.

5.2.1 Co-ordinating a New Program

If FORREX is going to lead a monitoring program, the organization will need to define its identity as a player in community-based ecosystem monitoring by selecting a region and an issue that fits with government needs and the public interest. Before it invests in program establishment, FORREX must also determine that a core of available volunteers exists who share its specific interests and possess the required skill set. Successful programs—whether large or small scale—tend to focus on specific species or issues (e.g., frogs, herons, ice, trees, or water quality).

When a region and an issue are identified, organizations can fill several distinct roles within a community-based ecosystem monitoring program. FORREX should determine whether its strengths and interests lie in:

- developing science-based monitoring protocols, observation forms, and databases;
- preparing communication, recruitment, and training materials for monitoring programs;
- co-ordinating volunteers; or
- supporting or linking other organizations in any of these endeavours.

FORREX could take on one or all of these roles, depending on its resources and partnerships. FORREX should also determine whether any of these roles are already filled. For instance, a frog monitoring program independent of EMAN would be unnecessary.

5.2.2 Supporting Existing Programs

An alternative role for FORREX would involve offering support to existing programs. For example, our research showed that the compliance monitoring conducted by advocacy groups such as Forest Watch, and the inventory and performance monitoring conducted by conservancy groups, both have the potential to evolve into community-based ecosystem monitoring programs. Rather than create a distinct program, FORREX could conduct workshops that extend information about the design of ecological monitoring programs, and prepare educational brochures and videos. A first step would involve drawing attention to the differences between inventories and monitoring and ensuring baseline inventories are designed so that long-term ecological monitoring is possible. Supporting new CBEM efforts that will be part of the proposed Canadian Communities Monitoring Network, through the CNF and EMAN, is another area where FORREX may offer its knowledge and expertise.

With this type of role, FORREX could both communicate "up" by linking community-based groups that collect information to the agencies that could use it, and communicate "down" by bringing an agency-designed program to community groups to carry out the fieldwork. In either case, FORREX's role is to share knowledge between government professionals and community-based groups and volunteers. Whether facilitating this transfer of knowledge "up" or "down," FORREX would need a solid understanding of agencies' requirements for information quality and community groups' desires for experience and outcome.

5.2.3 Possible Areas of Interest for FORREX

Organizations such as EMAN, Streamkeepers, and parks agencies have grown quickly. They are generally operating at full capacity and cannot take on more partners or initiate new programs. However, after FORREX has defined its role and has established involvement in community-based ecosystem monitoring, it may have concrete ideas to offer these institutions.

If FORREX focuses on the interests of NGOs and in communicating "up" to share knowledge with government agencies, it should investigate the possibility of providing support for community groups and conservancies who are showing interest in building on their existing inventory and performance monitoring programs. This might involve educating them about the elements of long-term monitoring, or presenting a design for a new program such as "adopt-a-cutblock." If FORREX focuses on the needs of the government and communicating "down" to NGOs, it could work with the Conservation Data Centre and regional offices of the B.C. Ministry of Water, Land and Air Protection to identify potential information gaps and possible NGO or community partners. With either approach, organizations such as the Citizens' Environment Watch and the Association for Canadian Educational Resources are examples of community-based initiatives that FORREX may look to for advice.

6 CONCLUSION AND RECOMMENDATIONS

International bodies (e.g., World Conservation Union), interagency government programs (e.g., EMAN), or large NGOs (e.g., World Resources Institute) excel in assessing policy-relevant data gaps and formulating conservation objectives. Government agencies are adept at translating international objectives for conserving biodiversity into national and regional policies and strategies. From there, it is the role of provincial, regional, or local governments to define the information needs required to support these policies. It is at this on-the-ground level that well-intentioned conservation policies often fail to meet their objectives, owing to a lack of human and financial resources for monitoring.

The provinces are legally responsible for managing most terrestrial natural resources. Therefore, as a starting point, FORREX should consult with the Conservation Data Centre and regional representatives of the B.C. Ministry of Water, Land and Air Protection to identify species and habitats of mutual interest. Analyzing the brochures from the "Wildlife at Risk" information series may be a good starting point.

When FORREX and the relevant authorities have identified common interests, FORREX could assume a role in promoting the concept of science-based, community-based ecosystem monitoring. It will be important to engage local governments, universities or colleges, and stewardship groups, advocacy groups, and other public groups or individuals to identify existing community-based programs, interests, and possibilities. FORREX could act as a catalyst for uniting other partners, play a supporting role as an educator and facilitator, or take on a co-ordinating role for the delivery of new programs. Whatever role FORREX assumes, the most important issue in the short term is to initiate a dialogue.

The other obvious role for FORREX is assisting in the compilation and translation of the best scientific monitoring protocols into convenient and user-friendly packages for citizen monitors. Every sector of biology, from bryology (the study of mosses) to cetology (whale science), has its own favoured set of monitoring methodologies for different situations, with obscure scientific jargon to match. Monitoring techniques in the social sciences can be equally confusing. Researchers within the same discipline often squabble over their preferred methodologies. Many more NGOs and citizen groups would become involved in CBEM if further attention were paid to developing a basic set of explicit, clearly explained methodologies that experts in the respective field agree upon. Whatever role FORREX assumes, the most important issue in the short term is to initiate a dialogue.

6.1 Recommendations

To define its role in community-based ecosystem monitoring, FORREX–Forest Research Extension Partnership should pursue the following four steps over the next 1–3 years:

1. Use this report as a basis for an internal consultation with the Board of Directors and staff to set goals and directions.
2. Advance the dialogue and advertise the Partnership's presence in the community-based ecosystem monitoring sector by holding an interactive workshop for government, academics, environmental NGOs, and stewardship groups.
3. Narrow down the issues, regions, and partners that are of specific interest to the Partnership.
4. Identify a specific component in which the Partnership could specialize, and seek out appropriate partners and funding support.

Making progress in any of these steps requires that FORREX initiate a dialogue with a broad range of like-minded organizations. In the short term, and as part of the larger consultation, FORREX should focus on steps 2–3 and invest its energies in defining its geographic area of interest (e.g., Interior, Coast), the issues on which to focus (e.g., wildlife species, habitat quality), and the agencies or groups with which it wishes to partner (e.g., EMAN vs. local governments, streamkeepers vs. conservancies). Defining its interests and strengths can only be done relative to the other organizations that play roles in community-based ecosystem monitoring.

Many people who contributed information for this study thought that it was timely. Many also indicated that their organizations would be willing to assist FORREX in initiating a dialogue or getting a new program off-the-ground. Some of those interviewed suggested that, to advance the CBEM dialogue, FORREX should organize a conference or workshop. A conference would be useful to review the principles of adaptive ecosystem management and to introduce and define the emerging concept of community-based ecosystem monitoring. Such a gathering would be beneficial from both an educational and a networking perspective.

It may take the Partnership some time to decide on the specific role it will play in promoting and facilitating community-based volunteers who contribute reliable information to the natural resource decision-making process. However, in the meantime there is much to be gained by raising awareness, advancing the dialogue, expanding the network of interested organizations, sharing experiences, and identifying alternative approaches and potential partnerships.

APPENDIX 1 Background on FORREX–Forest Research Extension Partnership

Founded in 1998, FORREX[2] is a non-profit society dedicated to promoting healthy and sustainable ecosystems throughout British Columbia. The Partnership includes natural resource agencies, resource managers from industry and communities, First Nations, learning institutions, special interest groups, and the public. The Partnership's goal is: "to foster partnerships in learning between natural resource users, researchers, and those with experiential and Indigenous knowledge, and to share and apply innovative ideas in the area of ecosystem management" (Southern Interior Forest Extension and Research Partnership 2000).

FORREX–Forest Research Extension Partnership is directed by a board and has developed projects in three main business areas: Identifying Information Needs, Extension Services, and Information Management. Within these areas, FORREX has nine extension[3] programs:

- Early Stand Dynamics
- Ecosystems and Stand Management
- Ecosystem Management and Forest Practices
- Aboriginal Forestry
- Socio-economics
- Natural Resource Information Management
- Watershed Management
- Small Woodlands
- Conservation Biology

Additional information about the Partnership, and its members, directors, and programs is available at: ***www.forrex.org***.

[2] Previously known as the Southern Interior Forest Extension and Research Partnership and registered as the Southern Interior Extension and Research Society.

[3] Extension refers to a program that makes information and knowledge available to people who would otherwise not have access to such resources.

Dear friends and colleagues:

Working on behalf of the Forest Research Extension Partnership (FORREX), I am preparing a report on the experiences of NGOs and citizen groups doing ecosystem monitoring (also known as "community-based ecosystem monitoring") and the potential for their data to be used in decision making.

I am contacting you, as an environmental professional with interests and experience in ecosystem management, capacity building, and (or) public involvement in decision making, in the hopes that you will be able to contribute to this study by assisting with any of the following:

1. Providing me with any relevant literature references on community-based ecosystem monitoring that you are aware of;
2. Discussing any relevant programs or experiences, and how you see community-based ecosystem monitoring developing in the future;
3. Identifying any obstacles or information gaps in the implementation of community-based ecosystem monitoring, and how an extension organization (NGO) might be able to resolve these gaps or obstacles; and,
4. Directing me to other colleagues or organizations that may have expertise in public/NGO involvement in ecosystem monitoring.

Thank you in advance for sharing your experiences and insights.

Sincerely,

Patrick Yarnell, MRM
Environmental Planning and Management
Vancouver, B.C.

REFERENCES

Literature Cited

Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada and Natural Resources Canada. 2000. Earth Tones . . . The Book: Federal science for sustainable development. Public Works and Government Services Canada, 2025/E.

Balvanera, P., G.C. Daily, P.R. Ehrlich, T.H. Ricketts, S.-A. Bailey, S. Kark, C. Kremen, and H. Pereira. 2001. Conserving biodiversity and ecosystem services. Science 291(5511):2047.

Banighen, T. 2001. On the ground: a volunteer's guide to monitoring stewardship agreements. Land Trust Alliance of B.C. and the Stewardship Centre for B.C. Salt Spring Island, B.C.

BC Hydro. 2001. The journey to sustainability: Triple bottom line report [Annual report]. Vancouver, B.C. URL: ***www.bchydro.com/rx_files/info/info1621.pdf*** [Other info: ***www.bchydro.com/info/reports/reports859.html***]

B.C. Ministry of Environment, Lands and Parks. 2001. Sensitive Ecosystem Inventories in British Columbia. B.C. Ministry of Environment, Lands and Parks, and Environment Canada Canadian Wildlife Service, and Habitat Conservation Trust Fund. URL: ***http://srmwww.gov.bc.ca/cdc/sei/***

B.C. Ministry of Water, Land and Air Protection. 2003. Wildlife at Risk in British Columbia. Brochure Series. URL: ***http://wlapwww.gov.bc.ca/wld/list.htm***

BC Parks. 2000. Park Watch program handbook. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. URL: ***http://wlapwww.gov.bc.ca/bcparks/involve/park_watch.pdf***

B.C. Parks Legacy Panel. 1999. Sustaining our protected areas: the final report of the Legacy Panel. Victoria, B.C. URL: ***http://wlapwww.gov.bc.ca/bcparks/bcplp/final/finalrpt.pdf***

Bliss, J., G. Aplet, C. Hartzell, P. Harwood, P. Jahnige, D. Kittredge, S. Lewandowski and M.L. Soscia. 2001. Community-based ecosystem monitoring. *In* Understanding community-based forest ecosystem management. G.J. Gray, M.J. Enzer and J. Kusel (editors). Journal of Sustainable Forestry 12(3–4):143–167.

Boyle, M. 1998. An adaptive ecosystem approach to monitoring: developing policy performance indicators for Ontario Ministry of Natural Resources. MSc thesis. Department of Environment and Resource Studies, University of Waterloo, Waterloo, Ont.

Campbell, M. 2000. Legislation: the cornerstone for biodiversity conservation and management in Canada. MSc thesis. University of Guelph, Guelph, Ont.

Canadian Endangered Species Conservation Council. 2001. Wild species 2000: the general status of species in Canada. URL: ***www.wildspecies.ca/wildspecies2000/en/home_E.html***

Craig, B. and H. Vaughan. 2001. EMAN and protected areas: cooperating in providing information for ecozone and local ecosystem management. Parks and Protected Areas Ecological Monitoring, EMAN Background Paper VII.

Drever, R. 2000. A cut above: ecological principles for sustainable forestry on BC's coast. The David Suzuki Foundation, Vancouver, B.C. URL: ***www.davidsuzuki.org/files/Cut_Above_final.pdf***

Environment Canada. 2000a. Monitoring the pulse of our ecosystems. Science and the Environment Bulletin 20:1–2.

____ . 2000b. Acid rain still plaguing lakes and loons. Science and the Environment Bulletin 20:4–5.

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

Forest Watch. 2001. Forest Watch Vermont, Goals adopted April 26, 1999. URL: ***www.forestwatch.org/whoweare/goals.php***

Fraser Basin Council. 2001. Sustainability indicators for the Fraser Basin: consultation report. URL: ***www.fraserbasin.bc.ca/documents/Indicator_Consult_Rpt.pdf***

Fraser River Estuary Management Program. 2001. Monitoring the estuary management plan: a report on the performance of FREMP and its partners. URL: ***www.bieapfremp.org/fremp/pdf_files/monitoring.pdf***

Grumbine, E. 1994. What is ecosystem management? Conservation Biology 8(1):27–38.

Holling, C.S. (editor). 1978. Adaptive environmental assessment and management. International Institute for Applied Systems Analysis and Wiley, Toronto, Ont. IIASA International Series, Vol. 3.

International Wildlife. 1988. Volunteers monitor acid rain nationwide. International Wildlife 18:28.

Kappelle, M. 2000. Criteria, indicators and tools for monitoring ecosystem health. Environmental Conservation 27(1):84–85.

Kay, J.J., and graduate students. 2001. The ecosystem approach. Department of Environmental and Resource Studies, University of Waterloo, Waterloo, Ont. URL: ***www.jameskay.ca/about/ecosys.html***

Lackey, R.T. 2001. Values, policy, and ecosystem health. BioScience 51(6):437–443.

Landres, P.B. 1995. The role of ecological monitoring in managing wilderness. Wilderness Research 32(1):10–13.

Lindenmayer, D.B. 1999. Future directions for biodiversity conservation in managed forests: indicator species, impact studies and monitoring programs. Forest Ecology and Management 115:277–287.

Martell, R.J. 1996. Multiscale environmental monitoring: a concise overview of six Canadian initiatives. Department of Environmental and Resource Studies, University of Waterloo, Waterloo, Ont. Unpublished paper.

____. 1999. The participatory design of an ecosystem approach to monitoring in support of sense-making: What's the point? MEs thesis. Department of Environment and Resource Studies, University of Waterloo, Waterloo, Ont. URL: ***http://ersserver.uwaterloo.ca/jjkay/grads/rjmartel/***

Monitoring Acid Rain Youth Program (Maryp). No date. Field manual. Dr. Jim Karagatzides, Department of Biology, Trent University. (Updated 17 September 1997). URL: ***www.trentu.ca/biology/maryp/***

Noss, R.F. 1999. Assessing and monitoring forest biodiversity: a suggested framework and indicators. Forest Ecology and Management 115:135–146.

Noss, R.F. and A.Y. Cooperrider. 1994. Saving nature's legacy: protecting and restoring biodiversity. Island Press, Washington, D.C.

Panel on the Ecological Integrity of Canada's National Parks. 2000. Unimpaired for future generations?: maintaining ecological integrity with Canada's national parks: Vol. I: A call to action; Vol. II: Setting a new direction for Canada's national parks. Department of Canadian Heritage, Ottawa, Ont.

Rosenau, M.L. and M. Angelo. 2001. The role of public groups in protecting and restoring freshwater habitats in British Columbia, with a special emphasis on urban streams. Prepared for the Pacific Fisheries Resource Conservation Council, Vancouver, B.C. URL: ***www.fish.bc.ca/reports/background_2001/Rosenau_September.pdf***

Scharpe, T. 2001. New research initiatives by Citizens' Environment Watch extends out to new communities. EnviroNews Winter 2001. URL: ***www.utoronto.ca/env/envnews/2001winter-research.htm#cew.***

Smithsonian Institution. 2003. Monitoring and assessment of biodiversity program. Smithsonian, Washington, D.C. URL: ***www.si.edu/simab/***

Southern Interior Forest Extension and Research Partnership. 2000. Business prospectus. Southern Interior Extension and Research Society, Kamloops, B.C.

Stabb, M. 2000. The power of networking: when it comes to the environment, the Ecological Monitoring and Assessment Network is designed to help Canadians see the big picture. Nature Canada 29(3):24–28.

____ . 2001. For the birds: volunteers in the community are helping to safeguard some of Canada's most important bird habitat. Nature Canada 30(2):18–22.

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology 1(2):1. URL: ***www.consecol.org/vol1/iss2/art1/index.html***

West Coast Environmental Law. 2000. Smart growth at work: protecting herons and habitat on Saltspring Island. News from West Coast Environmental Law 26(4):3.

Yarnell, Patrick. 1997. Implementation of buffer zones as a complimentary approach to conserving biological diversity in protected areas. School of Resource and Environmental Management, Simon Fraser University, Burnaby, B.C. Unpublished research paper.

____. 1999. Implementing an ISO 14001 environmental management system: a case study of environmental training and awareness at the Vancouver International Airport Authority. School of Resource and Environmental Management, Simon Fraser University, Burnaby, B.C. Report No. 230. URL: ***www.rem.sfu.ca/pdf/jyarnell.pdf***

Web Resources

Association of Canadian Educational Resources: ***www.acer-acre.org/***

B.C. Institute of Technology's Burnaby Lake System Project: ***www.penr.bcit.ca/fwr/community.shtm***

B.C. Ministry of Forests: ***www.gov.bc.ca/for/***

B.C. Ministry of Sustainable Resource Management, Conservation Data Centre: ***http://srmwww.gov.bc.ca/cdc/***

BC Wildlife Federation: ***www.bcwf.bc.ca/***

Bird Studies Canada: ***www.bsc-eoc.org/bscmain.html***

British Columbia Lake Stewardship Society: ***www.nalms.org/bclss***

British Columbia Watershed Stewardship Alliance: ***www.bcwsa.bc.ca***

Canadian Centre for Policy Alternatives: ***www.policyalternatives.ca/***

Canadian Nature Federation: ***www.cnf.ca***

Canadian Parks and Wilderness Society: ***www.cpaws.org/***

Citizens' Environment Watch: ***www.utoronto.ca/envstudy/cew/cew.htm***

David Suzuki Foundation: ***www.davidsuzuki.org***

East Kootenay Environmental Society: ***www.ekes.org/***

Ecosystem Monitoring and Assessment Network (EMAN): ***www.eman-rese.ca/eman/***

Ecotrust Canada: ***www.ecotrustcan.org/index.shtml***

Environmental Mining Council of British Columbia: ***www.miningwatch.org/emcbc/***

Federation of BC Naturalists: ***www.naturalists.bc.ca/***

Forest Watch of British Columbia: ***www.forestwatchbc.org/main.html***

Global Forest Watch: ***www.globalforestwatch.org/english/index.htm***

Granby Wilderness Society: ***www.granbywilderness.org***

Land Conservancy of British Columbia: ***www.conservancy.bc.ca/***

Land Trust Alliance of British Columbia: ***http://landtrustalliance.bc.ca/***

Nature Conservancy of Canada: ***www.natureconservancy.ca***

Nature Conservancy of Canada (British Columbia): ***www.natureconservancy.ca/files/frame.asp?lang=e_&region=8&sec=bc_welcome***

Nature Trust of British Columbia: ***www.naturetrust.bc.ca/***

Networking BC Rivers: ***www.educ.sfu.ca/nbcr/default.html***

Outdoor Recreation Council of British Columbia: ***www.orcbc.ca/***

Pacific Streamkeepers Federation: ***www.pskf.ca/***

Sierra Legal Defence Fund: ***www.sierralegal.org***

Sonoran Institute: ***www.sonoran.org/front.html***

South Okanagan–Similkameen Conservation Program: ***www.soscp.org/***

Stewardship Centre of British Columbia: ***www.stewardshipcentre.bc.ca***

Valhalla Wilderness Society: ***www.vws.org/***

West Coast Environmental Law: ***www.wcel.org/***

Western Canada Wilderness Committee: ***www.wildernesscommittee.org/***

Wetland Keepers: ***www.bcwf.bc.ca/programs/wetlands/wetlandkeepers.html***

Wildlands League: ***www.wildlandsleague.org/***

Personal Communications

Cannings, Richard. Consulting biologist and BC Program Manager for Bird Studies Canada, Naramata, B.C. Telephone interview: December 18, 2001.

Casselman, Alice. President, Association for Canadian Educational Resources, Mississauga, Ont. Telephone interview: December 18, 2001.

Craig, Brian. Network Science Advisor, Ecological Monitoring and Assessment Network Co-ordinating Office, Burlington, Ont. Telephone interview: December 18, 2001.

Gosal, Kindy. Community Liason, Columbia Basin Trust, Golden, B.C. Telephone interview: January 23, 2002.

Gunn, Robert. Instructor, Fish, Wildlife and Recreation, B.C. Institute of Technology and Co-ordinator, Burnaby Lake System Project, Burnaby, B.C. Telephone interview: December 19, 2001.

Hazlitt, Stephanie. Co-ordinator, B.C. Coastal Waterbird Survey, Bird Studies Canada, Delta, B.C. Telephone interview: December 13, 2001.

Henschel, Chris. Director, Forests Program, Wildlands League, Toronto, Ont. Telephone interview: December 18, 2001.

Kay, James J. Professor, Environment and Resources Studies, University of Waterloo, Waterloo, Ont. Telephone interview: December 20, 2001.

Kirkby, Jan. Conservation Science Ecologist, BC Conservation Data Centre, Ministry of Sustainable Resource Management, Victoria, B.C. Telephone interview: December 17, 2001.

Martin, Kathy. Canadian Wildlife Service, Centre for Applied Conservation Biology and Professor in the Department of Forest Sciences, University of British Columbia, Vancouver, B.C. Telephone interview: January 24, 2002.

O'Carroll, Aran. Director, Forest Watch of British Columbia, Vancouver, B.C. Telephone interview: January 17, 2002.

Riccius, Eva. Park Watch Co-ordinator, Canadian Parks and Wilderness Society, Vancouver, B.C. In-person interview: December 12, 2001.

Savan, Beth. Co-founder, Citizens' Environment Watch and Adjunct Professor, Planning and Geography, Innis College, University of Toronto, Toronto, Ont. Telephone interview: January 24, 2002.

Speller, Ron. Federation of BC Naturalists, Wildlife Tree Stewardship, Nanaimo, B.C. Telephone interview: December 14, 2001.

Stark, Carole. Canadian Program Associate, Yellowstone-to-Yukon Community Stewardship Project, Canmore, Alta. Telephone interview: January 22, 2002.

Steeger, Chris. Pandion Consulting, Nelson, B.C. Telephone interview: December 11, 2001.

Turner, Bill. The Land Conservancy of British Columbia, Victoria, B.C. Telephone interview: December 12, 2001.

Wornell, Heather. Park Planner, Greater Vancouver Regional District Regional Parks, East Division, Langley, B.C. Telephone interview: November 1, 2001.