Climate Change Adaptation for Park Managers

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Abstract

Climate has always been changing, is changing, and will continue to change. Since the 1960s, however, the pace of change of greenhouse gas concentrations, resulting radiative forcing, and climatic response has been, and will continue to be, more rapid than previously known in geological history. As a result, biomes, species distributions, hydrology, and the cryosphere will undergo profound changes. Protected areas management cannot contribute significantly to mitigation of this issue, but it can help the natural world adapt to it and help educate society about its causes and consequences. I propose a range of actions for consideration by park managers, organized under the acronym ALARM: Awareness of staff, Leading by example, Active ecosystem management, Research, and Monitoring. I counsel for adjusting park boundaries but not for moving parks in pursuit of migrating biomes, manipulating park resources to provide buffers or insurance against natural disasters, and modifying natural region boundaries where they guide park establishment policy.

Keywords: climate change, ecosystem management, mitigation, adaptation, park managers

Starting Point

This paper is based on Parks Canada discussions and a paper submitted for publication by the George Wright Forum (Welch, in press). The ideas have been presented to, and benefited from, several public audiences including the Atlantic region of Canada's Climate Impacts and Adaptation Research Network and the New England Governors/Eastern Canadian Premiers symposium on climate change adaptation. Notwithstanding this consultation, the following proposals are my own and are not yet Parks Canada policy.

For the sake of brevity I take it as given that climate has always been changing, is changing, and will continue to change. I also assume that readers have access to the numerous printed and Internet sources that describe climate change, its science, its impacts, and the range of adaptation options available to society at large. Here I focus on what park managers should think about and do.

Why and When to Adapt?

Protected areas will be impacted by climate change at least as much as other lands and waters in their natural regions. Indeed, the impacts may be greater. Fewer mitigation and adaptation options exist for natural areas than for those that can be routinely manipulated. Protected area custodians must therefore seek ways to adapt management practices to help maintain biodiversity and natural processes, to assist nature through her inevitable transitions, and to participate in programmes to reduce greenhouse gas emissions.

Adaptation means adjustments in practices, processes, and structures. It can be spontaneous or planned, and it can be carried out in response to, or in anticipation of, changes in conditions (Smit *et al.,* 2001). Unless it's your birthday, it is better to be prepared than to be surprised, so early adaptation is encouraged for several reasons:

- Climate change impacts cannot be prevented.
- Benefits will accrue from removing or halting maladaptive policies and practices that increase vulnerability.
- Benefits can be obtained by adapting in anticipation, rather than reactively, particularly if other stressors are mitigated.
- Visitor activities are tied to the timing and duration of annual climatic cycles and phases. Therefore infrastructure and marketing investments must take future climate into account.
- Leadership by example abets effective government. This means, for example, early achievement of greenhouse gas emission reductions from high profile public institutions like national and provincial parks will lead the public to similar reductions.

How to Adapt… Maybe

Protection strategies for protected and managed landscapes were addressed by Wein *et al.* (1990), Noss (2001), Hannah *et al.* (2002), and Hansen *et al.* (2003). They have the following recommendations:

- Locate parks with climate change in mind, develop contingency plans to expand conservation areas, and protect or establish connecting corridors.
- Avoid fragmentation, provide connectivity, and maintain buffer zones for boundary adjustments.
- Represent vegetation types and diverse gene pools across environmental gradients in reserves.
- Determine the necessity to transplant species, or to control rapidly increasing species.
- Integrate climate change into conservation plans and use active adaptive management.
- Involve local communities for management of biodiversity.
- Strengthen the research capacity of parks personnel, e.g., to identify sensitive biomes and to model biodiversity under changing climates.
- Conduct long-term monitoring to seek causality between climate and biodiversity responses at several levels of organization.

In sum, the limited protected area and climate change literature provides strong reasons to have parks and reserves, why there should be more of them, why they should be accorded enhanced protection, how they might be selected, and what ecological services they may provide to society. However, the literature provides little guidance to managers of existing protected areas. The rest of this paper attempts to fill this gap.

What to Do

Core principles

I propose the following core principles for a climate change strategy for protected areas:

- *House in order and public communications.* A park agency cannot mitigate global climate change by itself, but it can foster mitigation by putting its own emissions house in order and use its outreach and presentation activities to demonstrate leadership by example. Park visitors are generally ready to soak up information and listen to sound arguments by credible proponents. Indirect contributions through interpretation, education, and outreach can greatly improve in-house emission reductions, but credibility depends on such reductions.
- *Risk management*. Environments have a degree of resilience and in some cases can accommodate climate change by species migration or *in situ* adaptation. However, there are many other stresses impinging on ecological integrity, so I recommend a risk management approach whereby tractable stresses are reduced or eliminated. This can only happen through collaboration with interest groups and neighbours.
- *Focus on mandate, complement with partnerships.* Protected areas increasingly emphasize ecological and commemorative integrity in their mandates, outweighing tourism development, park infrastructure, and regional economic development. While these are important, they should not be put ahead of natural and cultural heritage. Place priority on actions within the responsibility of the agency, and leave to others the leadership of activities that are their responsibility. However, to the extent that internal capacity allows and that one's prime mandate is favoured, cooperate in such activities. Education, emission reduction, and national science programmes are good examples.
- *Porous landscapes.* Parks should be part of networks of ecological areas within which biodiversity can survive, move, and be appreciated. Park agencies should promote the importance of regional ecosystems characterized by connectivity and porosity for wildlife movement. Porosity means, not just defining wildlife corridors (connectivity), but removing impediments to movement across all lands. Examples include maintaining hedgerows and wood lots in agricultural areas, eliminating the cosmetic use of pesticides in urban areas, fostering dark sky preserves, and installing wildlife crossing alert lights on major highways, as in a Newfoundland pilot project.

Targets

Action plans need time-bound and measurable targets against which to assess progress and to redefine schedules and activities as appropriate. I propose three time frames and related goals:

- Within five years, appropriate climate change information is available to ecosystem and asset managers.
- Within ten years, climate change is factored into all aspects of ecosystem and asset management, and duly reflected in park management plans.
- Eventually, parks are nested within landscapes that are porous for the movement of native species and free of other significant threats to ecological integrity.

ALARMing actions

Many actions can be conceived to help reach these goals. To provide some structure, and to help see linkages between complementary activities, they can be grouped under categories that form the acronym ALARM:

- **A**wareness
- **L**eading by example
- **A**ctive management
- **R**esearch
- **M**onitoring

The following ideas are probably too many for any one agency to undertake them all. Rather, they are options from which an action plan can be developed.

A*wareness*

Staff awareness. Full engagement in any action depends on staff having an appropriate level of understanding of climate change impacts and adaptation. Actions include disseminating summary documents, newsletters, and technical reports, giving seminar and workshop presentations, and including climate change overviews in basic training components.

Stakeholder awareness. Successful adaptation depends in part on the management of surrounding natural areas. Urge your ecosystem partners to adapt in concert. Ideas include extending awareness activities, promoting ecological porosity between and around protected areas, and mitigating local and regional threats to ecological integrity.

General public awareness. The public should be made aware of the impacts of climate change upon species, ecosystems, and features and what adaptations may be required. Visitors should become aware of what they can do on vacation, at home, and at work by direct actions and by spreading the word to their friends and family. Include climate change messages in interpretation programmes. Post a climate change summary on your Internet site. Work with education authorities, other agencies, and non-government groups to deliver climate change information to children and adults alike. Collaborate with all levels of government to promote park adaptation strategies.

L*eading by example*

Reduce greenhouse gas emissions. Park agencies can use their favourable public presence to promote minimizing building energy consumption through design and operational practices, reducing fleet size, switching to more energy efficient vehicles, fuel switching, and taking advantage of emerging technologies.

Promote personal action plans for staff. Employees and volunteers can play a role through their personal actions at home and in their neighbourhoods. Employers can provide transit passes rather than subsidizing parking. They can provide incentives for carpooling, cycle commuting, and telecommuting, and promote energy-use reductions in homes and lifestyle choices.

Address climate change adaptation in park management plans. Management plans encapsulate a park's objectives and the activities that help to achieve them. These plans are also an accountability tool. Given the enduring nature of parks and the long-term implications of climate change, adaptation should therefore be addressed in management plans. For example, modify park purposes to protect processes and biodiversity rather than specific biomes and species. Review boundaries to seek opportunities for changes that optimize the protection and maintenance of ecological integrity. An example might be seeking higher elevation lands to protect Alpine tundra species. Management plans should endorse research and monitoring of indicators of climate change impacts. Take future climates and vegetation successions into account in ecosystem restoration projects such as fire restoration and land reclamation.

Report on natural and management adaptations to climate change. Whether reactive or adaptive, an integral part of management is the monitoring of progress towards a goal, assessing results, and modifying future actions accordingly. Documenting these processes is essential to full debate and support. A regular report series is the best guarantee of systematic publishing, dissemination, and readership. This does not have to be a scientific journal or series. Annual reports, quintennial or decennial state of park reports, or occasional papers are often more appropriate. Select indicators of climate change impacts for your park and its natural region, develop protocols and implement monitoring, and collaborate with regional partners to report impacts to the public and policy makers.

A*ctive ecosystem management*

Adapt natural region representation strategy. Natural region representation is often the basis for establishing new parks. It assures a distribution of parks across landscapes and ecotones, itself one of the best ways to protect biodiversity. It also deflects the strains of short- and medium-term demands for land protection when there is already a park representing a specific region. Natural regions are typically based on physiography and vegetation. While physiography remains largely constant in anything less then geological time, vegetation has changed significantly in living memory. Climate change will accelerate this process to the extent that natural successions will evolve within decades. Therefore retain map entities of natural regions, but revise their descriptions to reflect the dynamics of present and future climate. Locate and delineate new parks in ways that maximize site diversity and landscape porosity.

Eliminate or mitigate non-climate in situ *threats*. The growing body of research on interactions between climate and non-climate stresses suggests that responses are synergistic (e.g., Schindler, 2001). To maintain or rebuild ecosystem resilience one must reduce the number and/or magnitude of insults faced by an ecosystem. Fortunately, many stressors are more locally and regionally controllable than climate change. In a freshwater system this may require limiting the concentration of toxic substances in effluent. In a forest ecosystem it may mean preventing fragmentation by access roads. While not easy, these tasks are approachable on a local level through conservation partnerships.

Use adaptive management. Given uncertainty about the exact nature of climate change impacts and responses, effective management requires a responsive, flexible approach. Adaptive management allows one to proceed with only limited or uncertain knowledge. An intervention is conducted as if it were a scientific experiment (Nudds, 1998), with measurable, time-bound targets set in advance (policy = hypotheses), careful measurement of results as phenomenon happens (intervention = experiment, observation), and approaches adjusted as new information becomes available (reporting, analysis, re-setting hypotheses). Use adaptive management in impact abatements such as species protection, translocation of slow-spreading key species, or retardation of invasive pioneers. Decisions about fire management versus clear cutting in multi-use conservation lands (e.g., Bergeron *et al.*, 2004) present a clear need to use adaptive management.

Use climate change research results. There is a steep learning curve required to understand ensembles of climate change scenarios and their assumptions and uncertainties. It is not enough to have good primary science. There must be secondary products that digest and customize this knowledge for interdisciplinary professionals. Park agencies should commission reports that translate this vast body of science to regional and park-specific data sets. Parks Canada has done this through the work of Scott (2003) which resulted in spreadsheets of annual, seasonal, and monthly temperature and precipitation data for twelve GCM/emission scenario combinations for three periods in the twenty-first century for each national park, accompanied by narrative projections of physical and biotic changes for each park. By having access to localized information, it is easier for ecosystem managers to document climate change as a major stressor, to design ecological monitoring frameworks with climate change indicators in mind, and to detail research priorities.

As well as providing scientific syntheses, park managers need the tools to use climate change information in their decision-making processes. Climate change guidelines for environmental assessment are now available in Canada, covering projects that either have the potential to emit greenhouse gases, or projects that will be impacted by climate change (CEAA, 2003; Bell *at al.*, 2003).

Adjust park boundaries as needed for climate change adaptation. Changes in climate will lead to changes in habitats and species survival. Some plant species would have to migrate hundreds of kilometres to follow climate. Others might find a new home a short distance away. For the latter it may be possible to adjust park boundaries to capture the anticipated movement of habitats and species. Park boundaries could be realigned to accommodate transition zones where large changes of climate, habitat, and species distribution are expected.

R*esearch*

Understand the impact of past and future climate change. Decision-makers and park visitors alike benefit from a knowledge of Holocene landscape changes. This knowledge helps understanding of the changeable nature of climate and nature's ability to adapt autonomously, even in historical times. Research the impacts of climate change on natural processes and visitor activities before committing to expensive and irreversible ecosystem restorations or visitor infrastructure development. Rate each park for its sensitivity to a $3xCO_2$ atmosphere. However, the development of a research agenda should not be an excuse for postponing early action on awareness, leadership, and active ecosystem management when the no-regrets principle applies.

Identify values at risk of being significantly impacted by climate change. Ecosystems have too many components to understand and track them all. Identification of valued ecosystem components (VECs) provides a means to set management goals without bogging down in the minutiae of all species, all minerals, and so forth. A VEC is an "environmental attribute considered to be important for decision-making" (Munn, 2002). VECs are usually tangible things, like a keystone species or iconic vista, to which indicators for monitoring are tied. Identify a limited suite of VECs that are sensitive to climate change, such as species at the margins of their climatic range, species with limited or excessive abilities to migrate, and temperature sensitive features such as permafrost and ombrotrophic wetlands. Identify barriers to migration such as fragmented habitats and restricted vertical migration paths.

M*onitoring*

Data gathering and reporting actions. Each park should have long-term climate and climate change indicator data. These data should be reported at the park level and regional or national levels.

Promote parks as long-term integrated monitoring sites. Climate change will bring unexpected combinations of direct impacts, secondary effects, and new associations of processes, features, and species. Hence national parks should be managed as integrated ecosystems, not for one particular valued ecosystem component. Integrated monitoring is a complementary tool that can reveal unexpected linkages between ecosystem components and the drivers of environmental change. It can mine existing data to spot emerging influences and explain responses. Each stress does not need its own unique set of indicators. Often, several stresses can be tracked from a limited but well-selected ensemble of indicators. Integrated monitoring also fosters partnerships in which many agencies share costs while reaping benefits greater than the sum of their inputs.

What Not to Do

Do not move parks to anticipated biomes. The presence of a well-distributed system of protected areas is one of society's best adaptations to climate change. Species will have their best chance of finding new homes in a well-managed, well-distributed, well-connected, and properly sized network. While some parks might benefit from local boundary adjustments to protect ecosystems and habitats at risk from climate change, the notion of dynamic parks must be rejected. This would open the door to other reasons to move a park, e.g., to extract minerals or fibre. Also, the notion is unworkable in that few natural areas remain for new park establishment within regions that already have park representation. Rather, the present parks are often all that remains as a natural haven. Thirdly, park establishment is a lengthy process with no guarantee of success.

Do not use parks to buffer or mitigate other impacts. Parks are not an insurance policy to cover negligent or poor management of natural hazards and natural resource supply. The restoration, protection, and maintenance of natural systems preclude their manipulation to counter an anthropogenic threat. Ecosystem services may come about with the maintenance and restoration of ecological integrity, but parks should not be manipulated for flood protection, water supply, or carbon sequestration, for example. This would open the door to the commercialisation of natural resources in parks.

Do not modify natural region boundaries to fit future biomes. The natural region representation approach to national park establishment has served Canada well since its adoption by the Federal Cabinet in 1976. The constancy of the number of regions and their boundaries has ever since been a cornerstone of the national park system plan. It allows Parks Canada to pursue a consistent course towards completing a pan-Canadian system of national parks without being sidetracked by interest groups or lobbying to add a park just to satisfy vested local interests. If the precedent were to be set that the natural regions policy could be changed, then there could be no end to further pragmatic modifications of regions.

All climate scenarios are based on assumptions about future emissions, the physics and chemistry of the atmosphere, and geographical simplifications to allow world models to operate on today's supercomputers. Vegetation response is likewise modelled on plant succession assumptions. While these represent today's best science, the placement of boundaries remains notional and subject to change as models improve and as the world develops real emission inventories rather than scenarios. To change natural region boundaries on this basis would open up a never-ending process, and create an unrealistic setting for park feasibility studies and establishment negotiations that already take years or decades.

Conclusions

However well we manage protected areas, we cannot have much direct effect on greenhouse gas emissions. Yet, a good network of protected areas free of other stresses is one of society's and nature's best adaptations.

Park agencies can also influence visitors and the general public. Good parks and good interpretive, outreach, and education programmes in turn require well-researched and monitored climate change impact indicators as the basis for adaptive ecosystem management, accountability, and reporting systems. House-in-order programmes complement the messages that governments should send to their populaces. Research on the synergy between climate change and other stressors, such as habitat fragmentation and air pollution, can provide the knowledge to guide the mitigation of local and regional stressors, thereby restoring some of the natural resilience of ecosystems and wild species.

Regardless of the debate over climate forcing mechanisms and who does what to whom, we are more aware than ever that we have entered an era of rapid climate change and we had better get used to it. Protected areas should play a leadership role to ensure that wild nature also enjoys the ride.

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