

# Designing a Long-term Ecological Change Monitoring Program for BC Parks: Ecological Monitoring in British Columbia's Parks

Pamela A. **Wright**, *University of Northern British Columbia*, & **Tory Stevens**,  
*B.C. Ministry of Environment*

## Abstract

Global climate changes are affecting the entire landscape and although intended as ecological reservoirs and refugia, parks and protected areas are not immune to these changes. Provincially, BC Parks' staff evaluate stressors and threats in conservation risk assessments and have identified myriad challenges amplified by climate change. The role of monitoring in the management of protected areas, and particularly for climate change, is identified as central to most assessment and adaptation strategies. This article describes our work in the development and implementation of a province-wide, long-term ecological change monitoring program that can be conducted using a hybrid scientific/citizen-science model. The intent is to help understand: (1) the state of ecological integrity in British Columbia's parks at a provincial scale, and (2) long-term ecological changes, of which climate change is one of the leading causes. Although still in the preliminary stages of implementation, we reflect on some of the lessons we are learning along the way from discussions with field staff, scientists, and managers in the protected areas field.

**KEYWORDS:** citizen science; ecological integrity; monitoring; park

## Introduction

Global climate changes are affecting the entire landscape. Range changes and life history changes, in both the terrestrial and marine realms, are shifting ecological relationships and creating novel ecosystems. Parks and protected areas, although intended as ecological reservoirs and refugia, are not immune to these changes. These areas are also increasingly threatened by numerous external and internal stressors (Lemieux et al. 2010). Provincially, BC Parks' staff evaluate stressors and threats in conservation risk assessments and have identified myriad challenges, including declining snow packs and glaciation, changing hydrology, invasive species, hyperabundant animal populations, surrounding land use management practices, forest health and disturbance patterns, and recreation impacts (B.C. Ministry of Environment 2010 B.C. Ministry of Environment 2010b). Climate change, amplifies many of these impacts and layers on new ones, like rising sea levels (Hannah et al. 2002; Intergovernmental Panel on Climate Change 2007; Lemieux et al. 2007; Wilson & Hebda 2008; Koch et al. 2009; Mawdsley et al. 2009; Biffard & Stevens 2010).

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In general, the role of monitoring in protected areas management is identified as central to most assessment and adaptation strategies, and this is particularly true for the monitoring of climate change (Hannah et al. 2002; Hansen et al. 2003; Welch 2006; Baron 2009; Dudley et al. 2010; Lemieux et al. 2010). Timko and Innes (2009) commented that “for many reasons, including lack of budget or trained staff and managerial challenges, many national parks do not yet possess adequate monitoring and evaluation programs” (Timko & Innes 2009:677). Smaller jurisdictions are typically in a worse position. So although identified broadly as a priority response to climate change, less than a third of Canadian protected area agencies are undertaking systematic climate change monitoring (Lemieux et al. 2010).

Ecological monitoring is the “repeated observation, through time, of selected objects and values in the ecosystem to determine the state of the system” (Clayoquot Sound Scientific Panel 1995). Its potential value is well recognized (see, for example, Wolfe et al. 1987; Jeffers 1989; Pimm 1991). Specifically, monitoring may be useful to:

- build a base of understanding about the system by revealing patterns and trends;
- establish benchmarks of the current state for comparison to future conditions;
- serve as an early warning of change;
- support planning and management through the identification of key issues and trends;
- evaluate the effectiveness of programs and management;
- communicate about the state of the environment; and
- serve as an accountability mechanism.

Nevertheless, developing a rigorous, long-term monitoring program is not without challenges. Too often critiqued as “monitoring for monitoring’s sake,” some specific concerns include

- worries about the ultimate utility of monitoring data;
- data inadequacies and an inability to detect ecologically significant changes;
- reliance on qualitative or semi-quantitative techniques (Legg & Nagy 2006);
- illusion that something useful has been done (Peterman 1990);
- need for more targeted follow-up monitoring in response to broad change detection (Nichols & Williams 2006);
- time lags in identifying potential concerns (Nichols & Williams 2006);
- lack of causal information (Nichols & Williams 2006);
- lack of long-term commitment; and
- change in monitoring protocols or loss of key personnel over time.

Yet although critiques abound, long-term monitoring is noted as often delivering “unforeseen outcomes that might have a broader conservation impact” (McDonald-Madden et al. 2010).

Within British Columbia, the Office of the Auditor General, reporting on the state of conservation of ecological integrity in BC Parks and protected areas, noted that a system to address climate change impacts was not in place and that while “[m]onitoring is a vital component of responsive, pro-active protected areas management ... the ministry currently has no regular monitoring and evaluation taking place” (Office of the Auditor General 2010:22). Although BC Parks has implemented or participated in a number of monitoring programs in the past, these programs tend to be limited in geographical and temporal scope. Protected areas’ staff and partners agreed with the Office of the Auditor General that moni-



toring is critical to managing the ecological integrity of protected areas—particularly in regards to climate change (Rollins et al. 2010; Wright 2012).

This article provides a brief overview of the response by BC Parks. We are building a monitoring program that adopts widely held recommendations for good design, methods, and management of monitoring programs (see, for example, Slocombe 1992; Legg & Nagy 2006). Limited technical and financial resources that are often an excuse for inaction have become central to the design and implementation of this monitoring program, which uses a hybridized science/citizen-science approach. Still in the program's piloting stages, BC Parks continues to look for strategic partnership opportunities to ensure its long-term viability and enhance the utility of its results for both the B.C. Ministry of Environment and others.<sup>1</sup>

Our goal is to develop and implement a province-wide, long-term ecological change monitoring program that can be conducted with the resources and expertise available. The intent is to provide a broad picture of ecological response at the provincial scale. In addition, the monitoring program will help inform BC Parks decision makers at all scales in identifying:

- potential changes and concerns;
- where changes are happening relatively quickly;
- potential climate change refugia;
- areas where enhancing resistance and restoring resilience should be prioritized; and
- infrastructure concerns.

It will also aid in defining how/where visitor use patterns might change in the future and in enhancing communication efforts on ecological integrity and climate change.

The importance of this project goes well beyond the protected areas system. As a widespread monitoring effort focussed on areas of the province with little anthropogenic influence, the information provided can be used to describe the changes occurring in the natural world.

### Designing the Long-term Ecological Change Monitoring Program

The development of the monitoring program involved a relatively straightforward set of steps (see Figure 1). Although described in a stepwise fashion below, many of the steps are iterative

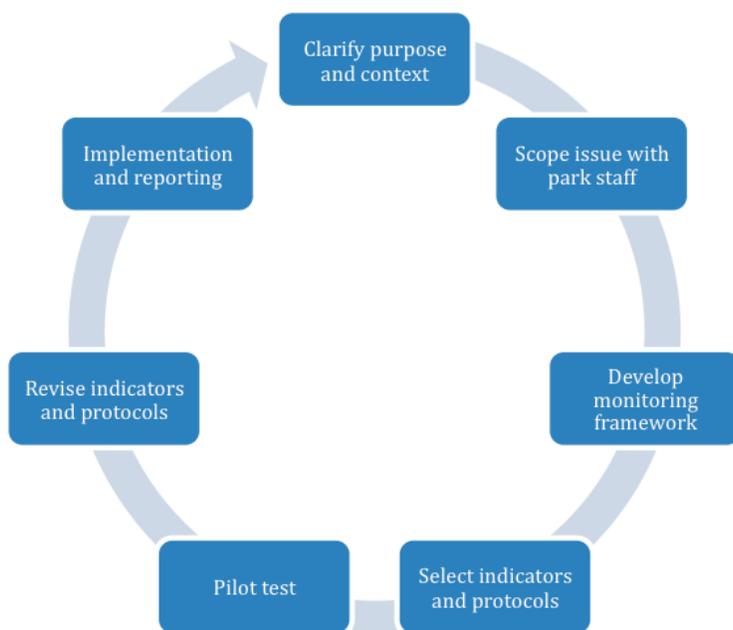


Figure 1. Steps in the design of the Long-term Ecological Change Monitoring Program.



or needed to be considered at the outset. For example, determining how and where data would be entered, stored, analyzed, and reported was one of the initial steps explored.

## Purpose

The intent of the monitoring program is to help understand (1) the state of ecological integrity<sup>2</sup> of BC Parks on a provincial scale, and (2) long-term ecological change, of which climate change is one of the leading causes. Although climate change was one of the key drivers behind the development of the monitoring program, our focus was on long-term ecological response, leaving the measurement of fundamental climate change indicators (e.g., temperature, precipitation levels and patterns) to the already established networks (e.g., climate stations). For example, there is no need for an independent effort to measure climate variables when an agreement has recently been made between the province's major observing network holders, combining 1500 stations across British Columbia into one network (B.C. Ministry of Environment 2010a).

The realities of budget and personnel limitations imposed a significant constraint on the design of the program, but these constraints also provided opportunities (see Box 1). Protected area monitoring programs tend to be designed and implemented in one of the following two ways (and at times, both).

1. Professional-based monitoring programs conducted by park scientists or academic researchers.
2. Citizen-based/community monitoring.

Some existing monitoring programs, although carefully constructed and scientifically based, could not be adopted because they were either too resource intensive (i.e., those of Parks Canada and the United States National Park Service)<sup>3</sup> or designed to monitor anthropogenic changes (i.e., the provincial Forest and Range Evaluation Program)<sup>4</sup>; however, these programs were examined for potential elements that could be used in monitoring protocols. The BC Parks monitoring program, although designed by scientific experts from the academic and agency communities, is largely being implemented by park rangers (e.g., area supervisors, permanent and seasonal rangers) as well as partners within academic organizations, trained volunteers, and non-governmental organizations. The protocols fall along a continuum, from those requiring significant training and most often carried out by park staff, to those developed for citizen scientists. The citizen-science protocols will be conducted by volunteers and often reported directly to the agencies responsible for the protocols. As such, the BC Parks monitoring program is best described as a hybrid science/citizen-science initiative.

## Scoping the issue with park staff

Essential to the development of the monitoring program was initiating a dialogue with park staff throughout the province to both identify concerns and observations regarding ecological change and build support for the program implementation. To this end, we conducted a series of focus group interviews with available area supervisors, park rangers, recreation officers, and ecosystem section representatives in six of nine provincial subre-

### Box 1. Context and constraints for monitoring

- No new staff resources—work with available staff time, estimating a maximum of 3 days per year per area
- Work in a distributed network for monitoring such that in any one area just a few indicators are monitored on an annual basis
- Take advantage of existing data, research studies, and partner monitoring programs
- Tie data and utility into existing monitoring/assessment programs
- Designed to be “grown” into, if and when additional resources become available
- Partner with community groups, universities, or individuals



gions. We then held a workshop at an all-staff meeting, providing feedback from the group interviews and soliciting additional input. Finally, we launched an online survey to solicit individual park ranger perspectives. Almost all the park staff contacted during this scoping process had observed ecological changes that they thought were due to climate change, although many noted that making causal attribution was difficult. These ranged from changes in hydrology to increased frequency and severity of natural disturbance events (see Box 2). The full results of this scoping process are presented in Wright (2012).

Field staff critiques about the lack of monitoring for climate change and broader park values echoed those of the Auditor General, noting that in many cases monitoring is a necessary precursor to decision making.

We have no systematic mechanisms for monitoring our ecosystems so we are ill-prepared to monitor changes let alone take any action. It is not just a lack of attention to climate change, it is a lack of attention to monitoring and managing park ecosystems. (BC Parks staff member, 2010)

It seems we first need monitoring data for X park, to know which way climate change is causing the ecosystems contained within it to change. When we know this, we can then begin to understand what we can do to facilitate this change, help species along, and get everyone through the bottleneck as unharmed as possible. (BC Parks staff member, 2010)

Support for research and monitoring was strong throughout the focus group interviews and surveys. Research and monitoring was the number one choice of management response for most of the ecological changes reported by field staff (Wright 2012).

### Framework for monitoring

Developing a framework to guide the development of the monitoring program is a means of translating its purpose and goals to specific monitoring elements. The framework also makes explicit both what we intend to monitor and what we think that monitoring information will provide. Consistent with other jurisdictions (e.g., Parks Canada), we attempted to select indicators of ecological integrity to examine both (1) biological diversity (structure and composition), and (2) ecosystem processes (function). In each case, we wanted to select indicators that were likely to show signals of adaptation to, and mitigation of, stressors and threats (paying particular attention to climate-related changes).

We used a biome approach in order to select indicators within broad land cover types. This approach allows us to monitor how ecosystems respond to change and is appropriately scaled, given available resources (Wiens & Bachelet 2009). In several cases, long-term ecological change is hypothesized to lead to changes at the transition point between two biomes (e.g., alpine–subalpine). Biomes are also readily identifiable by the public and thus provide a useful vehicle for communication. For consistency, we started with the

### Box 2. Frequently mentioned observations of climate change effects on parks from group interviews

#### Hydrology

- Decline in wetland area, ephemeral streams
- Increased temperature, turbidity
- Change in frequency and magnitude of runoff events

#### Ecosystem shifts

(concentrated at the elevational extremes)

- Loss of true alpine

#### Glacial recession, loss of permanent snow pack

#### Increased frequency/severity of natural disturbances

- Fire
- Wind events
- Forest pests
- Mass wasting

#### Species/community changes

- Accelerated presence of invasive species
- Declines in wetland dependent species
- Declines in fish species of concerns
- Changes in distributions of specific wildlife species

#### Changes in visitor use patterns

- Change in access routes for high alpine ascents
- Seasonal extensions for visitation in central interior



following biomes identified in the Biodiversity BC report (Austin et al. 2008) as the key environments affected by climate change.

- Coastal – divided into marine and intertidal
- Wetland
- Alpine/subalpine
- Forests – divided into northern and high altitude forests, coastal and inland temperate rainforest, and southern dry forests
- Grasslands
- Freshwater – divided between lakes and streams

### Selecting indicators and protocols

To identify potential indicators, we used an iterative process that involved identifying predicted long-term ecological changes for each biome, with the goal of selecting a mix of indicators (Table 1). We used several important sources in this process, including subject

**Table 1: Examples of elements from the BC Parks Long-term Ecological Change Monitoring Program**

Biome	Select changes	Indicator/protocol	Indicator type	Protocol source	Status
Wetlands	Changing hydrology (Cool, moist stable hydrology wetlands like bogs most heavily impacted as well as shallow-water interior wetlands)	Water level/surface extent	Stressor/function	Parks Canada	Pilot test 2012
	Abundance/composition for breeding and migratory birds (also amphibians)	Bird productivity (breeding pairs)	Structure/composition	B.C. Resources Information Standards Committee	Pilot test 2012
		Amphibian egg masses	Structure/composition	U.S. Geological Survey	In development
Alpine and Subalpine	Composition and distribution changes: Includes invasives and species at risk	Plant cover transects	Structure/composition	Brian Starzomski University of Victoria	Pilot test 2011
	Phenology concerns insects/alpine plants	Pollinator phenology	Function/structure/composition	California Pollinator Project (Xerces Society)	2012: Preliminary species collection is first step
	Alpine species of concern: marmot, wolverine, caribou, pika	Pika colony occupancy and relative abundance	Structure/composition	University of British Columbia–Okanagan and U.S. National Park Service/North America Pika Consortium	In development
	Temperature increases	Productivity (soil temperature)	Function	Global Observation Research Initiative in Alpine Environments Protocols	Review and evaluate
	Glaciated extent, snow duration, and snow pack	Glaciated extent, temperature, precipitation	Stressor	Western Canadian Cryospheric Network	Default to ongoing monitoring or specific research initiatives

matter experts (e.g., aquatic monitoring), biome specialists, and existing analysis of biodiversity and climate impacts (see, in particular, Austin et al. 2008; Wilson & Hebda 2008; Pojar 2010; U.S. Department of the Interior 2010).

Given the need to select monitoring methods suitable for use by non-technical field staff and citizen scientists, we searched for well-tested, simple protocols designed for implementation within a citizen-science, or similar, environment. Where possible, we married our protocols with more detailed monitoring or research initiatives so that we can share data and make inferences from these more in-depth studies. For example, in the



alpine/subalpine biomes, we examined composition and distribution changes (including treeline) and adapted a protocol for permanent transects developed by Dr. Brian Starzomski (University of Victoria), who established a long-term alpine monitoring program in the Coast Mountains. Community-based monitoring initiatives (e.g., the EMAN program, the Yukon Community Ecological Monitoring Project, and organizations such as the Grasslands Conservation Council) were key sources, but we also sourced protocols from Parks Canada, the U.S. National Park Service, and the British Columbia Resources Information Standards Committee (RISC). Where protocols were unavailable, or were too complicated or resource intensive for our use, we worked with subject matter scientific experts to adapt protocols. We screened indicators and protocols on more standard criteria (relevant, understandable, useful), as well as against more specific questions, including the following.

- Is someone else monitoring this indicator with reasonable coverage such that BC Parks could simply access the data and interpret the results?
- Is there an available, well-tested monitoring protocol for the indicator?
- Is the suggested monitoring protocol feasible for a “citizen-science” approach (i.e., easy to implement; low cost for materials and supplies)?
- Is the indicator relevant provincially (within one or several biomes), or is it limited in scope?
- How frequently does the indicator need to be monitored?
- Can a high-power sampling design be developed that will result in good quality data but with limited effort?
- Is there a current monitoring program in place, or are data available to supplement/enhance/contextualize the data?
- Does the protocol require complex or costly interpretation or analysis?

### Pilot testing

Ten protocols were ready for field testing during the 2011 field season, with others in various stages of development. Additional protocols (e.g., annual bird counts, stream water quality protocols, ocean acidity, reef fishes, eelgrass surveys) are being implemented by others where the focus is on co-ordination and accessing data. For those protocols implemented directly by BC Parks, pilot sites were selected to represent a relevant range of conditions (e.g., elevation, latitude) and a location where we had a ranger or partner committed to helping us field-test the protocol. The intent of the pilot-testing program is sixfold.

1. To ensure the protocol is understandable, feasible, and repeatable
2. To assess effort and specific skills required for implementation
3. To refine quality assurance/quality control procedures
4. To inform the development of automated data entry approaches
5. To inform the development of a high-power sampling strategy
6. To develop some degree of comfort, familiarity, and interest in the monitoring program

### Implementation and reporting

As protocols move through the pilot-testing phase, we are working with subject-matter experts and select field staff to identify detailed sampling strategies, training requirements and manuals, and quality assurance methods; testing field data recorders; and developing data entry and storage efficiencies.



When the project was initiated, we started by identifying how we thought the information could be used to inform management at multiple scales, and thus how the information could be reported out. We identified four potential reporting functions.

1. Park/area (or section) reporting of area/regional conditions and trends, with key issues reported through existing channels, such as the BC Parks Conservation Risk Assessment process or BC Parks Annual Reporting.
2. Periodic, detailed specialist reports on specific indicators (e.g., detailed reporting of invasive species or grassland integrity) in concert with specific research projects or with partners.
3. BC Parks system-level reporting of “a state of ecological integrity or conservation,” with an examination of the data on a periodic basis.
4. Co-reporting of monitoring data from BC Parks in an abridged format to integrate with others such as State of Environment reporting, when opportunities arise.

As we move through the pilot-testing process and into full implementation, we are beginning to work on the types of analyses, the time scales appropriate to each indicator for data collection and reporting, and various reporting formats.

### Lessons learned, opportunities, and challenges

Although we are still in the preliminary stages of implementing the Long-term Ecological Change Monitoring Program, we have already learned some lessons through discussions with field staff, scientists, and managers in the protected areas field.

Like many other jurisdictions, the conservation of ecological integrity is a key aim of the majority of the province’s parks and protected areas and thus understanding and tracking ecological condition is critical to wise stewardship. Climate change is only one of the many significant stressors facing parks and protected areas. Although the focus of this monitoring project is on understanding ecological change broadly, the climate change issue has brought with it a focus and urgency to the establishment of this program. As such, in the identification of potential concerns for biomes, those concerns related to climate change often come to the forefront. Likewise, when making decisions on where to select sampling sites, we are in many cases able to use latitude and (or) elevation as a proxy for change over time to inform our decision making. We did, however, make a conscious decision to maintain a focus on ecosystem response to stress; consequently, parsing out the specific impacts from climate change versus other stressors is not within our abilities. Similarly, we leave the monitoring of fundamental climate change indicators to others who have well-established systems in place.

Designing a high-value, high-power monitoring program, even if small in scope, is the aim. Although resource constraints led us to a hybrid science/citizen-science type monitoring program, there are other reasons why this approach makes sense. BC Parks staff and community partners are, like the protected areas they manage, distributed across the province and have in many cases significant local knowledge about these sites and a passion for their conservation. However, as most of the park staff who will be collecting the data are not scientists, we characterize this project as a “hybrid science/citizen-science” type of monitoring program. Citizen-science, or community-based environmental monitoring, are both terms used to describe collaborative initiatives between scientists and community members with no extensive scientific training. Such initiatives provide opportunities to enhance scientific data collection as well as delivering other benefits, such as community engagement, education, and public access to scientific information



(see, for example, Cornell Lab of Ornithology 2007; Irwin 1995). We can draw parallels to the notion of citizen science because the staff who will be engaged in the BC Parks monitoring program are, for the most part, not trained as scientists. The monitoring program is structured so that park staff are encouraged to work with community groups (e.g., naturalists clubs) and others to implement the program, potentially leading to both enhanced monitoring ability and community education (Yarnell & Gayton 2003). Additionally, some of the monitoring protocols have been developed specifically for citizen scientists and will be carried out by volunteers.

We are cognizant, however, of the reluctance of some within the scientific community to accept as valid, citizen-science initiatives (Delaney et al. 2008). Thus, throughout the design and implementation of the project, we are taking steps to ensure the scientific integrity of the monitoring program. The monitoring framework and selection of indicators has been shared and reviewed widely. Monitoring protocols have been designed, adapted, or reviewed by experts within the scientific community. Protocols are being piloted to check for, and improve, reliability and validity, and ultimately to develop sound quality assurance and quality control procedures.

Other, often unacknowledged, values are related to developing and implementing a monitoring program (Wright et al. 2002). Just a decade ago, the Canadian federal parks agency was strongly criticized as an organization for lacking a culture of conservation and for not being science-based (Parks Canada Agency 2000). Parks Canada has since made significant organizational changes that have imbued the entire agency with a culture of conservation. As a result, it has become one of the most significant conservation science organizations in the protected areas movement (Waithaka 2010). Regional consultations during the development the BC Parks monitoring program have helped promote a dialogue on climate change and adaptation, and on the value and role of monitoring to inform management. For BC Parks, embedding the practice and value of monitoring within the culture of the organization remains a challenge—particularly when, given the scope and intent of the program, an immediate payback of useable results is not possible. Active steps to build the functions and results of monitoring into the BC Parks system of reporting and accountability will help in this regard; however, we also acknowledge that those involved during the program's pilot-testing phase have the potential to make a significant contribution in communicating its value to others.

The implementation of any monitoring program, even if it is primarily a citizen-science project, requires resources. Support from headquarters staff and regional specialists will be needed on an ongoing basis to liaise with park staff, to update the monitoring program, to implement quality assurance and control procedures, and to report out on the results. Some protocols require more specific training (e.g., grassland assessments), and while we anticipate that those who participate in the first round of training can then become trainers, costs are involved. Although protocols with minimal equipment needs were selected, a pool of basic equipment (e.g., quadrats, field guides, thermometers, and samplers) is required.

Given the lack of additional personnel resources, we designed the program so that area supervisors would be responsible for implementing a small number of protocols each year, which represents only a few extra days of commitment. Information collected during pilot testing will refine these time estimates, but we also acknowledge that a significant learning curve is required during the first phase of implementation, particularly where permanent plots or transects need to be located or documented. While park staff can, and we hope will, develop partnerships with volunteer organizations, universities, or other



groups to assist in data collection, they will still need to commit time to continually maintain these relationships, support field efforts, and ensure data is collected and entered appropriately.

Implementation also requires the ongoing commitment of external partners. Academics and those from other organizations who assisted in the design of protocols are needed to help develop detailed sampling methods and to review analysis approaches. We hope that, by making data available through the province's DataBC portal, these partners will continue their involvement with the program.

By definition, an ecological change monitoring program requires a long-term commitment, and yet sustained funding and commitment to monitoring is the most frequently cited reason why these initiatives fail (Palmer & Mulder 1997; Natural Research Council 2000). To be sustainable over the long run, this program will require management commitment at all levels of the organization, the development of an organizational culture that supports and values monitoring, strong external partnerships, and the integration of monitoring tasks and results into planning and management.

Another element of monitoring programs that threatens sustainability involves the steps taken after data collection. Data entry, analysis, and reporting are critical parts in the design of a successful monitoring program (Palmer & Mulder 1997; Wright et al. 2002). For the pilot-testing phase, unique, stand-alone data entry sheets were developed, but a commitment is in place to develop an integrated data entry system. In addition, testing of potential field data collectors (e.g., tablets, smart phones) is part of the pilot and discussion has been initiated with government technology specialists to help build data-entry tools. Similarly, data storage in a centralized, widely accessible location can be a critical element. The current plan is to upload data from the program's system onto the Ministry of Environment sharepoint site. This allows individual staff to transfer data tagged to a specific park and then access it to inform park-specific management issues, as well as regional and provincial planning and management questions.

Government agencies now face many operational and financial constraints. Therefore, the Long-term Ecological Change Monitoring Program is, by necessity, small in scale and scope. Some have suggested that, given these constraints, we would be better served to wait. We argue, however, that we need to start somewhere, with "start" being the operative term. Ecosystem change is happening, and while anecdotal reporting is useful, building a system to track long-term change must start now. We have already identified indicators and protocols that could be added to the system if additional personnel and financial resources become available. We also anticipate that the program will require continual adjustments as we gather new information.

We reflect on Slocombe's 1992 paper, reiterating that ecological integrity is not a simple, singular concept. It is best considered as an emergent property of complex systems and thus single measures or indexes are insufficient to characterize the current state of ecological integrity. Instead, an improved understanding of ecological integrity will require tapping a variety of information sources, from in-depth research studies through to the design and implementation of a comprehensive monitoring program. The long-term ecological change monitoring initiative is a step in this direction.



## Notes

1. Some of our current partners include Partnership for Interdisciplinary Studies of Coastal Oceans, Bird Studies Canada, University of Victoria, University of Northern British Columbia, and Thompson River University.
2. BC Parks defines ecological integrity as occurring when an area or network of areas supports biological diversity, natural ecosystem composition, structure and function, and a capacity for self-renewal.
3. See, for example, the Parks Canada Ecological Integrity Monitoring website (<http://www.pc.gc.ca/eng/progs/np-pn/eco/eco3.aspx>); or the U.S. Department of Interior, National Park Service Vital Signs Monitoring website (<http://science.nature.nps.gov/im/monitor/index.cfm>).
4. See, for example, the Forest and Range Evaluation Program (FREP) website (<http://www.for.gov.bc.ca/hfp/frep/index.htm>) and Eddington et al. (2009).

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## Author information

Pamela A. Wright – Associate Professor, Ecosystems Science and Management Program, University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9. Email: [pwright@unbc.ca](mailto:pwright@unbc.ca)

Tory Stevens – Protected Areas Ecologist, B.C. Ministry of Environment, PO Box 9398 Stn Prov Govt, Victoria, BC V8W 9M9. Email: [Tory.Stevens@gov.bc.ca](mailto:Tory.Stevens@gov.bc.ca)

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DESIGNING A  
LONG-TERM  
ECOLOGICAL  
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MONITORING  
PROGRAM FOR  
BC PARKS:  
ECOLOGICAL  
MONITORING  
IN BRITISH  
COLUMBIA'S  
PARKS

Wright & Stevens



# Test your Knowledge

How well can you recall the main messages in the preceding article?  
Test your knowledge by answering the following questions.

## Designing a Long-term Ecological Change Monitoring Program for BC Parks: Ecological Monitoring in British Columbia's Parks

1. Which of the following is not a sign or effect of climate change that BC Parks staff have been observing?
  - a) Changing hydrology
  - b) Increasing invasive species
  - c) Increasing snow packs and glaciation
  - d) Ecosystem shifts particularly at elevational extremes
2. What are three of the important context points or constraints facing the design of BC Parks Long-term Ecological Change Monitoring Program?
  - a) No new staff resources – work with available staff time estimating a maximum of 3 days per year per area
  - b) Use the same monitoring protocols across all land management types in the province
  - c) Work in a distributed network for monitoring such that any one area may monitor just a few indicators on an annual basis
  - d) Take advantage of existing data, research studies, and partner monitoring programs
  - e) Provide a complete picture of the state of the ecosystem within a park
3. What are some of the other benefits to developing a monitoring program beyond the acquisition of data?
  - a) Informing a dialogue on conservation and climate change
  - b) Developing an organizational culture and establishing the value of monitoring
  - c) Engaging volunteers
  - d) All of the above

