CANADIAN PARKS AND PROTECTED AREAS:

Helping Canada weather climate change

Report of the Canadian Parks Council Climate Change Working Group

PARKS
Canadian Parks Council
Conseil canadien des parcs

Report prepared by
The Canadian Parks Council Climate Change Working Group
for the Canadian Parks Council

Citation: Canadian Parks Council Climate Change Working Group. 2013. Canadian Parks and Protected Areas: Helping Canada Weather Climate Change. Parks Canada Agency on behalf of the Canadian Parks Council. 52 pp.

CPC Climate Change Working Group members
Karen Keenleyside (Chair), Parks Canada
Linda Burr (Consultant), Working Group Coordinator
Tory Stevens and Eva Riccius, BC Parks
Cameron Eckert, Yukon Parks
Jessica Elliott, Manitoba Conservation and Water Stewardship
Melanie Percy and Peter Weclaw, Alberta Tourism, Parks and Recreation
Rob Wright, Saskatchewan Tourism and Parks
Karen Hartley, Ontario Parks
Alain Hébert and Patrick Graillon, Société des établissements de plein air du Québec
Rob Cameron, Nova Scotia Environment, Protected Areas
Doug Oliver, Nova Scotia Natural Resources
Jeri Graham and Tina Leonard, Newfoundland and Labrador Parks and Natural Areas
Christopher Lemieux, Canadian Council on Ecological Areas
Mary Rothfels, Fisheries and Oceans Canada
Olaf Jensen and Jean-François Gobeil, Environment Canada

Acknowledgements

The CPC Climate Change Working Group would like to thank the following people for their help and advice in preparing this report: John Good (CPC Executive Director); Sheldon Kowalchuk, Albert Van Dijk, Hélène Robichaud, Diane Wilson, Virginia Sheehan, Erika Laanela, Doug Yurick, Francine Mercier, Marlow Pellat, Catherine Dumouchel, Donald McLennan, John Wilmshurst, Cynthia Ball, Marie-Josée Laberge, Julie Lefebvre, Jeff Pender, Stephen Woodley, Mikailou Sy (Parks Canada); Paul Gray (Ontario Ministry of Natural Resources); Art Lynds (Nova Scotia Department of Natural Resources).

Report design and layout by Alison Scott Design

Cover photo: Lake Superior Provincial Park, Ontario © Ontario Parks

CAT. NO. R62-434/2013E

ISBN: 978-1-100-21893-9

(Cette publication est aussi disponible en français.)

Table of Contents

Preface

Canada has a magnificent natural heritage that defines our country in the eyes of Canadians and the world community. Our long tradition of establishment and effective management of parks and protected areas—whether they be vast, relatively untouched spaces or places for recreational enjoyment, learning and discovery—aims to protect our natural and cultural heritage for present and future generations. Canada's parks and protected areas are important to Canadians for their role in protecting significant landscape and seascape features, conserving biodiversity and cultural resources, and providing opportunities for recreation and connection with nature. In some parts of Canada, they may represent the only remaining examples of relatively undisturbed ecosystems. Most of these areas are managed by federal, provincial and territorial governments.

Parks and protected areas are increasingly being recognized for another important role they play: as a key means of adapting to and mitigating climate change. The world's climate is changing, and human and natural systems will need to find ways to adapt. Canadian provinces and territories, along with the federal government, are actively developing strategies to help all sectors of society adapt more effectively to climate change. Protected areas are an important part of any climate change strategy, as they protect ecosystems and the services they provide for communities; they store vast quantities of carbon thereby reducing emissions of carbon dioxide from land use change; and they provide safe havens for plants and animals.

This report highlights the roles of parks and protected areas in climate change adaptation and mitigation, and some of the actions taken to date by provincial, territorial and federal parks and protected areas agencies as they respond to the challenge of rapid climate change. The report builds on the work of the Canadian Council on Ecological Areas and others who have identified the need for greater collaboration across jurisdictions on this issue. Recognizing this need, the Canadian Parks Council (CPC) Climate Change Working Group is coordinating these efforts to build understanding and capacity among jurisdictions to respond to climate change and identify opportunities to work together.

Canada's parks and protected areas hold great promise as part of a natural solution to climate change. At the same time, there is much more to do to expand our protected areas networks, connect natural spaces, restore ecosystems and habitats, bring back native species, and inspire and engage Canadians. By reaching across boundaries, sharing best practices and learning from one another, parks and protected areas agencies can strengthen their contributions to climate change adaptation and mitigation. The goal of the members of the CPC Climate Change Working Group is to encourage the creation of ecologically resilient networks of parks and protected areas, connected through sustainably managed landscapes and seascapes, as a key part of the solution to Canada's climate change challenges.

Karen Keenleyside
Chair, Canadian Parks Council Climate Change Working Group

Executive Summary

Rapid, human-induced global climate change is occurring and will have far-reaching impacts on society, biodiversity and ecosystems. Adaptation measures are thus a necessary complement to reducing greenhouse gas emissions. Ecosystem-based adaptation—a complementary approach to other types of climate change adaptation—emphasizes the protection of biodiversity, the restoration of ecosystem functions and the sustainable use of resources to help nature and people adapt to climate change.

Parks and protected areas offer certain advantages for implementing ecosystem-based approaches to climate change adaptation. For example, parks and protected areas are already being managed to conserve biodiversity and maintain intact and functioning ecosystems; they are effective ways of retaining natural ecosystems and the services they provide; they form the core areas necessary for the long-term conservation of biodiversity within broader landscapes and seascapes; and they provide opportunities for public engagement and learning.

Canada's networks of parks and protected areas play an important role in strengthening both our ecological and social resilience to climate change, including:

- Protecting safe havens for wildlife: helping plants, animals and their habitats adapt;
- Working with partners to connect and restore landscapes and seascapes;
- Protecting ecosystem services and supporting healthy communities;
- Building knowledge and understanding of impacts and solutions; and
- Inspiring and engaging Canadians.

The challenges of climate change are such that Canadian parks and protected areas agencies must work together to strengthen their contributions to climate change adaptation and mitigation. Canadian parks and protected areas agencies have the opportunity to **protect** remaining large, relatively intact ecosystems, securing space for wildlife to move and adapt, protecting natural and cultural heritage, conserving traditional food sources, and diversifying economic opportunities for communities in the face of change. Practices that help to **connect** existing protected areas, reduce pressures from pollution and overexploitation, and/or help to **restore** ecosystems and habitats are fundamental to building the resilience of parks and protected areas.

To fully realize the potential of parks and protected areas as part of a "natural solution" to climate change, Canadian parks and protected areas agencies will need to collaborate with a full range of partners and stakeholders to:

- Protect more natural areas;
- Contribute to building resilient, well-connected networks of healthy ecosystems;
- Actively manage and restore the ecological integrity of ecosystems;
- Improve our understanding of climate change impacts and solutions for parks and protected areas;
- Share knowledge to help build capacity and ensure effective management of parks and protected areas; and
- Engage and inspire Canadians with hope for the future.

The types of projects described in this report are only the beginning. Much more needs to be done in order for parks and protected areas to fully realize their potential as natural solutions to climate change. Parks and protected areas agencies need to build their capacity to adapt proactively. And they cannot do it alone. Securing Canada's natural and cultural heritage—the underpinning of our economy, health and well-being—in a rapidly changing world will require new strategies, new partnerships and broad engagement with all sectors of Canadian society.

The challenge of climate change

Rapid human-induced global climate change is occurring and will have far-reaching impacts on society, biodiversity and ecosystems (IPCC 2007; Lemmen et al. 2008). The rate and magnitude of climate change have altered natural systems and are already driving ecological change. Changes in temperature, precipitation, and an increased frequency of extreme events such as drought and floods are occurring, along with associated ecosystem changes such as shifts in ranges of terrestrial and aquatic plants and animals, and melting of glaciers and permafrost (Lemmen et al. 2008; Environment Canada 2009; Federal Provincial and Territorial Governments of Canada 2010).

Reducing the amount of greenhouse gases being released into the atmosphere is critical for limiting the future rate and magnitude of climate change (IPCC 2007; Lemmen et al. 2008). These types of interventions, referred to as mitigation strategies, aim to reduce greenhouse gases by controlling emissions or by removing them from the atmosphere.

Climate change is occurring

An increase in the amount of greenhouse gases in the atmosphere has altered the planet's climate system and is the main driver of current rapid climate change. "Global atmospheric concentrations of CO2 [carbon dioxide], CH4 [methane] and N2O [nitrous oxide] have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years... Global increases in CO2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution" (IPCC 2007).

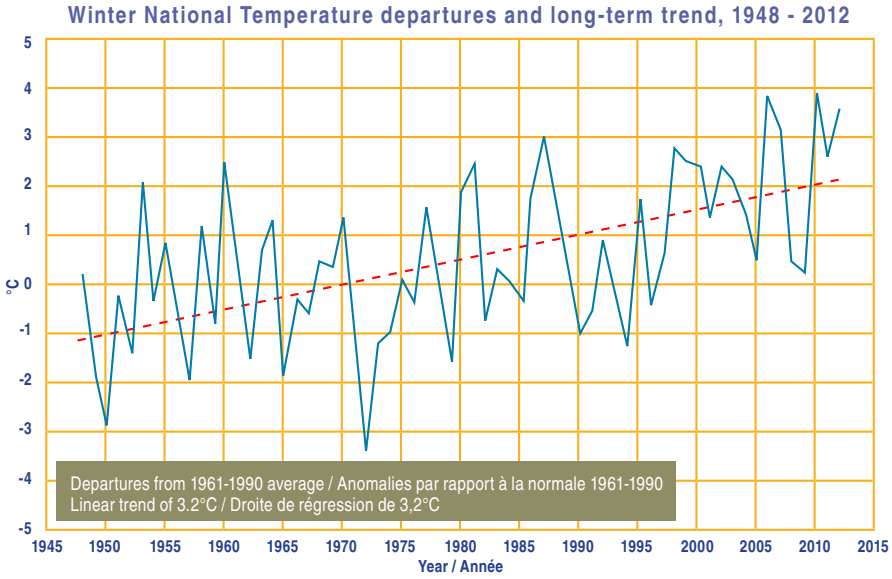
Melting ice, Aulavik National Park of Canada, Northwest Territories

Necessity for adaptation

Because climate change will continue to impact the planet even with mitigation efforts, adaptation measures are a necessary complement to mitigation (Lemmen et al. 2008; Eby et al. 2009; Solomon et al. 2009; Gillett et al. 2011). Many types of adaptation responses are already underway in most regions of Canada, and many more are being considered (Lemmen et al. 2008). Most of these adaptation strategies focus on human and managed systems, such as designing infrastructure and protecting coastal habitats to withstand the impacts of severe weather events, shifting agricultural practices to more drought- and pest-resistant crops, and increasing the efficiency of water use.

Climate trends for Canada

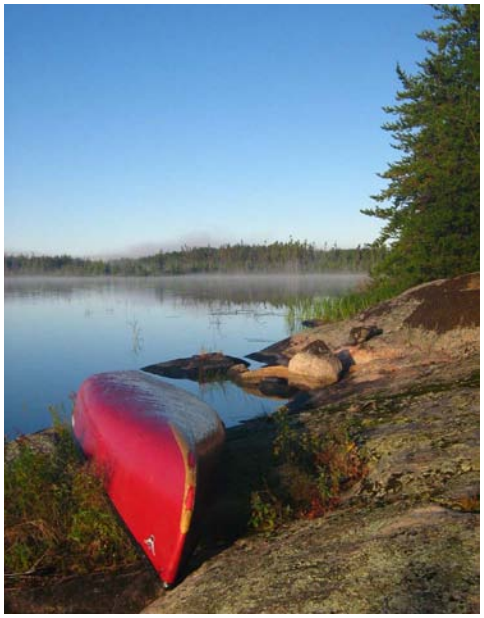
Records from 1948 to 2011 indicate that annual temperatures have warmed by 1.5°C (Environment Canada 2012a). Warming has been greatest in the north, with increases of 2.5°C in the Mackenzie District during this period. Warming has been least in Atlantic Canada with an overall increase of 0.7°C. No significant cooling trend has occurred at any location in any season, and the largest seasonal temperature increases (3.2°C) have been in the winter. These temperature changes are associated with a decrease in winter snowpack and earlier snowmelt, and an earlier start to the growing season (Federal, Provincial and Territorial Governments of Canada 2010). Annual precipitation generally increased from 1950 to 2007 (Federal, Provincial and Territorial Governments of Canada 2010), most strongly in the northern half of Canada, but the fraction of precipitation that fell as snow decreased in southern Canada.



Source: Environment Canada 2012a

Benefits of ecosystem-based adaptation

A complementary approach to adaptation known as ecosystem-based adaptation is gaining acceptance as a viable and cost-effective way to address the impacts of climate change (Secretariat of the Convention on Biological Diversity 2009; Dudley 2010; World Bank 2010; Lemieux et al. 2011). In this approach, the essential functions that ecosystems provide, such as maintenance of clean water, air and soil, are seen as vital components of any climate change adaptation strategy. The ecosystem-based approach emphasizes the protection of biodiversity, restoration of ecosystem functions and sustainable use of resources. This approach can also provide other benefits by supporting economic diversification and strengthening community resilience, as well as enhancing carbon capture and storage (i.e., climate change mitigation).



Obukowin Lake in Atikaki Provincial Park, Manitoba
© E. Roberge, Manitoba Conservation and Water Stewardship

> Climate change poses a serious threat to ecosystems. At the same time, protecting healthy ecosystems can provide natural buffers to the impacts of climate change, including extreme weather events, while also providing other benefits such as protecting biodiversity, supporting tourism, and enhancing carbon stores. Known as ecosystem-based adaptation, this approach is recognized internationally as an important part of climate change adaptation. *Government of Canada 2010*

Additional benefits of parks and protected areas

Parks and protected areas offer certain advantages for implementing ecosystem-based adaptation approaches to climate change. Most parks and protected areas are already being managed to conserve biodiversity and maintain intact and functioning ecosystems. When well-managed, they are effective ways of retaining natural ecosystems and the services they provide (Dudley et al. 2010; Lemieux et al. 2011). Protected areas usually have management plans that support a long-term commitment to maintaining or restoring natural and cultural conservation values, and often have associated staff whose expertise can be shared with others. They provide opportunities for public engagement and education, and share knowledge obtained through baseline monitoring and data collection.

As a key element of ecosystem-based adaptation, parks and protected areas form the core areas necessary for the long-term conservation of biodiversity within the broader landscape or seascape. As such, the agencies responsible for managing these core areas have an important role to play in working with partners beyond their boundaries to achieve regional conservation objectives. This understanding of conservation acknowledges that people are part of the ecosystem and reinforces the importance of working at the local level using community-based approaches (Lemieux et al. 2010).

> "The establishment or creation of networks of protected areas can ensure the continued provision of ecosystem services for adaptation as well as biodiversity conservation… Canada's national parks and other protected heritage areas contribute to climate change adaptation by protecting and restoring healthy, resilient ecosystems, cultural resources, communities, and local economies."
>
> *Government of Canada 2010*

© Ontario Parks

© Parks Canada

© Parks Canada

Parks and protected areas: part of the solution

Parks and protected areas are increasingly recognized as an important element in strategies that address the impacts of climate change on biodiversity and society in general. Terrestrial (land-based) protected areas account for almost 10% of Canada's total landmass, and marine protected areas (including the Great Lakes) account for 1% of Canada's marine territory (Environment Canada 2012b). Together, Parks Canada, Environment Canada and Fisheries and Oceans Canada manage the country's federal system of parks and protected areas, including national parks, national marine conservation and protected areas, national wildlife areas and migratory bird sanctuaries. Some national historic sites also include large natural areas. Each province and territory also manages its own system of parks and protected areas. The remainder of protected areas in Canada are made up of a variety of smaller ecological reserves and private land conservation trusts managed by non-governmental organizations, Aboriginal groups and local communities.

> "Natural ecosystems have greater resilience in the face of climate change impacts when additional stresses from industrial and commercial exploitation are reduced, and when species migrating to more suitable locations are facilitated through protected areas."
>
> *Government of Canada 2010*

References to "parks and protected areas" throughout this document refer to national, provincial and territorial parks and other areas designated for the conservation of nature under federal, provincial and territorial law. These other areas include wildlife areas, migratory bird sanctuaries, marine conservation areas, marine protected areas, Ramsar and other designated wetlands, ecological reserves, wilderness areas, and wildlife and forest reserves (Canadian Parks Council 2010). However, the concepts discussed are also relevant to other types of protected areas.

Strengthening resilience

Ecological resilience is critical if ecosystems and the essential services they provide are to be able to adapt to stresses such as climate change (Environment Canada 2009). Efforts aimed at maintaining or restoring ecosystem structure, function and diversity and enhancing the connectivity of landscapes and seascapes will generally help maintain or restore resilience and reduce the risk of catastrophic change (Elmqvist et al. 2003; Walker et al. 2004). Resilient parks and protected areas will assist in maintaining resilient ecosystems and the flow of important ecological services to communities as climate change plays out. In doing so, they will make a critical contribution to successful adaptation in the regional landscapes and seascapes in which they occur.

Young grizzly at BC coast © T. Stevens, BC Parks

Roles for parks and protected areas

Canada's parks and protected areas play an important role in strengthening both ecological and social resilience by building the capacity of species, ecosystems and communities to adapt to climate change. Some of these roles include:

- Protecting safe havens for wildlife: helping plants, animals and their habitats adapt;
- Working with partners to connect and restore landscapes and seascapes;
- Protecting ecosystem services and supporting healthy communities;
- Building knowledge and understanding of impacts and solutions; and
- Inspiring and engaging Canadians.

This report describes in detail each of these roles and provides some examples of the actions taken to date by provincial, territorial and federal parks and protected areas agencies. The examples cited are intended to illustrate these roles but are not exhaustive of all efforts by jurisdictions in responding to climate change.

> "The network of protected areas in Canada contributes to ecosystem resilience in the face of future ecological change."
>
> *Environment Canada 2011a*

Arctic tern nest, Aulavik National Park of Canada © Parks Canada

Parks and protected areas in climate change strategies

Some Canadian jurisdictions are beginning to integrate the role of parks and protected areas into their overall climate change adaptation strategies. For example, the governments of Newfoundland and Labrador, Northwest Territories and Ontario now recognize the value of parks and protected areas for increasing their overall capacity to adapt to and mitigate climate change:

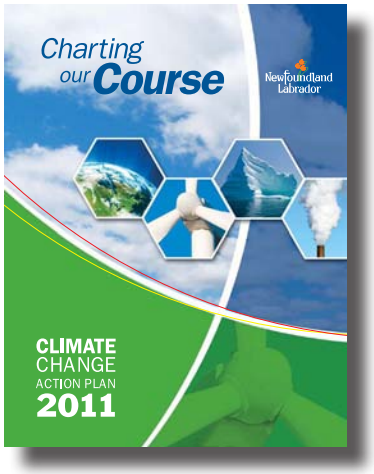
Newfoundland and Labrador: "The Department of Environment and Conservation continues to develop its Natural Areas Systems Plan to complete a comprehensive system of parks and protected areas. An expanded network of protected areas will increase the total land base supporting carbon sequestration and other climate change mitigation and adaptation services" *(Government of Newfoundland and Labrador's Climate Change Action Plan 2011).*

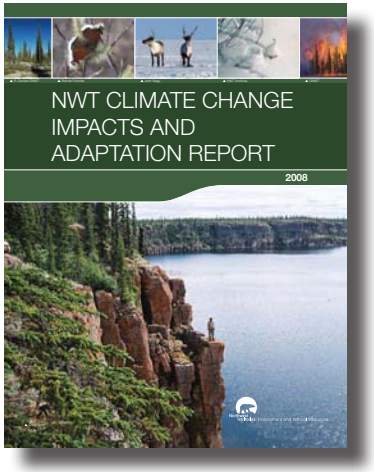
Northwest Territories: "The present industrial economic boom in the Northwest Territories is bringing change to this landscape at a time that coincides with changes resulting from the warming climate. Establishing parks and protected areas has been identified as an important way to minimize the impacts of climate change on biodiversity, especially in areas undergoing additional landscape pressures" *(NWT Climate Change Impacts and Adaptation Report 2008).*

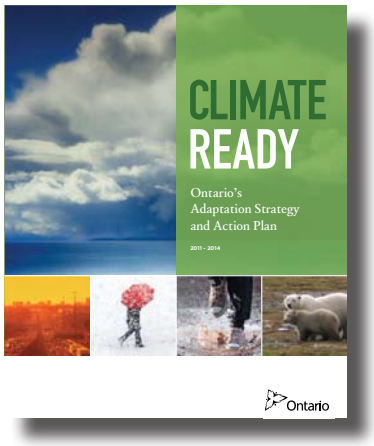
Ontario: "The provincial protected areas system plays a vital role in Ontario's ability to lessen and adapt to the impacts of climate change. Protected areas:

- capture and store carbon in their natural ecosystems
- reduce the impacts of natural disasters
- protect ecological services (e.g., purification of air, decomposition of waste)
- act as biodiversity refuges
- support the ecosystem resilience of the landscape"

(Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011-2014).







Protecting safe havens for wildlife: helping plants, animals and their habitats adapt

> Faced with a changing climate which will bring its own suite of ecosystem changes, the value of protected areas as refuges for biodiversity will only increase. *Environment Canada 2011a*

Parks and protected areas help to conserve all forms of biodiversity by providing relatively intact ecosystems and the space and resources that wild plant and animal populations need to persist or increase. In a changing climate, parks and protected areas are essential tools for conserving biodiversity because they help reduce the impacts from non-climatic stressors (such as invasive species, human activities and habitat fragmentation) and conserve vital gene pools (Hannah et al. 2007; Hannah 2009; Environment Canada 2009; Secretariat of the Convention on Biological Diversity 2009; Federal, Provincial and Territorial Governments of Canada 2010).

Parks and protected areas agencies across Canada are working to increase the number and size of protected lands and waters within their jurisdictions. Understanding how climate change will impact parks and protected areas, as well as their potential for enhancing climate change adaptation, is helping inform their creation and expansion.

Killer whale in Sirmilik National Park of Canada, Nunavut © Parks Canada

Expanding existing parks and protected areas

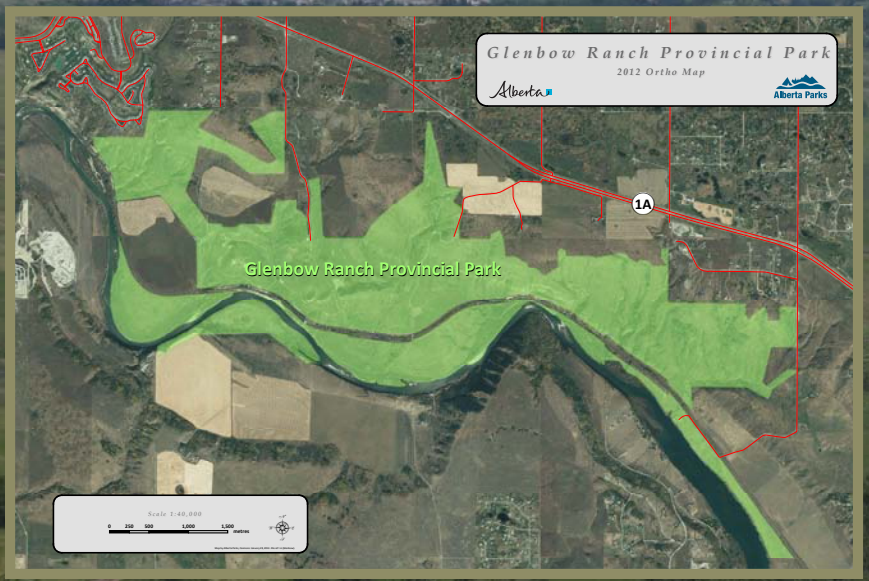
Through strong partnerships with Aboriginal people, local communities, other conservation organizations, and different levels of government, parks and protected area agencies continue to expand their systems of parks and protected areas. For example, with the six-fold expansion of **Nahanni National Park Reserve of Canada** in 2009, the Nahanni watershed will remain intact, and iconic wildlife such as grizzly bear, woodland caribou and Dall sheep will continue to roam freely across this northern landscape. The **Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site** was established in 2010 adjacent to the existing land-based national park, resulting in an expanded area that now protects from mountain-top to deep sea—nearly 5000 km^2 of land and ocean. This recently expanded site is part of a system of protected areas within the archipelago of Haida Gwaii that includes provincial parks, ecological reserves and 11 heritage sites/conservancies. Half the land base of Haida Gwaii is now in protected areas.

Dall sheep © Parks Canada

Establishing new parks and protected areas

The creation of more protected areas helps ensure the conservation of biodiversity, particularly in regions that are experiencing pressures from land use change. For example, in southern Alberta, **Glenbow Ranch Provincial Park** was established in 2006 to protect some of the last remaining native grasslands in the area from encroaching urban development. This historic ranch of over 1300 hectares, located only 34 km west of downtown Calgary, protects an intact example of the Foothills Fescue Grasslands—one of Alberta's most fragmented, modified and least protected ecosystems. Healthy, native grasslands are more resistant to drought and offer better soil protection (from erosion) than cultivated, non-native grasslands. As such, native grasslands are better able to sustain a wealth of biodiversity in changing climatic conditions.

Glenbow Ranch Provincial Park
© Alberta Parks



Climate change impacts on wildlife

Warmer temperatures, earlier springs and altered precipitation patterns across Canada over the past 50 years have had both direct and indirect impacts on plants and animals in terrestrial, freshwater and marine systems. Observed impacts include declines in the abundance of some species, and changes in the ranges, timing of breeding and movement patterns of others (Federal, Provincial and Territorial Governments of Canada 2010). For example, the average first date of observation for common loons in **Algonquin Provincial Park**, Ontario, was April 22 from 1961 to 1985 and April 14 from 1986 to 2010 (8 days earlier). Recent earlier arrival dates seem to be linked to climate warming advancing the availability of open water (R. Tozer, pers. comm.). A long-term study of gray jays in Algonquin Park showed that population declines in this species may be linked to climate change *(Waite and Strickland 2006)*.

Establishing large protected areas will allow more space for species to adapt to climate change and increase the likelihood that wildlife populations will be sustained into the future. For example, BC Parks is adding a new large protected area complex in the North as a result of the Atlin Taku Land Use Plan approved in July 2011. Large landscapes (>2700 km^2) currently make up more than 60% of BC's protected areas system. Large tracts of land in the North are also being protected in Manitoba. For example, two new provincial parks, **Nueltin Lake and Colvin Lake**, protect winter habitat for the Qamanirijuaq barren-ground caribou herd in the transition zone between boreal and tundra ecosystems. In addition, **Kaskatamagan Wildlife Management Area** protects some of the most southern denning habitat in Manitoba for the Western Hudson Bay polar bear sub-population.

Common loons are returning earlier to Algonquin Provincial Park © Ontario Parks

Protecting biodiversity in Nova Scotia

The only taiga ecosystem in Nova Scotia is almost entirely within **Cape Breton Highlands National Park of Canada**. This northern ecosystem is host to a variety of northern species at the southern extent of their range such as alpine whortleberry, northern blueberry, dwarf birch and Canada lynx. The fate of the taiga ecosystem in Nova Scotia in a warming climate is uncertain, but Cape Breton Highlands National Park may be the only refuge in that province for many of these northern species. Results from research at Dalhousie University (Inglis 2007) suggests that **Tobeatic Wilderness Area, Kejimkujik National Park and National Historic Site of Canada** and **Lake Rossignol Wilderness Area** are also important for maintaining healthy populations of moose, flying squirrel, American marten and fisher in the southwest part of that province.

Flying squirrel © R.D. Robinson, Parks Canada

Focusing on resilience

Ecological resilience to climate change depends on factors such as preserving a wide diversity of habitats across a range of landscape and seascape types. Through the establishment of networks of parks and protected areas, Canada's parks and protected areas agencies, along with their partners and stakeholders, can help to increase ecological and social resilience to climate change. For example, the Northwest Territories' Protected Areas Strategy (NWT PAS) is a community-based partnership among Aboriginal people, federal and territorial governments, industry and non-governmental organizations that is establishing a new network of protected areas. The NWT PAS is focused on protecting a range of different ecosystem types, latitudes, elevations, habitat types and enduring features in order to increase the resilience to climate change of both the wildlife and the people who live there. In 2009, **Saoyú-ʔehdacho National Historic Site of Canada** near the community of Dél̨ı̨ne became the first protected area established under the NWT PAS. Saoyú-ʔehdacho has intact boreal forest and is home to important wildlife species including woodland caribou, grizzly bears, wolverine and peregrine falcons.

Saoyú-ʔehdacho National Historic Site of Canada © Parks Canada

Working with partners to connect and restore landscapes and seascapes

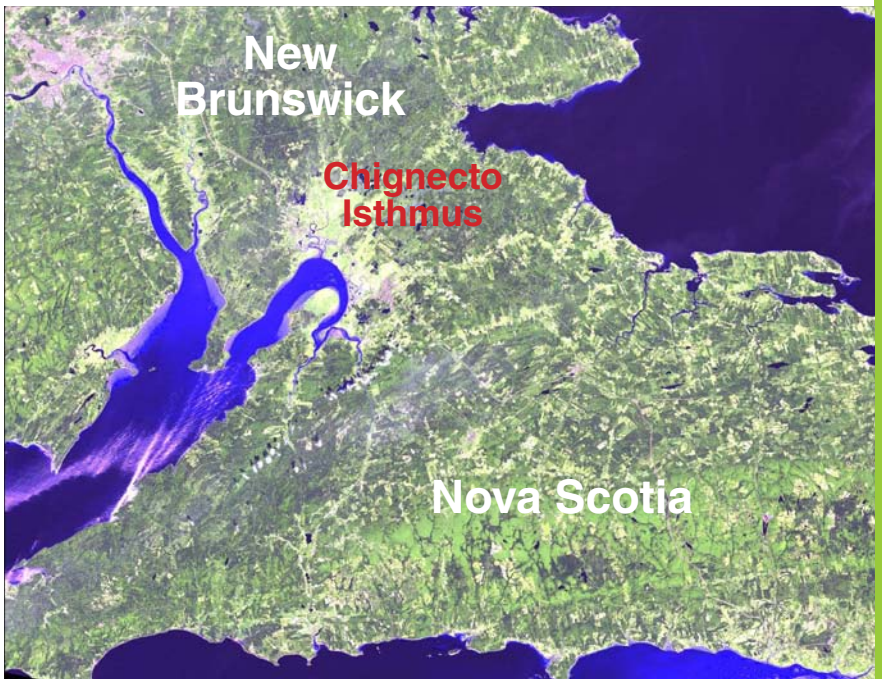
Along with expanding existing parks and protected areas and creating new ones to provide more effective refuges for wildlife, linkages between protected areas are of paramount importance for conservation. Isolated “islands” of protected areas will not be adequate to conserve biodiversity over the long-term (Bennett 1998; Shafer 1999). Connected networks of protected areas can achieve landscape- or seascape-level conservation objectives that exceed what individual protected areas can do on their own (WCPA/IUCN 2007).

Maintaining and enhancing connectivity among parks and protected areas is critical in the context of climate change (Lemieux et al. 2011). The ability of species to move and adapt will depend on other types of natural areas with varying levels of protection, which will provide the necessary linkages. This is especially the case in the more heavily populated southern and central parts of the country where large protected areas are less feasible.

Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site
© C. Cheadle, Parks Canada

Creating protected area networks

When parks and protected areas are managed to allow connectivity by land and/or water, plants and animals are able to maintain natural movement patterns, allowing for an increased probability of persistence (Secretariat of the Convention on Biological Diversity 2009). For example, a national network of **Marine Protected Areas** (MPAs) is being established to protect Canada's oceans and Great Lakes. The design of the MPA network relies in part on connectivity to strengthen the overall ecological resilience of the marine environment and to protect special species and places. As a result, MPA networks can increase adaptation to climate change by not only protecting representative examples of all habitat types but also by providing refuges for marine species being displaced from other areas (ICES 2011).



Chignecto Isthmus, LANDSAT 7 image, courtesy of United States Geological Survey

Creating and maintaining connections

The province of Nova Scotia has been working with others in the Chignecto Isthmus with the goal of helping to build and maintain a natural, protected corridor along its axis. Since the last glacial retreat, Nova Scotia has been connected to the rest of Canada by only a narrow strip of land. Over the past ten thousand years, the Chignecto Isthmus has gradually narrowed (as a result of relative sea-level rise) to the point where, today, it is little over 20 km wide. Parts of the isthmus have been heavily developed over the years by highways, farming, forestry and other land uses and, as a result, are dominated by disturbed habitats. At the same time, the isthmus is the overland route by which most native species have reached the province, and will be the primary route by which species reach Nova Scotia in response to changing climate. The protection of a substantial undeveloped wilderness on the isthmus will also safeguard the nearby Town of Amherst's drinking water well-field.

Working across boundaries

The effects of climate change are such that managers of parks and protected areas are presented with a set of novel and complex issues that transcend boundaries. Many protected area objectives will be achieved only through regional cooperation that crosses traditional political, legal and institutional boundaries. Trans-boundary partnerships—partnerships that cross provincial or territorial boundaries—will help build connectivity at landscape and seascape scales (Lemieux et al. 2010).

Ceremony of respect, Woodland Caribou Provincial Park, Ontario © H. Otake

For example, the provinces of Manitoba and Ontario are working together to conserve connections among protected areas in one of the world's most intact ecosystems, the boreal forest. Because of its relatively intact state, the boreal forest can accommodate many plants and animals whose ranges are shifting as a result of climate change. However, landscape fragmentation from industrial development, deforestation and fire suppression have the potential to weaken the capacity of the boreal forest and its inhabitants to adapt to climate change.

Manitoba-Ontario Interprovincial Wilderness Area

The **Manitoba-Ontario Interprovincial Wilderness Area** encompasses over 9400 km² of boreal forest along the border between the two provinces. It includes core protected areas such as **Woodland Caribou Provincial Park** and the **Eagle-Snowshoe Conservation Reserve** in Ontario, and **Atikaki Provincial Park** and parts of **Nopiming Provincial Park** in Manitoba. In addition, both provincial governments are supporting a proposal by First Nations to create an internationally recognized network of protected areas and managed landscapes on their ancestral lands. The First Nations are seeking inscription of the area on the UNESCO (United Nations Educational, Scientific and Cultural Organization) World Heritage List. The project, known as "**Pimachiowin Aki**" or "**The Land that Gives Life**", comprises over 30,000 km² of boreal forest that includes parts of the First Nations' planning areas and contiguous protected areas on both sides of the provincial border. By managing a cluster of parks and wilderness as one land area, the interconnectedness of an integral part of Canada's central boreal forest will be strengthened and its capacity to adapt to climate change will be enhanced.

Connecting with the broader landscape or seascape

To achieve greater landscape and seascape connectivity, parks and protected areas agencies are creating partnerships and expanding their engagement and collaboration to work with neighbours and stakeholders to manage protected areas as part of the broader landscape. For example, in Newfoundland and Labrador, park agencies are working with scientists and natural resource agencies to help inform forestry management planning and other land use activities so that large landscapes remain connected. One of their goals is to have **Terra Nova National Park of Canada, Bay du Nord Wilderness Reserve** and **Little Grand Lake Provisional Ecological Reserve** serve as core protected areas in a connected landscape.

Woodland caribou in Parc national de la Gaspésie, Quebec
© C. Isabel, Sépaq

Connecting the landscape to conserve biodiversity

In Quebec, park agencies are conducting research with the provincial government (protected areas, forest and wildlife management) and other research institutions on the potential for creating connected networks of protected areas to help conserve biodiversity in the context of climate change. Two pilot projects are underway to examine the potential for certain types of zones around parks and other core areas to be designated as IUCN Category V or VI protected areas. These designations would permit sustainable use of natural resources within these zones, while providing connectivity for the parks and other core areas to the surrounding landscape. For example, Quebec's **Parc national de la Gaspésie** is home to a remnant herd of woodland caribou, but the caribou frequently roam in areas outside the park. Managing forestry practices more sustainably in areas surrounding the park will give the caribou, and other species at risk found in the park, a better chance to adapt to change.

Restoring ecological integrity and reducing the influence of non-climatic stressors

Restoration efforts in parks and protected areas are important for maintaining or improving the ecological integrity and associated resistance and resilience of these special places to climate change. Moreover, restoration strategies that consider influences beyond the boundaries of parks and protected areas will more effectively protect the ecological integrity of core habitats and address non-climatic threatening processes such as habitat fragmentation, upstream pollution, and invasive species (Parks Canada Agency and Canadian Parks Council 2008). Park managers are increasingly working with partners to bolster restoration efforts in areas surrounding protected areas to reduce their overall vulnerability to climate impacts and enhance resilience of species and ecosystems (Lemieux et al. 2010). For example, in **Grasslands National Park of Canada** in Saskatchewan, park managers are working both inside the park and with landowners adjacent to the park to control invasive species that threaten the park's native grassland species. Invasive species management has led to collaboration among multiple jurisdictions and partners in the area surrounding the park.

Maintaining connections over time

Corridors and connected landscapes and seascapes that remain climatically suitable for species over time will be better able to allow species to migrate and adapt to climate change. The need for temporally connected migration corridors among protected areas will be essential to maintain biodiversity in a changing world. For example, many species found in Garry oak ecosystems are listed as "at-risk" under the Canadian *Species at Risk Act*. Areas such as **Gulf Islands National Park Reserve of Canada** in British Columbia currently protect their sensitive habitat. However, a recent study has modeled how Garry oak will respond to climate change, and what areas will be continuously suitable and temporally connected for Garry oak over the 21st century (Pellatt et al. 2012). Temporally connected protected areas will be important for the conservation of these ecosystems, both now and in the future.

Grasslands National Park of Canada, Saskatchewan © E. Anderson

Protecting ecosystem services and supporting healthy communities

People have always depended on healthy ecosystems for food, clean air and water, and other life-supporting processes. These functions are often referred to as "ecosystem services". No matter where people live, we depend on these services for our health and well-being. In the context of rapid climate change, protection of these services becomes even more important.

Parks and protected areas help provide for continuation of essential services in a changing climate. They also provide places for escaping the heat of urban areas and for spiritual renewal, recreation, stress relief and rejuvenation (Mulongoy and Gidda 2008; Secretariat of the Convention on Biological Diversity 2008; TEEB 2009). Through the protection and provision of these services, they support local economies and cultural traditions, thereby strengthening communities and helping people adapt to change. Parks and protected areas also play an important role in regulating climate by storing and sequestering carbon in healthy ecosystems.

Bay du Nord Wilderness Reserve

Protecting water supplies

Protecting headwaters and watersheds is an effective way to help ensure a supply of clean water into the future. For example, some parts of Canada, such as semi-arid southern Alberta, are predicted to experience more frequent droughts as the climate changes. Alberta's **Elbow-Sheep Wildland Provincial Park** in the Rockies protects the headwaters of the Elbow River, which supplies approximately half the city of Calgary's water. In addition, **Banff National Park of Canada** protects the Bow River Basin watershed, the most highly populated watershed in southern Alberta, helping to secure clean drinking water for 1.2 million people while sustaining the health and diversity of many natural ecosystems within and around the park. British Columbia's system of parks and protected areas also protects over 90 community watersheds.

Supporting health and well-being

Parks and protected areas help protect and sustain populations of wild plants and animals that are important to local communities as sources of food and as part of their cultural heritage. For example, in British Columbia, salmon are vulnerable to climate change and other stressors in the region. The salmon is an important symbol for the Haida Nation as illustrated by its presence in many Haida legends. It is also a vital economic resource and a mainstay of the diet of remote Haida communities. In 2009, **Gwaii Haanas National Park Reserve and Haida Heritage Site** launched an initiative to restore degraded streams and adjacent riparian forests to support the re-establishment of self-sustaining salmon populations in the island's creeks. The project is not only restoring ecological integrity of the park ecosystem but is supporting the traditional and commercial fisheries of the region and reconnecting the Haida people with this important symbol of their heritage.

Higher summer temperatures and other factors associated with climate change will bring an increased likelihood of health risks to Canadians. Heat waves represent a potentially significant health risk, especially to those living in urban areas (Séguin and Berry 2008; Lemmen et al. 2008). Evidence also suggests that along with other health-related impacts such as an increased prevalence of some diseases, climate change may have a negative impact on mental health (Berry et al. 2010; Coyle and Susteren 2011). Parks and protected areas provide cool, green spaces where people can go to escape the heat of the city (Lafortezza 2009), experience an increased sense of environmental well-being and benefit physically and mentally from being in contact with nature (Maller et al. 2005; Lemieux et al. 2012). The Canadian Parks Council's "Healthy by Nature" initiative seeks to foster this awareness. By spending more time in parks and protected areas, Canadians have the opportunity to improve their overall health and understand the connection between healthy ecosystems and human health.

Spawning salmon, Gwaii Haanas National Park Reserve and Haida Heritage Site

Contributing to a healthy economy

> Some of the benefits [of parks and protected areas] for local communities can be measured as direct benefits from employment, operations, and tourism. Parks and special places also provide safe and sustainable recreational opportunities... More so than other sectors, parks and special places and parks-related tourism have considerable ability to promote, strengthen and support Inuit culture, improve quality of life, and develop positive role models. This is because opportunities more closely reflect cultural traditions on the land and are at the community level.
>
> *Excerpt from www.nunavutparks.com*

Aboriginal interpretation
© B. Townsend, Parks Canada

Climate change is predicted to impact the Canadian economy in many ways, especially those resource-dependent communities that rely on agriculture, forestry or fisheries (Lemmen et al. 2008). Some of these communities may be particularly vulnerable to change and have limited opportunities for economic diversification. Parks and protected areas provide opportunities for employment and generate billions of tourism dollars, which helps to diversify local economies and increase their capacity to address change. Parks and protected areas generate a significant amount of economic activity by supporting tourism, providing jobs, generating tax revenue to governments and diversifying the economy, particularly in rural and remote areas of Canada.

Several recent studies have examined the economic benefits of parks and protected areas on the Canadian economy (The Outspan Group 2011a, 2011b). One study commissioned by the Canadian Parks Council found that in 2009, $5.2 billion in combined direct spending by park agencies and visitors added $4.6 billion to Canada's Gross Domestic Product (GDP), $2.9 billion of which was labour income (equivalent to 64,000 full time jobs). An additional $337 million was returned to municipal, provincial and federal governments as taxes (The Outspan Group 2011a).

Diversifying the economy in Canada's North

In Canada's North where the climate is changing particularly rapidly, the protection of traditionally-used lands helps to safeguard the traditional economy and resource uses such as traditional harvesting while also providing job opportunities that are linked to traditional lands. By providing another employment option and acquiring local goods and services to help support their operations, parks agencies help to strengthen communities and enhance their capacity to adapt to change.

Drying salmon © Parks Canada

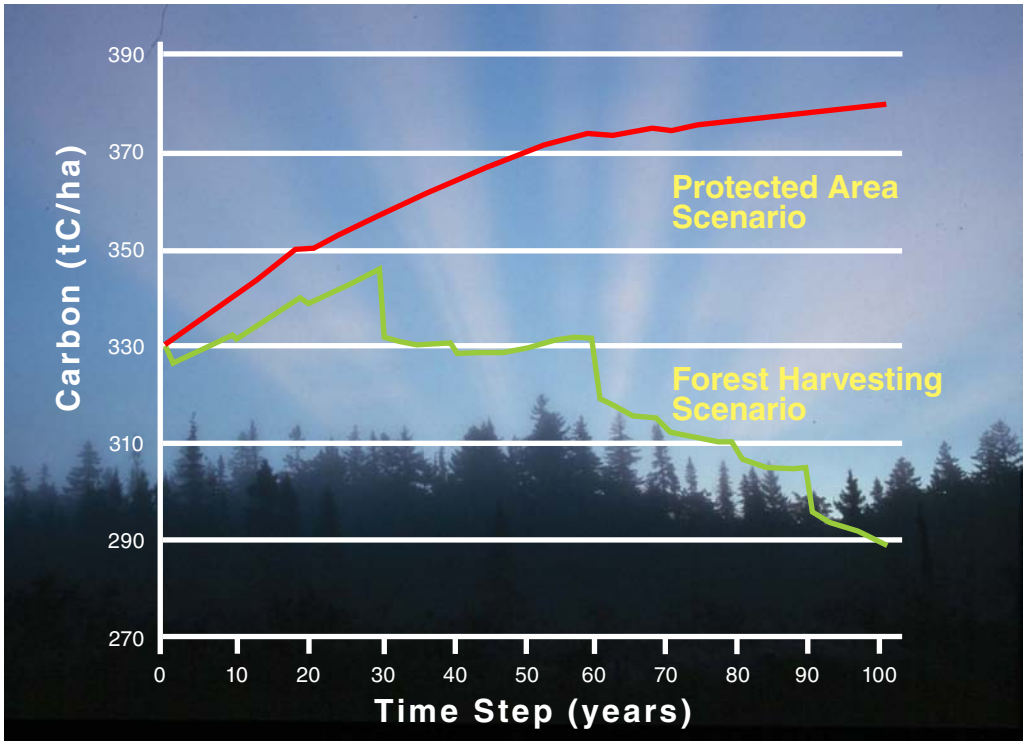
Storing carbon

Carbon is captured, stored, and released by living organisms. For example, trees and other plants take up (sequester) carbon dioxide from the atmosphere during photosynthesis. While all ecosystems sequester carbon, some ecosystems such as boreal and temperate forests, grasslands, peatlands and marine estuaries have been shown to store large quantities of carbon (Carlson et al. 2009; Nellemann et al. 2009; Boyd 2011). This is because these ecosystems either have large amounts of standing biomass (such as large trees) compared with adjacent areas, or because organic and inorganic carbon accumulates over thousands of years in undisturbed soils and sediments.

By protecting lands and waters from degradation and human activities such as deforestation, unsustainable agriculture, aquaculture or dredging, protected areas can continue to store carbon for decades to come (Dudley et al. 2010). One study estimated that Canada's system of national parks could store as much as approximately 4.43 billion tonnes of carbon (Kulshreshtha and Johnston 2004). This means that the amount of carbon stored is approximately equal to 23 times the 2009 level of Canada's annual greenhouse gas emissions (of approximately 690 megatonnes of carbon dioxide equivalent) (Environment Canada 2011b).

Climate change is influencing the economic value of some ecosystem services such as carbon and creating economic incentives for the establishment and effective management of protected areas. For example, BC Parks has protected 492 hectares of private land on Denman Island, which will be managed to promote the growth of new forest. The volume of carbon that will be sequestered through growth of the forest has enabled BC Parks to finance this purchase through the sale of carbon credits. This area will become a park in the provincial park system.

Musquash Estuary Marine Protected Area, New Brunswick © D. Thompson



Forecasted forest carbon stocks from 2006 to 2107 in Gully Lake Wilderness Area comparing continued protection versus forest harvesting scenarios. From Morton et al. 2010. Photo: O. Maass

Storing carbon in protected forests

Protected forests may store more carbon than other types of land uses, according to recent studies of carbon modeling in protected areas. For example, a study in Nova Scotia estimated the current stock and potential for future carbon storage of forests and peatlands in select **Wilderness Areas** in Nova Scotia (Morton et al. 2010). Results showed that Nova Scotia forests stored a significant amount of carbon. Although there was minimal long-term sequestration potential, carbon stocks were maintained through time. Non-harvest scenarios in protected forests maintained slightly higher carbon stocks than harvest scenarios. Another study is assessing forest carbon stocks and carbon dynamics inside and outside selected national parks in British Columbia in order to understand the role of protected areas in carbon sequestration and storage in comparison with adjacent forestry practices. Preliminary results of this collaborative research project with the Canadian Forest Service and Parks Canada show that, as expected, old forests store more carbon than younger forests. In addition, national parks that experience a fairly regular level of disturbance (e.g., fire and insects) coupled with prescribed burning stored and sequestered more carbon than adjacent forested landscapes that are managed for sustainable forest harvest. Further investigation of the environmental dynamics (e.g., forest age-class structure) is needed to understand the results of this study (Sharma et al. in prep.).

Collaborating on research in the Yukon

Northern parks are already experiencing more dramatic climate change effects than southern Canada, such as coastal erosion, melting permafrost, changes in vegetation, and impacts on wildlife populations as a result of changes in sea ice. **Herschel Island - Qikiqtaruk** and **Kusawa Territorial Parks** in the Yukon have become focal points for research, monitoring and education in Canada's North. Yukon Parks is collaborating on several climate change related projects with universities, colleges, government agencies, First Nations and non-governmental organizations. Studies include permafrost (Carleton University), coastal erosion (McGill University), ecosystem dynamics (University of British Columbia, Yukon College), and landslide monitoring (Yukon Geological Survey). Results from these studies will be used to anticipate and manage potential impacts to park ecological and cultural values; assess the conservation status of wildlife; formulate adaptive management strategies; protect and adapt park infrastructure and public safety; implement park operations that contribute to climate change mitigation; and incorporate climate change considerations and scenarios in the design of new protected areas.

Building knowledge and understanding of impacts and solutions

Parks and protected areas provide excellent locations to study and monitor the responses of natural systems to climate change. Because their ecosystems are not as affected by other anthropogenic stressors, they can act as environmental "controls" for monitoring potential impacts of important ecosystem drivers such as temperature and moisture. Because protected areas are located all across Canada, they also provide a representative sample of Canada's natural environments. As such, parks and protected areas can act as "benchmarks of change" that help us understand the nature, magnitude and rate of change occurring in natural systems as a result of climate change (Lemieux et al. 2011). In addition, parks may have knowledgeable staff, infrastructure, and baseline data to assist researchers working in remote areas, particularly in the north.

Herschel Island - Qikiqtaruk Territorial Park, Yukon © C. Eckert

Drawing on traditional knowledge

Parks and protected areas agencies are also involved in projects that draw on Aboriginal traditional knowledge as a vital part of efforts to understand long-term and shorter-term changes on landscapes and seascapes. Traditional knowledge can be integrated with scientific studies to help inform future management decisions. The information generated through this type of research can be used to inform decisions that will help communities adapt to changing conditions. For example, **Torngat Mountains National Park of Canada** is involved in research projects to study key food sources to Inuit, such as berries and ringed seals. The establishment of baseline data will inform future studies on the effects of climate change on these important species and provide Inuit with health information regarding these valued components of their traditional diet.

Inuit youth picking berries © L. Narraway, Parks Canada

Monitoring change

Environmental monitoring data being collected in protected areas are enabling park managers to make decisions that will give ecosystems and species the best chance to adapt. For example, an Ecological Integrity Monitoring Program in Quebec's parks is studying arctic-alpine vegetation in parks with alpine peaks such as **Parc national de la Gaspésie, des Hautes-Gorges-de-la-Rivière-Malbaie** and **des Grands-Jardins.** These plants are being monitored in these locations because they are sensitive indicators of climate-related ecological changes. These changes will have impacts on caribou (a species at risk) and other species that rely on habitats associated with these plant communities.

Parc national des Grands-Jardins, Quebec
© Sépaq

Ecological integrity monitoring in BC
© T. Stevens, BC Parks

Modelling shoreline sensitivity in BC

Coastlines are especially vulnerable to climate change because sea level is expected to rise, and storm surges may increase in both their frequency and intensity. BC Parks created a model of the sensitivity of shorelines to sea level rise and examined each coastal protected area to identify areas of high sensitivity. This knowledge will help guide and prioritize planning and management of protected areas along the coast. Landscape connections between intact natural areas within the province are also being studied to highlight locations where efforts should be focused to reconnect relatively intact natural areas, and provide movement opportunities for animals and plants. Both projects were done in collaboration with students at Vancouver Island University in Nanaimo, BC, under the mentorship of BC Parks staff.

Bird watching in Rondeau Provincial Park, Ontario © E. Meleg, Ontario Parks

Partnering in research

Research partnerships with protected areas agencies can provide a critical avenue to synthesize, apply and mobilize new and existing knowledge based on natural and social sciences research, and increase the impact of university-based research in government decision-making and policy formulation. For example, a research partnership between the University of Waterloo, the Centre for Applied Sciences in Ontario Protected Areas (CASIOPA) and the Ministry of Natural Resources has helped Ontario Parks with understanding the implications of climate change for the provincial protected areas system and to develop adaptation options. The research engaged experts and staff in identifying and evaluating adaptation options, such as considering climate change effects during park management planning and reducing pressures on protected areas to enhance their resilience (see Lemieux and Scott 2011). The results of the study have provided an important knowledge foundation for Ontario Parks to assess actions for adapting to climate change and for contributing to the development of provincial climate change strategies, such as *Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011-2014*.

Studying site of historic cabin in Ivvavik National Park of Canada
© Parks Canada

Maintaining connections to the past

Many parks and protected areas have sites of historical or cultural value. Conservation of these sites can help strengthen connections to the past and to the land. For example, permafrost degradation and wave action increasingly threaten cultural resources along the arctic seacoast of **Ivvavik National Park of Canada**. At Nunaluk Spit, the loss of an historic cabin and associated archaeological features is now considered inevitable. Efforts to document the site's cultural resources and to gather information on its occupation will help future generations maintain a connection with this site.

Ancient pictographs, Woodland Caribou Provincial Park, Ontario
© H. Otake

Assessing vulnerability in the Lake Simcoe watershed

A study of the vulnerability of Ontario's Lake Simcoe watershed to climate change is providing valuable insights that will inform adaptation planning in that region. The Lake Simcoe watershed extends over 3000 square kilometres and is home to over 400,000 people. The area attracts hundreds of thousands of visitors every year and generates millions of dollars in revenue for local economies. As part of the study, parks and other natural heritage areas were assessed for changes in tree species as a proxy for examining how climate change could affect representation of biodiversity. Results of the study indicate that future conditions may not be suitable for many species that currently exist in protected areas, indicating the need for adaptive strategies such as improving connectivity between terrestrial and aquatic natural areas. The Lake Simcoe study has led to development of *A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems* (Gleeson et al. 2011) to help natural resource managers integrate climate change vulnerabilities and adaptation planning into decision-making processes.

Lake Simcoe © Ontario Ministry of Natural Resources

Inspiring and engaging Canadians

As hosts to millions of visitors per year, Canada's parks and protected areas provide people with outstanding opportunities to experience nature and learn firsthand about climate change impacts and solutions. By fostering a sense of connection to nature through volunteer participation in research, monitoring, restoration and other stewardship projects, protected areas help people understand the importance of a healthy environment. By providing opportunities for direct involvement, they also motivate people to become better environmental stewards.

Promoting citizen science

Parks and protected areas are places where people can make real contributions to science that help us better understand the impacts of climate change. For example, **Algonquin Provincial Park** in Ontario monitors many natural history records throughout the year, but especially spring arrivals and first-of-the-year observations. Records include the first arrival of migrant birds, first emergence of turtles and hibernating mammals, first singing of frogs, flowering of certain plants, and first ice in and ice out dates. Lists are kept at the Algonquin Visitor Centre and visitors are encouraged to record their observations. Some of these data sets go back to the early 1960s, providing a long-term record of changes in recent decades.

Visitors to many of Newfoundland and Labrador's provincial parks are encouraged to become citizen scientists by monitoring wildlife through citizen-oriented programs. Park visitors assist interpreters in monitoring plant flowering times or with observations of a variety of species including dragonflies, butterflies, and other insects. Participation is encouraged by communicating results back to park visitors and highlighting the importance of climate change monitoring in interpretive programs. Similar citizen-science programs are conducted in many of Canada's parks and protected areas.

> "One of the reasons we always enjoy a spring day of birding in Algonquin Provincial Park is going back to the Visitor Centre to see if we can add any birds to the spring arrival list. It is also satisfying to know that the information collected is saved and used to update the park publications. Keep up the good work."
>
> *Excerpt from the Algonquin Provincial Park visitors' comment book*

Bird watching in Kouchibouguac National Park of Canada
© W. Barrett, Parks Canada

Encouraging participation in stewardship and restoration

By taking part in volunteer activities, people develop a connection to parks and protected areas, learn about environmental issues such as climate change, and become better stewards. Through volunteer programs, parks and protected areas agencies shares ideas, knowledge, talent and skills with the public and inspire people with hope that they can make a difference.

Volunteers planting trees in Waterton Lakes National Park of Canada, Alberta
© Parks Canada

For example, Parks Canada's national volunteer program has nearly 6000 volunteers involved at 85 sites across Canada. Since 2000, 1000 volunteers have contributed 100,000 volunteer hours to species at risk recovery and environmental conservation at **Kejimkujik National Park and National Historic Site of Canada**, one of the country's biodiversity hotspots. Many species at risk found in the park such as Blanding's turtles, eastern ribbonsnakes, Atlantic Coastal Plain flora, piping plovers, and monarch butterflies are under threat from changing environmental conditions. Volunteers have helped protect and monitor endangered Blanding's turtle nests, tracked turtles to examine survivorship, restored nesting habitat for piping plovers and monitored their nests. The park also produced a landowner stewardship guide describing best practices for shoreline and wetland habitats and opportunities for stewardship. By providing people beyond the park boundaries with tools, they can become actively involved in mitigating the impact of environmental changes on species at risk, and helping them adapt.

Bringing back the savannah

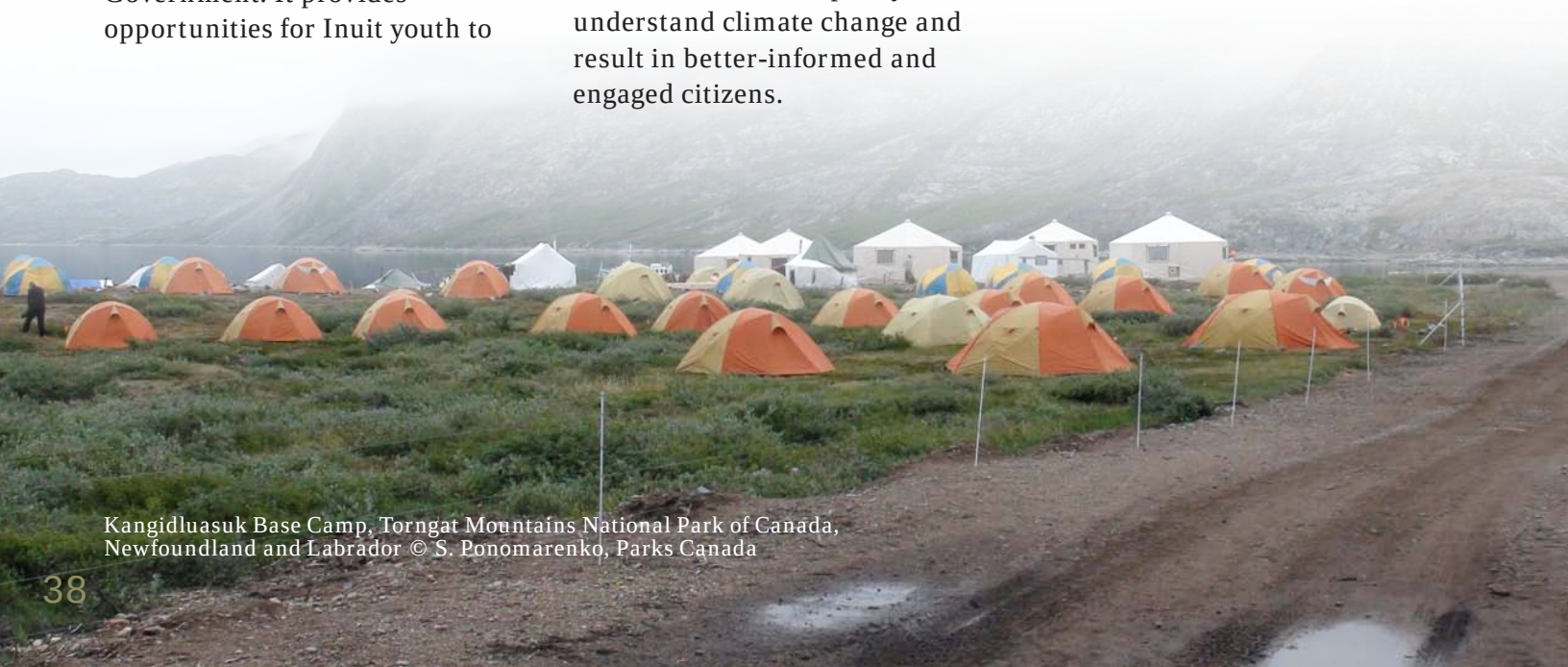
In southern Canada, **Point Pelee National Park of Canada** is engaging members of the local community to help restore one of its most vulnerable ecosystems. The Lake Erie Sandspit Savannah provides habitat for several species at risk including the five-lined skink, eastern fox snake, and eastern prickly pear cactus. But invasive species and native forest are encroaching on this meadow-like habitat and creating conditions that are hostile for these species. Efforts to restore the ecological integrity of this important but rare ecosystem will strengthen its ability to adapt to climate change and support the rare species that depend on it. Park visitors, local school groups, First Nations groups, corporate groups and individual volunteers are helping bring back the savannah by collecting seeds and planting native species. This restoration project has helped hundreds of volunteers become active stewards of the environment.

Targeting outreach and learning

Climate-driven ecological changes are already observable in many parts of Canada, but especially in Canada's North where climate change is threatening the viability of wildlife populations and human communities that depend on healthy ecosystems. Parks and protected areas have a role to play in helping people understand the impacts of and potential solutions for the challenges created by a rapidly-changing climate. For example, the Kangidluasuk Base Camp Student Intern Program is an experiential learning and outreach initiative of Parks Canada and the Nunatsiavut Government. It provides opportunities for Inuit youth to experience the land and work with visiting scientists at the southern boundary of **Torngat Mountains National Park of Canada**. Through direct participation in research projects, Inuit youth gain exposure to the relationships and connections between Inuit ways of knowing, science, and research. As a result of their involvement, young Inuit build an emotional connection to the lands of their ancestors and discover that everyone has a role to play in conserving our natural environment. This multi-faceted and cross-cultural internship integrating Inuit culture, Arctic science, and outdoor adventure will increase their capacity to understand climate change and result in better-informed and engaged citizens.

Reaching out to the classroom

Ontario Parks has developed "Campsite 24", a resource for students and teachers to explore parks and protected areas in the classroom and learn more about environmental protection, climate change, and plants and wildlife in Ontario's parks. Part of this resource includes an award winning series called "Hop to It" that encourages children to care about nature and protected areas, and inspires them to do things that are helpful such as reducing their impacts while camping and visiting parks.



Kangidluasuk Base Camp, Torngat Mountains National Park of Canada, Newfoundland and Labrador © S. Ponomarenko, Parks Canada

Fathom Five National Marine Park of Canada © B. Caulfeild-Browne

Building community involvement

In addition to its ecological impacts, climate change has implications for the social well-being of communities. Parks and protected areas act as sources of knowledge in their surrounding communities, and as focal points for having meaningful conversations about the future well-being of those communities. For example, a community forum was organized in 2012 on the topic of climate change, in close collaboration with **Bruce Peninsula National Park of Canada**, **Fathom Five National Marine Park of Canada**, and the Sources of Knowledge organization. Community members were able to share perspectives with their neighbours, community leaders were empowered to use local knowledge to inform their decision-making, and everyone was invited to learn about climate change in the context of their home community. Participants included Parks Canada team members, municipal officials, educators, students, business owners, non-governmental organizations, and local citizens.

Weathering
our future: the "natural solutions" approach

To date, the global community has not been able to put measures in place that will adequately address the level of greenhouse gases in the atmosphere in order to slow climate change in the foreseeable future. Canada's ability to cope with climate-driven changes will depend on the implementation of a variety of approaches to increasing our resilience and adaptive capacity. Protecting large natural spaces, connecting these spaces through sustainably managed landscapes and seascapes, restoring ecosystems and habitats, building knowledge and understanding of impacts and opportunities associated with climate change, and inspiring Canadians to engage with nature are central elements of an ecosystem-based, "natural solutions" approach to adaptation. Through their role in capturing and storing carbon, healthy ecosystems also contribute to climate change mitigation.

Glenbow Ranch Provincial Park, Alberta

Protect, connect, restore

Canadian parks and protected areas agencies have the opportunity to protect remaining large, relatively intact ecosystems (particularly in the North), securing space for wildlife to move and adapt, protecting natural and cultural heritage, conserving traditional food sources, and diversifying economic opportunities for communities in the face of change. Enhanced protection (i.e., an increase in protected areas coverage) will result in more resilient ecosystems that better buffer climate change impacts, provide habitat for native species for longer periods of time, and provide healthy, evolving systems with habitat and niche space for new combinations of species capable of adapting to new climates. Increased focus on the establishment of new parks and protected areas and the expansion of existing ones is central to implementing a natural solutions approach. Current or potential climate change influences should be considered in the design, distribution, and spatial arrangement of new parks and protected areas to the extent possible.

Efforts to protect important ecosystems need to be complemented by conservation and stewardship practices both inside and outside protected areas. For example, practices that help to connect these core areas, reduce pressures from non-climatic stressors such as pollution and overexploitation, and restore ecosystems and habitats where they have become degraded are fundamental to building the resilience of parks and protected areas. These efforts will also ensure that they continue to contribute effectively to resilience at landscape and seascape scales. This is particularly the case in more fragmented agricultural, coastal and urban landscapes and seascapes where parks and protected areas are the core places where biodiversity is concentrated.

New protected areas in the North

In 2010, a legislative basis was created for First Nations and the Ontario government to work together on community-based land use planning initiatives in Ontario's Far North. Under the Far North Act, at least 50% of Ontario's Far North is to be set aside in an interconnected network of protected areas to enhance climate change adaptation and help conserve Ontario's biodiversity. Quebec's Plan Nord also includes plans to add many new parks to their protected area systems in conjunction with plans for northern development. As part of Plan Nord at least 20% of this northern territory would be designated as protected areas by 2020. These large networks of protected areas will help species adapt by giving them the space they need without the additional pressures caused by development activities.

Contribute knowledge

In an uncertain climate future, well-studied and monitored parks and protected areas provide sources of knowledge to help strengthen adaptation strategies inside and outside their boundaries. Scientific monitoring and research programs coupled with traditional knowledge provide benchmarks of change that contribute to enhancing our understanding of natural systems and how they are responding to climate change. Sharing knowledge of impacts and related solutions will help Canadians make decisions that reduce the vulnerability of natural systems and the ecosystem services they provide. This knowledge will also help parks and protected areas organizations adapt proactively and take advantage of any potential opportunities that may be associated with climate change such as increased visitation in shoulder seasons.

Knowledge for navigating an uncertain future

Long-term ecological monitoring programs in several regions of Canada will help park agencies better understand and anticipate change and make more informed and proactive decisions that will facilitate effective adaptation. Climate models for Canada predict increases in temperature over the next 50 to 100 years that will drive ecological change sufficient to alter the composition, structure and function of many protected areas (IPCC 2007, Lemieux et al 2011). Given the magnitude of these predicted changes, even the largest and most intact protected areas will not be completely resilient at the scale of the protected area. Nonetheless, strengthening the resilience of protected areas will be key to assisting protected areas in adapting and changing so that they can continue to contribute to broader landscape- and seascape-scale resilience.

The task for protected areas managers will be to accept this ongoing and accelerating transformation in ecosystem composition, structure and function as the norm, and to develop forward-looking, knowledge-based management approaches that will help navigate these inevitable changes. For example, Parks Canada recently initiated a project called 'Understanding Climate Driven Ecological Change in Canada's Northern National Parks'. In addition, both Quebec and British Columbia have implemented programs to systematically monitor indicators of ecological changes throughout their parks and protected areas. Maintaining robust observation networks will contribute to increased understanding of the direction and pace of climate change and provide the opportunity to respond to those changes appropriately.

Nopiming Provincial Park, Manitoba

Lead by example

Parks and protected areas will continue to lead by example, giving Canadians inspiring opportunities to connect directly with their natural and cultural heritage and helping them understand that they can make a difference in strengthening that heritage in the face of climate change.

Solar panels in use at Misery Bay Provincial Nature Reserve visitor centre © Ontario Parks

Guiding principles for future expansion

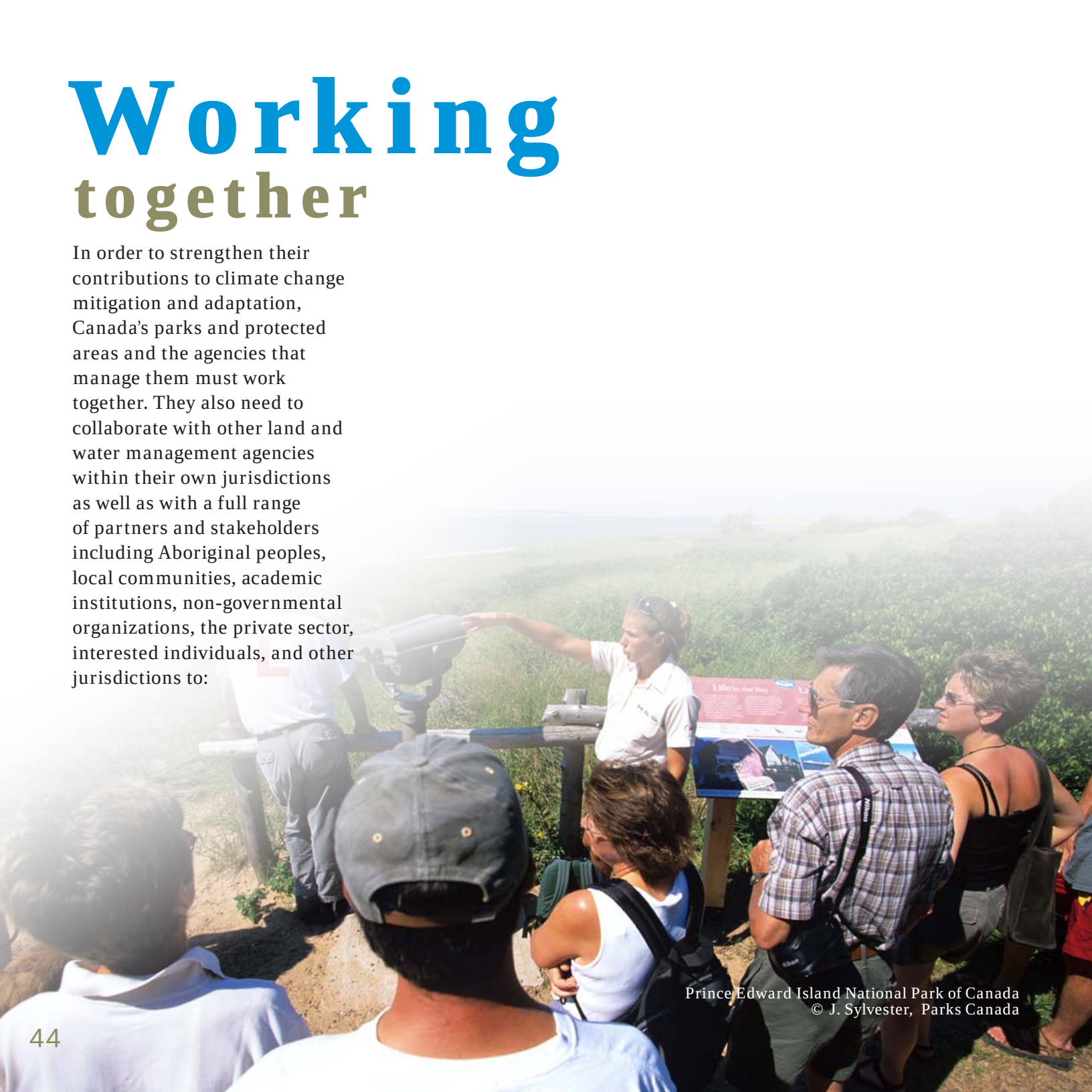
Priorities for future expansion of the Alberta Parks system are being addressed through a broader process known as the Alberta Land Use Framework. The development of regional plans will provide policy direction on the way land will be used for several planning areas in Alberta. Alberta Parks will identify priority areas for protection including those habitats that are especially vulnerable to the impacts of climate change and those that will provide functional linkages between protected areas. In addition, existing parks will be expanded to provide more effective refuges for wildlife. Headwaters, rivers, streams and riparian zones will be identified as high priorities for long-term protection, as their conservation is of paramount importance when planning for a changing climate. For example, the Lower Athabasca Region in northeast Alberta—an area impacted by oil sands development—will be the first to have a regional plan drafted under the Land Use Framework. The plan includes a quadrupling of park land (from 0.5 million ha to just over 2 million ha).

Greening park operations

Canada's parks and protected areas welcome millions of visitors each year and the impacts from operating campgrounds, facilities and other park activities add to their ecological 'footprint'. Many parks are adopting alternative energy and adapting facilities to reduce their greenhouse gas emissions. For example, Ontario Parks has developed a *Go for Green Strategy* that supports alternative transportation, infrastructure, programs and policies throughout its parks to reduce energy consumption. **Fushimi Lake Provincial Park** has retro-fitted its park warehouse with solar panels, and the visitor centre at **Misery Bay Provincial Nature Reserve** is completely off-the-grid, with solar panels and passive solar heating. Initiatives such as the "Park Once Challenge" encourage campground users to park their vehicles and to walk or bike while staying in the park.

Working together

In order to strengthen their contributions to climate change mitigation and adaptation, Canada's parks and protected areas and the agencies that manage them must work together. They also need to collaborate with other land and water management agencies within their own jurisdictions as well as with a full range of partners and stakeholders including Aboriginal peoples, local communities, academic institutions, non-governmental organizations, the private sector, interested individuals, and other jurisdictions to:



Prince Edward Island National Park of Canada
© J. Sylvester, Parks Canada

Protect more natural areas

- Identify and consider opportunities for increasing both the number and size of protected areas, with climate change adaptation as a key objective;
- Integrate understanding of changing ecological and cultural processes and shifting species distributions into plans for establishment of protected areas; and
- Integrate considerations of the co-benefits of biodiversity protection (such as the provision of ecosystem services for people and communities) into establishment plans and processes.

Contribute to building resilient, well-connected networks of healthy ecosystems

- Integrate protected areas and climate change considerations into regional land-use/water use and conservation plans;
- Identify opportunities to develop inter-jurisdictional conservation plans that incorporate improved understanding of climate-driven changes; and
- Encourage sustainable, ecosystem-based management of surrounding landscapes/seascapes that also considers climate change.

Actively manage and restore the ecological integrity of ecosystems

- Identify and implement ecological restoration priorities within and between protected areas;
- Integrate ecosystem services associated with biodiversity conservation (e.g., water quality, carbon storage and sequestration) and cultural resources conservation into restoration plans and best practices;
- Incorporate climate change into ecological restoration best practices (e.g., for establishing objectives and planning and implementing restoration actions related disturbance regimes, habitat, species management and recovery); and
- Reduce pressures on species and ecosystems caused by non-climatic stressors such as operations, infrastructure and recreational activities.

Improve our understanding of climate change impacts and solutions for parks and protected areas

- Evaluate existing science, social science, and other knowledge-related programs to determine how they contribute to understanding climate-driven changes and informing adaptation actions;
- Learn from leading academic and other experts about climate-related impacts and opportunities, and approaches to mitigation and adaptation;
- Use monitoring, research, and tools such as vulnerability assessments and scenario planning to understand responses of parks and protected areas to climate change and identify adaptation actions;
- Improve understanding of the contribution of parks and protected areas to carbon storage and sequestration and other ecosystem services such as flood control and water protection; and
- Strengthen internal expertise by ensuring that staff has a level of understanding of climate change impacts, opportunities and adaptation approaches appropriate to their mission.

Share knowledge to help build capacity and ensure effective management of parks and protected areas

- Share data, reports, and other information that will assist in integrating climate change considerations into management decision-making; take advantage of synergies with other conservation-related initiatives, conferences, workshops, and meetings to exchange knowledge with a broad range of partners and stakeholders;
- Improve or expand upon the use of internet-based interfaces and social media for information dissemination and exchange; and
- Improve the transfer of knowledge to decision-makers about the contribution of protected areas to understanding and responding to climate change and enhancing human health and well-being.

Engage and inspire Canadians with hope for the future

- Target visitor experience and outreach programs to enhance public awareness and understanding of the role of parks and protected areas in climate change adaptation and mitigation;
- Share compelling stories about concrete adaptation and mitigation actions broadly, by communicating effectively with traditional and non-traditional partners and stakeholders;
- Engage visitors, local communities and the public in stewardship and restoration projects in and around parks and protected areas;
- Demonstrate the strategies used to improve the ecological sustainability of park uses and operations; and
- Encourage partners and stakeholders to champion the role of parks and protected areas in climate change.

Realizing the potential

Parks and protected areas have an important role to play as part of ecosystem-based, "natural solutions" to climate change adaptation and mitigation. But the types of projects described in this report are only the beginning. Much more needs to be done in order for parks and protected areas to fully realize their potential as natural solutions to climate change. Parks and protected areas agencies need to build their capacity to adapt proactively. And they cannot do it alone. Securing Canada's natural and cultural heritage—the underpinning of our economy, health and well-being—in a rapidly changing world will require new strategies, new partnerships and broad engagement with all sectors of Canadian society.

Polar bears in Quttinirpaaq National Park of Canada © W. Lynch, Parks Canada

References

Bennett, A.F. 1998. Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland.

Berry, H.L., K. Bowen, and T. Kjellstrom. 2010. Climate change and mental health: a causal pathways framework. Int J Public Health 55: 123-132.

Boyd, R. 2011. Blue carbon: an oceanic opportunity to fight climate change. *Scientific American* 10 March, p.6.

Canada National Parks Act. 2000. Available at http://laws-lois.justice.gc.ca/eng/acts/N-14.01/page-1.html [Accessed 18 April 2012].

Canadian Parks Council 2010. Strategic Framework. Available at http://www.parks-parcs.ca/english/pdf/strategic_framework_2010.pdf [Accessed 3 April 201s2].

Carlson, M., J. Wells, and D. Roberts. 2009. The Carbon the World Forgot: Conserving the Capacity of Canada's Boreal Forest Region to Mitigate and Adapt to Climate Change. Boreal Songbird Initiative and Canadian Boreal Initiative, Seattle Washington and Ottawa. 33 pp.

Coyle, K.J. and L. Van Susteren. 2011. The Psychological Effects of Global Warming on the United States and Why the U.S. Mental Health Care System is Not Adequately Prepared. National Wildlife Federation Climate Education Program: National Forum and Research Report February 2012. National Wildlife Federation, Reston VA. 41 pp.

Dudley, N. (ed.) 2008. Guidelines for Applying Protected Area Management Categories, IUCN, Gland, Switzerland.

Dudley, N., S. Stolton, A. Belokurov, L. Krueger, N. Lopoukhine, K. MacKinnon, T. Sandwith, and S. Sekhran [editors]. 2010. Natural Solutions: Protected Areas Helping People Cope with Climate Change. IUCN-WCPA, TNC, UNDP, WCS, The World Bank and WWF, Gland Switzerland, Washington DC and New York.

Eby M, K. Zickfeld, A. Montenegro, D. Archer, K.J. Meissner, A.J. Weaver. 2009. Lifetime of anthropogenic climate change: millennial time scales of potential CO_2 and surface temperature perturbations. *Journal of Climate* 22: 2501-2511.

Elmqvist, T., C. Folke, M. Nyström, G. Peterson, J. Bengtsson, B. Walker, and J. Norberg. 2003. Response diversity, ecosystem change, and resilience. *Frontiers in Ecology and the Environment* 1: 488–494.

Environment Canada. 2009. Canada's 4th National Report to the United Nations Convention on Biological Diversity. Ottawa. 192 pp.

Environment Canada. 2011a. Environment Canada Protected Areas Strategy. Available at http://www.ec.gc.ca/ap-pa/ [Accessed 13 April 2012].

Environment Canada. 2011b. National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada. Executive Summary. Ottawa. Cat. No.: En81-4/1-2009E-PDF.

Environment Canada. 2012a. Climate Trends and Variations Bulletin – Annual 2011 and Winter 2011/12. Available at http://www.ec.gc.ca/adsc-cmda/default.asp?lang=En&n=77842065-1 [Accessed 26 October 2012].

Environment Canada. 2012b. Conservation Areas Reporting and Tracking System (CARTS). Environment Canada and Canadian Council on Ecological Areas, Ottawa. Available at http://www.ccea.org/en_carts.html [Accessed 20 March 2012].

Federal, Provincial and Territorial Governments of Canada. 2010. Canadian Biodiversity: Ecosystem Status and Trends 2010. Canadian Councils of Resource Ministers, Ottawa. 142 pp.

Gillett N.P., V.K. Arora, K. Zickfeld, S.J. Marshall, M.J. Merryfield. 2011. Ongoing climate change following a complete cessation of carbon dioxide emissions. *Nature Geoscience* 4: 83–87.

Gleeson, J., P. Gray, A. Douglas, C.J. Lemieux and G. Nielsen. 2011. A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems. Ontario Centre for Climate Impacts and Adaptation Resources, Sudbury, Ontario. 74 pp.

Government of Canada. 2010. Fifth National Communication on Climate Change. Submitted to the UNFCCC Secretariat on February 12th 2010; Government of Canada, Ottawa.

Government of Newfoundland and Labrador. 2011. Charting our Course: Climate Change Action Plan 2011. 83 pp. Available at http://www.exec.gov.nl.ca/exec/cceeet/2011_climate_change_action_plan.html [Accessed 3 April 2012].

Government of Northwest Territories. 2008. NWT Climate Change Impacts and Adaptation Report. 31 pp. Available at http://www.enr.gov.nt.ca/_live/documents/content/NWT_Climate_Change_Impacts_and_Adaptation_Report.pdf [Accessed 3 April 2012].

Government of Ontario. 2011. Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011-2014. Queen's Printer for Ontario. 124 pp. Available at http://www.ene.gov.on.ca/environment/en/resources/STDPROD_081665.html [Accessed 3 April 2012].

Hannah, L. 2009. A global conservation system for climate-change adaptation. *Conservation Biology* 24: 70-77.

Hannah, L., G. Midgley, S. Andelmon, M. Araujo, G. Hughes, E. Martinez-Meyer, R. Pearson, and P. Williams. 2007. Protected area needs in a changing climate. *Frontiers in Ecology and the Environment* 5: 131-138.

ICES. 2011. Report of the Study Group on Designing Marine Protected Area Networks in a Changing Climate (SGMPAN), 15-19 November 2010, Woods Hole, Massachusetts, USA. ICES CM 2011/SSGSUE:01. 155 pp.

Inglis, C. 2007. A framework for incorporating functional considerations into identifying key areas of landscape connectivity in southwest Nova Scotia. MES thesis. Halifax: Dalhousie University. 132 pp.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland. 104 pp.

Kulshreshtha, S., and M. Johnston. 2004. Economic Value of Stored Carbon in Protected Areas: A Case Study of Canadian National Parks. Available at http://sampaa.org/publications/conference-proceedings-1991-2000/2003-proceedings/economic-analysis-protected-areas [Accessed 4 April 2012].

Lafortezza, R., G. Carrus, G. Sanesi, and C. Davies. 2009. Benefits and well-being perceived by people visiting green spaces in periods of heat stress. *Urban Forestry and Urban Greening* 8: 97-108.

Lemieux, C.J. and D.J. Scott. 2011. Changing climate, challenging choices: Identifying and evaluating climate change adaptation options for protected areas management in Ontario, Canada. *Environmental Management* [published online August 18 2011]. DOI 10.1007/s00267-011-9700-x.

Lemieux, C.J., T.J. Beechey and P.A. Gray. 2011. Prospects for Canada's protected areas in an era of climate change. *Land Use Policy*, 28(4): 928-941. DOI: 10.1016/j.landusepol.2011.03.008.

Lemieux, C.J., T.J. Beechey, D.J. Scott and P.A. Gray. 2010. *Protected Areas and Climate Change in Canada: Challenges and Opportunities for Adaptation*. Canadian Council on Ecological Areas (CCEA) Occasional Paper No. 19. CCEA Secretariat, Ottawa.

Lemieux, C.J., P.F.J. Eagles, D.S. Slocombe, S.T. Doherty, S.J. Elliott, and S. Mock. 2012. Human health and well-being motivations and benefits associated with protected area experiences: an opportunity for transforming policy and management in Canada. *PARKS: the International Journal of Protected Areas and Conservation* 18: 71-86.

Lemmen, D.S., F.J. Warren, J. Lacroix and E. Bush, [editors]. 2008. From Impacts to Adaptation: Canada in a Changing Climate 2007. Government of Canada, Ottawa. 448 pp.

Maller, C., M. Townsend. A. Pryor, P. Brown, and L. St. Leger. 2005. Healthy nature healthy people:'contact with nature' as an upstream health promotion intervention for populations. *Health Promotion International* 21: 45-54.

Morton, C., R. Cameron, and P. Duinker. 2010. Modeling carbon budgets in four protected wilderness areas in Nova Scotia. *In* S. Bondrup-Nielsen, K. Beazley, G. Bissix, D. Colville, S. Flemming, T. Herman, M. McPherson, S. Mockford, and S. O'Grady (Eds). Ecosystem Based Management: Beyond Boundaries. Proceedings of the Sixth International Conference of Science and the Management of Protected Areas, 21–26 May 2007, Acadia University, Wolfville, Nova Scotia. Science and Management of Protected Areas Association, Wolfville, N.S. pp. 429-440.

Mulongoy, K.J. and S.B. Gidda. 2008. The Value of Nature: Ecological, Economic, Cultural and Social Benefits of Protected Areas. Secretariat of the Convention on Biological Diversity, Montreal, 30 pp.

Nellemann, C., E. Corcoran, C. M. Duarte, L. Valdés, C. De Young, L. Fonseca, and G. Grimsditch (Eds). 2009. Blue Carbon - The Role of Healthy Oceans in Binding Carbon. A Rapid Response Assessment. United Nations Environment Programme, GRID-Arendal, 80 pp.

Parks Canada Agency and the Canadian Parks Council. 2008. Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas. Parks Canada Agency and the Canadian Parks Council. Available online at http://www.pc.gc.ca/eng/progs/np-pn/re-er/index.aspx [Accessed 16 April 2012].

Parks Canada. 2010. Annual Report of Research and Monitoring in Torngat Mountains National Park. 62 pp. Available at http://www.pc.gc.ca/eng/pn-np/nl/torngats/plan.aspx [Accessed online 9 February 2012].

Pellatt , M.G., S. Goring, K.M. Bodtker, and A.J. Cannon. 2012. Using a down-scaled bioclimate envelope model to determine long-term temporal connectivity of Garry oak (*Quercus garryana*) habitat in western North America: Implications for protected area planning. *Environmental Management* 49: 802-815.

Secretariat of the Convention on Biological Diversity. 2008. Protected Areas in Today's World: Their Values and Benefits for the Welfare of the Planet. Montreal, Technical Series no. 36, 96 pp.

Secretariat of the Convention on Biological Diversity. 2009. Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. Montreal, Technical Series No. 41, 126 pp.

Séguin, J., and P. Berry. 2008. Human Health in a Changing Climate: A Canadian Assessment of Vulnerabilities and Adaptive Capacity. Synthesis Report. Health Canada, Ottawa. Cat.: H128-1/08-529E. 26 pp.

Shafer, C.L. 1999. National park and reserve planning to protect biological diversity: Some basic elements. *Landscape and Urban Planning* 44: 123-153.

Solomon S., G.K. Plattner, R. Knutti, and P. Friedlingstein. 2009. Irreversible climate change due to carbon dioxide emissions. *Proceedings of the National Academy of Sciences* 106: 1704-1709.

Taylor, P.D., L. Fahrig, K. Henein and G. Merriam. 1993. Connectivity is a vital element of landscape structure. *Oikos*, 68: 571-573.

TEEB (The Economics of Ecosystems and Biodiversity for National and International Policy Makers). 2009. Summary: Responding to the Value of Nature. Available at http://www.teebweb.org/ForPolicymakers/tabid/1019/Default.aspx [Accessed April 3, 2012].

The Outspan Group. 2011a. The Economic Impact of Canada's National, Provincial and Territorial Parks in 2009. Report prepared for the Canadian Parks Council. Available at http://www.parks-parcs.ca/english/cpc/economic.php [Accessed online Feb 14, 2012].

The Outspan Group 2011b. The Ecomonic Impact of Parks Canada. Report prepared for Parks Canada Agency. Available at http://www.pc.gc.ca/eng/docs/bib-lib/econo2011.aspx [Accessed April 4, 2011].

Waite, T.A. and D. Strickland. 2006. Climate change and the demographic demise of a hoarding bird living on the edge. Proceedings of the Royal Society 273: 2809-2813.

Walker, B., C.S. Holling, S.R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society* 9(2): 5. [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art5 [Accessed April 4, 2012].

WCPA/IUCN (World Commission on Protected Areas/International Union for the Conservation of Nature). 2007. Establishing Networks of Marine Protected Areas: A Guide for Developing National and Regional Capacity for Building MPA Networks. Gland, Switzerland: WCPA/IUCN. Non-technical summary report. 16 pp.

Wildlife Ministers' Council of Canada. 1990. A Wildlife Policy for Canada. Canadian Wildlife Service, Environment Canada, Ottawa. 29 pp.

World Bank. 2010. Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change. The International Bank for Reconstruction and Development: Washington, D.C.

Glossary

Carbon sequestration: A biochemical process by which atmospheric carbon is absorbed by living organisms, and involving the storage of carbon in soils and sediments, with the potential to reduce atmospheric carbon dioxide levels (adapted from Dudley et al. 2010).

Climate change adaptation: Adjustment in natural or human systems in response to actual or expected climate stimuli and their effects, which moderates harm or exploits beneficial opportunities (IPCC 2007; Lemmen et al. 2008).

Climate change mitigation: In the context of climate change, mitigation is an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks. (IPCC 2007; Lemmen et al. 2008).

Connectivity: Landscape (and seascape) connectivity refers to the degree to which the landscape (or seascape) facilitates or impedes movement among resource patches (Taylor et al. 1993).

Ecological integrity: With respect to a park, a condition that is determined to be characteristic of natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological components, rates of change and supporting processes (Canada National Parks Act 2000).

Ecosystem services: Ecological processes or functions having monetary or nonmonetary value to individuals or society at large. There are 1) supporting services such as productivity or biodiversity maintenance; 2) provisioning services such as food, fibre or fish; 3) regulating services such as climate regulation or carbon sequestration; and 4) cultural services such as tourism or spiritual and aesthetic appreciation (IPCC 2007; Lemmen et al. 2008).

Ecosystem-based adaptation: The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change (Secretariat of the Convention on Biological Diversity 2009).

Landscape/Seascape: A landscape is a mosaic of two or more ecosystems that exchange organisms, energy, water and nutrients (Parks Canada Agency and the Canadian Parks Council 2008). The term 'seascape' refers to a combination of adjacent land, coastline and bodies of marine or freshwater within a geographic area.

Protected area network: A collection of individual protected areas that operates cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone (adapted from WCPA/IUCN 2007).

Resilience: The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks (Walker et al. 2004).

Wildlife: All wild organisms and their habitats including wild plants, invertebrates, and microorganisms, as well as fishes, amphibians, reptiles, birds and mammals (Wildlife Ministers' Council of Canada 1990).