

CLIMATE CHANGE AND CONSERVATION: CHALLENGES AT THE SCIENCE-MANAGEMENT INTERFACE

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SUMMARY

Both the fourth World Congress on National Parks and Protected Areas (1993) and the United Nations Inter-governmental Panel on Climate Change (2002) concluded that global climate change poses a critical threat to ecosystems and that climate change adaptation must be a component of future protected area planning and management. The growing body of evidence documenting observed response of physical and biological systems to on-going climate change indicates that climate change also has immediate relevance for conservation managers. As the science community continues to advance its understanding of the potential biophysical impacts of climate change, too few linkages with conservation managers are being made. For the most part, discussions of ecosystem impacts and conservation implications of climate change have remained outside of the institutional frameworks of the organizations responsible for the management of protected areas. There has also been very little discussion of institutional capacity of conservation organizations to adapt to the unprecedented challenge of climate change. Using Parks Canada as a case study, this paper examines a range of climate change biophysical impacts and their implications for conservation policy and planning (both at the system and individual park level). The steady-state protected area system plans adopted by most federal and provincial-territorial jurisdictions were developed with the assumptions of climatic and biogeographic stability; assumptions that an accumulating body of research indicates are no longer tenable. Individual park objective statements, wildfire management strategies, non-native species management programs, species reintroduction programs, and visitor management plans are also vulnerable to the impacts of climate change. Climate change represents an unprecedented challenge for protected areas in Canada, as never before has there been an ecological stressor that has raised questions about the adequacy of our system of protected areas to conserve representative samples of Canadian ecosystems. The development of climate change adaptation strategies will be essential if the intergenerational conservation legacy of the Canada's protected areas is not to be diminished.

1. INTRODUCTION

The international community has recognized the significance of global climate change for ecosystem change and biodiversity (and by extension biodiversity conservation). The United Nations Framework Convention on Climate Change (1997-Article 2) articulated the critical linkage between climate change and biodiversity when it indicated that, "The ultimate objective of this convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at such a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change..." Unfortunately, the international community has yet to identify and agree upon an upper limit for greenhouse gas concentrations that would avoid irreversible ecological change.

For more than a decade, climate change has also been identified as an important emerging issue for protected areas. At the fourth World Congress on National Parks and Protected Areas, the International Union for the Conservation of Nature concluded, "Climatic change represents a critical and urgent threat to all ecosystems ... (and that) Existing ... protected areas may not

provide adequate future safeguards for the continued survival of existing ecosystems and species in a changing world.” (1) The Inter-governmental Panel on Climate Change special report on climate change and biodiversity also concluded that anthropogenic climate change represents a key threat to global biodiversity and needs to be taken into consideration in conservation planning (2).

For the most part however, discussions of ecosystem impacts and conservation implications of climate change have remained outside of the institutional frameworks of the organizations responsible for the management of protected areas. Comparatively few climate change assessments have applied biophysical impact projections to existing protected area systems and even fewer have explicitly examined the implications of climate change for policy and management within existing institutional contexts. Using examples from Canada’s national and provincial park systems, this paper illustrates some of the ways conservation policy and planning (both at the system and individual park level) in Canada are potentially vulnerable to climate change; an understanding of which is essential to advancing development of climate change adaptation strategies.

2. SYSTEM LEVEL POLICY AND PLANNING IMPLICATIONS

Most jurisdictions in Canada have adopted some type of ecoregion or biogeoclimatic land classification framework as the main system-planning tool for their terrestrial protected area system. On November 25, 1992, the Canadian Parks Ministers Council met jointly with the Canadian Council of Ministers of the Environment and the Wildlife Ministers Council of Canada in Aylmer, Quebec. At the meeting, each Council signed A Statement of Commitment to Complete Canada’s Networks of Protected Areas. In so doing, the key commitment for Parks Ministers was to “make every effort to complete Canada’s networks of protected areas representative of Canada’s land-based natural regions by the year 2000 and accelerate the protection of areas representative of Canada’s marine natural regions.”

Like protected area systems around the world, the park and protected area systems in Canada were developed to protect specific natural features, species and communities in-situ, with the assumptions of climatic and biogeographic stability. A growing body of scientific research indicates that these assumptions are no longer tenable. Although significant knowledge gaps related to ecosystem response to climate change remain, our current understanding suggests that climate change will significantly alter the spatial extent and composition of current ecological communities.

Vegetation modeling studies on the impacts of climate change on terrestrial vegetation in Canada have consistently projected major shifts in vegetation types over much of the country (3, 4, 5, 6, 7). An analysis (8) that used modelling results from equilibrium global vegetation models forced with multiple climate change scenarios examined how biome representation could change in Canada’s national park system. The results revealed that regardless of the vegetation scenario used, substantial changes in biome representation occurred. A new biome type appeared in over half of the national parks. The proportional representation of biomes in the national park system also changed, with diminishing representation of northern biomes (tundra, tundra/taiga, and boreal forest) and additional representation of more southerly biomes (temperate evergreen and temperate mixed forests in particular).

Biomes do not, however, shift as entities, but rather through the responses of individual species (9). Iverson and Prasad (10) modelled the potential distributions of 80 relatively common tree species in the eastern United States under climate change. Thirty-six species shifted their zones of maximum importance more than 100 km northward and seven were estimated to move more than 250 km. Spruce-fir forests were projected to disappear from New England and maple-beech-birch forests showed near extirpation from the region. These findings have implications for

conservation policy and planning in Canada (11). The loss of maple-beech-birch forests in the US means that the protection of any species (flora or fauna) associated with that assemblage would increasingly fall to Canadian agencies. The northward shift of species from the US, with ranges not currently in Canada, would meet Parks Canada's definition of 'alien species' and therefore could subject these species to management interventions.

As individual species respond to climate forcing over time, current species assemblages will begin to breakdown and new assemblages with no current analogue will begin to emerge. Species assemblages with no current analogue are an important feature of North American paleoecology (12). These new ecological communities will not equilibrate quickly, as the time frame for disassociation and resorting in response to past climate change appears to have been in the order of centuries (13). The latter part of this next century is therefore likely to be characterized by ecological communities in transitional stages. Indeed, a series of meta-analyses (14, 15, 16, 17) have compiled evidence from a wide range of studies that indicate physical systems and some species are already responding to on-going climate change.

In a changing climate, conservation planning based on protecting representative samples of natural areas, will have to deal with two important challenges. First, protected area system planners will have to attempt to 'hit a moving target' of ecological representativeness as climate change raises the fundamental question of 'What is to be considered a 'representative natural area' in an era characterized by transitory ecosystems?' Second, steady-state representative conservation based on current species assemblages would exclude future non-analogue assemblages. Because possible non-analogue assemblages are unknown, comprehensive representation in a system of protected areas will become an increasingly impractical objective. These challenges should not be construed as an argument against efforts to protect the ecological integrity of current protected areas or against the conservation value of existing protected areas. Rather, the point being made is that a policy of completing current protected area system plans without consideration for the effects of climate change should be reassessed so that contingencies for climate change could better optimize limited conservation resources.

Short-term climate change adaptations might include new park establishment focused on biomes projected to lose representation (tundra, taiga/tundra and boreal forest) in existing protected area systems, and might protect areas expected to remain refugia for current ecological communities, and on maximizing the potential of species to respond naturally to climate change (e.g., increasing connectivity, protecting outlier populations, changing management of the landscape matrix in which protected areas are situated). To do so would require rethinking current protected area selection criteria and perhaps the establishment of new protected areas designations.

Parks Canada's management paradigm is guided by the principle of ecological integrity, which is defined in the National Parks Act (clause 2) (18) as, "with respect to a park, a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes." With regard to the definition of ecological integrity, Parks Canada also states, "Ecosystems are inherently dynamic and change does not necessarily mean a loss of integrity. A system with integrity may exist in several states, but the change occurs within acceptable limits (their emphasis)." (19) The magnitude of climate change and associated changes in disturbance regimes are likely to accelerate ecosystem change beyond what science has observed to be the natural range in some regions. The compounded perturbations resulting from climate change (e.g., vegetation change, altered disturbance regimes, invasive species, increased extreme climate events) is also likely to heighten the occurrence of ecological surprises and non-linear responses by ecosystems (20). Consequently, it remains uncertain as to how

ecosystem change 'within acceptable limits' is to be interpreted by Parks Canada managers within the context of climate change.

3. IMPLICATIONS FOR INDIVIDUAL PROTECTED AREA MANAGEMENT

A review of management plans from several national parks revealed additional climate change implications for the management of individual protected areas. These included park objective statements, wildfire management strategies, individual species management plans and contingencies for species at risk, non-native species management programs, visitor management plans, and species reintroduction programs.

For example, each of Canada's national parks is responsible for protecting ecosystems representative of the natural region within which they are located. The management plan of each individual park defines the purpose of the park. The stated purpose of Prince Albert National Park is to, 'Protect for all time the ecological integrity of a natural area of Canadian significance representative of the southern boreal plains and plateaux ...' All six vegetation change scenarios examined by Scott et al. (8) projected the eventual loss of boreal forest in this park, suggesting that the park's mandate would be unsustainable in the long-term. Furthermore, the decision to reintroduce natural fire regimes in ecotonal parks like Prince Albert National Park, where vegetation models project a shift from boreal forest to grasslands, would hasten the transition to grassland communities and therefore be ostensibly in conflict with the current park purpose. The reintroduction of natural fire regimes, while necessary to preserve current biodiversity, might also be in conflict with future government policy to maximize carbon storage in order to achieve Canada's international commitments under the Kyoto Protocol. Similar provincial park objective statements are also sensitive to the impacts of climate change.

Like protected areas around the world, certain parks in Canada were established with the intent of protecting highly valued individual species and their habitats. For example, Wapusk National Park located on the coast of Hudson Bay was established in 1996 largely to protect the world's largest denning and gathering place for polar bears. The world's only maritime bear, polar bears require pack ice to hunt. Several studies offer evidence of declining Arctic sea ice extent and thickness and sea ice scenarios have projected 40-100% loss of summer sea ice by the end of the 21st century (21). The polar bear population in Wapusk National Park is near the southern limits of its range and may be extirpated from the park as a result of nutritional stress and/or reproductive failure related to projected declines in sea-ice cover. In this case, the ecological manifestations of climate change may be such that the established management objectives of the park are no longer viable. Several similar examples can be found in provincial park systems, including the protection of woodland caribou in the park plans of Nopiming Natural Park (Manitoba), Seager Wheeler Lake Representative Area (Saskatchewan) and Woodland Caribou Provincial Park (Ontario).

Nature-based tourism is one of the fastest growing tourism market segments globally and is an essential component of Canadian tourism. Canada's protected areas are a significant resource for nature-based tourism. Climate change would alter recreational opportunities and visitation patterns in protected areas, with implications for local tourism economies and visitor related ecological pressures. An analysis using a 'Tourism Climate Index' (22) found that the summer season was extended and improved over much of Canada under climate change scenarios, creating the potential for increased visitation in many of Canada's protected areas. An on-going study in Rocky Mountain National Park (Colorado) projected that increased visitation (193,000 to 333,540 visitors) would result in a 6-10% increase in local economic output and 7-13% increase in jobs (23). Visitor management plans would need to assess the capacity of protected areas to accommodate similar increases in Canada because of a more highly skewed tourism seasonality. In addition to seasonality changes, as climate change affects the natural setting (loss of glaciers,

special species, fire and disease impacted forest landscape) in protected areas, the quality of the tourism product could change with subsequent implications for visitation and local economies.

4. THE ROLE OF PROTECTED AREAS IN AN ERA OF CLIMATE CHANGE

The aforementioned policy and planning sensitivities highlight fundamental questions regarding the role of protected areas in an era of climate change. Are protected areas to continue to protect a representative sample of current ecological communities, or will conservation agencies become dedicated to the function of assisting ecological communities to adapt to climate change (or could both approaches be integrated into a coherent conservation strategy)? Scott and Suffling (24) described four very different policy directions that could be pursued and some of the challenges associated with each:

1. Static management: Continue to manage and protect current ecological communities within current protected area boundaries, using current goals.
2. Passive management: Accept the ecological response to climate change and allow evolutionary processes to take place unhindered;
3. Adaptive management: Maximise the capacity of species and ecological communities to adapt to climate change through active management (e.g., fire suppression, species translocation, invasive species suppression), either to slow the pace of ecological change or facilitate ecological change to a new climate adapted state;
4. Hybrid management: Some combination of the above

To pursue the first policy pathway (Static Management -- static in the sense of prolonging the ecological status quo) against unfolding evolutionary processes would be unsustainable. Whether preserving relic assemblages under evolving climate conditions can be considered compatible with maintaining ecological integrity also requires consideration. Passive Management advocates would argue that ecosystems are inherently adaptable to climate change and that they should be allowed to do so without human interference. A passive management approach is unlikely to prevent the loss of current biodiversity in some protected areas and Canadians would probably be unwilling to accept the casualties of this laissez faire approach. Where valued or symbolic species decline rapidly, a powerful interventionist lobby is sure to emerge. Canadians are likely to place greater demands on protected area managers to protect species and ecosystems under stress from climate change.

An Adaptive Management approach to climate change nonetheless raises important ethical and scientific dilemmas. Intervention strategies would, for the most part, be species specific. With limited conservation resources, managers would be faced with decisions about which species should receive assistance. There will be greater pressure to aid those most valued by society, but protected area managers will need to determine whether the continued protection of each threatened species is viable in a protected area that is losing suitable habitat. The level of scientific certainty required for adaptive management strategies will also be difficult to assess, both in terms of determining when intervention is warranted and the probability of success or unanticipated consequences. The information requirements for an adaptive management approach to climate change will be intensive at a time when conservation budgets are under increasing pressure.

An interpretation of existing policy and planning frameworks suggests that protected area management plans tend to support continued protection of current ecological communities, while the definition of ecological integrity, in contrast, would support protection of the processes that would facilitate ecosystem adaptation to climate change. These two distinct management paradigms have direct implications for protected area management decisions. For instance, the

translocation of populations at risk to climate change to areas more suitable, which is commonly proposed in the literature, could be interpreted as inconsistent with maintaining ecological integrity if the species in question was not native to the destination region and could have an adverse impact on species in existing communities.

5. CLIMATE CHANGE ADAPTATION

Climate change represents an unprecedented challenge for the agencies responsible for the planning and management of Canada's protected areas. If Canada's protected areas continue to be managed without contingencies for climatic change, the intergenerational conservation legacy of these lands could be diminished. The IPCC (2) reached a similar conclusion in a global context, stating that 'the placement and management of reserves and protected areas will need to take into account potential climate change in the reserve systems are to continue to achieved their full potential.'

Climate change adaptation by protected area agencies is likely to vary by jurisdiction. Adaptation strategies that are appropriate in one jurisdiction may not be suitable in another because they are in conflict with existing policy and planning regulations. For example, some of the management recommendations that Henderson et al. (7) put forward for maintaining forest cover on vulnerable and highly valuable Prairie island forests (including: 'countering potentially catastrophic insect or vegetation disturbances by biological, chemical or physical controls', 'introduction of new or non-native species best adapted to new climates', and 'undertake forest harvest where appropriate') may be possible in provincial forests, but are not in accord with existing national parks policy. The non-availability of particular adaptation strategies in some jurisdictions may have important implications for determining the direction and magnitude of ecosystem change and the management objectives for individual protected areas.

The policy and planning sensitivities identified above demonstrated the need for Canadian conservation agencies to begin to develop climate change policies and a coordinated adaptation strategy that would provide a framework for planning and management decisions in protected areas. Protected area agencies cannot act unilaterally to develop and implement comprehensive contingency plans for climate change, as this would necessitate a comprehensive reassessment of the agency mandates, policy frameworks, and resource allocations. Thus, federal and provincial-territorial leadership in the form of climate change adaptation policy (similar to mitigation policy in the form of Kyoto ratification) must be forthcoming. The issues related to the strategic response of protected area agencies to the challenge of climate change are very complex and will require significant input from conservation stakeholders.

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