Field Staff Perspectives on Managing Climate Change Impacts in British Columbia's Parks and Protected Areas

Research Report

Pamela A. ***Wright****, University of Northern British Columbia*

Abstract

Within protected areas, the impacts of climate change have been the subject of discussion for over two decades. Reported impacts included changes to species and habitat distributions, sea level rise, glaciation and snow packs, hydrologic processes, and disturbance patterns. As part of a project to develop a long-term ecological change monitoring program for BC Parks that had a specific focus on climate change, a series of focus group interviews and an electronic survey of field staff were conducted. Field staff throughout the province reported observing a wide range of ecological and social impacts from climate change with projected increases in the future. Support for monitoring these impacts was strong as was invasive species removal. Findings illustrate the need for clarified policy and planning direction; habitat and species vulnerability assessments; education and experimentation with various mitigation and adaptation techniques; and implementation of a comprehensive monitoring program.

KEYWORDS: adaptation; climate change; management; parks; perspectives

Introduction

Although much uncertainty remains about its future magnitude and frequency, the effects of climate change on ecosystems, species, and human populations are well established in the literature (Intergovernmental Panel on Climate Change 2007). The impacts of climate change on protected areas have been the subject of discussion for over two decades (Hannah 2008). Numerous studies have noted:

- range changes of invasive plants, animals, diseases, and pathogens;
- extinction or extirpation of isolated or range-restricted species or populations;
- changes in phenology or other life-history events;
- loss of, or significant shifts, in habitat (e.g., along elevational gradients); and
- corresponding changes in species distribution and demography (Hannah et al. 2002; Lemieux et al. 2007 Wilson & Hebda 2008; Mawdsley et al. 2009).

Within British Columbia alone, potential climate impacts on protected areas include

- shifting biogeoclimatic zones and tree species (e.g., Hamann & Wang 2006; Aitken et al. 2008);

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- sea level rise (e.g., Biffard & Stevens 2010);
- significant decline in glaciation and snow pack (e.g., Koch et al. 2009);
- significant shifts in the hydrologic cycle, including variables such as mean annual precipitation, soil moisture, and snow water equivalents (e.g., Compass Resource Management Ltd. 2006; B.C. Ministry of Environment 2010); and
- significant alterations in disturbance patterns like forest fires, insect pests, and disease (B.C. Ministry of Environment), among others.

Climate change, however, is not the only stressor facing protected areas. External threats such as increasing urbanization, accelerated resource extraction, fragmentation of greater park ecosystems, and internal threats such as recreation and tourism impacts, poaching and other trespass, among others, abound. All contribute to major declines in biodiversity that even without the additional input of climate change is resulting in significant impacts (Parks Canada Agency 2000; Woodley 2010). However, climate—as a key determinant in creating and controlling the distribution of ecosystems and species—is projected to be the most significant threat to protected areas globally, even though much of the impact is only now being detected (Austin et al. 2008).

Responding to climate change

The management goals of maintaining and restoring ecological integrity in protected areas are based on the notion of managing ecosystems within a range of variability constructed on some type of reference condition. As climate, a fundamental determinant of these conditions (Intergovernmental Panel on Climate Change 2007), is undergoing an increased rate of change (Baron et al. 2009), so too is the context for management (Landres et al. 1999). In response, agencies that manage protected areas are considering both climate change mitigation and adaptation strategies.

Mitigation

Mitigation strategies refer to responses to reduce greenhouse gas (GHG) emissions or to increase carbon sinks (Wilson & Hebda 2008; Dudley et al. 2010). Strategies that have been employed for GHG reduction are targeted at reducing carbon emissions in park design and operations (e.g., green infrastructure, low emission vehicles) and in encouraging park visitors to do likewise. More broadly, numerous policy efforts are under way internationally to account for the value of protected areas as carbon sinks (Pojar 2010:58).

Nevertheless, it widely acknowledged that climate change variables are already fluctuating (at rates faster than even the most aggressive GHG models projected) and that impacts will continue even if additional GHG input is stopped now. Thus, while efforts to mitigate current and future carbon emissions are important, much of the emerging literature and guidance is concerned with adapting to climate change (Millar et al. 2007; Lawler et al. 2009; Hansen & Hoffman 2010).

Adaptation

Adaptation in protected areas refers to strategies that will modify ecological, social, or political systems to fit the changing climate (Pielke 1998; Thompson et al. 2006). Multi-scaled adaptation strategies include designation, management, research and monitoring, policy and law, and communication (Hannah et al. 2002; Hansen et al. 2003; Scott and Lemieux 2005; Welch 2006; Lemieux et al. 2007; Wilson & Hebda 2008; Baron et al. 2009; Mawdsley et al. 2009; West et al. 2009; Dudley et al. 2010; Lemieux et al. 2010).

On the policy front, are calls for a "consistent top to bottom vision of how to incorporate climate change considerations into management [that] could promote short- and long-term adaptation practices" (Baron et al. 2009:1040). Macro-scale policy revisions may entail a need to revisit the designation and management objectives of the protected area as "in some cases, ecological change may be so significant that a park no longer represents the values for which it was originally established" (Lemieux et al. 2007:49).

More specific policies or guidelines for reconsideration include fire management (Lemieux et al. 2007) and definitions and management of "native" and "invasive" species. Species distributional changes resulting from climate will make conservation of rare or unique species or communities potentially difficult as new species will immigrate into protected areas for more favourable climates.

Numerous authors note that reducing other non-climactic stressors, through such actions as "minimizing sources of pollution, reducing the competition between non-native and native species, controlling the spread of disease, reversing trends of habitat fragmentation and loss, decreasing the extent of poaching or other types of resource exploitation, and restoring natural disturbance regimes," should be key priorities both to enhance resilience but also because climate will interact with other stressors (Baron et al. 2009:1039). Planners and managers should also consider: examining future conditions when making investments (e.g., changing flood plains, sea level rise, etc.); restoring to future, rather than historical conditions; and considering changes in natural disturbance events. Other techniques, such as assisted migration, and dynamic protected areas are more problematic and less widely accepted (see Hannah 2008 for a useful summary of both).

Selecting an appropriate response: Managers' perspectives on climate change

Although numerous studies have been conducted on attitudes towards climate change in the general population (see, for example, Curry et al. 2007; Kellstedt et al. 2008), few have examined park managers' attitudes or perspectives towards climate change and the associated management challenges. However, the following two recent studies were key in setting the context and informing the design of my study.

1. Canadian Protected Areas and Climate Change Survey (Lemieux et al. 2010)
2. BC Parks Research Needs Survey (Rollins et al. 2010).

In the Lemieux et al. (2010) Canada-wide survey, climate change ranked as an important or very important issue for almost all representatives (91%), with increasing importance projected over the next 25 years. The most important climate change impacts identified by respondents were related to watersheds (wetlands, water quality/quantity), wildlife, and vegetation. However, relatively few agencies (on average less than 15%) reported having yet conducted comprehensive climate change risk assessments, targeted their budgets, or devoted dedicated personnel to climate change issues, although several agencies reported considering a suite of climate change responses (Lemieux et al. 2010).

In the Rollins et al. (2010) British Columbia survey, just over 70% of park staff identified climate change as one of the most important management goals relative to other management priorities (6th out of 12 possible goals) for the province's parks. When conservation goals were probed specifically, monitoring the effects of climate change was identified as the fourth highest priority with several other items on the list related to fire and insect outbreaks (ranks of 6, 8, and 9) strongly linked to climate change (Rollins et al. 2010).

Study purpose and setting

Although there is increasing discussion in the academic literature summarizing climate change adaptation responses, as Mawdsley et al. (2009:1081) noted: "much of the actual work of climate adaptation will necessarily occur at a finer scale, on the level of individual reserves." Indeed, most frequently touted adaptation responses (e.g., improve connectivity; represent vegetation types along environmental gradients; conduct long-term monitoring; avoid fragmentation; adaptively manage) are not new—with few exceptions, these are the same suite of responses generally implemented for ecological management. Managers, however, "will increasingly need to view the ways in which they use these tools through the lens of climate-induced changes to species and ecosystems" (Mawdsley et al. 2009:1086). Clearly, a significant need exists to move the dialogue about climate change adaptation from the academic research and policy levels to the field level. Managers of parks and protected areas are required to manage an important part of the response to climate change and yet this task comes on top of existing responsibilities.

As Pielke (1998:160) noted: "[h]ow decision makers think about the concept of 'climate change' is an important factor in the climate policies which they adopt." Engaging field staff in the discussion of potential responses to climate change and learning from their experience and perspectives is part of moving the dialogue about climate change from the theoretical to the practical.

My study took place in the Canadian province of British Columbia where, under provincial jurisdiction, approximately 1000 provincial parks and protected areas cover nearly 13% of the land base (Figure 1). The mission of BC Parks is to protect representative and special natural places within the province's Protected Areas System for world-class conservation, outdoor recreation, education, and scientific study (B.C. Ministry of Environment 2011). Conservation and stewardship of ecological integrity is a key aim to achieving the mission (B.C. Ministry of Environment 2008).

In August 2010, the Office of the Auditor General of British Columbia conducted an assessment of the Ministry of Environment's success in meeting its goal of conserving ecological integrity in the province's parks and protected areas. This assessment found that a system to plan for and monitor the effects of climate change 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 Gen-

Figure 1: British Columbia parks and protected areas. *Note:* BC protected areas in grey and black, with black designating protected area complexes big enough to maintain disturbance sensitive species.

eral of British Columbia 2010:22). In response, BC Parks, with academic partners including myself (see Wright & Stevens 2012), initiated a project to develop a long-term ecological change monitoring program with a specific focus on climate change. In a related initiative, I undertook this research project, which was designed to engage protected areas' staff in discussions about ecological change, the observed and potential impacts of climate change, and potential management responses. Although supported logistically by BC Parks, this study was conducted independently. The results of this research are reported here.

Methods

Individual and focus group interviews

To initiate the development of the monitoring program, I began a dialogue with park staff to identify concerns and observations regarding their understanding of long-term ecological change, and more specifically, climate change. A series of focus group interviews were conducted in the fall of 2010 with available area supervisors, park rangers, recreation officers, and ecosystem section representatives (hereafter referred to as *field staff*) in six of nine provincial subregions.[1]

The focus groups lasted about 1.5–2 hours. Participants varied from office to office, including as few as two and as many as nine, for a total of 27 people. These groups discussed observations regarding the potential impacts of climate change in parks, and issues such as:

- concerns regarding climate change in parks;
- potential key elements or indicators of change for monitoring;
- constraints and opportunities for monitoring, including ongoing partnerships; and
- related monitoring and research efforts in the region.

In late fall of 2010, I attended a province-wide BC Park staff meeting and made a brief presentation to all attendees and offered a more focussed workshop for about 30 individuals. Pre-registration showed that just three of the participants at the workshop had participated in the earlier focus groups, and therefore the workshop was conducted in a manner similar to the original focus groups. As participants represented a cross-section of all regions, the group was broken up by broad ecosystem type (e.g., biomes) for smaller facilitated discussions.

Focus group and workshop results were loosely transcribed and analyzed using content analysis into common themes. These detailed discussions provided useful input into the design of the monitoring program but also gave insight into operational park staff perspectives on climate change. This information also helped to shape the subsequent online survey.

Survey

Survey design was informed by the focus groups, the climate change monitoring workshop, general survey design practices (Patton 2008; Babbie 2010), and by other relevant climate change studies (see, in particular, Lemieux et al. 2010). As the larger context and priority ranking of climate change relative to other management issues had just been surveyed in the BC Parks Research Needs Survey (Rollins et al. 2010), I focussed more specifically on

management responses and observations regarding climate change. The survey consisted of a mix of closed and open-ended questions covering:

- key ecological impacts of climate change on protected areas;
- possible management responses to these impacts;
- potential constraints;
- potential recreational impacts and opportunities from climate change; and
- implications for public education/communication.

Respondents completed their surveys from a regional perspective in three broad geographical areas: (1) Coast, (2) Southern Interior, and (3) North.

The draft survey was pre-tested for comprehension and reliability and the final survey was administered using a web-based survey tool. Item response order was randomly generated for each survey. Eighty-six park staff members, consisting generally of regional protected areas staff and including protected areas and recreation section heads, area supervisors, and rangers, were emailed an invitation to participate that outlined the purpose of the survey and clarified issues related to anonymity, confidentiality, and informed consent. As responses were anonymous, a reminder email was sent to the entire study population at the beginning of the third week of the 5-week survey period. In subsequent email, regional section heads were encouraged to remind staff about the survey. Seven invalid email addresses (in most cases these were seasonal rangers not working during the study period) were removed from the survey population and a total of 62 valid responses (78%) were received. Response rates for close-ended questions were at, or near, 100%, whereas responses to open-ended questions varied with a typical 50% response rate. Results were analyzed using descriptive statistics in SPSS (2010, version 19).

Box 1. Frequently mentioned observations of climate change effects on parks from group interviews (unranked by theme)

Changes in visitor use patterns
- Change in access routes for high alpine ascents
- Seasonal extensions for visitation in central interior of province

Ecosystem shifts (concentrated at the elevational extremes)
- Loss of true alpine (tree encroachment)

Glacial recession, loss of permanent snow pack

Increased frequency/severity of natural disturbance events
- Fire regimes
- Wind events
- Forest pests
- Mass wasting – erosion and avalanches

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

Species/community changes
- Accelerated presence of invasive species
- Declines in wetland dependent species (painted turtles, western grebes, tiger salamanders)
- Declines in fish species of concerns (salmon, bull trout)
- Changes in distributions of specific wildlife species (e.g., increases in elk populations in north, and wolf populations in the Kootenay)

Focus group results

The focus groups and workshop provided a good overview of the observed and potential impacts of climate change on protected areas (see Box 1). In almost all cases, climate change was noted as an issue of concern and most staff could identify some of the most dominant changes facing protected areas (i.e., changing hydrology, snowpack/glacial reduction, increasing severity/frequency of disturbances). Lack of specific knowledge of climate change processes and potential risks to specific ecosystems were expressed by a number of staff and several expressed caution about identifying impacts from climate change *per se*, noting the difficulty in teasing out causality. Indeed, in some parts of the province, other drivers such as second-home development dominated and tended to overwhelm any potential observations regarding climate change. Although common climate change observations and potential impacts were noted across the province, some regional differences appeared, a notion that was pursued in a more structured way through the survey.

> I'm uncomfortable saying for sure what is/isn't a result of climate change.
>
> I think in this region [southern interior area of province] that what is driving ecological change more is the influx of Calgarians building second homes in the area … for sure there are more visitors later and later in the year but with bigger and better RV's—maybe that's the reason?

Beyond the identification of observed and potential impacts, two other themes emerged from these discussions: (1) the role of fostering dialogue among staff about climate change, and (2) concerns about management response to climate change.

The issue of climate change is not a new one to BC Parks' staff. The provincial government has been active in implementing policies to reduce GHG emissions, including the implementation of a province-wide carbon tax, the establishment of a carbon offset program, and the initiation of carbon budget accounting practices for government staff. Within BC Parks, previous discussions on climate change involving all staff have occurred and an online community of practice on climate change in parks set up. A few provincial parks (e.g., Mt. Robson and Mt. Assiniboine) have engaged in more detailed climate risk assessments, and headquarters staff have recently completed a risk analysis on sea level rise for coastal/marine protected areas. Nevertheless, at the operational level, only limited discussions about climate change or detailed discussions about most conservation issues have taken place. Staff attributed this to the existence of other management priorities and limited fiscal or staff resources, rather than to a lack of interest or information per se (although staff noted the need for more information). It was clear from the outset that the dialogue promoted by these focus group interviews was as important as the specific information collected to help design the monitoring program. Some regional staff, particularly those with greater experience, were more easily able to identify ecological change. What started as a round-table inventory of observed changes typically turned into dialogue between staff as they identified shared issues and hypothesized about potential relationships, drivers, and impacts.

> This was good—we don't normally get a chance to think. (Focus group participant)

The second theme that emerged was one of concern regarding what could be done about climate change at the practical, operational level. This theme had the following important dimensions.

- Uncertainty about what could be done to respond to climate change.
- Concern that the attention focussed on the issue of climate change may be short-lived.
- Frustration that, with current resources and other management priorities, the ability to more thoroughly consider, never mind respond to climate change, was limited.

> Here we are seeing a big drop in water levels … I mean I can see that it's obvious if this continues we'll need to move boat ramps and docks but beyond this I'm not sure whether there's anything I can do about this … I don't even really understand what's going on. (Focus group participant)

The focus groups provided an initial insight into staff perspectives on climate change and, in particular, into some potential concerns or observations about climate change in a way that suggested a possible regional variation in these observations. However, as focus group participants represented only a subset of field staff, and views were relatively unstructured, the topic was pursued further through the development of a more structured survey that could receive wider distribution.

Survey results

Survey results are organized under the following five major headings:

1. Current and Future Climate Change Issues
2. Management Responses and Priorities
3. Constraints
4. Climate Change and Recreation
5. Communications

Survey respondents' comments (numbered to preserve anonymity) from open-ended questions and comment fields are used throughout this report to illustrate the findings.

Based on the focus group interviews, I hypothesized that identified climate change issues and management responses may potentially vary by: (1) management region and (2) the extent to which field staff felt that adapting to climate change was an important priority. The results of these two variables are reported first, followed by the variability in responses based on REGION and PRIORITY within the overall results (when significantly different).

Region of response

Field staff responded to the questions from a regional perspective and responses were proportionate to staff presence in the field. Respondents were relatively evenly distributed in the three management regions (NORTH, COAST, S. INTERIOR) used in the survey, with slightly fewer northern respondents corresponding to lower staff numbers in that region.

Attitudes and priorities towards climate change management

Field staff were asked to respond to a selection of attitudinal items on climate change management and adaptation. A general consistency in responses was noted (Figure 2). Although acknowledging that identifying specific impacts from climate change is difficult (73%), the overwhelming majority of respondents (84%) felt that, even with limited resources,

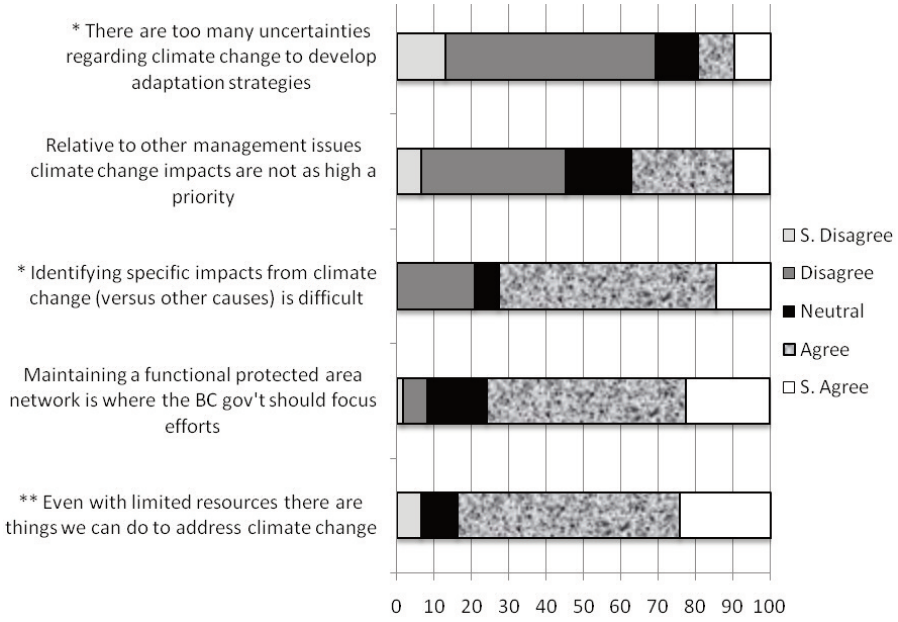

Figure 2: Attitudes towards climate change. * The group responding that "climate change was not a priority" was significantly more likely to agree with this item (ANOVA $p < 0.05$). ** The group responding that "climate change was not a priority" was significantly more likely to disagree with this item (ANOVA $p < 0.05$).

potential management actions could be taken. A relatively wide distribution of responses was only evident when respondents were asked whether managing for climate change impacts was a priority relative to other management issues.

After exploring various methods of clustering responses and autocorrelations, the item *relative to other management issues climate change impacts are not as high a priority* was used for further analysis. Respondents were divided into three groups:

1. a PRIORITY group (45% of respondents who felt that climate change was a priority);
2. a NEUTRAL PRIORITY group (18% of respondents who gave a neutral response); and
3. a NOT A PRIORITY group (37% who felt that, relative to other issues, climate change was not as high a priority).

The NOT A PRIORITY group was significantly more likely to agree that *identifying impacts is difficult* and that *there are too many uncertainties to develop adaptation strategies*. They were also significantly more likely to disagree with the statement that *even with limited resources there are things we can do* (see Figure 3). These groupings were then used in subsequent analysis.

Current and future climate change issues

Respondents rated the importance, from a regional perspective, of 16 potential drivers and responses to climate change, now and 25 years hence. Figure 3 displays mean scores for

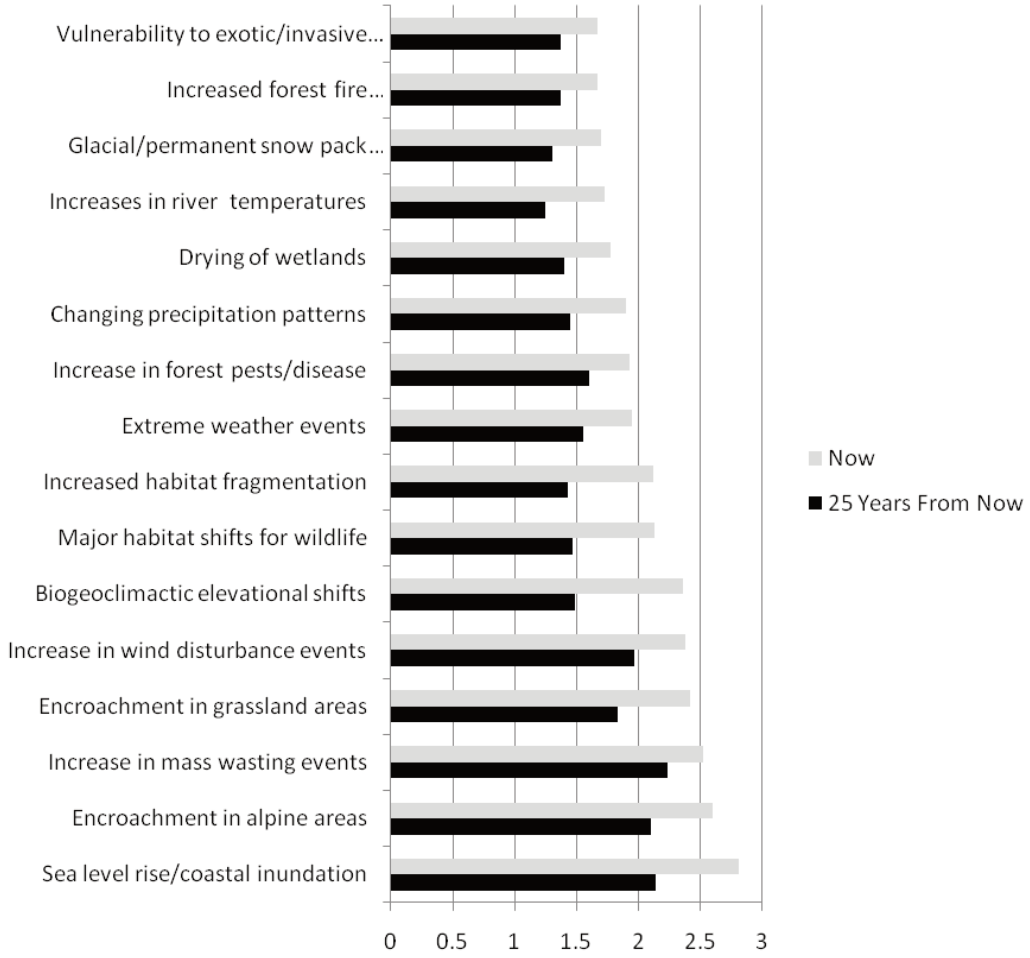

Figure 3: Average importance of 16 potential climate change issues currently and in 25 years. Scale: 1 = not at all important and 3 = important.

each item provincially. Field staff rated the top three issues currently as: (1) vulnerability to invasives, (2) increased forest fire severity/frequency, and (3) glacial/permanent snowpack retreat. Twenty-five years from now increased river temperatures had moved to the number one spot. Significant differences were found for each issue when issue importance was compared "now" versus "25 years from now" (paired t-tests, $p < 0.05$). Additionally, on 12 of the 16 items, the PRIORITY group was significantly more likely to identify a specific issue important in at least one of the two time periods (ANOVA $p < 0.05$).

When examined from a regional perspective, there were significant differences (ANOVA $p < 0.05$) for 11 of the 16 issues for at least one of the two time periods (Figure 4). Respondents from the Coast management region were more likely to identify a wide range of issues as important over both time scales.

> In the Northern areas of the province I think the most notable and concerning effect will be changes to habitat as a result of warmer temperatures allowing a shift in habitat suitability for animals and plants that are more cold sensitive. (S-54)

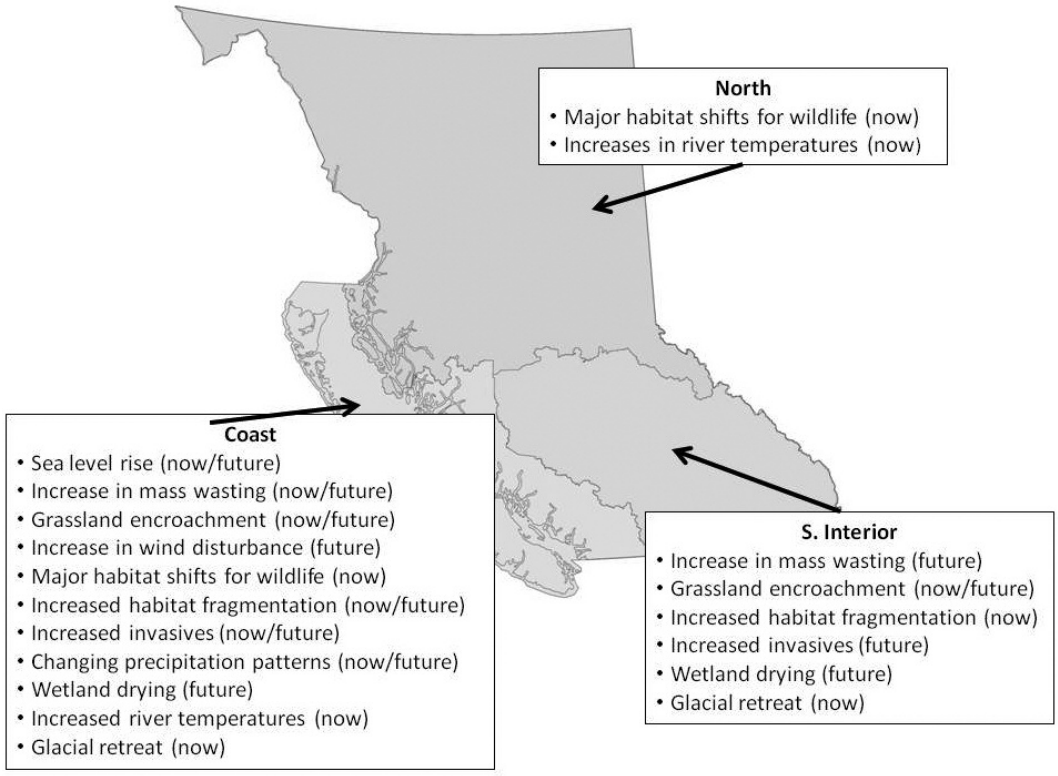

Figure 4: Regionally significant differences in issue importance as identified in ANOVA testing.

Management responses and priorities

As different climate change impacts may require specific management responses, field staff were asked to identify (from a fixed list of possible choices) the types of management responses that may need to be taken for a series of key issues (Figure 5). "Research/monitor" was the most frequently selected response and the first choice for 8 of 15 issues, followed by "ecosystem restoration" (5 of 15) and "no response possible" (2 of 15). Changing visitor use patterns or modifying park infrastructure were selected occasionally, particularly in response to changing precipitation patterns, forests pests, and disease and wind disturbance.

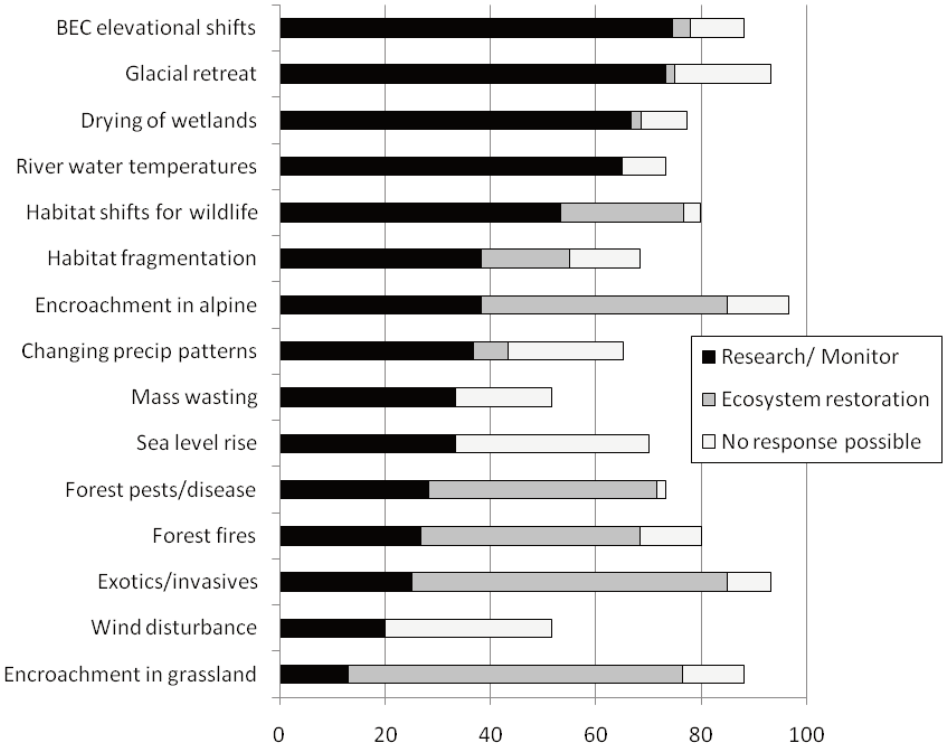

Figure 5: Top three preferences for potential management responses for key climate change issues. Note: Response choices provided: Research/ Monitor; Ecosystem restoration; Change in visitor use; Modify infrastructure; Partnerships; Modify boundary; Unsure; No response possible.

Examining overall priorities for responding to climate change, field staff identified *conducting species/habitat vulnerability assessments, invasive species management,* and *monitoring* as the top priorities (see Table 1). Regional comparisons showed almost no differences in priorities with the exception of *communication,* which ranked significantly higher for Coast region field staff compared to those in the North or Southern Interior regions. The PRIORITY group ranked *enhancing resilience, designating new protected areas,* and *conduct species/habitat vulnerability assessments* significantly higher than their NOT A PRIORITY counterparts.

Table 1: Rank order priority responses to climate change impacts in protected areas

1. Conduct species/habitat vulnerability assessments
2. Invasive species management
3. Monitor effects of climate change
4. Identify climate resistant systems and refugia
5. Managing for connectivity within the region
6. Enhance resilience of ecosystems
7. Communicate about climate change
8. Eliminate/mitigate non-climate threats
9. Boundary modifications to improve connectivity
10. Designation of new protected areas

> I think we need to identify the most vulnerable species to climate change, mitigate the other non-climate stressors to give them the best ability to adapt, and manage for that ability. (S-6)

> I would be very surprised if public, business and gov't advocated for and supported more new protected areas considering the amount now designated, including the recent round of Conservancies. Boundary modifications would require "give and take" but considering most high level land use plans are now finished for the coast, ha, good luck on that effort! Unfortunately, the PA system still has not achieved ecosystem representation, IE: lacking coastal Douglas fir variants. I would rather see we fill the ecosystem gaps now—they will all evolve in their own way relative to climate change. We have too much alpine tundra, rock and ice anyways represented in the PA system anyways. Trade some off." (S-28)

Field staff were also asked whether any policies or planning practices needed changing to assist in the response to climate change. Responses to this open-ended question were numerous but could be grouped into the following broad themes.

Policy direction Several field staff noted the need to set, or clarify, policy around climate change at a broad scale.

> Our conservation policies are very outdated and do not reflect any connection to climate change (CC). They need to be updated and connected to CC. (S-19)

Others identified the need for policies to support decision making.

> Need policy for cross-landscape management, funding and monitoring that can be recognized and embedded into current park specific policy framework. (S-26)

> Direction for field staff when the waves wash a park away what do we do? Do we rebuild facilities?????? (S-51)

> We have to work on systematic processes for determining priorities and allocating funding for all our work in maintaining ecological integrity, and responding to climate change should be one of the major themes. (S-67)

Incorporating climate change into planning processes Field staff identified the need for climate change to be addressed in park management plans.

> We need to incorporate adaptive management strategies and monitoring strategies into all of our old outdated management plans. This will ensure we can identify the issues being brought forward from climate change and allow Parks to modify their management strategies. (S-28)

> Strategies for formalizing this included adding a "climate change adaptation section to park management plan templates" and a "check box that a discussion has taken place about how whatever is being discussed [with] links to climate change in an annual management plan," and to "identify in management plan issue statements. …then identify appropriate objective(s) in plans." (S-9)

However, many respondents noted that "park management plans are not responsive enough to be useful in addressing climate change" and that "annual management plans

could be a useful tool for planning appropriate measures," although the limitations of this document, as it currently stands, were well illustrated.

> For annual management plans (which we are only now attempting to re-jig back into life), climate change might be considered a benefit or a risk. Most field staff are just narrow focused on trying to protect facilities by throwing tons of money at the problem—short sighted! In the current AMP now being circulated there is no identified focus on climate change—only a column for issues. (S-47)

Climate change mitigation Although BC Parks has publically profiled several prominent green infrastructure initiatives, field staff indicated that continued work was needed in this area.

> BC Parks facilities must be green and to show the public we are doing it. (S-56)

> Visitors can purchase carbon offsets from BC Parks—funds would be used to fund climate change adaptation initiatives in Parks. Convert generators to alternative energy sources. (S-71)

Rebuild or strategic retreat Field staff also indicated the need to re-think the placement of park infrastructure, acknowledging that rebuilding may not always be in the best long-term interest.

> There needs to be more work completed on those areas most at risk not only from a conservation lens but one that will begin to ask the tough questions about what strategies will be developed for our facility base. (S-24)

> I expect we will need to significantly change in the way we debuild or restore areas next to flood plains and those influenced by storms and tides. A lot of work will need to go into communication and the management of public's expectations in this area. (S-51)

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

> It is not just a lack of attention to climate change, it is a lack of attention to monitoring and managing park ecosystems. (S-2)

> 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. (S-38)

Specific management techniques Field staff also indicated a need to explore and experiment with various specific management activities, from ecosystem restoration and conversion to improving connectivity.

> I think that habitat shift, and land connectivity need to be considered in Land Use Planning and Protected Area designation, planning and management. What we are preserving today may be different in the future in terms of its ecological value, and we need to consider where else might in future provide that same ecological value and try to retain it. (S-73)

Working with others Finally, field staff noted that they need support and assistance from others both in problem analysis and in implementation of adaptation mechanisms.

> Need support from biologists and/or other specialists in identifying and implementing climate change adaption initiatives. (S-8)

> Strengthen ties & working relationships with MNRO to promote (and remove barriers to) the use of fire to manage fire driven ecosystems. (S-26)

Constraints

As with any management issue, responding to climate change will likely be constrained by a series of internal and external factors. Although a lack of financial resources was the anticipated primary constraint, I was interested in exploring the other key constraints. Agency or government priorities, uncertainty of the appropriate response, and staff time were the top three constraints following a lack of financial resources. These responses mirrored the barriers identified in the Canada-wide survey, namely capacity issues (lack of staff and financial resources), policy deficits, and lack of specific information (e.g., on specific species-at-risk) (Lemieux et al 2010:32).

Constraints were further analyzed by conducting a regional examination; for instance, a significant difference (ANOVA $p < 0.05$) was noted in rankings for field staff from the Southern Interior, who indicated that agency/government priorities and public priorities were less of a constraint and specific knowledge of real or anticipated CC impacts was more of a constraint (3rd rank overall). When compared by priority attitudinal groups (ANOVA $p < 0.05$), the PRIORITY group was significantly more likely to rank both agency/government priorities and public priorities as more of a constraint and specific knowledge of real or anticipated CC impacts as less of a constraint.

> Field staff always want to build and repair facilities. Removing facilities is foreign. Visitor Services want more, More, MORE! … Most regional staff probably "get" climate change. … However, it's all rather still esoteric, bigger picture stuff—hence the direction that best we rebuild the seawall than remove the sucker… YOU have to change mind set of all staff. (S-65)

> We need provincial/political support, dedicated champions and then appropriate funding/staffing. (S-54)

Climate change and recreation

Although the focus of this work was primarily on examining the impacts of climate change on ecological systems, I was also interested in probing the issues of climate change impacts on recreation and visitor services. Focus group participants mentioned primary and secondary effects of fire (e.g., evacuations, smoke, and fire bans), shifting visitor seasons, and changes in access. Many staff noted, however, that teasing out the influence of climate change on shifting recreational patterns, except in very specific situations such as change in high alpine ascents, was very difficult as it is typically influenced by other factors.

> Visitor use is still and always will be dictated by key holidays, especially summer holidays over a two month period when kids are out of school. (S-13)

Using the issues raised by focus group members about climate change impacts on recreational values, survey respondents were asked to indicate how strongly they thought

these issues may affect recreation in their region within the next 5–10 years. Responses showed a remarkable consistency, with approximately 80% of respondents indicating they agreed or strongly agreed that climate-related changes to recreation will, or may, affect their region. The highest ranked recreation impacts were those associated with disturbances (hazard trees, fire bans, smoke events). Although it is possible to interpret the consistent response pattern as a lack of uncertainty, a lack of discrimination between issues, or ambivalence, some significant regional variability was evident in rankings (ANOVA $p < 0.05$) that mirrors the expected change in ecological condition. In addition, the quality and quantity of follow-up, open-ended questions, and comments suggests that, across the board, field staff anticipate broad-scale impacts of climate change on recreation.

Northern region respondents noted more concern regarding hazard trees and expected to see more seasonal extensions from traditional summer peak season visitation.

> Warmer weather in the shoulder seasons will likely extend hiking season a few weeks, and get it going a few weeks earlier in the spring (faster melt-out in the mountains). (S-27)

Although impacts in the Coast region may be moderated by ocean climates and recreation patterns buffered by large population centres, respondents from the Southern Interior region noted significantly more concern regarding low water levels affecting recreation, increasing access issues, and marginal snow conditions.

Field staff also emphasized the potential threats to recreation caused by changing and, at times, unpredictable, disturbance regimes, temperatures, and precipitation patterns (see Box 2).

Given both the already observed and potential impacts from climate change, field staff noted the need to reconsider planning and maintenance on recreation facilities and infrastructure including relocating visitor facilities, strategic retreat from certain areas, and site restoration.

Box 2. Selected themes on climate change impacts on recreation opportunities

- Access due to flood events
- Beaches erosion
- Hazard tree issues/wind events
- Forest fire bans, smoke, closures
- Loss of snowpack for winter activities
- More unpredictable and varied extremes of weather
- River levels
- Shoreline activities and facilities due to rising sea levels and impacts due to extreme weather events

Communication

Although communicating to the public about climate change was not identified as a high priority management response (7 of 10) in an earlier question, field staff did comment on the need to talk to the public about climate change and the role and response of protected areas.

> Parks have a different and unique role that can be opportunities for research and learning. (S-37)

Specifically, field staff indicated that one major communication theme was to inform the public about the types of change and the uncertainty inherent in that change.

> Tell the public that the status quo is over. Don't expect PAs, recreation opportunities and facilities to remain as they've always been. The next 40 years are going to be far different than the last 40 years (of stability and "park standards") that boomers like me grew up with. (S-64)

> Expect extreme weather in Parks, take this into consideration when trip planning. (S-64)

Field staff also emphasized the importance of encouraging and modelling green behaviours.

> We should also be educating about ways to reduce human caused environmental impact. (S-11)

> … what we can do personally and what are parks doing to help. We need to be able to showcase ways of mitigation, should be leaders in this, not followers. (S-29)

Discussion and recommendations

Importance, uncertainty, and the need for more dialogue

Similar to the Canada-wide survey (Lemieux et al 2010), in both the focus group interviews and surveys, field staff identified a broad range of potential climate change issues affecting protected areas. In all cases, they projected the issue to be more important when forecasting 25 years hence. The dominant issues—invasive species, forest fires, and pests, and a host of hydrologic issues (glacial retreat/snowpack levels, river temperatures, drying of wetlands, changing precipitation patterns)—reflect those commonly covered by the media and mirrored in the Canada-wide survey.

Although the list of issues was broad, field staff acknowledged that making a causal attribution specifically to climate change was difficult and that knowledge about specific impacts was low. As with related studies (Lemieux et al. 2010; Rollins et al. 2010), field staff in this survey indicated that climate change, even given the uncertainties, is an important issue.

Although a self-assessment of respondent knowledge about climate change was not included, previous studies indicated that park staff were looking for more detailed information to support management. In particular, respondents to the Canada-wide survey identified information on the *ecological consequences of climate change* and *strategies for adaptation* as important needs (Lemieux et al. 2010:50).

Given the lack of knowledge about specific impacts and the interactions of climate change with other impacts, it was not surprising that BC Parks field staff reported relatively high levels of uncertainty in identifying the appropriate management responses; however, this may, in part, be associated with two other patterns observed in the survey:

1. support for information exchange, and
2. prioritization of invasive species management.

Throughout the survey, field staff indicated overall strong support for research, monitoring, and more detailed assessments. As this survey was intended to inform the development of a province-wide monitoring program, this response was certainly gratifying. Almost every contributor to the work on climate change adaptation for protected areas (e.g., Hannah et al. 2002; Lemieux et al. 2006 and 2010; Mawdsley et al. 2009; Wilson & Hebda 2008), including British Columbia's Auditor General (Office of the Auditor General 2010) identifies the importance of monitoring as a key element in the management response toolbox. Alternatively it is possible that the dominance of "research and monitoring" as the management response is perhaps a fallback response. Research and monitoring in the face of uncertainty is acknowledged as an appropriate default choice. However, in this situation, the default position may be an artifact of a study population who are lacking adequate knowledge to make an informed selection on the appropriate management response. The second pattern seems to support this.

Invasive species management was identified as the number two management response after *research/monitor* (see Table 1). Invasive species management is well established within British Columbia's Ministry of Environment, with developing expertise, training, and practice in response to several critical invasive species (see, for example, http://www.env.gov.bc.ca/wld/aliensp/). Invasive species are an important issue facing protected areas and certainly the spread and impact of these species is accelerated by climate change. Given that *vulnerability to exotics/invasives* received relatively low ranking (see Figure 3) as an issue of importance, the selection of invasive species removal as a management action may be motivated less by the urgency of the problem and more by the desire for a tangible response. In contrast, adaptation strategies such as reducing non–climate-related stressors, shifting visitor uses, and modifying park infrastructure—strategies strongly supported in the literature (Baron 2009)—were rarely selected. As with the *research/monitor* issue, the respondents' prioritization of invasive species management may reflect what park staff feel is a true priority or it may have been selected because it is a known and specific management action in a very complex management environment. This doesn't negate the value of invasive species management, but it may temper its selection as a priority management response.

Of course, these observed response patterns may be an artifact of how the survey was constructed and of the choices that were (or were not) presented to respondents. Nevertheless, if this pattern is valid, it emphasizes the need for BC Parks to build adaptive capacity and to provide assistance in developing a decision-making framework to determine the available range of appropriate choices and when to implement these choices.

Although this survey and the associated province-wide discussions on climate change adaptation are important in broadening the dialogue on management response, conducting more detailed analyses (e.g., *species and habitat vulnerability assessments* and the *identification of climate resistant systems and refugia*) are viewed by park staff as precursors to selecting the appropriate response. Several broad frameworks and guidelines on adapting to climate change are available at both the system level (Hannah 2008) and the individual park level (see, for example, Baron et al. 2009; Lemieux et al. 2010), but these are suitably vague given that climate change effects and ecosystem response in any specific area is complex and uncertain (Baron et al. 2009).

Given limited fiscal and staff resources, conducting detailed risk assessments at a scale appropriate to management will probably be overwhelming. Instead, BC Parks may need to develop climate change risk analysis and decision-making frameworks that can be used at a finer scale by field staff supported by regional biologists and other specialists (see Hole et al. [2011] for an example of a framework developed at a network level that could serve as a model approach). This approach could then be supported by a system-wide ecological response monitoring program, more detailed research-based analysis such as the sea level rise coastal park sensitivity assessment (Biffard & Stevens 2010), and an adaptive management ethos in the selection and implementation of management responses (Baron et al. 2009).

Adaptation strategies for further consideration

As noted above, some adaptation mechanisms received relatively low rankings from field staff. One in particular—*eliminate/mitigate non-climate threats*[2]—surprised me given that this mechanism ranks among the top suggestions in most of the climate change literature (Baron et al. 2009). A few possible explanations exist for this ranking, such as:

- limited understanding or a perceived lack of efficacy in how this action could assist in climate change management;

- potential difficulties with eliminating non-climate threats; or
- that eliminating these threats may lead to a corresponding loss, or perceived loss, of other opportunities (e.g., restriction/removal of certain types of recreational activities).

This ranking may also be an artifact of survey construction, as the respondents were not provided with a specific list of these potential actions. Because this adaptation response is more likely to be within management control of field staff and is typically a low or no-cost action, it is worth engaging staff in dialogue in this regard.

Another suite of adaptation strategies, *boundary modifications, designation of new protected areas,* and *connectivity management,* were ranked relatively low on the list of choices. Although designating new protected areas is fraught with myriad challenges, other strategies to improve the permeability and connectivity of landscapes (e.g., boundary reconsiderations, ecosystem management on non-protected areas landscapes, and other approaches to habitat management) abound; however, these strategies require significant cross-agency work and co-operation. Not only does this mean a significant time commitment from already over-extended staff, but it also requires a broader governmental and industry acknowledgment of the role and value of protected areas in contributing to climate change mitigation and adaptation.

Although discussions of climate change impacts and responses have previously focussed on the ecological side of the equation, field staff acknowledged that there is a wide range of real and potential impacts of climate change on the recreational values of protected areas. The idea of reconsidering park infrastructure and certain visitor activities or patterns is rarely advocated. Rebuilding, reinvesting, and providing more opportunities for the public is buttressed by a significant suite of financial reporting tools and required management protocols.

Region/priority group comparisons

I originally hypothesized that responses could exhibit variability, depending on the respondents' region or on the extent to which the respondent viewed taking action on climate change as a priority management activity. Although some differences were noted (e.g., higher issue ranking across the board by the PRIORITY group and consistent attitudes towards taking action at all cost; regional variation in issue importance corresponding largely with geography), the patterns were not so distinct as to suggest different strategies in implementation. While the PRIORITY group are likely to be the most supportive of climate change adaptation strategies, this group is also likely to represent a relatively large group (45% of respondents) of individuals who could champion climate change management.

Implementation constraints and opportunities

Although at a provincial level British Columbia may be viewed as a leader on carbon offset initiatives, climate change may not be viewed as an issue for which BC Park staff can take much concrete action. In focus groups, staff expressed concern about conservation issues (such as climate change) and management; however, the more mundane activities, such as financial accounting, reporting visitor use statistics, and managing park use permits, had established and required procedures and accountabilities that appeared to convey the true agency priorities. The second-ranked constraint of *agency/government priorities* and the fourth-ranked constraint of *staff time* may well reflect this. Also heard was a concern that the current attention on climate change may simply be a passing "fad" and that "typically climate change is an add-on topic in management planning rather than a core issue."

These potential constraints suggest opportunities for BC Parks to reinforce its important conservation role through, for example:

- supporting sustained dialogue about climate change;
- developing resources and materials to help field staff respond to specific impacts;
- piloting and profiling best practices in climate change response; and
- developing accountability tools.

Conclusions

This study was designed to help lay the groundwork for the development of a long-term ecological change monitoring program for BC Parks. It became part of the dialogue about monitoring climate change and helped to:

- build and understand staff support for monitoring and climate change adaptation;
- engage field staff in the monitoring project;
- understand the key issues of concern for field staff;
- explore thoughts on possible adaptation strategies; and
- identify issues that can be addressed through communications.

Conducting additional research may ultimately help contribute to our understanding of climate change responses in protected areas, but as survey respondents noted, *even with limited financial resources* there are things that can be done now. The following are some of those that came to the forefront in this study.

- Clear and consistent policy direction at all levels of the agency.
- Implementation of a climate change habitat and species vulnerability assessment process.
- Meaningful incorporation of climate change risks and response in multi-scaled planning initiatives.
- Initiatives to build understanding of the techniques and value of specific adaptation techniques (e.g., reducing non-climate threats).
- Strategic trials of various mitigation and adaptation techniques.
- Widespread communication both within BC Parks and to the public about climate change impacts and responses in protected areas.
- Implementation of a comprehensive monitoring program.

Although the generalized impacts of climate change are known, much remains to be learned about the applicability and efficacy of adaptation responses (Halpin 1997). In addition to the need for continued ecological research on climate change impacts, vulnerability assessments and the like, there are also significant research gaps from a social science perspective. To further understand field and operational staff responses to climate change, potential directions for future research include

- assessing detailed knowledge of climate change science;
- enhancing and examining the ability of park managers to assess climate change risk (as per Baron et al. 2009); and
- developing a deeper understanding of perspectives on specific adaptation strategies such as assisted migration among other topics.

As environmental bellwethers, parks and protected areas may be critical not only for their inherent ecological and social values but because these areas may also be the first to display the effects of climate change, in the absence of many other stressors. As such,

they can also serve as experimental areas to demonstrate the potential for impact reduction and as a location to develop and test adaptation strategies.

Notes

1. The other three subregions were not easily accessible within the time and resources available; however, representatives from these subregions participated actively in the province-wide workshop and were proportionately represented in the survey.
2. Reducing non-climate threats includes, for example, reducing increased fragmentation from road access or major trail development, reducing the influx of pollutions into freshwater ecosystems (Welch 2006) and stressors within the park that come from recreational use.

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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

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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

ANSWERS: 1=c; 2=a, c, & d; 3=d