Foundation of fair use **of materials protected** by copyright for educational purposes

UCI
University for International Cooperation

University for International Cooperation (UCI)

Foundation of fair use of materials protected by copyright for educational purposes

The following material has been reproduced, strictly for educational and illustrative purposes, related to the material´s subject. The material is intended to be used in the University for International Cooperation´s (Universidad para la Cooperación Internacional: "UCI", for its acronym in Spanish) virtual campus, exclusively for the teaching role and for the students´ private studying, in the "Development and usage control of resources for the efficient management of protected areas" course which is part of the academic program.

UCI wishes to state its strict adherence to the laws related to intellectual property. All digital materials that are made available for a course and for its students have educational and research purposes. The use of these materials is not intended for profit. It is understood as a special case of use for distance education purposes, in places where it does not conflict with the normal use of the document and where it does not affect the legitimate interests of any actor.

UCI does a FAIR USE of the material, based on the exceptions to copyright laws set out in the following regulations:

a- Costa Rican Legislation: Ley sobre Derechos de Autor y Derechos Conexos (Law on Copyright and Related Rights), No.6683, dated October 14th, 1982, Article 73 and Ley Sobre Procedimientos de Observancia de los Derechos de Propiedad Intelectual (Law on Procedures for Enforcement of Intellectual Property Rights), No. 8039, Article 58, which allow for the partial copying of works for educational illustration.

b- Mexican Legislation: Ley Federal de Derechos de Autor (Federal Law on Copyright), Article 147.

c- Law of the United States of America: In reference to fair use, it is contained in Article 106 of the copyright law of the United States (U.S. Copyright - Act), and establishes a free use of documents for purposes such as criticism, comments and news, reports and teaching (which includes making copies for classroom use).

d- Canadian Legislation: Copyright Act C-11, makes reference to exceptions for distance education.

e- WIPO: Within the framework of international legislation, according to the World Intellectual Property Organization (WIPO), this matter is foreseen by international treaties. Article 10(2) of the Berne Convention allows member countries to establish limitations or exceptions regarding the possibility for legal use of literary or artistic works, by way of illustration for teaching, through publications, radio broadcasts, or sound or visual recordings.

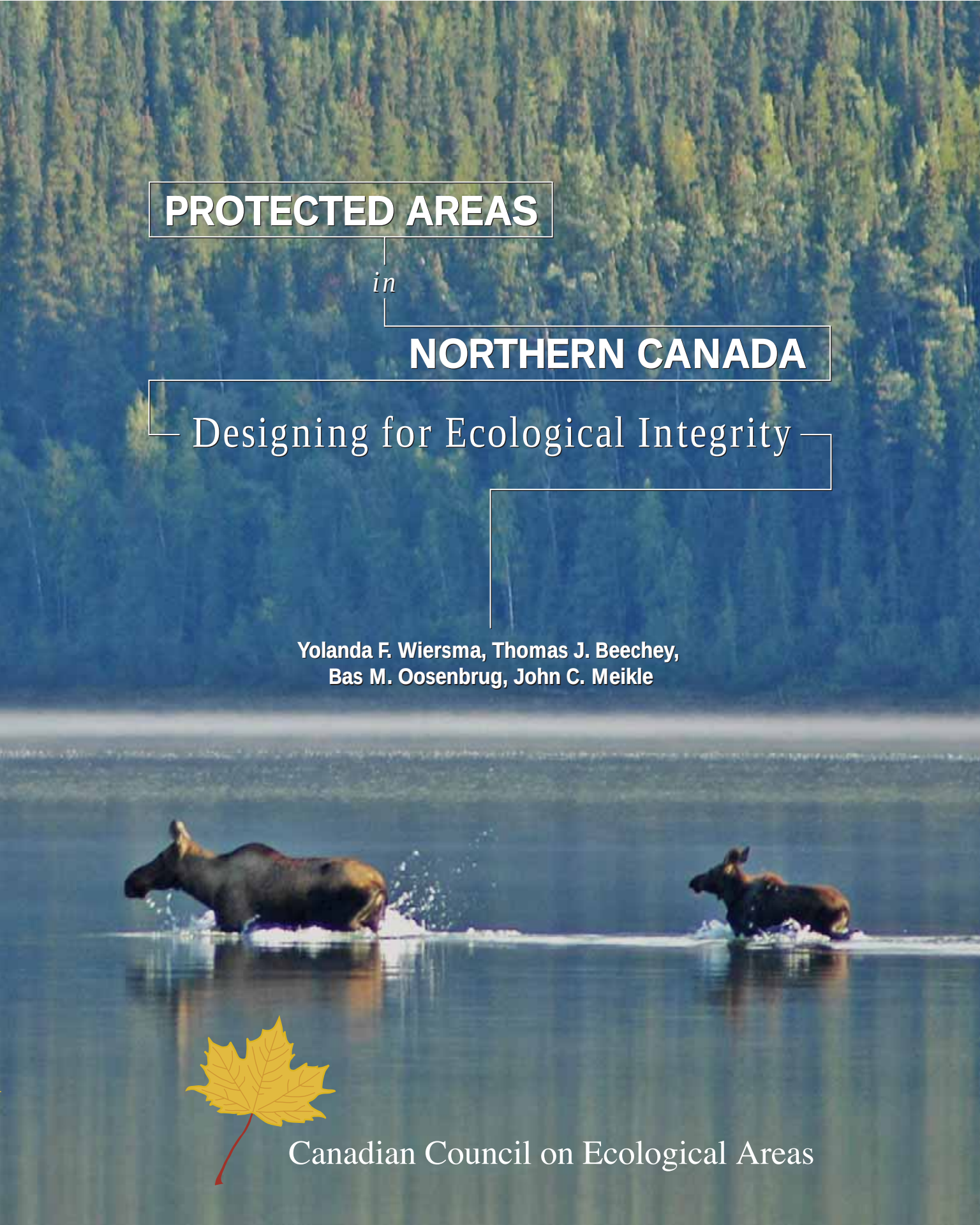
In addition, and by UCI´s indication, virtual campus students have a duty to comply with what is stated by the relevant copyright legislation in their country of residence.

Finally, at UCI we reaffirm that we do not profit from the works of third parties, we are strict about plagiarism, and we do not restrict in any way, neither our students, nor our academics and researchers, the commercial access to, or acquisition of, any documents available in the publishing market, may it be the document directly, or through scientific databases, paying themselves for the costs associated with such access or acquisition.

PROTECTED AREAS *in* NORTHERN CANADA

Designing for Ecological Integrity

Yolanda F. Wiersma, Thomas J. Beechey,
Bas M. Oosenbrug, John C. Meikle



Canadian Council on Ecological Areas

Protected Areas in Northern Canada: Designing for Ecological Integrity Phase 1 Report

Yolanda F. Wiersma, Thomas J. Beechey,
Bas M. Oosenbrug, John C. Meikle

Canadian Council on Ecological Areas

CCEA Occasional Paper No. 16

Protected Areas in Northern Canada: Designing for Ecological Integrity Phase 1 Report

Phase 1: A literature review and summary of science-based approaches for protected area design with a survey and assessment of existing protected areas, current practices and future needs.

The full citation for this report is:

Wiersma, Yolanda F, Thomas J. Beechey, Bas M. Oosenbrug and John C. Meikle. 2005. Protected Areas in Northern Canada: Designing for Ecological Integrity. Phase 1 Report. CCEA Occasional Paper No. 16. Canadian Council on Ecological Areas, CCEA Secretariat, Ottawa, Ontario, Canada. xiv + 128 pp. + folded map.

Library and Archives Canada Cataloguing in Publication

Protected areas in northern Canada: designing for ecological integrity/Yolanda F. Wiersma (*et al.*).

Includes bibliographic references
ISBN 0-7708-0147-1

1. Protected areas—Canada, Northern. I. Wiersma, Yolanda F. (Yolanda Francine), 1973-
II. Canadian Council on Ecological Areas

QH77.C3P745 2005 333.78'209719 C2006-901362-4

Canadian Council on Ecological Areas
Secretariat: c/o Canadian Wildlife Service, Environment Canada
3rd floor, 351 St. Joseph Boulevard, Gatineau, QC
K1A 0H3

♻ Printed on recycled paper
Printed and bound in Canada

Cover: Moose (*Alces alces*) is a symbol of Canada's northern forests, Frances Lake, Yukon (Photo by J. Meikle)

CCEA Mission

The Canadian Council on Ecological Areas (CCEA) is an independent national organization constituted in 1982 to encourage and to facilitate the selection, protection and stewardship of a comprehensive network of protected areas in Canada. In 1995, CCEA became a registered charitable organization. The Council draws its following and support from First Nations and Inuit peoples, federal, provincial and territorial government agencies, non-governmental organizations, universities, industry and private citizens concerned with protected areas.

The goal of CCEA is to facilitate and to assist Canadians with the establishment, management and use of a comprehensive viable network of protected areas that represents the diversity of Canada's terrestrial, marine and other aquatic ecosystems. To that end, the work of CCEA is centred on the following activities:

1. Promoting the value of protected areas for conserving biodiversity and for helping to sustain ecosystems for the environmental, social and economic well being of all Canadians;
2. Providing scientific advice and guidance in the design of a nation-wide network of protected areas incorporating both terrestrial and aquatic ecosystems and the selection of areas to complete it;
3. Advancing sound ecological and science-based stewardship practices for protected areas including the management, restoration and use of them for conservation, science, education and heritage appreciation;
4. Assisting in determining the administrative and institutional arrangements for the securement, protection, management and use of protected areas;
5. Communicating and working with regional, national and international interests toward the achievement of Council's goal and objectives;
6. Monitoring and reporting on initiatives and progress regarding the establishment, conservation, management and use of protected areas; and,
7. Conducting other such work and activities as may be necessary to support these aims.

For more information, visit the CCEA website: www.ccea.org

Dedication

Dr. J. Stan Rowe

June 11, 1918 – April 6, 2004

CCEA colleagues and associates will long remember Dr. J. Stan Rowe, who passed away peacefully at home on April 6, 2004.

Widely known for his book, *Forest Regions of Canada*, Dr. Rowe gained special notoriety for his later writings on ethics and conservation, which demonstrate his intimate insight of ecology and the caring attitude that we need to adopt as environmental stewards.

Dr. Rowe's notions of ecological sustainability and stewardship, so eloquently portrayed in his popular work, *Home Place: Essays in Ecology*, and his other writings, offer illuminating guidance for Canadian conservation efforts.

Among his many contributions to conservation, CCEA associates are especially indebted to Dr. Rowe for his early involvement in promoting protected areas and helping to establish the Council to advance this important mission.

Dr. Rowe's environmental philosophy and reverence for Nature, embodied in his actions and his writings, are nowhere more applicable than in efforts to conserve Canada's North.

This report is dedicated as a tribute to Stan Rowe, with special thanks and appreciation for his vision and leadership that are a true inspiration for preserving wilderness in Canada.

Acknowledgements

This report reflects over a year of collaboration between the authors, associates of the Canadian Council on Ecological Areas, and protected areas planners, managers and directors across the country. The CCEA Executive provided encouragement and support throughout the project. The Governments of Canada, Alberta, Northwest Territories and Yukon provided funding for research and production of the report.

The report would not have been possible without the thoughtful and generous time given by the following survey respondents, who provided reflective input to the comprehensive questionnaire (Appendix D) reported on in section 4.

Yvonne Beaubien, Protected Areas Initiative, Manitoba Conservation

Fred Beek, Resource Stewardship Branch, Saskatchewan Environment

Bill Crins, Ontario Parks, Ontario Ministry of Natural Resources

Christine Doucet, Inland Fish and Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador

Cameron Eckert, Yukon Parks Branch, Department of the Environment, Yukon Government

Sian French, Parks and Natural Areas Division, Department of Environment and Conservation, Government of Newfoundland and Labrador

Vincent Gerardin, Ministère de l'Environment du Québec, Direction du patrimoine écologique et du développement durable

Joyce Gould, Parks and Protected Areas Division, Alberta Community Development

Ken Harris, Habitat Conservation Branch, Canadian Wildlife Service

Katie Hayhurst, Yukon Parks Branch, Department of the Environment, Yukon Government

Helios Hernandez, Parks and Natural Areas Branch, Manitoba Conservation

Steve Holmes, Great Lakes Forestry Centre, Canadian Forest Service, Natural Resources Canada

Afan Jones, Yukon Parks Branch, Department of the Environment, Yukon Government

Paul Latour, Prairie and Northern Region, Canadian Wildlife Service

David Livingstone, Renewable Resources and Environment, Department of Indian and Northern Affairs and Development

Ken Mallet, Northern Forestry Centre, Canadian Forest Service, Natural Resources Canada

Brenda McAfee, Canadian Forest Service, Natural Resources Canada

Dan Mulrooney, Ontario Parks, Ontario Ministry of Natural Resources

David Monteith, Parks and Conservation Areas, Government of Nunavut

Bas Oosenbrug, Wildlife Division, Department of Environment and Natural Resources, Government of the Northwest Territories

Dan Paleczny, Ontario Parks, Ontario Ministry of Natural Resources

Brian Pelchat, Yukon Fish and Wildlife Branch, Department of the Environment, Government of Yukon

Jacques Perron, Ministère de l'Environment du Québec, Direction du patrimoine écologique et du développement durable

Floyd Phillips, Wildlife and Ecosystem Protection Branch, Manitoba Conservation

Wayne Schick, Parks Branch, Saskatchewan Environment

Carol Sheedy, Eastern Canada Directorate, Parks Canada Agency

Jason Simms, Marine Protected Areas Program, Department of Fisheries and Oceans, Newfoundland and Labrador

Glen Suggett, Wildlife and Ecosystem Protection Branch, Manitoba Conservation

Erik Val, Yukon Parks Branch, Department of the Environment, Yukon Government

Duane West, Western Canada Directorate, Parks Canada Agency

Rob Wright, Forest Ecosystem Branch, Saskatchewan Environment

A draft of the report was made available for review to academics, practitioners and environmental NGOs interested in protected areas in Canada. We thank the following individuals who volunteered their time to provide a careful and thoughtful review of the draft report.

Bill Crins, Ontario Parks, Ontario Ministry of Natural Resources

Pauline de Jong, Northwest Territories Protected Areas Strategy Secretariat

Alan Fehr, Western Arctic Field Unit, Parks Canada Agency

Sian French, Parks and Natural Areas Division, Department of Environment and Conservation, Government of Newfoundland and Labrador

Frances Gertsch, Ecological Integrity Branch, Parks Canada Agency

Joyce Gould, Parks and Protected Areas Division, Alberta Community Development

Katie Hayhurst, Yukon Parks Branch, Department of the Environment, Yukon Government

Alain Hébert, Ministère des Resources Naturelles, de la Faune et des Parcs, Government of Québec

Helios Hernandez, Parks and Natural Areas Branch, Manitoba Conservation

Jim Johnston, Director General, Parks Canada Agency

Paul Latour, Prairie and Northern Region, Canadian Wildlife Service

Nicole Lights, Parks and Natural Areas Division, Department of Environment and Conservation, Government of Newfoundland and Labrador

Gordon Nelson, Parks Research Forum of Ontario

Wayne Schick, Parks Branch, Saskatchewan Environment

Fiona Schmiegelow, Department of Renewable Resources, University of Alberta

Scott Slocombe, Department of Geography, Wilfrid Laurier University

Tory Stevens, Ministry of Water, Land and Air Protection, Government of British Columbia

Stephen Virc, National Protected Areas Office, Canadian Wildlife Service

Ed Wiken, Wildlife Habitat Canada

Heidi Wiebe, Deh Cho Land Use Planning Committee, Northwest Territories

Richard Wyma, Department of Environment, Government of Nunavut

Thanks also to *Kathryn Kuntz*, who prepared the figures in Section 4, and *George Cordiner* of Ontario Parks who prepared the map of the Great Lakes Heritage Coast, Figure 14. Thanks to Gerry Perrier for supplying the source map used for Figure 1. *Rob Vanderkam* and *Grahame Cole* of Environment Canada provided the oversize folded map of the northern protected areas and the ecozone map in Figure 1. *John Vandall, Rob Wright, Peter Jonker* and *Ted Mosquin* are acknowledged for their help with the photo search and the tribute to *Dr. Stan Rowe*.

Special thanks to Rob Wright for providing the photo of Dr. Rowe. Other photo credits and sources are cited with photo captions in the report. In addition, the following individuals and organizations are acknowledged for their help in obtaining photos for the report.

Geoff Bailey and *Sian French*, Department of Environment and Conservation, Newfoundland and Labrador

Jean Gagnon and *Benoit Limoges*, Ministere du Developpement durable et des Parcs, Quebec

Martyn Obbard, Ontario Ministry of Natural Resources

Phil Kor, Ontario Parks

Andrea, Allison and *Robin Reilly*, Quetico Provincial Park, Ontario Parks

Helios Hernandez, Manitoba Parks

Arnold Santos, Lac La Ronge Provincial Park, Saskatchewan Parks

John Vandall, Saskatchewan Department of the Environment

Rob Wright, University of Saskatchewan

Peter Jonker, University of Saskatchewan

Joyce Gould, Parks and Protected Areas Division, Alberta

Karen MacDowell and *Ken Morrison*, Parks and Protected Areas, British Columbia

Andre Guiton and *Kevin MacNamee*, Parks Canada Agency

Andree Mailloux and *Robert Helie*, Canadian Wildlife Service

Thanks to Dianne Villesèche of Raven Ink, Whitehorse, for finalizing the report design and layout and for preparing the print-ready files.

Not surprisingly, given the extent of the input and review of this project, many comments were received on various aspects of the draft report. The authors assume sole responsibility for assessing the reviews and determining the final content of the report.

Foreword

The conservation of wildlife and of protected areas in northern Canada has been a matter of longstanding interest and concern. Early efforts to establish parks, wildlife reserves and sanctuaries were farsighted, drawing on the limited knowledge and science of the day, more often buttressed with solid intuition. With escalating pressures to develop northern Canada in the 1960s and 70s, ecological surveys and planning for protected areas assumed a more methodical attitude following the impetus of the International Biological Programme (IBP). Altogether, IBP reported on many ecological areas 'North of 60°' that were proposed for conservation, some of which have achieved protected areas status, and others which have not. Current efforts to plan and to design protected areas continue to recognize the value of many of these sites, as well as others that have been subsequently identified for conservation.

The purpose of this report is to review and to assess science-based approaches for the design of protected areas in relation to current agency-based policies, programs and practices across northern Canada. The focus is decidedly biased toward large protected areas and area networks mindful of the need to plan for both the conservation of area-demanding and disturbance-sensitive wildlife, and large scale ecological processes that insure the integrity and viability of protected areas in extensive landscape settings. This report compares current theory and science-based approaches for protected area design against agency practices and cultures for protected areas planning in an effort to advance a vision and support for a comprehensive network of protected areas in northern Canada.

The Canadian Council on Ecological Areas (CCEA) has as its mission the goal "*to facilitate and to assist Canadians with the establishment and management of a comprehensive network of protected areas representative of Canada's terrestrial and aquatic ecological diversity*". Driven by modern paradigms for biodiversity conservation, ecological sustainability and land-use planning, the past decade has witnessed an unprecedented surge in the planning for and the establishment of protected areas across Canada — work that has substantially advanced the implementation of CCEA's vision across the country, including the northern regions. All jurisdictions — Inuit Peoples and First Nations, territorial, provincial and federal governments, non-governmental organizations and industry — deserve credit for this collective achievement.

Throughout this process, CCEA's role has been to advance a science-based outlook and to provide technical guidance on the design of protected areas within a network context. Initial foundation work to develop a national registry of protected areas building on the pioneer work of the International Biological Programme (IBP) evolved into the *Canadian Conservation Areas Database* (CCAD), which enabled practitioners to assess the state of protected areas across Canada. Subsequent work on developing guidelines to select ecological areas quickly led to the development of a national framework for protected areas based on the concept of ecological representation. Case studies on gap analysis demonstrated local application of systems concepts. Regular reporting by CCEA helped to calibrate and mark progress along the way.

Notwithstanding the substantial gains in establishing protected areas over the past decade, and the still valid representation construct advanced by CCEA and others, as a basis for developing a comprehensive system of such areas, additional work remains to be done. New insights and understandings of ecosystem structure and function, supported by robust enquiry in fields such as conservation biology and landscape ecology, demand consideration and application in ongoing efforts to build upon and refine past work. This perspective is especially true for Canada's vast northern regions where special needs for nature conservation and protected areas command attention as never before. In this regard, this report complements and builds upon the earlier and ongoing systems-oriented work of CCEA rather than striking a departure from it.

A central thesis of this report is that large protected areas with inherent ecological integrity are a cornerstone in efforts to conserve wildlife and other landscape scale biodiversity features, along with the ecological processes necessary to sustain them. Indeed, this idea is not foreign to Canada where highly revered places like Algonquin, Quetico and Wood Buffalo, representing early visionary protected area efforts, are largely in harmony with current science-based views on protected areas design. These, together with more recent additions such as Thelon, Quttinirpaaq, Cape Churchill and Bay du Nord, already give Canada a substantial foundation of world-class protected areas upon which to build a viable network. At landscape scale, such areas protect major ecosystem segments that safeguard natural and cultural heritage values for all Canadians and they help to meet the nation's obligations to protect global biodiversity and world heritage assets.

Given the scale of the project, we decided early on that the scope needed to be confined to the scientific and ecological dimensions of protected areas planning and design. The strong agency interest in this work, emanating from the 2003 Yellowknife CCEA workshop — *Wild Places for Wildlife* — steered the project toward a review aimed at serving protected area practitioners and closely allied interests. Notwithstanding this deliberate focus, the report does acknowledge the many other complementary disciplines and considerations that also need to be addressed as part of a comprehensive strategy for the design, selection, establishment and stewardship of protected areas in the North, notably the importance of sustainable ecosystem management on the intervening landscape and the human dimensions associated with the pursuit of this goal. While aimed at protected area practitioners, the report should serve as an informative reference for a much wider audience.

This report represents Phase I of the CCEA's Northern Protected Areas (NPA) project. Phase 2 will build on the background provided by Phase I and will present the results of a modelling exercise that attempts to implement some of the recommendations and design guidelines highlighted in Phase 1.

In moving forward, we believe that continual advancement of theory and practice will require the ongoing involvement of all parties having a stake in the stewardship of Canada's northern heritage and natural resources. While science can offer insights on the ideal architecture of protected areas design, we recognize that local needs may dictate local adjustments, and that implementation can only happen with the full involvement and support of community interests including Inuit Peoples and First Nations, governments, non-governmental organizations, industry and other partners.

This project has been carried out under the direction of CCEA with considerable government agency-based input. While this input and the resultant report is intended to advance efforts in Canada concerning protected area selection, design and management, this report is not intended to be seen as deterministic of policy for any of the participating governments.

Yolanda Wiersma, University of Guelph
Tom Beechey, Nature Matters
Bas Oosenbrug, Government of Northwest Territories
John Meikle, Government of Yukon

Table of Contents

List of Tables

List of Figures

1. Introduction and Rationale

Much of Canada's north contains naturally functioning ecosystems, such as the vast Peel River watershed in Yukon and NWT. Within the Peel, the Hart River Basin, above, is winter habitat to the Hart River Caribou herd, one of the most northern woodland herds in Canada.

Canada's North[1] is a vast and largely undeveloped area of the country characterized by large, relatively unfragmented landscapes and a low human population density. Across this region, ecological processes and communities of plants and animals are still relatively intact. However, the North is also changing dramatically in response to increasing domestic and global demands for natural resources. World energy shortages are driving increased exploration for and development of fossil fuels and ongoing consideration for hydro-electric generation across the northern regions of most of the provinces and throughout the territories. Mineral exploration and development are a priority in all regions and timber harvesting continues to expand northward at an accelerated rate. North American water shortages are sure to bring pressure to the longstanding debate on water export. Backcountry recreation and tourism are ever-growing industries challenging wider access to remote regions. As well, climate change presents a threat to northern ecosystems, the magnitude of which is not yet understood (Scott *et al.* 2002; Suffling and Scott 2002; Galley 2004; Hassol 2005).

[1] In this report the term "North" refers to the area of Canada that is largely roadless (see Figure 1) and includes the boreal, taiga, and tundra biomes. It incorporates the three territories (Yukon, Northwest Territories and Nunavut), all of Newfoundland and Labrador, and the northern parts of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec.

Canada's participation in the International Biological Programme Conservation of Terrestrial Ecosystems Panel 9 (IBP/CT) in the 1960s and 70s set a benchmark for methodical efforts to identify significant northern ecological areas for conservation purposes. The work of IBP/CT in Canada identified many northern sites that participants advanced for conservation (Nettleship and Smith 1975; Revel 1981). Given the pace of recent changes and development proposals, the requirement for protected areas in northern Canada is infused now with a sense of urgency (NCC 2003). A number of northern agencies and jurisdictions are currently involved with, or are interested in, protected areas planning. Local communities, First Nations and Inuit land-use planning organizations, academics, government scientists, and non-governmental agencies are also focused on this urgency, as evidenced by the broad spectrum of participants at CCEA's 2003 Yellowknife workshop on planning northern protected areas (Wiersma 2003).

"The world is at a critical turning point. There is significant uncertainty about how things will go in the next few years, but there is growing concensus that the decisions we make as a society, at this critical point, will determine the course of the future for quite some time to come."

Robert Costanza,
SAMPAA Proceedings (2002)

CCEA has long been involved in broad-scale comprehensive protected areas planning, and this report builds on CCEA's previous work, which was initiated with the development of guidelines for the selection and evaluation of ecological areas for conservation (Beechey 1989). Through a series of Occasional Papers, CCEA articulated a framework for establishing representative protected areas based on ecological principles (Peterson and Peterson 1991; Gauthier 1992; Gauthier *et al.* 1995). The ecological framework called for ecosystem representation, based on an "enduring features" approach (i.e., essentially a physiographic/landscape representation approach) at the ecoregion level (i.e., at a lower level of spatial hierarchy or finer resolution than the ecozones illustrated in Figure 1 (see Wiken *et al.* 1996 for background on ecozone and ecoregion classification), and set out general guidelines for protected areas design including the promotion of "ecological integrity" as a critical consideration. This report builds upon this previous work with current literature on the subject to provide an update on scientific research with respect to protected area design. We hope that it will be useful to northern protected areas planners and managers as well as to resource and land-use planning boards. Unlike previous CCEA Occasional Papers, this report provides a uniquely northern focus, and it also reports on how practitioners are applying current ecological knowledge for planning and managing protected areas in the North.

1.1 Overview

This report reviews and discusses the scientific basis for protected areas, reflecting concepts of ecological representation, biodiversity conservation and ecological integrity[2], particularly as they apply to Canada's northern regions. The report uses the IUCN's (World Conservation Union) definition of a protected area as "*an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means*" (www.iucn.org/themes/wcpa). Thus, protected areas here include national, provincial, and territorial parks; national wildlife areas and migratory bird sanctuaries; provincial ecological reserves, and allied designations (e.g., conservation reserves in Ontario). Ideally, when fully classified, most protected areas in northern Canada will fall within IUCN categories I-IV.

Although the analysis and discussion are confined primarily to terrestrial protected areas, we fully acknowledge the importance of establishing protected areas to assist with the conservation of marine and aquatic ecosystems and species. Indeed, while not the focus of this project, some of our conclusions have application to marine and freshwater systems and the designation of protected areas to conserve them.

As advocated more than three decades ago, protected areas serve an important role as ecological benchmarks (Jenkins and Bedford 1973). Northern protected areas are also important for scientific research and monitoring, protection of wildlife including species-at-risk and of wildlife habitat, and in addition have aesthetic, cultural, spiritual and recreational values (CAFF 2002).

[2] The goals of ecological integrity are to have protected areas that contain the composition and abundance of native species with supporting ecological processes that are characteristic for the region.

While sustainable resource management strategies by themselves can contribute to ecological integrity and may help to protect similar values, protected areas remain an important strategy for long-term conservation, and as such, are the focus of this report. Moreover, given the extent of Crown land across northern Canada, most protected areas will be established through government programs. These will have to be carried out in concert with First Nations and Inuit land claim agreements. Ecologically or culturally important areas may be recommended for protection by land and resource planning boards in the territories, where these play a more prominent role than in the provinces.

> *"Protected area systems should be built upon strong scientific, scholarly, professional and local knowledge. The ideal approach is multidisciplinary, interinstitutional, and broadly civic in nature."*
>
> Resolution, Tijuana Parks and Protected Areas Workshop (2002)

Thus, we emphasize the roles that various government agencies play in protected areas design and management, while at the same time highlighting the important roles of Aboriginal people, land-use planning boards, environmental non-governmental organizations (ENGOs), and industry involved in the process of protected areas planning.

The purpose of this report then is to review current knowledge and practices for the design and selection of protected ecological areas, to identify gaps in system planning needs, and to provide preliminary guidelines for the design of protected ecological areas and networks in northern Canada. The goal is to provide practitioners with principles, guidelines and best practices for designing, planning, establishing and managing northern protected areas and networks. The specific objectives include a review of the literature and relevant conservation science, and an assessment and synthesis of ecological criteria and principles related to protected areas planning and management.

> *According to a cross-Canada poll taken in November 1999, 91 per cent of Canadians feel it is important that governments take action to protect the wilderness, 83 per cent believe it is important for Canada to be seen as an international leader in protecting wilderness, and 80 per cent want to see protected areas established before lands are committed to industrial development.*
>
> John Turner, *The Globe and Mail*, December 8, 1999

The Northern Protected Areas (NPA) study area is defined in Figure 1. Protecting habitat and species in this northern region will inherently involve different techniques and confront different challenges than for the rest of the country (Wiken 2003). While the study area is referred to throughout this report as the "northern study area", and summaries and conclusions are made under the assumption that the region is relatively homogeneous, in practice this is not the case. The southern portions of the study area may be viewed as a 'near northern' zone that is already quite developed, while the 'far northern' portion of the study area is still comprised of pristine landscapes. However, the current pace of development demonstrates the very real incremental northward expansion of the 'near northern' zone.

In order to have an effective system of protected areas, reliable knowledge from all fields of inquiry must be integrated into protected areas planning, design and management. While the focus here is primarily on ecological scientific knowledge, it also touches on Traditional Ecological Knowledge (TEK) and local knowledge, as these play important roles for northern protected areas. Additionally, social and economic considerations are important components of protected areas planning and management, especially in the far northern context, where many protected areas are being developed in cooperation with local communities and Aboriginal groups. However, due to limitations of space and author expertise, the social sciences are not considered in detail here.

The assessment underpinning this report is based on four main components: i) a comprehensive survey of the peer-reviewed literature; ii) a selective review of agency-based literature; iii) an inventory of the current status of protected areas; and, iv) a comprehensive questionnaire survey sent to directors of agencies involved with protected areas across the country to determine how scientific knowledge is being used for northern protected areas planning and management. The literature survey (Section 2) identifies science-based and theoretical research goals and design strategies, while the overview of the current state of protected areas (Section 3) and the survey summary (Section 4) provide a more applied perspective. Section 5 provides a summary of the preceding sections

and includes practical information for managers together with case study examples of protected areas and network designs that apply a number of science-based approaches. Thus, we compare scientific and practical perspectives with the hope that this review will help to better bridge theory and practice. In this spirit, we provide conclusions in Section 6 based on findings from the literature, the enumeration of current protected areas, and the practitioners' survey. Appendices listing the protected areas in the study area and the actual NPA survey are included for reference.

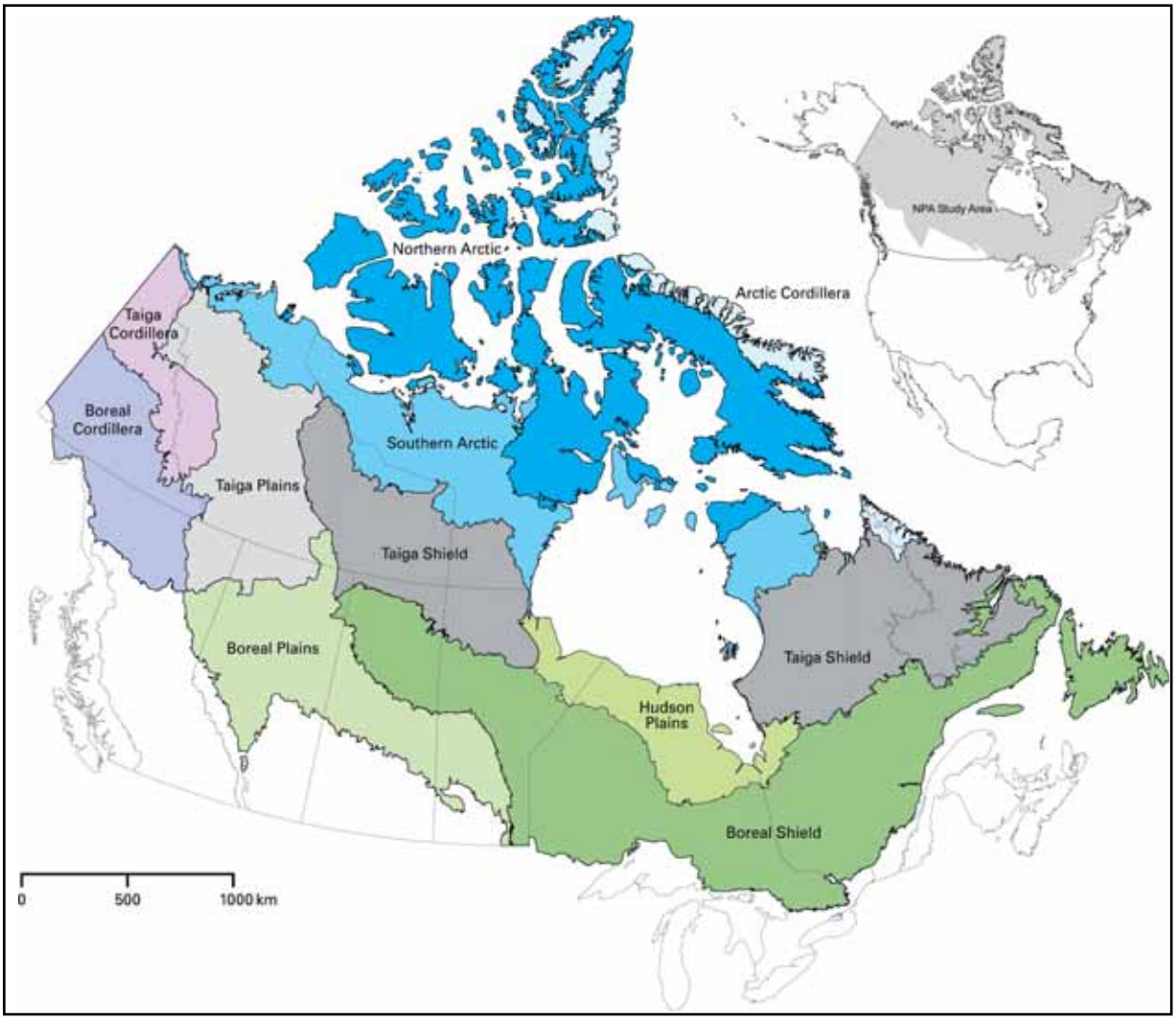


Figure 1 *Ecozones of Canada comprising the Northern Protected Areas (NPA) study area. The NPA study area includes the boreal, taiga and arctic ecozones. Source: Ecological Stratification Working Group (1996).*

1.2 Protected Areas for Biodiversity Conservation

Worldwide, human activities that contribute to habitat loss are the leading cause for the extinction of species. Given the expansive and seemingly remote nature of northern Canada, it may seem that this vast region is largely immune to pressures more typical of temperate and tropical regions. However, northern Canada's ecosystems and wildlife, though extensive and dispersed, are inherently fragile and sensitive to human development and use. Many of the region's charismatic species are 'disturbance-sensitive' and require large undisturbed areas for their life cycles. Conservation of northern wildlife and wild places are obligations of all levels of society, including local communities and regional jurisdictions, as well as national conventions and global responsibilities. Under Canada's Biodiversity Strategy (BCO 1995), protected areas play a key role in biodiversity conservation. While sustainable use of northern ecosystems may help to ensure the long-term viability of wildlife species, careful management alone will not be sufficient. Protected areas have a central role to play in the conservation of wildlife and wild places by acting as a 'safety net' and as ecological benchmarks.

> *"A science of land-health needs first of all, a base datum of normality, a picture of how healthy land maintains itself as an organism. Wilderness, then, assumes unexpected importance as a laboratory for the study of land-health."*
>
> Aldo Leopold,
> *A Sand County Almanac* (1949)

1.3 Protected Areas as Ecological Benchmarks

Compared to the rest of the country, and indeed, most of the world, much of Canada's northern regions still appear to be in a 'wilderness' state. Thus, it may seem unnecessary to set aside protected areas, as it seems unlikely that this region will ever become as fragmented and developed as habitat areas in southern Canada. However, the near North is already showing effects of fragmentation due to resource development activities. Moreover, it is not possible to predict future development activities, and thus protected areas serve an important role as ecological benchmarks against which the effects of development can be compared (Jenkins and Bedford 1973; Arcese and Sinclair 1997; Wiersma 2005).

To be effective as benchmarks, protected areas require as high a degree of ecological integrity as possible. Ecological integrity has been formally defined by Parks Canada (Parks Canada Agency 2000) and national parks are legislatively mandated to manage for ecological integrity[3]. However, despite the fact that management for ecological integrity is not legislatively mandated for most protected areas, we feel that it nevertheless is a useful concept for developing strategies for protected areas design and planning.

Some protected areas practitioners see the use of the term 'ecological integrity' as simply another buzzword. In the early 1990s the term 'ecosystem management' was widely applied to protected areas. Increasingly, this term has been taken up by the resource development sector, leading some to regard it more as jargon rather than a useful, pragmatic management framework.

While the term 'ecosystem management' has likely been used inappropriately, the concept of ecosystem management does incorporate the utility of protected areas as ecological baselines (Grumbine 1990, 1994; Groves *et al*. 2000; Groves 2003). The term should be familiar to many in the protected areas field, as a number of agencies and jurisdictions in Canada have recognized aspects of

[3] However, many Aboriginal groups and northern protected areas managers feel that the Parks Canada Ecological Integrity Panel was too focused on issues threatening southern parks. Consequently the Senate Subcommittee on Aboriginal Economic Development issued a report (Government of Canada 2001) to address this perceived gap between ecological issues facing northern versus southern parks. Others feel that, because national parks are the only type of protected area legislatively mandated to manage for ecological integrity, that the concept is not usefully applied to provincial/territorial parks, wildlife or migratory bird sanctuaries. Perhaps it is because southern parks face the greatest threats to ecological integrity (Canadian Heritage 1998) that the Ecological Integrity Panel Report (Parks Canada Agency 2000) appears to focus less on northern parks. Rather than see the absence of threats to ecological integrity as a reason not to use it as a criteria for northern ecosystems, it may be useful to think of northern ecosystems and protected areas as inherently having a relatively high degree of ecological integrity, and to carry out planning and management of current and future protected areas to ensure that ecological integrity is maintained.

ecosystem management in their protected areas policy and guidelines, including Saskatchewan (Saskatchewan Biodiversity Interagency Steering Committee 2005), Ontario (Ontario Parks website www.ontarioparks.com; Poser *et al*. 1992), and British Columbia (Ministry of Environment Lands and Parks 1997). So then why is there a need for a new term in addition to 'ecosystem management'? Grumbine (1994) identifies "ecological integrity" as one of the dominant themes of ecosystem management, so why not stick with a familiar term? We advocate the use of the term 'ecological integrity' over 'ecosystem management' for several reasons. For one, it is a term that has not yet been co-opted. Second, unlike the concept of ecosystem management, the concept of 'ecological integrity' carries with it a more specific need for very clear guidelines and standards for determining whether or not a protected area or (eco)system possesses integrity or not. In short, the definition of 'ecological integrity' as used in this report is more specific, clear and concise, and it is in line with the concept of protected areas as ecological benchmarks.

> *"An ecosystem has integrity when it is deemed characteristic of its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes."*
>
> Parks Canada Agency (2000)

Unless protected areas have a high degree of ecological integrity, it will not be possible to determine whether observed landscape changes outside of protected areas are due to the effects of resource development or other human-mediated change, or whether they reflect natural ecosystem dynamics (i.e., they cannot serve as ecological benchmarks). Because of the critical importance of ecological integrity, there is an inherent bias in this report toward large protected areas, which biological intuition and research predicts will have higher integrity. Large protected areas (> 3000 km^2) are an essential component of a protected areas network that can better assure the maintenance of ecological integrity than systems composed of smaller protected areas (Newmark 1995; Gurd and Nudds 1999).

While small protected areas have ecological and conservation values in that they can capture small-scale features, help to maintain genetic diversity, and act as linkages between core protected areas (Shafer 1995), their susceptibility to environmental perturbations and stressors limits their value for large-scale conservation and makes them less suitable as benchmarks for monitoring environmental change. Consequently, small (<10 km^2) protected areas are not the focus of this report. Additionally, a number of northern protected areas have been, or are in the process of being set aside primarily to conserve social, cultural and spiritual values. Although these are also important reasons to have protected areas, since their prime focus is not ecological, they will likely not serve as useful ecological benchmarks, and thus they are not discussed in depth here.

1.4 Design at Multiple Spatial Scales

Because ecosystems operate at multiple spatial scales, protected areas should be designed using a 'coarse-filter' approach that addresses the needs of landscape-scale ecological communities and processes, and a 'fine-filter' approach that is tailored to meet the requirements of specific guilds or species (Haufler 1999). These approaches correspond with the two extremes of spatial scale on the landscape that must be considered for effective protected area design (Haufler 1999; Schwartz 1999; Scott *et al*. 1999; Wall 1999). Similarly, the planning process may occur through a 'top-down' government driven process, and/or via a 'bottom-up' community-driven process. For example, the *Northwest Territories Protected Areas Strategy* (NWT-PAS) is largely community-driven (NWT Protected Areas Strategy Advisory Committee 1999; Purchase 2003), with local communities proposing candidate protected areas for interim protection.

A recent study comparing two biosphere reserves[4], one in Switzerland and the other in Ukraine, one of which (Switzerland) was implemented through a top-down approach and the other (Ukraine) via community involvement, showed

[4] Biosphere reserves are areas identified for their natural and/or cultural significance under the UNESCO (United Nations Environmental Scientific and Cultural Organization) Biosphere Program. Biosphere reserves may include protected areas, but may also combine core zones of protected areas with buffer zones where sustainable use takes place, often on a voluntary basis, or through co-operation between citizen groups and government agencies (see www.unesco.org/mab).

that residents outside the biosphere reserve that had been implemented through government direction alone felt that their goals and the goals of the reserve were incompatible, while those residents outside of the reserve that had been created through community discussion felt more affinity for the reserve's goals (Wallner 2003). Indeed, such opposing experiences are mirrored in many other jurisdictions. Local and traditional knowledge about specific sites and features, together with scientific knowledge on conservation biology and landscape ecology, can provide a synergistic approach to identifying values and making decisions about final boundary delineation (or, as in a recent case at Nahanni National Park Reserve, Northwest Territories, in decisions about boundary expansion) (Tate 2003)). These two types of knowledge can contribute at all levels, but generally local knowledge contributes more to the fine-filter approach, while scientific knowledge is better positioned to lend a regional (or often national or international) focus to the coarse-filter, landscape approach (see Figure 2). Nevertheless, scientific knowledge can contribute significantly to fine-filter research, as can TEK to a coarse-filter issue. Indeed, this meshing of knowledge of various orientations and scales through regional land-use planning processes is increasingly being advocated for protected areas planning and conservation decision-making (Nelson *et al*. 2003).

"Modern concepts about protected areas and wilderness have evolved from ancient cultural and religious ideas related to spirituality and primeval nature. Although the notions of parks and wilderness are foreign to most Aboriginal languages that reflect the place of humans as an integral part of nature, many cultures have embraced the idea of sacred places."

Juri Peepre and Philip Dearden, *Parks and Protected Areas in Canada*, 2nd edition: p. 323

Figure 2 is a simplified schematic of the interaction between top-down and bottom-up policy-making and scientific research and information in the Canadian North. For example, individuals may wish to have continued sustainable access to traplines. Their local community articulates these goals to the regional land-use planning boards (LUPBs) and perhaps to the provincial, territorial or federal government (through the local government representative and the legislative process). Land-use planning boards engage in planning and consultation with local communities, are mandated to consult with industry and ENGOs, and work within a legislative and policy framework imposed by the government(s). LUPBs may recommend certain areas of land as "closed to industry" as a means of supporting continued trapping activities. The government agency, in turn, may decide to fund research on fur bearers, and engage government scientists to conduct a study to help set sustainable harvest levels. Government scientists may collaborate with university researchers, and may be confronted with lobbying activities by ENGOs. To gain more diverse forms of knowledge, government scientists consult with communities that have access to local knowledge and traditional ecological knowledge (TEK). Government scientists in turn share scientific knowledge with communities that may facilitate research projects conducted in cooperation with individuals (e.g., monitoring the harvest on a sample of trap lines). Results from a study that incorporates local, traditional, and scientific knowledge may ultimately influence government policy. This, in turn, may trickle down to local communities and individuals in the form of local regulations on trapping activities.

A similar specific example could be envisioned for protected areas planning and management. From the bottom-up, individuals contribute information about goals for protected areas to their local communities and eventually up to the government agency. LUPBs can play an important role in setting aside areas for interim protection, which may be formally assumed by government protected areas agencies in the future. Alternatively, LUPBs may develop regulations regarding resource use that *de facto* confer protected status to certain areas identified by local communities. Local communities may also share TEK with government researchers, who will incorporate this into recommendations about protected areas design. From the top-down, scientists can bring in a national or global conservation and ecological context to be merged with TEK in the planning process. As well, government can facilitate the implementation of protected areas through policy and legislation. Indeed, this generalized model has been adapted in many Canadian jurisdictions, such as British Columbia (Thompson 1998), Ontario (OMNR 1997a, b) and others, where it has been a key ingredient underpinning successful planning initiatives for protected areas planning.

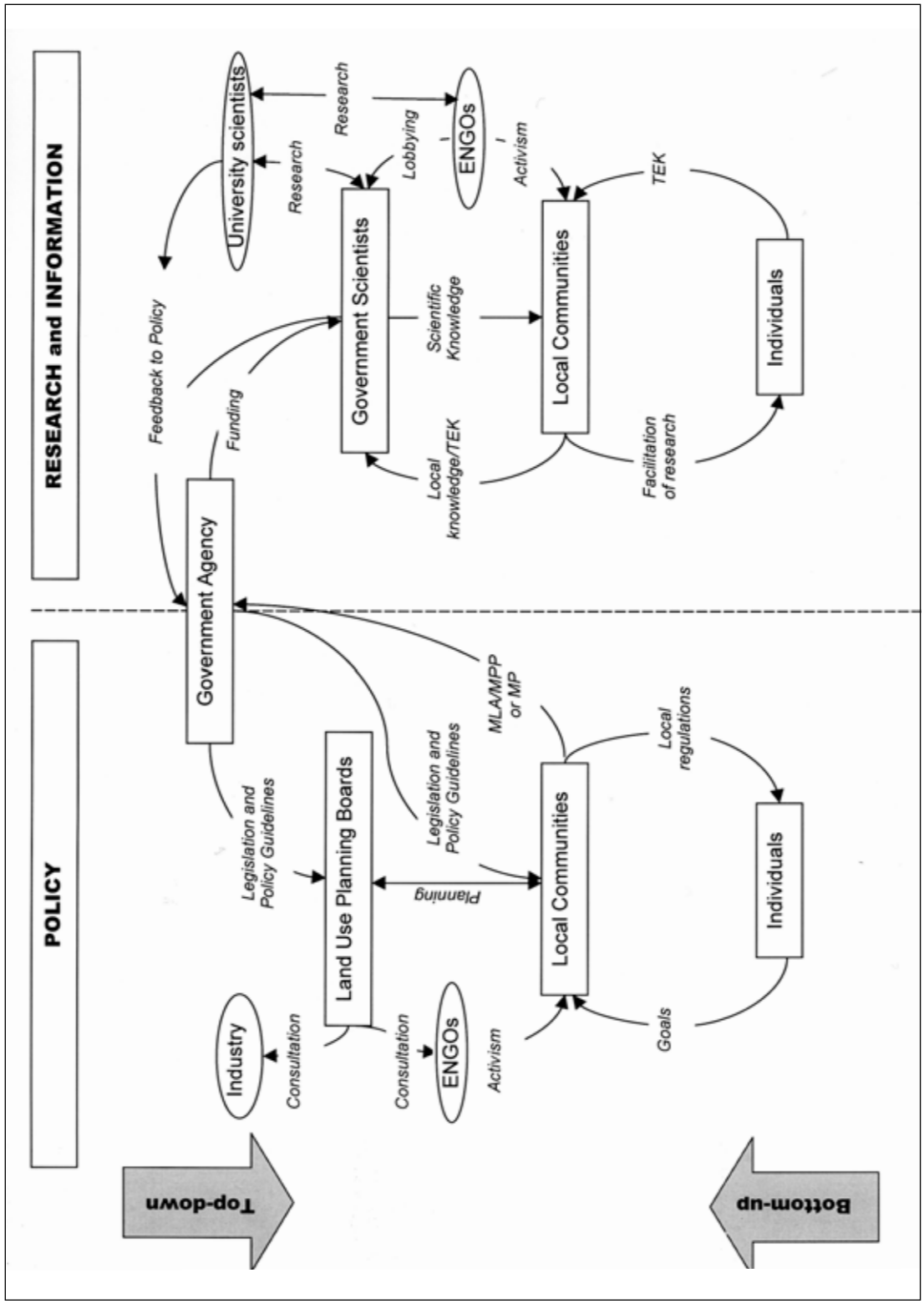


Figure 2 *A schematic of the interaction between top-down and bottom-up policy-making (left hand panel) and research and information (right hand panel) in the Canadian North as it relates to conservation issues. In reality, the links are likely even more complex. See the text for illustrative examples of how top-down and bottom-up policy and knowledge might interact.*

2. Current Knowledge for Designing Protected Areas

Two main criteria must be met for protected areas (and ecosystems) to have ecological integrity[5] with respect to species richness and composition[6]. First, protected areas must be large enough and sufficiently linked to the surrounding habitat matrix[7] to ensure that species can continue to persist in the face of landscape changes outside of protected area boundaries. Second, protected areas must be established in multiple locations across a region in a way that ensures representation of as many species, communities, landscapes, processes, and features of interest as possible, at multiple spatial scales. In addition, placement of protected areas within a viable network design can maintain ecological functioning through linkages and connectivity, and via sympathetic environmental management of the intervening landscape. Once these criteria and conditions have been met, it will be necessary to identify appropriate science-based targets and methods for final site selection and boundary

The quiltwork of tolerant hardwood forests and boreal enclaves, interspersed with lakes and rivers in the upper Great Lakes region, requires extensive protected areas to represent the full range of habitat conditions and native flora and fauna.

[5] As per Parks Canada Agency's definition. While we acknowledge that other agencies do not have a legislated mandate to manage for ecological integrity, as does Parks Canada, we use this definition in our report for consistency and clarity.

[6] Species richness refers to the number of species within a protected area, while composition refers to the identity and the associations of species (and may also include relative abundance).

[7] Habitat matrix refers to the area surrounding the protected areas. An inhospitable matrix would be one dominated by human development. Design criteria for other parts of North America suggest that protected areas be embedded in a matrix of buffer zones immediately outside of protected area boundaries, with cores and linkages to provide connectivity where the matrix is less hospitable (Noss and Harris 1986). Others have suggested a "reverse matrix" model is more appropriate for the North, where human development occurs in nodes with limited connectivity (i.e., transportation corridors), and the matrix includes protected areas as benchmarks as well as areas that exist under various conservation management scenarios, including resource development (Schmiegelow *et al*. in review).

delineation. There are many political and economic challenges in determining where protected areas should be located, and how large they should be to conserve northern ecosystems and their component species. This is compounded in northern environments that often feature extensive, complex ecological gradients and contain diverse concentrations of migratory species. Additionally, much of the relevant research on protected areas has been conducted in tropical and temperate ecosystems. Because of differences in climate, topography, species composition and land-uses, results of research from southern regions often cannot readily be extrapolated to northern protected areas planning. To help to offset this bias, a set of principles and guidelines for arctic conservation has been developed by the Circumpolar Protected Areas Network (Cooch and Pagnan 1996). Although these guidelines are quite general, they do represent an early and important effort to implement protected areas planning with a uniquely northern focus. In addition to addressing ecological concerns, the guidelines include useful socio-economic and cultural considerations, which this report does not address.

2.1 Minimum Area Requirements

In southern Canada, a habitat matrix that has been altered by agriculture, logging, and/or other forms of human development surrounds many protected areas, and thus protected areas here essentially function as 'islands of habitat' (*sensu* MacArthur and Wilson 1967). As such, many of these isolated areas have lost species that would have been present prior to widespread European settlement (Newmark 1995, 1996; Gurd and Nudds 1999; Wiersma and Nudds 2001). Data on historical species distributions have been used to estimate what species would have been present in the areas that are now protected, and a comparison of these to the number of species now present in these areas allows for calculating the size at which an insularized protected area should no longer lose its component species. This gives an estimate of the minimum reserve area (MRA)[8] — the minimum size above which an insularized protected area will still contain its historical complement of species. The MRA for southeastern Canada has been estimated to be at least ~3000 km^2 (Gurd *et al.* 2001), a size threshold that is consistent with estimates in other parts of North America (Shaffer and Samson 1985; Beier 1993; Schoenwald-Cox *et al.* 1998; Landry *et al.* 2001). Estimates will need to be similarly developed for northern Canada that take into account the region's unique features and processes (see section 2.4). For now, the MRA for southeastern Canada is adopted here as a 'provisional' estimate for northern protected areas, pending the completion of research to finalize minimum size requirements for northern protected areas. Agencies in southern Canada are responding to this need for large protected areas. Frameworks like Carolinian Canada's *Big Picture* (Reid 2002) and The Nature Conservancy of Canada's *Conservation Blueprint* being developed in line with Groves (2003) are seeking to conserve and restore tracts of natural areas in southern Canada, even though it may not be possible to re-establish protected areas large enough to re-introduce and sustain wide-ranging mammals. Establishing protected areas of a suitable size for the North, at the start, is a proactive measure that would minimize future needs for expensive restoration exercises, such as those now required for southern Canada.

> *"CCEA believes that our collective goal should be to achieve for Canada a nation-wide network of ecological areas developed on the basis of representation and integrity and managed to the highest standard of ecological protection."*
>
> CCEA, *Framework for Developing a Nation-wide System of Ecological Areas* (1992)

Another technique to estimate minimum areas using a landscape-scale approach is based on the concept of minimum dynamic area (MDA) (Pickett and Thompson 1978), which suggests that protected areas need to be large enough to contain dynamic processes inherent to the ecosystem. For example, since fire is the dominant force of change in the northern boreal forest, an MDA for this region would have to be several times larger than the average size of natural forest fire that is predicted to occur. Fire size in the boreal forest varies, but if an average fire size is ~100 km^2, a protected area here should be at least an order of magnitude larger so as to be able to contain a spectrum of fire dependent scenarios in a given locality.

[8] The term "reserve" is intended to be synonymous with "protected area", and refers to areas protected by legislation primarily for the conservation of natural features.

Large protected areas afford opportunities to sustain fire dependent ecosystems either through natural wild fires or prescribed burns, Quetico Provincial Park, Ontario.

Using a fine-scale approach, minimum critical area (MCA) analyses are another method to estimate minimum size requirements for protected areas, based on single-species population viability analyses (PVAs)[9]. Calculations of MCA are species-specific, whereas MRA estimates are based on minimum requirements for a number, or suite of species, and MDA estimates are based on landscape-scale processes. Despite discrepancies among the methods, together they suggest that protected areas in northern Canada should be on the order of several thousand square kilometres in size (Table 1).

Given the low human population in northern Canada, and the relatively minimal amount of industrial development, the concern for maintaining large tracts of protected areas may seem less urgent than in the southern parts of Canada where the surrounding natural habitat matrix has already been compromised and continues to disappear. However, as it is impossible to predict the degree of habitat change that will occur in northern Canada in the future, a prudent and precautionary course of action is to create protected areas that are at least several thousand square kilometres in size. Each northern ecosystem (described at ecoregional scales) should be represented with at least one large protected area. Indeed, some ecoregions already achieve this target with existing large protected areas (see section 3.1). Despite the common assertion that sustainable resource use may be able to maintain habitat and conservation values of northern landscapes, large protected areas are still essential as ecological benchmarks (Arcese and Sinclair 1997; Wiersma 2005) to ensure that these management practices are sustainable. A minimum size of at least 3000 km^2 (but possibly larger in some cases) appears to be the threshold suggested from scientific analyses of species demographics and patterns of local extinction across North America (Shaffer and Samson 1985; Beier 1993; Schoenwald-Cox *et al.* 1998; Landry *et al.* 2001). However, given the differences in productivity between southern and northern ecosystems, coupled with many migratory species in the North, protected areas in northern Canada may need to be even larger than this. At the same time, small protected areas can provide an important component of a larger network of cores, linkages and corridors (Noss and Harris 1986). Currently 66 of 744 protected areas in the NPA study area exceed 3000 km^2 (Figure 3). It should be noted that Figure 3 shows protected areas by ecozone, whereas CCEA's Ecological Framework (Gauthier 1992; Gauthier *et al.* 1995) called for representation at the ecoregion level (i.e., at a lower level in the spatial hierarchy). Until further work is done, representation at the ecoregion level may be a reasonable scale for delineating large protected areas across the North.

"Conservation biologists routinely face two basic questions: (1) what elements of biological diversity… should be used as a basis for conservation planning, and (2) what proportion of the area occupied by an element of biological diversity, must be protected to assure long term viability? There is, however a third question… how should the portion of the area that is to be protected be geographically distributed so as to take into account the potential range of genetic and ecological variation within an element of biological diversity?"

J.M. Scott *et al.*, in *Biodiversity and Conservation* 10:1297

[9] Population viability analysis (PVA) is an exercise whereby ecologists model species demographics to determine minimum population sizes that can persist in the face of unpredictable genetic and demographic changes.

Table 1 *Estimates of minimum area (km²) for protected areas from the literature that apply to planning for northern species and ecosystems. MRA: minimum reserve area; MDA: minimum dynamic area; MCA: minimum critical area; PVA: population viability analysis. These area estimates apply to individual reserves within a network of protected areas.*

Area (km²)	Study area	Target species	Method	Reference
2700–13 000	South eastern Canada	Disturbance-sensitive mammals	MRA: Comparison of historical to present-day species-area curves	Gurd *et al.* 2001
3140[10]	National parks south of 60th parallel	Disturbance-sensitive mammals	MRA: Model selection on landscape and human use variables	Wiersma *et al.* 2004
770-1270	Northern Québec and Labrador	Target species are not included in MDA models	MDA: based on a reported average fire size of 77-127 km²	Hunter 1993
70-7000	Alberta	Target species are not included in MDA models	MDA: based on a reported average fire size of 7-700 km²	Cumming 2001
1906	Yukon	Target species are not included in MDA models	MDA: based on being large enough to contain the largest fire size on record	Frid 2001
1000	Ontario & Québec	Target species are not included in MDA models	MDA: based on a reported average fire size of 100 km²	Bergeron *et al.* 2001
2200	USA	Cougar	MCA: based on PVA	Beier 1993
1000-13 500	USA	Grizzly bear	MCA: based on PVA	Shaffer and Samson 1985
1080	USA	Timber wolf	MCA: based on PVA	Schoenwald-Cox *et al.* 1988
768-1707	Canada	Timber wolf	MCA: based on PVA	Landry *et al.* 2001
1717-15 970	Canada	Black bear	MCA: based on PVA	Landry *et al.* 2001
1911-10 946	Canada	Grizzly bear	MCA: based on PVA	Landry *et al.* 2001

[10] So long as there is at least 18 000 km² of habitat within a 50 km radius outside of park boundaries.

Another possibly effective strategy for northern Canada is based on a "reverse-matrix" model (Schmiegelow *et al.* in review), which envisions a network of large ecological benchmarks (protected areas) plus other reserve elements and nodes of more intensive human use embedded in a predominantly natural habitat matrix. This approach facilitates ecological integrity through the conservation of natural areas and sustainable resource uses by way of an integrated conservation framework. A project is currently underway to explore whether the reverse-matrix model can be implemented in the Canadian boreal forest region (Schmiegelow *et al.* in review). Interested readers should consult the BEACONs website (listed at the end of the references) for further information.

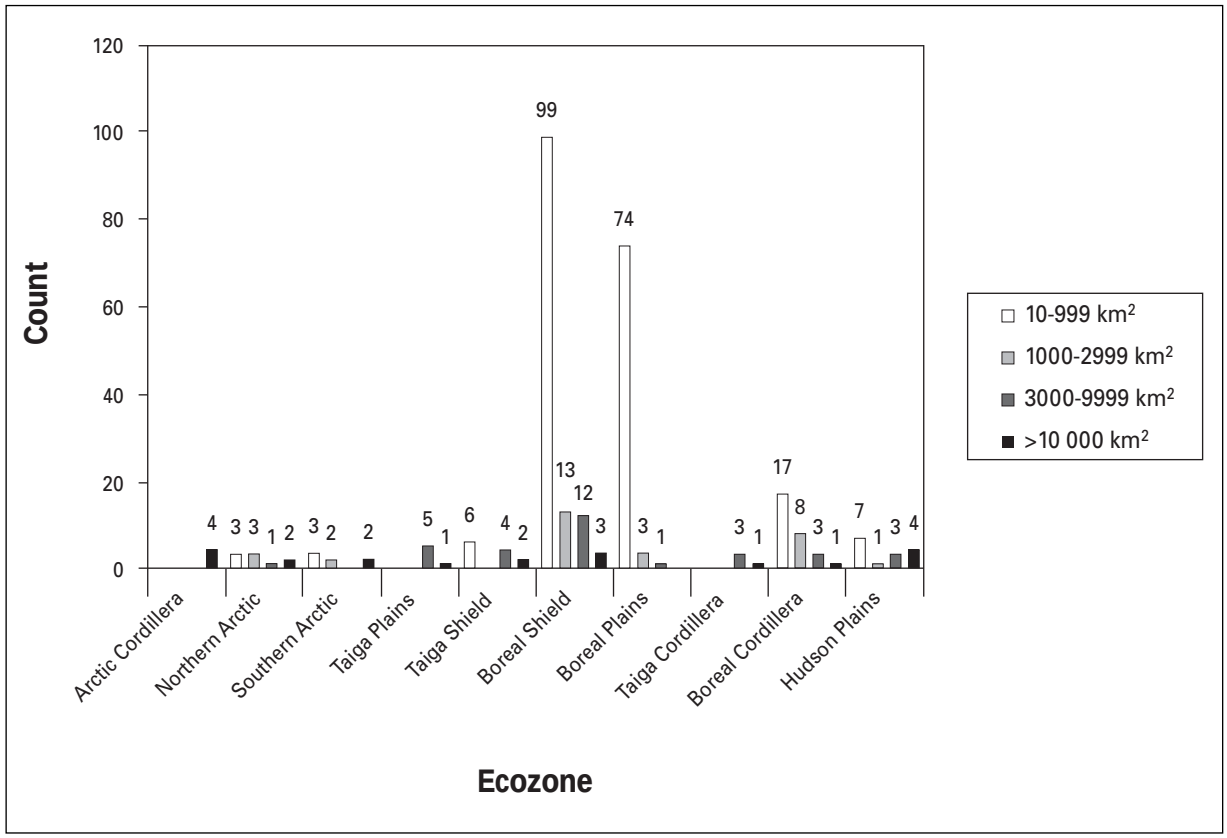


Figure 3 *Distribution of protected areas >10km² for ecozones within the NPA study area. Protected areas numbers in this chart do not correspond exactly to the listing in Appendix A, as digital GIS files used to generate this chart are currently not available for all protected areas. Values are indicated above each bar – where no value is listed, the count is zero.*

2.2 Minimum Requirements for Representation

The concept that protected areas should be representative of natural features is articulated in many protected areas strategies and plans in northern Canada. CCEA has long advocated criteria for protected areas based on representation of Canada's ecoregions and ecozones (Peterson and Peterson 1991; Gauthier 1992). Others have articulated principles and criteria for representation of forest ecosystems (Peterson *et al.* 1995). Examples of applications of ecoregion representation at the provincial and territorial level include extensive efforts in British Columbia (Thompson 1998) and Ontario (Crins and Kor 2000; OMNR 1997a, b), where representation was adopted as a core construct for the selection and establishment of new parks and protected areas through the 1990s. The *Yukon Protected Areas Strategy* (YPAS), which was not

as widely implemented, stated "*protected areas should attempt to capture the full range of ecosystem types that are present in the ecoregion*" (YPAS 1998). Similarly, the *Northwest Territories Protected Areas Strategy* (NWT-PAS) states that one of the goals of the strategy is to "*protect core representative areas within each ecoregion*" (NWT-PAS Advisory Committee 1999). Manitoba is committed to protecting *"a representative portion of each of our eighteen natural regions and subregions... representative areas are intended to encompass the biological and landscape diversity of natural regions"* (Manitoba Natural Resources 1998), while Saskatchewan is just completing identification of sites that will be representative of each of the province's 11 ecoregions under its representative areas network (RAN) initiative.

The concept of representation as a goal for protected areas is relatively simple; however the methodologies for identifying representative protected areas are much more complex. Moreover, it will be challenging to identify representative areas, and maintain them, in the face of climate change. The literature outlines heuristic reserve selection algorithms[11] (Margules *et al.* 1988) that can be used to efficiently select minimum sets of protected areas that together capture the full biodiversity of regional ecosystems. These algorithms are based on the principle of complementarity[12], and can be rarity-based (prioritizing for rare species) or richness-based (prioritizing for areas with high biodiversity) (Margules *et al.* 1988; Pressey *et al.* 1993; Freemark *et al.* 1999).

Much of the advocacy literature on representativeness for protected areas has focused on minimum percentage area targets, supported to some extent by research findings. The targets in the peer-reviewed literature vary from 5–99%. Driven by the Brundtland Commission's recommendations, the World Wildlife Fund's *Endangered Spaces* campaign set a target for setting aside 12% of Canada as protected areas, based on representation of enduring features (Hummel 1995). In Canada, the British Columbia (Kennett 1994), Ontario (Ontario's Living Legacy 2002), and Saskatchewan governments (W. Schick, pers. comm.) have put this target into practice. However, a recent study illustrated that the actual value for a percentage target was highly sensitive to the number of targeted species and their relative endemism[13], as well as the planning unit size (i.e., size of the candidate protected area) (Rodrigues and Gaston 2001). In addition, percentage targets do not include prescriptions for protected area design that will improve chances for species persistence (the ability of populations to survive in an area over time), thus we discourage the use of unsubstantiated percentage targets.

Several studies have addressed the concept of representation and species persistence simultaneously (Cowling *et al.* 1999; Rodrigues *et al.* 2000a, b; Cabeza and Moilanen 2001; Wiersma and Nudds 2003). For example, Rodrigues *et al.* (2000a) suggested that sites should be selected where species occur in high relative abundance and hence are less likely to go extinct (Rodrigues *et al.* 2000a). In the absence of abundance data, Rodrigues *et al.* (2000b) suggested setting targets for multiple representations (i.e., capturing species in more than one site), or by setting targets for a certain percentage of each species' range to be captured within a protected area (Rodrigues *et al.* 2000b). Other research has suggested that in order to have a representative protected areas network with ecological integrity, it is important to *first* consider the minimum size requirements for each site, and *then* consider how many of these minimum-sized areas might be necessary within a given region to achieve representation (Wiersma and Nudds 2003).

Most of the scientific literature on representation is focused on the representation of species. CCEA's ecological representation framework was defined largely on "enduring features"[14] (Gauthier 1992), however, it implicitly recognized the importance of habitat at

[11] Heuristic algorithms, or "rule-based" algorithms, refer to a process where a suite of representative protected areas are iteratively selected from a broader set of candidate sites following a series of simple rules. For example, a richness-based algorithm selects the site with the highest overall species richness to be a component in the network. On the next iteration, the algorithm will select the site with the next highest richness of species not already captured in previous selections. For an overview of heuristic algorithms see Margules *et al.* (1988) and Pressey *et al.* (1993).

[12] The principle of complementarity refers to sites that differ from each other in terms of species composition. For example, if a region contains species A, B, C and D, and a protected area already exists that conserves species A and B, then a complementary protected area should capture species C and D.

[13] Endemism refers to the degree to which a species is locally unique (i.e., not found elsewhere).

[14] Enduring features refer to physical features on the landscape that remain over time (i.e., landforms, soils).

a range of scales. This approach was subsequently advocated by World Wildlife Fund Canada as part of its gap analysis of Canada's ecozones and ecoregions. The boreal, taiga and tundra biomes contain a complex matrix of habitat and microhabitat types, including variously aged stands of trees, gradients in elevation, and terrestrial habitats interspersed with lakes, rivers and wetlands of varying sizes. CCEA's position has consistently been that protected areas must be large enough to capture as many habitat and micro-habitat types as possible, and be replicated across the region of interest (e.g., an ecoregion) to maximize diversity and variation between habitat types, e.g., sub-alpine boreal vs. plains boreal habitats (Peterson and Peterson 1991; Gauthier 1992; Gauthier *et al.* 1995).

> *"Conservation planning is usually done within geo-political units that tend to encompass only part of the geographic range of most species. Consequently, the relative rarity of a species within the study area considered does not necessarily reflect its relative global rarity or its conservation relevance."*
>
> A.S.L. Rodgrigues and K.J. Gaston, *Conservation Biology* 16: 674

2.3 Site Selection Procedures

2.3.1 Data Issues

In selecting candidate protected areas, the best available data should be used in combination with consistent procedures for site selection, using both local/traditional knowledge and regional/scientific knowledge. Adequate funding for inventory and assessment work *must* be part of any protected areas strategy, however we realize that funding for data collection is finite. Thus, inventory data should be shared as widely as possible (Meese *et al.* 2003) among all those working in protected areas planning and management in the region (i.e., Aboriginal groups, ENGOs, land-use planning boards, academics, other government agencies). Once general guidelines have been outlined for the minimum design requirements (size and number of protected areas), the process of selecting specific sites and features and delineating boundaries can take place. However, this process will only be effective with reliable data, collected at multiple spatial and temporal scales (e.g., satellite imagery, radio/satellite-telemetry locations, vegetation mapping and sampling, breeding bird surveys). To reliably estimate minimum reserve area requirements using PVA analyses, fine-scale demographic data for a range of species of interest (species-at-risk, predators and keystone prey species) are necessary. Conversely, when identifying minimum replication requirements, more coarse-scale data on the distribution of species and habitat types will suffice.

Currently, the only available species information across northern Canada is derived from coarse-scale range data for birds and mammals from *NatureServe* (www.natureserve.org), Limited habitat information comes from Forest Resource Inventory data, and other habitat data at varying degrees of resolution, derived from LANDSAT and other satellite imagery. However, satellite data are relatively expensive to obtain (and become outdated quickly), and many agencies do not have the resources to acquire, store and interpret these data. It is likely that agencies, departments, and even individuals already possess useful data on species and habitats at a local scale. The NPA Survey (see Section 4) revealed that some agencies and jurisdictions are in the process of consolidating data and developing sampling and data standards. However, nearly all of the respondents to the NPA survey identified the lack of spatially explicit wildlife data as a factor limiting their research programs.

Most conservation agencies in Canada report that data suited to conservation area design is limited, even for well studied large mammals.

Northern coastal protected areas, such as Aulavik National Park in Northwest Territories, afford opportunities to represent marine and terrestrial arctic environments important for wildlife, scientific research and environmental monitoring.

Data collection and inventory work should not be carried out in a piecemeal fashion, or by agencies in isolation; this applies to socio-economic data collection as well. Inventory work should be carried out with a specific research question in mind (for an example, see the discussion on surrogate species, below). Methods for data collection should be standardized as much as possible across the North, to facilitate sharing of information and extrapolating across large areas. Meese *et al.* (2003) and Moore and Latour (2003) present methodologies that could possibly be adapted across the North. Standards for data and mapping, such as those used by Conservation Data Centres (CDCs) like the Ontario Natural Heritage Information Centre (NHIC) and its counterparts across Canada enable the sharing and extrapolation of data for protected areas planning.

2.3.2 Site Selection Programs

Several software programs exist to facilitate the process of site selection: SITES/MARXAN (Ball and Possingham 1999; Andelman *et al.* 1999), C-PLAN (Anonymous 1999, Cowling *et al.* 2003) and PORTFOLIO (Urban 2002). These programs are summarized and compared to each other in Table 2. Simple heuristic algorithms based on prioritizing sites with high species richness or presence of rare species can also yield near-optimal[15] solutions to the problem of efficiently representing biodiversity with a suite, or group (network) of protected areas (Csuti *et al.* 1997).

[15] Because algorithms are based on the principle of complementarity (see note 11), the solution is near-optimal, in that it attempts to maximize representation of species or features of interest with the minimal amount of area possible (i.e., least economic cost). For a discussion on optimality in reserve algorithms see Underhill (1994) and Pressey *et al.* (1996).

Table 2 *Comparison of site-selection software packages available for protected area identification.*

Package	Platform(s)	Software Integration and Data Requirements	Advantages	Disadvantages	References
SITES and MARXAN	PC (Windows)	*Software integration*: ArcView 3.x GIS software. Results are CSV files that can be viewed in Microsoft Excel. *Minimum data requirements*: Spatially referenced data on species composition of candidate sites. Additional attribute data of sites is desirable.	• Interactive • Allows user to map the *irreplaceability* of sites — this is a measure of the cost[16] of not including the site in the portfolio. • Uses either heuristic algorithms or simulated annealing[17] • Allows user to assign pre-determined weights to criteria such as inter-reserve distance.	• A recent paper (Mier *et al*. 2004) that examined MARXAN suggests that unless plans are put into place immediately, simple rules of thumb perform as well, if not better than, complex computer algorithms.	Andelman *et al*. 1999
C-PLAN	PC (Windows)	*Software integration*: ArcView 3.x GIS software Report outputs can be viewed in Microsoft Excel. *Minimum data requirements*: Spatially referenced data on species composition of candidate sites. Additional attribute data of sites is desirable.	• Interactive • Full documentation of selection process • Based on the principle of complementarity • Sums for irreplaceability of sites[18] • Allows the integration of data sets from other sectors (e.g., industry, tourism) to model potential trade-offs between conservation and other uses.	• Better results are obtained with data sets on other land-uses — these may be difficult to obtain.	Anonymous 1999; Cowling *et al*. 2003
PORTFOLIO	PC or UNIX	*Software integration*: None *Minimum data requirements*: Species composition at all sites Data on inter-reserve distance is optional.	• Interactive • Choice of four selection criteria (greedy richness, simple rarity, greedy rarity, connected area[19]) • Process of selection is self-documenting.	• Data must be prepared as text files (possibly labour intensive). • Analysis is limited to 24 species and 32 sites. • Limited to heuristic algorithms.	Urban 2002

[16] In terms of lost opportunities for conservation of a specific species or feature.

[17] A more flexible system that generally yields more efficient solutions than greedy algorithms (see also notes 11 and 15).

[18] Irreplaceability is a measure of how essential a site is to the total network; the more unique species and features that a site contains, the more irreplaceable it is.

[19] "Greedy" algorithms refer to heuristic algorithms (note 10) where the initial rule for site selection seeks to maximize a certain feature (e.g., species richness).

2.3.3 Surrogate Species

In the absence of comprehensive data on species, surrogate species have been suggested as useful approximates for selecting sites (Cluff and Paquet 2003). Surrogate species are species used as "replacements" for other types of information. However, there is much confusion and misunderstanding over the terminology and use of surrogate species (Simberloff 1998; Caro and O'Doherty 1999).

Definitions of Surrogate Species

Umbrella species: large, wide-ranging species. The assumption is that protection of habitat for these species will automatically protect habitat for a range of species.

Indicator species: species whose presence, absence or abundance indicates particular (often biophysical) information about their environment.

Keystone species: a species that plays a key role in the stability of a food web, ecological community or ecosystem. Examples include top predators, or species that make dramatic changes to their habitat (e.g., beavers).

Flagship species: a charismatic species chosen for its public appeal in attracting attention to an issue.

Focal species: a 'catch-all' phrase for umbrella, indicator, keystone, or flagship species. This term is sometimes used even more broadly to refer to a species that is being focused on for a variety of reasons.

Aside from Warman *et al.* (2004), there is limited evidence to date suggesting that strategies using surrogate species are effective (see summary of studies in Table 3). A literature review (Flather *et al.* 1997) found that overall, biodiversity indicators did not function well, and the authors did not recommend that indicators be used as part of conservation (protected areas) planning. Rather, researchers should simply use the best available data and acknowledge its limitations. The majority of studies reporting success with the use of surrogate species have been those using plants or invertebrates with small spatial distributions as surrogates for overall biodiversity or for presence of rare elements. In northern Canada, the best biological information is available for large mammals, many of which are habitat generalists, and thus may not serve as good surrogates. As well, the distribution of the species and the spatial scale for using northern surrogate species may be much larger than for most studies reported in the literature (Kremen 1992; Fleishman *et al.* 2000, 2001; Kintsch and Urban 2002; Suter *et al.* 2002). However, others advocate using large, wide-ranging species that are highly interactive[20] within their ecosystems can be successful (B. Miller, pers. comm.). Highly interactive species are postulated to be keystone species that play important ecological roles within their ecosystems (Miller *et al.* 1998/99, 2003; Foreman *et al.* 2000, 2003), however most species have many links within their ecosystem, and some of these (e.g., insects) are highly interactive, but potentially more difficult to study.

Alternatively, environmental diversity[21] (ED) may be used as a surrogate for biodiversity (Faith and Walker 1996). Araújo *et al.* (2001) tested this procedure by using environmental variables related to climate as surrogates for a range of taxa in Europe. They found that the ED method performed no better at representing species diversity than a random selection of sites, and performed worse than representation using heuristic algorithms (Araújo *et al.* 2001). Faith (2003), in turn, has pointed out that the results of Araújo *et al.* (2001) were no worse than those of other surrogacy methods, and suggested that the use of other measures of environmental diversity (such as soil, vegetation and topographic patterns) beyond simple climate parameters might yield better results.

Given the uncertainties inherent with surrogate species, protected areas planning in the North that makes use of

[20] This term refers to species that play many roles within a food web/ecosystem (i.e., may be prey for a range of species and/or may also be predators for other species and/or may alter habitat dramatically through their activities).

[21] ED could include diversity in climate variables (temperature, precipitation) or in landscape features (e.g., soil types, landforms, etc.).

surrogates should be approached within an experimental, adaptive management framework[22]. This could be done experimentally, by implementing different strategies (i.e., representation of landscape features, large or small species as biodiversity indicators, and rare species as surrogates). With careful use of a study design to compare different approaches using surrogates to select potential sites, protected areas planning in the North can make significant contributions in this regard, particularly for biomes that have received relatively little conservation attention. For example, traditional harvesters could contribute spatially referenced observational data on species of interest — information that could be incorporated into a regional study on the potential usefulness of focal species.

The use of flagship species, or species of interest to a particular community, has value in conservation area design. However, research suggests that using a surrogate species habitat-based approach alone may not yield a design optimal for all biodiversity.

2.3.4 Alternative Approaches

Perhaps the best approach to identify potential protected areas is to use a combination of methods. For example, Noss *et al*. (2002) identified special elements, combined with representation goals for environmental features and critical habitats for focal species (e.g., grizzly bear, *Ursus arctos*; timber wolf, *Canis lupus*; wolverine, *Gulo gulo*; Canada lynx, *Felis lynx*; and elk, *Cervus elaphus*), to delineate candidate protected areas in the Greater Yellowstone Ecosystem. In a similar analysis, Miller *et al*. (2003) compared two approaches for identifying protected areas in the southern Rockies. They identified protected areas based on the habitat needs of large carnivores and compared these with The Nature Conservancy's rare-species and representation approach. They found a high degree of overlap between the protected areas selected using the two methods, and concluded that the approaches were complementary (Miller *et al*. 2003). However, using several approaches takes time and carries a higher cost, and thus may not be practical.

> *"Although we acknowledge that land allocation sometimes proceeds with no data, not much judgement is needed to understand that such decisions can protect actual priority areas only occasionally and accidentally."*
>
> R.L Pressey and RM. Cowling, *Conservation Biology* 15:275

Once data are collected, and guidelines for minimum size and replication requirements for protected areas established, boundary delineation is possible for individual sites, for example by way of The Nature Conservancy's Five-S Framework (The Nature Conservancy), or for a suite of protected areas, landscapes and networks (Poiani and Richter 1999; NCC and NHIC 2004), or using criteria summarized elsewhere (Noble and Kor 1982). In all cases, it is important to try to minimize bisecting habitats or ecosystems with protected area boundary lines. Most protected areas in Canada south of 60°, have reduced ecological integrity due to habitat changes outside their boundaries, and/or political boundaries that do not correspond with ecological boundaries (Parks Canada Agency 2000), as well as to their history of being in a region with a mosaic of land-uses and land tenures. While most boundaries will invariably intersect an ecosystem, following watersheds or discernible landforms is one useful technique that can often help to minimize the potential ecological disruption associated with boundary delineation.

[22] Adaptive management refers to the process of "learning while doing". In adaptive management, policy directions are cast as research hypotheses and management is carried out in a rigorous, experimental fashion. With careful monitoring, results can be used to modify management practices and policy directions as needed. For more on adaptive management, see Holling (1978), Walters (1986), and Nudds (1999).

Table 3 *Summary of a sample of studies that have examined species as surrogates to predict biodiversity protection.*

Surrogate species	Surrogate for	Study area	Conclusion	Reference
Butterflies	(Micro) habitat heterogeneity	Madagascar	Good indicator of heterogeneity but poor indicator of plant diversity.	Kremen 1992
Butterflies	Overall biodiversity	Various parts of the USA	Good umbrellas in one region were not necessarily useful in other regions.	Fleishman *et al.* 2000
Butterflies and birds	Overall biodiversity	Various parts of the USA	Limited within taxonomic groups. Good umbrellas in one region were not necessarily useful in other regions.	Fleishman *et al.* 2000
Plants that are habitat specialists	Rare plant species	Amphibolite Mountains, North Carolina	Good, but expensive. High rate of over-prediction.	Kintsch and Urban 2002
Capercaillie (*Tetrao urogallus*)	Other avian species	Sub-alpine forests in Switzerland	No significant difference between sites where capercaillie was and was not present.	Suter *et al.* 2002
Variety of plants, beetles, and fungi	High quality forest (i.e., high bio-diversity/old growth/ concurrent rare species)	Spruce forests in Sweden	Some indicators performed better than others, but even those that performed well did not perform equally well at different scales, and sometimes indicated contrasting results.	Jonsson and Jonsell 1999
Species richness of birds, mammals, amphibians, reptiles, COSEWIC species (each used as a separate surrogate group)	Birds, mammals, amphibians, reptiles, species richness	Across Canada	One taxon generally was a good surrogate for other taxa. COSEWIC species from across taxonomic groups also performed well.	Warman *et al*. 2004
Summed irreplaceability of sites (using C-Plan) for each taxa	Birds, mammals, amphibians, reptiles, species richness	Across Canada	Positively correlated among taxa, but not as high as for species richness.	Warman *et al*. 2004
Minimum set for representation of all species of one taxa	Birds, mammals, amphibians, reptiles, species richness	Across Canada	Low correlation.	Warman *et al*. 2004
'Incidental representation' of non-surrogate taxa	Birds, mammals, amphibians, reptiles, species richness	Across Canada	Low correlation.	Warman *et al*. 2004

2.4 Special Considerations for Northern Protected Areas

While there is an extensive literature on protected areas design, much of it is focused on temperate or tropical ecosystems. The unique ecology of boreal, taiga, and tundra biomes requires special consideration for protected areas design. Several issues of particular significance to northern ecosystems warrant attention. These include: migratory species, ecosystem processes, resource development, and climate change.

> *"The most important considerations in designing and managing such (protected area) systems are representation of all ecosystems; population viability of sensitive species; and perpetuation of ecological and evolutionary processes."*
>
> Reed Noss,
> *The Wildlands Project* (1992)

2.4.1 Migratory Species

Many northern wildlife species are seasonal or migratory, such as caribou that move from tundra calving grounds to winter ranges in the boreal forests; alpine species that migrate to higher elevations in the summer and which spend the winter in valleys; or those species that breed in the North and winter in the sub-tropics or tropics, as do many bird species. The ephemeral nature of many species' distributions in northern Canada presents a unique challenge to protected areas planning.

*Research is underway to understand the migratory routes, seasonal habitats and potential sub-populations of trumpeter swan (*Cygnus buccinator*). This information is key to designing an effective conservation area strategy for this recovering species.*

While a local approach to protected areas planning will assist in identifying areas that are seasonally important, a regional approach involving cross-boundary cooperation with agencies in adjacent provinces and territories, or states or countries where these species reside seasonally, will be necessary to ensure that the species are protected year-round. An example of cross-boundary cooperation exists for the whooping crane (*Grus americana*), which breeds in Wood Buffalo National Park and winters in Texas. However, this species is still at risk along the migratory route, and thus it is imperative to protect important stopover areas along the flyway as well. For migratory caribou, practitioners have suggested strictly protecting the calving grounds, while simultaneously applying other strategies, such as temporary access restrictions, when and where protected area delineation is not practical (Gunn 2003). To date, there have not been any rigorous studies on alternative conservation strategies for wide-ranging species to determine whether these are effective. In the face of uncertainty about effective management strategies, maintaining landscape connectivity is a good safeguard to help to maintain seasonal migrations (Cabeza 2003).

Protecting wide-ranging, terrestrial species requires a landscape scale management perspective. An example of this approach to promote ecological connections is the *Yellowstone to Yukon* (Y2Y) initiative (see: www.y2y.net and section 5.4 for an overview). The Y2Y is a trans-boundary strategy that facilitates coordination of land-use and protected areas along a biogeographically defined axis (the Western Cordillera) in order to assist with the protection of large wide-ranging carnivores, including wolves and grizzly bears. Initiatives such as *The Wildlands Project* (Soulé and Terborgh 1999) are examples of proposed landscape scale networks of protected areas in the context of landscapes where other activities, such as forestry, agriculture and tourism, also take place.

2.4.2 Ecosystem Dynamics

Fire is the dominant disturbance shaping vegetation and landscape patterns in the boreal forest. Within such a dynamic ecosystem, large protected areas that contain a

range of stand types and age classes will be better suited to maintain their ecological integrity and natural fire regimes than small protected areas with only a few stand types and ages, assuming wild fire is not suppressed in such areas (Pickett and Thompson 1978).

Other processes pertinent to the boreal forest include periodic insect infestations, blow downs and disease outbreaks, not to mention dramatic seasonal fluctuations in temperature, precipitation and hydrology. In tundra and taiga regions, many populations may undergo dramatic population fluctuations, and thus protected areas also should be designed to accommodate these processes. Again, large protected areas will more likely be able to accommodate these processes, and will contain the range of competitors and predators that can quickly respond to population fluctuations and pest outbreaks with minimal human interference. As in other situations, smaller protected areas and protected corridors and linkages can be important assets in designing networks of protected areas.

"A cooperative, precautionary policy set, that assumes limited resources, is the most rational and resilient course in the face of fundamental uncertainty about the limits of technology."

Robert Constanza,
SAMPAA Proceedings (2002)

2.4.3 Resource Development

Resource development (which includes industrial logging, mining, oil/gas development and hydro-electric development) continues to be an important part of the northern Canadian economy. Since these activities may be in conflict with conservation goals, strategies to accommodate both conservation and resource development are necessary. Because of the human dimensions associated with resource developments, this is an area where collaboration with social scientists and experts in environmental economics is necessary. To date, northern jurisdictions have adopted different policies to deal with resource development activities. For example, both the Yukon[23] and NWT-PAS have suggested that they will incorporate buffers[24] around protected areas to mitigate the effects of mineral extraction outside of protected area boundaries (Wenig 2003). In Ontario, modified management areas have been adopted to guide resource management in and around sensitive areas (OMNR 1997a, b; OMNR 1999). With prudent planning, it should be possible to allow for resource development without long-term, adverse effects on critical species and ecosystems. Site selection software, such as SITES/MARXAN and C-PLAN, may help map trade-offs between conservation and economic goals, and provide a useful means to avoid conflicts at the outset (e.g., Gonzales *et al*. 2004).

It will also be important to understand local economies and values with respect to resource development in order to gain support for potential protected areas (Hiedanpää 2002). Ultimately, protected areas managers will need to cooperate with resource managers operating outside of protected areas boundaries, as certain types of resource development activities may have greater effects on the ecological integrity of protected areas than other activities. Careful planning of monitoring programs at the outset of resource development can assist in identifying both the impacts of these activities as well as appropriate mitigation. For example, in a study of reforestation patterns in the boreal forest of Saskatchewan, Fitzsimmons (2003) showed that different patterns of cutting, and especially reforestation, can have dramatically different effects on the degree of forest fragmentation. Patterns of harvest and reforestation suggest that efforts be focused on maintaining or enlarging large uncut patches as the most efficient way to reduce habitat fragmentation (Fitzsimmons 2003).

Other strategies for addressing resource development include using a multi-stakeholder approach[25]. This has been successfully carried out in the Muskwa-Kechika area of northern British Columbia (Madill 2003). There, land-use planning also includes stipulations to the resource sector concerning regulations on development and rehabilitation following resource development activities.

[23] Note that the Yukon PAS has been suspended.

[24] "Buffers" could include zones of no development, as the concept was originally envisioned. However, for large northern protected areas a "buffer" might more appropriately be delineated though land-use planning, which could identify zones of importance around protected areas and restrict or regulate certain types of activities in these areas.

[25] A multi-stakeholder approach involves consultation with stakeholders as well as Aboriginal governments on land-use issues. Stakeholders can include local communities, ENGOs, industry and government agencies.

In preparation for the proposed Mackenzie Valley Pipeline, governments, First Nations and conservation organizations are undertaking ecosystem inventories and mapping in support of conservation area design.

For example, logging companies may face restrictions on the types and the extent of roads that they can build, or oil/gas companies may have to use low-impact technologies such as heli- or directional drilling to minimize their ecological footprint (Madill 2003). Elsewhere, strategies may focus on the timing of activities, such as restricting resource development activities during caribou calving, but allowing activities when caribou are on their winter range (Gunn 2003).

2.4.4 Climate Change

Climate change will have unpredictable impacts on northern ecosystems, and of all northern conservation issues, climate change has captured the most attention in the popular media. While scientists generally agree that climate change is occurring, the exact nature of what will happen remains under debate. Already, species in the North are showing variable responses to climate change; for example, the Porcupine caribou herd experienced a decline in tandem with the a shift to the warm phase of the Arctic Oscillation in the 1990s, while other herds did not decline, or even increased (Galley 2004). Most scientists agree however, that northern ecosystems will be dramatically affected (Hassol 2005). Generally, it is predicted that warming effects will result in northward biome shifts. Several studies have attempted to model the extent of biome shifts (e.g., Halpin 1997; Scott *et al*. 2002; Suffling and Scott 2002; Burns *et al*. 2003), but there is still a great deal of uncertainty in terms of how vegetation patterns will respond to climate change. As well, climate change is expected to increase the magnitude and frequency of extreme events, such as droughts and fires.

While national- and international-level strategies, such as the *Kyoto Protocol* are one avenue for addressing climate warming, conservation planners need to consider how protected areas can be designed for a changing climate. One strategy might be to have protected areas oriented to each other along a south to north gradient to capture species as they shift northwards (Halpin 1997). Very large protected areas with some altitudinal diversity may allow some of their current species to persist under future climate scenarios (Halpin 1997). However, these strategies have not been tested, and no matter what action is taken, some species are likely to be extirpated from current protected areas due to biome shifts. Other species, such as polar bear (*Ursus maritimus*), which depends on ice floes for hunting, may disappear. Long-term, careful monitoring of protected areas is the only way through which an in-depth understanding of the impacts of climate change as they emerge will be gained, and thus benchmark areas will be a critical component of the northern landscape. The *International Tundra Experiment* (ITEX) is an example of a long-term monitoring project aimed at understanding the effects of climate change on plant physiology (Northwest Territories Biodiversity Team 2004).

Designing protected areas in anticipation of climate change is an important precautionary measure. Protected areas policies will also have to change to adapt to new biological systems that may result from climate change (Scott 2003). For example, biomes will not shift uniformly and planning protected areas based on representation, particularly those focused on biotic ecosystem components, may well be like trying to hit a moving target. Policy and research will have to adapt as more knowledge is gained.

2.5 Conclusions

Given the expansive nature of the North, and the nomadic nature of many species, it will be necessary to manage some species (e.g., caribou) on a rangewide or ecosystem

The effects of climate change can be monitored in protected areas, and an effective representative protected areas network with sufficient environmental diversity may assist with species and ecosystem persistence.

basis that includes a network of representative protected areas. It will also be challenging to consider what occurs outside of protected area boundaries, and to try to anticipate the impacts of future resource development activities. In southern Canada, land-use planning is carried out through provincial land-use designations, or sometimes through municipal zoning regulations. In contrast, landscape management in northern Canada will likely be carried out jointly by government and Aboriginal government co-management structures, and through land-use planning boards. Experience in the Northwest Territories suggests that cooperation with First Nations and Inuit groups is an effective means to identify ecologically significant areas (Northwest Territories Biodiversity Team 2004), as many Aboriginal land claims include land-use planning processes that allow for the designation of protected or special management areas (McKenzie 2003; Wiebe and Cizek 2003). Once areas are established, cooperative management between the responsible government agency and local Aboriginal communities can have mutual benefits for research and management, and can provide a vehicle for combining TEK with scientific knowledge (Gertsch *et al*. 2003). Thus, land-use plans and land-use planning boards are critical components of protected areas planning in the North.

Our literature review suggests a number of general design criteria for northern protected areas. Because protected areas research has not focused on northern biomes, further research is necessary to develop more specific guidelines. Design guidelines for representative networks of northern protected areas that have a high degree of ecological integrity, and suggestions for further research activities are summarized in Table 4. An overview and further practical suggestions for network design, together with three case examples are described in Section 5.

Table 4 *Guidelines for design attributes for northern protected areas, with rationale and data and research needs identified for each.*

Design Attribute	Minimum Recommendation	Rationale	Data and Research Needs
Size	> 3000 km^2	Figures are based on minimum reserve area estimates for mammals in southern Canada; this area may also be large enough to allow fires to occur naturally.	Species-specific demographic data to refine estimates of minimum critical area (MCA). Data on forest dynamics for boreal regions to refine estimates of the minimum dynamic area (MDA).
Replication	At least one large protected area per ecozone or ecoregion, with additional smaller ones to capture fine-resolution features of interest.	A single, strategically placed, protected area may capture the majority of mammalian diversity in an ecologically defined region.	Research on species distributions and occurrences to identify the locations of sites to efficiently represent species in the region. Site-selection algorithms and fine-scale data on unique species, habitat types, geological features etc. to identify additional sites.
Physical attributes	A range of habitat and micro-habitat types, e.g., locating some protected areas along latitudinal or altitudinal gradients.	Protecting a range of habitat types increases the probability of conserving a high proportion of a region's biodiversity. Locating protected areas along latitudinal or altitudinal gradients may mitigate the effects of climate change.	Detailed habitat and topographic data to identify key areas. Research on climate models to help predict the effects of climate change on habitats and species.
Aquatic habitats	A range of aquatic features (i.e., lakes, rivers, streams, marshes, bogs, etc.). Lakes should include bodies of varying depth, orientation and size.	Protecting a range of aquatic habitats will ensure a diversity of aquatic biodiversity is maintained. Further, terrestrial species that depend in part on aquatic habitats for some part of their life cycle will have a better chance of persistence.	Fine-resolution map or infrared satellite imagery to identify aquatic systems, coupled with ground-truthing to quantify attributes such as depth, pH, salinity, etc.
Priority species	A range of taxa to include all trophic levels and to include species that occupy a range of habitat types. Threatened and endangered species to be included whenever possible.	Protecting a range of different taxa and trophic levels for which distribution and detailed habitat data are known increases the probability of protecting species for which data are unavailable.	Detailed abundance and distribution data for as many species as possible, or where this is not available, reliable predictive habitat models from other regions that can be extrapolated to the North.

Table 4 *continued*

Design Attribute	Minimum Recommendation	Rationale	Data and Research Needs
Boundary geometry	Follow natural boundaries (e.g., watersheds, heights-of-land), or as round as possible.	Following natural boundaries reduces the possibility that critical parts of a species habitat will be left outside of the protected area and attempts to incorporate physical processes within the boundaries. A round shape minimizes the edge-to-interior ratio (although this is less of an issue for most large protected areas).	Detailed topographic data (e.g., digital elevation model maps) to assist in boundary delineation.
Inter-reserve distance	Small enough that wide-ranging species (e.g., birds, caribou) can travel between them as required	Allowing wide-ranging species to travel between protected areas can mitigate reproductive and genetic isolation within protected areas. Appropriate distances can maintain connectivity between seasonal habitats.	Data on species demographics and movement patterns to help to identify specific inter-reserve distances.
Surrounding land-uses	Compatible with the principles of 'ecological integrity'.	Buffer zones from 10-50 km are effective to 'soften' the boundaries around protected areas. In the North, the "reverse matrix" model (Schmiegelow *et al*. in review) may be more appropriate.	Continued monitoring of species and habitats within protected areas to help to identify the impacts of surrounding land-uses on the ecological integrity of protected areas. Requirement for long-term ecological monitoring sites.
Allowable activities	A variety of activities (including subsistence harvest of animals and plants), so long as populations and the ecological integrity of the protected areas are not compromised.	Certain types of activities are not anticipated to have an adverse effect on the ecological integrity of a protected area; the nature of the activities is dependent on the site and values in questions.	Assessing the impacts of various types of activities and continued monitoring of the effects of allowable activities to ensure that ecological integrity is maintained.
Zoning	No adverse affects on the ecological integrity of the protected area; ideally infrastructure (if any) to be minimal, planned for one small, high-density area, rather than many low-density areas throughout the protected area.	Certain types of infrastructure will not have an adverse effect on the ecological integrity of a protected area; the nature of the activities is dependent on the site and species/values in question.	The impacts of various types of infrastructure and continued monitoring of the effects of allowable activities to ensure that the ecological integrity of protected areas is maintained.

3. Current Status of Northern Protected Areas

Appendix A describes current (as of May 2005) protected areas in northern Canada under federal, provincial and territorial jurisdiction. For a more detailed analysis of legislation, policy and guidelines governing these areas, interested readers are encouraged to consult the appropriate references. Because protected areas across Canada are continually being established, and because the development of policy and law is a dynamic process, the most up-to-date information on protected areas is obtained via the websites for the relevant agencies listed (following the references) at the end of this report. The list of existing protected areas represents the best available data collected from the Canadian Conservation Areas Database (CCAD), a range of published documents, maps and web-based sources, and through contact with directors of protected areas agencies across the country. A national initiative, the Conservation Areas Reporting and Tracking System (CARTS), being developed by CCEA with federal, provincial and territorial jurisdictions and other partners, is underway to consolidate data on existing protected areas, and to provide a mechanism for agencies to conduct periodic (e.g., annual or semi-annual) self-reporting and updating of the database. The effort to compile data on protected areas for this project illustrated the fragmented and inconsistent nature of protected areas data across the country. Efforts to consolidate, standardize and update protected areas data under the CARTS initiative will be beneficial to future research. In addition, the inclusion of data on biodiversity and stewardship metrics[26] will add value to the CARTS project.

[26] Such as current management status, species-at-risk, details on monitoring programs, etc.

The Conservation Areas Reporting and Tracking System (CARTS) will facilitate national understanding across jurisdictional lines, from the rugged Torngat Mountains Special Management Area (provisional national park) on the Labrador Peninsula (above) to Ivvavik National Park and Herschel Island Territorial Park in Canada's Northwest.

Northern Protected Areas Facts

- There are 774 protected areas in the (NPA) study area, covering a total of 997 776 km^2.
- The average size of northern protected areas is 1341 km^2.
- The largest northern national park is Wood Buffalo (44 802 km^2).
- The largest northern protected area is Queen Maud Gulf Migratory Bird Sanctuary (62 782 km^2).

The term 'protected area' is generically used to refer to land and/or water that has been designated for some form of ecological protection. However, the type of protected area, and the degree of protection afforded can vary.

There are currently several types of protected areas in northern Canada; they are described in more detail below. These have been designated by different governments[27], and by different agencies within the same government. Historically, there has been some coordination among the various agencies responsible for protected areas. This is increasing, with recent workshops and conferences, (e.g., CCEA, Science and Management of Protected Areas Association (SAMPAA)), bringing together landscape and wildlife managers to discuss common goals and priorities for northern ecosystems within Canada. In a similar vein, the Federal Panel on the Ecological Integrity of Canada's National Parks identified a need for more coordination both within Parks Canada, and between Parks Canada and appropriate federal, territorial and provincial government agencies (Parks Canada Agency 2000).

In North America, protected area size increases with latitude (Rivard *et al*. 2000; Andelman and Willig 2003) — that is, most large protected areas are at high latitudes. Our literature review suggests that large protected areas are an appropriate conservation strategy for northern Canada. Across the NPA study area (Figure 1), there are 774 protected areas greater than 10 km^2, covering a total area of 997 776 km^2. These figures do not include Heritage Rivers, Biosphere Reserves, World Heritage Sites, Ramsar Sites, proposed protected areas, or existing or proposed marine protected areas. Figure 4 summarizes the protected areas by jurisdiction and IUCN code. Figure 5 charts the history of protected areas establishment; note that the number of protected areas is increasing under several protected areas strategies currently underway. However, more protected areas does not necessarily equal better-protected areas; hence the need for careful planning and sound management. The summary of the NPA survey (section 4.2) gives a more detailed overview of the state of protected areas with respect to ecological threats, management issues, and plans for expanding existing systems of protected areas.

[27] Currently federal, provincial and territorial.

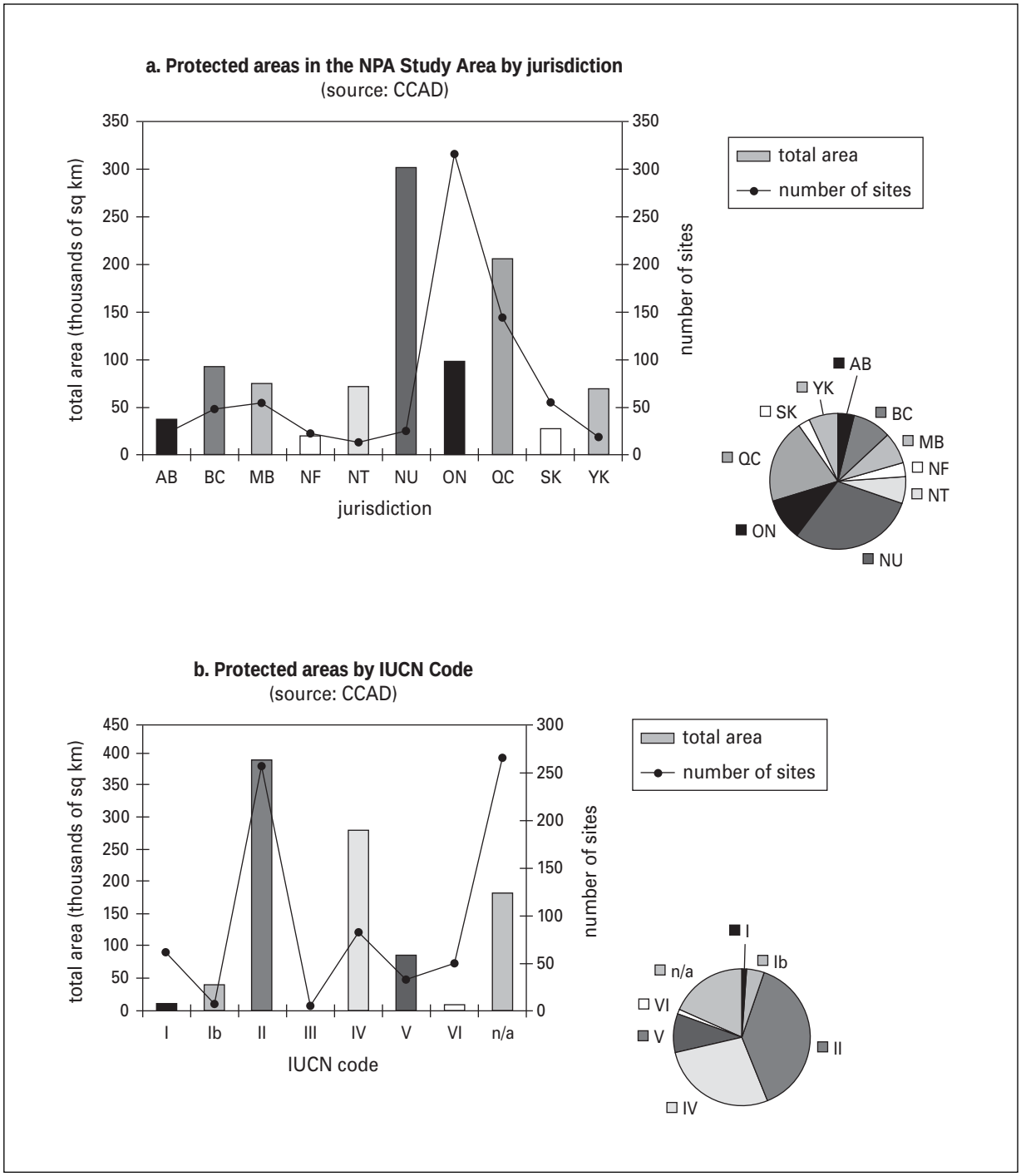


Figure 4 *Main panel: The number and total area of all protected areas (> 10 km²) in the study area within each Canadian province or territory. Data presented here corresponds to that listed in Appendix A. Insert panel: The percentage of land area protected in the study area within each province or territory in Canada.* ***b.*** *Main panel: The number and total area of all protected areas (> 10 km²) by IUCN class in the study area. Insert panel: The percentage of land area protected in the study area by IUCN class in Canada. (Source: Canadian Conservation Areas Database (CCAD)). IUCN categories are described in Appendix B.*

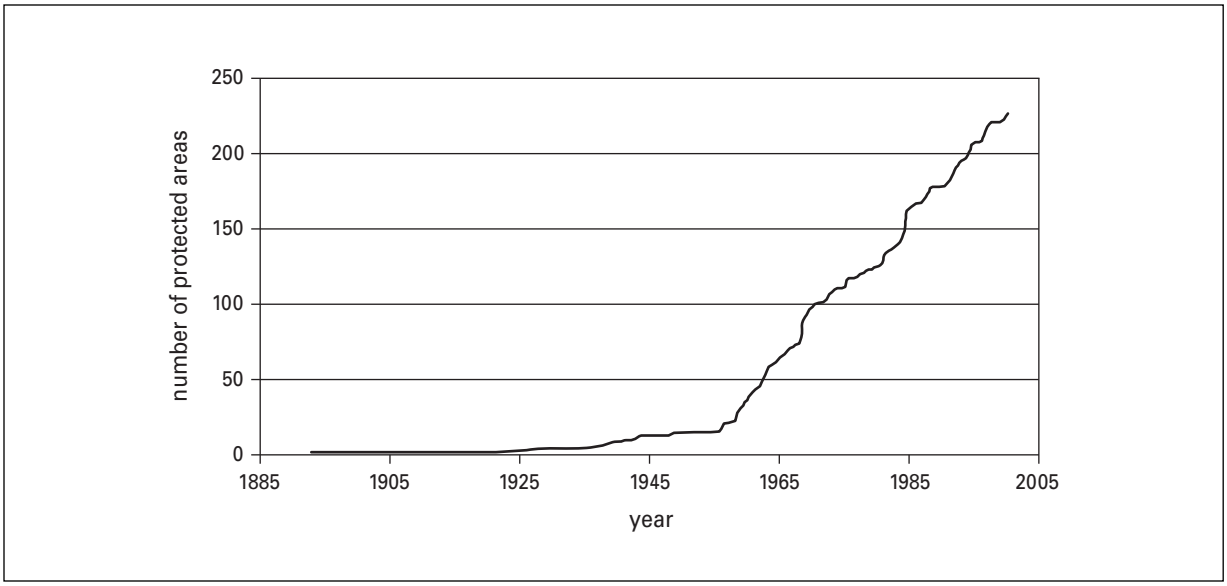


Figure 5 *Growth in number of northern protected areas over time. (Source: Canadian Conservation Areas Database (CCAD). Note that date of establishment was not available for all sites).*

Analyses of the state of ecological integrity in existing northern national parks suggest that they are functioning better than southern protected areas, but they still face threats (Canadian Heritage 1998). Unlike the situation for southern protected areas, Gurd and Nudds (1999) did not detect any mammal extirpations from northern national and provincial parks. However, of the 774 protected areas in the study area, only 66 (8.5%) exceeded the MRA of 3000 km^2 suggested as a minimum size threshold by our review of the literature. However, a disproportionate number of protected areas, most of these relatively small, are located in the Boreal Shield and Boreal Plains ecozones (Figure 3). The current configuration of large protected areas in the North leaves many ecoregions, the target unit for representation advocated by the CCEA ecological framework (Peterson and Peterson 1991; Gauthier 1992; Gauthier *et al*. 1995), unrepresented by large protected areas. The majority of protected areas in the NPA study area appear to be too small to maintain their ecological integrity over the long-term, even if some of them are relatively intact at present (possibly due to the fact that they are largely located within a habitat matrix that is currently intact, but this may change in the future).

"Globally, most protected areas occur in steep, infertile, inaccessible or economically unproductive areas. The challenge is to establish protected areas where they need to be rather in those areas that no one wants."

Geoff Lipsett-Moore,
CCEA Yellowknife Proceedings (2003)

However, these smaller protected areas, as well as sites less than 10 km^2, may still serve important roles as linkages between protected areas and may represent fine-scale features and species with limited home ranges.

It is not possible to determine how well the 774 protected areas are representing and maintaining northern species and ecosystems, since detailed comprehensive surveys of flora and fauna have not been conducted, or are unavailable for many of these sites. Eleven of the 39 "natural regions" identified by Parks Canada that overlap with the NPA study area currently do not have a national park, although five of these have candidate parks at various proposal stages. An analysis of representation requirements for mammals in Yukon (Wiersma and Urban 2005) suggested that 10 of the 19 ecoregions required two strategically located protected areas to capture all of the mammals; the remaining nine ecoregions could represent all mammals with just one protected area. However, representation requirements are affected by scale; the same study showed that, if the territory as a whole were the target for representation, all the mammals in the territory could be captured with four

strategically placed protected areas (Wiersma and Urban 2005). In addition to consideration of other measures, assessments of representation will have to carefully consider issues of species targets and scale.

3.1 Federal Protected Areas

National Parks

The first national park 'North of 60°' was established in 1922, with the creation of Wood Buffalo National Park. Most national parks in Yukon, Northwest Territories and what is now Nunavut were established in the 1970s or later, and they were often viewed as the federal government imposing its own preservation agenda on northern residents (Seale 1998). A system plan for Canada's national parks was developed in 1971 (Parks Canada 1997) and called for the establishment of one protected area in each of the 39 "natural regions" identified by Parks Canada (Lopoukhine 1998). Currently, most national parks are established through centralized planning efforts coordinated with regional field units. Public input occurs as part of the process, but generally not until reconnaissance inventory work has been completed and an initial boundary proposal has been developed. Once a national park is established, only an Act of Parliament can remove land from within its boundaries. The *Canada National Parks Act* stipulates activities that may or may not be permitted, and makes the maintenance of ecological integrity the primary goal (Government of Canada 2000). Mining and forestry activities are not allowed in any of the national parks, and with the exception of subsistence activities by local Aboriginal people, hunting and gathering is banned. Sport fishing is allowed in many parks, but is regulated.

Currently there are three national parks in Yukon; four in Northwest Territories, with one in the proposal stage; and four in Nunavut, with three more plus the expansion of one (Tuktut Nogait) proposed (see Appendix A). The largest national parks in the boreal zone of the provinces include Wood Buffalo in Alberta and the Northwest Territories (44 802 km^2), Prince Albert National Park in Saskatchewan (3874 km^2), Gros Morne National Park in Newfoundland (1805 km^2), Wapusk National Park (11 475 km^2) in Manitoba, and Pukaskwa National Park in Ontario (1878 km^2). There are no national marine protected areas in the study area, although one is in the later proposal stages for the north shore of Lake Superior.

Migratory Bird Sanctuaries

Migratory bird sanctuaries have been established under the *Migratory Bird Convention Act* to protect migratory birds and nests. The first migratory bird sanctuary, Hannah Bay, was established in 1939 in what is now Nunavut. Under the *Migratory Bird Sanctuary Regulations* all hunting and collection of migratory birds or eggs is prohibited, as is the disturbance of nests and habitat. However, regulations only apply when birds are present (Dearden 2001). There are four migratory bird sanctuaries in Northwest Territories, one in Alberta, nine in Nunavut, and one that is shared between Ontario and Nunavut (Appendix A).

National Wildlife Areas

These are established under the *Canadian Wildlife Act* (1973) and managed by the Canadian Wildlife Service. National wildlife areas are created through an Order-in-Council, or through agreements with provinces and territories to protect wildlife and habitat for conservation, research and/or interpretation. There are four national wildlife areas in Nunavut, and one in Yukon. Areas are managed to maintain natural conditions, although management strategies to improve habitat for wildlife are allowed. Most national wildlife areas allow for hunting, fishing, birdwatching, hiking, photography and canoeing, unless the habitat is particularly fragile. An assessment of the state of federal protected areas for wildlife covering both national wildlife areas and migratory bird sanctuaries has been completed (Turner & Associates 2002).

3.2 Provincial and Territorial Protected Areas

Yukon

The first territorial park in Yukon (Herschel Island (Qikiqtaruk) Territorial Park) was established in 1984 as part of the *Inuvialuit Final Agreement*. Currently there are four territorial parks in Yukon. Territorial parks are established under the *Parks and Land Certainty Act*, which also mandated the recent *Yukon Protected Areas Strategy*. The act outlines four types of territorial parks: Recreation, Wilderness, Natural Environment and

Ecological Reserves. The *Yukon Parks and Certainty Act* allows for development within territorial parks, but only within specified zones when deemed necessary for the economic interest of the territory. The Executive Council can establish parks and apply zoning without bringing these to the Legislative Assembly. Public consultation is limited to the establishment of parks, and then only at the discretion of the Minister (Henderson 1994).

Under the *Umbrella Final Agreement* with the First Nations of Yukon, protected areas established on the traditional territories of First Nations are referred to as "Special Management Areas". These can be further designated as Habitat Protection Areas, Wildlife Management Areas, National Parks or Territorial Parks. Currently there are two Special Management Areas in Yukon (Old Crow Flats and Ta'Tla Mun); others that were initially designated as Special Management Areas have now been, or are in the process of being, designated as Habitat Protection Areas. Habitat Protection Areas are established under the *Yukon Wildlife Act* (Henderson 1994), which largely exists to govern hunting activities. A 1992 amendment to the act prohibited development within Habitat Protection Areas unless otherwise authorized (Henderson 1994). Currently there are five Habitat Protection Areas in Yukon. Wildlife Management Areas, of which there is one in Yukon, are governed under the *Yukon Environment Act*, which exists to maintain ecological processes and preserve biodiversity. The *Yukon Environment Act* also calls for a high degree of public participation in developing regulations for these areas (Henderson 1994).

The Yukon government developed a comprehensive *Protected Areas Strategy* (YPAS 1998) that was well regarded by both academics and practitioners. YPAS stipulated that much of the planning for protected areas was to come through community involvement. However, the process became increasingly perceived as a top-down, government-driven one, and public support waned. The government that took over after the 2002 territorial election shelved the entire initiative.

Northwest Territories

Northwest Territories established its first territorial parks in the 1960s, but these were more focused on promoting tourism and economic objectives than protection of ecological values (Seale 1998). Most territorial parks in Northwest Territories continue to be small wayside parks along the highways that have minimal ecological value, and thus are not further discussed in this report. Along with the newly created Department of Environment and Natural Resources, recent amendments to the *Territorial Parks Act* however provide for two new territorial legislative options — Wilderness Conservation Areas and Cultural Conservation Areas; these are able to embody the two goals of the *Northwest Territories Protected Areas Strategy* (NWT-PAS), but have not yet been used.

Through the NWT-PAS (Northwest Territories Protected Areas Strategy Advisory Committee 1999), candidate protected areas receive 5-year interim protected area designation while ecological and resource assessments take place. After this time, candidate areas can be formally protected under various government agency legislation, including, but not limited to national parks, territorial parks, national wildlife areas and migratory bird sanctuaries. The NWT-PAS process is largely community-driven; communities identify sites that are ecologically or culturally important. Government scientists provide expertise and a regional context when necessary. To date Northwest Territories has eight sites at various stages of the NWT-PAS process, which together encompass 96 193 km^2 (P. deJong, pers. comm.).

Nunavut

A relatively new (1998) jurisdiction, Nunavut currently has only one territorial park that meets the 10 km^2 size criterion. There are however, examples of smaller parks centred on historically and culturally important areas. Consultation with communities with respect to parks and conservation areas is emphasized in Articles 8 and 9 of the *Nunavut Land Claims Agreement*. Currently, the Government of Nunavut is developing a Nunavut Parks Program that will identify the roles and values of protected areas through broad consultation. The goal is to develop a Parks and Conservation Areas System Plan following broad consultation under the Nunavut Parks Program.

British Columbia

British Columbia has the second largest parks network in Canada after the national parks system. The Ministry of Environment, Environmental Stewardship Division,

The move to establish Ecological Reserves in Canada was initiated by British Columbia, where separate legislation proclaimed in 1971 has led to the creation of over 150 Ecological Reserves, such as Gladys Lake, above.

governs the BC Parks and Protected Areas legislation. There are three classes of provincial parks (A, B and C). Class A parks are regulated under the *Park Act* or the *Protected Areas of BC Act* and constrain issuing of park use permits "*unless, in the opinion of the minister, to do so is necessary to preserve or maintain the recreational values of the park involved*." Conversely, Class B parks permit a wider range of activities. Class C parks are crown lands managed by a local board. Ecological reserves are established to preserve representative and natural ecosystems and species, and as such, have the highest level of protection and the least amount of human use. Their main use is for scientific research and education. They are governed under the *Ecological Reserve Act*. Within the northern portion of British Colunbia that overlaps with the NPA study area, there are four ecological reserves, 31 provincial parks (of which two are designated wilderness provincial parks) and one wilderness park (Tatshenshini-Alsek).

An interesting land-use planning initiative has been underway in northern British Columbia, which may serve as a useful model for integrated land management in other northern jurisdictions. The *Muskwa-Kechika Management Area* (M-KMA) came out of regional land-use planning that involved local communities and governments. M-KMA is governed under a *Management Act* and a set of management plan regulations. The plan calls for zoning that attempts to meet the needs for protection of wildlife, along with regulating forestry, oil and gas development, and recreation. Community consultation and involvement of all interest groups are key components of the M-KMA model (Madill 2003). See Section 5.4 for a more detailed overview of M-KMA.

Alberta

Provincial parks in Alberta are governed under the Department of Community Development. This department also oversees Ecological Reserves and Natural Areas. Alberta Community Development develops policies for protected areas under the *Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act*. The Department of Sustainable Resource Development, through the *Public Lands Act*, govern land management activities. One site, the Willmore Wilderness Area, has its own piece of legislation, the *Willmore Wilderness Park Act*. Provincial parks, of which there are 12 in the NPA study area, are designed to protect natural and historical features and to provide opportunities for visitor enjoyment and education. Ecological reserves, of which there are four in the study area, are designated to protect functioning ecosystems for scientific research and heritage appreciation. Roads, development, and other facilities are not permitted within ecological reserves. There are four natural areas in the NPA study area; these protect locally and regionally significant landscapes; limited facilities here allow for education and low intensity recreation.

Saskatchewan

Protected areas in Saskatchewan are the mandate of the Department of Environment. Currently there are three provincial parks and two game preserves in the NPA study area. Saskatchewan is in the process of developing a Representative Areas Network (RAN) and has identified 24 RAN sites (see Appendix A). This process is being conducted through collaboration with provincial experts and local communities, First Nations and industry. The goal is that each of the province's 11 ecoregions will have one very large (> 100 000 ha) and several small protected areas. The RAN process of selecting sites is nearly complete, and the process of designating the lands and developing management plans is underway (www.se.gov.sk.ca/ecosystem/sran). When complete, RAN will double the amount of land protected in Saskatchewan.

Ecological functions governing meandering riparian systems need to be well understood in designing protected areas to conserve such ecosystems, Lac La Ronge Provincial Park, Saskatchewan.

*The creation of Wood Buffalo National Park in 1922, to assist with the recovery of wood bison (*Bison bison athabascae*), demonstrated early on the important role that large protected areas can provide for the conservation of area-demanding species, Chitek Lake Park Reserve, Manitoba.*

Saskatchewan also has nine community pastures within the study area. These are governed by the Department of Agriculture and are public lands that allow for the grazing of cattle and sheep under a set of regulations and for a prescribed fee. Government, in cooperation with users and local land managers, manages the land to be sustainable over the long-term.

Manitoba

Manitoba Conservation oversees two ecological reserves, 11 provincial parks, and 30 wildlife management areas within the NPA study area. The government undertook its protected areas initiative (PAI) in 1990, which to date has increased the amount of protected lands in the province from 350 000 ha to just over 5.4 million ha. PAI was based on an 'enduring features' approach, and the size of protected areas was based on making them ecologically sustainable for the features that they were selected to represent. A 'coarse-filter' approach was used to identify sites of interest, and a 'fine-filter' approach was used in final delineation of boundaries. However, this approach was not always strictly applied, as in some cases boundaries were delineated by adjacent land-uses and associated practical considerations (H. Hernandez, pers. comm.).

Manitoba wildlife management areas (WMAs) are crown lands managed by the Wildlife and Ecosystem Protected Branch, primarily for wildlife conservation and recreation. WMAs are generally areas with little resource potential for hydro-electric development, logging or mining. Hunting and trapping is permitted, and big game harvests are closely monitored for sustainability. The Wildlife and Ecosystem Protection Branch played a supporting role in PAI, by identifying candidate wildlife management areas that could be included in PAI. These were fully or partially protected under the *Wildlife Act*, using the *Use of Wildlife Lands Regulations*. These sites are protected to the same standards as sites under the PAI and are identified in Appendix A. Similarly, hydro-electric exploration and development, mineral exploration or extraction, and logging activities are prohibited in these sites. Similar to WMAs, hunting and trapping may be allowed in provincial parks.

Ontario

Ontario has a very large system of provincial parks, and conservation reserves, which is managed by Ontario Parks and the Ministry of Natural Resources. Ontario is in the process of drafting new legislation governing

parks; the current *Provincial Parks Act* dates back to the 1950s. The province recently completed a significant expansion of the system under the *Ontario's Living Legacy* (OLL) program. The area of the province north of the 51st parallel was not included in this program, but protected areas planning for this region is committed under the *Northern Boreal Initiative*. The OLL program solicited input from the public and interest groups through a variety of roundtables; however, delineation of boundaries came via a top-down approach. Given the large First Nations presence in northern Ontario, ENGOs are currently lobbying the government to have a more community-driven approach applied to protected areas planning under the *Room to Grow* program.

Provincial parks are categorized into six classes. Three of these offer the best opportunities for conserving ecological integrity: Wilderness Parks, which are designed to let natural systems function freely, and allow non-motorized access only; Nature Reserves, which represent distinct natural habitats and landforms in the province, and are protected for research and education; and Natural Environment Parks, which incorporate outstanding recreational landscapes with representative natural and historical features. The three other classes of parks, Waterway Parks, Historical Parks and Recreational Parks have goals other than ecological integrity as their first priority, although Waterway Parks represent and protect many highly significant rivers and riparian corridors and connect many other parks.

Conservation reserves were introduced in the 1990s, under the *Public Lands Act*, to represent and protect landscape segments and features that complement provincial parks. Protection policies for conservation reserves are less restrictive than those for provincial parks, but do prohibit logging, mining and hydro-electric development (Beechey *et al*. 1998; OMNR 1999; OLL 2002). Currently, more than 300 provincial parks and conservation reserves in northern Ontario meet the minimum size of 10 km^2 adopted by this study.

Québec

Provincial parks (called "national parks" in Québec) are managed by the Ministère des Ressources naturelles, de la Faune et des Parcs. Currently there are 12 provincial parks, six ecological reserves, 21 wildlife sanctuaries and one conservation park in the NPA study area. The

Intricate mosaics of terrestrial and aquatic habitats, common to many northern landscapes, provide ecological diversity that can only be captured in substantial protected areas. Natashquan-Aguanus-Kenamu park project, north shore St. Lawrence Gulf, Quebec.

government strives to manage parks under the same standards set for national parks around the world. The parks operate under a dual mandate of protection and recreation. The Parks Québec mission is to permanently protect and develop representative protected areas for each of the province's 43 natural regions. Recently, the provincial government arranged a cooperative venture with the Makivik Corporation and the Kativik regional government in Nunavik (northern Québec) to establish three provincial parks north of the 52nd parallel.

Newfoundland and Labrador

There are five provincial parks, two wilderness reserves, five ecological reserves, and two wildlife reserves in Newfoundland and Labrador. As well Torngat Mountains Special Management Area is currently protected under the *Lands Act*, and is expected to become a national park in the near future. The two wilderness reserves are extensive natural areas that are set aside primarily for research and outdoor recreation. Permits are required to visit the wilderness reserves. Both are governed under the *Wilderness and Ecological Reserves Act*, which prohibits logging, mining, buildings, roads, motorized access, fishing, hunting and trapping. Fishing is permitted in the province's provincial parks, but hunting is not.

3.3 Other Designations Applicable to the Canadian North

World Heritage Sites

World Heritage Sites (WHS) are recognized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) to identify and promote the protection of areas of significant physical, biological or geological formations, or areas that are habitats for threatened species of animals and plants, as well as areas with scientific, conservation or aesthetic value. WHS designation does not automatically confer legal standing; the responsibility for protecting these sites lies with the national governments. UNESCO can provide financial and technical assistance for conservation and management of WHS. In Canada's North, four national parks (Nahanni and Wood Buffalo in the Northwest Territories, Kluane in Yukon, and Gros Morne in Newfoundland and Labrador) have been designated as World Heritage Sites. The Kluane/Wrangell-St.Elias/Glacier Bay/Tatshenshini-Alsek complex, which encompasses parts of Yukon, British Columbia and Alaska, is another WHS in the NPA study area.

Ramsar Sites

Ramsar sites identify internationally important wetland areas under the *Ramsar Convention*. As with World Heritage Sites, conservation and management of Ramsar-designated wetlands fall under the jurisdiction of the signing parties (national governments), and designation under Ramsar does not confer protection in and of itself. Ramsar sites in northern Canada occur within one national park (Whooping Crane Summer Range in Wood Buffalo National Park, Northwest Territories/Alberta), and within three migratory bird sanctuaries (Queen Maud Gulf, McConnell River, Dewey Soper) and one national wildlife area (Polar Bear Pass) in Nunavut. There is also one Ramsar site in Nunavut that is managed by the Department of Indian and Northern Affairs (Rasmussun Lowlands) and one in Yukon that is currently designated as a Special Management Area (Old Crow Flats Ramsar). Additional northern Ramsar sites occur in Alberta (Peace-Athabasca Delta, Hay-Zama Lakes, Beaverhill Lake), Ontario (Southern James Bay, Polar Bear Provincial Park), and Newfoundland (Grand Codroy Estuary).

Biosphere Reserves

The International Man and the Biosphere (MAB) Program was created in 1971 to provide a scientific basis for addressing human needs in harmony with nature. A major tool of MAB is the biosphere reserve — an area that is designated by UNESCO as representative of one of the world's major ecosystems (www.biosphere-canada.ca). Each biosphere reserve is intended to serve as a demonstration area for practical and innovative approaches to conservation and (ecologically) sustainable development. A reserve will contain one or more protected core areas, a buffer area, and a surrounding zone of cooperation. The UNESCO designation, however, does not create a protected area, and it does not produce any change in authority over land and water use. Major activities include research, monitoring, education, training and capacity building. Local participation is an essential element of a functioning biosphere reserve, and in Canada local residents coordinate many of its activities. These local committees also share information and experience with a worldwide network of over 450 biosphere reserves in almost 100 countries. Of the existing 13 biosphere reserves in Canada, the only one within the NPA study area occurs in Ontario (Georgian Bay Littoral Biosphere Reserve).

Heritage Rivers

Heritage Rivers are designated through cooperation between the federal, provincial and territorial governments. The Canadian Heritage Rivers System (CHRS) was established in 1984 and a Board made up of government officials and members of the public administers the program (www.chrs.ca). Heritage Rivers carry no special protection, but each must have a management plan that outlines how existing legislation, regulations, and Aboriginal treaty rights will be used to promote the natural values of the rivers in perpetuity. Yukon has four Heritage Rivers (Alsek, Tatshenshini, Bonnet Plume and the Thirty Mile portion of the Yukon), while Northwest Territories has two (Arctic Red and South Nahanni). Nunavut has one (Kazan), with another shared with Northwest Territories (Thelon). Alberta and Saskatchewan share one (Clearwater), and Manitoba has one (Seal) with a second (Bloodvein) shared with Ontario. Ontario has another four (Missinaibi, Boundary Waters, French and Mattawa), while Newfoundland and Labrador has one (Main).

The Canadian Heritage Rivers System provides for the recognition and designation of outstanding waterways in Canada, Main River Canadian Heritage River, Newfoundland and Labrador.

4. Northern Protected Areas Survey

4.1 Methods

A key part of this project included a questionnaire survey (Appendix D) aimed at collecting information from federal, provincial and territorial agencies about the use of scientific approaches and ecological knowledge in the planning and management of northern protected areas. The intent was to compare and contrast the orthodoxy in the current literature with existing practice. The survey was sent to directors of all provincial and territorial parks, wildlife and forestry agencies within the NPA study area, as well as regional directors of Parks Canada, Environment Canada, Natural Resources Canada, Fisheries and Oceans, and Indian Affairs and Northern Development. Surveys were sent to 49 parties at the end of September 2004. Follow-up included a minimum of two e-mails and one phone call to each recipient. In total 23 surveys were returned, however, three jurisdictions combined responses (e.g., provincial fish and wildlife directors collaborated with parks directors), so a total of 26 agencies were actually represented in the responses, including at least one response from each agency (Figure 6). In addition, five of the respondents indicated that they would not be completing the survey, because they did not have protected areas within the NPA study area, or they were not involved in protected areas planning.

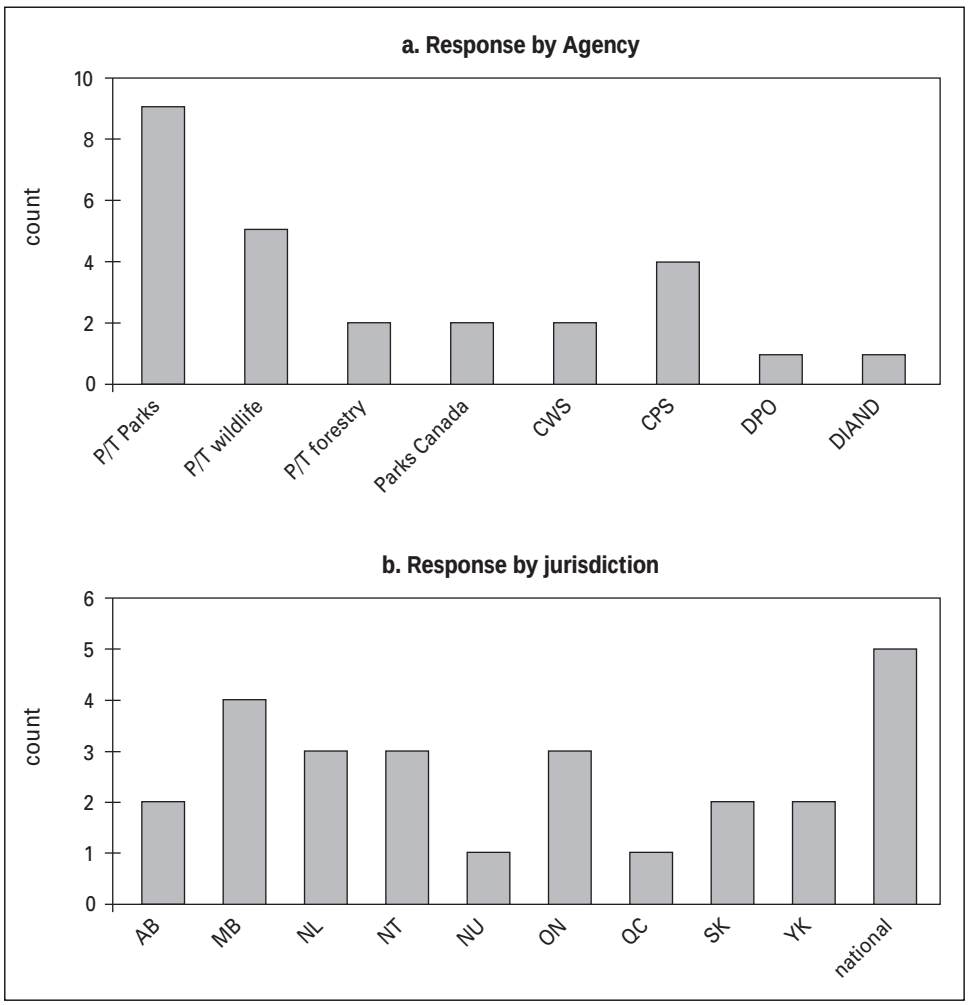


Figure 6 *Number of responses to the NPA survey questionnaire by agency (P/T: provincial/territorial; CWS: Canadian Wildlife Service, CFS: Canadian Forest Service; DFO: Department of Fisheries and Oceans; DIAND: Department of Indian Affairs and Northern Development).* **b.** *Number of responses by province/territory (AB: Alberta; MB: Manitoba; NL: Newfoundland and Labrador; NT: Northwest Territories; NU: Nunavut; ON: Ontario; QC: Québec; SK: Saskatchewan; YK: Yukon). Responses from regional offices of federal agencies (e.g., CFS-Ontario office) are quantified by region in panel b.*

4.2 Results

Results have been grouped under several headings that relate to the literature review and "current status" sections of this report (Parts 2 and 3). The numbers in italics indicate the question on the survey (included as Appendix D) to which the information refers, and numbers in parentheses indicate the number of responses.

4.2.1 Current Status and Threats

When asked about the main purpose of protected areas in their jurisdiction (Question I.1), the majority of agencies cited biodiversity protection (21). Other important purposes included education and heritage appreciation (17), terrestrial ecosystem representation (17), and scientific research (16) (Figure 7). The most common threats to protected areas (Question I.2) were identified as climate change (16), population declines (16), habitat fragmentation (13), and incompatible land-use outside of protected areas (13). Of these, incompatible land-use was ranked the highest on average, followed by habitat fragmentation, climate change, interruption of natural cycles, and population declines. One respondent identified a specific challenge: *"A lack of land-use plans to direct the allocation of resources. [We] need... First Nation engagement in resource planning and benefit sharing related to protected areas"*.

Our literature review concurred that climate change was a significant threat to northern protected areas (Scott *et al.* 2002; Suffling and Scott 2002). Moreover, Parks Canada identified several specific land-uses outside of park boundaries, such as forestry, mining, and petro-chemical production as threats to northern parks (Canadian Heritage 1998). Strategies that agencies use to enhance the ecological integrity of protected areas (Question III.15) include the establishment of buffer zones outside of protected areas (10), expansion of existing protected areas (11), modification of management practices around protected areas (10), the use of linkages and corridors (6), and monitoring and adaptive management around protected areas (11). The common threats and strategies applied across the survey responses are consistent with the notion that protected areas networks comprised of large areas are a more effective strategy for maintaining ecological integrity on the landscape than addressing these issues via standalone sites.

When asked to describe the areas in which their agency has expertise (Question I.6), most listed ecological integrity (19), protected areas design/modelling (17), and recreation planning/management (13), although a range of areas of

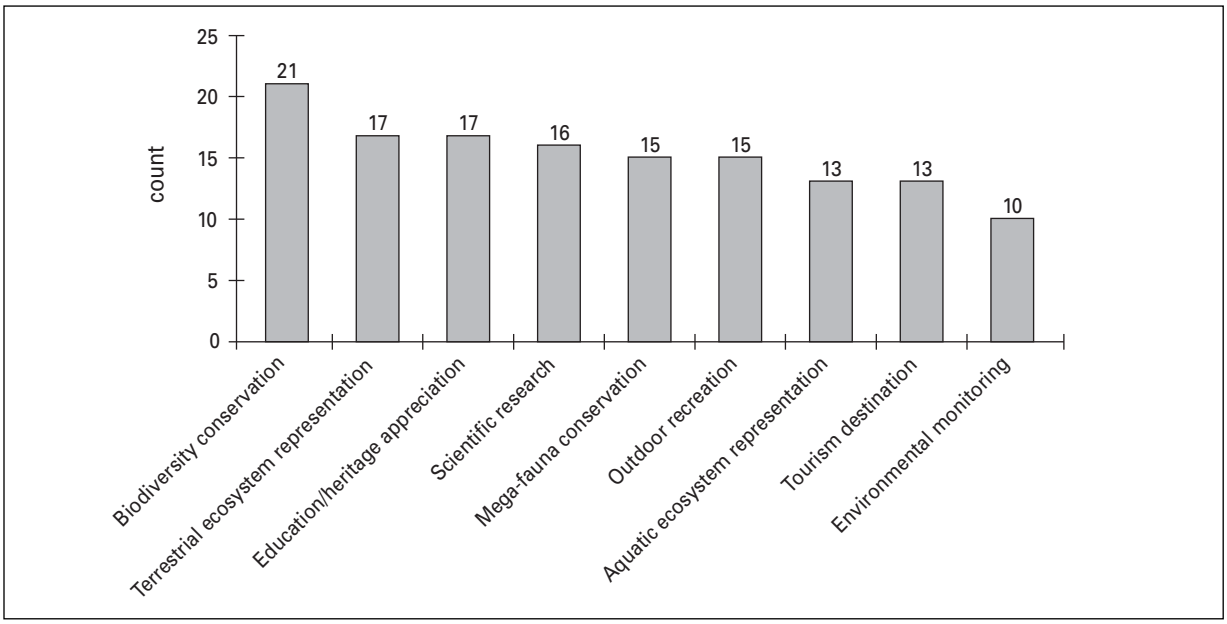


Figure 7 *Question I.1: What purpose do protected areas serve in your agency's jurisdiction?*

expertise was cited (Figure 8). In addition, agencies are involved in a range of projects related to these and other areas of expertise (Figure 9). Despite the declared areas of expertise, many significant needs identified in the literature survey do not seem to be addressed adequately. Much expertise seems to be applied to and within specific protected areas, and network modelling is scantily applied. Little activity on climate change is apparent, and improvement of ecological integrity via restoration and/or species introductions is not widely practiced. Moreover, agencies and jurisdictions often appear to be working in isolation, when synergies could be realized by more coordination and cooperation across boundaries and among jurisdictions.

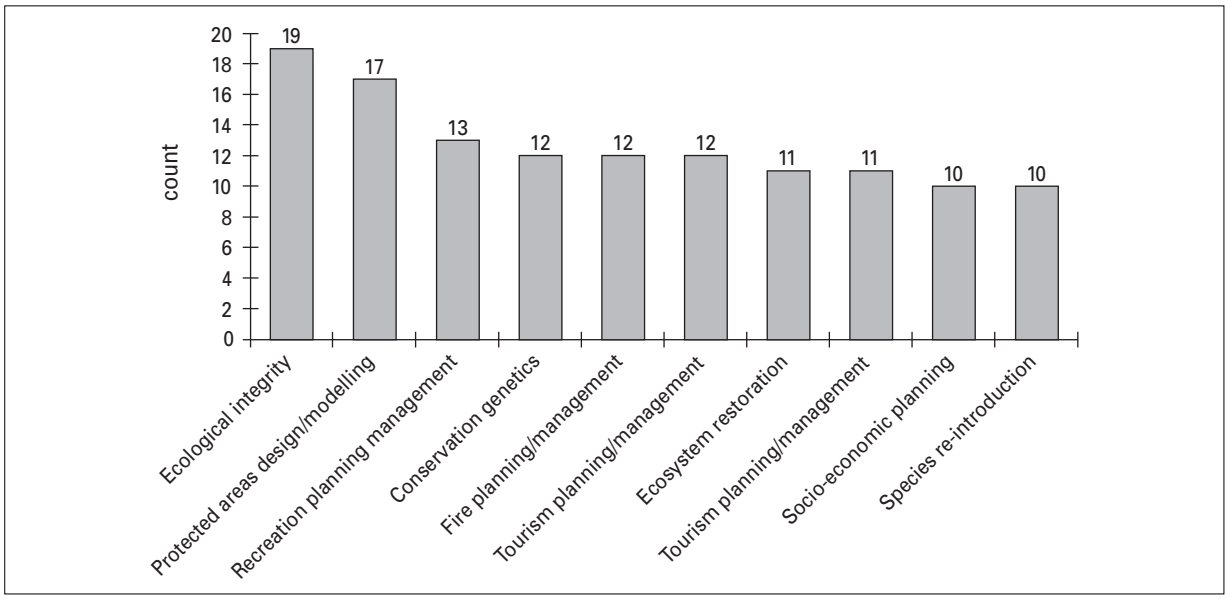


Figure 8 *Question I.6: In what areas does your agency have expertise to assist with the management of protected areas?*

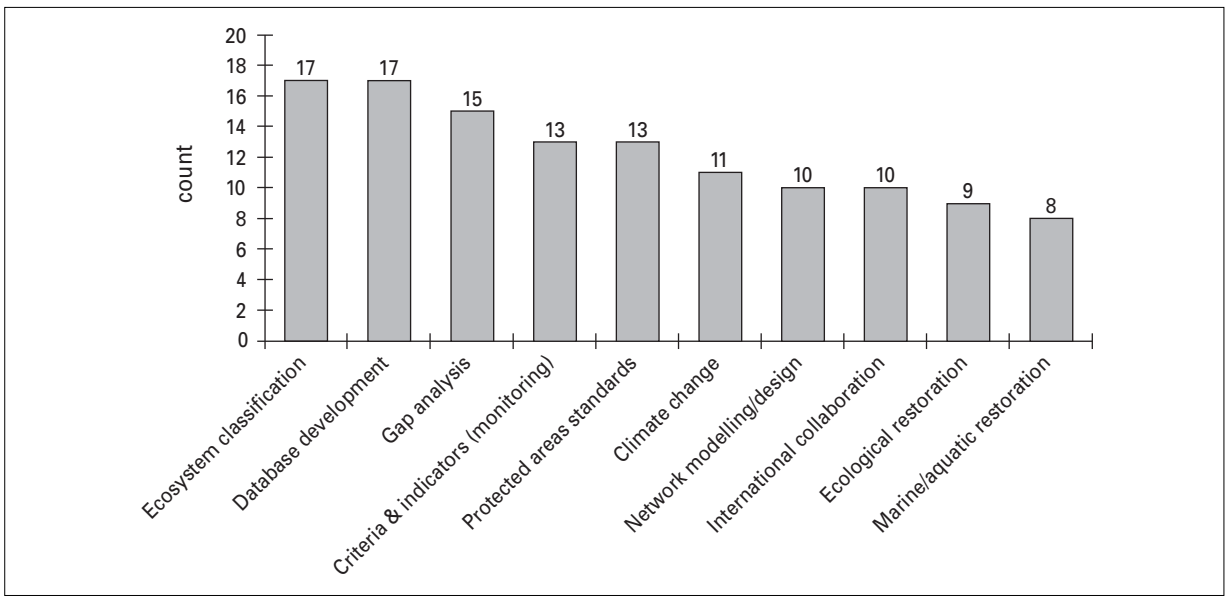


Figure 9 *Question I.7: Is your agency currently involved in any projects on protected areas dealing with these topics?*

4.2.2 Legislation and Policy

Nearly half (10) of the agencies are in the process of developing new policy and legislation for protected areas (Question I.4). The majority (14) of agencies engage in systems planning, which we defined as *"a comprehensive plan for the identification and establishment of a network of protected areas within a particular ecologically- or politically-bounded area"* (Question II.2). Consistent with the findings from our review of the literature, the survey stated that a system plan should include *"goals for minimum number/size requirements of protected areas, and strategies for identifying sites and implementing protected areas"* (Question II.2). However, only five agencies have legislation that underpins minimum requirements for the number of protected areas (Question II.3), although 11 agencies cited government policy as underpinning minimum targets for the number of areas. Most legislation is focused on natural heritage appreciation (14), while most policy is focused on ecosystem representation (14) and natural heritage appreciation (16). Clearly, stronger legislation is needed to support northern protected areas planning and management, and it appears that quite a number of agencies are in the process of drafting such legislation. Many agencies have policies that support large protected areas, and which recognize the need for different designations of protected areas to address various user groups and needs. Although quite a number of agencies have system plans in place, these are often focused on designating a collection of protected areas rather than on viable networks. Moreover, legislation generally applies only within the boundaries of a protected area and does not address adjacent or surrounding land- uses. Parks Canada's inclusion of "ecological integrity" in its legislative mandate, however, does allow for a federal minister to call for an environmental assessment on provincial/territorial land outside of park boundaries, if a proposed development has potential adverse effects on the ecological integrity of the park. However, Parks Canada is the only agency that has incorporated the concept of "ecological integrity" into its legislation while it is also part of Ontario Parks new draft legislation, which is currently before committee.

4.2.3 Knowledge-based Approaches to Protected Areas Design

Scientific information and knowledge is being applied to different aspects of protected areas design, and these are discussed in more detail below. A number of respondents indicated that scientific knowledge is only one component of protected areas planning, and that integration with community stakeholders and local knowledge is vital. One respondent stated that, *"Scientific advice is provided for community consideration"*, and another illustrated how science and TEK are being integrated: *"As a result of First Nation Final Agreements, the knowledge and experiences of aboriginal people is integrated with scientific knowledge; ... [First Nations] people have equal participation in resource management; responsibilities for resource management are developing at the community level; and the culture, identity and values of.... [First Nations] are being preserved"*. Others illustrated a desire to integrate more traditional/local knowledge into their work, *"[We] try to obtain [TEK] as part of community consultations for establishing new sites, but with some limited input to date"*. These comments illustrate the need for protected areas planning and management to embrace research from the social sciences more than has been carried out in the past. As indicated earlier, we contend that more research into the socio-economic aspects of protected areas planning and management is needed; however, it is not the focus of this report.

Requirements to meet Ecological Integrity

Nineteen of the respondents identified ecological integrity as an area of expertise (Question I.6, Figure 8). Our literature review indicates that protected areas should meet minimum criteria for size and replication in order to have ecological integrity. Ecological integrity (EI), as a concept, is provided for more often in legislation (11) and in policy (12) than its component parts (Question II.3, Figure 10). For example, ecological design criteria are rarely found in legislation (4) but more commonly in policy (11). Minimum criteria for replication of protected areas occur rarely in legislation (5) but more often in policy (11). Despite the fact that percentage targets are generally not considered scientifically defensible (Rodrigues and Gaston 2001; Wiersma and Nudds 2003), some agency policy (9) still provides for minimum percentage targets, as evidenced by a response that stated that a recent action plan *"provides direction to… secure 12% of [the province's] land base as protected areas"*. The literature indicates that selection of protected areas should take into account the ecological integrity of potential sites. While a number (18) of respondents indicated that ecosystem functions and processes are inherent considerations in site selection

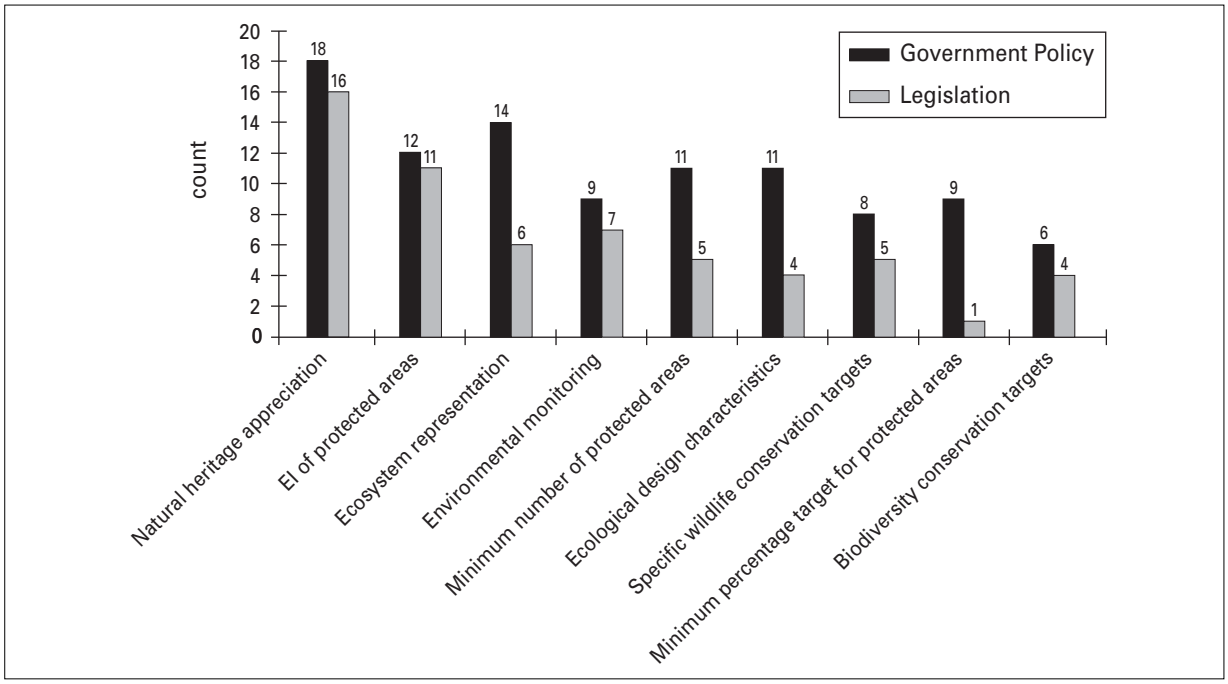


Figure 10 *Question II.3: Does government policy and/or legislation for protected areas include these specific planning considerations or objectives?*

(Question II.5), less indicated specific ecological processes such as fire regimes (7) and hydrological functions (11). The definition used in the *Canada National Parks Act* (from the Ecological Integrity Panel Report) clearly sets out the criteria for ecological integrity and states that sites with ecological integrity should include natural processes and composition and abundance of native species. Such specific targets should be part of all aspects of protected areas design and management, and they should be used in tandem with stated goals for ecological integrity. The Ecological Integrity Panel Report, while focused on a federal agency (Parks Canada), may well be a useful document to apply ecological integrity concepts to protected areas in other jurisdictions. However, without clearly laid out design criteria and specific targets for ecological integrity (Parks Canada Agency 2000), the term may simply become jargon and not be applied.

A majority (14) of respondents do not consider the Federal Ecological Integrity Panel report (Parks Canada Agency 2000) in their work (Question III.14), although one provincial respondent felt strongly that the report was a useful document, stating that *"[the] panel report has informed staff and managers on the issues and evolving needs. It has been consulted when developing an agency definition for use in policies and legislative review. More could be done on discussing this product on an inter-agency basis across Canada, for example through collaborative mechanisms such as the Canadian Parks Council or CCEA."*

The literature suggests that boundary delineation should focus on capturing natural systems (e.g., watersheds) within a boundary, and ensuring that sites meet requirements for minimum dynamic area (MDA), including processes such as fire. However, only four respondents said that disturbance regimes are taken into account in boundary delineation (Question II.6), and only 10 considered hydrological features. While complementarity of protected areas is a major concept in the literature on protected area design, it was only considered with respect to boundary delineation by 11 of the respondents. Boundary delineation most often considered adjacent land-uses (18) and physiographic diversity (16), however, capturing physiographic diversity (e.g.,'enduring features') does not guarantee that all elements of biodiversity will be captured in all protected areas (Araújo *et al*. 2001). Given data limitations faced

by most jurisdictions, an 'enduring features' approach often is the only option available to practitioners. The fact that boundary delineation and protected area design follows other land-uses or enduring features instead of incorporating ecological integrity elements (hydrological features, dynamic processes, intact populations, etc.), is likely because ecological integrity is not a key component of policy and legislation. While ecological integrity may be viewed by some agencies as strictly the purview of Parks Canada, we believe that the concept is integral to the design of protected areas that will function as effective benchmarks.

One respondent indicated that boundary delineation involves both science and politics and stated: *"Scientific data are used extensively at the feasibility stage in order to design appropriate boundaries and to provide a strong rationale for the creation of a new protected area… limited original research is carried out… Stakeholder involvement is a key part of the feasibility study."* Other considerations for boundary delineation included land claim negotiations and First Nations and Inuit interests for traditional land-use (2), ecological and cultural significance to communities (1), legal commitments on Crown lands (2), gap analysis (1), and community priorities (1). By and large, the criteria taken into account for boundary delineation reflect the perception that incompatible land-uses outside of protected areas pose the largest threat to protected areas. These findings further illustrate the importance of social sciences as an area meriting further investigation, but which are beyond the scope of this report.

Protected Areas Modelling

The literature on protected areas design is replete with papers on various modelling procedures. While most (17) respondents listed protected areas design/modelling as an area of expertise (Question I.6), only six stated that they use modelling activities in connection with protected areas planning (Question II.1), and only three use predictive modelling as a consideration in the selection of protected areas (Question II.5). Moreover, only six use algorithm-based models as part of the process to document and assess candidate protected areas (Question II.8), even though nearly all the scientific papers on protected areas design make use of one type of algorithm or another. Most protected areas planning (Question II.1) appears to involve identifying candidate areas (20), consulting with stakeholders (20), consulting with scientific experts (19), conducting GIS and data base development (17), and developing system/network targets (15).

4.2.4 Management

General Practices

The most important ingredients in agency management approaches (Question III.2) include public consultation (18), clear definition of prohibited (16) and permitted (13) uses, and designation of management zones in protected areas (13). Eleven respondents indicated that they use the IUCN classification (see Appendix B) as part of their management approach. Twelve conduct periodic reviews and updates of management plans, even though such reporting and review is an important component of any monitoring process (Wiersma and Campbell 2002). It appears that agencies use a range of approaches to add knowledge-based rigour to the management of protected areas (Question III.3): advisory committees (13), scientific literature (16), field studies (17), TEK (14), and public consultation (18) are all common approaches. The application of knowledge-based rigour to identify protected areas (Question II.4) does not differ very much from that used for management (Figure 11). This includes external advisory committees (11 vs. 13), agency-based technical committees (18 vs. 12), use of scientific literature (20 vs. 16), agency-sponsored field research (20 vs. 17), technical meetings and conferences (14 vs. 12), TEK (19 vs. 14), and public consultation (21 vs. 18). The one practice not used widely in both the identification and management of protected areas is peer-review of technical work (10 in both cases). This may be due to the fact that not much technical work is published. Protected areas practitioners generally do not publish (13) research in the peer-reviewed literature (Question III.10). Instead research findings are mainly shared via the grey literature (Question III.11) and via public forums (Question III.16) such as agency websites (20) and agency publications (16), and through audio-visual presentations (13) and interpretative programs (11). However, some peer-review may be inherent through the use of technical and advisory committees. Nonetheless, more widespread publication and dissemination of research and technical methods (e.g., monitoring, fire research, census techniques, statistical tools, modelling tools, etc.) would have benefits across agencies and jurisdictions.

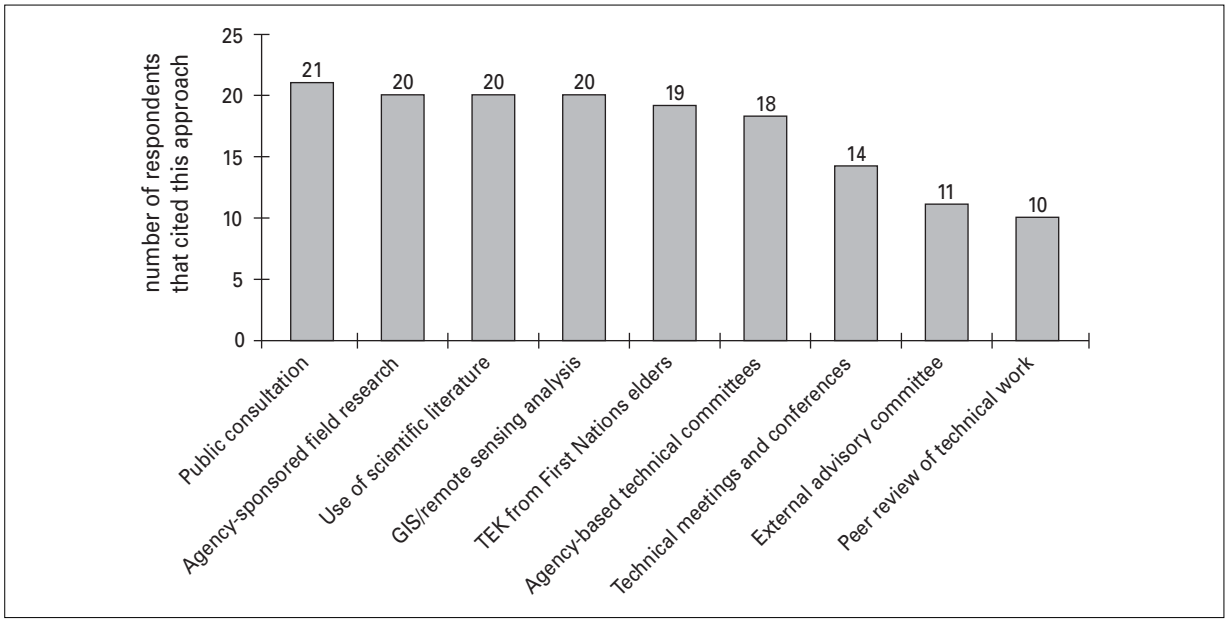


Figure 11a *Question II.4: What approaches are used to add knowledge-based rigour to identifying sites for protected areas?*

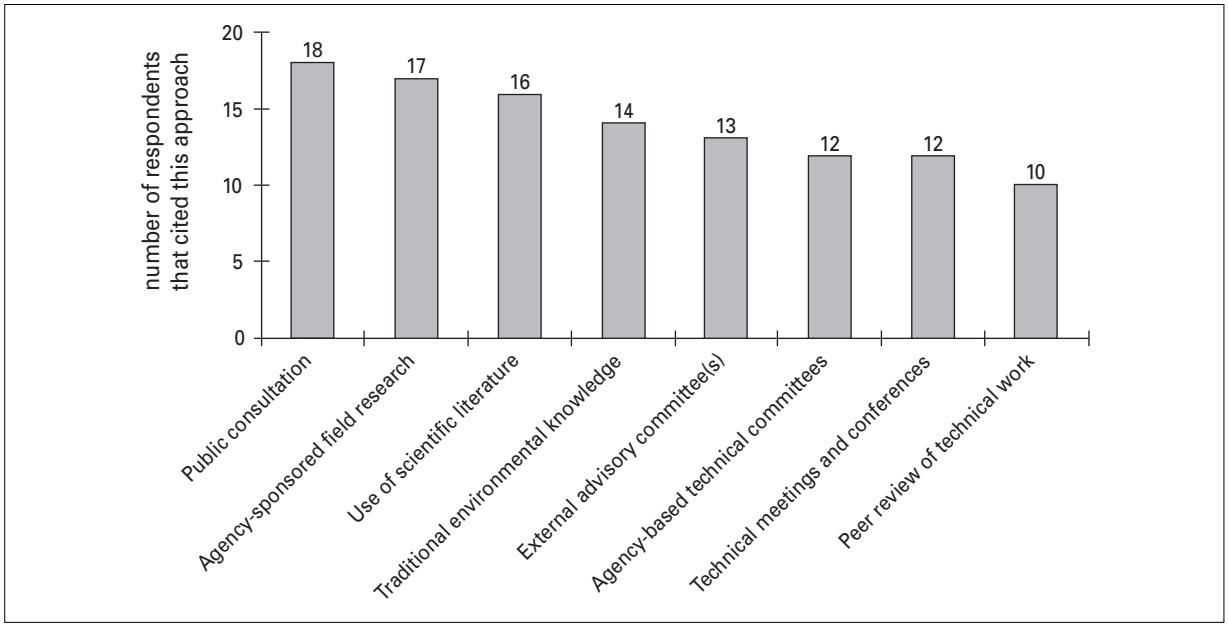


Figure 11b *Question III.3: What approaches are applied to add knowledge-based rigour to management of protected areas?*

Research Activities

Most field studies (Question III.4) appear to be single species research (12), while seven agencies are engaged in community-level research, and five are involved with ecosystem projects. Research in the social sciences appears to be limited to visitor (8) and economic impact (7) studies. Other research activities include ecological assessment (1), park user surveys (1), and carbon sequestration (1). Most research is carried out

collaboratively (Question III.7), with nearly equal collaboration with other government agencies (11), universities (13), First Nations (10), industry (10), and independent contractors (14). A number of agencies (9) also collaborate with NGOs. As indicated in the section above, we believe that not enough agency research is published and disseminated widely.

Much research could be carried out and shared across the country through the use of 'model' protected areas (somewhat akin to the concept of 'model' forests used in forestry research and conservation (Forestry Canada 1992)). However, only four respondents indicated that their agency had established any model protected areas to showcase best practices for protected areas design and management[28] (Question III.17).

Monitoring

Monitoring is seen to be an integral part (10) of agencies' protected areas programs (Question I.3), and was identified as an area of research (Question I.7) by 13 respondents, as well as a function (Question III.1) inherent to the management of protected areas (11). However, fewer respondents (7) indicated that the results of their monitoring program are used in protected areas management (Question III.6), which begs the question as to the purpose for the monitoring. One respondent stated that, *"each area is monitored according to the area's management plan with specific objectives and actions. These may be periodic population or habitat surveys, and monitoring human activities such as hunting and trapping and wilderness recreation. On roughly 5-year intervals, management plans will be reviewed and revised through a public/stakeholder consultation process"*. This statement illustrates how monitoring can be an integral part of an "adaptive management" process (Parks Canada Agency 2000; Wiersma and Campbell 2002). Results from monitoring are being used by agencies for several applications (Question III.6, Fig. 12), but policy amendment was least common (4).

[28] These include Kekerten Historic Park in Nunavut, and four CWS sites: Alasken National Wildlife Area (NWA) in British Colombia, Last Mountain Lake NWA in Saskatchewan, Suffield NWA in Alberta, and Cap Tourment NWA in Québec. As well, the Canadian Forest Service indicated that several of its model forests include protected areas within their boundaries.

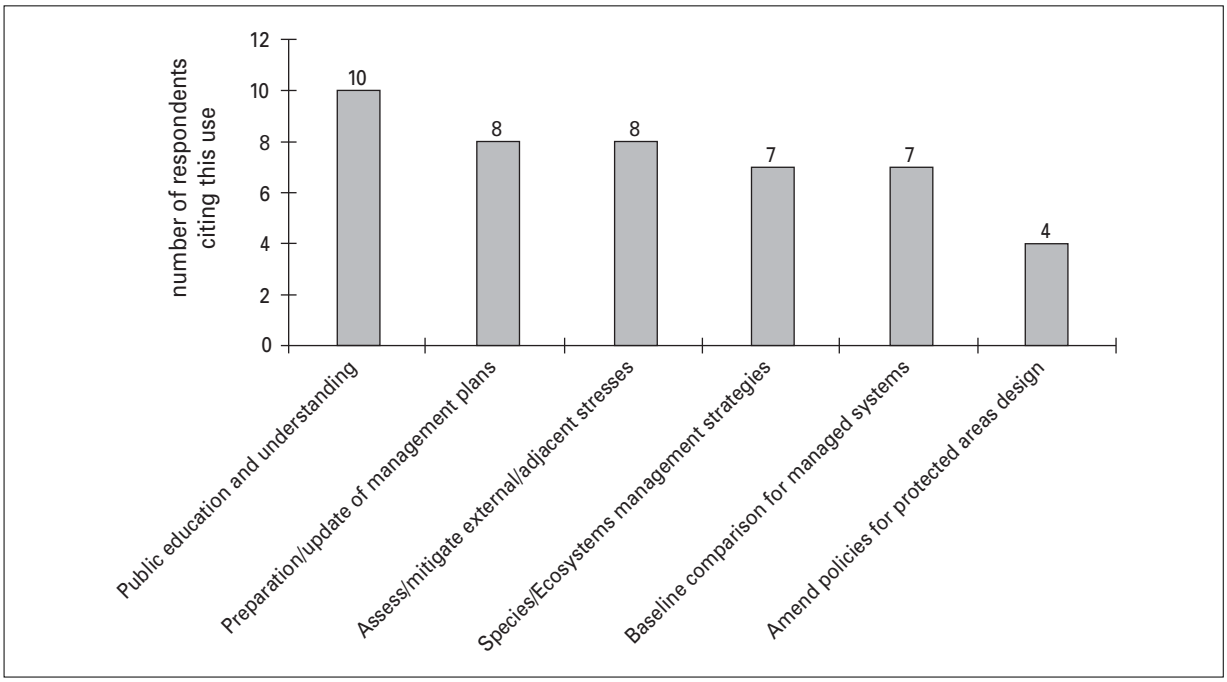


Figure 12 *Question III.6: How are the results of monitoring efforts used in your agency's protected areas?*

A further important component of monitoring and 'adaptive management' is reporting (Parks Canada Agency 2000), yet when asked whether their agency published 'state of protected area' reports (Question III.12), most agencies do not (9), while others publish them every five years or more frequently (10). Some respondents indicated that they agreed regular reporting was important, and in some cases was even mandated in relevant government legislations. However, respondents could not conduct reporting as desired or legislated, because they did not have the staff or resources to undertake this task. Where reporting was carried out, the target audience (Question III.13) included ENGOs and other protected areas organizations (12), the general public (12), stakeholders and partners (10), responsible ministers (9), and other protected areas agencies in Canada (8).

Reporting is an integral part of the monitoring process, because without this feedback loop, adaptive management cannot take place. Results from monitoring can have added value across agencies and jurisdictions if monitoring methods and protocols are standardized, thus facilitating comparison of trends in different parts of the country (Wiken 1999). None of the survey respondents indicated that they are using EMAN's monitoring protocols, which is one of the more commonly available standardized monitoring protocols (Environment Canada 2000).

4.2.5 Capacity

Agency staff devoted to science-focused work (Question I.5) varies (Table 5), however, discrepancies between agencies and jurisdictions may be due to different interpretations of the question. As well, some jurisdictions chose not to answer this question. Staffs generally attend conferences related to their field of research (Question III.8) at least every second year (19), with 13 of these attending a conference at least annually.

The majority of the agencies and jurisdictions indicated that they use scientific literature to add knowledge-based rigour to protected areas planning (Question II.4) and management (Question III.3). In support, most agencies subscribe to academic journals (Question III.9); the more popular ones included the 'Ecology' family of journals (which includes *Ecology, Ecological Applications*, and *Ecological Monographs*) (11), *Journal of Wildlife Management* (12), *Conservation Biology* (9), and *Biological Conservation* (8). Our review of the literature reveals some discrepancies between what journals agencies reportedly are reading and the journals reviewed in this report. Journals which were not used in this review, but to which a number of agencies subscribe include *Arctic* (10), *Arctic Anthropology* (1), *Environmental Management* (6), *Information North* (3), *Journal of Leisure Research* (1), *Natural Areas Journal* (4), *Journal of Ecology* (1), *Journal of Animal Ecology* (1), *Journal of Applied Ecology* (1), *Parks* (2), and the *Canadian Field-Naturalist* (1).

Many of these journals do not carry the same academic 'weight' as those cited in our literature review, but they are also less expensive. Cost and priorities for agency-based research using more affordable journals may explain the preferred reading material of agencies. One respondent indicated that he maintained a personal subscription to several journals (including the 'Ecology' family of journals) that were then shared in the office. We did not ask respondents whether they access scientific journals outside of their offices (i.e., at local academic institutions), however the differences between the number of agencies purporting to refer to the literature and the number of subscriptions suggests that this may indeed be happening. Staff may also be accessing science-based literature through attending conferences, reading conference proceedings, and reading on-line journals and reports.

When asked to candidly identify ways in which their agency is limited in implementing science-based principles to protected areas design (Question II.9), the majority of

PY's	Natl.	Natl.	Natl.	Natl.	Natl.	NL	NL	NL	QC	MB	MB	MB	MB	SK	AB	AB	NT	NU	YK	Mean	Total
Full-time	6	15	150	35	6	0.5	2	1	2	3	0.25	0.01	2	2.5	1.6	4	1	5	7	13.75	261.3
Part-time	x	5	200	10	x	0.5	x	0	0	0	0	0	0	0	0	2	1	1	0	11.55	219.5

Table 5 *Summary of full-time and part-time person years (PY's) devoted to science-based protected areas work by jurisdiction/agency. Specific agencies are not named; however multiple listings from a jurisdiction indicate more than one agency reporting. 'x' indicates no response given. "Natl." indicates a federal agency and includes both headquarters and field staff.*

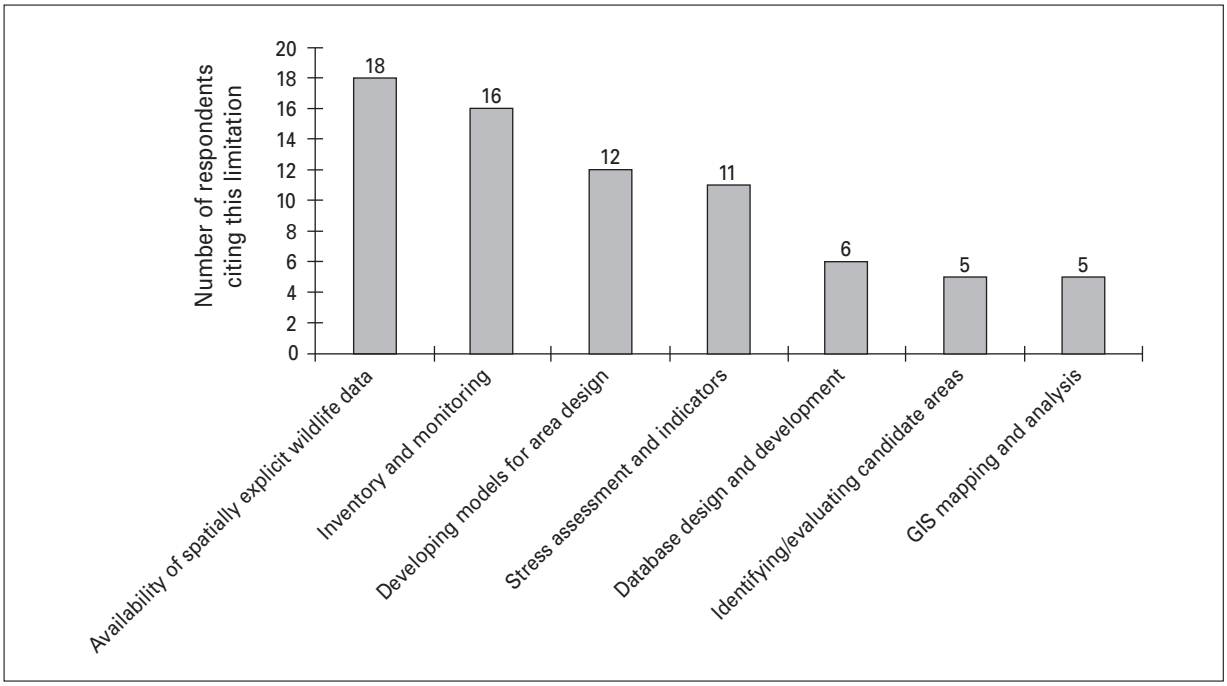


Figure 13 *Question II.9: In what ways is your agency limited in implementing scientific and planning principles to protected areas design?*

respondents (18) cited the lack of spatially explicit wildlife data. Other limitations include developing models (12), stress assessment and indicators (11), and inventory and monitoring (16) (Fig. 13). One respondent expressed that *"In a sense, all of these items could be checked off; with more funding, more work could be done. However, funding is not unlimited. Overall, we have the knowledge and experience to do this, but we are challenged by the high cost of conducting baseline inventories in the vast and remote northern areas"*. Extensive standardized inventory and data are crucial for protected area network planning and management. Efforts to generate standardized inventory protocols should be promoted. Conservation Data Centres (CDCs), such as NatureServe and Natural Heritage Information Centres often have a dearth of data on the North. The Nature Conservancy of Canada's effort in advocating CDCs in each of the territories is highly laudable (Nature Conservancy Canada 2003).

4.3 Survey Summary

Overall, it appears that northern protected areas managers are somewhat aware of the current scientific literature on protected areas design, but not necessarily up-to-date with the latest research and techniques. Limitations appear to be primarily that of capacity. Agencies often do not have enough data to conduct the desired analyses. Some of the approaches and techniques found in the protected areas literature (e.g., use of algorithm-based models, predictive modelling) are not widely used by agencies. This may reflect a lack of capacity (staff, training, time), limitation in data availability for use in models, or a difference in focus between the more theoretical scientific literature and the practical realities of management. Findings from the literature, such as the unreliability of percentage targets, and concepts such as minimum dynamic area (MDA), appear to be integrated with some, but not all agency practices. We do not know whether those agencies whose practices are more up-to-date with the literature correspond with those whose staffs attend academic conferences regularly. However, it seems likely that exposure to the latest research via conferences and journals is a good strategy to keep the theoretical and practical knowledge on protected areas in step with each other.

The practical aspects of protected areas planning and management were expressed by the many agencies that emphasized the importance of working with stakeholders

and regional land-use agencies. Many respondents cited the importance of consultation with First Nations and local communities as part of the planning process; a process which academic scientists often ignore. TEK and community consultation have been shown to improve buy-in for establishing protected areas (Wallner 2003) and we encourage these practices.

A rather surprising finding of the survey was that few agencies are making use of the Parks Canada Report on Ecological Integrity (Parks Canada Agency 2000). While this is a document that analysed the federal protected areas agency, the report is a comprehensive overview of the state of protected areas planning and management generally, and many of its recommendations are applicable to other agencies and jurisdictions. The Panel on Ecological Integrity clearly defined and set targets for ecological integrity. If agencies across the country adopted similar definitions and targets, the concept of 'ecological integrity' would be strengthened, and the risk of the term simply becoming jargon would be minimized. A common framework across the country would also help to facilitate inter-agency collaboration.

A key area of work for which our survey results suggest inconsistencies is monitoring. Many agencies purported to do monitoring, although when asked specific questions about monitoring programs, the number of positive responses was considerably less. Monitoring is far more than inventory work (Wiersma and Campbell 2002), and should be set up as a rigorous program with clear goals for information and management. Monitoring can be a useful technique for assessing impacts of a variety of anthropogenic effects, such as visitor use, resource development activities, and climate change, as well as providing baseline information on ecosystem dynamics. A key component of monitoring is reporting, so that results can be used to feed back into policy and management (Wiken 1999). However, very few agencies appear to engage in formal reporting; we believe this is an area that should be strengthened in the future. Reporting not only assists and improves protected area management, but reports that are shared widely can provide synergy to other protected areas managers. Our literature review indicated that many northern protected areas face similar challenges and threats; sharing of research and monitoring activities across northern protected areas is a cost-effective way to improve the ecological integrity of protected areas across the North.

There are many encouraging findings from the survey. Practitioners appear to be quite involved in research activities, and are aware of the current challenges facing protected areas. Many of the respondents indicated a willingness and interest in doing more to increase their use of scientific principles in the design and management of protected areas, but cited a lack of personnel and resources as limiting factors. If the discrepancy between what respondents can do, and what they would like to do could be addressed with the appropriate resources, knowledge and infrastructure, then the process of protected areas planning and the results reflected in measurable biodiversity conservation could change dramatically.

5. Bridging Science and Practice for Northern Network Design

Exposed limestone cliffs on Lake Mistassini present colder-than-normal habitats that sustain 'krummholz' palisades with arctic flora on subtending cliff-faces, Albanel-Temiscamie-Otish park project, Quebec.

5.1 A Prescriptive Approach

Effective protected networks should be more than a collection of protected areas. While this report places an emphasis on large protected areas, in practice these should form the backbone of a network that integrates large core areas with smaller protected areas, buffers, linkages and corridors, together with ecologically sustainable management of the intervening landscape. Such a model has been described in detail elsewhere (Noss 1992; Woodley *et al*. 1993; Groves *et al*. 2000). Essentially, core areas should be large, representative examples of the region, where natural processes can continue with minimal human interference (see also Table 4 in Section 2.5). Recreational use of these areas should be strictly controlled, and industrial development of any kind should be prohibited. Smaller protected areas can conserve special features of interest (i.e., rare geological features, rare plants), or species with smaller home range requirements. More intensive management (e.g., prescriptive fire, culls, and visitor restrictions) may be required in such areas to ensure long-term species persistence. When placed in clusters, small protected areas may protect a higher diversity of species through metapopulation dynamics than when placed further apart on the landscape (Diamond 1975).

> *"Studies in conservation biology point to the need for not individual parks and protected areas, but rather systems of protected areas, linked and buffered – in other words a reserve network system – if biodiversity is to be truly protected."*
>
> Steve Gatewood,
> *The Wildlands Project* (2003)

Buffer zones around protected areas can minimize edge effects, and provide a zone of transition between protected areas, where no development is

allowed, to the 'working landscape'[29], where resource development takes place. Thus buffer zones may be designed to accommodate non-extractive development (e.g., hydro-electric development), related infrastructure (roads, hydro corridors), and more intensive levels of human use (i.e., non-Aboriginal hunting, trapping, fishing). Cores and corridors may provide linkages between protected areas (Noss 1987; Noss and Harnis 1986; Newmark 1993), however, they should be applied cautiously, as research has shown that corridors may also have negative effects (Simberloff and Cox 1987; Simberloff *et al*. 1992). Given that much of the northern landscape is still fundamentally unfragmented, corridors are likely not to play a prominent role in network design. Rather, a more suitable strategy will be to manage the intervening landscape to maximize ecological integrity and landscape connectivity (see section 5.3). In many areas of northern Canada, a reverse-matrix model (Schmiegelow *et al*. in review) may be a more appropriate strategy.

> *"The Wildlands Project envisions an area large enough for natural processes and succession with core reserve areas and corridors that connect them. Core areas are roadless reserves large enough to provide security for wary predators and raptors, thereby providing habitats for a large number of species. Connecting corridors facilitate movement and allow interbreeding of populations. They also allow for a shift in species as climates change…"*
>
> Michael Soule,
> *SAMPAA Proceedings* (1998)

Ecosystem-based management (or 'ecosystem management') (Grumbine 1990, 1994) is a practical strategy that has been adopted for protected areas as well as by resource managers (see for example Bormann 1994; Huff 1994; National Forest Strategy Coalition 2003). While resource managers have often applied 'ecosystem management' as a buzzword to satisfy environmental groups as to the sustainability of their practices, effective application of ecosystem management in the intervening landscape will, nevertheless, contribute to the overall ecological integrity of the region (see also section 5.3).

5.2 Strategies for Network Development

Developing effective northern protected networks will require adopting a 'big picture' approach to planning. Rather than considering the establishment of new protected areas on a case-by-case basis, the establishment of new protected areas should be carried out in the context of a larger vision for an ecologically viable network. This will be challenging, as planning practices have traditionally established protected areas one at a time. The development of a network 'vision' for a given region is an important first step. In practice, this step should involve all interest groups in the region, so that implementation is not viewed solely as a 'top-down' process. The best available data should be consolidated and incorporated in the network development. The network vision should include key elements to maximize ecological integrity of the region. First, it should identify an appropriate minimum reserve area for protected areas to have ecological integrity (Gurd *et al*. 2001). This area may vary depending on the region and species of interest. An analysis of minimum viable populations (Shaffer and Samson 1985; Beier 1993; Schoenwald-Cox *et al*. 1998; Landry *et al*. 2001) and minimum dynamic areas (Pickett and Thompson 1978) can contribute to refining a minimum reserve area estimate. Northern regions, which have more wide-ranging species, may need a larger minimum reserve area than areas in southern regions. Second, the vision should identify minimum replication requirements for representation of species and features of interest, using some of the tools and techniques outlined in Section 1 and 2 (e.g., Margules *et al*. 1988; Andelman *et al*. 1999; Anonymous 1999; Urban 2002). Finally, once such a vision is articulated on a map, it can be compared with existing protected areas as a form of 'gap analysis' to identify where elements of the network are already in place, where expansion or consolidation of existing smaller sites is needed, and where additional protected areas may need to be established (e.g., Flather *et al*. 1997). Such a mapping exercise may also be valuable in that it allows for potential resource conflicts and trade-offs to be identified (and potentially negotiated) well in advance of the process of establishing boundaries for protected areas (e.g., Gonzales *et al*. 2004).

With a vision and gap analysis in place, delineation of protected areas can proceed. In some parts of the region,

[29] The term 'working landscape' refers to those areas that are used for economic activities and may have relatively few restrictions in terms of ecological protection.

consolidation and/or expansion of existing smaller protected areas may contribute to the network. In other cases, a change in designation for a protected area from one that allows extractive use to a stricter designation may be necessary. Such decisions can be carried out as trade-offs. For example, the development of a network vision may identify that an existing protected area with strict protection is in fact not optimally located to contribute to an efficient network. Thus, relaxing use restrictions on this area may open up an opportunity to gain stricter protection of an area that is more optimally located, but which in the past may have allowed more intensive use. As the last step, gaps in the network should be addressed through the establishment of new protected areas. In all cases, decisions can be supported based on how well they contribute to the overall network vision. If the network vision is based on the best available knowledge, using scientific data and community input, then decisions about land-use designations should more readily achieve support than if planning for protected areas is carried out in a more piecemeal fashion.

> *"We will win or lose the biodiversity battle on the landscape between the protected areas."*
>
> Gray Merriam (1993)

As illustrated through our questionnaire survey results, the process of establishing new protected areas should involve community input at all stages. If communities are involved in the development of the 'vision' network, there is likely to be more buy-in for the establishment of new protected areas, or changes in the designation or management of existing sites.

5.3 Intervening Landscape Management

The protected areas network should not be viewed as nodes and "corridors of 'green space' in a sea of hostile landscape". Much of the literature on protected areas assumes such a scenario (e.g., Noss 1992), but this is because past research is largely based in more southern latitudes where development of the intervening landscape is more intense. In much of northern Canada, the intervening landscape is relatively intact. Thus, careful management of the landscape to promote ecological integrity is strategic and the "reverse matrix" model (Schmiegelow *et al*. in review) is a potentially applicable concept. The reverse matrix model envisions nodes and corridors of development within an intact landscape with protected areas serving as benchmarks against which use of the intervening landscape is compared. Conducting the network vision process as described in section 5.2, with the reverse matrix model as a conceptual framework, may assist in the identification of sites where intensive development can occur with minimal impact. Currently, there are no examples of direct applications of the reverse matrix model; however, the Muskwa-Kechika Management Area (described in more detail in Section 5.4, below) is the best example of which we are aware, of a regional management plan with specific prescriptions for land-use and development activities in the intervening landscape.

Management strategies for the northern intervening landscape, which may help to promote the ecological integrity of the protected area network, can include many considerations: elements of prescriptive cutting, including cut block size, shape, snag management, and the inclusion of buffers around rivers and water bodies; guidelines on the types of materials used for road building (e.g., permeable vs. impermeable surfaces); prescriptions on the timing of resource development activities to avoid conflicts with species at certain times of the year (e.g., caribou calving, migratory bird nesting); and guidelines for removal/restoration of roads, infrastructure and habitat restoration after resource extraction has finished. Some agencies and jurisdictions already include some or all of these elements as part of their management principles and guidelines (e.g., the *Ontario Forest Accord*, *Canada Forest Accord*). The inclusion of representatives from the resource sector at the table, when the vision network is developed, could assist with effective management in sensitive areas of the intervening landscape.

5.4 Selected Case Examples

This section provides a brief overview of three case examples of protected areas planning that incorporates further thinking toward network design.

5.4.1 Great Lakes Heritage Coast

The Great Lakes basin is arguably one of the most distinctive and one of the most significant ecological regions of North America. Together, the ameliorating

effect of the Great Lakes, juxtaposed with the attenuating effect of Hudson and James Bay, generates a remarkable latitudinal compression of ecological conditions bridging Carolinian, Great Lakes-St. Lawrence and boreal regions (locally with subarctic remnants) that crosscut the intrusion of prairie affinities from the west and Atlantic coastal plain influences from the east. Nowhere is the mix more striking than in the coastal region of the Great Lakes where examples of these ecosystems and biogeographical affinities often occur side-by-side. Housing 20% of the world's freshwater, and featuring a virtual kaleidoscope of ecosystems, flora and fauna, the Great Lakes basin deserves concerted conservation attention (Beechey 2002).

In 1999, the Ontario Government announced the designation of the "Great Lakes Heritage Coast" (GLHC) as a flagship initiative of *Ontario's Living Legacy* (OLL), and as a comprehensive land-use strategy for that portion of northern Ontario largely corresponding with the Precambrian Canadian Shield. Altogether, OLL announced 350 new provincial parks and conservation reserves to cap the implementation of *Nature's Best*, the protected areas segment of OLL that was first introduced by the government in 1995. Together with these new protected area designations, OLL announced nine signature sites—conservation proposals that are regional-scale complexes housing multiple protected areas in managed landscapes. GLHC was celebrated as the model signature site, being the largest and most prominent area containing the highest concentration of existing and newly announced protected areas (OMNR 1999).

GLHC is a corridor that incorporates more than 4200 km of the coastline of Lake Superior, the North Channel and eastern Georgian Bay, stretching from the Ontario-Minnesota border in the west to almost the south end of Georgian Bay in the east (Figure 14). Altogether, it takes in the entire portion of the Canadian coastline of the Great Lakes that coincides with the southern boundary of the Canadian Shield (O'Donoghue 2002). GLHC spans six of Ontario's 14 eco-regions and 12 of

The north shore of Lake Superior is marked by a rugged coastline featuring a dramatic interface of marine and terrestrial boreal ecosystems, Sleeping Giant Provincial Park, Ontario.

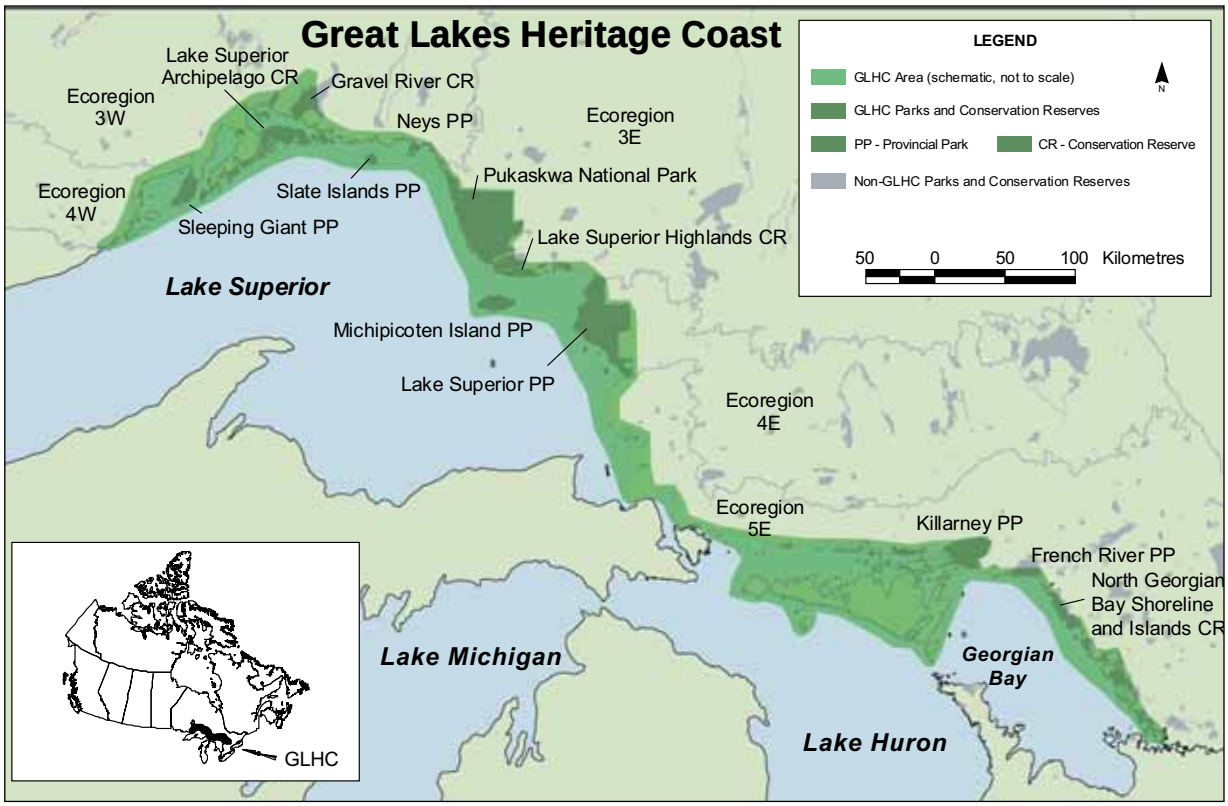


Figure 14 *The Great Lakes Heritage Coast showing major parks and conservation reserves in the area (sources: OLL 2002; OMNR 1999).*

its eco-districts incorporating the coastal mainland, littoral zone and the proximal islands. Collectively, the array of ecological conditions, communities, flora and fauna in the area far exceeds that found in any other single conservation proposal in Ontario. So defined, GLHC takes in a very diverse ecological gradient along the southern boundary of the study area adopted in this report (Beechey 2002).

The conservation designations within GLHC comprise almost 1 000 000 ha made up mainly of three protected area designations including all or portions of 71 pre-existing and newly established OLL provincial parks and conservation reserves, and two national parks. Other conservation designations include enhanced management areas, Crown game preserves and forest reserves. The surrounding area consists of Crown lands (mainly provincial), patent lands primarily in the southern portion, and some First Nations lands. Through OLL, significant gains were made in adding new provincial parks and conservation reserves, and expanding existing ones in GLHC. Notable additions include those between Pukaskwa National Park and Lake Superior Provincial Park, and those around Killarney Provincial Park extending around the east side of Georgian Bay (OLL 1999). The new provincial parks and conservation reserves were selected and rationalized on the basis of the representation methodology for selecting such areas throughout the OLL planning region (Crins and Kor 2000). While most of the protected areas in the GLHC are terrestrial, approximately 10% incorporate aquatic environments on the Great Lakes. Significant areas in parks such as Pukaskwa, Lake Superior, Sleeping Giant, Michipicoten, Slate Islands and Killarney offer significant opportunities to develop the aquatic component of protected areas in GLHC.

The impetus for GLHC issued from longstanding interest to protect the coastal area of the upper Great Lakes for its special natural values and wilderness

character, as well as its associated amenity, recreational and tourism values.[30] Working from this perspective, initial efforts on advancing the GLHC initiative centred on three of seven provincial recommendations arising from government based consultations with local communities and stakeholders: 1) the development of a GLHC Strategy; 2) continued promotion of cooperation and partnerships; and, 3) commitment to implement the GLHC Strategy With broad-based support among the many stakeholders to proceed with the initiative, the Ontario Government pursued further consultation on these fronts (O'Donoghue 2002), including special efforts to engage First Nations (Robbins 2005).

Since 2002, work has continued on completing the regulation of the new parks and conservation reserves declared through OLL, including those in GLHC. However, provincial commitment has dissipated on advancing the broader GLHC initiative, which was aimed at developing a more comprehensive view on the conservation and management of the many significant protected areas in the GLHC area. Notwithstanding this retreat, the GLHC initiative remains a valuable model that illustrates a number of principles important for designing protected areas within regional-scale landscapes:

1) Recognizing an extensive, significant natural system with inherent ecological integrity as a framework for planning and managing protected areas;

2) Including many pre-existing and newly announced protected areas based on a consistently applied (albeit terrestrial) 'representation' methodology;

3) Incorporating aquatic ecosystems (even though not well rationalized) in the protected areas network;

4) Adopting protected area design principles including large size, reserve clusters, connectivity and multiple designations;

5) Applying complementary conservation designations adjacent to many of the protected areas; and,

6) Using a broad-based, consultative planning process involving local communities, stakeholders, non-governmental organizations and scientific interests.

The key shortcomings of the GLHC model basically centre on the limited scientific and ecological consideration in its initial development, the *carte blanche* acceptance of many of its pre-existing protected areas without in-depth analysis of their ecological integrity, and its confined geographic scope which failed to elaborate the importance of connectivity with inland systems and protected areas. The decision not to proceed with implementation of a GLHC Strategy has arrested opportunities for discussion and consultation that could rectify these limitations with the model.

Although commitment has waned on the global idea of GLHC, complementary initiatives continue to advance conservation in the coastal region of the upper Great Lakes. One such initiative is the recently declared "Georgian Bay Littoral Biosphere Reserve", an extensive area some 347 000 ha in size that incorporates the Thirty Thousand Islands of eastern Georgian Bay, intervening and surrounding open waters, and the adjacent mainland (GBLBRI 2003). Additionally, through its initiative to develop a Conservation Blueprint for the Great Lakes basin, The Nature Conservancy of Canada continues to be involved in bi-national and regional initiatives to conserve critical areas around the Great Lakes, including a concerted focus on the north shore of Lake Superior, the North Channel and eastern Georgian Bay (NCC and NHIC 2004; Jalava *et al*. 2005). Finally, recent provincial/federal negotiations lend optimism to the prospect of creating a marine conservation area on the northern coast of Lake Superior.

5.4.2. Yellowstone to Yukon

The Yellowstone to Yukon (Y2Y) region is a vast, 3200 km long region stretching along the spine of the Rocky Mountains from Yellowstone National Park in Wyoming to the northern Yukon. The Y2Y region comprises approximately 1 200 000 km^2. The Y2Y Initiative states that it is made up of "*people working together to maintain and restore the unique natural heritage of the Yellowstone to Yukon region*" (Y2Y website). The Initiative seeks to

[30] Over the years, various conservation designations including biosphere reserves and marine conservation areas have been advocated for Lake Superior. Ongoing federal/provincial negotiations are an encouraging sign that an agreement may be struck to establish a marine conservation area on the northern coast.

combine science and stewardship to ensure that the ecological integrity of the region is maintained.

The Y2Y Initiative is not a protected areas network managed by a single agency or jurisdiction. Instead, it is a joint network of over 800 organizations, institutions, foundations and conservation-minded individuals on both sides of the Canada-U.S. border. Yet, the Y2Y vision clearly articulates a network of protected areas, and envisions that these will be linked together so that their contribution to conservation is greater than the sum of the parts. The Y2Y Initiative uses both 'bottom-up' and 'top-down' principles. The Initiative has a central office in Canmore, Alberta, which coordinates the partnerships and provides overhead administrative support. Local communities are encouraged to participate in conservation within the Y2Y area, and stewardship programs are encouraged. Partners may show their support by posting the Y2Y logo on their websites.

The Y2Y Initiative also acknowledges the need for a 'working landscape', and states that its vision is to ensure that the region functions as an ecosystem *"capable of supporting all of the natural and human communities that reside within in, for now and for future generations"*. The Y2Y Initiative envisions a future when all resource management decisions are made with ecological integrity as the over-arching goal. To support the initiative, Y2Y has a significant science and research program. The Y2Y Initiative coordinates grants for research by universities and non-governmental organizations (NGOs). From 1999-2004 the granting program supported 55 different projects, 63 principal researchers, 11 universities, and 37 non-governmental organizations with 74 grants totaling over US $1.25 million. The science program promotes ecological and socio-economic research related to the Rocky Mountain ecoregion at a range of spatial scales. The program has as one of its main goals to develop a scientifically defensible 'Conservation Area Design' (i.e., a network of protected areas). The Y2Y Conservation Science program is also actively involved in research related to grizzly bears, the ecological effects of roads, land-use analysis and mapping, and aquatic research. In addition, Y2Y plays a large role in education and raising public awareness. Resources for teachers and the public are made available on its website (www.y2y.net), as are a vast array of reports on research activities.

The Y2Y Initiative embodies many of the principles of large-scale conservation. It has been a leader in developing and using good science to support its program. It works closely with community groups, and is very much a 'bottom-up' organization. While the central Y2Y office provides a measure of 'top-down' coordination, the Y2Y model does not have direct government involvement, as does the Muskwa-Kechika Management Area (see Section 5.4.3 below). Given that the Y2Y region overlaps with one territory, two provinces, and three states, together with 31 First Nations territories, this lack of direct government involvement is logical. Rather, the Y2Y Initiative uses its research and partnerships to lobby governments on specific issues within the individual jurisdictions of the larger region.

The Y2Y Initiative recognizes that large-scale conservation programs such as this one must necessarily take a long-term and large-scale view. Indeed, the Federal Panel on Ecological Integrity recognized Y2Y as a model for moving from protected areas as islands, to a network approach.

Figure 15 *Yellowstone to Yukon Conservation Initiative, showing critical cores and corridors. Readers can find out more about the Y2Y Initiative at www.y2y.net*

5.4.3. Muskwa-Kechika Management Area

The Muskwa-Kechika Management Area (M-KMA) is a 6.4 million ha area in northern British Columbia (Figure 16) that applies a unique management framework to combine protected areas within the "working landscape". M-KMA is comprised of a combination of Protected Areas (26% of the M-KMA land area), Special Management Zones (58% of the area), and Wildland Zones (15% of the area), which together have been designated with the objective of allowing for resource development (the area is rich in oil, gas and minerals) while maintaining values for wilderness and wildlife. These areas vary in the level of resource development permitted; Protected Areas prohibit resource development, while resource development that does not adversely affect the ecological integrity of the region is allowed in Special Management and Wildland Zones. For example, commercial timber harvesting is not allowed in Wildland Zones, and any roads must be temporary.

M-KMA is also unique in terms of the process that created it. M-KMA was very much created through a combination of a 'top-down' and 'bottom-up' planning process. 'Bottom-up', community driven planning played a significant role, and local people from several communities developed M-KMA out of their own Land and Resource Management Plans. While there is government legislation (the *Muskwa-Kechika Management Act*) that underpins planning and land-use, a local strategic planning framework, together with an Advisory Board, ensures that local needs are addressed while provincial and nation-wide standards are adhered to in the process.

The Premier appoints members to the Advisory Board, which includes representatives from local communities and First Nations. The Advisory Board functions to make recommendations on planning and strategic management, as well as to approve local strategic plans and provide advice on the use of trust fund monies. The strategic planning framework includes plans that the resource sector must complete in advance of development. These include landscape objectives, pre-tenure plans and recreational plans.

A $6 million trust fund was established by the provincial government in 2000 to help fund research and integrated management projects. The fund receives annual donations from both the government and the private sector and has helped to fund a research chair at the University of Northern British Columbia. The trust fund has also been used to fund local strategic planning, clean-up projects, outreach, public education and research.

Although M-KMA has been successful in meeting resource development, recreation, wilderness, community, and First Nations needs, there are challenges in setting up such a planning framework. Jurisdictions in the NPA study area should be aware that success with a plan such as this requires local buy-in *and* political support. Efforts to maintain public awareness are critical, as is sufficient funding to support the necessary research and planning initiatives. Legislation to support planning helps lend a degree of legal support to land management. Finally, the M-KMA project illustrates that protected areas network planning with widespread community consultation in concert with legislative support is a time-consuming process.

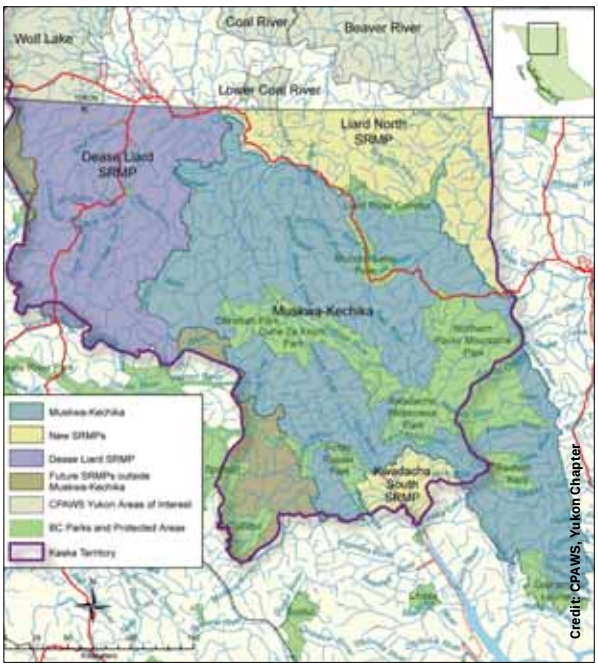


Figure 16 *The Muskwa-Kechika Management Area, British Columbia (courtesy www.muskwa-kechika.com). Find out more about the Muskwa-Kechika Management Area at www.muskwa-kechika.com*

6. Summary of Findings and Conclusions

*Protected areas that include all seral stages in fire-driven northern ecosystems are important to specialist species such as Canada lynx (*Lynx canadensis*). So too is a healthy habitat matrix between protected areas as these species are occasionally required to migrate considerable distances in search of suitable habitats.*

Canada's North is a remarkable storehouse of biodiversity and a global heritage asset. Relatively unspoiled and remote to most, its grandeur and diversity are, in reality, insecure in relation to pressures to develop its resources. The conservation of northern Canada — its ecosystems, species and unique cultures — needs to be a carefully directed pursuit. There is no room for complacency in matters of conserving Canada's North.

Around the world, protected areas have been accepted as a 'best bet' strategy aimed at conserving wild places and their component wildlife. This report has delved into some central aspects pertinent to ongoing efforts to advance the effectiveness of protected areas in northern Canada. Specifically, our review of current conservation science relevant to protected areas and network design, the review and assessment of currently designated protected areas and the survey of current jurisdictional attitudes, policies and practices are critical aspects that can help to forge future progress.

Many of the conclusions arising from this review confirm strategic directions already set out in the current CCEA Business Plan (CCEA 2004). CCEA's priorities on ecological integrity, climate change, the completion of protected area networks, information management and reporting are wholly in stride with the findings of this report.

Summarily, we present the following observations, conclusions and recommendations.

From the Literature Review:

1. Protected areas greater than ~3000 km^2 and located within an intact habitat matrix should be able to maintain their historical complement of species and natural processes. The more fragmented the habitat matrix surrounding protected areas, the larger the protected area itself will have to be. The 3000 km^2 is a *minimum* size guideline; to better ensure that ecological integrity is maintained over the long-term, protected areas should be as large as possible. Some species (e.g., migratory caribou) may still not be sufficiently protected with areas of this size; for these species complementary strategies in addition to protected areas will be necessary (see also Table 4 in section 2.5). Although a number of northern protected areas, particularly in Yukon, Northwest Territories and Nunavut already meet this minimum area requirement, it's best taken as a minimum standard based largely on research in southern Canada that should be applied cautiously to northern Canada. Ecosystem dynamics (e.g., fire), migratory species, and factors such as resource development and climate change are some of the elements that will have to be considered in order to effectively estimate a minimum reserve area for northern biomes.

2. Percentage targets (e.g., the 12% target) do not proffer guidelines for how large protected areas should be or where they should be located. Moreover, research has shown that there is no simple percentage target that can be universally applied.

3. As an alternative to percentage targets, a useful approach is to establish several protected areas that meet minimum size requirements for ecological integrity. Another strategy is to set targets to capture a certain percentage of each species' range, but this requires good distributional data (see also Table 4 in section 2.5).

4. Replication of protected areas in a manner that follows the principle of complementarity will help address representation targets. Representation targets can be based on representation of mammal provinces (e.g., Wiersma and Nudds 2003), or on ecozones or ecoregions (e.g., Gauthier 1992; Gauthier *et al*. 1995). Which level of spatial hierarchy is set as the representation target is an issue that merits further discussion and analysis. The number of protected areas required to represent the diversity of target regions will vary; studies have shown that for mammals, it may be possible to represent all species within an ecoregion using just one or two large protected areas. However, to represent other taxa and features, an increase in the number of protected areas will most likely be necessary.

5. Data used to identify and select protected areas (e.g., species distributions, soil and vegetation patterns, physiography) should be verified for accuracy, and new data should be spatially referenced and documented. Data sharing between agencies will facilitate better design of regional protected areas systems. Data collection will be more cost-efficient if it is planned with protected area design in mind.

6. Surrogate species should not be relied on exclusively for selecting protected areas. Research shows that indicator and umbrella species are highly scale dependent, and a species that functions as a surrogate in one region may not transfer well to another location. Any research on surrogate (focal) species in northern Canada should be undertaken within an 'adaptive management' framework in order to be able to make significant contributions to the larger body of research on surrogate species.

7. Conservation of wide-ranging migratory species in the North is best addressed via a cross-boundary approach. The *Yellowstone to Yukon* Initiative is an example of such an approach that may well provide area protection for a number of wide-ranging species. Local knowledge will be valuable to identify areas that are important habitat at certain times of the year. Cross-boundary and inter-agency collaboration can also help to build trust, which in turn may facilitate effective data sharing (see Recommendation 6, above).

8. Large (>3000 km^2) protected areas embedded in an unfragmented habitat matrix will allow natural processes (e.g., fire, insect outbreaks, population fluctuations) to take place with minimal management (see also Table 4 in Section 2.5).

9. Minimizing impacts of development will require active negotiation with the resource sector with

respect to techniques and timing of activities (see also Table 4 in Section 2.5). The exact nature of these will depend on the activities in question, the ecosystems in which they are taking place, and the species that are presumed to be affected.

10. The effects of climate change on protected areas will be best understood through long-term, careful monitoring of abiotic and biodiversity characteristics of protected areas. Large protected areas with habitat and altitudinal diversity and that are oriented along south-to-north axes *may* capture more species as biomes shift (see also Table 4 in section 2.5), however, the full impact of climate change cannot be predicted at this time.

11. Published research on protected areas and protected area networks in Canada's North is relatively sparse. More research is needed on these topics in order to formulate firmer guidelines and best practices for the selection, design, planning and management of northern protected areas and their component values. This need spans the full spectrum of disciplinary subjects including natural sciences and socio-economic studies.

From the Protected Areas Status Review:

1. A substantial foundation for a protected areas network in northern Canada already exists, and the total area has virtually doubled in size over the past two decades. The northern protected areas estate includes 744 areas greater than 10 km^2, of which 66 exceed 3000 km^2. This series includes a range of designations covering nationally owned and managed parks and wildlife areas and their provincial and territorial counterparts.

2. To date, protected area efforts across northern Canada have largely focused on identifying and protecting individual sites, which has given rise to a series of largely isolated areas in a landscape matrix. The notion of viable networks of protected areas has not yet been aggressively pursued, partly because of other commanding land-use constraints, and partly because the current and projected extent of development across the North is not yet viewed as an over-bearing threat to warrant the kind of attention assigned to networks in more fragmented southern landscapes. However, just as the North still presents opportunities to establish large protected areas, so too does it present opportunities to establish comprehensive functional networks of such sites and this goal should be pursued while the opportunity exists to do so.

3. Although this survey focused on areas greater than 10 km^2 in size, there are thousands of smaller protected areas across northern Canada that complement the conservation objectives of larger areas. In addition to their inherent conservation value, these smaller areas may also have value as linkages and corridors among the full series of sites. The possible role of these areas as potential cores to build reserve clusters to expand into larger protected areas, or to develop as links for complementary biodiversity conservation, needs further assessment and consideration.

4. The focus for most current protected areas is primarily terrestrial. Nonetheless, many of the sites have significant aquatic components, including both marine and especially freshwater environments and biodiversity. The aquatic realm in existing protected areas needs further assessment, as does systems work to guide the expansion of this domain within protected areas networks.

5. Jurisdictional information and data on existing protected areas for northern Canada is highly variable. The *Canadian Conservation Areas Database* (CCAD) compilation is incomplete and still quite rudimentary in concentrating on basic geographical and administrative attributes. The *Conservation Areas and Reporting Tracking Scheme* (CARTS) initiative is a welcome initiative that should yield a comprehensive tally of protected areas to facilitate future enumerations, assessment and reporting needs. Ideally after the basic CARTS database is fully populated, metrics can be developed to better characterize the biophysical attributes of protected areas and report on biodiversity conservation and target achievement throughout the North.

From the Questionnaire Survey:

1. Specific targets and goals for ecological integrity (i.e., targets for species, communities and ecological processes) should be incorporated into policy and legislation. Doing so will help prevent the term

In northern Canada, future securement of habitats will be achieved through regional land-use planning initiatives, such as those occurring in the Mackenzie Valley. Considerable First Nation and local ecological knowledge will contribute to reserve design.

'ecological integrity' from becoming another buzzword, and will allow for rigorous, measurable standards to be set that can be assessed against scientific criteria.

2. Protected areas practitioners could make more use of models in the planning process. Some may view models as a theoretical academic exercise; however, models help generate hypotheses about the impacts of different management strategies, and as such can form an important component of adaptive protected areas planning and management.

3. Data are too limited. High-resolution satellite data may provide habitat data in difficult-to-survey areas, but are expensive. Data on species demographics are necessary to refine estimates of minimum critical area for protected areas. More resources need to be put into data collection, and this should be carried out with a specific purpose in mind. Research to test the utility of surrogates in biodiversity assessment would be a useful project. If designed in an experimental manner such a project could contribute to the wider research community, aid in protected area selection, engage local communities, and increase knowledge about the region.

4. Protected areas practitioners should have the opportunity to attend a scientific conference at least once a year. Not only will this enable them to stay current on protected areas ecology, it will allow them to share the realities of management with the academic community. Forums such as the Parks Research Forum of Ontario (PRFO), the Parks and Protected Areas Research Forum of Manitoba (PPARFM), the Science and Management of Protected Areas Association (SAMPAA), and the Canadian Council on Ecological Areas (CCEA) conferences and workshops are excellent venues for sharing research findings.

5. More opportunities to share research and management strategies among northern protected areas could be realized via regular reporting. While many agencies publish material on-line or in agency publications, formal intra- and inter-agency reporting could be an effective means of addressing issues common to many northern protected areas. Reports could highlight recent research findings and outline current research activities. As well, if monitoring takes place, reports can synthesize the information gleaned from the monitoring program and make recommendations for legislation, policy, management and future research. Key initiatives also can be reported on the Bulletin Board of CCEA's website at www.ccea.org.

6. Data on the current state of protected areas and associated attribute data is fragmented, and sometimes inconsistent between the *Canadian Conservation Areas Database* (CCAD) and the *North American Conservation Areas Database* (NCAD). *The Conservation Area Reporting and Tracking System* (CARTS) initiative aims to consolidate and standardize Canadian data and reporting, and agencies should be encouraged to actively participate in this project. The CARTS project can help support future research and planning, especially if it includes data on biodiversity and stewardship.

7. There appears to be limited use of socio-economic knowledge in northern protected areas planning. While socio-economic knowledge was not the focus of this report, planning for protected areas that does not take into account economic issues and social values will not be effective. This is particularly true with respect to involvement of local and Aboriginal communities in land-use and protected areas planning.

8. Stewardship of northern protected areas presents a daunting challenge for agencies and jurisdictions mandated to protect them. The ability to cope with many of the issues and challenges is constrained by limited staffing, insufficient resources, and serious limitations of information to complete and to implement management plans. Pooling of expertise and resources, sharing case study experiences, and generally wider reporting of relevant activities could all help to mitigate the operational pressures associated with the ongoing protection and stewardship of northern protected areas.

Conclusion

Protected areas are important components of land-use strategies aimed at conserving biodiversity and maintaining ecological sustainability. In particular, protected areas help to conserve ecosystems, flora and fauna and they provide important benchmarks to assess the effects of surrounding land-uses and global environmental changes.

This report builds upon the earlier work of the Canadian Council on Ecological Areas aimed at promoting and guiding the establishment and management of a comprehensive network of protected areas in Canada designed on the basis of ecological representation, species persistence and ecological integrity.

Although there is a solid foundation of protected areas in northern Canada, significant gaps remain in ecological representation, area integrity and network development. However, legislation, policy and practice across the North offer promise of ongoing progress in stride with conservation science for protected areas.

7. Selected References and Websites of Interest

7.1 References

Andelman, S.J., I. Ball, F. Davis, D. Stoms. 1999. *Sites v. 1.0: An Analytical Toolbox for Designing Ecoregional Conservation Portfolios*. The Nature Conservancy, Arlington, VA.

Andelman, S.J., M.R. Willig. 2003. Present patterns and future prospects for biodiversity in the Western Hemisphere. *Ecology Letters* 6: 818-824.

Anonymous. 1999. *C-Plan: Conservation Planning Software, User Manual, Version 2.2*. National Parks and Wildlife Service, Armidale, NSW, Australia.

Araújo, M.B., C.J. Humphries, P.J. Densham, R. Lampinen, W.J.M. Hagemeijer, A.J. Mitchell-Jones, J.P. Gasc. 2001. Would environmental diversity be a good surrogate for species diversity? *Ecography* 24: 103-110.

Arcese, P., A.R.E. Sinclair. 1997. The role of protected areas as ecological baselines. *Journal of Wildlife Management* 61: 587-602.

Ball, I.R., H.P. Possingham. 1999. *Spexan Manual, Version* 3.1. Adelaide University, Adelaide, South Australia, Australia (available online at www.ecology.uq.edu.au/marxan.htm).

BCO (Biodiversity Convention Office). 1995. *Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity*. Ministry of Supply and Services Canada. Hull, QC. 77 pp.

Beechey, T.J. 1989 *Guidelines for the Selection of Protected Ecological Areas*. CCEA Occasional Paper No. 3. Canadian Council on Ecological Areas, Ottawa, ON. 14 pp.

Beechey, T. J. 2002. Great Lakes protected areas in Ontario: a celebration with a challenge. In: *Parks and Protected Areas Research in Ontario 2002, Proceedings of the Parks Research Forum of Ontario (PRFO) Annual Meeting 2002, April 25, 26 & 27, Ridgetown, Ontario.* (C. J. Lemieux, J. G. Nelson and T. J. Beechey, eds.). Parks Research Forum of Ontario, Waterloo, ON. pp. 7-34.

Beechey, T.J., R.J. Davidson, S.B. Feilders, D.R. Mulrooney. 1998. Science, information and research needs for Ontario's parks and protected areas in the Canadian Shield. In: *Proceedings of the Parks Research Forum of Ontario, Annual General Meeting, February 5 and 6, Peterborough, Ontario.* (J.G. Nelson, K. Van Osch, T.J. Beechey, W.R. Stepehnson, J. Marsh, eds.). Parks Research Forum of Ontario, Waterloo, ON. pp. 11-29.

Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. *Conservation Biology 7*: 94-108.

Bergeron, Y., S. Gauthier, V. Kafka, P. Lefort, D. Lesieur. 2001. Natural fire frequency for the eastern Canadian boreal forest: consequences for sustainable forestry. *Canadian Journal of Forest Research* 31: 384-391.

Bormann, B.T. 1994. *Adaptive ecosystem management in the Pacific Northwest*. US Department of Agriculture. Forest Service. Pacific Northwest Research Station. Portland, OR. 22 pp.

Burns, C.E., K.M. Johnston, O.J. Schmitz. 2003. Global climate change and mammalian species diversity in U.S. national parks. *Proceedings of the National Academy of Science*: 100-11474-11477.

Cabeza, M. 2003. Habitat loss and connectivity of reserve networks in probability approaches to reserve design. *Ecology Letters* 6: 665-672.

Cabeza, M., A. Moilanen. 2001. Design of reserve networks and the persistence of biodiversity. *Trends in Ecology and Evolution* 16: 242-248.

CAFF (Conservation of Arctic Flora and Fauna). 2002. *Protected Areas of the Arctic: Conserving a Full Range of Values*. Habitat Conservation Report No. 10. Ottawa, Canada.40 pp.

Canadian Heritage 1998. *Parks Canada State of the Parks 1997 Report*. Minister of Public Works and Government Services Canada, Ottawa, ON. 190 pp.

Caro. T.M., G. O'Doherty. 1999. On the use of surrogate species in conservation biology. *Conservation Biology* 13: 805-814.

CCEA (Canadian Council on Ecological Areas). 2004. *Canadian Council on Ecological Areas Business Plan 2004-2007.* Canadian Council on Ecological Areas, Ottawa, ON.

Cluff, D., P. Paquet. 2003. Large carnivores as umbrella species for identifying protected areas in the north. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop.* (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 28-31.

Cooch, F.G., J.L. Pagnan. 1996. *Principles and Guidelines for the Conservation of Artic Flora and Fauna*. Habitat Conservation Report No. 4. 12 pp.

Cowling, R.M., R.L. Pressey, A.T. Lombard, P.G. Desmet, A.G. Ellis. 1999. From representation to persistence: requirements for a sustainable system of conservation areas in the species-rich Mediterranean-climate desert of southern Africa. *Diversity and Distributions* 5: 51-71.

Cowling, R.M., R.L. Pressey, M. Rouget, A.T. Lombard. 2003. A conservation plan for a global biodiversity hotspot—the Cape Floristic Region, South Africa. *Biological Conservation* 112: 191-216.

Crins, W.J., P.S.G. Kor. 2000. *Natural Heritage Gap Analysis Methodologies used by the Ontario Ministry of Natural Resources*. Natural Heritage Section, Ontario Ministry of Natural Resources, Peterborough, ON.

Csuti, B., S. Polasky, P.H. Williams, R.L. Pressey, J.D. Camm, M. Kershaw, A.R. Kiester, B. Downs, R. Hamilton, M. Huso, K. Sahr. 1997. A comparison of reserve selection algorithms using data on terrestrial vertebrates in Oregon. *Biological Conservation* 80: 83-97.

Cumming, S.G. 2001. Forest type and wildfire in the Alberta boreal mixedwood: What do fires burn? *Ecological Applications* 11: 97-110.

Dearden, P. 2001. Endangered species and terrestrial protected areas. In: *Politics of the Wild: Canada and Endangered Species*. (K. Beazley, R. Boardman, eds.) Oxford University Press, Toronto, pp. 75-93.

Diamond, J.M. 1975. The island dilemma: lessons of modern biogeographic studies for the design of nature reserves. *Biological Conservation* 7: 129-146.

Ecological Stratification Working Group, 1996. *A National Ecological Framework for Canada*. Agriculture and AgriFood Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of Environment Directorate, Ottawa/Hull. 125 p.

Environment Canada. 2000. *Selecting Core Variables for Tracking Ecosystem Change at EMAN Sites*. Final consultants report prepared by Geomatics International Inc., Guelph Ontario for Environment Canada, EMAN Coordinating Office, Burlington, ON. 28 pp.

Faith, D.P., P.A. Walker. 1996. Environmental diversity: on the best possible use of surrogate data for assessing the relative biodiversity of sets of areas. *Biodiversity and Conservation* 5: 399-415.

Faith, D.P. 2003. Environmental diversity as surrogate information for species-level biodiversity. *Ecography* 26: 374-379.

Fitzsimmons, M. 2003. Effects of deforestation and reforestation on landscape spatial structure in boreal Saskatchewan, Canada. *Forest Ecology and Management* 174: 577-592.

Flather, C.H., K.R. Wilson, D.J. Dean, W.C. McComb. 1997. Identifying gaps in conservation networks: of indicators and uncertainty in geographic-based analyses. *Ecological Applications* 7: 531-542.

Fleishman, E., D.D. Murphy, P.F. Brussard. 2000. A new method for selection of umbrella species for conservation planning. *Ecological Applications* 10: 569-579.

Fleishman, E., R.B. Blair, D.D. Murphy. 2001. Empirical validation of a method for umbrella species selection. *Ecological Applications* 11: 1489-1501.

Foreman, D., K. Daly, B. Dugelby, R. Hanson, R.E. Howard, J. Humphrey, L. Klyza Linck, R. List, K. Vacariu. 2000. *Sky Islands Wildlands Network Conservation Plan*. The Wildlands Project, Tucson, Arizona, USA.

Foreman, D., K. Daly, R. Noss, M. Clark, K. Menke, D.R. Parsons. 2003. *New Mexico Highlands Wildlands Network Vision*. The Wildlands Project, Burlington, Vermont, USA.

Forestry Canada. 1992. *Canada's Model Forest Program: an Initiative for Sustainable Development*. Hull, QC. 16 pp.

Freemark K., H. Moore, D. Forsyth, A. Sinclair, D. White, T. Barrett, R. Pressey. 1999. Identifying sites for conserving biodiversity across Canadian landscapes using a complementarity approach. *Proceedings of Landscape Futures*. Centre for Bioregional Resource Management, UNESCO, Armidale, New South Wales, Australia.

Frid, A. 2001. *Applying Conservation Biology to the Design of Yukon Protected Areas: A Preliminary Framework*. Report to the Yukon Protected Areas Secretariat, Whitehorse, YK.

Galley, K.E.M. (ed.). 2004. *Global Climate Change and Wildlife in North America*. Technical Review 04-2. Technical Review Committee on Global Climate Change and Wildlife. The Wildlife Society. Bethesda, MD.

Gauthier, D. (ed.). 1992. *Canadian Council on Ecological Areas Framework for Developing a Nationwide System of Ecological Areas, Part 1 – A Strategy*. Report of the Systems Framework Task Force. CCEA Occasional Paper No. 12. Canadian Council on Ecological Areas, Ottawa, ON.

Gauthier, D., K. Kavanagh, T. Beechey, L. Goulet, E. Wiken (eds.). 1995. *Canadian Council on Ecological Areas Framework for Developing a Nationwide System of Ecological Areas, Part 2 – Ecoregion Gap Analysis*. CCEA Occasional Paper No. 13. Canadian Council on Ecological Areas, Ottawa, ON.

GBLBRI (Georgian Bay Littoral Biosphere Reserve Incorporated). 2003. *Nomination Submission from Canada for the Georgian Bay Littoral Biosphere Reserve*. Revised Draft, November 2003. Georgian Bay Littoral Biosphere Reserve Inc. (c/o Georgian Bay Foundation), Don Mills, ON. 130 pp + maps.

Gertsch, F., G. Dodds, M. Manseau, J. Amagoalik. 2003. Recent experiences in cooperative management and planning for Canada's northernmost national park: Quttinirpaaq National Park on Ellesmere Island. In: *Making Ecosystem Based Management Work, Proceedings of the Fifth International Conference on Science and Management of Protected Areas*. (N.W.P. Munro, P. Dearden, T.B. Herman, K. Beazley, S. Bondrop-Nielsen, eds.) CD-ROM Proceedings, Chapter 2.

Gonzales, E.K., P. Arcese, R. Schulz, F.L. Bunnell. 2004. Strategic reserve design in the central coast of British Columbia: integrating ecological and industrial goals. *Canadian Journal of Forest Research* 33: 2129-2140.

Government of Canada. 2000. *Statutes of Canada, chapter 32. An Act respecting the National Parks of Canada. Bill C-27.* Assented to October 20, 2000.

Government of Canada. 2001. *Northern Parks: A New Way.* A report of the subcommittee on Aboriginal Economic Development in relation to Northern National Parks of the Standing Senate Committee on Aboriginal Peoples.

Groves, C. 2003. *Drafting a Conservation Blueprint*. Island Press, Washington, DC. 457 pp.

Groves C., L. Valutis, D. Vosick, B. Neely, K. Wheaton, J. Touval and B. Runnels. 2000. *Designing a Geography of Hope: A Practitioner's Handbook for Ecoregional Planning. 2 volumes*. The Nature Conservancy, Arlington, VA.

Grumbine, E. 1990. Protecting biological diversity through the greater ecosystem concept. *Natural Areas Journal* 10: 114-120.

Grumbine, E. 1994. What is ecosystem management? *Conservation Biology* 8: 27-38.

Gunn, A. 2003. Arctic ecosystem conservation: protected areas and beyond. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop*. (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 11-13.

Gurd, D.B., T.D. Nudds. 1999. Insular biogeography of mammals in Canadian parks: a re-analysis. *Journal of Biogeography* 26: 973-982.

Gurd, D.B., T.D. Nudds, D.H. Rivard. 2001. Conservation of mammals in eastern North American wildlife reserves: how small is too small? *Conservation Biology* 15: 1355-1363.

Halpin, P.N. 1997. Global climate change and natural-area protected: management responses and research directions. *Ecological Applications* 7: 828-843.

Hassol, S. 2005. *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*. Cambridge University Press, UK. 139 pp.

Haufler, J.B. 1999. Strategies for conserving terrestrial biological diversity. In: *Practical Approaches to the Conservation of Biological Diversity.* (R.K. Baydack, H. Campa III, and J.B. Haufler, eds.) Island Press, Washington, DC, pp. 17-34.

Henderson, L. 1994. Legal tools for protected areas in the north: opportunities and obstacles. In: *Northern Protected Areas and Wilderness*. (J. Peepre and B. Jickling, eds.) Canadian Parks and Wilderness Society and Yukon College, Whitehorse, YK, pp. 164-177.

Hiedanpää, J. 2002. European-wide conservation versus local well-being: the reception of the Natural 2000 reserve network in Kariva, SW-Finland. *Landscape and Urban Planning* 61: 113-123.

Holling, C.S. (ed.). 1978. *Adaptive Environmental Assessment and Management*. John Wiley: London. 377 pp.

Huff, M.H. 1994. *Applications of Ecosystem Management: Expanding Horizons of Forest Ecosystem Management: Proceedings of the Third Habitat Futures Workshop*. US Department of Agriculture, Forest Service. Pacific Northwest Research Station. Portland, OR. 100 pp.

Hummel M. (Ed.). 1995. *Protecting Canada's Endangered Spaces: An Owner's Manual*. Key Porter, Toronto, ON. 251 pp.

Hunter, M.L. Jr. 1993. Natural fire regimes as spatial models for managing boreal forests. *Biological Conservation* 65: 115-120.

Jalava, J. V., W. L. Cooper and J. L. Riley. 2005. *Ecological Survey of the Eastern Georgian Bay Coast*. Nature Conservancy of Canada, Toronto and Ontario Ministry of Natural Resources, Peterborough, ON. 180 pp.

Jenkins, R.E., W.B. Bedford. 1973. The use of natural areas to establish environmental baselines. *Biological Conservation* 5: 168-174.

Jonsson, B.G., M. Jonsell. 1999. Exploring potential biodiversity indicators in boreal forests. *Biodiversity and Conservation* 8: 1417-1433.

Kennett, K. 1994. Ecoregions, biodiversity and representative protected areas. In: *Northern Protected Areas and Wilderness*. (J. Peepre, B. Jickling, eds.) Canadian Parks and Wilderness Society and Yukon College, Whitehorse, YK, pp. 78-82.

Kintsch, J.A., D.L. Urban. 2002. Focal species, community representation, and physical proxies as conservation strategies: a case study in the Amphibolite Mountains, North Carolina, USA. *Conservation Biology* 16: 936-947.

Kremen, C. 1992. Assessing the indicator properties of species assemblages for natural areas monitoring. *Ecological Applications* 2: 203-217.

Landry, M., V.G. Thomas, T.D. Nudds. 2001. Sizes of Canadian National Parks and the viability of large mammal populations: policy implications. *The George Wright Forum* 18: 13-23.

Lopoukhine, N. 1998. Protected areas in the next millennium: managing for ecological integrity. In: *Proceedings of the Parks Research Forum of Ontario, Annual General Meeting, February 5 and 6, 1998, Peterborough, Ontario*. (J.G. Nelson, K. Van Osch, T.J. Beechey, W.R. Stephenson, J. Marsh, eds.). Parks Research Forum of Ontario, Waterloo, ON, pp. 49-64.

MacArthur, R.H., E.O. Wilson. 1967. *The Theory of Island Biogeography*. Princeton University Press, Princeton, NJ.

Madill, H. 2003. The Muskwa-Kechika management area: applying the management model. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop*. (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 47-50.

Manitoba Natural Resources. 1998. *A System Plan for Manitoba's Provincial Parks*. Manitoba Department of Natural Resources, Parks and Natural Areas Branch, Winnipeg, MB. 63 pp.

Margules, C.R., A.O. Nicholls, R.L. Pressey. 1988. Selecting networks of reserves to maximize biological diversity. *Biological Conservation* 43: 63-76.

McKenzie, S. 2003. Nành' Geenjit Gwitr'it T'igwaa'in – Working for the Land: The Gwich'in Land Use Plan. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop.* (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 67-70.

Meese, R.J., V.M. Neronov, G.M. Alestchenko, M. Ruggiero. 2003. Rapid acquisition and dissemination of standardized biological inventories from Russian Biosphere Reserves. *Biodiversity and Conservation* 12: 1421-1429.

Mier, E., S. Andelman, H.P. Possingham. 2004. Does conservation planning matter in a dynamic and uncertain world? *Ecology Letters* 7: 615-622.

Miller, B., R. Reading, J. Strittholt, C. Carroll, R. Noss, M. Soulé, O. Sanchez, J. Terborgh, D. Brightsmith, T. Cheeseman, D. Foreman. 1998/99. Using focal species in the design of nature reserve networks. *Wild Earth* 8: 81-92.

Miller, B., D. Foreman, M. Fink, D. Shinneman, J. Smith, M. DeMarco, M. Soulé, R. Howard. 2003. *A Southern Rockies wildlands network vision*. Colorado Mountain Club Press, Boulder, Colorado, USA. 248 pp.

Ministry of Environment, Lands and Parks. 1997. *BC Parks Conservation Program Policies*. Government of British Columbia.

Moore, S., P. Latour. 2003. Rapid ecological assessment of candidate protected areas in the Northwest Territories. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop*. (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 32-33.

National Forest Strategy Coalition. 2003. *A Sustainable Forest: The Canadian Commitment*. National Forest Strategy 2003-2008. Ottawa, ON. 27pp.

NCC (The Nature Conservancy of Canada). 2003. *Looking North: A Review of Conservation Opportunities in Central and Northern Canada*. The Nature Conservancy of Canada, Toronto, ON.

NCC and NHIC (The Nature Conservancy of Canada and Ontario Natural Heritage Information Centre). 2004. *Great Lakes Conservation Blueprint for Terrestrial Biodiversity*. 2 volumes. Queens, Printer for Ontario. Toronto, ON.

Nelson, J.G., J.C. Day, L.M. Sportza, J. Loucky, C. Vasquez. (eds.). 2003. *Protected Areas and the Regional Planning Imperative in North America*. University of Calgary Press, Calgary AB and Michigan State University Press, East Lansing, MI. 429 pp.

Nettleship, D.N. and P.A Smith (eds.). 1975. *Ecological Sites in Northern Canada*. Canadian Committee for the International Biological Programme, Conservation Terrestrial—Panel 9. Ottawa, ON. 330 pp.

Newmark, W.D. 1993. The role and design of wildlife corridors with examples from Tanzania. *Ambio* 22: 500-504.

Newmark, W.D. 1995. Extinction of mammal populations in western North American National Parks. *Conservation Biology* 9: 512-526.

Newmark, W.D. 1996. Insularization of Tanzanian parks and the local extinction of large mammals. *Conservation Biology* 10: 1549-1556.

Noble, T.W., P.S.G. Kor. 1982. *An Annotated Bibliography of Ecological Criteria as applied to Size and Boundary Determinations of Large Protected Natural Areas*. Open File Report, Parks and Recreational Areas Branch, Ontario Ministry of Natural Resources, Toronto, ON.

Northwest Territories Biodiversity Team. 2004. *Northwest Territories Biodiversity Action Plan – Major Initiative on Biodiversity*. Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories. Yellowknife, NT.

Northwest Territories Protected Areas Strategy Advisory Committee. 1999. *Northwest Territories Protected Areas Strategy: A Balanced Approach to establishing Protected Areas in the Northwest Territories*. Unpublished report.

Noss, R.F. 1987. Corridors in a real landscape: a reply to Simberloff and Cox. *Conservation Biology* 1: 159-164.

Noss, R.F. 1992. The wildlands project: land conservation strategy. *Wild Earth* Special Issue: 10-25.

Noss, R.F., L.D. Harris. 1986. Nodes, networks and MUMs: preserving diversity at all scales. *Environmental Management* 10: 299-309.

Noss, R.F., C. Carroll, K. Vance-Borland, G. Wuerthner. 2002. A multicriteria assessment of the irreplaceability and vulnerability of sites in the Greater Yellowstone Ecosystem. *Conservation Biology* 16: 895-908.

Nudds, T.D. 1999. Adaptive management and the conservation of biodiversity. In: *Practical Approaches to the Conservation of Biological Diversity*. (R.K. Baydack, H. Campa III, J.B. Haufler, eds.) Island Press, Washington, DC, pp. 179-193.

O'Donoghue, B. 2002. Great Lakes heritage coast: opportunities for protection and community development. In: *Parks and Protected Areas Research in Ontario 2002, Proceedings of the Parks Research Forum of Ontario (PRFO) Annual Meeting 2002, April 25, 26, & 27, Ridgetown, Ontario*. (C. J. Lemieux, J. G. Nelson and T. J. Beechey, eds.). Parks Research Forum of Ontario, Waterloo, ON. pp. 57-63.

OMNR. 1997a. *Lands for Life: A Commitment to the Future*. Queen's Printer for Ontario, Toronto, ON. 11 pp.

OMNR. 1997b. *Nature's Best, Ontario Parks and Protected Areas: The Framework and Action Plan*. Queen's Printer for Ontario, Toronto, ON. 37 pp.

OMNR (Ontario Ministry of Natural Resources). 1999. *Ontario's Living Legacy Land Use Strategy*. Queen's Printer for Ontario, Toronto, ON. 136 pp.

OLL (Ontario's Living Legacy). 2002. *Approved Land Use Strategy*. On-line document: (www.ontarioslivinglegacy.com). Queen's Printer for Ontario.

Parks Canada. 1997. *National Parks System Plan*. Parks Canada, Ottawa, ON. 106 pp.

Parks Canada Agency 2000. *"Unimpaired for Future Generations"? Conserving Ecological Integrity with Canada's National Parks. Vol. II. Setting a New Direction for Canada's National Parks*. Report of the Panel on the Ecological Integrity of Canada's National Parks. Minister of Public Works and Government Services, Ottawa, ON.

Peterson, E.B., N.M. Peterson, D.F.W. Pollard. 1995. Some principles and criteria to make Canada's protected areas systems representative of the nation's forest diversity. *Forestry Chronicle* 71: 497-507.

Peterson, E.B., N.M. Peterson. 1991. *A First Approximation of Principles and Criteria to make Canada's Protected Areas Systems Representative of the Nation's Ecological Diversity*. Occasional Paper No. 11. Canadian Council on Ecological Areas, Ottawa, ON. 65 pp.

Pickett, S.T.A., J.N. Thompson. 1978. Patch dynamics and the design of nature reserves. *Biological Conservation* 13: 27-37.

Poiani, K., B. Richter, 1999. *Functional Landscapes and the Conservation of Biodiversity*. Working Papers in Conservation Science No. 1, the Nature Conservancy, Arlington, VA.

Poser, S.F., W.J. Crins, T.J. Beechey. 1992. *Size and Integrity Standards for Natural Heritage Areas in Ontario*. Proceedings of a Seminar held at The Royal Ontario Museum, June 3, 1992. Provincial Parks and Natural Heritage Policy Branch, Ontario Ministry of Natural Resources, Toronto, ON. 138 pp.

Pressey, R.L., C.J. Humphries, C.R. Margules, R.I. Van-Wright, P.H. Williams. 1993. Beyond opportunism: key principles for systematic reserve selection. *Trends in Ecology and Evolution*. 8: 124-128.

Pressey, R.L., H.P. Possingham, C.R. Margules. 1996. Optimality in reserve selection algorithms: when does it matter and how much? *Biological Conservation* 76: 259-267.

Purchase, D. 2003. The Northwest Territories protected areas strategy: background. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop*. (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 52-55.

Reid, R. 2002. *Practical Options for the Greening of Carolinian Canada*. Bobolink Enterprises and The Carolinian Canada Coalition.

Revel. R.D. 1981. Conservation in northern Canada: International Biological Programme sites revisited. *Biological Conservation* 21: 263-287.

Rivard, D.H., J. Poitevin, D. Plasse, M. Carleton, D.J. Currie. 2000. Changing species richness and composition in Canadian national parks. *Conservation Biology* 14:1099-1109.

Robbins, M. 2005. Territorial parks, coastal guardians and other concepts for First Nations involvement in the Great Lakes heritage coast. In: *Social Science in Parks and Protected Areas, Proceedings of a Symposium held at Algonquin Provincial Park Visitor Centre, March 2003*. PRFO Occasional Paper #3. Algonquin Provincial Park, Whitney and Parks Research Forum of Ontario, Waterloo, ON. pp. (Tom to check this reference)

Rodrigues, A.S.L, R.D. Gregory, K.J. Gaston. 2000a. Robustness of reserve selection procedures under temporal species turnover. *Proceedings of the Royal Society of London B*. 267: 49-55.

Rodrigues, A.S.L., K.J. Gaston, R.D. Gregory. 2000b. Using presence-absence data to establish reserve selection procedures that are robust to temporal species turnover. *Proceedings of the Royal Society of London B*. 267: 897-902.

Rodrigues, A.S.L., K.J. Gaston. 2001. How large do reserve networks need to be? *Ecology Letters* 4: 602-609.

Saskatchewan Biodiversity Interagency Steering Committee. 2005. *Caring for Natural Environments: A Biodiversity Action Plan for Saskatchewan's Future 2004-2009*. Government of Saskatchewan.

Schmiegelow, F.K.A., S.G. Cumming, S. Harrison, S. Leroux, K. Lisgo, R. Noss, B. Olsen. In review. Conservation beyond crisis management: a reverse-matrix model: A Discussion Paper for the Canadian BEACONs Project. *Ecological Letters*.

Schoenwald-Cox, C.M., R.J. Baker, J.W. Bayless.1988. Applying the population/area model to the planning of large mammal translocation. In: *Translocation of wild animals*. (L. Nielsen, R.D. Brown, eds.) The Wisconsin Humane Society and Caesar Kleberg Wildlife Institute, Kingsville, Wisconsin, pp. 52-63.

Schwartz, M.W. 1999. Choosing the appropriate scale of reserves for conservation. *Annual Review of Ecology and Systematics* 30: 83-108.

Scott, D. 2003. Climate change and conservation: challenges at the science-management interface. In: *Making Ecosystem Based Management Work, Proceedings of the Fifth International Conference on Science and Management of Protected Areas*. (N.W.P. Munro, P. Dearden, T.B. Herman, K. Beazley, S. Bondrop-Nielsen, eds.) CD-ROM Proceedings, Chapter 3.

Scott, D., J.R. Malcolm, C. Lemieux. 2002. Climate change and modelled biome representation in Canada's national park system: implications for system planning and park mandates. *Global Ecology and Biogeography* 11: 475-484.

Scott, J.M., E.A. Norse, H. Arita, A. Dobson, J.A. Estes, M. Foster, B. Gilbert, D.B. Jensen, R.L. Knight, D. Mattson, M.E. Soulé. 1999. The issues of scale in selecting and designing biological reserves. In: *Continental Conservation: scientific foundations of regional reserve networks*. (M.E. Soulé, J. Terborgh, eds.) Island Press, Washington, DC, pp. 19-37.

Seale, R. 1998. Parks past, present, future: a northern perspective. In: *Changing Parks: The History, Future and Cultural Context of Parks and Heritage Landscapes*. (J.S. Marsh and B.W. Hodgins, eds.) Natural Heritage/ Natural History Inc. Toronto, pp. 250-255.

Shafer, C.L. 1995. Values and shortcomings of small reserves. *BioScience* 45: 80-88.

Shaffer, M. L., F. B. Samson. 1985. Population size and extinction: a note on determining critical population sizes. *The American Naturalist* 125:144-152.

Simberloff, D. 1998. Flagships, umbrellas, and keystones: is single-species management passé in the landscape era? *Biological Conservation* 83: 247-257.

Simberloff, D., J. Cox. 1987. Consequences and costs of conservation corridors. *Conservation Biology* 1: 63-71.

Simberloff, D., J.A. Farr, J. Cox, J., D.W. Mehlman. 1992. Movement corridors: conservation bargains or poor investments? *Conservation Biology* 6: 493-504.

Soulé, M.E., J. Terborgh (eds.). 1999. *Continental Conservation: Scientific Foundations of Regional Reserve Networks*. Island Press, Washington DC. 227 pp.

Suffling, R., D. Scott. 2002. Assessment of climate change effects on Canada's national parks system. *Environmental Monitoring and Assessment* 74: 117-139.

Suter, W., R.F. Graf, R. Hess. 2002. Capercaillie (*Tetrao urogallus*) and avian biodiversity: testing the umbrella-species concept. *Conservation Biology* 16: 778-788.

Tate, D.P. 2003. Expanding Nahanni National Park Reserve – the contributions of research, consultation and negotiation. In: *Making Ecosystem Based Management Work, Proceedings of the Fifth International Conference on Science and Management of Protected Areas*. (N.W.P. Munro, P. Dearden, T.B. Herman, K. Beazley, S. Bondrop-Nielsen, eds.) CD-ROM Proceedings, Chapter 9.

The Nature Conservancy. No date. *Five S Framework for Site Conservation Planning: A Practitioners Handbook for Site Conservation Planning and Measuring Conservation Success*. Available from Jeff Baumgartner (jbaumgartner@tnc.org)

Thompson D. 1998. Parks and protected areas – integrating the ecological, social, and economic context in land use planning – lessons from British Columbia. In: *Parks and Protected Areas Research in Ontario in 1998, Proceedings of the Parks Research Forum of Ontario (PRFO) Annual General Meeting, February 5 & 6, Peterborough, Ontario* (J.G. Nelson, K. VanOsch, T.J. Beechey, W.J. Stephenson, J. Marsh, eds.) Parks Research Forum of Ontario, University of Waterloo, Waterloo, ON, pp. 80-92.

Turner, A.M. & Associates. 2002. *The State of Federal Protected Areas for Wildlife* (SOFPAW). Habitat Conservation Branch, Canadian Wildlife Service, Environment Canada. Ottawa, ON. 49 pp.

Underhill, L.G. 1994. Optimal and suboptimal reserve selection algorithms. *Biological Conservation* 70: 85-87.

Urban, D.L. 2002. Prioritizing reserves for acquisition. In: *Learning Landscape Ecology: A Practical Guide to Concepts and Techniques*. (S.E. Gergel, M.G. Turner, eds.) Springer-Verlag, New York, pp. 293-305.

Wall, W.A. 1999. Maintaining biodiversity in an intensively managed forest: a habitat-based planning process linked with a fine-filtered adaptive management approach. In: *Practical Approaches to the Conservation of Biological Diversity*. (R.K. Baydack, H. Campa III, J.B. Haufler, eds.) Island Press, Washington, DC, pp. 127-140.

Wallner, A. 2003. Local people's perception of protected areas: a cross-cultural study. In: *Making Ecosystem Based Management Work, Proceedings of the Fifth International Conference on Science and Management of Protected Areas*. (N.W.P. Munro, P. Dearden, T.B. Herman, K. Beazley, S. Bondrop-Nielsen, eds.) CD-ROM Proceedings, Chapter 1.

Walters, C.J. 1986. *Adaptive Management of Renewable Resources*. Macmillan: New York. 374 pp.

Warman, L.D., D.M. Forsyth, A.R.E. Sinclair, K. Freemark, H.D. Moore, T.W. Barrett, R.L. Pressey, D. White. 2004. Species distributions, surrogacy, and important conservation regions in Canada. *Ecology Letters* 7: 374-379.

Wenig, M.M. 2003. Integrating protected area strategies and minerals management – a comparison of four Canadian strategies. In: *Making Ecosystem Based Management Work, Proceedings of the Fifth International Conference on Science and Management of Protected Areas*. (N.W.P. Munro, P. Dearden, T.B. Herman, K. Beazley, S. Bondrop-Nielsen, eds.) CD-ROM Proceedings, Chapter 7.

Wiebe, H. and Cizek, P. 2003. Protected land and water in the Deh Cho, Northwest Territories. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop.* (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 64-66.

Wiersma, Y.F. (ed.). 2003. *Designing Protected Areas: Wild Places for Wildlife. Summary and Proceedings of the Canadian Council on Ecological Areas and Circumpolar Protected Areas Workshop*. September 9-10, Yellowknife, Northwest Territories. 97 pp.

Wiersma, Y.F. 2005. Environmental benchmarks vs. ecological benchmarks in assessment and monitoring in Canada: is there a difference? *Environmental Monitoring and Assessment* 100: 1-9.

Wiersma, Y.F., M. Campbell. 2002. A monitoring framework for Canada's National Parks: assessing integrity across a system. In: *Managing Protected Areas in a Changing World, Proceedings of the Fourth International Conference on Science and Management of Protected Areas*. (S. Bondrop-Nielsen, N.W.P. Munro, eds.), Science and Management of Protected Areas Association, Wolfville, NS, pp. 196-212.

Wiersma, Y.F., T.D. Nudds. 2001. Comparison of methods to estimate historic species richness of mammals for tests of faunal relaxation in Canadian Parks. *Journal of Biogeography* 28: 447-452.

Wiersma, Y.F., T.D. Nudds. 2003. On the fraction of land needed for protected areas. In: *Making Ecosystem Based Management Work, Proceedings of the Fifth International Conference on Science and Management of Protected Areas*. (N.W.P. Munro, P. Dearden, T.B. Herman, K. Beazley, S. Bondrop-Nielsen, eds.) CD-ROM Proceedings, Chapter 7.

Wiersma, Y.F., T.D. Nudds, D.H. Rivard. 2004. Models to distinguish effects of landscape patterns and human population pressures associated with species loss in Canadian national parks. *Landscape Ecology* 19: 773-786.

Wiersma, Y.F., D.L. Urban. 2005. Beta diversity and nature reserve system design: a case study from the Yukon. *Conservation Biology* 19: 1262-1272.

Wiken, E.D. (ed.) 1999. Measuring up responsibly: assessing protected areas through state of environment reporting and indicators. *George Wright Forum* 16:2 (Special Issue)

Wiken, E.D. 2003. Status of northern protected areas: protecting biodiversity at the habitat and ecosystem levels. In: *Designing Protected Areas: Wild Places for Wildlife: Proceedings summary of the 2003 Canadian Council on Ecological Areas (CCEA) and Circumpolar Protected Areas Network (CPAN) Workshop.* (Y. Wiersma, ed.) Canadian Council on Ecological Areas, Ottawa, pp. 6-9.

Wiken, E.B., D. Gauthier, I. Marshall. K. Lawton and H. Hirvonen. 1996. *A Perspective on Canada's Ecosystems: An Overview of the Terrestrial and Marine Ecozones*. Canadian Council on Ecological Areas (CCEA). Occasional Paper No. 14. Ottawa, ON. 69pp

Wildlife Habitat Canada. 2001. *The Status of Wildlife Habitats in Canada's Arctic Landscapes*. Wildlife Habitat Canada's National Habitat Status Series. No. 6. Ottawa, ON. 15 pp.

Woodley, S., J. Kay, G. Francis. (eds.). 1993. *Ecosystem Integrity and the Management of Ecosystems*. St. Lucie Press, Delray Beach, FL.

YPAS (Yukon Protected Areas Strategy). 1998. *Types of Protected Areas and Criteria for Selection*. Technical Paper No. 2. Department of Renewable Resources, Yukon Government.

7.2 Websites

Provincial and Territorial Protected Areas Agencies

British Columbia Parks: www.env.gov.bc.ca/bcparks

Alberta Parks: www.cd.gov.ab.ca/preserving/parks/index.asp

Manitoba Parks: www.gov.mb.ca/conservation/parks

Newfoundland and Labrador Parks: www.gov.nf.ca/parksandreserves/

Northwest Territories Parks: www.enr.gov.nt.ca/pas

Nunavut Parks: www.nunavutparks.com

Ontario Parks: www.ontarioparks.com

Québec Parks: www.fapaq.gouv.qc.ca/en/park_que/parc_que.htm

Saskatchewan Parks: www.se.gov.sk.ca/saskparks/

Yukon Parks: www.environmentyukon.gov.yk.ca/parks

Federal Protected Areas Agencies

Environment Canada: www.ec.gc.ca

Fisheries and Oceans Canada: www.dfo-mpo.gc.ca

Parks Canada: www.parkscanada.gc.ca

International Protected Areas Agencies

IUCN – World Commission on Protected Areas: www.iucn.org/themes/wcpa

Ramsar: www.ramsar.org

United Nations Environment Program — World Conservation Monitoring Centre Protected Areas Programme: www.unep-wcmc.org/protected_areas/data

UNESCO Man and the Biosphere Program: www.unesco.org/mab, or www.biosphere-canada.ca

UNESCO World Heritage Sites: http://whc.unesco.org

Convention: http://whc.unesco.org/nwhc/pages/doc/main.htm

World Resources Institute. Earth Trends: The Environmental Information Portal: www.earthrends.wri.org

Non-government Environmental Organizations

Canadian Boreal Initiative: www.borealcanada.ca

Canadian Heritage Rivers System: www.chrs.ca

Canadian Nature Federation: www.cnf.ca

Canadian Parks and Wilderness Society: www.cpaws.org

Ducks Unlimited Canada: www.ducks.ca

The George Wright Society: www.georgewright.org

The Muskwa-Kechika Management Area: www.muskwa-kechika.com

The Nature Conservancy of Canada: www.natureconservancy.ca

The Nature Conservancy (USA): www.nature.org

Sierra Legal Defence Fund: www.sierralegal.org

Widlife Habitat Canada: www.whc.org

World Wildlife Fund Canada: www.wwfcanada.org

The Yellowstone to Yukon Initiative: www.y2y.net

Academic, Intergovernmental, and Professional Societies

Canadian Council on Ecological Areas (CCEA): www.ccea.org

Canadian Arctic Resources Committee (CARC): www.carc.org

Canadian Circumpolar Institute: www.ualberta.ca/~ccinst/

Conservation of Arctic Flora and Fauna (CAFF): www.caff.is

Science and Management of Protected Areas Association (SAMPAA): www.sampaa.org

University of the Arctic: www.dfait-maeci.gc.ca/circumpolar/

The BEACONs (Boreal Ecosystems Analysis for Conservation Networks) Project: www.rr2.ualberta.ca/Research/Beacons/

Conservation Planning Tools and Software

C-Plan: http://members.ozemail.com.au/~cplan/

SITES/MARXAN: www.ecology.uq.edu.au/?page=20882andpid=

PORTFOLIO: www.nicholas.duke.edu/landscape

Conservation Action Planning (CAP) Toolkit: http://conserveonling.org/workspaces/cap/toolkit

CCP GIS Tools (USGS): http://www.umesc.usgus.gov/management/dss/gis_tools_for_conservation_planning.html

CLUZ: http://www.mosaic-conservation.org/cluz/index.html

CODA: http://members.ozemail.com.au/~mbedward/coda/coda.html

Corridor Tool: http://climate.ornl.gov/~forrest/pubs/Lozar_CorridorTool_TR.pdf

MIST: http://www.berggorilla.de/english/gjournal/tested/23mist.html

Nature Serve's Vista software: http://natureserve.org/prodServices/vist.jsp

PANDA: http://www.ecology.uq.edu.au/index.html?page=36767&pid=27710

Prisma: http://gis.esri.com/library/userconf/proc00/professional/papers/PAP307/p307.htm

ResNet: http://uts.cc.utexas.edu/~consbio/Cons/ResNet.html

Smart Conservation: http://www.smartconservation.org/scmAbout.asp

SPEXAN: http://www.biogeog.ucsb.edu/projects/tnc/copy%20of%20download.html

Worldmap: http//www.nhm.ac.uk/research-curation/projects/worldmap/

Species Data

Nature Serve: www.natureserve.org

Appendix A. Jurisdictional Listing of Protected Areas >10 km^2 in the (NPA) Study Area

Sources:

Canadian Conservation Areas Database (CCAD)

North American Conservation Areas Database (NCAD)

Alberta Community Development website

Saskatchewan Parks website

Personal communications:

Sian French and Nicole Lights, Government of Newfoundland and Labrador

Frances Gertsch, Parks Canada

Joyce Gould, Government of Alberta

Helios Hernandez, Government of Manitoba

Monique Kuyvenhoven and Rick Phillips, Ontario Parks

John Meikle, Yukon Government

Bas Oosenbrug, Government of Northwest Territories

Jacques Perron, Gouvernement du Québec

Wayne Schick and Fred Beek, Government of Saskatchewan

Please note: The CARTS (Conservation Areas Reporting and Tracking System) initiative is in the process of consolidating and updating protected areas data across the country. This appendix should be viewed as part of the CARTS updating process, but when completed, the CARTS database will override the listing below. IUCN categories are described in Appendix B.

Jurisdiction	Name	Size (km^2)[1]	Type of Protected Area	IUCN Category
Alberta	Athabasca Dunes	37.74	Ecological Reserve	I
Alberta	Goose Mountain	12.46	Ecological Reserve	I
Alberta	Holmes Crossing Sandhills	19.83	Ecological Reserve	I
Alberta	Silver Valley	18.05	Ecological Reserve	I
Alberta	Carson Pegasus	12.10	Provincial Park	II
Alberta	Colin-Cornwall Lakes	704.28	Provincial Park	II
Alberta	Fidler-Greywillow	65.21	Provincial Park	II
Alberta	Hilliard's Bay	23.23	Provincial Park	II
Alberta	La Butte Creek	181.46	Provincial Park	II
Alberta	Lesser Slave Lake	75.66	Provincial Park	II
Alberta	Marguerite Crag and Tail	313.53	Provincial Park	II
Alberta	Maybelle River	153.09	Provincial Park	II
Alberta	Moonshine Lake	11.03	Provincial Park	II

[1] Area figures are those provided by sources and have not been rounded off for this summary.

Alberta	Notikewin	96.97	Provincial Park	II
Alberta	Winagami	12.12	Provincial Park	II
Alberta	Wood Buffalo, Alberta portion	35 580	National Park	II
Alberta	Young's Point	30.72	Provincial Park	II
Alberta	Harper Creek	26.2	Natural Area	IV
Alberta	Jack Pines	18.59	Natural Area	IV
Alberta	Pine Sands	13.5	Natural Area	IV
Alberta	Richardson Lake	116.62	Migratory Bird Sanctuary	IV
Alberta	Sand Lake	28.44	Natural Area	IV
British Columbia	Grayling River Hot Springs	14.21	Ecological Reserve	Ia
British Columbia	Gladys Lake	430.40	Ecological Reserve	1a
British Columbia	Sikanni Chief River	24.73	Ecological Reserve	Ia
British Columbia	Smith River	13.90	Ecological Reserve	Ia
British Columbia	Atlin	2065.75	Provincial Park	II
British Columbia	Bearhole Lake	127.05	Recreation Area	II
British Columbia	Bearhole Lake	47.55	Provincial Park	II
British Columbia	Boya Lake	45.97	Provincial Park	II
British Columbia	Chase Park	362.26	Provincial Park	II
British Columbia	Chukachida	196.37	Protected Area	II
British Columbia	Denetiah	903.79	Provincial Park	II
British Columbia	Denetiah Corridor	74.14	Protected Area	II
British Columbia	Dune Za Keyih	3307.74	Provincial Park	II
British Columbia	Dune Za Keyih	160.59	Protected Area	II
British Columbia	Ed Bird-Estella Lakes	55.68	Provincial Park	II
British Columbia	Ekwan Lake	15.25	Protected Area	II
British Columbia	Finlay-Russel	1092.14	Provincial Park	II
British Columbia	Finlay-Russel	135.66	Protected Area	II
British Columbia	Graham-Laurier	990.04	Provincial Park	II
British Columbia	Gwillim Lake	323.26	Provincial Park	II
British Columbia	Hay River	23.23	Provincial Park	II
British Columbia	Kinaskan Lake	18.00	Provincial Park	II
British Columbia	Klua Lakes	280.18	Provincial Park	II
British Columbia	Kwadacha Wilderness	1302.79	Provincial Park	II
British Columbia	Liard River Corridor	831.59	Provincial Park	II
British Columbia	Liard River Corridor	47393	Protected Area	II
British Columbia	Liard River Hot Springs	10.82	Provincial Park	II
British Columbia	Liard River West Corridor	19.03	Provincial Park	II
British Columbia	Maxhamish Lake	265.87	Protected Areas	II
British Columbia	Milligan Hills	72.26	Provincial Park	II
British Columbia	Mount Edziza	2660.95	Provincial Park	II
British Columbia	Muncho Lake	884.20	Provincial Park	II
British Columbia	Northern Rocky Mountains	6657.09	Provincial Park	II
British Columbia	Peace River Corridor	20.14	Provincial Park	II
British Columbia	Pitman River	163.16	Protected Area	II
British Columbia	Redrern-Keily	807.12	Provincial Park	II
British Columbia	Scatter River Old Growth	11.40	Provincial Park	II

British Columbia	Sikanni Chief Canyon	46.41	Protected Area	II
British Columbia	Sikanni Old Growth	14.39	Provincial Park	II
British Columbia	Spatsizi Plateau Wilderness	6963.60	Provincial Park	II
British Columbia	Stikine River	2571.77	Provincial Park	II
British Columbia	Stone Mountain	256.90	Provincial Park	II
British Columbia	Tatlatui	1058.29	Provincial Park	II
British Columbia	Tatshenshini-Alsek	9470.26	Wilderness Park	II
British Columbia	Thinahtea North	37.74	Protected Area	II
British Columbia	Thinahtea South	167.05	Protected Area	II
British Columbia	Todagin South Slope	35.57	Provincial Park	II
British Columbia	Tuya Mountains	180.01	Provincial Park	II
Manitoba	Baralzon Lake	390	Ecological Reserve	I
Manitoba	Long Point	16	Ecological Reserve	I
Manitoba	Sand Lakes	8310	Provincial Park	I
Manitoba	Wapusk	11 475	National Park	II
Manitoba	Caribou River	7640	Provincial Park	II
Manitoba	Clearwater Lake	595.7	Provincial Park	II
Manitoba	Duck Mountain	1274	Provincial Park	II
Manitoba	Elk Island	10	Provincial Park	II
Manitoba	Grass River	2289.6	Provincial Park	II
Manitoba	Grindstone	258.41	Provincial Park	II
Manitoba	Hecla	863.09	Provincial Park	II
Manitoba	Numaykoos Lake	3600	Provincial Park	II
Manitoba	Paint Lake	226.6	Provincial Park	II
Manitoba	Atikaki Wilderness	4668.41	Provincial Park	IV
Manitoba	Basket Lake**	71.9	Wildlife Management Area	IV
Manitoba	Broad Valley*	36.92	Wildlife Management Area	IV
Manitoba	Cape Churchill**	18 772	Wildlife Management Area	IV
Manitoba	Catfish Creek**	62.81	Wildlife Management Area	IV
Manitoba	Cayer	14.89	Wildlife Management Area	IV
Manitoba	Dog Lake	323.89	Wildlife Management Area	IV
Manitoba	Grahamdale**	14.89	Wildlife Management Area	IV
Manitoba	Gypsumville**	24.65	Wildlife Management Area	IV
Manitoba	Hilbre	35.27	Wildlife Management Area	IV
Manitoba	Inwood**	27.19	Wildlife Management Area	IV
Manitoba	Lee Lake**	69.66	Wildlife Management Area	IV
Manitoba	Little Birch*	228.02	Wildlife Management Area	IV
Manitoba	Lundar**	11.01	Wildlife Management Area	IV
Manitoba	Mantagao Lake*	503.39	Wildlife Management Area	IV
Manitoba	Marshy Point	14.9	Wildlife Management Area	IV
Manitoba	Narcisse*	137.81	Wildlife Management Area	IV
Manitoba	Peonan Point	23.39	Wildlife Management Area	IV
Manitoba	Point River**	33.7	Wildlife Management Area	IV
Manitoba	Rembrant**	13.6	Wildlife Management Area	IV
Manitoba	Sandridge**	18.79	Wildlife Management Area	IV
Manitoba	Saskeram**	966.48	Wildlife Management Area	IV

Manitoba	Sharpewood**	22.66	Wildlife Management Area	IV
Manitoba	Sleeve Lake	149.64	Wildlife Management Area	IV
Manitoba	Steeprock**	18.9	Wildlife Management Area	IV
Manitoba	Tom Lamb**	2179.6	Wildlife Management Area	IV
Manitoba	Washow Bay*	13.92	Wildlife Management Area	IV
Manitoba	Westlake*	57.39	Wildlife Management Area	IV
Manitoba	Alonsa	131.65	Community Pasture	V
Manitoba	Birch River	14.78	Community Pasture	V
Manitoba	Cape Tatnam**	5222.6	Wildlife Management Area	V
Manitoba	Dauphin-Ethelbert	100.42	Community Pasture	V
Manitoba	Duck Mountain	90.23	Community Pasture	V
Manitoba	Lenswood	73.3.	Community Pasture	V
Manitoba	McCreary	162.21	Community Pasture	V
Manitoba	Mulvihill	73.17	Community Pasture	V
Manitoba	Narcisse	57.59	Community Pasture	V
Manitoba	Pasquia	19.3	Community Pasture	V
Manitoba	Sylvan Dale	53.12	Community Pasture	V
Manitoba	Alonsa*	105.59	Wildlife Management Area	VI
Manitoba	Moose Creek*	789.17	Wildlife Management Area	VI
Newfoundland & Labrador	Avalon	1070	Wilderness Reserve	I
Newfoundland & Labrador	Bay du Nord	2895	Wilderness Reserve	I
Newfoundland & Labrador	Cape St. Mary's Seabird	10.1	Ecological Reserve	I
Newfoundland & Labrador	Redfir Lake-Kapitagas Channel	82.33	Ecological Reserve	Ia
Newfoundland & Labrador	Watt's Point	30.9	Ecological Reserve	Ia
Newfoundland & Labrador	Barachois Pond	34.97	Provincial Park	II
Newfoundland & Labrador	Butterpot	28.33	Provincial Park	II
Newfoundland & Labrador	Chance Cove	20.68	Provincial Park	II
Newfoundland & Labrador	Gros Morne	1805	National Park	II
Newfoundland & Labrador	Little Grand Lake	731.0	Ecological Reserve[2]	II
Newfoundland & Labrador	King George	18.41	Ecological Reserve	II
Newfoundland & Labrador	La Manche	13.94	Provincial Park	II
Newfoundland & Labrador	Sir Richard Squires	15.74	Provincial Park	II
Newfoundland & Labrador	Terra Nova	401.63	National Park	II
Newfoundland & Labrador	Torngat Mountains	9700.0	Special Management Area[3]	II
Newfoundland & Labrador	West Brook	10.74	Ecological Reserve	II
Newfoundland & Labrador	Terra Nova	12.15	Migratory Bird Sanctuary	IV
Newfoundland & Labrador	Middle Ridge	618	Wildlife Reserve	V
Newfoundland & Labrador	Glover Island	177.58	Public Reserve	VI
Newfoundland & Labrador	Little Grand Lake	568.8	Wildlife Reserve	VI
Newfoundland & Labrador	Salmonier	14.55	Nature Park	VI
Northwest Territories	Thelon (NWT portion)	21 791	Wildlife Sanctuary	Ib

* A portion of these areas is strictly protected from industrial development.

** These areas are not strictly protected but may have some restrictive land-use regulations.

[2] Provisional, but protected under the *Wilderness and Ecological Reserves Act*.

[3] Provisional, but protected under the *Lands Act*, and expected to be gazetted as a national park in the near future.

Northwest Territories	Aulavik	12 200	National Park	II
Northwest Territories	Hidden Lake	31	Territorial Park	II
Northwest Territories	Nahanni	4765	National Park	II
Northwest Territories	Tuktut Nogait	16 340	National Park	II
Northwest Territories	Wood Buffalo (NWT portion)	9222	National Park	II
Northwest Territories	Anderson River Delta	1083	Migratory Bird Sanctuary	IV
Northwest Territories	Banks Island No. 1	20 518	Migratory Bird Sanctuary	IV
Northwest Territories	Banks Island No. 2	142	Migratory Bird Sanctuary	IV
Northwest Territories	Kendall Island	606	Migratory Bird Sanctuary	IV
Northwest Territories	Gwich'in	88	Territorial Park	V
Northwest Territories	Mackenzie Bison Sanctuary[4]	6275	Wildlife Sanctuary	VI
Nunavut	Thelon (Nunavut portion)	34 005	Wildlife Sanctuary	I
Nunavut	Auyuittuq	19 384	National Park	II
Nunavut	Quttinirpaaq	38 148	National Park	II
Nunavut	Sirmilik	2210	National Park	II
Nunavut	Ukkusiksalik	20 500	National Park	II
Nunavut	Akimiski Island	3367	Migratory Bird Sanctuary	IV
Nunavut	Bylot Island	10 878	Migratory Bird Sanctuary	IV
Nunavut	Cape Dorset	259	Migratory Bird Sanctuary	IV
Nunavut	Dewey Soper	816	Migratory Bird Sanctuary	IV
Nunavut	East Bay	116	Migratory Bird Sanctuary	IV
Nunavut	Hannah Bay (Nunavut Portion)	59.6	Migratory Bird Sanctuary	IV
Nunavut	Harry Gibbons	1489	Migratory Bird Sanctuary	IV
Nunavut	McConnell River	329	Migratory Bird Sanctuary	IV
Nunavut	Prince Leopold Island	504	Migratory Bird Sanctuary	IV
Nunavut	Queen Maud Gulf	62 782	Migratory Bird Sanctuary	IV
Nunavut	Bowman Bay	1079	Wildlife Sanctuary	IV
Nunavut	Igaliqtuuq	5928	National Wildlife Area	IV
Nunavut	Nirjutiqawik	1780	National Wildlife Area	IV
Nunavut	Qaaqalluit (Cape Searle) and Akpait (Reid Bay)		National Wildlife Area	IV
Nunavut	Katannilik	17	Territorial Park	V
Ontario	Black Duck River	1000	NRZ within Polar Bear PP	I
Ontario	Brent Crater	13.9	NRZ within Algonquin PP	I
Ontario	Brule Harbour	12.74	NRZ within Lake Superior PP	
Ontario	Butler Lake	34	Provincial Nature Reserve	I
Ontario	Cape Challion	19.48	NRZ within Lake Superior PP	I
Ontario	Chapleau Nemgosenda River Addition	47.90	Provincial Park	II
Ontario	Coldspring Lake watershed	53.96	NRZ within Algonquin PP	I
Ontario	Gina Lake	13.23	NRZ within Obatanga PP	I
Ontario	Grassy River	26.70	Provincial Park	II
Ontario	Greenleaf Creek watershed	37.3	NRZ within Algonquin PP	I
Ontario	Hicks-Oke Bog	58.8	Provincial Nature Reserve	I

[4] PWildlife Management Area under the NWT *Wildlife Act and Regulations*.

Ontario	Kabitotikwia River	19.65	Provincial Nature Reserve	I
Ontario	Knife Creek	14.95	NRZ within Obatanga PP	I
Ontario	Lake Abitibi Islands	23.70	Provincial Park	II
Ontario	Livingstone Point	18	Provincial Nature Reserve	I
Ontario	Lola Lake	65.72	Provincial Nature Reserve	I
Ontario	Lower Agawa River	23.93	NRZ within Lake Superior PP	I
Ontario	Lower Sand River	11.5	NRZ within Lake Superior PP	I
Ontario	Manitou Islands	19.26	Provincial Nature Reserve	I
Ontario	Minnitaki Kames	44.22	Provincial Nature Reserve	I
Ontario	Nadine Lake Hardwoods	11.05	NRZ within Algonquin PP	I
Ontario	Nagagami Lake	16.5	Provincial Nature Reserve	I
Ontario	O'Conner	15.65	NRZ within Lake Superior PP	I
Ontario	Petawawa Rapids	14.11	NRZ within Algonquin PP	I
Ontario	Sioux Lookout Moraine	11.5	NRZ within Brightsand River PP	I
Ontario	Site 416	93	NRZ within Polar Bear PP	I
Ontario	Site 421	93	NRZ within Polar Bear PP	I
Ontario	Sunray Lake	17.4	NRZ within Brightsand PP	I
Ontario	Treeby Lake	10.05	NRZ within Lake Superior PP	I
Ontario	Wachi Creek	500	NRZ within Polar Bear PP	I
Ontario	West Bay	11.2	Provincial Nature Reserve	I
Ontario	Windigo Bay	83.78	Provincial Nature Reserve	I
Ontario	Wood Creek	500	NRZ within Polar Bear PP	I
Ontario	Kesagami	559.77	Provincial Park	Ib
Ontario	Killarney	504.00	Provincial Park	Ib
Ontario	Lady Evelyn Smoothwater	724	Provincial Park	Ib
Ontario	Opasquia	4730	Provincial Park	Ib
Ontario	Polar Bear	23552	Provincial Park	Ib
Ontario	Wabakimi	8920.61	Provincial Park	Ib
Ontario	Abititbi-de-Troyes	110.68	Provincial Park	II
Ontario	Agassiz Peatlands	54.15	Provincial Park	II
Ontario	Albany River	951.00	Provincial Park	II
Ontario	Alexander Lake Forest	19.34	Provincial Park	II
Ontario	Algoma Headwaters	427.36	Provincial Park	II
Ontario	Algonquin	7,723	Provincial Park	II
Ontario	Arrowhead	12.37	Provincial Park	II
Ontario	Aubinadong River	27.22	Provincial Park	II
Ontario	Aubinadong-Nushatogaini Rivers	49.28	Provincial Park	II
Ontario	Aubrey Falls	48.60	Provincial Park	II
Ontario	Batchawana River	26.84	Provincial Park	II
Ontario	Big East River	10.50	Provincial Park	II
Ontario	Bigwind Lake	19.67	Provincial Park	II
Ontario	Biscotasi Lake	233.62	Provincial Park	II
Ontario	Black Sturgeon River	235.31	Provincial Park	II
Ontario	Blind River	54.02	Provincial Park	II
Ontario	Blue Lake	23.14	Provincial Park	II
Ontario	Bon Echo	80.12	Provincial Park	II

Ontario	Bonnechere River	12.57	Provincial Park	II
Ontario	Brightsand River	412.50	Provincial Park	II
Ontario	Butler Lake	34.0	Provincial Park	II
Ontario	Castle Creek	10.75	Provincial Park	II
Ontario	Chapleau-Nemegosenda River	186.09	Provincial Park	II
Ontario	Cranberry Lake	28.0	Provincial Park	II
Ontario	Dana-Jowsey Lakes	85.92	Provincial Park	II
Ontario	Eagle-Dogtooth	411.28	Provincial Park	II
Ontario	East English River	175.13	Provincial Park	II
Ontario	Egan Chutes	11.0	Provincial Park	II
Ontario	Englehart River Fine Sand Plain and Waterway	40.41	Provincial Park	II
Ontario	Esker Lakes	32.37	Provincial Park	II
Ontario	Fawn River	121.34	Provincial Park	II
Ontario	French River	751.45	Provincial Park	II
Ontario	Fushimi Lake	52.94	Provincial Park	II
Ontario	Goulais River	50.86	Provincial Park	II
Ontario	Greenwater	82.44	Provincial Park	II
Ontario	Grundy Lake	47.28	Provincial Park	II
Ontario	Gull River	71.94	Provincial Park	II
Ontario	Halfway Lake	51.13	Provincial Park	II
Ontario	Hicks-Oke Bog	58.8	Provincial Park	II
Ontario	Ivanhoe Lake	82.48	Provincial Park	II
Ontario	Jocko River	112.99	Provincial Park	II
Ontario	Kabitotikwia River	19.65	Provincial Park	II
Ontario	Kashabowie	20.55	Provincial Park	II
Ontario	Kenny Forrest	22.00	Provincial Park	II
Ontario	Kettle Lakes	12.61	Provincial Park	II
Ontario	Killbear	17.60	Provincial Park	II
Ontario	Kopka River	312.05	Provincial Park	II
Ontario	La Cloche	176.25	Provincial Park	II
Ontario	La Verendrye	182.8	Provincial Park	II
Ontario	Lake of the Woods	204.37	Provincial Park	II
Ontario	Lake Superior	1608.10	Provincial Park	II
Ontario	Larder River Waterway	55.79	Provincial Park	II
Ontario	Little Abitibi	200.0	Provincial Park	II
Ontario	Little Current River	99.3	Provincial Park	II
Ontario	Little White River	127.82	Provincial Park	II
Ontario	Livingstone Point	18.0	Provincial Park	II
Ontario	Lola Lake	65.7	Provincial Park	II
Ontario	Lower Madawaska River	12.0	Provincial Park	II
Ontario	Magnetwan River	34.24	Provincial Park	II
Ontario	Makobe-Grays River	14.27	Provincial Park	II
Ontario	Manitou Islands	19.26	Provincial Park	II
Ontario	Mashkinonje	42.43	Provincial Park	II
Ontario	Matawin River	26.15	Provincial Park	II
Ontario	Matinenda	287.58	Provincial Park	II

Ontario	Mattawa River	139.45	Provincial Park	II
Ontario	Michipiconten Island	367.4	Provincial Park	II
Ontario	Minnitaki Kames	44.2	Provincial Park	II
Ontario	Missinaibi	1396.8	Provincial Park	II
Ontario	Mississagi	118.29	Provincial Park	II
Ontario	Mississagi Delta	23.95	Provincial Park	II
Ontario	Mississagi River	912.47	Provincial Park	II
Ontario	Nagagami Lake	16.5	Provincial Park	II
Ontario	Nagagamisis	379.39	Provincial Park	II
Ontario	Nakina Moraine	53.19	Provincial Park	II
Ontario	Neys	73.2	Provincial Park	II
Ontario	Nimoosh	35.5	Provincial Park	II
Ontario	Noganosh Lake	30.8	Provincial Park	II
Ontario	North Channel Inshore	37.6	Provincial Park	II
Ontario	Obabika River	205.2	Provincial Park	II
Ontario	Obatanga	94.09	Provincial Park	II
Ontario	Obonga-Ottertooth	211.6	Provincial Park	II
Ontario	Ogoki River	232.5	Provincial Park	II
Ontario	Ojibway	26.31	Provincial Park	II
Ontario	Otoskwin-Attawapiskat River	825.25	Provincial Park	II
Ontario	Pakwash	39.93	Provincial Park	II
Ontario	Pancake Bay	16.59	Provincial Park	II
Ontario	Pantagruel Creek	26.85	Provincial Park	II
Ontario	Pichogen River Mixed Forest	30.43	Provincial Park	II
Ontario	Pipestone River	973.75	Provincial Park	II
Ontario	Pokei Lake/White River Wetlands	17.68	Provincial Park	II
Ontario	Polar Bear	24 087	Provincial Park	II
Ontario	Pukaskwa	1877.8	National Park	II
Ontario	Pukaskwa River	14.65	Provincial Park	II
Ontario	Quetico	4757.8	Provincial Park	II
Ontario	René Brunelle	30.15	Provincial Park	II
Ontario	Restoule	40.35	Provincial Park	II
Ontario	Round Lake	25.85	Provincial Park	II
Ontario	Ruby Lake	27.34	Provincial Park	II
Ontario	Sable Islands	26.4	Provincial Park	II
Ontario	Samuel de Champlain	25.5	Provincial Park	II
Ontario	Sandbar Lake	80.5	Provincial Park	II
Ontario	Sandy Islands	25.5	Provincial Park	II
Ontario	Sedgman Lake	57.1	Provincial Park	II
Ontario	Severn River	829.6	Provincial Park	II
Ontario	Silent Lake	16.2	Provincial Park	II
Ontario	Silver Falls	32.6	Provincial Park	II
Ontario	Slate Islands	65.7	Provincial Park	II
Ontario	Sleeping Giant	244.0	Provincial Park	II
Ontario	Solace	59.4	Provincial Park	II
Ontario	South Bay	15.3	Provincial Park	II

Ontario	Spanish River	353.9	Provincial Park	II
Ontario	Spruce Islands	14.8	Provincial Park	II
Ontario	St. Raphael Lake	905.2	Provincial Park	II
Ontario	Steel River	112.4	Provincial Park	II
Ontario	Sturgeon River	80.0	Provincial Park	II
Ontario	Temagami River	33.9	Provincial Park	II
Ontario	The Massassauga	138.5	Provincial Park	II
Ontario	The Shoals	106.4	Provincial Park	II
Ontario	Trout Lake	71.5	Provincial Park	II
Ontario	Turtle River – White Otter Lake Addition	492.9	Provincial Park	II
Ontario	Upper Madawaska River	10.85	Provincial Park	II
Ontario	Wakami Lake	222.2	Provincial Park	II
Ontario	Wanapitei	34.1	Provincial Park	II
Ontario	Wenebgon River	163.8	Provincial Park	II
Ontario	West Bay	11.2	Provincial Park	II
Ontario	West English River	229.2	Provincial Park	II
Ontario	West Montreal River	75.6	Provincial Park	II
Ontario	White Lake	60.9	Provincial Park	II
Ontario	Whitesand	113.4	Provincial Park	II
Ontario	Widdifield Forest	21.7	Provincial Park	II
Ontario	Wildgoose Outwash	10.71	Provincial Park	II
Ontario	Windigo Bay	83.8	Provincial Park	II
Ontario	Winisk River	14.11	Provincial Park	II
Ontario	Winnange Lake	47.5	Provincial Park	II
Ontario	Woman River Forest	6301	Provincial Park	II
Ontario	Woodland Caribou	4797.9	Provincial Park	II
Ontario	Hannah Bay (Ontario Portion)	238.4	Migratory Bird Sanctuary	IV
Ontario	Adair Lake	28.00	Conservation Reserve	tbd
Ontario	Ahmic Forest and Rock Barrens	60.81	Conservation Reserve	tbd
Ontario	Akonesi Chain of Lakes Complex	14.69	Conservation Reserve	tbd
Ontario	Archambeau Lake Forest	12.34	Conservation Reserve	tbd
Ontario	Attwood River	213.14	Conservation Reserve	tbd
Ontario	Aulneau Interior	22.96	Conservation Reserve	tbd
Ontario	Ballantyne Lake Drumlins	33.82	Conservation Reserve	tbd
Ontario	Bear Lake Peatland	38.45	Conservation Reserve	tbd
Ontario	Bennet Lake Esker Kame Complex	35.11	Conservation Reserve	tbd
Ontario	Black Bay Bog	18.81	Conservation Reserve	tbd
Ontario	Blue Lake End Moraine	14.08	Conservation Reserve	tbd
Ontario	Bob Lake	26.57	Conservation Reserve	tbd
Ontario	Boulter-Depot Creek	23.48	Conservation Reserve	tbd
Ontario	Brace Creek Outwash Plain	47.05	Conservation Reserve	tbd
Ontario	Brokenmouth River	10.71	Conservation Reserve	tbd
Ontario	Brown's Inlet	29.31	Conservation Reserve	tbd
Ontario	Bruce Lake	54.62	Conservation Reserve	tbd
Ontario	Byrnes Lake White Birch	15.69	Conservation Reserve	tbd
Ontario	Cache Bay Wetland	39.26	Conservation Reserve	tbd

Ontario	Campfire River	41.80	Conservation Reserve	tbd
Ontario	Campus Lake	194.52	Conservation Reserve	tbd
Ontario	Cardwell Township Old Growth	10.29	Conservation Reserve	tbd
Ontario	Cherriman Township	10.03	Conservation Reserve	tbd
Ontario	Clear Lake	13.07	Conservation Reserve	tbd
Ontario	Cliff Lake	29.47	Conservation Reserve	tbd
Ontario	Cognashene Lake	29.45	Conservation Reserve	tbd
Ontario	Commanda Creek	16.57	Conservation Reserve	tbd
Ontario	Conroys Marsh	20.49	Conservation Reserve	tbd
Ontario	Coral Rapids Wetland	61.82	Conservation Reserve	tbd
Ontario	Deacon Escarpment	21.76	Conservation Reserve	tbd
Ontario	Dog River	26.48	Conservation Reserve	tbd
Ontario	Dryberry Lake	218.50	Conservation Reserve	tbd
Ontario	Dube Creek Iceberg Keel Marks	11.36	Conservation Reserve	tbd
Ontario	Dutcher Lake	19.52	Conservation Reserve	tbd
Ontario	Eagle - Snowshoe	356.21	Conservation Reserve	tbd
Ontario	Eagle Lake Islands	33.95	Conservation Reserve	tbd
Ontario	East Bay	18.94	Conservation Reserve	tbd
Ontario	East Lady Evelyn Lake	56.12	Conservation Reserve	tbd
Ontario	East Larder River Bedrock Conifer	70.03	Conservation Reserve	tbd
Ontario	East Wabigoon River	12.99	Conservation Reserve	tbd
Ontario	East Wenebegon Forest	30.53	Conservation Reserve	tbd
Ontario	Echo River Hardwoods	102.36	Conservation Reserve	tbd
Ontario	Elzevir Peatlands	22.46	Conservation Reserve	tbd
Ontario	Fishnet Lake	35.03	Conservation Reserve	tbd
Ontario	Fraserdale Wetland Complex	185.24	Conservation Reserve	tbd
Ontario	Friday and Scotia Lakes	19.30	Conservation Reserve	tbd
Ontario	Garden - Pakashkan	125.86	Conservation Reserve	tbd
Ontario	Glenn N. Crombie	69.52	Conservation Reserve	tbd
Ontario	Grassy River Halliday Lake Forests & Lowlands	27.76	Conservation Reserve	tbd
Ontario	Gravel River	466.32	Conservation Reserve	tbd
Ontario	Gull - Christina	18.63	Conservation Reserve	tbd
Ontario	Gulliver River	27.37	Conservation Reserve	tbd
Ontario	Hammell Lake	19.01	Conservation Reserve	tbd
Ontario	Harmony Forest	10.12	Conservation Reserve	tbd
Ontario	Harth Lake	37.22	Conservation Reserve	tbd
Ontario	Hilliardton Marsh	55.02	Conservation Reserve	tbd
Ontario	Holdridge Creek	13.72	Conservation Reserve	tbd
Ontario	Hungry Lake	35.19	Conservation Reserve	tbd
Ontario	Ile Parisienne	46.69	Conservation Reserve	tbd
Ontario	Isko Dewabo Lake Complex	29.67	Conservation Reserve	tbd
Ontario	Island Lake Forest and Barrens	154.75	Conservation Reserve	tbd
Ontario	Ivanhoe River Clay Plain	70.71	Conservation Reserve	tbd
Ontario	Jackson Lake	11.66	Conservation Reserve	tbd
Ontario	Jevins & Silver Lake	21.44	Conservation Reserve	tbd
Ontario	Jim Edwards Lake	86.56	Conservation Reserve	tbd
Ontario	Jog Lake	484.82	Conservation Reserve	tbd

Ontario	Kagianagami Lake	12.47	Conservation Reserve	tbd
Ontario	Kahshe Lake Barrens	32.37	Conservation Reserve	tbd
Ontario	Kaladar Jack Pine Barrens	10.86	Conservation Reserve	tbd
Ontario	Kama Cliffs	37.13	Conservation Reserve	tbd
Ontario	Kesagami River Outwash Plain	19.94	Conservation Reserve	tbd
Ontario	Killala Lake	124.84	Conservation Reserve	tbd
Ontario	Kwinkwaga Ground Moraine Uplands	126.50	Conservation Reserve	tbd
Ontario	La Cloche Ridge	40.04	Conservation Reserve	tbd
Ontario	La Verendrye/Ogidaki	10.39	Conservation Reserve	tbd
Ontario	Lac des Mille Lacs	25.38	Conservation Reserve	tbd
Ontario	Lac Seul Islands	147.23	Conservation Reserve	tbd
Ontario	Lake Nipigon	1881.36	Conservation Reserve	tbd
Ontario	Lake of the Woods	449.41	Conservation Reserve	tbd
Ontario	Lake of the Woods Waters	17.95	Conservation Reserve	tbd
Ontario	Lake Superior Archipelago	491.81	Conservation Reserve	tbd
Ontario	Lake Superior Highlands	467.34	Conservation Reserve	tbd
Ontario	Lake Superior North Shore	15.01	Conservation Reserve	tbd
Ontario	Lawrence Lake	14.09	Conservation Reserve	tbd
Ontario	Lingham Lake	19.88	Conservation Reserve	tbd
Ontario	Long Lake	17.20	Conservation Reserve	tbd
Ontario	Longlac North	18.29	Conservation Reserve	tbd
Ontario	Low/Bell	55.76	Conservation Reserve	tbd
Ontario	Lower Moon River	27.23	Conservation Reserve	tbd
Ontario	MacDougal Point Penninsula	48.46	Conservation Reserve	tbd
Ontario	Magpie River Terraces	20.88	Conservation Reserve	tbd
Ontario	Manitou	72.03	Conservation Reserve	tbd
Ontario	McCrae Lake	20.39	Conservation Reserve	tbd
Ontario	McGarry Township Forest	14.34	Conservation Reserve	tbd
Ontario	Melgund Lake	10.94	Conservation Reserve	tbd
Ontario	Meteor Lake Outwash Fans	35.52	Conservation Reserve	tbd
Ontario	Mistinikon Lake Uplands	43.30	Conservation Reserve	tbd
Ontario	MojikitLake	625.97	Conservation Reserve	tbd
Ontario	Mozhabong Lake	43.54	Conservation Reserve	tbd
Ontario	Musk Lake	48.54	Conservation Reserve	tbd
Ontario	Nahma Bog and Poor Fens	35.47	Conservation Reserve	tbd
Ontario	Nakina Northeast Waterway	139.09	Conservation Reserve	tbd
Ontario	Night Hawk Lake Shoreline Bluffs	13.92	Conservation Reserve	tbd
Ontario	Nipigon Palisades	115.22	Conservation Reserve	tbd
Ontario	Nipigon River	26.50	Conservation Reserve	tbd
Ontario	North Georgian Bay Shoreline and Islands	201.28	Conservation Reserve	tbd
Ontario	North Muskego River Mixed Forest	28.65	Conservation Reserve	tbd
Ontario	North of the North French River	1587.29	Conservation Reserve	tbd
Ontario	North Yorston	133.23	Conservation Reserve	tbd
Ontario	Northern Claybelt Forest Complex	720.11	Conservation Reserve	tbd
Ontario	Northern McConkey	12.49	Conservation Reserve	tbd
Ontario	Nova Township Clay Plain Peatlands	31.46	Conservation Reserve	tbd
Ontario	Onaman Lake	47.34	Conservation Reserve	tbd

Ontario	Onaping Lake	166.98	Conservation Reserve	tbd
Ontario	Ottertail Creek	16.50	Conservation Reserve	tbd
Ontario	Ottertooth	287.93	Conservation Reserve	tbd
Ontario	Pakeshkag River Forest	12.99	Conservation Reserve	tbd
Ontario	Pinard Moraine	180.00	Conservation Reserve	tbd
Ontario	Pinetorch Lake	36.23	Conservation Reserve	tbd
Ontario	Pipestone	95.36	Conservation Reserve	tbd
Ontario	Pointe au Baril Forests and Wetlands	23.66	Conservation Reserve	tbd
Ontario	Rainy Lake Islands	54.77	Conservation Reserve	tbd
Ontario	Ranger North	70.20	Conservation Reserve	tbd
Ontario	Rawhide Lake	46.33	Conservation Reserve	tbd
Ontario	Scenic Lake	18.90	Conservation Reserve	tbd
Ontario	Scotty Lake	14.97	Conservation Reserve	tbd
Ontario	Seguin River Conifer and Fens	65.39	Conservation Reserve	tbd
Ontario	Severn River	99.27	Conservation Reserve	tbd
Ontario	Shanly Creek Drumlins	35.00	Conservation Reserve	tbd
Ontario	Shawanaga Lake	49.37	Conservation Reserve	tbd
Ontario	Slim Jim Lake	64.60	Conservation Reserve	tbd
Ontario	Smith Lake	16.49	Conservation Reserve	tbd
Ontario	South Greenhill Lake Sand Delta	13.78	Conservation Reserve	tbd
Ontario	South Michipicoten River - Superior Shoreline	29.23	Conservation Reserve	tbd
Ontario	Strickland River Mixed Forest Wetland	16.38	Conservation Reserve	tbd
Ontario	Sugar Lake	61.43	Conservation Reserve	tbd
Ontario	Tatachikapika River Plain	44.11	Conservation Reserve	tbd
Ontario	Tembec Wetland	79.22	Conservation Reserve	tbd
Ontario	Tikamaganda Lake	29.57	Conservation Reserve	tbd
Ontario	Torrance Barrens	19.06	Conservation Reserve	tbd
Ontario	Trewartha Creek	97.36	Conservation Reserve	tbd
Ontario	Trollope Lake Burnt Hill Poplar Spruce	21.54	Conservation Reserve	tbd
Ontario	Trout Lake	601.86	Conservation Reserve	tbd
Ontario	Upper English River	122.95	Conservation Reserve	tbd
Ontario	Upper Shebeshekong Wetland	53.04	Conservation Reserve	tbd
Ontario	Vimy Lake Uplands	28.20	Conservation Reserve	tbd
Ontario	Wagong Lake Forest	23.81	Conservation Reserve	tbd
Ontario	Wahwashkesh - Naiscoot	17.34	Conservation Reserve	tbd
Ontario	Wapus Creek	22.16	Conservation Reserve	tbd
Ontario	Western Lake Superior	12.30	Conservation Reserve	tbd
Ontario	White Bear Forest	12.42	Conservation Reserve	tbd
Ontario	Whitefish and East Whitefish Lakes Sandy Till Upland	105.30	Conservation Reserve	tbd
Ontario	Whitefish River Sandy Till	38.73	Conservation Reserve	tbd
Ontario	Whitemud	184.85	Conservation Reserve	tbd
Ontario	Widgeon Lake Moraine	12.40	Conservation Reserve	tbd
Ontario	Windermere Goldie Lake Complex	178.64	Conservation Reserve	tbd
Ontario	Woman River Complex	94.63	Conservation Reserve	tbd
Québec	Chicobi	21.2	Ecological Reserve	Ia

Québec	de la Baie-des-Loups	33.5	Migratory Bird Sanctuary	Ia
Québec	de la Forêt-la-Blanche	19.5	Ecological Reserve	Ia
Québec	de la Matamec	186.0	Ecological Reserve	Ia
Québec	de la Pointe-Heath	18.7	Ecological Reserve	Ia
Québec	de Tantaré	14.5	Ecological Reserve	Ia
Québec	des Iles-Sainte-Maire	41.0	Migratory Bird Sanctuary	Ia
Québec	du Grand-Lac-Salé	23.4	Ecological Reserve	Ia
Québec	du Gros-Mécatina	23.1	Migratory Bird Sanctuary	Ia
Québec	du Lac-Malakisis	30.3	Ecological Reserve	Ia
Québec	J.Clovis-Laflamme	10.2	Ecological Reserve	Ia
Québec	Judith-de Bresoles	10.9	Ecological Reserve	Ia
Québec	Louis-Babel	235.4	Ecological Reserve	Ia
Québec	Rolland-Germaine	13.7	Ecological Reserve	Ia
Québec	d'Aiguebelle	268.3	National Park (Québec)	II
Québec	d'Anticosti	571.8	National Park (Québec)	II
Québec	d'Oka	23.7	National Park (Québec)	II
Québec	de l'Archipel-de-Mingan	150.0	National Park and National Park Reserve	II
Québec	de la Gatineau	361.3	National Capital Commission	II
Québec	de la Jacques-Cartier	670.6	National Park (Québec)	II
Québec	de la Pointe-Taillon	92.2	National Park (Québec)	II
Québec	de Plaisance	28.1	National Park (Québec)	II
Québec	des Grands Jardins	310.0	National Park (Québec)	II
Québec	des Hautes-Gorges-de-la-rivière-Malbaie	224.7	National Park (Québec)	II
Québec	des Monts-Valin	153.6	National Park (Québec)	II
Québec	des Pingualuit	1133.9	National Park (Québec)	II
Québec	du Mont-Tremblant	1510.1	National Park (Québec)	II
Québec	du Saguenay	283.6	National Park (Québec)	II
Québec	de la Mauricie	536.1	National Park	II
Québec	de l'Ile-à-la-Brume	43.2	Migratory Bird Sanctuary	III
Québec	de Saint-Augustin	55.7	Migratory Bird Sanctuary	III
Québec	de Watshishou	113.2	Migratory Bird Sanctuary	III
Québec	Ashuapmushuan	4487.0	Wildlife Sanctuary	IV
Québec	Assinica	8885.0	Wildlife Sanctuary	IV
Québec	Comeau	31.9	Research Forest	IV
Québec	de la Colline de la Table	142.0	Wildlife Habitat	IV
Québec	de la Pointe de l'Est	1139.0	Wildlife Habitat	IV
Québec	de la Rivière Chicotte, Rivière de la Chaloupe	2610.0	Wildlife Habitat	IV
Québec	de la Rivière du Brick, Rivière Jupiter	406.0	Wildlife Habitat	IV
Québec	de la Rivière MacDonald, Rivière Natiscotec	884.0	Wildlife Habitat	IV
Québec	de Mattawa	20.5	Wildlife Habitat	IV
Québec	du Lac McDonald	30.5	Wildlife Habitat	IV
Québec	du Lac Wickenden	690.0	Wildlife Habitat	IV
Québec	du Petit Lac Plat	16.6	Wildlife Habitat	IV
Québec	Ile d'Anticosti	303.0	Wildlife Sanctuary	IV
Québec	La Verendrye	13 610.0	Wildlife Sanctuary	IV
Québec	Lacs Albanel Mistassini & Waconichi	16 400		IV

Québec	Laurentides	7934.0	Wildlife Sanctuary	IV
Québec	Mailhot	16.9	Research Forest	IV
Québec	Mousseau	34.7	Research Forest	IV
Québec	Portneuf	774.0	Wildlife Sanctuary	IV
Québec	Rouge-Mattawin	1394.0	Wildlife Sanctuary	IV
Québec	Saint Mauice	782.0	Wildlife Sanctuary	IV
Québec	Sept Iles-Port Cartier	6423.0	Wildlife Sanctuary	IV
Québec	Waswanipi	8470.0	Wildlife Sanctuary	IV
Québec	Baie Trinite	356.0	Wildlife Sanctuary	V
Québec	Eastmain	4344.0	Wildlife Sanctuary	V
Québec	Fort George	18 166.0	Wildlife Sanctuary	V
Québec	Fort Rupert	11 240.0	Wildlife Sanctuary	V
Québec	Intowin	88.0	Wildlife Sanctuary	V
Québec	Kipawa	4636.0	Wildlife Sanctuary	V
Québec	Mistassini	17 870.0	Wildlife Sanctuary	V
Québec	Nemiscau	2338.0	Wildlife Sanctuary	V
Québec	Nouveau Comptoir	75 210.0	Wildlife Sanctuary	V
Québec	Pointe-Taillon	75.0	Conservation Park	V
Québec	Post de la Baleine	5354.0	Wildlife Sanctuary	V
Québec	Riviere Matamec	1036.0	Wildlife Sanctuary	V
Québec	de l'Ile aux Oiseaux, Pointe du Rapide	10.7	Wildlife Habitat	VI
Québec	de la Baie de Boatswain	179.0	Migratory Bird Sanctuary	VI
Québec	de la Baie de Mille-Vaches	14.4	Wildlife Habitat	VI
Québec	de la Baie des Homards	10.1	Wildlife Habitat	VI
Québec	de la Baie des Sarcelles, Cap à l'Ours	10.3	Wildlife Habitat	VI
Québec	de la Baie du Petit Makasti, Cap Caron	10.3	Wildlife Habitat	VI
Québec	de la Baie Nicerson	14.3	Wildlife Habitat	VI
Québec	de la Baie Pashashibou	10.6	Wildlife Habitat	VI
Québec	de la Batture aux Alouettes	38.5	Wildlife Habitat	VI
Québec	de la Batture de l"ile Puyjalon	11.4	Wildlife Habitat	VI
Québec	de la Batture de Matamec	10.4	Wildlife Habitat	VI
Québec	de la Batture Ouest de la Rivière Romaine	12.7	Wildlife Habitat	VI
Québec	de la Petite rivière Romaine, Ruisseau aux Vases	10.3	Wildlife Habitat	VI
Québec	de la Pointe à la Batterie, Cap à la Table	28.0	Wildlife Habitat	VI
Québec	de la Pointe à la Carriole	11.3	Wildlife Habitat	VI
Québec	de la Pointe à la Vache, Cap Observation	15.4	Wildlife Habitat	VI
Québec	de la Pointe au Minerai, Tête de Sheldrake	14.1	Wildlife Habitat	VI
Québec	de la Pointe au Naufrage, Pointe à la Vache	52.6	Wildlife Habitat	VI
Québec	de la Pointe aux Ivrongnes, Baie du Petit Makasti	48.1	Wildlife Habitat	VI
Québec	de la Pointe de la Croix, Pointe du Sud	17.9	Wildlife Habitat	VI
Québec	de la Pointe Heath, Pointe de la Croix	30.7	Wildlife Habitat	VI
Québec	de la Rive à Stéphane	11.1	Wildlife Habitat	VI
Québec	de la Rive de Vieux-Poste	11.3	Wildlife Habitat	VI
Québec	de la Rivière à la Loutre, Baie des Sarcelles	46.4	Wildlife Habitat	VI
Québec	de la Rivièew des Petites Escoumins, Petite rivière Romaine	15.2	Wildlife Habitat	VI

Québec	de la Rivière Pentecôte	10.2	Wildlife Habitat	VI
Québec	du Cap à l'Ours, Cap Robert	16.9	Wildlife Habitat	VI
Québec	du Cap aux Goélands, Pointe Heath	14.2	Wildlife Habitat	VI
Québec	du Cap Caron, Pointe aux Kakawis	22.3	Wildlife Habitat	VI
Québec	du Cap de la Table, Pointe Merrimack	19.4	Wildlife Habitat	VI
Québec	du Cap l'Ours, Pointe aux Ivrongnes	19.6	Wildlife Habitat	VI
Québec	du Cap Observation, Pointe Guy	29.2	Wildlife Habitat	VI
Québec	du Cap Tourmente	10.2	Wildlife Habitat	VI
Québec	du Cap-Tourmente	24.0	National Wildlife Area	VI
Québec	du Haut-fond de Betsiamites	11.7	Wildlife Habitat	VI
Québec	du Havre du Brick, Pointe au Naufrage	28.3	Wildlife Habitat	VI
Québec	I.O. Saint-Jean Ouest	10.3	Wildlife Habitat	VI
Québec	Albanel-Témiscamie-Otish	5937.0	Québec national park project†	tbd
Québec	Cap-Wolstenholme	1263.0	Québec national park project†	tbd
Québec	de la Rivière aux Feuilles	12 155.0	Wildlife Habitat	tbd
Québec	de la Rivière George	14 255.0	Wildlife Habitat	tbd
Québec	des Lacs-Guillaume-Delisle-et-à-l'Eau-Claire	7360.0	Québec national park project†	tbd
Québec	des Montes-Torngat-et-de-la-Rivière-Koroc	4295.0	Québec national park project†	tbd
Québec	Monts-de-Puvirnituq	1795.0	Québec national park project†	tbd
Saskatchewan	Athabasca Sand Dunes	1925	Provincial Wilderness Park	I
Saskatchewan	Clarence-Steepbank Lake	175.49	Provincial Wilderness Park	I
Saskatchewan	Clearwater River	2240.3	Provincial Wilderness Park	I
Saskatchewan	Amisk Lake	16.95	Representative Area Ecological Reserve	I
Saskatchewan	Bainbridge River	10.51	Representative Area Ecological Reserve	I
Saskatchewan	Big Valley Lake	24.48	Representative Area Ecological Reserve	I
Saskatchewan	Budd Lake	179.25	Representative Area Ecological Reserve	I
Saskatchewan	Carragana Swamp	14.73	Representative Area Ecological Reserve	I
Saskatchewan	Caribou Flats	86.6	Representative Area Ecological Reserve	I
Saskatchewan	Carrot River	95.16	Representative Area Ecological Reserve	I
Saskatchewan	Chappius/Fontaine	230 345	Special Management Area	I
Saskatchewan	Connell Creek	50.5	Representative Area Ecological Reserve	I
Saskatchewan	Fir River	44.05	Representative Area Ecological Reserve	I
Saskatchewan	Greenbush River	25.55	Representative Area Ecological Reserve	I
Saskatchewan	Halldorson Bay	66.9	Representative Area Ecological Reserve	I
Saskatchewan	Jan Lake	329.05	Representative Area Ecological Reserve	I
Saskatchewan	Mari Lake	318.5	Representative Area Ecological Reserve	I
Saskatchewan	Misaw Lake	236 715	Special Management Area	I
Saskatchewan	Nakuchi Lake	46.08	Representative Area Ecological Reserve	I
Saskatchewan	Pasquia River	51	Representative Area Ecological Reserve	I
Saskatchewan	Perry Lake	398	Representative Area Ecological Reserve	I
Saskatchewan	Pickle Lake	15.87	Representative Area Ecological Reserve	I
Saskatchewan	Primrose Lake-McCusker River	1590	Representative Area Ecological Reserve	I
Saskatchewan	Rice River	74.12	Representative Area Ecological Reserve	I
Saskatchewan	Seager Wheeler Lake	1779.6	Representative Area Ecological Reserve	I
Saskatchewan	Selenite Point	40	Representative Area Ecological Reserve	I
Saskatchewan	Smoking Tent Creek	15.65	Representative Area Ecological Reserve	I

Saskatchewan	Sturgeon-weir River	45.69	Representative Area Ecological Reserve	I
Saskatchewan	Tazin Lake	124 190	Special Management Area	I
Saskatchewan	Wapawekka Hills	677.15	Representative Area Ecological Reserve	I
Saskatchewan	McBride Lake	175.41	Recreation Site	III
Saskatchewan	Anglin Lake	13.6	Recreation Site	V
Saskatchewan	Jan Lake	20.7	Recreation Site	V
Saskatchewan	White Swan Lake (Whelan Bay)	18.34	Recreation Site	V
Saskatchewan	Bertwell	29.02	Provincial Community Pasture	VI
Saskatchewan	Crooked River	48.04	Provincial Community Pasture	VI
Saskatchewan	Donlands	36.01	Provincial Community Pasture	VI
Saskatchewan	Mistatim	12.02	Provincial Community Pasture	VI
Saskatchewan	Paddockwood	34.82	Provincial Community Pasture	VI
Saskatchewan	Pontrilas	25.66	Provincial Community Pasture	VI
Saskatchewan	Smeaton	21.27	Provincial Community Pasture	VI
Saskatchewan	Smoky Burn	24.48	Provincial Community Pasture	VI
Saskatchewan	Whitebeech	69.67	Provincial Community Pasture	VI
Yukon	Fishing Branch	5213.4	Wilderness Preserve	I
Yukon	Ivvavik	9695.6	National Park	II
Yukon	Kluane	22 158.6	National Park and Reserve	II
Yukon	Vuntut	4376.1	National Park	II
Yukon	Agay Mene	697.3	Natural Environment Park	II
Yukon	Asi Keyi	3023.8	Natural Environment Park	II
Yukon	Herschel Island	113.0	Territorial Park	II
Yukon	Kusawa Lake	3210.0	Natural Environment Park	II
Yukon	Tombstone	2113.1	Natural Environment Park	II
Yukon	Coal River Springs	16.1	Ecological Reserve	III
Yukon	Fishing Branch	169.1	Ecological Reserve	III
Yukon	Nisutlin Delta	54.9	National Wildlife Area	IV
Yukon	Ddhaw Ghro	1610.1	Habitat Protection Area	IV
Yukon	Fishing Branch	978.5	Habitat Protection Area	IV
Yukon	Horseshoe Slough	77.0	Habitat Protection Area	IV
Yukon	Lewes Marsh	25.9	Habitat Protection Area	IV
Yukon	L'hutsaw Wetlands	32.1	Habitat Protection Area	IV
Yukon	Nordenskiold	77.4	Habitat Protection Area	IV
Yukon	Pickhandle Lake	62.2	Habitat Protection Area	IV
Yukon	Six Mile	15.6	Habitat Protection Area	IV
Yukon	Old Crow Flats	7742.1	Special Management Area	IV
Yukon	Ta 'Tla Mun	33.2	Special Management Area	IV

Appendix B. IUCN Protected Area Category Descriptions

The IUCN protected area classification provides a generic framework to group protected areas into one of six categories based on protection and generally defined management regimes. The six categories cover the full spectrum of protected areas ranging from areas strictly protected and managed for science through to areas managed mainly for sustainable use of natural ecosystems. CCEA's mission, as reflected in this appendix and widely subscribed to by parks and wildlife conservation agencies across Canada, concentrates on IUCN categories I-IV. By adopting this approach, CCEA and others can standardize the analysis, assessment and reporting of this wide range of Canadian protected areas within an ecoregional context.

Category	Name	Description
Ia	Strict Nature Reserve	Managed mainly for science
Ib	Wilderness Area	Managed mainly for wilderness protection
II	National Park	Managed mainly for ecosystem protection and recreation
III	Natural Monument	Managed mainly for conservation of specific natural features
IV	Habitat/Species Management Area	Managed mainly for conservation through management intervention
V	Protected Landscape/Seascape	Managed mainly for landscape/seascape conservation and recreation
VI	Managed Resource Protected Area	Managed mainly for the sustainable use of natural ecosystems.

Classified as IUCN Category IV, Migratrory Bird Sanctuaries (MBS) and National Wildlife Areas (NWA) such as Nisutlin Delta NWA in Yukon, comprise a significant series of protected areas established to conserve wildlife across Canada including many highly significant areas in the North.

Appendix C. Overview of Protected Areas in the Circumpolar North

As of 1996, 286 protected areas (defined as being larger than 1000 ha and meeting IUCN categories I-V) were identified in the circumpolar Arctic, comprising two million km^2 (approximately 14% of the Arctic territory) (CAFF no date). It is difficult to quantify precisely the extent of protected areas across the eight circumpolar countries, as each has its own definitions and categories for protected areas. As well, like much of northern Canada, many of the circumpolar countries have sub-national jurisdictions (e.g., states, territories, municipalities, counties), which are also responsible for designating and maintaining protected areas. A final challenge lies in the fact that protected areas networks are being expanded in many of the circumpolar nations. To place the current status of Canadian northern protected areas in a global context, a brief overview of the types of protected areas present in each of the eight circumpolar countries, and as up-to-date an estimate as possible of the current number of protected areas is presented below. It should be noted that some of the numbers given are for the arctic regions of the respective countries, and thus are not directly comparable to the values given for the definition of the Canadian north given in this report.

Alaska (U.S.A.)

Protected areas in Alaska include both federal and state-managed public land. The United States National Parks Service maintains eight national parks, 10 national preserves, and two national monuments, and the United States Fish and Wildlife Service is responsible for 16 national wildlife refuges. At the state level, there are 42 parks, five recreation areas, and three wildlife sanctuaries, managed by the State Department of Fish and Game and the State Parks and Recreation Division (CAFF 2002). In total, the state of Alaska has over 46% of its area designated as protected with IUCN Category IV or higher designation.

Russia

Russian protected areas fall under the federal authority of the Ministry of Natural Resources, which manages strict nature reserves (*zapovedniks*), national parks, and habitat/special management areas (*zakazniks*). At the state level, there are state sanctuaries and natural monuments, as well as regional (republic) level *zakazniks*. Finally, Russia also has local, municipal protected areas. Currently, there are eight Arctic *zapovedniks* (IUCN Category Ib) and one Arctic national park (IUCN Category II) (CAFF 2002). According to the World Resources Institute (World Resources Institute website), Russia has 7.6% of its land in 11,141 protected areas, of which 229 are greater than 1000 km^2 in area.

Norway

Norwegian protected areas are governed under the *Nature Conservation Act*, which designates four types of protected areas: national parks, protected landscape areas, nature reserves and natural monuments (Backer 1991). Biotope reserves and bird sanctuaries can also be created under this Act, which protect species of interest without meeting the legal requirements for other protection categories. Other legislation for protected areas includes the *Planning and Building Act*, which allows local municipalities to designate conservation areas, and the *Forestry Act*, which allows for specific areas of forest to be set aside for nature conservation or recreation, so long as the long-term economic benefits to the owner of the land are not compromised (Backer 1991). While protected areas are designated by royal decree, local level pilot projects are used to select candidate areas, and management and governance of protected areas falls under the Ministry of the Environment, Directorate for Nature Management (CAFF 2002). Norway has a total of 1786 protected areas on the mainland (19 national parks, 106 protected landscape areas, 1485 nature reserves, 101 natural monuments, and 85 other types), covering 8.12% of the total land area. Forty additional national parks are currently being proposed for mainland Norway. The Svalbard Archipelago has 22 protected areas (three national parks, 18 nature reserves, and one other), covering 55.87% of the archipelago (CAFF 2002).

Finland

A range of acts governs protected areas in Finland, the main one being the *Nature Conservation Act*. Under the act, State-owned land can be designated as either natural parks if designated for general conservation, or as national parks, if designated as special conservation areas. Natural parks carry with them greater restrictions (Hollo 1991). Other categories of protected areas include mire reserves, protected herb-rich forests, protected old-growth forests, grey seal protection areas, and wilderness areas (established under the *Wilderness Act*, and applied uniquely to Lapland). In addition, individual owners may apply for their estates to be designated as conservation areas. Approval is contingent on evaluation of the conservation value of the land by the Ministry of Environmental Affairs (Hollo 1991). Protected areas on state-owned land are under the jurisdiction of the Finnish Forest and Park Service and the Finnish Forest Research Institute (CAFF 2002). There are 100 protected areas in the Finnish arctic and 3454 sites in the rest of the country, which cover 8.9% of the country (World Resources Institute website).

Sweden

Sweden was the first European nation to embrace the national parks idea. Protected areas are governed under the *Nature Conservation Act*, which identifies several categories of protection, including national parks, nature reserves, natural monuments, nature conservation areas, and protected species areas (Michanek 1991). These vary in the degree of restrictions that can be imposed within them, as well as whether landowners are compensated when a site is designated on their property. In addition, biotope protection areas can be identified to protect small areas that are habitat for endangered flora and/or fauna (Michanek 1991). Sweden has 4701 protected areas that meet IUCN Categories I-IV, including 27 national parks, 2192 nature reserves, 1433 natural monuments, 1049 wildlife sanctuaries, 140 nature conservation areas, and over 1500 biotope protection areas (CAFF 2002). Together these cover approximately 7.2% of the country's total land area (World Resources Institute website).

Iceland

The Nature Conservation Agency manages a system of national parks, nature reserves and natural monuments in Iceland, which are governed under the *Nature Conservation Act* (CAFF 2002). In addition, municipalities manage county parks, which are designated primarily for recreation purposes. Elected conservation committees within each municipality play an advisory role to the national government (CAFF 2002). Iceland has 70 protected areas, only one of which is greater than 1000 km^2. Together, these protected 4.6% of the country (World Resources Institute website).

Greenland (Denmark)

Greenland boasts the world's largest national park, the 1 million-km^2 Greenland National Park. Protected areas in Greenland are managed under the *Nature Conservation Act*. In addition, the Qingua Valley Forest is protected under a Greenland Council Resolution. Several smaller protected areas exist to commemorate scenic landscapes, geologic formations, and areas with cultural and scientific value (CAFF 2002).

Appendix D. Canadian Council on Ecological Areas: Survey on the State of Planning and Management for Protected Areas in Northern Canada

Issued September 29, 2004

Dear Colleague;

This survey is being undertaken in connection with a two-part project initiated by the Canadian Council on Ecological Areas (CCEA) to review efforts and approaches on designing, establishing, planning and managing protected areas in northern Canada. The geographic focus of the ***CCEA Northern Protected Areas (NPA)*** study is decidedly northern, encompassing the boreal, sub-arctic and arctic regions. The aim of this survey is to capture information on northern protected areas programs in this region, with the emphasis on the documentation of key science- and knowledge-based approaches and practices underpinning agency-based planning and management efforts. Accordingly, the survey seeks to document such efforts on a wide range of protected areas, including parks, wildlife areas/sanctuaries, demonstration/forest reserves, marine/aquatic reserves and other designations. I would ask that throughout the survey, you focus your answers on protected areas within the northern ecozones associated with your agency's jurisdiction (see map in appendix for the boundaries of the NPA study area that coincide with your jurisdiction).

The enclosed survey includes four segments: 1) a brief section on background information; 2) a section on planning; 3) a section on management; and, 4) a short freestyle essay. As well, an appendix with an inventory of northern protected areas in your jurisdiction, drawn from CCAD (Canadian Conservation Areas Database) and NCAD (North American Conservation Areas Database), is enclosed for your reference. You are welcome to check and update the appendix for any errors or omissions; corrections will be shared with CCAD and CARTS (Conservation Areas Reporting and Tracking Scheme) now being developed by CCEA with other partners.

- Please refer to the map in the attached appendix for the boundaries of the NPA study area associated with your agency's jurisdiction.
- Terms in italics are defined in the attached glossary.
- Please return surveys to me no later than **October 29, 2004**.

If your program is not sufficiently involved with protected areas to warrant completion of this questionnaire, please be sure to advise me of this to insure that we have a complete response to the survey mailout.

For further information on the Canadian Council on Ecological Areas (CCEA) please visit www.ccea.org

Thank you for your time in completing this survey!

Yolanda Wiersma, Project Consultant for CCEA
Department of Organismal Biology, Ecology and Evolution
University of Guelph
Guelph, Ontario N1H 5C2
Email: ywiersma@uoguelph.ca
Phone: (519) 824-4120 x56307
Fax: (519) 767-1656

Respondent Information

Name(s): _____

Title(s): _____

Affiliation/Program Name: _____

Mailing address: _____

Phone: _____ Fax: _____ Email: _____

I. Background Information

1. What purpose do protected areas in your agency's jurisdiction serve? Check any that apply.

   - ☐ Biodiversity conservation
   - ☐ *Terrestrial ecosystem representation*
   - ☐ Aquatic ecosystem *representation*
   - ☐ Mega-fauna conservation
   - ☐ Scientific research
   - ☐ Environmental monitoring
   - ☐ Education and heritage appreciation
   - ☐ Outdoor recreation
   - ☐ Tourism destinations
   - ☐ Other _____

2. What are the issues facing northern protected areas within your agency's jurisdiction? Rank the issues that apply with 1 as the highest threat. Mark with an "X" those issues that do not apply.

   - ☐ Species extirpations (list one or two key species) _____
   - ☐ Population declines (list one or two species of concern) _____
   - ☐ Invasive species (list one or two species of concern) _____
   - ☐ Habitat fragmentation _____
   - ☐ Interruption of natural cycles (e.g., fire regimes) _____
   - ☐ Increased visitor use _____
   - ☐ Changing visitor use (e.g.) _____
   - ☐ Compromised air and/or water quality _____
   - ☐ Climate change _____
   - ☐ Incompatible land uses outside of protected areas (please describe these briefly) _____
   - ☐ Other: _____

3. Which of the following activities/functions are integral to your agency's program for protected areas?

   ☐ Development of legislation

   ☐ Formulation of policy

   ☐ System planning

   ☐ Management planning

   ☐ Conducting research

   ☐ Monitoring

   ☐ Reporting on activities

   ☐ Other _____

4. Is your agency in the process of developing new policy and legislation for protected areas?

   ☐ Yes

   ☐ No

If yes, please describe briefly, with specific reference to any provisions being considered to augment scientific, planning and management efforts for protected areas.

5. Approximately how many full-time and part-time seasonal person years (PY's) within your agency are devoted to science-focused work related to protected areas planning and management (this includes legislation, policy, research, planning, management and monitoring).

   Full time: _____

   Part-time seasonal: _____

6. In what areas does your agency have in-house expertise or otherwise access to expertise to assist with the planning and management of protected areas? Check any that apply.

   ☐ Protected areas design/modelling

   ☐ Ecosystem restoration work

   ☐ Conservation genetics

   ☐ Species re-introduction

   ☐ Fire planning/management

   ☐ Aquatic ecosystem conservation

   ☐ Ecological integrity

   ☐ Recreation planning/management

   ☐ Tourism planning/management

   ☐ Socio-economic planning

   ☐ Other expertise _____

7. Is your agency currently involved in any projects on protected areas dealing with the following topics? Check any that apply.

   ☐ Ecosystem classification

   ☐ Marine/aquatic conservation

   ☐ Gap analysis

   ☐ Network modelling/design

   ☐ Protected area standards

   ☐ Ecological restoration

   ☐ Climate change

   ☐ Criteria and indicators (monitoring)

   ☐ Data base development

   ☐ International collaboration

II. Protected Areas Planning

1. Which of the following functions/activities are conducted by your agency in connection with planning for protected areas?

   ☐ Developing system/network targets

   ☐ Modelling protected area networks

   ☐ Conducting GIS analysis and assessments

   ☐ Completing regional ecological surveys

   ☐ Identifying and documenting candidate areas

   ☐ Database development and management

   ☐ Consulting with scientific experts

   ☐ Publishing technical reports

   ☐ Consulting with stakeholders

   ☐ Other _____

2. A *system plan* is defined as a comprehensive plan for the identification and establishment of a network of protected areas within a particular *ecologically-* or politically-*bounded* area. The plan should include goals for minimum number/size requirements of protected areas, and strategies for identifying sites and implementing protected areas.

   Given this definition, does your agency engage in system planning?

   ☐ Yes (go to question #3a)

   ☐ No (skip to question #4)

   a) If yes, what governance/authorities explicitly underpin system planning on protected areas? Check any that apply.

   ☐ Legislation

   ☐ Statutory regulations

   ☐ Government policy

   ☐ Agency level policy

   ☐ Agency program guidelines

   ☐ Other:

3. Please indicate with a yes or no (Y/N) whether legislation and/or government policy for protected areas includes specific provisions for any of the following:

Planning Considerations/Objectives	Legislation? (Y/N)	Government Policy? (Y/N)
System-wide plan for protected areas – minimum number of protected areas		
System-wide plan for protected areas – minimum percentage target for protected areas		
Biodiversity conservation targets		
Ecological design characteristics of specific protected areas (e.g., size, shape)		
Ecosystem representation		
Specific wildlife conservation targets		
Natural heritage appreciation		
Ecological integrity of protected areas		
Environmental monitoring		

4. What practices/approaches are used to add scientific knowledge-based rigor to **identifying** sites for protected areas? Check any that apply.

   - ☐ External advisory committee(s)
   - ☐ Agency-based technical committees
   - ☐ Use of scientific literature
   - ☐ Conducting Agency-sponsored field research
   - ☐ Peer review of technical work
   - ☐ GIS/remote sensing analysis
   - ☐ Technical meetings and conferences
   - ☐ Traditional knowledge (TEK) from First Nations elders
   - ☐ Public consultation (local knowledge from communities and other *stakeholders*)
   - ☐ Other _____

5. Which of the following attributes/considerations are inherent in the **selection** of candidate protected areas? Check any that apply.

   - ☐ Application of a *system plan*
   - ☐ Predictive modelling of scenarios
   - ☐ Clearly defined targets (describe: _____)
   - ☐ Species habitat requirements
   - ☐ Ecosystem functions and processes
   - ☐ Fire regimes
   - ☐ Hydrological functions
   - ☐ Restoration needs
   - ☐ Other _____

6. For **delineating boundaries** of selected candidate protected areas, what approaches and/or functions are considered? Check any that apply.

   - ☐ *Single species approach*
   - ☐ *Focal species approach*
   - ☐ Incorporating physiographic diversity
   - ☐ Ensuring complementarity of reserves
   - ☐ Capturing beta-diversity
   - ☐ Accommodating meta-population boundaries

- ☐ Disturbance regimes/patch dynamics (e.g., fire)
- ☐ Hydrological functions
- ☐ Atmospheric contaminants/fallout
- ☐ Adjacent land uses
- ☐ Other _____

7. What attribute data are collected and stored for candidate protected areas?

   - ☐ Size of the area
   - ☐ Area boundary
   - ☐ Geological characteristics
   - ☐ Biological communities
   - ☐ Species occurrences
   - ☐ Wild life habitat requirements
   - ☐ Disturbance history
   - ☐ Condition of the area
   - ☐ Sensitivities and threats
   - ☐ Constraints/other uses
   - ☐ Other _____

8. What tools/technologies does your agency use to document and assess candidate protected areas?

   - ☐ Manual files
   - ☐ Paper maps
   - ☐ Automated relational databases
   - ☐ GIS analysis and mapping
   - ☐ Algorithm-based models (e.g., C-Plan, diversity indices, etc.)
   - ☐ Standardized reporting functions
   - ☐ Other _____

9. In what ways is your agency limited in implementing scientific and planning principles to protected areas design? Check any that apply.

   - ☐ Developing models for protected area(s) design
   - ☐ Identifying and evaluating candidate areas
   - ☐ Availability of spatially explicit wildlife data

- ☐ Data base design and development
- ☐ GIS mapping and analysis
- ☐ Stress assessment and indicators
- ☐ Inventory and monitoring
- ☐ Other _____

II. Protected Areas Management

1. Which of the following functions are conducted by your agency to carry out management of protected areas?

   - ☐ Developing management policies
   - ☐ Conducting ecological inventories
   - ☐ Completing environmental impact assessments
   - ☐ Preparing management plans
   - ☐ Enforcing policies/regulations on use and prohibitions
   - ☐ Developing user access and facilities
   - ☐ Implementing ecosystem/wild life management
   - ☐ Conducting ecological monitoring
   - ☐ Maintaining protected areas database
   - ☐ Providing for professional training and development
   - ☐ Other _____

2. Which of the following ingredients are common to the management approach applied by your agency? Check any that apply.

   - ☐ Consistent management policy for protected areas
   - ☐ Clear definition of prohibited uses
   - ☐ Clear definition of permitted uses
   - ☐ Standardized planning process for management plans
   - ☐ Designation of management zones in protected areas
   - ☐ Use of IUCN protected area classification
   - ☐ Use of public consultation in preparation of management plans
   - ☐ Periodic review/update of management plans

3. What approaches/practices are applied to add scientific and knowledge-based rigor to **management of** protected areas in your agency's jurisdiction? Check any that apply.

   ☐ External advisory committee(s)

   ☐ Agency-based technical committees

   ☐ Use of scientific literature

   ☐ Agency-sponsored field research

   ☐ Peer review of technical work

   ☐ Technical meetings and conferences

   ☐ Traditional environmental knowledge (TEK)

   ☐ Public consultation (local knowledge from communities and other stakeholders)

   ☐ Other _____

4. What types of research does your agency engage in as part of management of protected areas? Check all that apply, and indicate whether they have occurred on a one-time basis or, if on a regular basis, identify on what cycle they occur i.e., annually, every 5 years, etc.

Research Activity	One-time? (Y/N)	Frequency?
Single species research (species: _____)		
Community level research (e.g., stream communities, old-growth forest communities)		
Ecosystem processes (e.g., fire)		
Oral history projects		
Visitor impact studies		
Economic impact studies		
Other (describe)		

5. Does your agency do ecological monitoring?

   ☐ Yes (go to question #5a)

   ☐ No (skip to question #7)

   a) Briefly describe your monitoring program and/or monitoring activities with specific reference to definition of indicators, monitoring protocols and standards, and reporting to satisfy planning/management objectives/needs.

6. How does your agency use the results of monitoring efforts in protected areas? Check any that apply.

   ☐ Preparation/update of protected area management plans

   ☐ Develop species/ecosystem management strategies

   ☐ Amend policies for protected area design

   ☐ Assess/mitigate external/adjacent stresses

   ☐ Baseline comparison for managed ecosystems

   ☐ Public education and understanding

   ☐ Other _____

7. In general, how is research carried out for protected areas within your agency's jurisdiction? Check any that apply.

   ☐ Primarily in-house within a single protected area. (e.g., within Nahanni National Park)

   ☐ Primarily in-house within the protected areas agency (e.g., within Parks Canada – NWT Branch).

   ☐ Through co-operation with other agencies (indicate any major ones) _____

   ☐ Through co-operation with First Nations

   ☐ Through co-operation with university research (list universities) _____

   ☐ Through co-operative projects with non-governmental organizations (indicate major ones) _____

   ☐ Through co-operation with industry

   ☐ Contracted out to consultants and/or freelance researchers

   ☐ Other _____

8. How often do the staff members who are involved with this research have the opportunity to attend a conference related either to protected areas in general, or specifically to their field of research?

   ☐ More than once a year.

   ☐ Once a year.

   ☐ Every second year.

   ☐ At least once every five years.

   ☐ At least once every ten years.

9. Please indicate (Yes/No) whether your agency subscribes to any of the peer-reviewed journals related to protected areas research.

Journal Title	Subscribe? (Y/N)
Annals of Tourism Research	
Arctic	
Arctic Anthropology	
Biological Conservation	
Conservation Biology/Conservation in Practice	
Ecology/Ecological Applications/Ecological Monographs	
Environmental Management	
The George Wright Forum	
Information North	
Journal of Leisure Research	
Journal of Park and Recreation Administration	
Journal of Wildlife Management	
Landscape Ecology	
Natural Areas Journal	
Northern Perspectives	
Park Science	
Polar Record	
Recreation Research Review	
Other:_____	
Other:_____	
Other:_____	

10. Does your agency contribute material to peer-reviewed journals?

    ☐ Yes (go to question #10a)

    ☐ No (skip to question #11)

    a) Please supply references for any published work conducted within your agency in the last 5 years, **OR**, if more than 5 articles have been published in the past five years, please provide a list of the number of publications, and a sample reference for each, under each of the following categories.

- Planning and management
- Ecology and conservation biology
- Earth sciences and physical geography
- Tourism and human geography

☐ Other _____

11. Please list any "grey" literature published by your agency that has been made available and/or used by other agencies, universities and/or the general public.

12. How often does your agency produce comprehensive *"state of" reports* for the protected areas within your agency's jurisdiction?

☐ Once per year

☐ Every two years

☐ At least every five years

☐ At least every 10 years

☐ As needed

☐ Never (skip to question #14)

13. Who is the target audience for these reports? Check any that apply.

☐ Director/Chair of agency

☐ Minister responsible for protected areas

☐ Other protected areas agencies in Canada

☐ ENGO's and/or other protected areas organizations

☐ Research community and academia

☐ *Stakeholders* (e.g., industry, First Nations, local communities)

☐ General public

☐ Other _____

14. How is your agency using the Ecological Integrity Panel Report issued by Parks Canada in 2000? Check any that apply.

☐ Reform of protected areas policy

☐ Reform of protected areas legislation

☐ Planning/design of protected areas

☐ Management of protected areas

☐ Adoption of specific recommendations

- ☐ Template for agency program review
- ☐ Report under review and consideration
- ☐ Other: _____
- ☐ Not considering the EI Panel Report

15. What measures does your agency take to enhance the ecological integrity of protected areas within its jurisdiction? Check any that apply.

    - ☐ Establish buffer zones around/adjacent to protected areas
    - ☐ Expand existing protected areas
    - ☐ Adopt sympathetic/modified management practices around/adjacent to protected areas to reduce/mitigate external stresses
    - ☐ Establish linkages and *corridors* to connect protected areas
    - ☐ Use monitoring and adaptive management in and around protected areas
    - ☐ Other _____

16. What methods does your agency use to inform the public about protected areas design and management? Check any that apply.

    - ☐ Agency website
    - ☐ Agency publications
    - ☐ Audio/visual presentations
    - ☐ Interpretative programs
    - ☐ Other _____

17. Have any 'model' protected areas been established in your jurisdiction to showcase 'best practices' for protected areas design, protection and management?

    - ☐ Yes
    - ☐ No

    If yes, please provide name of area(s)

ADDITIONAL SPACE

Please feel free to use the space below to provide additional comments, or to provide further clarification to questions above where space did not permit a complete answer. Be sure to reference specific comments to specific questions.

III. Freestyle Answer

Please note: Your answer to this question will be compiled with others as a series of short essays in the final CCEA Northern Protected Areas report. We will be polling respondents from across northern Canada and the circumpolar north, in an effort to compare and contrast scientific-knowledge based management in various regions. For this reason, we would appreciate it if you would constrain your answers within the headings provided, with an overall limit of 1000 words (2 pages) for your response.

Question: How has the use of scientific knowledge in planning and managing protected areas changed over time? Please describe how the process of identifying sites for and establishing protected areas has changed within your agency. Define an appropriate historical time frame for your agency/region. Please focus your answer on changes in the application of conservation science and the use of scientific knowledge in planning and management of protected areas.

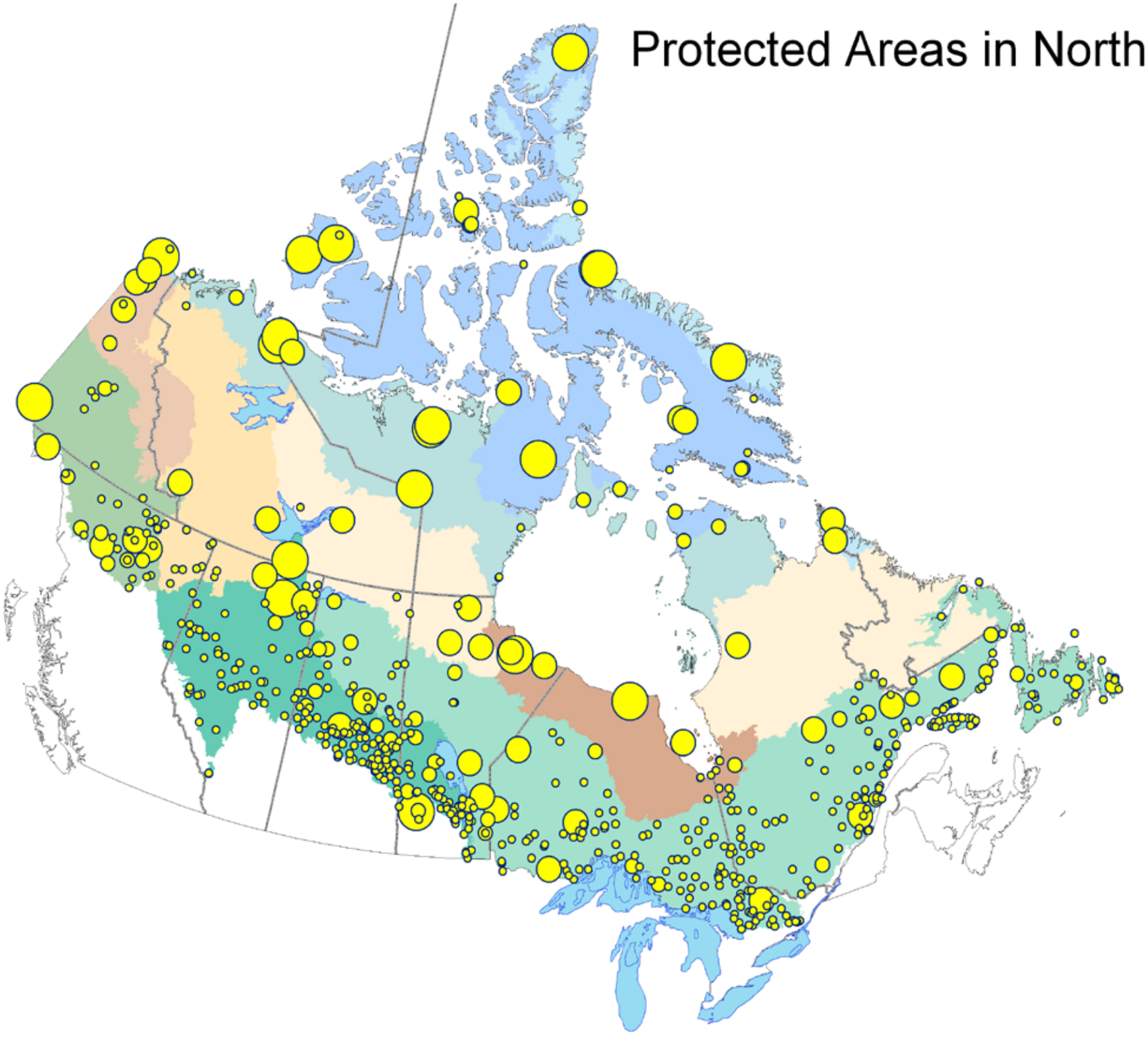
I. Historical Process of Establishing Protected Areas

1. Definition of historical time frame
2. Description of the process of establishing protected areas
3. Description of the use of scientific knowledge/methodologies in planning and managing protected areas
4. *Stakeholders*
    a) Who are they?
    b) How do they influence the process?

II. Present-day Process of Establishing Protected Areas

1. Definition of present-day time frame
2. Description of the process of establishing protected areas
3. Description of the use of scientific knowledge/methodologies in planning and managing protected areas
4. *Stakeholders*
    a) Who are they?
    b) How do they influence the process?

Protected Areas in Northern Canada



Legend

Protected Area Size Classes (Square Km)

- 10 - 999
- 1000 - 2999
- 3000 - 10 000
- 10 000 - 62782

ECOZONES

- Arctic Cordillera
- Northern Arctic
- Southern Arctic
- Taiga Plains
- Taiga Shield
- Boreal Shield
- Boreal Plains
- Taiga Cordillera
- Boreal Cordillera
- Hudson Plains

Projection

Atlas of Canada
Lambert Conformal Conic
North American Datum 1983

This map accompanies the report "Northern Protected Areas, Designing for Ecological Integrity" published by the Canadian Council on Ecological Areas

The Protected Area data is from the Canadian Conservation Area Database (CCAD),03/11/05. It includes all designations of PA's in Canada such as National, Provincial Parks, Migratory Bird Sanctuaries and National Wildlife Areas.

Environment Canada | Environnement Canada
Canadian Wildlife Service | Service canadien de la faune
Habitat Conservation | Conservation des habitats

A literature review and summary of science-based approaches for protected area design with a survey and assessment of existing protected areas, current practices and future needs.

CCEA

www.ccea.org