The Parks Research Forum of Ontario (PRFO) logo of three ellipses depicts core protected areas nested in protected area systems within working landscapes. The horizontal axis represents the interface between terrestrial and aquatic systems. The logo indicates the general range of PRFO's interest in promoting and reporting on research relevant to parks and protected areas.

The Parks Research Forum of Ontario 1998 Annual Meeting was organized by:

- Heritage Resources Centre
  University of Waterloo
  Waterloo, Ontario
  N2L 3G1

- Frost Centre for Canadian Heritage and Development Studies
  Trent University
  Peterborough, Ontario
  K9J 7B8

- Ontario Parks
  PO Box 7000, 300 Water Street
  Peterborough, Ontario
  K9J 8M5

- Parks Canada, Professional Services–Ontario
  111 Water Street, East
  Cornwall, Ontario
  K6H 6S3
Acknowledgements

Many thanks are extended to all the presenters who prepared and delivered invited and volunteered papers at the Parks Research Forum of Ontario Annual Meeting in Peterborough, Ontario on February 5th and 6th, 1998. Thanks as well to the individuals who moderated sessions of volunteered papers on the second day of the meeting.

Thanks are also due to Ontario Parks, Parks Canada-Ontario Region, the Frost Centre for Canadian Heritage and Development Studies (Trent University) and the Heritage Resource Centre (University of Waterloo) for providing financial and other support to organize and conduct the meeting as well as to prepare these Proceedings.

A number of people contributed to the successful staging of the meeting. Jan Warfield of the Frost Centre provided much assistance in helping to arrange and conduct the meeting in Peterborough. Kirsty Dickson, Patrick Lawrence, Heather Black and Lucy Sportza of the Heritage Resources Centre and Brian Kutas of the Frost Centre provided additional support.

PRFO would like to thank Norm Richards, Barton Feilders, Bob Davidson and Dan Mulrooney from Ontario Parks for their support and assistance in organizing and staging the meeting. PRFO would also like to acknowledge the following officials of the Ministry of Natural Resources for their support in staging the meeting: Ron Vrancart, Deputy Minister; Cam Clark, Assistant Deputy Minister, Field Services Division; Gail Beggs, Assistant Deputy Minister, Natural Resources Management Division; Jim MacLean, Director, Science Development and Transfer Branch; Dave Watton, Director, Land Use Planning Branch; Adair Ireland-Smith, Manager, Natural Heritage Section; and Mark Garscadden, Manager, Wildlife and Natural Heritage Section.

Thanks are also extended to Nancy Begley and Burton McClelland, Communications Services, Ministry of Natural Resources, who provided the poster display system and audio-visual equipment. Lloyd Walton, Film and Video Producer, with Communications Services, MNR, video-taped the keynote presentations, panel discussion, working group reports, closing commentaries, and award to George Priddle on the first day of the meeting. Kristen McCoy assisted in transcribing material from the video-tapes. Video-tape coverage of the first day is available through Ontario Parks.

Bill Stephenson and his colleagues at Parks Canada (Cornwall) have been supportive of PRFO for a long time. Parks Canada provided the initial support for PRFO and has been an active colleague ever since. He arranged for the presentations and participation at PRFO of a number of Parks Canada personnel and helped review the Proceedings.

John Marsh and his colleagues at Trent were helpful as well. John Wadland arranged for financial and staff support at the PRFO meeting and made a contribution to the costs of publishing these Proceedings. We are grateful for the support of Trent.
This set of Proceedings was edited and produced to the camera-ready stage at the Heritage Resources Centre. Special thanks are due to Colleen Cirillo who contributed greatly to the initial compilation and editing of the manuscript.

All of us owe very special thanks to Ken Van Osch of the Heritage Resources Centre who was most effective in the planning, organizing and implementation of the PRFO meeting and the completion of the Proceedings. In his capacity as PRFO Co-ordinator, Ken has been key to its success to date.

It is not possible to thank everyone individually who helped with PRFO but we are grateful to all who participated in the event and look forward to working together in the future. Although a great many people helped in many ways, these Proceedings are of course the responsibility of the editors.

Gordon Nelson
Waterloo, Ontario
December 10, 1998

for
Gordon Nelson and Ken Van Osch with Tom Beechey, Bill Stephenson and John Marsh
Editors
Dedication

These Proceedings are dedicated to Dr. George Priddle who received the Ontario Parks Heritage Protection Award at the February 5th and 6th, 1998 meeting of the Parks Research Forum of Ontario. The citation and two testimonials to Dr. Priddle are presented in these Proceedings. Dr. Priddle passed away on September 6, 1998. His outstanding work on parks will be missed in Ontario and indeed elsewhere. We are very grateful for his many contributions to parks and so to all the people who use and enjoy them.

Editors.
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<th>Description</th>
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<tbody>
<tr>
<td>AFA</td>
<td>Algonquin Forestry Authority</td>
</tr>
<tr>
<td>AGJV</td>
<td>Arctic Goose Joint Venture</td>
</tr>
<tr>
<td>ANSI</td>
<td>Area of Natural and Scientific Interest</td>
</tr>
<tr>
<td>APP</td>
<td>Algonquin Provincial Park</td>
</tr>
<tr>
<td>BIS</td>
<td>Background Information Study</td>
</tr>
<tr>
<td>BPNP</td>
<td>Bruce Peninsula National Park</td>
</tr>
<tr>
<td>CARE</td>
<td>Conservation of Agricultural Resources and Environment</td>
</tr>
<tr>
<td>CARP</td>
<td>Centre for Archeological Resource Prediction</td>
</tr>
<tr>
<td>CHIPP</td>
<td>Cultural Heritage Inventory Protection Program</td>
</tr>
<tr>
<td>CIFFC</td>
<td>Canadian Interagency Forest Fire Centre</td>
</tr>
<tr>
<td>CITES</td>
<td>Convention on International trade in Endangered Species</td>
</tr>
<tr>
<td>CLTIP</td>
<td>Conservation Land Tax Incentive Program</td>
</tr>
<tr>
<td>COSEWIC</td>
<td>Committee on the Status of Endangered Wildlife in Canada</td>
</tr>
<tr>
<td>COSSARO</td>
<td>Committee on the Status of Species at Risk in Ontario</td>
</tr>
<tr>
<td>DACPAN</td>
<td>The Canadian Task Force on Amphibian Populations</td>
</tr>
<tr>
<td>DBH</td>
<td>Diameter at breast height</td>
</tr>
<tr>
<td>DOC</td>
<td>Dissolved oxygen content</td>
</tr>
<tr>
<td>ECP</td>
<td>Ecosystem Conservation Plan</td>
</tr>
<tr>
<td>ELC</td>
<td>Ecological Land Classification</td>
</tr>
<tr>
<td>EMAN</td>
<td>Ecological Management and Assessment Network</td>
</tr>
<tr>
<td>ESA</td>
<td>Environmentally Significant Area</td>
</tr>
<tr>
<td>FFNMP</td>
<td>Fathom Five National Marine Park</td>
</tr>
<tr>
<td>FON</td>
<td>Federation of Ontario Naturalists</td>
</tr>
<tr>
<td>FRI</td>
<td>Forest Resource Inventory</td>
</tr>
<tr>
<td>GPE</td>
<td>Greater Park Ecosystem</td>
</tr>
<tr>
<td>LSPAM</td>
<td>Lake Superior Protected Areas Managers</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
</tr>
<tr>
<td>NAWMP</td>
<td>North American Wetland Management Plan</td>
</tr>
<tr>
<td>NCC</td>
<td>Nature Conservancy of Canada</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-governmental organization</td>
</tr>
<tr>
<td>NHIC</td>
<td>Natural Heritage Information Centre</td>
</tr>
<tr>
<td>NSERC</td>
<td>National Science and Engineering Council</td>
</tr>
<tr>
<td>OMNR</td>
<td>Ontario Ministry of Natural Resources</td>
</tr>
<tr>
<td>ONTA</td>
<td>Ontario Nature Trust Alliance</td>
</tr>
<tr>
<td>PICs</td>
<td>Problems, Issues and Concerns</td>
</tr>
<tr>
<td>RENEW</td>
<td>Recovery of Nationally Endangered Wildlife</td>
</tr>
<tr>
<td>TNC</td>
<td>The Nature Conservancy</td>
</tr>
<tr>
<td>WL</td>
<td>Wildlands League</td>
</tr>
<tr>
<td>WWF</td>
<td>World Wildlife Fund</td>
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</table>
INTRODUCTION

Point Pelee National Park

Sandbanks Provincial Park
Opening Remarks

Norm Richards
Managing Director
Ontario Parks
PO Box 7000, 300 Water St.
Peterborough, ON K9J 8M5

Good morning, and welcome to Peterborough and the 1998 annual meeting of the Parks Research Forum of Ontario. Judging by the number of registrants here today, the idea of the Parks Research Forum of Ontario has quickly gained momentum.

In a moment, Gordon Nelson will be giving you a short rundown on the purpose of the Forum and the programme for the meeting today and tomorrow. But before inviting Gordon to do so, let me say that the idea of the Forum, and the theme of its conference today—Parks and Protected Areas in the Canadian Shield—are especially topical and timely. This meeting affords us an opportunity to reflect on the origins of our magnificent system of provincial parks and other protected areas in Ontario, which developed out of the early foundation parks in the Canadian Shield, such as Algonquin, Quetico, Lake Superior and Sleeping Giant.

From an organizational perspective, Ontario Parks is now charged as a new organization in the Ministry of Natural Resources, with special new authorities that allow it to work more effectively on planning, managing and operating provincial parks.

From an ecological perspective, Ontario Parks and the Ministry of Natural Resources have embraced the idea of ecosystem management, which is exemplified by our approach to parks and resource management practices in the Canadian Shield.

Provincial parks and other protected areas are now viewed as a cornerstone in our efforts to conserve biodiversity and to protect and manage the environment and natural resources in an ecologically sustainable way.

These directions are reinforced by Lands for Life/Nature’s Best, which highlights the Government’s commitment to ecologically-based land-use planning in a manner that embraces provincial parks and other protected areas as a central objective to be met through land-use planning.

Science, information and research are now viewed as central components of the Ministry’s core business with both Ontario Parks and other Ministry programmes working hard to develop genuine partnerships that will engage people and resources more effectively in scientific endeavors.

So we view the Parks Research Forum of Ontario, and today’s meeting, as a particularly welcome opportunity to explore common needs and exchange ideas.
that will strengthen the protection, understanding and appreciation of Ontario’s
parks and other protected areas.

With those few comments, I now call upon Gordon Nelson to provide a brief
overview of the Parks Research Forum of Ontario and the interesting meeting
before us.*

* Gordon Nelson’s opening comments at the conference have been incorporated
into the introductory preface to this volume.
Parks and Protected Areas Research in Ontario:
An Introduction

The Need
For many years concerned people have talked about the need for more understanding of the role of research in planning, managing and deciding upon parks and protected areas and related conservation and sustainable development programs in Ontario and indeed Canada more generally. The information arising from research can help to demonstrate the contribution of parks and protected areas environmentally, socially and economically.

Concerned professionals, politicians and citizens can benefit from research in the following ways.

- Researchers working on or interested in parks and protected area issues can learn more about what research is completed or underway and what the opportunities and challenges are for the future.
- Planning and management can be better informed and more effective.
- Conservation of plants, animals and other elements of parks and protected areas can be undertaken more successfully.
- The economic, social and environmental impacts of human use can be more fully appreciated and taken into account.
- The training and education needs of practicing professionals and concerned citizens can be enhanced.
- Recreationists and tourists can increase their understanding and enjoyment through the information provided by research on parks and protected areas.

All these contributions are especially important now when pressures upon and the need for parks and protected areas are increasing rapidly.

Formation of the Parks Research Forum of Ontario

In the light of these needs and motivations an inaugural planning forum was convened by The Heritage Resources Centre, University of Waterloo; The Frost Centre for Canadian Heritage and Development Studies; Ontario Parks; and Parks Canada (Ontario Region). This initial meeting was held at Buckhorn Lake near Peterborough in March 1996. The meeting was attended by about 50 people from government, business, universities and non-government organizations and a set of proceedings was published (Lawrence and Nelson 1996). This meeting led to the creation of the Parks Research Forum of Ontario (PRFO) and to the establishment of the following goal, objectives and activities.

Goal: The goal of the PRFO is to encourage research applying to parks and protected areas.

Objectives: The objectives of PRFO are to:

- promote research to improve understanding, planning, management and decision-making for parks and protected areas;
- encourage educational and training activities relating to parks and protected areas;
- facilitate more co-operation in parks and protected areas research;
• establish a meeting place for people involved in parks and protected areas research;
• exchange information on a regular basis among people involved in parks and protected areas research;
• monitor and report on research on parks and protected areas.

**Activities:** A set of activities have been planned to meet these objectives. These activities are initial and strategic and could change and evolve as PRFO grows and evolves. The activities are to:

• sponsor an annual general meeting of the PRFO;
• arrange state-of-the-art workshops and other meetings which focus on parks and protected areas research;
• publish a newsletter in electronic and paper formats on parks research;
• conduct research and publish reports on strategic efforts that advance the goal of the PRFO;
• fund-raise for purposes relevant to PRFO activities.

In 1998-1999, PRFO began to implement these activities. It arranged for the second annual meeting of PRFO on February 5 & 6, 1998 in Peterborough, Ontario. These Proceedings are a result of that workshop.

**1998 Proceedings of the Parks Research Forum of Ontario**

The Proceedings demonstrate the value of research on parks and protected areas and the role of PRFO and its annual meeting. A number of invited papers were presented on the theme of parks in the Canadian Shield in a special session held to open the Forum in Peterborough. These papers are of basic value to persons concerned about the role of parks and protected areas in northern Ontario generally and particularly the *Lands for Life* review of northern wildlands.

Many papers were volunteered for presentation at the Forum as well. Thirty-three of these papers are published here as major papers, reports, poster papers and abstracts. These various papers, reports and abstracts differ in their completeness; their scientific, scholarly and professional format; the way in which the information is presented; and in writing style. The volunteered papers tend to involve analysis, assessment and interpretation and to be more complete than the reports which are essentially descriptive. Papers presented as posters at the meeting are generally included in the reports section of the Proceedings. The Proceedings also include reports of working groups and a list of attendees.

The Proceedings reflect the desire to receive and disseminate research that is in various phases of completeness. We are interested in research that is complete or nearly so — as well as in work that is in the early stages. Our intent is to encourage communication and co-operation among researchers in universities, government and private situations and to stimulate research and its use for the greater good of parks and protected areas and society in Ontario as a whole. PRFO's focus is on research and its role in parks and protected areas.

In this respect, the papers and reports in this volume are not organized by theme. One referee suggested that this be done but the editors decided against this
because of the differing and uneven character of the papers, reports and abstracts that would be included in each theme section under this arrangement. However, we do note in the Table 1 the major themes identified by the referee and the papers, reports and abstracts that he felt fell under those themes.

Summary of the Results of the 1998 PRFO Meeting

To summarize the results of the 1998 Forum and the work to date is impossible in the space and time available here. Some of the major findings are that:

- A considerable amount of research is currently underway.
- Some of the research is relatively well known.
- Some of the research is new even to people knowledgeable about parks and protected areas in Ontario.
- A considerable amount of other research undoubtedly is underway that we do not know much about and whose contribution is therefore not as available to society as it should be.
- Many more people are involved in parks and protected areas research than is generally understood to be the case.
- Much remains to be discovered and encouraged through the work of PRFO.

Much of the ongoing research that we know of is ecological and biological in nature, although considerable research on the chemistry and related aspects of water and on hydrology and earth sciences is also underway. Some research is available on the human dimensions of parks and protected areas, for example on visitor patterns, economics, resident and user communities, tourism, land use, education, and other activities, processes and patterns. Much more research is needed on the human dimensions of parks and protected areas.

Overall, our feeling is that we have made a big step toward our goal and objectives. We need to press on and secure the increasing benefits to be derived from doing so. We welcome expressions of interest and advice as we move toward the next Forum to be held in Spring 1999. We also welcome ideas and proposals for state-of-the-art workshops and other planned activities by PRFO.

J. Gordon Nelson, Chair, Parks Research Forum of Ontario
Heritage Resources Centre, University of Waterloo
Tom Beechey, Ontario Parks
Bill Stephenson, Parks Canada – Ontario Region
John Marsh, Frost Centre for Canadian Heritage and Development Studies
Trent University

Reference

<table>
<thead>
<tr>
<th>Major Themes</th>
<th>Papers, Reports and Abstracts</th>
</tr>
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</table>
| **Strategies for Park Management and Conservation** | • A Research Strategy for Algonquin Provincial Park  
• Easement and Dedication Programs for Parks and Private Lands  
• Protecting Cultural Resources Through Forest Management Planning in Ontario  
• Priority Sites for Conservation Action in the Niagara Escarpment Biosphere Reserve  
• Amphibian and Reptile Conservation in Ontario: Guidelines for Parks and Protected Areas at Long Point, Rondeau, and Point Pelee  
• The Forest Fire Management Program at Pukaskwa National Park  
• Natural Area and Land Use Planning Connections in the Carolinian Canada  
• Faunal Survey and Inventory in Ontario Parks  
• Assessing the Evolution of Marsh Management in Protected Areas: with special reference to Point Pelee, Rondeau and Long Point, Lake Erie, Canada  
• The Identification of Candidate Protected Areas for the *Lands For Life* Planning Process by the *Partnership For Public Lands*  
• Ecosystem Conservation Plans for Bruce Peninsula National Park and Fathom Five National Marine Park  
• Building Community and Conserving Cultural Landscapes through Inventory  
• Enhancing Trail Access for People with Disabilities  
• Protected Areas and Other Land Uses - A Spatially Explicit Evaluation  
• Research and Monitoring Needs Catalogue for Ontario Region National Parks  |
| **Evaluating Park Management and Conservation** | • Use of Estimated “Pristine” Species-Area Relations as Null Models For Evaluating Size and Integrity Standards for Protected Areas: An Update  
• Economic Benefits of Provincial Parks in Ontario: A Case Study Approach  
• Community Evaluation Methodology  
• From Inventory to Interpretation: A Definition of Process  
• Chemical and Biological Status of Killarney Park Lakes (1995-1997): A study of lakes in the early stages of recovery from acidification  |
| **Empirical Inventories and Monitoring at Different Spatial Scales: Population** | • Snow Geese in Polar Bear Provincial Park: Implications of a Trophic Cascade  
• Historical and Present Status of Woodland Caribou (*Rangifer tarandus*) in Pukaskwa National Park, Ontario and Implications for Metapopulation Management, a Review  
• Seasonal Movement Patterns and Feeding Habits of Large Adult Male Black Bears in Algonquin Provincial Park, Ontario  
• The Effects of Human Disturbance on Eastern Massasauga Rattlesnakes (*Sistrurus catenatus catenatus*) in Killbear Provincial Park, Ontario  
• Some Possible Causes of Fatal Attacks on Humans By Large Adult Male Black Bears - A Discussion  
• Linking Geology to the Effects of Acid Precipitation on the Food Chain of *Gavia immer*.  
• Spatial Relations between Migratory Algonquin Park Wolves and Resident Wolves in a Winter Deer Yard (Winter 1997 Preliminary Results)  |
| **Empirical Inventories and Monitoring at Different Spatial Scales: Communities** | • Bird Species Richness and Composition in White Pine (*Pinus Strobus*) Stands in Algonquin Provincial Park, Ontario — In Response to the First Cut of the Uniform Shelterwood Silvicultural System  
• Overgrazed Ecosystems: Do Plant Communities Recover?  |
| **Empirical Inventories and Monitoring at Different Spatial Scales: Ecosystems** | • Investigation of Nutrient Sources to Point Pelee Marsh  
• Release of Nutrients from On-site Wastewater Disposal Systems, Point Pelee National Park, Ontario, Canada  
• An Overview of Environment Canada's Groundwater Research Activities at Point Pelee National Park  
• Coastal Geomorphology and Assessment of Proposed Dyke Construction at Lighthouse Point Provincial Nature Reserve, Pelee  |

Table 1: A Suggested Organization by Themes
PART I: SPECIAL SESSION ON
PARKS AND PROTECTED AREAS IN THE CANADIAN SHIELD: INFORMATION AND RESEARCH NEEDS

INVITED PAPERS

Pinery Provincial Park
Science, Information and Research Needs for Ontario’s Parks and Protected Areas in the Canadian Shield

T. J. Beechey, R. J. Davidson, S. B. Feilders and D. R. Mulrooney
Ontario Parks, PO Box 7000, 300 Water St., Peterborough, ON K9J 8M5

Abstract
Curiosity about the natural world, and concern for its preservation, helped to forge early scientific interest in parks and other protected areas in many jurisdictions. Contemporary understandings of ecological sustainability and biodiversity have reinforced these early motivations and interests among both scientific and agency personnel. Ontario’s system of provincial parks and other protected areas currently reflects these inclinations through a well-established tradition of research. A central aim of the parks and protected areas system is to represent a cross-section of the ecological and geological diversity of Ontario and thereby secure baseline opportunities for research, monitoring and understanding of the province’s natural diversity. Although the research record documents projects in a wide spectrum of disciplines, historical patterns of research demonstrate a very strong focus on biological research with more than 75% of all documented studies in this category. Notwithstanding the value of parks and other protected areas in furnishing opportunities for both pure and applied research, current efforts by Ontario Parks seek to attract more studies of direct relevance to planning, managing and monitoring park ecosystems and their associated values and benefits. Efforts are being made to engage scientists in the Ontario Ministry of Natural Resources (OMNR) through OMNR’s Science Team and its corporate science, information and research strategy. Concurrently, Ontario Parks’ involvement in the Parks Research Forum of Ontario (PRFO) and other collaborative ventures is seeking to attract wider scientific support and involvement in these efforts.

Introduction
The relationship between parks and protected areas and science and research has been a long-standing one motivated by mutual interests in conserving natural diversity and understanding Nature. For their part, natural scientists have been persistent advocates for parks and protected areas as one means to conserve natural diversity and to secure ecological areas for scientific study. Motivated more by recreational mandates than scientific reasons in the past, land management agencies are now increasingly supportive of such designations as cornerstones in efforts to achieve ecological sustainability and biodiversity conservation, both of which demand more scientific rigour.

This paper examines contemporary needs for science, information and research for planning and managing provincial parks and other protected areas in Ontario. Specifically, its aims are threefold: 1) to elaborate the context for identifying contemporary needs and priorities; 2) to relate briefly past research trends and activities; and, 3) to address implementation aspects to meet new challenges confronting park and protected area agencies today. Although dwelling on the mandate of Ontario Parks to plan, protect and manage Ontario’s provincial park
system, many of the issues and ideas have relevance for parks and protected area agencies elsewhere in Canada and North America.

In many respects, this is a timely and topical review in Ontario. The Precambrian Shield houses the backbone of the provincial parks system, including many of its most significant foundation parks, such as Algonquin established in 1893, Quetico in 1904, and Lake Superior and Sleeping Giant in 1944 (Killan 1993). New administrative authorities for the provincial parks programme through the creation of Ontario Parks in 1994 (OMNR 1996a), coupled with its protection mandate and new outlook for ecosystem management, have strengthened the organization’s view of science, research and information needs. These directions are further reinforced by *Nature’s Best*, a provincial initiative committed to ecological sustainability including the completion of a system of parks and other protected areas (OMNR 1997b).

**The Scientific Context**

Science, information and research have long been regarded as pursuits associated with the establishment, management and use of parks and other protected areas. Indeed, the recent surge to expand park systems around the world is largely motivated by scientific interests and ideals to protect ecosystems and natural features for heritage conservation, research, education and appreciation (Green and Paine 1997). Much of that thrust derives from earlier inclinations, reflected in land-use philosophies such as that of Aldo Leopold (Leopold 1949). Another stimulus has been the movement to establish professional organizations such as the Natural Areas Association and the George Wright Society in the United States, and the Canadian Council on Ecological Areas and the Science and Protected Areas Association in Canada. So while parks and protected areas were largely regarded as “set asides”, “withdrawals” or “reserves” by land management agencies in the past, scientific interests have influenced their broader acceptance today.

Over the past decade, new imperatives have emerged to strengthen the scientific support for parks and protected areas. Notable among these is the broadening recognition and support for parks and protected areas as exemplified in the *Canadian Forestry Accord* and the *National Forest Strategy* (CCFM 1992), the signing and ratification of the *United Nations Convention on Biological Diversity* (UNEP 1992), the development of the *Canadian Biodiversity Strategy* (BCO 1995), and efforts by organizations such as the Canadian Council on Ecological Areas (Gauthier et al 1995; Gauthier D. 1992) and World Wildlife Fund Canada (Hummel 1989; Kavanagh and Iacobelli no date; Noss 1995) which promote the completion of a Canadian system of parks and protected areas. At the same time, new perspectives on conservation biology and landscape ecology have highlighted serious concerns about the design and management of protected areas for the conservation of species and spaces (Riley and Mohr 1994; Poser, Crins and Beechey 1993; Noss 1995, 1992; Grumbine 1990).

Today, a fuller understanding of our relationship with Nature is manifest in new paradigms that we express as “biodiversity conservation”, “ecosystem management” and “ecological sustainability”. These templates relate to a more sophisticated land-use philosophy, more fully embraced by both land management agencies and scientific sectors, that places paramount importance
on the need to sustain ecological features, processes and systems as prerequisites for ecological sustainability. Parks and protected areas are a central component in these new paradigms, which more than ever rely on environmental benchmarks to assess our ability to manage ecosystems in a sustainable way. So, today, the importance of parks and protected areas to land-use management is greater than ever before, and their broad-based acceptance has been fortified by new ecological understanding.

These overall trends are manifest in Ontario. As early as the 1950s, the notion of “representation” emerged in connection with the efforts of the Department of Lands and Forests to identify sites for wilderness areas that were ultimately protected under the new Wilderness Areas Act, introduced in 1959. Subsequently, the activities of the International Biological Programme (IBP) in Ontario involved leading scientists and agency personnel in efforts to identify almost 600 representative and special natural areas for conservation purposes, including scientific research and education. The Provincial Parks Policy, first approved by the Ontario Government in 1978, reflects many of the scientific principles introduced through the IBP/CT (Beechey, 1980). Strategic land-use planning in the 1980s virtually doubled the provincial parks system (OMNR 1983), while efforts through the ongoing Lands for Life planning exercise provide another opportunity to add substantially to the system (OMNR 1997a).

Today, the relationship between parks and protected areas and science and research is largely a mutually supportive and beneficial one in regard to achieving ecological sustainability. In short, parks and protected areas provide the following functions: 1) they preserve unique and representative segments of natural and cultural diversity; 2) they serve as benchmarks to gauge and to assess the effects of environmental changes, such as global warming; 3) they provide secure locations for long-term, time-trend research and cumulative effects monitoring; and 4) they provide living laboratories for training, educational and interpretative programming. In turn, science and research activity confer the following benefits: 1) they strengthen the rationale for and improve our understanding of parks and protected areas; 2) they generate essential information and knowledge to inform management efforts in and beyond protected areas; 3) they provide the intellectual and educational dimension for interpretative programming; and, 4) they extend the sense of ownership for protected areas (Beechey 1996).

**Provincial Parks in the Canadian Shield**

The Canadian Shield is a vast area of ancient Precambrian bedrock comprising the central core of Canada’s mid-north. In Ontario, the Shield includes approximately two thirds of the province—an area twice the size of the British Isles (Figure 1). Comprised of four distinct structural provinces in Ontario, it is highly diverse in its geological make-up and landscapes, which contain dramatic physiographies, thousands of lakes, river systems, watersheds and wetlands. The Shield is home to most of Ontario’s vast Boreal and Great Lakes-St. Lawrence Forest regions. Not surprisingly, the Shield is rich in Aboriginal and European history and culture, and today, remains a primary source of natural resources—forest products, minerals, fisheries and wildlife. For parks and protected areas, the region is a storehouse of natural heritage, ecotourism and
recreational values providing most of Ontario’s accessible wilderness areas, waterways and natural environments.

![Map of Canadian Shield](image)

**Figure 1: The Canadian Shield**

As announced in February 1997, the provincial government has initiated a comprehensive land-use planning process called *Lands for Life*, which is seeking to allocate natural resource and heritage values for protection and appropriate utilization across the broad forested region of Ontario that generally corresponds with the Canadian Shield (OMNR 1997a). The efforts to establish new provincial parks and other protected areas, generically referred to as natural heritage areas, takes its direction from a parallel commitment set out in the document *Nature’s Best: A Framework and Action Plan* (OMNR 1997b). *Nature’s Best* is provincial in scope and specifies three broad regions—essentially southern, central and northern Ontario—where approaches to heritage protection will be specially tailored to the particular needs of these regions (Figure 2).

The selection, planning and management of provincial parks in the Canadian Shield are guided by *Ontario’s Provincial Parks Policy* (OMNR 1978a) and the companion *Ontario Provincial Parks Planning and Management Policies* (OMNR 1978b). First adopted by the provincial government in 1978, these policies set out the goal, objectives, principles and park classification guiding the planning, protection and management of the provincial parks system. The goal is to provide a variety of outdoor recreation opportunities and to protect provincially significant natural, cultural and recreational environments. The protection and heritage appreciation objectives address the conservation of ecological, geological and cultural values, while the recreation and tourism objectives deal with day use, car camping and back country recreational activities. Guided by
systemic approaches, the policies are defined to include targets for wilderness, natural environment and waterway classes of parks (Davidson 1997a, McCleary et al 1992).

Figure 2: Nature’s Best Planning Regions

Park targets are defined on the basis of frameworks that have been developed to organize the natural and cultural diversity to be represented in Ontario’s provincial parks system. Geological targets have been derived through a classification that recognizes 44 themes and more than 1200 features including rock types, fossil assemblages, landforms and associated geological processes (Davidson 1981). Ecological targets include species, site types, vegetation communities and landscape patterns characteristic of the 14 site regions and 67 site districts in Ontario (Beechey 1980). Cultural targets are based on a topical organization of Ontario’s human history that recognizes 13 themes containing 115 theme segments spanning recorded human occupation of the province (OMNR no date). Park classes, notably wilderness, natural environment and waterway, are vehicles to capture assemblages of these units, with nature reserves and historical parks being assigned specifically for representing natural and cultural diversity respectively (Davidson 1997a).
Wilderness parks are substantial areas where the forces of nature are permitted to function freely and where visitors travel by non-mechanized means and experience solitude and personal integration with nature. The target for wilderness class parks is to establish one park, 50,000 hectares or greater in size, or an equivalent size national park, and one complementary wilderness zone of 5000 hectares in size or greater, in each of Ontario’s 14 site regions. By virtue of their size and natural condition, wilderness parks afford unique opportunities to study landscape scale ecosystems and the processes that sustain them, and associated back country use. Currently seven of nine site regions on the Canadian Shield include wilderness parks, and seven of nine regions contain wilderness zones (Figure 3)\(^*\) (Davidson 1997a).

\* The insert graphs in Figures 3 to 6 show the total areas within wilderness, natural environment, waterway, and nature reserve park classes as well as conservation reserves. These figures also show the area needed to meet the target for each.
Natural environment parks incorporate outstanding recreational landscapes with representative natural features and historical values to provide high quality recreational and educational experiences. The target for natural environment class parks is to establish one park, 2000 hectares or greater in size or an equivalent natural environment or wilderness zone, in each of Ontario’s 67 site districts. Though generally much smaller than wilderness parks, natural environment parks still encompass substantial natural areas that provide important opportunities for scientific research and environmental monitoring. Currently, 59 of 67 site districts contain a natural environment park (although 17 of these are less than 2000 hectares in size) with absolute gaps in only three of the 42 site districts in the Canadian Shield (Figure 4) (Davidson 1997a).

Figure 4. Natural Environment Park Class Target Achievement
Waterway parks incorporate outstanding water routes with representative natural features and historical values to provide high quality recreational and educational experiences. The target for waterway parks is to establish one park, having a minimum 200 metre setback from the river, or an equivalent waterway corridor in each of the 67 site districts. Waterway parks present diverse opportunities for research into human history and settlement patterns and the physical and biological sciences. At present 37 of the 67 targets have been achieved, mostly in northern Ontario, with only eight of the 42 site districts in the Canadian Shield having no waterway parks. Another 12 properly designed areas could complete representation in northern Ontario, while complementary approaches may need to be adopted in southern Ontario where no waterway parks currently exist (Figure 5) (Davidson 1997a).

Figure 5: Waterway Park Class Target Achievement
Nature reserves are areas selected to represent the distinctive natural habitats and landforms of the province and are protected for educational purposes and as gene pools for research to benefit present and future generations. Protection targets for nature reserves are determined by geological and biological frameworks that define the natural features to be represented. Nature reserves are selected to represent and protect Ontario’s most significant natural features, landscape segments, habitats and species. Owing to the diverse range of natural features that they contain, and the high degree of protection afforded to these areas, nature reserves are ideal sites for scientific research and monitoring. Although 63 of the 94 nature reserve parks in Ontario occur within the Canadian Shield, extensive gaps still exist in most regions (Figure 6) (Davidson 1997a).
Two other park classes, historical parks and recreation parks, make up the remainder of the provincial parks system. Historical parks are areas selected to represent the distinctive archaeological and historical resources of the province protected for interpretation, education and research. Recreation parks provide a wide variety of outdoor recreation opportunities such as car camping and day use activities in attractive semi-natural outdoor settings.

In 1994, a new category of protected areas called conservation reserves was established to provide protection for significant geological and ecological areas. Conservation reserves prohibit logging, mining and hydro-electric development, while permitting other selected traditional uses such as hunting, trapping and fishing making them less suitable than nature reserves as baselines for research, environmental monitoring, education and heritage appreciation. Conservation reserves are established through regulation under the Public Lands Act and managed in accordance with provincial policies for this designation. Since their inception in 1994, 23 conservation reserves with a total of 68,734 hectares have been regulated (Davidson 1997a).

To summarize, the Canadian Shield houses an impressive network of provincial parks created through ongoing efforts dating back to the establishment of Algonquin Park in 1893. Notwithstanding this important achievement, additional well-designed wilderness, natural environment, waterway, and nature reserve parks are still required to meet current park system planning objectives. As well, the design of many existing provincial parks in all classes could be improved with boundary amendments to augment representation, incorporate special features and enhance ecological integrity. These steps have an important bearing on the adequacy of the provincial parks system to meet scientific, research and associated educational objectives.

To address these system planning needs, gap analysis (Crins and Kor, this volume) is being combined with the assessment of previously documented natural areas to identify candidate provincial parks and conservation reserves to be considered through the Lands for Life planning programme. In addition to these area identification methodologies, further consideration is being given to the evaluation of special features, including flora and fauna, and systemic design considerations that will enhance the ecological integrity of the overall system. Taken together, these measures address system planning requirements in a manner that will strengthen the value of the provincial parks system and other protected areas for scientific research and environmental monitoring.

Research Trends in Provincial Parks
Past trends demonstrate a diverse record of research in provincial parks driven by agency-based planning and management needs and external scientific interest. From a programme standpoint, basic survey and inventory work over the past three decades have provided considerable baseline documentation on the provincial parks system. Geological surveys have provided reporting and mapping of bedrock and surficial geology in many provincial parks. Ecological surveys have generated vegetation mapping with accounts of the flora and fauna in many parks. Archaeological and historical studies have documented pre-settlement and settlement artifacts and conditions. And socio-economic studies, including user surveys, have been conducted on a regular basis. This
information has been widely applied to develop park management plans and assist with heritage protection, management and visitor services programming.

Scientific research by the external scientific community has been more wide-ranging and less focused on its specific application to meet park planning and management needs. Here efforts have spanned projects from basic surveys and inventories through studies of ecosystem process and function. Classic long-term studies have been completed to demonstrate population dynamics, other ecological trends over time, and the influence of environmental perturbations on natural systems, features and processes. The extent and depth of such studies attest to the significant benchmark role of provincial parks, and their increasing importance in future efforts to manage surrounding landscapes and resources in a sustainable manner.

The foregoing trends have been fueled by a variety of circumstances. First and foremost, there has been a long-standing scientific interest in parks and protected areas, with research in many areas even pre-dating the formal designation of many sites. In some cases, such as Schreiber Channel, on the north shore of Lake Superior, and Ojibway Prairie, in the city of Windsor, extensive scientific interest is the primary motivation for establishing areas as provincial nature reserves. In the 1960s, an initial research policy for provincial parks attracted further scientific interest, which increased with subsequent promotion in the last three decades. More intensive marketing of research needs and opportunities in provincial parks in the 1970s drew peak interest coincident with the environmental movement and availability of funding (Figure 7).

An assessment of some 1500 records of research in provincial parks by discipline indicates that activity in biological research far surpasses all other research activity. This reflects the pre-disposition of the biological fraternity to pursue research on natural ecosystems, features and processes which often coincide with parks and protected areas. Some of this skewed interest reflects the considerable research on forest ecosystems, fish and wildlife associated with the Ministry’s research orientation to help serve its conservation mandate in these programme areas. Conversely, the comparatively low research activity by other disciplines reflects less interest in these sectors, motivated by more wide
ranging research pursuits less reliant on the unique opportunities associated with natural ecosystems found in provincial parks (Figure 8).

Research efforts in provincial parks are heavily skewed, with concentrated activity in a few parks and relatively little to none in others. For example, more than 400 research projects have been documented for Algonquin Park, since the introduction of an application and approvals process. The park bibliography includes more than 1800 citations, with references to a great deal of additional research pre-dating the formal research application procedure (Tozer and Checko 1996). By comparison, other provincial parks with far more modest, but still substantial research records, such as Killarney, Rondeau, Presqu'ile, Long Point and Lake Superior, together, have less than 100 approved projects on file. Figure 9 depicts the overall pattern of research for this suite of parks when broadly segregated into “Shield” (Algonquin, Killarney and Lake Superior) versus “Non-Shield” (Rondeau, Presqu’ile and Long Point) parks.

![Figure 8. General Trend in Park Research Activity by Discipline.](image)

![Figure 9. Research Priorities for Selected Provincial Parks.](image)
A review of research records for provincial parks reveals other interesting facets about the nature of the clients and their activities. Not surprisingly, most researchers are from Ontario, either associated with universities or government agencies. While personnel from all Ontario universities are represented in the client profile, some, such as the University of Toronto, University of Waterloo and University of Guelph stand out for their extensive contribution. Among government agencies, noteworthy contributors include the Ministry of Natural Resources and Agriculture Canada. The records also document a number of long-term studies, such as the small mammal population work of J. B. Falls and his students beginning in 1952 in Algonquin Park, and wolf studies by the late D. Pimlott, J. Theberge and their students dating back to 1963 in Algonquin.

In summary, the research records for provincial parks, although far from complete, document some interesting patterns of use. Concentrated research occurs in relatively few parks across the system. Past and ongoing efforts are heavily focused on the natural sciences, mainly biology. The work tends to be focused on narrow topics, often based on one or a few species, rather than broad-based systemic studies with broad ecological application. And finally, overall activity peaked in the 1970s, showing subsequent declines probably associated with funding levels and interest which also peaked during this period of the environmental movement.

**Current Research Needs and Priorities**

The extensive record of research in provincial parks demonstrates the important role that these areas play in providing opportunities for both pure and applied research. Notwithstanding their importance for pure research, new challenges facing parks and protected areas highlight the need to generate more applied research directly oriented to protecting and managing these areas. Common needs and experiences worldwide have led to the formulation of guidelines for research on parks and protected areas (Thorsell 1992). In general terms, three closely related research streams can be identified around the broad themes of “building”, “managing” and ”monitoring” the system (Figure 10).

In regard to building the system, there is need to adopt a more holistic outlook that embraces not only the natural sciences, but also the social and economic aspects of parks and protected areas, with emphasis on the many benefits that accrue from these areas (Whiting 1998 and this volume; Wells 1997; Stanley 1997; Mosquin, Whiting and McAllister 1995). While more research is required to better define and update approaches and targets for representation, complementary efforts also are required on the social and economic dimensions. These needs are predicated on better documentation and evaluation of heritage and recreational assets and the management of values to sustain appropriate visitation and use. The realization that park agencies must become more self-reliant necessitates careful evaluation and assessment of heritage assets to insure that these values are not compromised by traditional uses and new enterprises such as ecotourism.
In terms of managing the system, there is a pressing need for current information on the state of parks and protected areas. Cultural and natural heritage inventories must be current along with surveys of park use to gauge thresholds of activity which might impact park values. Management and operational plans need to be based on current information and ongoing assessment that informs managers of natural carrying capacity, natural changes, user impacts and socio-economic benefits. Such information is critical for protecting, managing and utilizing heritage and recreation assets, which otherwise can be compromised through inappropriate management or excessive use.

In comparison to the impacts induced by internal park use, more attention is required on trans-boundary processes and stresses associated with adjacent uses and activities beyond protected area boundaries. Such trans-boundary influences may be numerous and often complex, and have given rise to the adoption of ecosystem management perspectives on parks and protected areas (Grumbine 1994; Slocombe 1993; Woodley, Kay and Francis 1993). In many ways, the research and information challenges facing parks and protected areas are embraced by the greater area ecosystem perspective, which recognizes the close relationship of park environments to the surrounding ecological, social and economic realities, and the wide range of external activities, uses and impacts that stress park ecosystems (Keiter and Boyce 1991) (Figure 10).

The foregoing needs substantiate the importance of developing a monitoring programme to recognize and to assess changes in the system on a regular basis. Such a programme requires the definition of indicators for environmental, social and economic integrity, with emphasis on measuring and documenting the ecological integrity of the system and its component parts. This requires a standardized approach to monitoring cumulative effects, using reliable parameters to gauge appropriate levels of use and environmental stress. Parks
Canada continues to provide leadership and valuable guidance in this area (Skibicki, Stadel, Welch and Nelson 1994).

In addition to the foregoing scheme, efforts need to be accelerated on specific research to deal with the management of particular issues. This includes work on topics such as species re-introduction and recovery, control of alien species, fire management and restoration ecology. A number of excellent examples of such applied research are reported in this volume. And notwithstanding these very applied needs, there is an ongoing need to encourage, accommodate and support pure research that is not explicitly aligned to managing protected areas.

**Advancing a Research Strategy**

Taken together, the foregoing needs present a formidable agenda to be dealt with on several related fronts. At a corporate level, the Ministry of Natural Resources has developed a science plan that sets out the goal, objectives, and programme dimensions for corporate science, information and research efforts including parks and protected areas and heritage conservation. This plan has been developed by a multi-disciplinary, inter-divisional committee established by the Ministry’s science team (OMNR 1996b).

Through the science plan, the science team sets priorities for the Ministry, and monitors and reports on research activities and progress on a regular basis. A key aspect of the plan is the transfer and application of results, focusing on the relevance of the products to park users. This approach will enable the development of a science business plan in line with the corporate business planning which is the foundation for decision-making in the Ministry.

Within the context of the Ministry’s science plan, Ontario Parks is well on the way to developing a research and information strategy that addresses its specific needs for planning and managing provincial parks. This strategy sets out a framework for setting priorities and evaluating projects, and allocating resources to complete them. This approach ensures that science, research and information needs are dealt with in a rationale way consistent with the Ministry’s corporate approach and business planning for Ontario Parks (Davidson 1997b).

Associated with these efforts, Ontario Parks is working with other partners to encourage, and to strengthen efforts on research most relevant to provincial parks and other protected areas. Examples of these endeavors are agreements with cooperating universities in a variety of areas, such as, the co-operative research station with the University of Waterloo at Presqu’ile Provincial Park (Suffling, Knight and Immerseel 1992), initiatives with Brock University at Short Hills Provincial Park; and a newly developing research collaborative with the University of Guelph.

In the interests of catalyzing and coordinating more research efforts for parks and protected areas, Ontario Parks has been an initial sponsor of the Parks Research Forum of Ontario (PRFO). Working with the other lead partners—Heritage Resources Centre, University of Waterloo; Frost Centre, Trent University; and Parks Canada, Ontario Region—the partners aspire to catalyze and report on research relevant for parks and protected areas.
Conclusion

Scientific interest in parks and protected areas in Ontario, as elsewhere, is a long-standing one motivated by professional and philosophical inclinations to preserve and understand the natural world. Although often driven more by curiosity than park goals, all of this research adds to our understanding of park ecosystems and strengthens the rationale to preserve these special places.

Ontario’s system of provincial parks is a diverse one that offers a wide range of research opportunities in the natural and social sciences. Research needs range from wilderness management in the north to restoration ecology in the south. Increased visitation coupled with greater demands for resource extraction in surrounding areas are challenging park managers to better design, protect and manage these areas in line with a greater ecosystem perspective.

Applied research is central to improving decision-making for parks and protected areas. To that end, strategies are needed to define, carry-out and apply priority research to improve the planning and management of parks and protected areas. Business planning for science is essential to insure that limited resources are allocated most effectively on priority research needs.

At the same time, management agencies must recognize that pure, less applied research, remains a valid and desirable pursuit in parks and protected areas. Though perhaps less applicable for addressing immediate management issues, such research enriches the relevance, understanding, appreciation and programming for parks and protected areas as baselines for more comprehensive ecosystem management efforts.

Ontario Parks is far along in realizing the importance of science, information and research for planning and managing provincial parks. Internal strategies combined with outreaching partnerships are viewed as complementary ways to engage the scientific community in research pursuits of joint relevance to improve the provincial parks system.

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Selected References


International Trends in Park Tourism and Economics: Implications for Ontario

Paul F. J. Eagles, Professor
Department of Recreation and Leisure Studies and
School of Urban and Regional Planning
University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1
Chair, Task Force on Tourism and Protected Areas,
World Commission on Protected Areas
World Conservation Union (IUCN), Gland, Switzerland

Abstract
Nature-based tourism is a large and growing global industry. Much of this tourism is based in parks and other forms of protected areas. The existing tourism depends upon high levels of environmental quality and suitable levels of consumer service. Several countries have nature-based tourism as their most important export industry. Canada has an important and well-recognized nature-based tourism industry, partially based in Canada’s parks. However, Canada lags behind many countries in the development of this industry. There are significant limitations in national and provincial policy development and program implementation in the field. Ontario has some international reputation and experience in the field, but has major limitations for any significant further development. A detailed discussion is presented of Ontario’s opportunities and limitations.

Introduction
Nature-based tourism is a large and growing global industry. Much of this tourism is based in parks and other categories of protected areas. This tourism is dependent upon two fundamental components: high levels of environmental quality and proper levels of consumer service.

This paper looks at parks as elements of a tourism market. It discusses several components of this market globally and provides context for the situation in Canada and Ontario. Both opportunities and challenges are presented for the development of international tourism in Ontario’s parks.

Nature-based tourism is the travel and tourism activity dependent upon the positive destination attributes of the natural environment. Eagles (1995a) suggests that the nature-tourism market is sufficiently large that it contains at least four, recognizable niche markets: ecotourism, wilderness use, adventure travel and car camping. Each of these niche markets is determined by a unique set of social motives. An understanding of these motives is essential for recreation planning. Each of the niche markets is at a different stage in the typical business cycle (Figure 1). However, for this paper the broadly defined term of nature-based tourism will be used as a synonym for sustainable tourism and will be considered to contain all of the four identified niche markets.
Global Park Trends

The area of parks and protected areas continues to increase. By 1996 the world's network of 30,361 parks covered an area of 13,245,527 square kilometres, representing 8.84% of total land area. This area occurred in 225 countries and dependent territories (Green and Paine, 1997). Figure 2 shows the growth of this network over a 100-year period. The impressive growth of the world's park network is the result of the widespread acceptance of the ecological ethic. In addition, the tourism activity occurring in these sites creates a self-perpetuating phenomenon of visitation, education, and desire for more parks, visitation and education.

The network includes a wide variety of types of protected areas, ranging from nature reserve through to protected landscape, within the IUCN six-category system. Table 1 shows the global network by management category. All six categories are well represented in the network, but with national parks and...
resource management areas being particularly important. National Parks, Class II, cover 2.67% of the earth’s land surface. The name national park is closely associated with nature-based tourism, being a symbol of high quality natural environment with a well-designed tourist infrastructure. Eagles and Wind (1994) found that Canadian ecotour companies frequently used the name national park as a brand name to attract potential ecotourists to their sales offerings. With 30,361 parks in the world, and 3,386 given the well-known name of national park, it is clear that any particular political unit, such as the Province of Ontario, has a major task to get its sites recognized globally. There is a lot of global opportunity for potential ecotourists. Ontario has the disadvantage of having many of its sites known as provincial parks, a name unknown outside Canada and suggestive of a lower level of importance.

<table>
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<tr>
<th>IUCN Category</th>
<th>Number</th>
<th>Percent</th>
<th>Total Area in km²</th>
<th>Percent</th>
<th>Mean Area in km²</th>
<th>Percent total land area of the world</th>
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<td>1,182</td>
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<td>193,022</td>
<td>1%</td>
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<td>220</td>
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<td>27%</td>
<td>1,243</td>
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<td>100%</td>
<td><strong>13,245,527</strong></td>
<td>99%</td>
<td>436</td>
<td>8.84%</td>
</tr>
</tbody>
</table>

Table 1: Global Protected Areas classified by IUCN Management Category

**Economics**

Economics is an important component of societal decision-making. It is usually downplayed in the parks world. In parks, the very strong emphasis given to ecology is seen by park proponents as sufficient justification for public policy action. However, nature tourism is increasingly becoming important within sustainable development because of the potential for contributing to local and national economic development while also providing incentive for nature conservation and biodiversity conservation (Wells, 1997).

Most of the world's protected areas charge minimal entry and user fees. These fees typically cover only a portion of the cost of protecting the resource and providing the features on which park visitation depends. This pricing policy developed during a period in which resource protection was seen as the overwhelmingly important objective, a public objective that benefits all of society. If a public good benefits all, it can be reasonably argued that it should be paid for by taxes on society. However, this logic falters when applied to outdoor recreation in parks as only those who participate in outdoor recreation are beneficiaries. In a time of government financial retrenchment, it is increasingly difficult to justify public expenditure to subsidize the recreation of a few.
Governments across Canada are utilising this logic, in part, in the reduction of grants (Eagles, 1995b) and the development of new forms of park administration and new pricing policy (Van Sickle and Eagles, 1998). The Parks Canada business plan summarizes this concept with the statement that “subsidies will be phased-out on services of benefit to individuals, by transferring the operation to the nonprofit voluntary or private sectors, or these services will be stabilized on a full cost recovery basis” (Parks Canada, 1995, p. 7).

There are dramatic differences amongst the world’s parks in terms of pricing policy, tourism income, and financial management. A global study of biosphere reserves found that only 32 of 78 responding sites charged visitors admission fees (Tye and Gordon, 1995). The fees ranged from less than $5.00 per person per day to $110, in United States funds, with the majority at the lower range. There was a statistically significant relationship between total direct income and the numbers of visitors for all biosphere reserves. Higher visitor numbers corresponded to higher budgets. The authors concluded, “better financed biosphere reserves are likely to be better managed, thereby attracting more tourists” (Tye and Gordon, 1995, p. 29). Presumably those reserves with more tourists gained higher political profile. This political strength allowed them to argue for more budget allocation from government. Some sites also earned income from use fees. This study is important because it shows a strong and positive relationship between protected areas budgets and tourism levels. The general principle is that those parks with high levels of satisfied clients gain political power. This power can be translated into higher budget allocations.

Parks often supply the most important part of the nature tourism experience, but typically capture little of the economic value of the stream of economic benefits. The low entry and use fees in parks are one result of the consolidated revenue effect. Since park management does not keep the fees within its financial structure, there is little benefit in adequate fee collection. This effect also contributes to a low emphasis on park visitor management. Return rates, length of stay, visitor satisfaction and service quality all suffer when the financial return from the visitors is not tied directly to the financial operation of a park. This lack of proper emphasis on visitor management results in a dwarfed nature-tourism industry, one not fulfilling its potential.

Many governments see nature-based tourism as an important tool for economic development. Unfortunately, most have not invested sufficiently in staff training, infrastructure or park resources that are needed to support nature tourism. This exposes sensitive sites to tourism-caused degradation (Wells, 1997).

Most national tourism agencies do not keep statistics on market sectors. Other management units, such as park agencies, seldom fill this information void. As a result, important sectors, such as nature-based tourism, are not clearly documented for the benefit of policy determination. This situation is evident in Canada. Clearly nature-based tourism is one of the key elements of Canadian tourism. Filion et al. (1994) estimated that as much as one quarter of the tourism expenditures in Canada, can be attributed to wildlife tourism, one of the elements of nature tourism. Generally, the importance of nature tourism is severely underrated due to lack of adequate information.
In Canada, there is no national documentation of park-based tourism. Neither the volumes of park visitation nor its economic impacts are systematically collected and made available for government and private consumption. Compare this situation to other economic generators, such as auto manufacturing or forestry where the volumes and economic value of the products are carefully documented within a continuous stream of information. The new Canadian Tourism Commission is now providing quarterly Canadian tourism figures to governments, business and the media. These data have considerably raised the profile of tourism within the business sector.

Wells (1997) documented, globally, the economic studies available on nature tourism. Most of these studies are of individual parks or wildlife reserves. There are few regional or national studies of the economic impact of the tourism associated with parks and reserves.

Wilkie (1997), an undergraduate student at the University of Waterloo, compiled a national park use database for Canada. She found that in 1994, the last year that complete data were available for all 13 senior park agencies in Canada, 117,000,000 visitor days occurred in Canadian national and provincial parks.

Ontario has a large and well-used provincial parks system consisting of 272 parks. In 1992 the total economic output from park users and by government was $831,200,000 (OMNR and Econometric Research, 1993). A total of 12,172 years of employment resulted from parks. This benefit was calculated from data on the 109 parks that were staffed to allow visitor use in 1992. More economic benefit would be found if national parks and conservation areas were added to the calculations.

Ontario Parks uses the Ministry of Natural Resources Social and Economic Impact model for estimates of economic impact of the provincial parks (Mulrooney, pers. comm.). Information from this model is used for budget planning, local political promotion and sales of park product. However, this modest effort needs to be increased in scope. Currently, Ontario Parks receive inadequate recognition for their local economic contributions.

The most recent economic benefits study for a park system undertaken in Canada was done for BC (Coopers and Lybrand, 1995). The study concluded that the BC provincial parks system is a major source of economic activity in the province. In 1993 the parks generated 5,300 jobs directly and 4,000 jobs indirectly. The 5,300 jobs created by parks are comparable to other industries such as newsprint (4,200), metal mining (3,800) and coal mining (3,000).

Coopers and Lybrand Consulting (1995) calculated that in 1993 British Columbia provincial parks produced total benefits of $430,000,000 (Canadian). These benefits included direct benefits, and consumer surplus. In 1993 the parks had 22,300,000 visitor days of activity. Therefore, each day of recreation produced an economic benefit of $19. The OMNR and Econometric Research (1993) calculated that in 1992 the total economic output due to Ontario parks was C $831,200,000. This amount included direct, indirect and induced impacts of parks. In 1992 Ontario had 7,000,000 visitor days of recreation activity. Therefore, each day of recreation produced an economic benefit of $119. The differences in impact per person come from different approaches to the
calculation of impact. However, if one takes this range of economic benefits and applies it to the visitation to Canada’s parks, an economic benefit occurs of between $2.3 and $14 billion. Clearly, a standard and consistent method of calculating economic impact is required, and one is now being discussed by the park directors of Canada (Murphy, 1998). However, whichever figure is used, the implications of such a large economic impact on public policy making are immense.

Parks Canada conservatively estimates the economic impact of national parks, national historic sites and parks, and national canals to Canada’s GDP at $1,250,000,000. Around 30,000 person-years of employment occur due to this spending. Non-resident visitors contribute 25% of the visitor spending, or $275,000,000 annually (Parks Canada, 1995).

Impressive as these figures are, they have not convinced Canadian governments to maintain the tax-based grants levels upon which most of the park systems depend. Figure 3 shows the impact of massive budget cuts on 13 national, territorial and provincial park systems in Canada as estimated in a recent survey (Van Sickle and Eagles, 1998). Clearly the budget cuts and resultant reductions in services and operations have impaired the effectiveness of park agencies in Canada.

Figure 3: Impacts of Budget Cuts in Canadian National, Provincial and Territorial Park Agencies

The Canadian, Ontario and British Columbia studies show the significance of parks to economic life. However, generally there is a lack of national and provincial economic data on parks. This is a major inhibitor in public policy making across Canada. A similar situation occurs in most countries. For park economics to have the policy impact that it warrants, there must be a continuous stream of up-to-date data provided. At the very least, yearly studies are required.
However, quarterly figures provided to government, business and the media would be more useful and beneficial.

The National Parks Service of the United States developed the money generation model to provide yearly park level economic impact data (NPS, 1995). The MGM estimates the economic benefits to the local economy resulting from monies that come into the local economy from outside sources. The three major categories of financial impact include: expenditures of park visitors who live outside the local area; park-related federal government expenditures; and park-related expenditures by other non-local parties. This model uses park visitation figures, local economic studies and national financial trends to provide an estimate of economic impact for every park, every year. These impact data are used locally to reinforce the concept of parks providing economic benefit. Local park managers reportedly find it useful in discussions with local businesses and governments (Hornback, 1997). The MGM may be the only example of park managers being provided yearly with economic impact figures relevant directly to the park that they manage.

Driml and Common (1995) showed that the economic benefits of nature-based tourism in selected Australian locales far exceed the government expenditures. This research estimated the financial value of tourism in five Australian World Heritage Areas – Great Barrier Reef, Wet Tropics, Uluru National Park, Kakadu National Park, and Tasmanian Wilderness. The five areas studied experienced tourism expenditures in 1991/92 of $1,372,000,000. The total management budgets were $48,700,000, and the user fee income to the management agencies was $4,160,000. Therefore, the management budgets were only 3.5% of the tourist expenditure that occurred in the World Heritage Areas. The revenue raised by government through user fees represented only 8.5% of the government expenditures.

This study shows the very high financial value of tourism in the foregoing five World Heritage Areas. It also reveals the low level of government expenditure for management and the very low level of government cost recovery. Driml and Common (1995) question the ability of the existing management structure to maintain environmental quality in the face of large increases in tourism use. They point out that tourism research expenditures in Australia are very low compared to other economic generators such as agriculture and mining, both of which have a smaller economic impact than tourism.

Within Canada there is a large range of financial structures within the senior parks agencies; some are government agencies while others function like corporations. Figure 4 shows the range in cost recovery for the 13 most senior park agencies in Canada. The recovery of management costs from tourist charges varies from only a few percent to slightly over 50%. This variation is largely due to government policy dictating the financial structure of the agencies, not to the volume of tourism or the area being managed.
Parks Canada has designed a management structure that encourages much higher levels of cost recovery. To provide the management structure necessary to implement the new business approach, Parks Canada (1995) obtained government permission to retain and reinvest all revenues; plan and operate on a multi-year, non-lapsing basis; increase non-tax revenues from products and services; borrow against future revenue; and link revenues to costs and to depreciate assets. The approach moves this government agency into management very similar to that of a corporation, a government-owned corporation or a parastatal. To implement this plan new national parks legislation was introduced in the federal parliament in early February 1998.

**Tourism Market**

Is there a market for increased levels of nature-based tourism in Canada? The largest ecotourism market study ever undertaken was done for British Columbia and Alberta in 1995 (HLA and ARA, 1995). For this study ecotourism was defined as “nature, adventure and cultural experiences in the countryside” (HLA and ARA, 1995, p ES-1). The study found a very large ecotourism market in Canada and the United States. In the seven metropolitan areas studied – Seattle, San Francisco, Los Angeles, Dallas, Chicago, Toronto and Winnipeg – a market of 13.2 million potential ecotourists was found. This is much larger than anticipated, and shows that a large market is now present in North America alone.

The study found that the natural setting is the most critical factor in the determination of a quality product. The tourists showed increasing desire to find experiences in environments that were ecologically well managed. Recreational activities were important, and multiple activities were desired. Midrange accommodation was desired, and the experienced ecotourist placed much higher emphasis on the outdoor experience than on the accommodations. Experienced guides and quality interpretive programs enhanced experience quality. The
preferred trip was long, at seven days or more. Parks and the activities found in
the parks were indicated as very important components of the travel experience
(HLA and ARA, 1995).

Clearly, there is a large and growing ecotourism market in North America. Travel
trends throughout the world point to growing markets in Europe and Asia. The
issue is not one of potential market size; the issue is one of providing a travel
product that fits the market.

**Visitation Statistics**

All decisions are based upon data and the better the data, the better the chance
of a good decision. A fundamental data for decision making is that of product
volume. No private company can survive without thorough, accurate and up-to-
date data on the numbers and timing of its products and their subsequent sale.
However, the consolidated revenue fund effect means that some parks pay low
levels of attention to documenting their level of recreation use. In recent years
during budget cutting, some managers cut gate staff and visitor management
staff, people seen as less important. Imagine a store firing all their cashiers!

However, the move towards fee income reverses this trend, and places much
higher emphasis on capturing as many of the clients as possible. However, many
parks are poorly designed for documentation of visitation levels. Parks often are
quite large with many entry points, making it difficult to tabulate all entrances.
Some park clients will try to sneak in, so as to avoid fees. Many parks do not
have staff covering all entrances at all times of the day and of the year. Shoulder
season visitation is often weakly documented. Within one agency, there may be
different data collection procedures in different parks. And in large parks there
may be different data collection procedures at different entrances (Wade, 1998).

Ontario has a history of collecting accurate and useful park use figures. Figure 5
shows the visitation trends in Ontario provincial parks over the last decade.
Clearly, increases in use are the trend. And it is probable that the budget cuts in
Ontario mean that the figures shown in the last few years are underestimated, as
staff is not available to count properly in shoulder seasons and in low use periods
during the day. The dip from 1995 to 1996 is probably due to this factor.

Every park system has its own, unique system of counting and recording its
visitors. Some count all that enter, including recreationists, service vehicles and
vehicles just passing through. Some count only those who stay over during the
night, ignoring day visitors. Some count only those who pay. Some record the
numbers of entrants, some the numbers of visitor hours and others the numbers
of visitor days.

There is a need to standardize across the globe the definition, collection
procedures and reporting of park tourism statistics. When that is done the park
movement will have a new and powerful tool for influencing public policy
discussions.
Figure 5: Visitor Use trends in Ontario Provincial Parks

Ontario in Context
Ontario has a number of opportunities and challenges for the development of a park-based tourism industry. Table 2 outlines the opportunities.

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Discussion</th>
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<tbody>
<tr>
<td>Parks</td>
<td>Ontario’s 272 provincial parks, six national parks and hundreds of conservation areas are an excellent resource for the development of nature-based tourism. Many of the parks have potential for development as international destinations.</td>
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<td>Management</td>
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<td>Canada has a global image of being a premier destination for outdoor recreation and nature. Ontario has some international profile.</td>
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<td>Transportation</td>
<td>Ontario’s international airports, road and water transportation system are first rate and capable of handling the tourism traffic.</td>
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<td>Experience</td>
<td>Ontario has over 100 years of experience in being a destination for international nature-based travel.</td>
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<td>Finance</td>
<td>The national parks, provincial parks and conservation authorities have sufficient finance to operate the parks that now exist, albeit usually at quite low levels.</td>
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<td>Location</td>
<td>Ontario is in the geographical centre of Canada, well positioned for American and global traffic.</td>
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Table 2: Opportunities for the Development of Nature-based Tourism in Ontario’s Parks

Ontario has 272 provincial parks, six national parks and hundreds of conservation areas that are an excellent resource for the development of nature-based tourism. The province has 43 senior park management agencies, Parks Canada, Ontario Parks, the St. Lawrence Parks Commission, the Niagara Parks...
Commission, the St. Clair Parks Commission and 38 Conservation Authorities. There are thousands of parks owned and managed by municipalities, but it is doubtful if any of these parks are worthy of consideration as international destinations. Many of the senior parks have potential for development as international destinations. Many do not, but can still fulfill an important regional and local role. It is important that tourism development emphasis be placed on those sites that have the most international potential. Ontario has the best wilderness canoeing in the world, much of it occurring in two provincial parks. Ontario has an impressive set of campgrounds that provide high levels of camping satisfaction. Ontario has large numbers of small sites with impressive natural features that taken together can become international destinations.

In Ontario, the park management authorities are familiar with park visitation. Most are capable of handling some international tourism. The parks work within a competent, co-ordinated system. The national parks, provincial parks and conservation authorities have sufficient finance to operate the parks that now exist, albeit usually at quite low levels. The parks’ systems have had damaging budget cuts in the last decade, but still retain a competent core of management staff and functions.

Canada has a global image of being a premier destination for outdoor recreation and nature. Europeans, Asians and Americans see Canada as a natural destination. Ontario has some international profile, but much less than the western provinces.

Ontario’s international airports, road and water transportation system are first rate and capable of handling significant levels of tourism traffic. Access to the significant sites in Ontario is comparatively easy. This is a major advantage over many of the destinations in poorer countries. Ontario is in the geographical centre of Canada, well positioned for American and global traffic. However, location is now less of an issue due to inexpensive air travel that allows tourists to travel to virtually all corners of the world.

Ontario has over 100 years of experience in being a destination for international nature-based travel. All sectors of society are familiar with the needs of tourism, and capable of handling the social, cultural and economic impacts. There are also challenges for the development of nature-based tourism in Ontario’s national, provincial and conservation parks (Table 3).

At least half of Ontario’s parks are not now equipped to handle international tourism. Typically these parks lack management capability, sufficient staff, and infrastructure. Examples to illustrate this lack of expertise are easy to find. The five most important countries for Canadian inbound tourism are the United States, the United Kingdom, Japan, France and Germany. What is done to encourage and assist visitation by people from these countries? The answer is, very little. The only group that finds it relatively easy is the experienced camper from the United States who wanders across the border expecting to find suitable sites to visit and camp.
At least half of Ontario’s parks are not equipped to handle international tourism due to a lack of management capability, staff, and infrastructure. Ontario’s parks have insufficient numbers of people with expertise in tourism, marketing, service quality evaluation, and international ecotourism. Only a few of Ontario’s parks have an international reputation and clientele. Those that do include Point Pelee, Algonquin, Pinery, Niagara Falls and Quetico. Ontario’s parks management has weak understanding of the global ecotourism market. Ontario’s parks do very little to facilitate international visitation. It is difficult for Europeans and Asians to visit Ontario’s parks. There is very limited roofed accommodation in the parks to handle the international ecotourism market. There is insufficient finance to hire trained staff, to develop the research base, to develop the product line, to advertise the product and to handle the visitors when they arrive. Neither Canada, nor Ontario have a nature-based tourism policy. Neither does Parks Canada, or Ontario Parks.

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Table 3: Challenges for the Development of Nature-based Tourism in Ontario’s Parks

Ontario’s parks have insufficient numbers of people with expertise in tourism, marketing, service quality evaluation, and international ecotourism. The level of expertise in these areas will have to be considerably upgraded, if the agencies are to be successful in developing a successful international tourism industry, one that can compete globally. Expertise in service quality management is particularly needed. The North American service industries are the global leader in the development and application of service quality management principles. As a result, the North American consumer expects high levels of quality from service providers.

Government agencies lag far behind the private sector in applying service quality management principles, and this lack is obvious to their clients. Other countries, most specifically the United States, Australia and the United Kingdom, have aggressive tourism research, education and development programs aimed at nature-based tourism. For example, the National Parks Service of the United States is in the process of developing a suite of national cooperative research and training institutes at first-line universities in that country. This follows a similar initiative previously undertaken by the US Forest Service and another by the US Fish and Wildlife Service. Recently, the park agency in the State of Victoria in Australia funded a major cooperative research and education unit in a local university. The recent nature tourism strategy for the State of New South Wales proposes a strengthened link between the national parks agency and universities in that country. No such cooperative units are found in Ontario or in Canada.

Ontario’s parks are generally unknown outside the local area, and have no mechanism to provide a higher level of profile. Most of these parks have resources of limited international appeal. Therefore, it is reasonable to suggest
that only some parks should play an international role. These should be carefully chosen within a province-wide tourism development strategy.

Only a few of Ontario’s parks have an international reputation sufficient to attract people to the sites as primary travel destinations. Those with an international reputation as tourism destinations include Point Pelee, Algonquin, Pinery, Niagara Falls and Quetico. Generally, provincial parks suffer due to their name. The phrase provincial park is an unknown concept outside Canada, and is typically seen to mean a second class site, when compared to a national park. Australia does not have this problem because all its state parks are called national parks, whether or not the site is of local, national or international stature. The term conservation area is unknown outside Ontario. This phrase uses the word “area”, which provides no useful connotation of its purpose. A better word would be “park”, a word and concept well-known in most European languages.

Four northern Ontario consultants to Tourism Canada in 1990 bluntly concluded that “exceptional concentrations of unique wildlife species are not a key feature of northern Ontario ... therefore nature viewing will be a secondary enhancement to other adventure product offerings such as canoeing” (Ethos Consulting, 1990: 20). This same study felt that northern Ontario has weak potential for sea kayaking, bicycle touring, sailing, scuba use, backpacking, heli-skiing, trail riding and river riding.

However, the consultants concluded that this part of Ontario has good potential for long-distance snowmobiling, fly-in fishing and canoeing. Provincial parks cater heavily to the canoeing, and general crown land is the locale for most of the snowmobiling and fishing.

The consultants felt that the weaknesses of northern Ontario for outdoor recreation included very long distances between service communities, too much visible resource extraction, repetitive and boring landscape, and lack of vertical relief. In northern Ontario the existing provincial parks were seen as very important components of the nature-based tourism industry. They occupy some of the most interesting landscapes. They also have information and infrastructure that attract tourists. And they can be used within a system of linked travel routes for long-distance travel. However, personal observation suggests that the parks are not managed within a system of linked travel routes.

Ontario’s parks administrators show weak understanding of the global ecotourism market. There does not appear to be a policy envelope, an administrative structure nor a staffing complement that recognizes an international role. This is in contrast to the situation in Australia, with both national and state level nature or ecotourism strategies that explicitly deal with the parks as international destinations (Allcock et al., 1994; Worboys, 1997).

A visible example of the lack of understanding of international tourism is the lack of programs and facilities aimed in this direction. International visitation is not directed through a well-designed system of information for the international visitors. Multilingual publications are almost nonexistent. Staff language ability is generally in English, sometimes in French and almost never in any other important language such as German, Spanish or Japanese. Pre-booking by international visitors is difficult or non-existent. There is no way for international
tourists to work through their travel agents to facilitate visitation to any of Ontario’s parks. Visitors are expected to bring all the necessary equipment for camping or outdoor recreation, a very difficult and expensive task for trips that involve air travel. Rental or sale of equipment sometimes occurs in the parks, but its availability is spotty and, when available, very difficult to access for international visitors. Access to guides, specialised information or ethnic food for international travellers is seldom easy. Close cooperation with airlines, tour agencies, recreation vehicle rental companies, or hotel chains is almost non-existent. Clearly, parks in Ontario do very little to encourage or even facilitate the visitation by people from Canada’s major foreign tourism markets. Given these challenges, it is a wonder that as many international travellers find their way to Ontario’s parks as do. However, if these challenges were tackled, the numbers of international visitors could increase dramatically.

The parks’ infrastructure is designed for the knowledgeable and experienced Canadian. It is difficult for Europeans and Asians to visit Ontario’s parks, unless they camp, itself an extremely complicated procedure. Imagine the complexity for a French or Italian citizen who has not camped before or visited Canada before. It is very difficult for her or him to gain the knowledge of a park, to obtain access, to get all the necessary equipment, to learn how to use the equipment, to gain suitable transport and then to visit an Ontario park. This camping complexity redirects many visitors into other forms of accommodation. However, there is very limited roofed accommodation in the parks to handle the international ecotourism market. There are often suitable accommodations outside the parks, but these are typically small-scale and difficult to access by people from remote locales of the world.

The largest international market for Ontario’s parks is in the United States. Ontario is well positioned geographically to attract from the large American populations in the central and northeastern areas of the country. However, Ethos Consulting (1990) concluded that when comparing Ontario’s parks to those located in the United States “comparative products can be found closer to home within the US which are better known and well developed.” For Ontario to better attract from this market the problems of convenient access, knowledge level and tourism infrastructure development need to be tackled.

Some of the deficiencies outlined are due to insufficient finance. At present, there is insufficient finance to hire trained staff, to develop the research base, to develop the product line, to advertise the product and to handle the visitors when they arrive. The new provincial and national agency status in Parks Canada and in Ontario Parks can help self-finance this endeavour when it gets rolling, but there are insufficient start-up funds. It is important for government to recognize what the private sector already knows: one must spend money to make money. Allocations from Canadian national and provincial governments need to be increased for the development of nature-based tourism. These allocations must be made within the context of a carefully constructed national, provincial and agency policy environment.

Canada and Ontario do not have a policy for the development of tourism on crown land outside parks. Such tourism does occur, and is often important; however, the government action is fragmented and inefficient. Positively, a tourism policy for Ontario crown land is under development within the Ontario
Lands for Life program. It will be very interesting to see its content, scale, interagency and intergovernmental connections, and roles given to public and private cooperation.

The challenges are partially due to a nature-tourism policy void in Ontario. Neither Canada, nor Ontario has a nature-based tourism policy. Neither does Parks Canada, or Ontario Parks. The Conservation Authorities around the west end of Lake Ontario have recently developed coordinated policy, but most authorities have no such policy. There is an urgent need for a coordinated federal-provincial nature-based tourism strategy for Ontario. This could involve the Canadian Tourism Commission, the Ontario tourism agency, Parks Canada, Ontario Parks and the Conservation Authorities. This strategy would have to identify key policy priorities, consider which sites have potential for international ecotourism, develop recommendations for market development, provide backing to financial development and schedule a multi-year development plan.

Summary and Discussion

If park tourism is to be given the level of public policy recognition that it deserves, a more consistent and thorough procedure for the collection of visitation and economic data is required. The World Commission on Protected Areas is attempting to standardize the collection and use of park tourism data. The Task Force on the Economics of Protected Areas, headed by Lee Thomas of Environment Australia, has produced guidelines for the measurement of economic impact of parks. The goal of this effort is to standardize methods of measurement and to encourage the collection and dissemination of the output, in countries all over the world.

In parallel work, the Task Force on Tourism and Protected Areas, headed by Paul Eagles of the University of Waterloo in Canada, is tackling the issue of visitor use measurement. This Task Force has a group, headed by Ken Hornback who recently retired as the chief social scientist of the National Parks Service of the United States of America, that has produced draft guidelines on the definitions and methods for collecting visitor use data (Hornback et al., 1997).

The goal of this effort is to standardize the terminology, the measurement methods and the reporting of park visitation globally. Carlson (1997) discussed the complexities of evaluating and monitoring recreation and tourism use. After his study of economic evaluation of recreation and tourism in New South Wales he called for “a more consistent approach to data collection.” The Task Force project aims to provide a consistent and standardized approach to data collection, reporting and management.

The output of both task forces will be combined after the next data collection for the United Nations List of National Parks and Protected Areas. This data collection, which is planned for 2000, will ask for visitor use data from all countries. Once compiled, this inventory will provide the first global documentation of park use. Using economic models, this visitor use data will be the base for the calculation of global tourism impacts.

With the movement towards documentation of tourism’s volume and impact, discussion is starting on the evaluation of the park management’s ability to
handle tourism (Hockings, 1997). The development of management effectiveness guidelines and procedures can assist policy makers, senior management and the public in understanding the capability of park managers and their institutions.

Nature-based tourism is a large and growing component of international tourism. Several countries in the world have nature-based tourism as a very important component of their most important export industry, tourism. These countries include Australia, Kenya, Nepal, New Zealand, Tanzania, Costa Rica and Botswana. Canada has global competition in this field and this competition is becoming more sophisticated each year. The economic importance of the tourism industries in these countries has led to thoughtful policy and institutional development. The national ecotourism strategy for Australia succinctly summarizes the background to the aggressive and successful policy development in that country:

.. ecotourism offers the potential to generate foreign exchange earnings, employment, and other economic and social benefits, particularly in regional areas. It presents Australia with the opportunity to make the most of its competitive advantage, with its spectacular and diverse natural features, unique flora and fauna and diverse cultural heritage. Ecotourism can also provide resources for environmental conservation and management and an incentive for the conservation and sustainable use of public and private land (Allcock et al., 1994: 5).

To ensure the success of the national policy, the Australian government committed $10,000,000 over four years for the implementation of the strategy. Following the national lead, each state started to develop a similar regional policy, the latest being the one for New South Wales (Worboys, 1997).

Tanzania has a draft national tourism policy document, an integrated master plan and an infrastructure plan (Wade, 1998). A key part of this plan is to develop a southern tourism loop to exploit the national parks and wildlife reserves, such as Ruaha National Park and Selous Game Reserve, in the southern part of the country. This new loop will complement the very successful northern loop that contains sites such as Kilimanjaro National Park, the Serengeti National Park and the Ngorongoro Conservation Area. New Zealand has a very successful nature-based tourism policy that involves high levels of public and private cooperation in the protection of landscapes, the management of protected areas, and the delivery of tourism services.

Strangely, Canada with its abundant resources and well-developed profile in the field has been slow to develop policy and procedures in the field. Canada needs a national sectoral tourism strategy for nature-based tourism. Each park agency at the national and provincial level would benefit from the development of an agency-specific policy, nested within the national policy envelope. Multi-sectoral cooperation with the Canadian Tourism Commission, private business, environmental and recreation groups would be essential. A substantial increase in tourism research is necessary to provide the conceptual base for policy development. Substantial federal funding for implementation of the developed strategies would ensure the launching of a more progressive and successful nature-tourism industry in Canada.
Ontario has an important nature-based tourism industry, partially based on the existing national parks, provincial parks and conservation areas. This industry has the potential for growth, but only if the significant limitations to this growth are recognized and dealt with. The parks agencies are a fundamental element of the industry, but these agencies must further develop their internal policies, staffing resources and procedures for their contribution to be effective. The agencies need to cooperate with each other, with the tourism agencies of government and with the private tourism sector. Crown land in Ontario can play an important role, but not with the existing level of policy development and implementation. Ontario will only become a global player in the nature-based tourism industry with novel, progressive, cooperative and farsighted policy development by government. This policy must be followed with sufficient resources to ensure successful implementation.

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References


Protected Areas in the Next Millennium: Managing for Ecological Integrity

Nikita Lopoukhine
A/Director, Natural Resources Branch
National Parks Directorate, Parks Canada, 25 Eddy St., Hull, PQ, K1A 0M5

Abstract
The history of protected areas in Canada begins towards the end of the nineteenth century. Initial purposes of recreation for the wealthy with minimum of risk have been supplanted with notions of ecological integrity and biodiversity conservation. The example of evolving expectations for national parks reflects the changing values in Canadian society. Amendments to the National Parks Act in 1988 and governing operating policies introduced responsibilities for ecological integrity. A broader framework for these Canadian values is evident in the ratification of the International Biodiversity Convention, the preparation of a strategy for the conservation of biodiversity, and its implementation. Canadian protected areas are a prominent component of the strategy. Yet, internal stressors such as tourism and park management practices along with external stressors such as adjoining land uses are undermining the values placed on protected areas. In many protected areas, to maintain ecological integrity, active management must become the norm. It is only through applying principles of adaptive management that native biodiversity and ecological integrity can be maintained into and through the next millennium. A number of research topics are suggested to this end.

Introduction
Canada has a long history relative to other countries in the establishment of protected areas. The first protected areas in Canada were established in the latter years of the 19th Century. The first national park created was Banff. Its inception in 1885 was intended to preserve outstanding scenic areas, provide recreation and tourism as well as to protect wildlife habitat.

The central idea governing the establishment and management of national parks has changed over time. The shift reflects a change by Canadians in their expectations for their protected areas. As well, it reflects an increased scientific understanding of the principles of sustainable development and the role of protected areas. The Ontario Lands for Life (Anonymous, 1997) initiative of creating more protected areas and defining uses is an expression of this growing understanding. Over a century ago, parks were established primarily as pleasuring grounds for those who could afford the amenities. During this period of the national park movement, "improvements" such as killing predators, and the construction of hotels, golf courses, and other tourism infrastructures were actively pursued. Eventually, over time, the exploitation of natural resources through mining and logging was no longer considered acceptable. Also with time the natural role of predators and fire became accepted. They, like all the other functional and structural components of an ecosystem, were recognized as belonging in protected areas. In tandem to this line of reasoning, establishment
of parks began to be based on a system plan anchored in the concept of representation. Similar patterns of park establishment and management occurred within both Federal and Provincial jurisdictions.

This commitment to representation and protection of the range of Canadian ecosystems, from the cordillera to the boreal to the marine recognizes their Canadian heritage value. These broad ecological zones are the fundamental components that define Canada and continue to define its inhabitants and their culture. Canada has pursued the establishment of a system of national parks since the 1970s. Likewise provincial governments have fixed frameworks as the basis for establishing protected areas.

In the case of national parks there is widespread recognition of the heritage values within each of the National Parks. This assigns the responsibility and challenge to Parks Canada for protecting the ecosystems within each park in their integral form. It is a challenge indeed for all Canadian protected area managers if in the next millennium we are intent on meeting the legal obligations of ratified international conventions and Canadian legislation.

This paper reviews the context for the evolving values associated with protected areas with particular reference to national parks in Canada. The example of stressors facing national parks provides a backdrop for offering solutions to mitigating impacts and to restore the degraded.

**Canadian Context**

**Canadian Biodiversity Strategy**

Canada has developed a Biodiversity Strategy. This activity flowed from Canada’s decision to sign and ratify the International Biodiversity Convention. The formulation of a strategy was a complex undertaking for Canada, a federal decentralized country. A working group with members from federal departments and provincial and territorial governments was organized. To broaden the support for the Strategy, representatives drawn from regional and urban governments, private property owners, businesses, local and indigenous communities, conservation organizations, research institutions, foundations, and others were asked to form an advisory group.

They advised on the formulation of strategies to address specific Biodiversity Convention Articles. More importantly perhaps, direction was also given on how best to engage a majority of Canadians in responding to the challenges of conserving biodiversity. From the start, it was recognized that a wide-base acceptance, among all Canadians, was fundamental to realizing the Strategy’s goals.

The actions in the Strategy are formulated under five goals:

- conserve biodiversity and use biological resources in a sustainable manner;
- enhance both our understanding of ecosystems and our resource management capability;
- promote an understanding of the need to conserve biodiversity and sustainably use biological resources;
• provide incentives and legislation that support the conservation of biodiversity and the sustainable use of biological resources; and,
• work with other countries to conserve biodiversity, use biological resources sustainably and share equitably the benefits that arise from the utilization of genetic resources.

The first goal’s achievement is fully dependent on the implementation of ecologically based planning and management. It is a first step in achieving conservation and sustainable use of biodiversity. The success of the planning and management depends significantly on the completion of a network of protected areas. The Strategy builds on the notion that protected areas contribute to the conservation of biodiversity.

The Biodiversity Strategy provides direction on completing protected area systems and protecting such sites. Fundamental to protection is the institution of management regimes that incorporate the views of local and regional stakeholders on minimizing biodiversity losses and other impacts. There is full recognition in the Strategy of the role played by various levels of governments as well as non-governmental organizations in realizing this goal. In effect ecosystem-based management is proposed but, to be clear, this means management based on ecosystems for the purpose of maintaining native biodiversity.

Non-Federal protected area roles in biodiversity conservation
Canada has approximately 800,000 km² (8% of Canada’s area) of protected area (Table 1). Four percent of Canada is areas protected from all commercial extractive activities. National Parks take up approximately two percent or half of the non-extractive protected areas in Canada. A National Conservation Data Base maintained by the Canadian Council on Ecological Areas identifies 10,000 km² of the protected area total to be held by non-government groups.

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Table 1: Major Groups of Protected Areas Owned or Managed by Government in Canada (CCEA)

Private
In Canada most non-government owned or administered land which could be categorized as protected is held by groups such as the Nature Conservancy, Federation of Ontario Naturalists, provincial based nature trusts, and Ducks Unlimited. The objectives for these lands vary from strict protection to
management for the enhancement of species, particularly those with exploitative potential. Approximately 8,600 sites encompassing over one million hectares are privately held under a protection regime in Canada.

Municipal
Each municipality or regional government in Canada maintains extensive green areas either as city parks or green belts. These are for the most part oriented for recreational purposes but do, to some extent, add to the overall Canadian biodiversity conservation objectives. Certainly, large city parks such as High Park in Toronto, Mont Royale in Montreal – Canada’s first city park, established in 1872, Stanley Park in Vancouver and Point Pleasant Park in Halifax have intrinsic biodiversity values. These areas are poised to contribute a larger share as broader environmental perceptions and management objectives infiltrate the municipal levels. Ecological restoration activities are taking place. In Toronto’s High Park, for example, restoration of an oak savanna is underway. The idea of restoration is spreading to smaller parks. Naturalization programs of municipal parks and even schoolyards are being sponsored throughout Ontario.

Provincial
The provincial and territorial governments administer a number of categories of protected areas. The variety of these areas is exemplified by their purpose that varies from ecological reserve to roadside picnic areas. There are 1554 provincial and territorial parks totaling 15,313,537 hectares. In addition to these areas, 471 ecological reserves amount to 982,501 hectares. Another 43 areas totaling 795,593 hectares are designated as wilderness, and along with the ecological reserves are Canada’s only protected areas fitting into Category I, the highest level of protection, under the IUCN system of protected area classification. Ontario has a variety of protected areas (Figure 1).

National Parks in Canada
System planning for the next millennium
Canada’s 38 national parks are all classified as Category II under the IUCN system of classification. National parks in Canada are established according to a plan devised and adopted in the early 1970s (McComb, 1994). Canada was divided according to vegetation and physiographic criteria into 39 Natural Regions. The objective is to protect outstanding representative sample areas within each of these 39 major Canadian landscapes. Presently there are 16 regions (40%) without representation. In 1990 the Government of Canada placed a time frame for completing this system (Anonymous, 1990). The present Government, re-elected in 1995, reaffirmed its commitment to this objective.

The process of establishment of a national park is a slow and often unpredictable process. Negotiations or feasibility studies are presently underway in areas of the North West Territories, Labrador, Manitoba and British Columbia. A similar process is underway in establishing marine conservation areas, intended to promote conservation and sustainable use of the natural marine environment. Currently five of 29 marine regions have representation.
Figure 1: The Protected Areas of Ontario (Canadian Council of Ecological Areas)

**Societal context**

In a recent survey, national parks of Canada were identified as the third ranking Canadian symbol, after the flag and anthem. Yet, the average Canadian is not likely to differentiate national and provincial parks. This confusion could perhaps be excused given that all protected areas are but anthropocentric mechanisms of designating geographic areas on the basis of a value to society. Society is clearly not interested in who is responsible but rather that the protected areas are in place and delivering on their mandate. That is the source of pride.

Governments have been interpreting such values while leading in the establishment of parks. The initial values in Canada were centred on assuring recreation opportunities primarily for the wealthy. The frame of reference then was to provide a way to experience the values – initially, primarily aesthetic – offered by national parks with a minimum of risks. To assure the experience was rewarding, charismatic mega-fauna species were protected from predators and forest fires.

The governing Parks Canada Policy now has sections dedicated to eliminating anthropocentric biases and recognizes protection as the primary mandate (Anonymous, 1994). Yet, the fact that parks are for people as well as for protection is not obscured. It is one of the objectives of national parks. Indeed visitation continues to generally increase (Figure 2).
The continued revision of policies and public debates is a characteristic of a politically accountable agency (Freemuth, 1989). NASA, in contrast, with its original mission of placing a man on the moon is an example of a professionally accountable agency where a task is assigned without direction on methods for achievement. However, Parks Canada managers, as part of a politically accountable agency and with a divergent set of objectives, must strive for consensus.

Consensus on the definition of objectives for a national park is reached somewhere along the pendulum swing between the recreational use of yesteryear and the complete closure to public access. The appropriate point must be determined by society. In this context, Freemuth (1989) argues that the role for science and technology is not to provide the basis for park management but rather to provide the means of building consensus among the differing interests in national parks. In Canada the consensus is derived through a process of consultation associated with the preparation of park management plans.

Once a national park is established, preparation of a plan is not a matter of choice. The 1988 amendments to the National Parks Act require that the Minister responsible for national parks tables a management plan in the House of Commons within five years of establishment. Each national park management plan is to be reviewed every five years. Previously, management plan preparations were laborious exercises to develop prescriptive plans mostly addressing developments. Now plans are to be prepared in one year's time, focus on the inter-relationships of the park with surrounding areas and be much more strategic in nature. Ecological integrity issues rather than development is now the focal point.

This shift in management planning reflects the shifting pendulum trace of park purpose. Purpose definition has never been stationary and it will remain a moving target. In the realm of the “protection” objective of national parks, Parks
Canada has traversed from the “let nature take its course” paradigm to one espousing scientific-based ecosystem management, ecological restoration and indeed the notion of change.

Legislation and Policies

Ecological integrity:
The societal contexts for national level protected areas are reflected in the governing “Guiding Principles and Operational Policies” and of course also the National Parks Act. The above factors, which affect the management for protection, must be placed in juxtaposition to the National Parks Act. The Act, amended in 1988, now states: “Maintenance of ecological integrity through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan”. A legal responsibility for maintaining ecological integrity has been established. Various definitions have been proposed (Woodley et. al., 1993; Anonymous, 1994). A simple definition for ecological integrity is a condition where the structure and function of an ecosystem are unimpaired by human activity and are likely to persist.

The simplest interpretation of ecological integrity is that there is now a requirement to protect and manage for “completeness or wholeness” in ecological terms, that is, a functioning ecosystem with all its parts including processes. In the context of native biodiversity, ecological integrity means the full complement of native life and its processes from genes to ecosystems. Maintaining ecological integrity is a mammoth task that Canadians have assigned Parks Canada. This assignment in fact is perhaps unrealistic where predators, disease or other ecosystem regulators have been tampered with or eliminated. In Point Pelee National Park the once ubiquitous bullfrog along with five other amphibians are now listed as extirpated.

In a world without artificial boundaries and drastically altered landscapes and where climate would change slowly and gradually, maintaining ecological integrity would be simple. It would be a matter of not interfering. Now, with natural processes modified, small protected areas isolated by surrounding non-conforming land uses and bombarded by long-range transported pollutants, benign neglect cannot and does not equate with ecological integrity.

An active management regime is the only recourse. Managers must decide how and when to manipulate. The activities of course must be in accordance with objectives of ecological integrity/biodiversity conservation, which are clearly stated in a park management plan, and thus publicly debated. Results of these activities must be monitored as the knowledge gained provides the basis for not only reporting but also for adjusting the objectives. In effect, adaptive management (Walters and Holling, 1990; Walters, 1997) is the prescription.

It would be inadequate to leave adaptive managers with only an institutional framework by which to define appropriate management objectives. An ethical framework must also be provided (Serafin et al., 1989). An ecological integrity framework must govern managing. The most complete representation possible must be the over-arching goal. Within such a framework, clear objectives of ecological integrity must guide management decisions.
State of Parks Report

Canadians want to be kept abreast of the state of their national parks. In response, the National Parks Act was amended in 1988 to specify that a State of Parks report must be tabled in Parliament every two years. The first report was tabled in 1991 (Anonymous, 1991). The second edition was tabled in 1995, three years behind schedule (Anonymous, 1995). The second edition featured a summary of stressors facing national parks as compiled by Woodley (1992). The third edition is in the final stages of review and will also present the latest results of stressors affecting national parks (Figure 3).

A questionnaire, designed to assess the state of park ecosystems based on a “stress response” framework, was sent out to 34 national parks. Teams, consisting of three to five knowledgeable individuals at each park, completed the questionnaire on a consensus basis. The greater ecosystem within which the park is located was used as the framework in formulating the responses.

A stress is considered to have an impact if: 1) it is having a definite ecological impact; 2) it is having an impact upon an area greater than a local scale (> 1km²); and, 3) the trend in the intensity of the stress is either increasing or stable. The results revealed that common issues were affecting most national parks. Tourism infrastructure and exotic species were the top two stressors originating from within the parks. A particularly important result of the questionnaire is the realization that many of the stressors originate from outside the parks. Clearly, a park’s ecological integrity depends on developing harmonized inter-relationships with its surrounding greater ecosystem.

In terms of impacts, the two primary results of the stresses were a loss of community structure and reductions of populations. Perhaps as revealing is that in many cases—one third overall—the impacts were reported as unknown. This is an acknowledgment of the complexity of assessing ecological impacts as much as a need for research.

The conclusion to draw from this is that ecological integrity is impacted within each national park. It further endorses the notion that active management is becoming a necessity if the National Parks Act is to continue being respected.

Managing Canada’s Protected Areas

Wilderness

In North America, objectives for protected areas have traditionally flirted with the notion of wilderness. Wilderness, aside from its traditional qualities of vast remoteness, also is valued for biocentric and anthropocentric reasons (McCloskey, 1990). A common thread among most of the 118 papers delivered at the 1989 “Managing America’s Enduring Wilderness” Conference (Lime, 1990) was the idea that wilderness areas once designated need only to be left alone. In effect, the argument is that this form of management, benign neglect or natural regulation would ensure ecological integrity, biodiversity conservation and thus “wilderness”. Wilderness management for the majority of the presenters at this conference was a matter of resolving a people problem through education and/or restricting access or adjusting nefarious practices on adjoining land areas.
Figure 3: Number of Parks Reporting Significant Ecological Impacts from Various Human Stresses – 1996
The constituency of wilderness is clearly subjective (Lopoukhine, 1992) and as such dependent on temporal and spatial concepts. Within many countries, such areas are now designated and separated from people as much as possible. This kind of wilderness came about through the development of an agrarian society which went about separating the civilized from "uncontrolled" wild areas or, in the parlance of forestry, the unimproved. The paradox of "wilderness" is that civilization created it and now threatens its existence while setting up the conditions for its appreciation (Nash, 1983).

The word "wilderness" is an Anglo-Germanic word without equivalence in other languages. The etymology of "wilderness" is a place (ness) with wild (will) animals (deor) (Nash, 1983). Henberg (1994) suggests since humans are but another form of beast we should not be distinguishing one area of beast from others in defining areas. Separation of areas into wilderness is in direct contrast to the notion of one – inseparable – as viewed by many indigenous cultures including native North Americans (Martinez, 1993).

The indigenous culture, while viewing itself as linked to its environs, nevertheless practiced control, whether in the use of fire, harvesting of plant materials or hunting. Through these actions the North American landscape was shaped (Kay, 1994). There was control and human domination prior to Europeans' arrival on the American continents. Waipole Island, north of Windsor, Ontario, is the only place in North America where patterns of burning by humans have not been interrupted since Europeans stepped onto this continent (Martinez, 1993). Is it coincidence that this remnant controlled area under continued restoration is the sole locale for some 60 plant species listed as either vulnerable, threatened, or endangered by the province of Ontario? Is this domination or stewardship? Further, with the care being provided are they really endangered?

At the Managing America's Enduring Wilderness conference, one dissenting voice to the notion of benign neglect was a paper presented by DeBenedetti (1990). He argued that to maintain wilderness values in the Pinnacles National Monument, fire – the dominant natural process – had to be managed. This area, for which he was responsible, was too small and surrounded by inimical land uses to permit fire to occur randomly. In order to ensure ecological integrity and assure safety for occupiers of surrounding land areas prescribed fires were necessary.

It can be argued that the case of the Pinnacle National Monument is applicable to all protected areas. The stress results noted above (Woodley, 1992) are further proof of the barrage of problems facing protected areas with the responsibility of meeting objectives of ecological integrity. There really is no choice if you consider the reality of protected areas (Lopoukhine, 1990), namely:

- Parks do not exist in isolation from neighbouring lands and the impacts thereon.
- Park areas are not, nor ever were, established on the basis of functioning ecosystems.
- Most natural process management solely within a park is impossible.
- Parks represent nodes or anchors for dynamic species and processes which extended beyond the confines of a park area.
• Few, if any, parks contain unaltered ecosystems. All show signs of modification due to recent human activities.
• The vast areas of both land and water within even the largest of parks are profoundly altered by direct human intervention.
• Restoration of ecosystems to absolute pristine conditions is impossible. Furthermore, a definition of pristine for the areas now occupied by parks is impossible.
• Global-scale changes preclude setting inherited ecosystems or vignettes of past landscapes as a goal of perpetuation.

To some the idea of maintenance or active management is problematic, particularly if the governing definition for ecological integrity includes the notion of persistence. However, before rejecting this notion it may be worth reflecting on the mounting evidence that persistence in the past was in fact dependent on human maintenance. Ecosystems in the historical or the indigenous models were maintained. Where this is reality to assure “wilderness”, maintenance is unavoidable.

**Flux of Nature**
Protected area agencies need to adopt and exhibit a culture that conserves biodiversity approaching the level of success exhibited at Walpole Island. It requires abandoning the balance of nature paradigm for the pursuit of adaptive management principles. One important principle is determining the objective for such management. The world has from time immemorial exhibited a variety of pathways of change and compositions. Glaciation, variable rates of vegetation migrations, climate and humans have all yielded variety over time. Fossils are physical proof of change over time. Which state to choose or how to consider defining an appropriate framework for such a state is an unresolvable riddle. Pickett (1994) suggests that to assume that there is only one ecologically legitimate or ideal system is a trap. White and Walker (1997) suggest that there is a constellation of possible states.

The specific dynamics of any one system will be contingent on its history, the accidents of arrival of species at the site, and the nature of the system’s connection to its landscape or current influences. With this realization of course comes the fortunate or unfortunate realization that we must now also deal with choices. Nature provides a variety of choices and we as managers are faced with this cornucopia of choice. One option is to let things evolve under the current influences and so do nothing. This will encourage the loss of endemics – species and stages of development – and permit exotics to have their way. A second option is to resolve to take specific actions to achieve predetermined and approved objectives.

The process of change is constant. Natural disturbances of course guarantee periodic change. However, on a more subtle scale, change is also to be expected since all ecosystems are open on a spatial and hierarchical scale. As such they are regulated from outside their boundaries. Thus multiple equilibria or end points are possible along a variety of multiple succession pathways. Furthermore, humans have and always have had an effect. These fundamental truths are the framework for the new paradigm, now also referred to as the “flux of nature”
(Pickett et al., 1992). It is in direct contrast with the old paradigm of balance of nature that focused on stasis and fixed equilibrium points.

The “balance of nature” metaphor that “nature has only one way to be” has been difficult to shed. In part because it is rooted in history traced back as far as Plato and even earlier (Egerton, 1993). Dan Botkin (1990) in his book *Discordant Harmonies* provides numerous examples where this perspective has led to many disasters – from park management to resource harvesting.

What relevance is this to Canada’s protected areas? Essentially this analysis leads to the conclusion that focusing on one stage within a limited time and spatial scale is inappropriate. The landscape must be kept in the context of our ecosystem management objectives. Botkin (1990) asks the question – if we can accept that for one species change is required then how can we reject any changes? The problem then becomes what change must we accept. Some are good and others are not. It is tempting to say that some are natural and others are not. In the case of groping with whether a fire’s origin is natural, Van Wagner (1983) answered this by in effect stating why bother, as if nature was a conscious entity that cared how a fire starts. The issue in fire and indeed ecosystem management boils down to what does society want our parks to represent – the results of a suppressed fire regime or one exhibiting ecological integrity.

The question we must invariably answer is what is the appropriate objective and how do we know it is the appropriate objective. This is a question that ecological restorationists must face in their pursuits (Whyte and Walker, 1997). Temporal and spatial variation in nature is a critical consideration in setting objectives. Analogs and historical variation based goals are the normal basis of determining restoration end points.

**Ecosystem management**

Existing protected areas are rarely large enough to enclose the requirements of large mammals such as a population of grizzly bears. Areas burned by wildfires, if tracked over a decade or longer, will be found to fall in and outside of protected areas. Land uses in and around many of Canada’s protected areas are inimical to the purpose of protected areas, resulting in relatively undisturbed islands surrounded by developed lands. All of this creates the variety of ecological stresses depicted above. For these reasons, an ecosystem-based approach to management has become the latest policy instrument by which many protected area agencies are attempting to achieve goals of biodiversity conservation and ecological integrity.

Ecosystem management aims to integrate biological, physical and sociological information. It is a comprehensive way to deal with the host of environmental issues that seem overwhelming when considered separately. Ecosystem management is certainly a concept with a broader scope than ecosystem science. It has been interpreted to mean a broad, consensus-based approach to land management. Agee (1996) warns that ecosystem management is a paradigm under development, as yet to be proven, but holding much promise. Nevertheless, it is appropriate for us to apply it to park management.
Ecosystem management is a way to:

- integrate parks and protected areas into their surrounding landscapes and thus avoid isolation;
- account for the range of interactions that occur at spatial and temporal scales beyond the traditional scales used in park management; and,
- incorporate a range of human values into the protection and use of the landscape.

An ecosystem management approach is being attempted in and around many national parks. These efforts take many institutional forms. Some parks are part of the International Biosphere Reserve program, such as Waterton Lakes National Park. Waterton is part of a large ecosystem management program called Crown of the Continent, which involves the Provinces of British Columbia and Alberta, Glacier National Park in Montana, as well as private ranches. The significance of this area has been recognized recently by the acceptance of the area as a World Heritage Site.

Four national parks are part of Canada’s Model Forest Network, including Fundy National Park in New Brunswick. While active forestry does not occur on parklands, Parks Canada provides research capability, public education and a core protected area that is an essential part of sustainable forestry. The Fundy Model Forest includes over thirty partners, including an international forestry company, a private woodlot owner’s cooperative, environmental organizations, and recreation clubs.

Still other parks use ad hoc partnership arrangements to achieve the same results. Banff National Park is part of the Central Rockies Ecosystem project. This project includes provincial wildlife and forest management agencies, and universities, among others, in an effort to understand and protect populations of large carnivores and to clarify the role of wildfire. To achieve these goals, it is essential for partners to jointly define and work towards common goals.

Conclusions

Canada is about to enter the next millennium with one of the world’s premium systems of protected areas. Most importantly, Canadians value these protected areas. It is this value which causes Canada’s government to commit itself to completing the system and to meeting biodiversity conservation objectives. Recent examples of this commitment are the soon-to-be-announced blue ribbon panel on ecological integrity as promised in the Liberal Government’s election platform and Ontario’s Lands for Life program with consultations leading to more protected areas.

What is becoming clearer to all those intimately engaged in the management of protected areas, is that issues are more complex than ever. This added complexity has led to the acceptance of an ecosystem-based approach to management of protected areas. With this however, comes the revelation that much information is lacking to assure that decisions are truly science-based and sound. Research has been given a clear role as a partner in dealing with these issues. Specifically research must yield information in regards to meeting a protected area’s biodiversity conservation and ecological integrity goals. Ecological research must address issues of fragmentation, historical variation of
ecosystems, meta-population management and issues of connectivity among protected areas. Parallel to the ecological, social science research focused primarily on human use management must also be encouraged to assure that the principle of use without impairment is not compromised.

Michael Williams (1993) quotes Carl Sauer: “the cultural landscape is fashioned out of a natural landscape by a cultural group. Culture is the agent, the natural area is the medium, the cultural landscape is the result.” Native American cultural landscapes were captured within many park areas. Now, in turn, these protected areas’ management agencies are imposing their culture on these landscapes. To date it has been an anthropocentric-based culture. Management decisions are only beginning to reflect biocentric values.

This is perhaps understandable when we consider that our protected area management culture has been moulded by policies of recreation, predator control, natural regulation, and internal solutions to problems. It is only recently that we have begun to reshape our culture with notions of ecological integrity and ecosystem management at a regional scale. Now, we even have at our disposal the opportunities of using ecological restoration (Jackson et al., in press) to bring our culture to the point where biodiversity conservation is a reality from the landscape level down to the genetic level, and ecological integrity is maintained. In achieving this reality we will have entered the next millennium managing for “wilderness” as it should be and not as a romantic notion.

References


Communication and the Human Dimensions of Parks and Protected Areas on the Canadian Shield

James G. Cantrill
Communication and Performance Studies
Northern Michigan University, Marquette, Michigan

Abstract
Recently, agencies responsible for managing protected areas in North America have come to re-evaluate the role of humans in natural resource planning. Traditional management approaches for public land, which preference the economics of resource extraction (Peterson and Peterson, 1996), are now seen as breeding distrust in governmental action and promoting what Williams (1995) has called a “view from nowhere” in environmental policy making. In contrast, agencies such as Parks Canada are now required to acknowledge “the importance of human needs while at the same time confronting the reality that the capacity of our world to meet those needs in perpetuity has limits and depends on the functioning of ecosystems” (Christensen et al., 1996: 666). As a result, government agencies on both sides of the Canadian/American border are adopting proactive policies to ensure a more viable balance between a sustainable society and a sustainable environment through a regimen of “ecosystem management,” often associated with networks of parks and protected areas (Interagency Task Force, 1995; Ontario Ministry of Natural Resources, 1997). The search for this more viable balance is discussed in this paper in terms of: human perceptions in planning for protected areas; scales of protected areas planning; researching and using human dimensions data; and, research limitations and implications for the Lands for Life initiative.

Introduction
The concept of ecosystem management is well entrenched in the Great Lakes basin and on the Canadian Shield. For example, nearly twenty years ago, the Great Lakes Research Advisory Board (1978), now known as the Great Lakes Science Advisory Board, presented a special report to the International Joint Commission that stressed the need for an “ecosystem approach” to managing the Great Lakes. That report, in its call for an integrated development of policy within an ecosystem context, was pivotal in initiating an approach that went beyond the historical emphasis on water within a narrow politico-jurisdictional context (Allen, Bandurski and King, 1993; Francis, 1993; Lee, Regier and Rapport, 1982; Vallentyne, 1983).

Perhaps more important has been the growing recognition of the social factors attending any drive toward sustainable resource policies. Although most treatises and discussions of ecosystem management, and the role of protected areas therein, tend to foreground analyses of the biotic and abiotic components of ecosystems, more attention is now being paid to the “human dimension” of resource planning. This perspective embraces a variety of values beyond either resource extraction or pristine wilderness preservation and typically accounts for
an ongoing human presence within whatever tract of land is being considered for development or preservation (Bengston, 1994; Schroeder, 1992).

In many ways, the Province of Ontario – through agencies such as ONMR – is well ahead of the international curve toward placing humans within a greater ecosystem context for policy making. Such is certainly true of the Lands for Life program. The acquisition of lands and protection of significant regional, indeed global, natural resources through the Nature’s Best component must proceed in concert with – as opposed to, in defiance of – community values and shared systems of land management (Ontario Ministry of Natural Resources, 1997b). To achieve a balance between social and ecological priorities, though, necessitates careful attention to the role of communication as a medium both for agencies knowing what is important to landed constituencies as well as for citizens learning what is in the best interests of a sustainable society.

To explore the relationship between communication practices and the human dimension of protected area planning, this paper explores several issues. After briefly reviewing what constitutes the human dimension of resource planning, I suggest a number of ways in which social factors are related to protected area policies at various scales of land management. Examples of human dimension research from across North America are indexed, and particular emphasis is placed upon the development of such research in the Lake Superior basin. The paper concludes with a preliminary analysis of where research in support of the Lands for Life initiative should now be directed.

The Niche for Human Perception in Planning for Protected Areas

A number of scholars (e.g., Behan, 1990; Rolston and Coufal, 1991; Shannon, 1992) have argued that, to avoid potentially disastrous consumptive practices, current natural resource planning should connect the biological foundations of regional landscapes with the sociological constraints facing those who use them for a variety of purposes. What is called for is an appreciation for how human understandings of where we live, work, and recreate are socially constructed and endowed with value. This distinctly human dimension has become an integral component in any number of planning documents, development initiatives, and visions of sound resource stewardship (e.g., Binational Program, 1996; Bitterroot Social Research Institute, 1994; United States Man and the Biosphere Program, 1995). In particular, the perceptual interface between people and habitat should be considered a pivotal factor in designing communication programs in accordance with almost half of the principles – i.e., balance, openness, consensus, respectfulness, and fairness – which guide the Lands for Life planning process (Ontario Ministry of Natural Resources, 1997b).

As a general definition, the human dimension of land and ecosystem management consists of the feelings, beliefs, and values – e.g., instrumental, aesthetic, expressive and ecological – that people possess regarding the world they inhabit. These cognitions, as represented in discourse, range from the very specific (e.g., “I think Grangousier Hill has the best view of the Lake.”) to the very general (e.g., “The way the forest products industry abuses Crown land is despicable!”) and form the perceptual grist for one’s so-called “quality of life.” Furthermore, the general values implicated by these fundamental environmental perceptions have become integrated into a variety of land-use planning schemes,
including Ontario’s “Criteria for Designing a Natural Heritage Areas System” (Ontario Ministry of Natural Resources, 1997a). In part, the human dimension may be represented by stakeholders associated with interest groups such as those invited to join regional roundtables in the *Lands for Life* planning process. More often than not, it can only be found in the daily thoughts and conversations of common citizens, connected to particular sites of residence, embedded in a range of cultures (Davidson, 1997: 6).

A determination of the relationship between human effect or perception and government action *vis a vis* *Lands for Life* is important for a variety of reasons. Protected area managers and agencies trying to promote regional ecosystem management policies must understand and take into account local perceptions when employing various securement vehicles associated with specific protected areas (Bright et al., 1993; Carpenter et al., 1986; Kiely-Brocato, 1980; Manfredo and Bright, 1991; Manfredo, Yuan and McGuire, 1992; Reiling, Criner and Oltmanns, 1988; Vining, 1987; Young, 1980). For example, the need for a human dimensions perspective is certainly implied in the Nature’s Best Action Plan where “unclear procedures for identifying and protecting [Areas of Natural and Scientific Interest] values, including landowner involvement” are cited as a barrier to policy implementation (Ontario Ministry of Natural Resources, 1997a: 7).

**Human Dimensions and Scales of Protected Area Planning**

When one considers the role of human dimensions in planning for parks and protected areas, questions may arise concerning the psychological mechanisms people bring to bear when attending to environmental communications. Arguably, if we know how citizens construct the social and natural world in the mind, we are in a better position to pitch policies that account for stakeholders’ perceptions. And, indeed, we know a good deal about the psychological bases for environmental communication. For example, Cantrill (1996a) has identified a range of potent cognitive biases people employ when faced with advocacy regarding the environment. However, Williams and Carr (1993) suggest that the issue for resource managers is not how local stakeholders perceive the world around them but, rather, what that sense of place entails and the extent to which such meanings are shared within communities affected by natural resource policies. Mitchell, Force, Carroll, and McLaughlin (1993) concur when they write: “At the heart of today’s forest management issues is emotion. The ‟felt’ perceptions of the forest are as real and as important as ‟scientific facts.’ Both should be incorporated into land management planning.” In short, a more pragmatic focus for research managers might be to understand the human dimension as it relates to planning for and administering parks and protected areas at various scales of analysis.

One way to consider the relationship between human dimensions analysis and various scales of land use planning is to adopt one of the various classification schemes now used to parse biotic and abiotic boundaries (e.g., Davidson, 1997; McNab and Avers, 1994). Yet, whereas this approach has proven extremely useful in the practice of traditional environmental science, it may not prove as heuristic when looking at the sundry social interactions that generally cross ecological divisions at the level of landscape/ecosystem analysis. In contrast, consider the set of nested scales in Table 1, loosely patterned after the *Lands for*
Life land use planning structure, each accompanied by an indication of the key constituencies and factors influencing human actions (cf. Cantrill, 1993) which may be of most importance to the planning process:

<table>
<thead>
<tr>
<th>Scale Classification</th>
<th>Key Constituencies</th>
<th>Mitigating Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected Area</td>
<td>Government Employees, Citizens with Inholdings, Concessionaires</td>
<td>Primary Group Allegiances, Interpersonal Relations, Employer Preferences, Historical Access and Land-Use Patterns</td>
</tr>
<tr>
<td>Local Operational Planning Unit</td>
<td>Adjacent Municipal Officers, Local Interest Groups, Visitors and Seasonal Residents</td>
<td>Local Economic Base, Local Print Media, Secondary Group Allegiances</td>
</tr>
<tr>
<td>Sub-Regional Planning Unit</td>
<td>District Government, Broadcast News Agents, Alternate Protected Area, Managers and Local Citizen’s Committees</td>
<td>District Economic Base, Broadcast Media and Educational Systems, Local Migration Patterns</td>
</tr>
<tr>
<td>Regional Planning Unit</td>
<td>Provincial Government, Regional Media Agents, Interagency Contacts, Major Metropolitan and Industrial Executives</td>
<td>Regional Economic Base, Regional and National Media, Transportation and Social Infrastructures, Regional and Pan-Regional Migration Patterns</td>
</tr>
</tbody>
</table>

Table 1: Nested Scales and Key Constituencies

Table 1 provides a schematic for linking land management foci with the human dimensions of ecosystem management. It suggests that the task of effectively communicating the value of parks and protected areas to the general public may be complicated in at least two ways. On the one hand, natural resource managers must correctly identify how expansive any given policy or land use decision will be in the eyes of target audiences (i.e., a problem of scale). Williams (1995) believes individuals will distort information that accompanies policy changes if those directives run counter to their senses of place and selves in the environment and it may be very difficult for government agents to determine how large that “place” or “environment” is without first assessing the general assumptions of a population. These assumptions are the product of intersecting social – i.e., mitigating – factors.

On the other hand, merely prompting citizens to focus on the interaction between humans and the biosphere may trigger attitudinal backlash grounded in their preference for values and systems other than those a policy is designed to protect or enhance, i.e., a problem of presumption. Again, the social context for human interaction influences such presumptions. Twigger-Ross and Uzzell (1996: 208) argue that “the self can be threatened by unwanted disruptions to emotionally salient places.”

Even well-intended management plans that take into account the importance of some facets of the human dimension – e.g., allowing for staged introductions of policy, assisting transitional economies, maintaining motorized access to relatively wild areas – may be sabotaged by the perception that any focus on biotic or abiotic elements places the social value of a place at risk. In this context, advocates for regional ecosystem management must segment their
target audiences, identify what is important to those subsets of the population, and appropriately highlight a range of perceived benefits associated with sustainable land use policies.

**Current Experience with Researching and Using Human Dimensions Data**

Although the study of how people connect themselves to their local environment is a relatively new field of research, a history of empirical research in cognitive psychology (e.g., Kok and Siero, 1985; Tversky and Hemenway, 1983), political science (e.g., Mitchell, 1984; Sears and Funk, 1991), and the study of environmental advocacy (Cantrill, 1996a; Ham, 1983) suggests that it is the environment-as-perceived, rather than the cold reality of ecology, that matters in the promotion of environmental policy. And reviews of general research concerning human dimensions (e.g., Cantrill, 1993), indicate that initiatives such as Ontario’s Land for Life may be thwarted by (a) pre-existing cultural factors favoring the maintenance of lifestyles largely dependent on resource extraction, (b) informational bases (i.e., education, media, and interpersonal networks) poorly attuned to traditional environmentalist causes, and (c) ways of thinking about the self that generally do not lend significant support to regional ecosystem programs. These general presumptions may prove to be the most problematic.

Even relatively high levels of information awareness do not necessarily compel responsible behaviour among stakeholders; many among us have been conditioned to systematically exclude such “facts” in the processing of communication, to place more reliance on immediate self-interests, or to calculate opportunity-costs in terms of a different value scale than that used by resource managers. In short, to generate a public consensus that actively supports an expanded regional network of protected areas on the Canadian Shield may be quite difficult.

Difficult as the generation of consensus may be, recent experience suggests that it is not impossible. In addition to the successful experience of the British Columbians discussed at this conference, human dimension analysis has found a productive role in a variety of other Canadian planning exercises. For example, protected area gap analyses in several provinces more or less reference the need to deal with the human dimension in acting upon observed network shortcomings (World Wildlife Fund, 1993).

In the United States, the analysis of social values and environmental perception has generally accompanied large watershed management regimes such as those being used in the Applegate, Bitterroot, and Payette valleys and the Columbia River Basin (e.g., Bitterroot Social Research Institute, 1994; McLaughlin, Sanyal and Steinhorst, 1994; Priester, 1994; Schroeder, 1996). And, closer to home, the social science of parks planning in the greater Lake Superior basin has received a good deal of attention as well.

In the 1990s, a broad consensus among policy makers has emerged indicating that any viable approach to marshaling resources and fostering sustainable human practices in the Lake Superior basin must take into account the human dimensions of ecosystem management (Binational Program, 1996). Following discussions at an Ecosystem Management Conference in Duluth (1994) and a
Sustainable Forestry Conference in Sault Ste. Marie (1995), the Lake Superior Protected Areas Managers (LSPAM) workgroup – composed of resource specialists and administrators attached to parks and preserves in Canada and the United States — specifically recognized the benefits of a broad human dimension information program for successfully communicating protected area conservation needs to the communities of the Lake Superior catchment. An understanding of the relationships between quality-of-life expectations, economic aspirations, social structures, and entrenched values was considered vital in the formation of communication campaigns and advocacy designed to protect Lake Superior resources. In line with this assumption, two research tracks have been undertaken to explore the human dimension of ecosystem management across the watershed.

**Human dimensions as reflected in a “Sense of Place”**

A significant line of research and theory regarding the role of perception in environmental advocacy has been associated with the idea of a “sense of place.” Various definitions for the sense of place construct have been offered (e.g., Agnew, 1989; Fournier, 1991; Lutwick, 1984; Steele, 1981; Stokols and Shumaker, 1981; Tuan, 1974; Williams, 1995) yet, regardless of definition or approach, those interested in the construct seem to agree that a sense of place is the perception of what is most salient in a specific location, which may be reflected in value preferences or how that specific place figures in discourse.

A number of general treatises (e.g., Basso, 1988; Stokols, 1990) and specific studies (e.g., Cantrill and Masluk, 1996; Carbaugh, 1992; Frech, 1993; Hester, 1985; Mitchell, Force, Carroll and McLaughlin, 1993; Schroeder, 1996) have focused on the sense of place construct. Taken together, this family of research suggests that the cognitions residents use to relate themselves to where they live can be observed in discourse, are quite powerful in the generation of responses to environmental policies, and may serve to distance individuals from one another or the agencies that regulate the use of natural resources. Furthermore, there is an apparent interaction between the social and environmental components of perception; one’s tenure in a region seems to mediate the extent to which one highlights either social or natural features in describing a felt sense of place. For example, Kitayama and Markus’ (1994) analysis suggests that relative newcomers to a region may view their relationship to a location independent of social relations, whereas those with a longer tenure exhibit interdependent self-construals – i.e., interpersonal relations form the cement that bond one to a place.

In 1995, Parks Canada sponsored LSPAM’s development of a protocol for defining the sense of place citizens share in the Lake Superior basin. The agency was particularly interested in examining perceptions associated with protected areas that qualify as “core” protected areas within the “Man in the Biosphere” model (Biosphere Reserve Directorate, 1994; Cantrill, 1996b). To this end, three human dimension analyses in the Lake Superior basin have been conducted in an attempt to define residents’ sense of place near Apostle Islands National Lakeshore (Lagerroos, Shifferd and Graf, 1995); near Pukaskwa National Park (Quinn and Potter, 1997); and near Pictured Rocks National Lakeshore (Cantrill, in press).
As with other attempts to systematically map out the meanings communities have for residents’ senses of place (e.g., Brandenberg and Carroll, 1994; Hester, 1985), Lagerroos and her associates (1995) relied on the use of interviews followed by a qualitative analysis of the resulting responses. Reasoning that the place-bound feelings and attitudes prevalent in the Chequamegon Bay region could be discerned in responses to in-depth probes, the investigators asked twenty nine residents of the area to describe the boundaries of, connections to, and meanings associated with what they identified as their “neighborhood” (Preister, 1994). Qualitative analysis of the data revealed that respondents were able to define the boundaries of their “area,” could indicate the range and strength of their connections to that location, and often peppered their depictions with references to “spiritual” or similar deeply embedded meanings for where they lived.

The results of the Canadian study demonstrate that the natural environment, social environment and, to a lesser extent, the economy, all play a significant role in defining a sense of place for residents of the Marathon area. Residents felt a strong sense of affiliation with other inhabitants of the North Shore of Lake Superior. Qualities that seem to best characterize the area included remoteness, wilderness, pioneering, small community, and resource-based perceptions. Residents of the Marathon area had a deep-rooted sense of place that was constituted by both natural and social factors and the wilderness character of the North Shore dominated their responses. Respondents had a much stronger affinity for North Shore inhabitants than for people or places on the other side of the Lake and the “Superior Circle Tour” was the only real connection the respondents had to the South shore. The relative hardship of the natural environment contributes to the felt isolation of the community and also serves to establish strong communal bonds and a pioneering spirit. Thus, Quinn and Potter’s (1997) data suggest that there may be support for a policy compatible with a Lands for Life network if it were approached from the standpoint of ensuring the continuance of existing environmental conditions.

In addition to essentially mirroring the results of the other two studies, Cantrill (in press) observed that a person’s understanding of where they reside and who they are in relation to the environment often depends on how long they have lived in an area (cf. Cantrill, 1996c; Freudenberg, 1991; Preister, 1994, Twigger-Ross and Uzzell, 1996). Specifically, as one spends a longer period of time in a sparsely settled region, social forces such as interpersonal relationships become more important than environmental conditions in describing one’s surroundings. Thus, even within relatively compact communities, perceptions of how one fits into the natural environment are indeed complex and not likely amenable to simple market segmentation practices so often employed in the promotion of policy (cf. Grunig, 1989).

As a suite of findings, the three sense of place studies suggest that others in the region – especially northern Ontario – might perceive themselves in relation to the environment in much the same manner. In particular, those promoting the Lands for Life initiative will want to identify the social relations existing between those living in sparsely settled regions and their length of tenure in any given area. Additionally, Henderson’s (1997) socioeconomic network analysis for Ashland reveals that, for the most part, resident’s perceptions of where they live and how they might respond to ecosystem management practices or initiatives
seem driven by economies of scale that eschew deeper reflections of the bioregion as a whole. Although the economic impact of, say, tourism is certainly one component in the calculus of constructing a sense of place, the predominant force of “community” and “place” seems governed by the use of resources to maintain social institutions, sometimes to the detriment of the natural environment. Consequently, what is called for is an inspection of the attitudes and values which shape local decision making in the socioeconomic sphere and how this process influences the restoration, continued use, or preservation of the Shield ecosystem, especially as related to protected areas.

**Human dimensions as reflected in attitudes and values**

For a long time, it has been customary for news organizations, polling firms, and academicians to survey opinions regarding the environment in the United States and Canada. Generally, such surveys have focused on the trans-national agenda regarding resource conservation (e.g., Dunlap, Gallup and Gallup, 1993; Kempton, Boster and Harley, 1995; Walker, 1990), though some studies (e.g., Cook County Planning, 1995; Donohue, Olien and Tichenor, 1989) have centred on the attitudes of residents in the Lake Superior basin and northern Ontario.

In 1996, the LSPAM workgroup, following the lead of Parks Canada, endorsed the notion that a viable approach to appreciating the broader program of human dimensions research in the Lake Superior basin should investigate the opinions of community leaders spread across the watershed, especially those living adjacent to major protected areas (Cantrill and Potter, 1997). The aim of the study was to produce a representative profile of basin decision-makers’ knowledge of and attitudes about protected areas, the extent to which these perceptions could be indexed by respondent demographics, such as location and position, and to isolate those beliefs which seem to reflect a lack of knowledge regarding the role and worth of protected areas in the respondents’ social and economic spheres. In all, 336 community leaders in 18 towns around Lake Superior provided responses to a wide range of questions regarding perceptions of nearby and basin-wide networks of parks and protected areas.

Analysis of the Cantrill and Potter (1997) data revealed that, in general, respondents from Canadian communities were more positive toward the role of protected areas and had a more unified perception of issues than the respondents from the United States. This may reflect a more unified collectivist Canadian culture than that found in the United States. Furthermore, as the Canadian north shore of Lake Superior largely consists of vast tracts of seemingly untouched wilderness areas, residents may be more connected to it and intuitively value it as part of their identity. Most respondents, on both sides of the border, also had a reasonable idea of the number of protected areas in their region, a favorable opinion of government management of protected areas, and a majority of community leaders realized that the inherent ecological values of protected areas may be compromised by private enterprise. Nonetheless, a large portion (30 - 40%) of respondents believed that existing parks and refuges should allow more development and resource extraction and either rejected or were unsure about the desirability of creating more protected areas in the Lake Superior basin.

The Cantrill and Potter (1997) data are somewhat at odds with a recent telephone poll prepared for the Federation of Ontario Naturalists (Oracle
Parks and Protected Areas Research in Ontario Research, 1997). In contrast to the LSPAM study which focused on key decision makers, the Oracle findings were based on a sample of 1250 Ontarians, with no account given for demographics. Focusing only on selected responses from northern Ontario and noting that the Oracle report does not indicate what this area contains, what constitutes wilderness or what is the size of the subsample, one must be careful when drawing conclusions. The observations of this poll are as follows:

- 91% are favorably inclined toward the protection of wilderness;
- a little more than half (50% to 59%) are opposed to resource extraction in wilderness areas;
- 68% believe that more than 20% of publicly-owned land should be set aside for wilderness, even in areas where timber is in short supply;
- 41% are opposed to privatizing control of forest management on Crown land; and
- 67% strongly supported the idea of the Provincial government’s protection of Ontario’s remaining wilderness areas

Taken together, these surveys of regional attitudes and values suggest that resource managers should not anticipate outright resistance to promoting the role of protected areas in the public sphere. At the same time, agencies should not assume they would receive a ringing endorsement from the population for any proactive stance they might take in the service of the *Lands for Life* initiative. Some issues dealing with regional ecosystem management, for example timber sales, may have to be differentially targeted for different publics such as youth or recent newcomers to the basin. And, although attitudes regarding the role of government intervention to protect the natural environment are generally positive, they clearly differ from location to location. On the other hand, given that most attitudes found in the studies suggest some uncertainty or ambivalence towards the perception of protected areas, it may be easier to influence the extent to which citizens are willing to act regarding resource conservation (Biel and Gärling, 1995; Gunter and Finally, 1988).

Research Limitations and Implications for *Lands for Life* Initiative

Despite the aforementioned studies, the application of what we know about human dimensions to the development of a protected areas network system in Ontario’s north may be hampered by a lack of theory and research regarding optimal communication strategies to be used in very rural settings. As it is, environmental advocates too often exhibit an over-reliance on perceptions of risk in promoting protected area policy by stating, for example: “If we don’t preserve this area, much will be lost.” Instead they should be emphasizing opportunity – for example: “By developing this park, we have the potential for identifying new sources of income” – since the immediate risks of unchecked consumption are not apparent to current generations. To their great credit, OMNR and Parks Canada seem to demonstrate a greater sensitivity to this issue when one examines literature associated with the *Lands for Life* initiative. Yet, just the same, the human dimension habitually gets last billing on the marquee of reasons why we want to conserve the resources in certain areas. The need for social research is often neglected. For example, the Nature’s Best Action Plan makes no allowance for empirically studying the human dimension in the boreal north (Ontario Ministry of Natural Resources, 1997a) and, in general, less than
one-fifth of research in Ontario’s provincial parks has thus far been devoted to social science research.

One ongoing objective for the agencies would be to conduct more social scientific studies and develop and test more efficient models for effectively advocating ecosystemic policies that can be applied to both regional as well as local initiatives. By modeling environmental communication processes based on what we know about human cognition and the social forces influencing sustainable lifestyles, as well as testing the framework in the hinterlands of the province, we may improve our chances of conserving natural resources for future generations through the Lands for Life program.

Clearly, one approach to making “the big picture” matter to citizens in Ontario is to deluge them with personally meaningful information regarding the Lands for Life initiative. If people are inundated with persuasive appeals suggesting that their immediate self-interests are well served by the program, related research (e.g., Allen, 1990; Bishop et al., 1980; Schuman and Presser, 1979; Vogel, 1986; Zimmerman, 1996) indicates they are likely to change their attitudes toward the idea of protected areas overall. The warrant for increasing citizen ownership in the project is especially relevant to issues that are not easily seen in daily life, such as the preservation of biodiversity (Savage, 1993; van Es et al., 1996). For example, in light of the economic underpinning of attitudes suggested above, it may be important to highlight the real-world monetary value associated with local and regional networks of protected areas since some studies (e.g., Cordell, Bergstrom and Watson, 1992) indicate this type of information compels decision makers to take a more expansive view.

The crux of the issue thus becomes what is the self interest to which one should appeal? The answer will not likely be found in a mere reliance on hand-picked advisory boards which may not truly be in touch with the broader public. And, although the Lands for Life plan calls for Local Citizens Committees to “provide advice on planning procedures, review and improve the local information base, assist in the development and review of management approaches, and resolve local issues” (Ontario Ministry of Natural Resources, 1997b: 9), such local operational planning is left to the discretion of land managers. In other words, the only human dimensions input may be based on the possibly ill-informed assumptions of sub-regional roundtable stakeholders who may not live adjacent to particular protected areas. At the very least, roundtable advice should be augmented by information collected in public forums or empirical surveys targeted to specific locations. An ongoing dialogue should then be established between land use planners and local constituencies. Such would better meet the letter and spirit of the Lands for Life regional planning process (Ontario Ministry of Natural Resources, 1997c).

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Parks and Protected Areas – Integrating the Ecological, Social and Economic Context in Land Use Planning – Lessons From British Columbia*

Derek Thompson
Assistant Deputy Minister, Land Use Coordination Office, British Columbia

Abstract
British Columbia’s recent work to double the park and protected areas system provides valuable insights into the application of ecological principles in public choice over the creation and management of a new protected areas system. Land use planning undertaken by planning teams (tables) made up of representatives of key local stakeholders and community interests, working with government agencies, are the primary mechanisms to select new protected areas. The tables are provided with technical information and analyses and terms of reference. They are guided by terms of reference based on government policy and overall goals – which includes the Protected Area’s Strategy. The planning tables have often achieved consensus but in so doing, they have often adapted existing policy and practice to achieve their particular objectives. The results have been substantial increases in protected areas representation in most ecosystems but there continues to be strongly stated public preference toward selection of large, wilderness areas as contrasted to small representative areas.

Introduction
British Columbia (BC) continues to be in the midst of changes to land use and management practices that are of historic proportions. This paper presents a brief introductory overview of the work presently underway in BC to double the parks and protected areas system in the province. The paper considers the historic and current forces that have shaped the initiative and the current situation. A particular focus is the interplay at open land use planning tables where professional staff and public stakeholders are working to apply scientific classification systems and concepts based on conservation biology and using technical information. In an example from one part of the province, some of the principal inter-connections and resulting conclusions are presented. The paper ends with a brief consideration of implications for future research.

Background: Recent Trends in Parks and Protected Areas Establishment
The park and protected areas system in BC has grown since the early seventies to become the largest system of its kind in Canada (Figure 1). In particular, the system has grown substantially since 1990 and now covers 10.6% of the

* This paper was presented at the Parks Research Forum of Ontario by Warren Mitchell, Director of Planning, Land Use Coordination Office, Province of British Columbia.

A number of maps are used to illustrate the text. These were originally in colour and have not reproduced well. Copies of the maps can be obtained from: British Columbia Land Use Coordinator Office, PO Box 9426 Stn Prov Govt, Victoria BC, V8W 9V1.
province. As with many of Canada's parks, this initiative is based on achieving the twin goals of: 1) representation of elements – typifying the more than 110 eco-sections and the 16 biogeoclimatic zones described in the province (Lewis and Westmacott 1996); and, 2) protection of significant natural features. As Figure 1 illustrates, the level of representation afforded by the new additions, as measured in simple area coverage and in biogeoclimatic zone representation, has significantly altered the nature and balance of the system throughout the province. However, there are constraints on the system including: 1) public support for the previously existing non-representative areas; 2) public choice over which new areas to designate; 3) the complex nature of the interplay between BC biota and physiography, and in particular the mountainous nature of the province; and, 4) the establishment of a set target of 12% for this expansion. These constraints have resulted in a system which will not be equally representational of all features. This is leading to some continuing criticism about the application of these goals. This notwithstanding, all analyses demonstrate substantial positive changes in the system with many additions of significantly under-represented ecosystems and special natural features in every region.

In order to fully comprehend this situation, it is important to know that the nature, location and size of the new protected areas have been substantially determined by the province's strategic land use planning program. Beginning in the early 1990s and continuing today, this is a program that is driven by public representatives. Initially, three regions and two sub-regions were established. Experience gained in this led to adjustments in 1995 which are reflected in the current program covering an additional 16 sub-regions. In total, land use plans are now approved or under development for more than 80% of the land area of the province (Figure 2). A cabinet approved schedule is in place to complete the strategic land use plans for all sub-regions by early in the next century and plans have also begun for substantial marine components.

While land use planning, and in particular the work to “complete” a system of protected areas, was initially the centre of much public attention, other key initiatives are closely tied to this and have had significant impact on both ecosystem conservation and resource industries. These include: the preparation and implementation throughout the province of a new Forest Practices Code; the analysis by the Chief Forester of timber supply on all Crown forests and the re-setting of all Annual Allowable Cuts; the commencement of treaty negotiations with First Nations who claim title to much of the province; and, the establishment and funding of Forest Renewal – and now also, Fisheries Renewal – to assist and direct resource industry and labour transition in the face of environmental and economic forces.

In short, BC is in the midst of a complex and demanding process of change in the way in which all its natural resources are allocated and managed. It is a change that has impacted every community and continues today. The resulting changes to both protected areas and the management of surrounding lands move the province toward a more ecologically sustainable model for resource development. In the next sections, the issues of the forces and the practices that are driving these changes are briefly considered in terms of their implications for protected areas today and the challenges for the future.
Figure 1a: Ecoregions of British Columbia – Percent Protected 1970
(Reproduced from colour original.)

Figure 1b: Ecoregions of British Columbia – Percent Protected 1980
(Reproduced from colour original.)
Figure 1c: Ecossections of British Columbia – Percent Protected 1991
(Reproduced from colour original.)

Figure 1d: Ecossections of British Columbia – Percent Protected 1998
(Reproduced from colour original.)
The Reasons for Growth in Protected Areas

The forces which have combined to drive this historic growth in the park and protected area system of BC have been presented elsewhere (e.g., Thompson 1996). In summary, they include the following:

- **Historical Roots**: A century of continuous and increasingly frustrated public debate about government policies concerning industrial allocation of natural resources.
- **Options**: BC has some of the most significant relatively unutilized large natural areas remaining in temperate regions.
- **Increased Competition**: With population increases and increased resource utilization, the limits to both the available resource base and wilderness areas became clear.
- **Public Advocacy**: Public advocates brought international focus and leadership to intense debate about protection of world class resources, with a focus on old growth forests.
- **Uncertainty**: The resulting valley by valley clashes, demonstrations and illegal acts caused investment uncertainty and community instability because of BC’s dependency on vulnerable export markets.
- **Public Consensus**: A clearly stated need for change was endorsed throughout society – radical solutions were acceptable.
- **Political Leadership**: A new government set an agenda for long-term change and drove those changes purposefully.
Parks and protected areas played a central role in both shaping and being shaped by these forces.

Historically, parks were designated primarily on the basis of advice from technical staff with a small amount of public consultation. This has all changed. Public debate about the establishment of new protected areas has precipitated a number of the changes in the decision-making process in BC which provides useful lessons to resource managers and decision-makers elsewhere. However, it must be re-emphasized that protected area designation is only one part of the intricate interplay of issues and responses.

Over a period of a decade, as conflicts rose to a crescendo by 1990, governments and resource managers came to understand more clearly that Canadians places a high – perhaps even a paramount – value on the protection of our natural legacy. This value has been increasingly influenced and informed by growing scientific knowledge and models about the principles and practices of ecosystem management. However, we also have learned that this science can never be considered as absolute or the resulting concepts seen as inviolable in the intense societal debate about which areas to protect and why.

In order to make effective resource management decisions it is now necessary to understand the forces and inter-relationships between conservation science and resource management practice on the one hand and the social, cultural and economic forces in society as a whole on the other. As society has become concerned with, and intimately involved in, resource management, so too must the professional resource manager and the elected official grapple with how to manage and direct the interplay of these forces and to understand the new roles they are expected to play.

There has been intense pressure everywhere for decentralization of decision making and public empowerment. The public has become far better informed about and involved in decisions that have provincial, national and international implications. As BC’s First Nations become involved in these debates, the pressure for decentralization is enhanced. This fundamentally alters the way in which the traditional elites in society – academics, resource managers, company presidents and provincial premiers can wield their influence.

As a result of these forces, it was apparent in BC by 1992 that "(the) public and private interests had converged in seeking government leadership and advocating for a land use plan to be developed through open, community based public involvement of all stakeholders in land and resources" (Thompson 1996). It is this process and the lessons learned for parks and protected areas which is the focus of the next section.

**Land Use Planning and Protected Areas Establishment**

Recognizing the forces discussed in the previous section, BC adopted a radical approach to resolving this issue involving the following:

- A new land use plan for the entire province by early in the next century.
- Planning to be done by roundtables of public and resource managers, sharing decision-making advice with cabinet, and working on a consensus-seeking model.
• A target to double protected areas by 2000 based on the goals of ecosystem representation and special features protection.
• A new forest sector strategy based on renewing the resource and the industrial sector; setting new sustainable annual allowable cuts; encouraging industry employment adjustment and transition; and establishing a new Forest Practices Code.
• Commencement with the federal government on a treaty process with all First Nations.

A crucial first step in land use planning was to make an external body—the Commission on Resources and the Environment—responsible. The Commission was established in 1992 and took the first radical and unpopular steps that permitted the government to subsequently learn from and adapt experience for application to the entire province and eventually replace the Commission with a government led process.

For parks and protected areas the impact has been dramatic. In open, balanced community processes the public has for the first time directly determined the size, location and boundaries of new protected areas. Debate at the planning tables also has provided a forum to resolve conflicting values. The results are very powerful. Government has not once changed the basic recommendations of a public consensus recommendation from any planning tables. The implications for resource scientists and professionals are profound.

The planning tables have provided recommendations on which new areas to protect. They are guided by systematic, science-based analysis provided by resource managers for all 112 provincial ecossections and the gaps in current representation. The professionals also provide information to the tables on which areas are considered best candidates to achieve the goals of representation and feature protection. It is the public tables that then select the areas to be proposed to government as new protected areas. In so doing they provided insights into: the relevance and application of the emerging principles of conservation biology; the relevance of economic impact analysis; and the current models of professional park and protected area stewardship. There have also been many lessons on effective process management along the way.

**Lessons from Land Use Planning**

In 1992, the province commenced three regional plans, by 1998 decisions had been made and implemented. Six sub-regional plans had also been completed, approved and implemented. New plans were underway in a further 12 sub-regions (Figure 2). With 80% of the province now in planning, it is possible that the processes can be completed on schedule by early next century.

*For parks and protected areas we have learned:*

1. The Protected Areas Strategy policy set is critical to success. However, while working within a strict framework, it is vital to retain some flexibility in application of the strategy.
2. Protected areas issues must be dealt with as part of a negotiated package of land designations and objectives. Dealing with protected areas issues alone results in an imbalance at the negotiating table.
3. The rational science based gap analysis of “representation” informs negotiations. However, public desire for protection of large wilderness areas, as against small representative areas, has often substantially influenced choices at the table.

4. Extremely large and complex wilderness ecosystems, such as those occupied by wide ranging carnivores like wolves and grizzlies cannot be accommodated in their entirety inside even very large protected areas. These ecosystems require other management regimes. The planning tables have proposed a number of innovations to deal with this issue and retain certainty for all parties.

5. Traditional parks agency models of resource stewardship are being outstripped and challenged by a combination of funding shortages, community antipathy to restrictive management, and the need for cooperative management between neighbouring land owners.

6. Application of the current park legislation is being “tested” by the requirement for a limited amount of flexibility in management applications. The planning tables and First Nations have often achieved agreement on protection of areas, so long as certain traditional activities – which are not usual in parks – continue or certain future options remain. This has meant that legislation other than the Park Act has had to be used.

7. Economic impact analyses are completed for every recommendation but in practice these do not often change the recommendations because the knowledge they portray has been implicitly understood and considered by the participants during the negotiations.

On process management we have learned:
1. Consensus processes require major investments in training the participants; preparing the information base before the public table is convened; and providing the appropriate guidance, such as the protected areas strategy, to the tables at the correct time once negotiations begin.

2. Government has to play an equal role at the tables and directly manage the process toward completion. To do so, it must proceed in a manner that is not biased or arbitrary and is definitely open to change.

3. The terms of reference for plans must be prepared and signed onto by all parties before planning begins. These ensure a balance of participant interests and potential benefits. All “communities” need to participate and have a stake in the results.

4. The processes must take place at a geographic scale that is relevant to and intimately known by the participants. People who know the resource and the communities are better able to plan than outside advocates and “experts”. For this reason, regional plans in heavily settled parts of the province have not worked as well as sub-regional plans.

5. These are negotiations and to be successful the conditions for effective negotiation must exist. All parties must benefit from the negotiations and have something to lose if they fail.

6. Planning tables can lose contact with the general public and their expectations. If they do, they can be vulnerable to political lobbying. Open, continuous public communications are vital.

7. Involvement of First Nations is of paramount importance. This requires much effort before planning begins and resourcing assistance during the planning.
On decision making and implementation we have learned:
1. Working to a single consensus is far more powerful than the traditional options approach. It is worth struggling to achieve and may take more time.
2. Resource managers will be uncomfortable with the results of public consensus and will seek to change things if they have not been part of the process.
3. The resulting plans must be clear as to intent and objective but open to flexible and practical implementation. It is a significant challenge for public consensus processes to achieve this level of clarity.
4. There has to be sufficient opportunity for continuing public and community oversight and commentary during the implementation phase.
5. Implementation is more difficult and costly than planning and benefits greatly from clear plans and objectives.

The recent completion and announcement of government decisions on the Fort Nelson and Fort Saint John land use plans demonstrate much about the progress being made and provide many lessons and exciting challenges for the future.

Land Use Planning and New Protected Areas in North East BC
Covering approximately one quarter of the province, the northeast or Omineca Peace region has been the focus of eight distinct sub-regional (LRMP) land use plans (Figure 2). These began in the period 1992-93 and have benefited from the lessons gained through the earlier regional plans.

In 1997, the first planning teams began to reach their conclusions. First in Vanderhoof and then in Fort Nelson and Fort Saint John, the public and inter-agency teams achieved consensus recommendations on complete strategic land use plans which recommend zoning, objectives and broad strategies for all Crown lands in their district. Government has approved these recommendations and anticipates receiving plans from Robson Valley, Prince George, Dawson Creek and Fort Saint James in 1998. As Figure 1 demonstrates, the approved plans have significantly altered the parks and protected areas system. Further changes can be expected in 1998.

Closer examination of the Fort Nelson and Fort Saint John land use plans (LRMPs) provides further insights concerning parks and protected areas.

The Fort Nelson and Fort Saint John Experience
These two sub-regions cover an area of almost fourteen and a half million hectares in the northeast corner of the province. Remote and largely roadless until the Second World War construction of the Alaska Highway, this is a region of BC that is similar to northern Alberta. Its economy reflects the geography. It is based on agriculture in the southern “Boreal Plains”; natural gas exploration and development in a north to south band on the Boreal and the Taiga Plains; forest products in the centre and north; and nature based tourism–especially hunting–in the north and west and particularly in the northern extension of the Rocky Mountains which is an extremely large and remote wild area. Lightly populated, totalling 24,500 (1991 census), the area includes one of the fastest growing populations in the province–Fort Nelson with a population of 5000. Most of these people are dependent on a resource industry for their livelihood.
The Challenge of Land Use Planning
Protected areas issues presented the planning processes with the following challenges:

- The Northern Rockies part of the region is acknowledged by wildlife experts as the most significant wilderness wildlife habitat south of the sixtieth parallel. It is typified by complex predator-prey ecosystems involving grizzly, wolves and large ungulates living in a wilderness condition.
- Geologists estimate this same area to be underlain by possibly several trillion cubic feet of natural gas. However, limited exploration has occurred since there are no roads.
- A similar situation prevails for mineral prospects – some of which are anticipated to be very high.
- Forestry activity is presently situated in the river valleys and plains near Fort Saint John and Fort Nelson. In the future this activity will extend into the Foothill Ranges and the valleys of the Rockies.
- Eco-system gap analysis demonstrated that much of the area of greatest wildlife and wilderness interest in the “Rockies” was already “represented” in several large spectacular mountain wilderness parks – Kwadacha, Muncho Lake, Stone Mountain and Wokkpash – while the Boreal and Taiga plains had little representation and few advocates.
- The guide-outfitting businesses in the region had significant concerns about future extractive resource development – but almost equal concerns about the impact of potential park designation on their hunting business and wildlife management activities. Local elected officials made it quite clear that they were opposed to any provincial parks.
- National and international conservation interests were strongly urging protection of the entire five million hectare Northern Rockies as a centrepiece of the Yellowstone-to-Yukon strategy to provide linkage among the national parks in Alaska, the Yukon and the Canadian Rockies.

Together these factors would usually result in the sort of escalating conflict between the various interests which has been seen previously elsewhere in BC and Canada. The result here, however, was a text book example of consensus public land use planning and was similar to the experience of the Chilko Lake team (1994); the Kamloops LRMP (BC 1995); the Lower Mainland PAS team (1996); and the Vanderhoof and Bulkley (BC 1997, 1998) LRMPs.

The Results – Applying the Lessons from Elsewhere
In a previous section of this paper, some of the lessons from earlier processes were identified. In the northeast, these have been applied to good effect.

1. On Process Organization and Management
   - In Fort Nelson and Fort Saint John, two separate local public planning teams worked closely with staff to resolve the park and protected area issues as part of a package of negotiated solutions to all resource zones and objectives.
   - Government staff led the two teams and included representatives from local communities, resource industries, agriculture, local conservation groups,
guide outfitters, trapper and others, all of whom know and identify strongly with the area.

- These local residents worked positively with provincial and national public advocates representing various values, who were prepared to sit down and work through issues with them at their community tables.
- The process went through various stages over more than four years that allowed the participants to absorb information and communicate with the general public.
- The province provided resource information and analysis to the table including innovative socio-economic impact studies. In particular the province provided analysis of park and protected area values and, when negotiations bogged-down, gave new policy directions including setting targets for the amount of protected areas.

2. On Protected Areas

- The tables negotiated the location of 31 new protected areas and set their boundaries covering 1.25 million hectares. Their choices amply demonstrate the reality of social choice as contrasted to purely scientific measures of representation. The new protected areas increase representation of many but not all eco-sections; however, they add considerably to representation of the previously well represented areas. This recognizes the great significance of these ecosystems ecologically and for recreation – and especially their wilderness condition.
- The tables reached several unusual “compromises” about protected area values and management regimes that allowed all parties, with the single exception of the mining industry, to agree on all aspects of the plans. The most important of these concessions were:
  - Directional drilling for natural gas was proposed under a number of small new protected areas and around the periphery of several large ones. This pragmatic solution allows some resource development to encourage employment and wealth generation that will offset any loss of development potential in the protected area. This was known to be contrary to strict interpretation of the provincial Protected Areas Strategy, but was justified by the entire table because it can be done with no surface impact and because it will ensure resource revenues which would not otherwise be available. In January 1998 sale of rights under one of these areas realized $7 million to the provincial treasury.
  - An extremely large Special Management Area covering 3.5 million hectares was agreed to covering most of the area previously advocated as park. This decision recognizes the natural values but also the impossibility of protecting the entire northern Rockies eco-system. A specific plan directs the following: industrial activity will occur subject to further planning to ensure continuing wilderness values; the work will be guided by the direction set by the planning table; and an advisory committee of local people and recognized experts will be established and a special $2 million trust fund will be formed, outside normal budgets to ensure management of the area.
  - All of this will be legislated in 1998 to ensure all parties observe the terms. This designation and management regime is without precedent in BC, and is quite probably unique in Canada. It is akin to a Biosphere Reserve but with legislated guarantees.
• The new protected areas will be parks but their management must be subject to the agreements established at the land use tables. As a result, both hunting and guide outfitting shall continue within them.

• One new park may, in the future, have an access corridor for mineral exploration. However, this can only occur if an open public assessment process concludes that this is the best option.

It is a significant tribute to the power of consensus achieved by local residents, that the Premier and Ministers accepted the entire land use plan package without changes. In so doing, it was fully recognized that they contain departures from the norm. Perhaps most significantly, local First Nations endorsed the results too and the oil and gas industry voluntarily relinquished tenures in the new protected areas while also agreeing to provide matching funds for ecological research in the area.

Future Challenges Implications for Managers and Researchers

The experience of the past decade in BC clearly shows the power and effectiveness of local stakeholders in decision making and the role that they play in working with experts and specialized knowledge. Although the revolution in resource management in BC is still underway, it seems unlikely that the course of community based strategic planning will be fundamentally changed now. For example, treaty negotiations with First Nations throughout the province will likely add impetus to public, local empowerment, while also changing and re-shaping its nature. Resource managers and politicians also have been challenged by the pace and direction of the changes, and will continue to be stretched to adapt, adjust and respond.

Researchers can help if they themselves are part of the process, understand the currents of change and are able to look ahead and anticipate the choices that must be made. If they do, they will provide useful information, analysis and support for the decisions which must be made.

In the field of parks and protected areas, there are a number of areas of potentially fruitful research that would help managers and decision-makers. On the topic of biological systems, it is clear that the evolution of complex natural inter-relationships is imperfectly understood. Questions remain about the nature of change and the system’s sensitivity to and resulting disturbance from various activities. The protected areas and surrounding special management zones, riparian corridors and forest ecosystem networks have been set in place to provide a framework to proactively manage change, often on the basis of relatively little inventory and research. There continues to be significant need for long-term studies of population-habitat interrelationships, particularly as they apply to species such as wolves, caribou and grizzlies. In this regard, the Muskwa-Kechika area will provide an ideal laboratory. The guarantee of funding from government and industry presents an opportunity to develop long-term studies of the area’s ecology.

The question is far broader still of course, since we continue to need evidence of whether and how the protected areas and other zones contribute to sustaining biological diversity across the landscape.
Given the effective relationship that has emerged between public perceptions and behaviour in the environment, it might be argued the topic of social and economic values and the interrelationship between humans and environment is a vital research field. There continue to be many fascinating issues which recent experiences raise. For example, what is the role of information from the various educational systems, the media and other information sources, as a factor in the development of public attitudes toward environment? How do local people interact with and form opinions about environment and how might science better inform their opinions? In turn, resource managers need better information and understanding about those relationships so that they can adjust their behaviour accordingly.

Research in resource and environment governance and decision-making models around the world could be valuable in assisting the various parties to understand and direct the evolution in BC toward effective local empowerment in management of the process. At times, the challenge seems to be how to effectively undertake any of this research when the systems being studied are themselves subject to ever-faster change. It may be argued that it is the change itself that might be the subject of attention, while efforts to understand the fundamental processes and forces are also vital too.

What is clear to this author is that research can not simply focus on protected areas or on the established models for protected area establishment. The systems with which we are dealing are large, fluid and constantly evolving. The challenge for researchers is to expand their horizons to keep up with society's needs.

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PANEL COMMENTARIES ON SPECIAL SESSION

Charleston Lake Provincial Park
Cultural Heritage Conservation

Peter Carruthers
Environmental Assessment Coordinator
Ministry of Citizenship, Culture and Recreation
77 Bloor St. W., 2nd Floor, Toronto, Ontario M7A 2R9

Research priorities
Thank you very much for the opportunity to address cultural heritage issues in the context of your Forum on Research in Parks and Protected Areas. The conservation of heritage is a public interest which binds the activities of municipalities and government ministries and agencies under statutes such as the Planning Act and the Environmental Assessment Act. From a research and planning viewpoint, heritage sites include places of archaeological, historical, architectural, structural, and symbolic significance as well as landscapes which contain all of the above in their natural or cultural setting. Areas of traditional use such as places for resource gathering or for spiritual renewal are examples that connect natural with cultural categories of land.

For this reason we recommend that all work of the type being discussed here be done using an ecosystem approach as defined in Figure 1. Some form of human activity has altered most landscapes south of Thunder Bay. All landscapes in the province have been occupied to some degree or another. Our job would be infinitely easier if it was generally accepted that human activity has occurred and will occur throughout Ontario and that ‘natural’ area designations exclusive of cultural, are fictions.

Research protocols are important to analysis, curation and reporting of both existing and future data.
Data management in the past has been very uneven relying as it did on the presence of and use by the original researcher. Many of these individuals are gone; their offices closed; their files and maps dispersed. The aggregate effect of the large amount of research investment has been less than might have been the case if the data management had been standardized. Research protocols developed and signed in advance and monitored throughout are recommended for future work.

Cultural resource identification, evaluation, mitigation, and protection must be carried out prior to land use change.
Research in a time of fewer resources can be effectively carried out as part of an approach triggered by a planning process. Inventory and understanding can be less imperfect if done within a framework of expectations. Land use change must always be preceded by a level of data gathering, analysis and evaluation appropriate to the proposed level of change. The Lands for Life initiative for example, raises fears about a parallel, unregulated decision-making exercise being carried out in the absence of enough data. No destruction should occur without being preceded by an appropriate level of research.
Research into relationships between aboriginal and non-aboriginal views about cultural heritage will have wide benefit.

Non-Aboriginal views about heritage and human-land relationships are perceived as differing from Aboriginal views even though the same places are often involved. For example, a non-Aboriginal researcher may see a burial ground as data while a Native person may see it as a sacred area. Artifacts on a point of land may flag an archaeological site that may have Aboriginal significance as a traditional fishing area. The ability to protect a site or a landscape increases with the number of values that overlap. Research into parallel value systems can lead to cooperation and common ground rather than opposition.

Marketing research into inter-relationships among tourism, resident and visitor use, recreation, life-long learning, public awareness, and public priorities needs to be clearly understood and communicated.

Conservation success also flows from the economic argument which is often seen as sullying the higher ground of moral integrity. There is little doubt that the sustainable use of conserved public land carries with it the very real danger of overuse as seen in Banff. The benefits of non-consumptive use however, are increasingly acknowledged and need to be researched, documented and widely communicated so that resource extraction can be placed in its proper perspective.

Research into interpretive alternatives has much potential.

A constant in any discussion of conservation success is the need for education and training at all levels. Reaction to Lands for Life has exposed a strong conservation voice in the north whose public expression is muffled by the lack of access to reliable information. Research is necessary into creative alternatives for delivering facts about the state of the environment, economic realities about resource extraction, realistic employment opportunities, and the daily intricacies of the ecosystems which include people along with all other living things. Educational opportunities embodied in park and crown lands need to be delivered widely and everywhere and we need to explore every aspect of how to do this.
ECO-SYSTEM APPROACH
A planning process which systematically considers air, land, water, living organisms including humans, and past, present and future interactions among them.

The above graphic, adapted from publications of the Waterfront Regeneration Trust, represents an interlocking, mutually dependant ecosystem which has included humans in the past and is strongly affected by humans in the present who have a responsibility to pass on a functioning system to future residents.

Figure 1: Ecosystem Approach
Protected Areas and Lands for Life: Will Protection Policies be Met and Available Information Used?

John L. Riley
Director, Conservation and Science
Federation of Ontario Naturalists

In February 1997, Ontario's Premier Michael Harris and Minister of Natural Resources Chris Hodgson announced that a new protected-areas strategy – *Nature's Best* – would be delivered through the *Lands for Life Planning* exercise over a two year period. Three regional Round Tables would undertake public consultation for the government on the public lands of the central 46% of Ontario, about 39,000,000 ha of forest landscapes.

This planning area is 83% publicly-owned, with 58% of those lands considered as production forests. The average area harvested or burned each year is 1.3% of production forests and increasing, with clear implications for sustainability. "Ontario's softwood sawtimber [harvest] has been held above sustainable levels in the past, and will have to be reduced in coming decades as inventories are depleted" (OMNR 1992). About 60,000 direct forest-product jobs flow from this harvest, a number in steady decline even as the harvest increases. The industry contributes to a balance-of-payment surplus of about $3 billion for the province.

The planning area has about 185 parks and conservation reserves comprising 6.4% of the area. There are less than 50 roadless areas left over 10,000 ha in size, and all the roadless areas of this size comprise only about 7% of the *Lands for Life* area. The net of harvesting roads is closing more rapidly than the public realizes, and wilderness clearly faces a 'supply problem' in central Ontario. By Ontario Parks' own calculations, the provincial park system is only half completed. To complicate matters further, the legal conditions of the Timber Environmental Assessment concerning the protection of old-growth and roadless areas remain unfulfilled.

The *Partnership for Public Lands* formed quickly to address the interests of the conservation community. It is led by the *Federation of Ontario Naturalists*, *World Wildlife Fund Canada* and the *Wildlands League*. More than 30 local, provincial and national groups now support a common set of goals and objectives for the *Lands for Life* planning process that include:

- **Communities**: Healthy sustainable communities with an economic base capable of providing continuity and diversity of employment, an attractive investment climate and the same range of community services available in the rest of Ontario.
- **Land Stewardship**: Public lands outside of protected areas are managed so that planning and resource-use practices maintain the ecological integrity of the region.
- **Land Protection**: To protect Ontario's biological and geological diversity through recognition of a network of distinctive and representative protected areas.
An early goal of the Partnership was to be clear about its goals and concepts in presentations to the Round Tables, starting with definitions of what constitutes a protected area:

A protected area is a geographically defined area that is designated or regulated and managed to achieve specific conservation objectives. (IUCN)

It also became important very early to address issues of permitted uses and to communicate the conservation-community consensus that protected areas provide for a wide variety of compatible, multiple-uses. These include: parks and conservation reserves; remote and semi-remote tourism areas; wildlife management areas; game preserves and bird sanctuaries; First Nation homelands; fishing and hunting; recreation; and potential new designations such as wilderness and old-growth areas. The three exceptions to this were commercial logging, mining and hydro-electric development.

A simple rationale was presented, based on the federal and provincial Statement of Commitment to Complete Canada’s Networks of Protected Areas (Canadian Council of Ministers of the Environment et al. 1992), which otherwise would not have been provided to the Round Tables as support materials. "Protected areas have scientific, educational inspirational and recreational values for humankind and contribute to sustainable development. Protected areas are essential to Canada’s environmental health, biological diversity and ecological processes. The opportunities to protect Canada’s natural regions and wildlife habitat are quickly being foreclosed". We backed this up with public-opinion polling in November 1997, indicating overwhelming support for wilderness protection and for setting aside at least 20% of public lands for wilderness protection. This support was as strong in the planning area and in northern Ontario as it was in the province as a whole.

The challenge facing the Round Tables, the Ontario Ministry of Natural Resources (OMNR) and the Partnership is to develop land-use options that:

• protect the areas that best – and adequately – represent the biological and geological diversity of our ecosystems;
• protect areas that have special conservation values of community concern, for example, wetlands, old-growth, wilderness areas, and significant wildlife habitats;
• protect areas that have important recreation uses, tourism uses, community uses, science and legacy values, and resource uses that are compatible with protected-area designations, tourist operations, wilderness, recreation, hunting, fishing, and so on; and,
• in as effective and efficient a manner as possible reflect accepted principles of conservation biology, landscape ecology and landscape-level land-use planning.

The Round Tables were directed to work within existing OMNR and government policies in their deliberations. The Partnership adopted this direction, but with the additional goal of introducing to the Round Tables some of the policies that we felt might not otherwise be brought to their attention. For example, for roadless-wilderness areas, old-growth areas, wetlands, wildlife areas; representative areas; and remote and semi-remote tourism areas, we feel that there is OMNR and government policy but that full OMNR buy-in is lacking as well as a
readiness to implement these policies in a credible, scientifically-defensible manner: As the planning process is already confirming, it is only "representative" areas that OMNR is willing to discuss, despite a policy environment that clearly embraced the other values.

The Partnership mapped roadless-wilderness areas from digital and hard-copy road mapping which, like other data bases, were being assembled by OMNR on a catch-up basis and were being shared with the Partnership through an agreement brokered by the Minister of Natural Resources. We introduced the Round Tables to the policy background for roadless-wilderness areas. "OMNR shall develop a provincial policy on roadless wilderness areas" (TEA 1994). "The Ministry is committed to involving clients and partners in discussions to...define and identify wilderness characteristics, ...and, assess the need for additional guidelines and techniques to manage for wilderness characteristics" (OMNR 1997d).

We cited examples for the Round Tables. According to the Wilderness Act of 1964, in the U.S., wilderness areas must be statutorily designated on all federal public lands. By 1985, 13% of all federal lands were so designated. In British Columbia (BC) park legislation provides for the identification of parks, recreation areas and "wilderness conservancies", areas "which will be managed as a roadless tract in which natural systems proceed without alteration." We welcomed a comparable departure, here, from purely-regulated protected areas.

We proposed that the Round Tables identify roadless-wilderness areas by using OMNR road data, and by identifying other areas with low road densities. Based on available crude mapping, we estimated that roadless wilderness areas of more than 5000 ha in size and more than 5 km from road systems occupy something in the order of 7-12% of the planning area. Much of this is in existing protected areas and in waterbodies. These data provide the best definition of the "area of opportunity" for protected-areas design. Data of this kind were first brought to the Round Tables by the Partnership.

With respect to old-growth areas, the Partnership drew the Round Tables' attention to various policies supporting appropriate protection. "OMNR has been slow to respond to this interest [in old growth]. Its apparent reluctance has left some people doubting its good faith. Old growth ecosystems are important because they are the ultimate expression of the natural processes which define and create our forest environment. They are the ultimate expression of the natural forest...a living laboratory... OMNR shall develop a policy to provide an environmentally sound conservation strategy and definitions of old growth specific to Ontario forest conditions" (TEA 1994).

We noted submissions to the Timber Environmental Assessment stated that Ontario should retain 10% of all forest ecosystems in the old-growth condition. As well the World Bank stated in October 1997 that all jurisdictions should protect a minimum of 10% of their forest ecosystems in a pristine state. Even Ontario's own policy is to "ensure that old growth forest ecosystems are maintained on the landscapes of Ontario now and in the future" (OMNR 1997b).

Again, we noted examples such as Research Natural Areas (RNAs) identified on federal public lands in the US and Western Australia's protection of its jarrah and
karri forests – their most important commercial forests – wherein 33% and 46% of these forests are reserved from cutting, respectively.

The Partnership has asked OMNR to map and categorize old-growth areas from Forest Resource Inventory (FRI) mapping, and has requested mapping of FRI stands by age. Apparently, however, these data will not be assembled except on a generalized FRI-block basis and, so, will not influence protected-area identification.

With respect to wetlands, the Partnership was informed by OMNR that Ontario has no stated policy to conserve or protect wetlands on Crown lands. Nevertheless, we noted that OMNR's Goals and Objectives included one – "To protect natural heritage and biological features of provincial significance" – that, along with the published methods on how to evaluate provincial wetlands, suggests that wetland protection should be part of the Lands for Life planning process. This parallels the provincial policy to protect wetlands on private lands, as a policy under the Planning Act. "Natural heritage features and areas will be protected from incompatible development. ...Natural heritage features and areas, such as significant wetlands...[are] important for their environmental and social values as a legacy of the natural landscapes of an area" (Ontario 1996).

Again, we noted that wetlands can also be mapped from a variety of sources including: digital or manual National Topographic Series (NTS) mapping; digital Ontario Peatland Inventory Landsat imagery, and digital Provincial Land Cover Mapping and Radarsat. We also noted that a large proportion of wetlands – marshes, open water, bogs and fens – do not support harvestable forests but do have extremely high wildlife and biodiversity values.

We also said that wildlife areas should be identified – again to meet OMNR Goals and Objectives – "to ensure the long-term health of ecosystems by protecting and conserving our valuable...wildlife resources as well as their biological foundations" (OMNR 1994). It is an accepted principle of conservation biology and landscape ecology that the habitat needs of wildlife species are a critical consideration in the determination of adequate habitat protection and optimal protected-areas boundaries. Rough – and in some instances excellent – approximations of the area and habitat needs of species are known to wildlife biologists. This is especially important for the protection of:

- featured species such as Woodland Caribou, Pine Marten, Bald Eagle, Red-shouldered Hawk, and Pileated Woodpecker;
- species of conservation concern such as neotropical-migrant birds; and,
- area-sensitive, vulnerable, threatened and endangered species.

As with wetlands on private lands, provincial policies to protect significant wildlife habitats are in place under Ontario's Planning Act. There are public expectations that public lands will be managed to the same standards that public agencies insist that private lands be managed. As the planning exercise develops however, it is becoming clear that, with the exception of Woodland Caribou habitat in northwestern Ontario, no data on the occurrence or habitats of wildlife species is going to be used in the identification of protected areas by OMNR gap-analysis methods.
A more complex discussion is taking place with regard to the identification of representative areas upon which OMNR will be basing its protected-area site selection. Parks and protected areas occupy about 7% of the planning area and these include many areas considered to be "representative" natural areas. The new OMNR gap-analysis methods focus on "representative" areas which OMNR has indicated to be less than 50% complete. Only 16 of 67 site districts are moderately or fully represented (OMNR 1997a).

There are many different approaches to gap-analysis and we have encouraged a full discussion at the Round Tables and with OMNR of different approaches. For example, OMNR, \textit{Partnership}, university and out-of-province specialists in gap-analysis work might try to reach agreement on methods through a "Protected Areas Science Workshop" at the University of Toronto Faculty of Forestry (1997).

At least four varying gap-analysis methods are being applied in the planning area. OMNR's own documents speak to the shortcomings: "The geological and terrestrial science methodologies used to identify and measure adequacy of representation need to be updated to incorporate the best available science and to ensure that they can be consistently applied across the province" (OMNR 1997a). OMNR's approach does "not address the question of adequacy of representation" (OMNR 1997a).

In Ontario, the goal is to provide "core minimum representation" (University of Toronto Faculty of Forestry 1997). Methods specify "minimum adequacy rules" that appear to limit the identification of areas to a 5-7% representation solution. This is the areal extent that we have seen identified to date by OMNR gap-analysis studies. Because of this, there appears to be two choices. Additional lands, such as wetlands, old-growth, wildlife areas, and tourism areas, could be deliberately added/nested/fitted geographically to these core minimum areas, to address the need for larger protected areas that better meet the need for ecologically adequate representation. An alternative is to instruct OMNR to bring forward the "best representative 15-20% of an area", thus encouraging OMNR to address the question of the adequacy of representative areas being selected.

To this end, we have discussed with the Round Tables the \textbf{identification of an adequate protected-areas system}. We have noted for them the differences with the BC experience where a percentage figure was used to set the degree of representation that would be achieved. "British Columbia is committed to developing and expanding a protected areas system that will protect 12% of the province by the year 2000" (British Columbia 1993). To provide comparisons, we noted that Nova Scotia by 1995 had more than 19% of all its public lands as part of the province's system of protected areas.

We reminded the Round Tables of the province's commitment which stated that: "The complete range of natural heritage values is considered and assessed in order to determine which areas will most efficiently represent natural diversity" (OMNR 1997a). \textit{Nature's Best} also indicated that the criteria for designing a protected-areas system included not only representation, but also diversity, uniqueness, quality, sensitivity, rarity, natural linkages and corridors, larger landscape processes and disturbance regimes, and the sustainability of areas (OMNR 1997a, 9).
Based on the OMNR Natural Heritage Training Manual (OMNR 1997c), we have noted for the Round Tables some of the recommended assembly rules of protected-area systems:

- The full range of habitat-landform types that occur in an area are protected.
- Large patches are generally more valuable than small patches.
- Avoid fragmenting natural areas.
- Connected patches are usually better than unconnected patches.
- Patches that contain a high diversity of plant and animal species are generally more valuable than lower-diversity patches.
- Waterbodies, wetlands and other [wet] areas should be protected wherever possible.

The Partnership is undertaking a kind of GIS-based "scoping" exercise around how to integrate these resource values – or landscape components – effectively and this is the subject of a poster presentation summarized elsewhere in these proceedings.

The goal of our independent work was to identify in each ecological district, candidate protected areas in remote natural states that would contribute to the protection of Ontario's biological and geological diversity; its wilderness, old-growth, wetland and wildlife values; and the many recreational, resource and social uses that are compatible with protected areas. Our initial estimate, based on scientific studies elsewhere and in the planning area (e.g. Geomatics International's study of site district 4E-3), is that about 15% to 20% of the planning area’s public lands and waters may be identified as a result of this work.

To date, however, it appears that the Lands for Life Round Tables will not be provided with data and mapping, other than that from the Partnership, on values such as old-growth, wildlife, wetlands and roadless-wilderness areas. Neither does it appear that they will consider the overall landscape-ecology concerns central to modern conservation biology.

Because they are not digital, many other data will also not be considered. International Biological Program candidate protected areas will not be discussed by OMNR. Nor will past, neo-classical park-reserve surveys or inventories that were based on actual field studies. A remote gap-analysis project, based on a framework of "diversity" restricted to FRI or Landsat classifications only, will be done on computers in Winnipeg, without field assessment. These may become the basis of the deliberations of the Round Tables.

As well, data on historical sites, archaeological sites, First Nation values, high-tourism-potential areas, and other values, will not be organized and presented to the Round Tables unless independent groups can introduce them. This is highly unlikely. With Lands for Life, a new modern mantra comes to mind: "If it isn't digital, it isn't real." And because so few data bases are digital at this point, a blitzkrieg planning process like Lands for Life may well end up without any basis in science, and without any of its methods or biases peer-reviewed.

References


University of Toronto Faculty of Forestry. 1997. Summary of Discussions from the Protected Areas Science Workshop. 30 May. Toronto.
Comments on Parks and Protected Areas Research with special reference to Tourism

Patrick L. Lawrence  
Research Associate  
Heritage Resources Centre, University of Waterloo  
Waterloo, Ontario  N2L 3G1

Many of the presentations this morning touched on a number of common themes or issues. There is always a risk when asked as a panel member to comment on the nature of the discussions when often so many diverse ideas and concepts are introduced in a forum. Given this concern, I have decided to reflect on one important issue that I see as fundamental to many of our common interests related to research in parks and protected areas. This issue is partnership.

When addressing the issue of partnership we can begin by considering two key questions: “What is the need for partnerships” and “How can we develop partnerships?” Many of us in our work associated with parks and protected areas research in Ontario are actively involved in a wide range of types and formats of partnerships. In fact the meeting that we are all at today is the result of a partnership among organizations with a common interest in parks and protected areas research in Ontario. In terms of thinking about partnerships of the type that would assist in improving research in Ontario parks and protected areas I would like to use my remaining time to focus on three key issues: Science and Research, Ecosystem Planning, and Tourism Opportunities.

Science and Research

As funding and other operational resources for parks and protected areas in the province of Ontario continue to shrink, the potential for wide spread utilization of partnerships is being considered. This is occurring in the context of organizational restructuring in many parks agencies, including Parks Canada and Ontario Parks. I think this provides an opportunity to develop models of linkages among universities, non-government and community organizations, the private sector, First Nations, and parks and protected areas to support, enhance and facilitate research.

The key question that needs to be examined is what does each partner bring to the table? Many parks and protected areas already assist and support research in a number of ways including the provision of in-kind support, staff assistance, sharing of information and existing databases, technical advice, use of equipment, accommodation, and other readily available assistance. Both Parks Canada and Ontario Parks have completed, or are currently developing, research catalogues that summarize ongoing research and current and future research needs. It may also be possible for park management agencies to join academic researchers in the development of research grant funding proposals to federal government programs such as the National Science and Engineering Research Council (NSERC) or private foundations.

With reduced funding available for research, parks and protected areas also need to consider improved community and volunteer involvement in science and
research in parks. There are already good examples including the many friends of parks organizations that assist with programs such as annual bird counts. As parks and protected areas begin to examine broader social science perspectives – for example historical and cultural resources – in the context of ecosystem planning and other initiatives, it will become increasingly important to consider partnerships among local citizens, First Nations and community groups.

Ecosystem Planning

True ecosystem planning requires a new paradigm for park and protected area management. No longer is it possible to simply expand the existing ownership, regulatory and control planning model to include the natural features and processes that define the ecosystem to be managed. As parks and protected areas people begin to consider the need to examine the ecosystem they will be forced to fundamentally change their perspective on the management of resources, land uses, and natural systems that fall outside the park and outside of their direct control. This situation will force parks and protected areas to develop partnerships with landowners, government agencies, municipalities, non-government and community organizations, First Nations, and the private sector in order to effectively and efficiently implement ecosystem planning. The question is what is the best approach to undertake this task? How do the traditional governmental park and protected area organizations adapt their mandates, approaches, institutional philosophies and capacities to move to a more cooperative model for research? This will be a major challenge in itself and also in the context of declining funding for parks and protected areas in Ontario.

Tourism Opportunities

The growing demand for and interest in tourism and visitor use in parks and protected areas in Ontario as outlined by Paul Eagles this morning clearly indicates the potential for tourism opportunities. Ultimately this growth may provide the best long-term chance to develop partnerships. Many parks have already begun to examine or undertake the use of private sector expertise in such park management activities as marketing, user profiles and customer service. However, the concern for park management is how many of these activities can be undertaken directly by park and protected area agencies and at what cost. Providing or supporting these services places increased pressure on limited and reduced operational resources. The need or interest in supporting tourism opportunities may take staff and funding support away from the conservation or protection mandates of many parks and protected areas. The planning and management of tourism provides an excellent opportunity to strengthen partnerships through the involvement of local communities and citizens in a wide range of tourism activities and services. These types of partnerships will also provide an additional benefit in the form of increased public awareness and appreciation of parks and protected areas as well as their values and roles in conservation and natural area protection.

In conclusion, the many changes occurring in the planning and management of Ontario’s parks and protected areas provide opportunities and potential to consider a wider range of partnerships to assist and facilitate research. No longer do parks, government agencies, non-government organizations, universities and other interested parties or stakeholders have the resources or
support to undertake basic fundamental and applied research in parks and protected areas on their own. With the need for continued science and research, growing interest in undertaking ecosystem planning, and increasing tourism opportunities, partnerships are a means to more effectively and efficiently plan and manage parks and protected areas in Ontario.
Commentary on Parks and Protected Areas Research from the Perspective of a Member of First Nations

Gary Potts

Gary began his remarks by emphasizing that he did not speak for or on behalf of First Nations. Gary is a bushman who grew up in the Bush.

As Gary began speaking he gave an illustration of the rage within him. This rage is caused by the ignorance of colonial society institutions when speaking of nature as wilderness-savages. These words were on a poster entitled *Partnerships for Public Lands* which was put together by World Wildlife Fund Canada, Federation of Ontario Naturalists and Wildlands League.

In commenting on the morning presentations Gary felt that the word ‘money’ framed all of the presentations. Human values, emotions and science as well as *Lands for Life* were all affected by ‘money’.

In the universal human cosmos, Mother Earth is a park. What is now Canada’s indigenous presence has been smothered by a colonial "saran wrap". Overhead screen images represent the colonial painting of homelands which have been occupied by our people for thousands of years. However, communication and research are enabling people to break holes in the saran wrap. People on both sides of the saran wrap are starting to talk to each other. This is a good thing.

Humans are predators and not separate from the predator-prey system. It’s in that light that we should be speaking of predator-prey sustainability. Man’s dominion over nature can be turned around to show nature’s dominion over man – life as we know it.

What was attempted at Temagami was the joining of the ancient homeland of the Teme-Augama Anishnabai (4000 square miles) with the settlers'. Recent institutions thus represent the past and present as well as a future of working together based on seven principles which govern land use (Table 1). This approach was intended to demonstrate over time that all things are connected and we must consider future generations and not deprive them of a base of life from which to grow and enjoy.

In the park mentality people may say in effect: "I am going to the park to be with my natural mother." In the Temagami Treaty of Co-Existence negotiations, we wanted to establish a basis where in time people would or might say:

“*I live with my Natural Mother who will be the mother of all life until Father Sun burns out, or an asteroid or comet of sufficient size hits earth, eliminating most life or until the human predator overloads or breaks down life sustaining systems. Of the three, the last one is the only one we can influence.*”

The End and the Beginning.
The basic principles which will direct land stewardship decisions in N’Daki Menan and the implementation of this Agreement are:

a) The goal of land stewardship will be to sustain life and to maintain the natural integrity of all life forms in and on the land;

b) The protection of burial, sacred cultural and heritage sites will have priority;

c) Sustainable development of the lands, for instance, development which does not compromise the options or the quality of life for future generations will have priority;

d) The recognition and management of rare, threatened and endangered flora and fauna to ensure sustained and enhanced populations will have priority;

e) The recognition and management of areas of natural heritage which may have significant natural features and attributes, such as areas of natural and scientific interest in order to preserve their unique qualities will have priority;

f) Any planned human activities must respect, protect, maintain or rehabilitate fully functioning ecosystems and the life therein; and

g) The parties agree that the water systems, levels and quality throughout N’Daki Menan are a matter of significance to both parties and that all planned activity on the land or water must respect, protect, maintain or rehabilitate the quality, levels and quantity of the water systems.

Table 1: Basic Principles for Directing Land Stewardship Decisions in N’Daki Menan
Research — A Fundamental Management Tool

Jay Leather
Zone Manager
Northwest Zone, Ontario Parks
Ministry of Natural Resources
Suite 221, 435 James St. S.
Thunder Bay, Ontario P7E 6S8

As the park superintendent of Quetico Provincial Park, I have a little different twist on some of the things that you might have heard this morning. As a park superintendent, I bring the perspective of a manager who is actually in charge of protecting and managing an area on the ground, as compared to those having a wider corporate view associated with regional or provincial planning and management.

It really comes home—the relationship between research and park management—when you do not have enough information to deal with a specific issue on stewardship of the resources that you are charged to administer. And I have had reason to reflect on that relationship a number of times in the past, and I can’t recall getting into trouble for having had too much information and research in a park. But I do recall getting into trouble for not having had enough information.

So the value of research, as I see it, is that it provides an understanding of the park resources as well as the visitors that utilize the park. The bottom line is that you can’t really manage what you don’t understand, and a good understanding is absolutely essential to be an effective steward of a park. In terms of the public and the administration of the park, research can be a valuable tool for public accountability. It can often turn what can be a very antagonistic issue or situation into one that can be supportive, allowing the managers of that park to get on with business. So research in essence becomes a very fundamental tool for managing the park.

In terms of priorities, I guess that my sense of priorities might be a little bit different than that expressed by others on this panel. I don’t know that we do as good a job as we need to on this, but collecting and maintaining basic knowledge of a park’s resources through resource inventories is a fundamental need. This includes information on both the park’s resources and park visitors. It is my sense in Quetico that we have a fair bit of knowledge about our park visitors. This may be an atypical situation associated with Quetico’s stature, which garners a lot of support for research activity to help us to understand our park visitors. Enough is conducted to provide us with the information that we need to manage this aspect of the park’s resources and use.

Knowledge of the biophysical resources of Quetico, and most other parks, is perhaps a little bit different. From this perspective, I see three basic research priorities in Quetico, that are commonly shared with most other parks:

1) collecting and maintaining basic knowledge through good resource inventories;
2) monitoring change in the park over space and over time to determine what is happening to the park; and,
3) issues and problem solving, an area where we probably spend most of our time.

Issues oriented research is often the focus of research after the fact, and it would be nice if we could be more anticipatory in dealing with problems before they escalate into issues. Unfortunately, we spend too much time in reacting to issues.

Reflecting on the elements of a park research programme, I see five characteristics that are central to an effective research programme:
1) contribute to the park’s knowledge base in a catalytic fashion that stimulates further research;
2) document natural and anthropogenic change in the park;
3) evaluate management policy and the park management plan;
4) help to minimize reactionary management; and,
5) serve as an issue management tool when and where necessary.

While there may be wide agreement on the merit of research in parks, there are also some problems associated with research activity and coverage. Certainly a major one has to do with gaps in research coverage which may arise through agency or institutional bias. Recently I experienced a vivid example of this in a presentation on moose distribution and density in northwestern Ontario where mapping based solely upon harvest data revealed a large white hole centred on Quetico Provincial Park. A basic lack of data gave rise to this gap, which may not seem so critical in a provincial context, but is serious from the park’s perspective.

I have seen other problems in the past with what I call “hobby horses”, where either agency-based personnel or academics pursue interests that are “nice to do in parks”, but the work does not contribute substantially to the management of the park.

Research in the way of issues management is often a very slow process, and its not the kind of thing that you can deal with quickly. It often takes substantial effort to collect several years of data and information, and that can delay important decisions that need to be made sooner.

There is always a problem with funding research, and its not the kind of activity that often is assigned the highest priority by park managers. But in terms of meeting this challenge, I would support Patrick Lawrence in his call for developing productive partnerships to further research in parks. Partners and partnerships, whether its two parties or a large collaborative, are really important.

Another problem is the failure to focus on priorities. In Quetico, focusing on priorities is very important, where our rule of thumb is to concentrate on essential research that stimulates broader interest to beget additional research. In a sense, good investments generate broader interest to expand partnerships that extend the initial capability.

However, beyond partnerships, direct sponsorship is important. In Quetico, the stature of the park creates a fortunate situation for marketing a diversity of
research opportunities, and attracting sponsors to assist with funding priority projects. On top of this, we have to look at providing base funding for research, which is an area that we do not provide with enough programme funding.

By way of comparison, in 1990, I was fortunate to talk to a fellow named Fred Varley who is the head of research in Yellowstone Park. He indicated to me that 4% of the base funding for Yellowstone was allocated for research in the park, and that part of his job was to apply this funding creatively to lever additional funding from other sources amounting to three times the park allocation.

Finally, there are things that managers can do beyond direct funding to support research in parks. This can include the assignment of equipment, provision of accommodation, subsidizing meals, access to transportation, and others kinds of logistic support and assistance.

But the bottom line, as wise stewards of the resource, park managers are in the unique position of identifying critical research priorities and insuring to see that they are executed so that we have the knowledge to protect and manage our parks in an informed manner. And the bottomline for me—my quest if you will—is to insure that there are no maps where Quetico Park appears as a “white hole”.
PRESENTATION OF
ONTARIO PARKS HERITAGE PROTECTION AWARD
TO GEORGE PRIDDLE
Ontario Parks Award Presentation to Dr. George Priddle

A highlight of the PRFO meeting was the granting of the first Ontario Parks Heritage Protection Award to Dr. George Priddle in recognition of his outstanding contributions in teaching, research and advocacy associated with parks and protected areas. With these credentials, Dr. Priddle is a most deserving recipient of this first Ontario Parks Heritage Protection Award.

The award is a framed print of a painting by Dwayne Harty, featuring a winter scene of the hilly forested landscape around Fork Lake in Algonquin Park. The inscription reads:

Ontario Parks Heritage Protection Award

George B. Priddle, PhD

For Outstanding Contributions to the Provincial Park System through Research, Teaching and Advocacy

February, 1998

Mr. Norm Richards, Managing Director, Ontario Parks, presided over the award ceremony which included warm commentaries and tributes to Dr. Priddle from two of his first graduate students, Mr. Cameron Clark, now the Assistant Deputy Minister for the Field Services Division of the Ontario Ministry of Natural Resources, and Mr. Larry Douglas, now the Director of the Corporate Affairs Branch with the Ministry. Following are the tributes presented at the ceremony by Messrs. Clark and Douglas.
Tribute to Dr. George Priddle by Mr. Cam Clark

Norm Richards gave me some reference material this morning to assist me with this pleasant task. But this is one presentation where I do not need notes. I will try to incorporate everything that is here, but this is something, Norm, that really comes from the heart.

About two weeks ago, I had a call from Tom Beechey, whom many of you know through his lengthy involvement with parks and protected areas, when he informed me about the Ontario Parks Heritage Protection Award and the idea of granting the first of these awards to George Priddle, here, today. I can't tell you how delighted that I was at the time—it made me feel really tremendous! So I was very, very eager to have the opportunity, George, to come and offer a few words of congratulations from me, and on behalf of the Ministry of Natural Resources, Ontario Parks, and a host of people in Ontario and far beyond who would want to share the warmth, affection and respect that comes with this award.

I had some time to think about this when I was flying in from Thunder Bay last night. I had a glass of wine and reflected on my relationship with George and our involvement in parks and protected areas over the last few years, when it occurred to me that I met you 30 years ago! I had another glass of wine—I got over it.

I need to recount a little bit of personal history because I think that George has touched so many of us, and he has touched so many of us in this way. Thirty years ago, I was what you would characterize in demographic terms as a semi-dependent, undirected second year student, trying to find his way academically, and a little unclear about my future. I can recall my wife-to-be saying: “You know, Cam you have tried a few things—business, history—maybe you should try geography.” The mother science! Not having a clear sense of where I was going, I thought that I would do that. So I did.

What a tremendous turning point for me, because as I got into the geography programme, one of the first professors whom I met was this young fellow named Dr. George Priddle, recently from Clark University in Worcester Massachusetts. Up until then, I just had not found anyone who captured just what I wanted, and this guy was bright, he was congenial with a nice sense of humour and a contemporary view of things. You have no idea, George, what an impact that had on me and many, many other people.

And I listened to George carefully. When George read Leo Marx’s Machine in the Garden, I read. There are many things like that, that I remember. I also remember somebody who brought the young people, like me, together, and encouraged us to talk about resource management issues in a congenial setting where people were encouraged to think freely and to engage in a dialogue. And it didn’t matter whether it was in the classroom or the Blue Moon Hotel, we did it all, and we had a great time doing it. It kind of brought a perspective of academia that I had not experienced before, and one that I have carried with me throughout my career.
In retrospect, the thing that most impresses me about George is that, if it wasn’t for him, I would not be here today. And I was trying to figure out what it was that encouraged me, and there are a number things that George brought together as a package. He was a geographer, first and foremost—a convenient acronym that kind of lets you do a lot of things. So, part of what George brought was this concept of man and environment relationships, and that was sort of fundamental to everything that we did.

The second thing that George brought was this fascination with what we then called “perception and behavioural studies in resource management”, really looking at the human dimensions and everything that we deal with in the resource management business. And there is not a day that goes by when I don’t say: “You know, you were right!” It is so much a part of what I do now, so much a part of what the Ministry of Natural Resources does, and it is so fundamental to getting the job done.

The next thing is this real fascination with parks and protected areas. For George, this found substance in Algonquin Provincial Park, which is a physical reality that has tremendous symbolic content for him. And for people like me, this was just a wonderful menu which opened the door for all kinds of ideas and discussions, and frankly, let me and numerous other people pursue careers in the resource management sector. First of all, there is Larry Douglas, who is sitting on George’s left side. He and I worked together as graduate students, and in fact, if it wasn’t for Larry, I probably would not have made it through school. George, Larry and I, in particular, pursued research in Algonquin Park. George had done the seminal work on wilderness perception, and I did the follow up study—mine was slightly better.

Anyway, some of the students that were there then, who I know George remembers with fondness include John Lewis, Kevin McNamee, Ken Cox, Ken Morrison, Gary Allan, Ken Cain, Sheila MacFeeters, Brian Howard, Barton Feilders, and the list goes on. I know that George had some 50 masters and PhD students that he has worked through the system. And for all of us, George, you did a wonderful job. You peaked our enthusiasm, encouraged us to be a little innovative—and probably a little left of centre, in a healthy kind of way. You brought a kind of infectious enthusiasm, that made us want to be part of the game—the resource management game. Now, what more can I say. It was great, and I am absolutely delighted to have the opportunity to come and say these few words about you.

There are a few other points that I do want to mention. In a more institutional setting, George also had a very active life. He served for seven years as the first Chair of the Ontario Provincial Parks Council. Special advisory committees, such as the Parks Council, sit at the interface between politicians and bureaucrats. And so if you were a George Priddle, you were stuck between a couple of bureaucrats who tried to control the agenda, and the political side that was a moving target. And for anyone to last for seven years in any position like that is a very impressive achievement. And I know why George succeeded—he has a tremendous facility to deal with people. And I know that in that particular enterprise, it required a lot of tact, a lot of diplomacy, a tremendous sense of humour, and very much a leadership role in terms of bringing people together.
and exploring ideas—whether you were dealing with Quetico or Algonquin, or whatever.

George, as many of you know, was also a member to the Canadian Delegation of the Second World Conference on Parks and Protected Areas in Wyoming, and the Third World Conference on Parks and Protected Areas in Bali, Indonesia. He was also part of the Canadian Delegation at the IUCN Conference in ChristChurch, New Zealand. In recent years, he has been involved in trails and greenways, and if you know George, he has been involved in these initiatives right from the beginning. It did not matter if it was in the Baden Sandhills or the Grand River, George and his students were involved in one way or another. George continues to employ students in a variety of functions, just like he did with me, Larry, Ken Cox and a whole bunch of other people.

I think that you should also know that George has authored three books, and chapters in 10 other books. He has written more than 100 papers and reports on parks and protected areas and associated outdoor recreation interests. And so, you can see that when I received the call about this event, I thought “Boy, what a great guy to receive this award”. I am so proud to be able to be here, and to be a part of this celebration. And George, I would just like to say, on behalf of myself, everybody here, and numerous others who have touched you in this particular business over the years, thank you very, very much—it is a wonderful accomplishment!”.
Tribute to Dr. George Priddle by Mr. Larry Douglas

Like Cam, I share many fond memories of George. I guess that it was three years later, after Cam first met him, that I came into contact with George. I certainly share the affection that Cam does, and as Cam was speaking, I was thinking of all of the grad classes that we had at the Blue Moon Hotel, and how that tended to be symbolic of George’s way of doing things. It wasn’t always the standard way, but it certainly was a good way. I am certainly pleased that George is being given this award, and I think it is a real tribute to someone who has made a significant impact on parks and protected areas in Ontario and Canada, and particularly our perspectives on them.

George always saw things from a unique perspective, and I think that this is what created the innovation and attractiveness of working with him. George’s contributions stem from what I think of as several inter-related strengths which are difficult to separate. George is an innovative and free thinker. He loves to breakdown boundaries between disciplines, and he loves to break down jurisdictional barriers and institutional jealousies. He just loves to do that.

He saw, I believe, breaking down such barriers and boundaries as a means of creating new ideas. I think that he reveled in situations when he got different groups together. He particularly had fun when dealing with a group with a unique view. He would either challenge that view himself, or he would create situations where other disciplines or perspectives would come together and they would challenge each other. He would just sit there and smile. When the debate went on, and new ideas emerged, somebody would say: “We are not getting anywhere clinging to our own roots; how do we bring our perspectives together?” That’s when George knew that progress was being made. I think that was really the unique ability of George. He could bring together people with diverse perspectives; he could organize them in settings that were not confrontational, that enabled them to break down barriers and develop new solutions.

Another characteristic of George that I liked was that he was a rebel. Not only did he like to bring the different perspectives together, but he liked to see the sparks flying. When he brought people with different perspectives together, there was something beyond ‘We’ll get a good idea.’—‘This will be a good show, too!’ He enjoyed that, and we always knew that.

We talked about Algonquin Park. A story about George and Algonquin Park. I do not know whether this is true, or not, but I understand that when he was working in Algonquin Park as a student, he commuted one night to a bar in Huntsville in a road grader. I’ll leave that to the historians to document whether this is true or not.

George loved to play, loved to create new ideas, and loved to challenge existing orthodoxy. I think that is really his contribution, and he has brought this not only to parks and protected areas, but also to academic settings. Certainly when Cam and I were in geography, at Waterloo, probably what attracted us to George, more than anything else, was that you did not need to worry about boundaries. Later, George became part of a department with a perspective even wider than
geography, known then as the Man-Environment Department and now as the Environment and Resource Studies Department.

George, I really appreciate what you done for us and for the province in breaking down historical ways of looking at things, adding creativity, and getting the job done. Thanks.
Remarks by George Priddle

Thank you very, very much.

I won’t keep you very long, because I know that we are already running late for lunch. But I can’t tell you how thrilled that I am to receive this award, and especially to receive it from two of my first graduate students, Larry and Cam, whom I did not know were going to be here today. And so today is an especially great thrill for me.

Also mentioned in passing was John Lewis. The first graduate student whom I had was John Lewis and the second was Cam Clark—so we have Lewis and Clark. And they ended up in a canoe one day checking out the French River as a heritage river, and they hit the first rapid and over went the canoe. I’m told that’s a true story. The road grader—I can’t remember.

But it has been very exciting being involved with parks and parks people, and a big thrill for me seeing so many familiar faces here today—all the memories rushing back to Algonquin Park, which I guess was my first real entree into the parks business—and I’ve kind of been at it ever since then. It has been a real thrill and of course you meet wonderful people doing it.

From some of the things that we heard this morning, it’s a business that’s ongoing. We massage the language, but its the same stuff, you know, and we’re wrestling with the same problems, so its an unending battle.

I am retired now and enjoying it, but I am still quite involved in some things, like rails and trails, and having students involved in this work in the local area where I live in the Regional Municipality of Waterloo—so it keeps my hand in it.

Thank you very much gentlemen, I really appreciate your being here today. Thank you so much to the organization for this wonderful presentation and this wonderful award.

I’ll be around this afternoon, since I am moderating the first panel.

Thank you.
PART II: GENERAL SESSION

VOLUNTEERED PAPERS

Bruce Peninsula National Park
Easement and Dedication Programs for Parks and Private Lands

Ian Attridge
Barrister and Solicitor
575 Gilchrist St., Peterborough, Ontario, K9H 4P2

Abstract
Many of the challenges for conserving Canada's biodiversity within representative areas occur on private lands. Beyond purchase and agency management, new approaches must be advanced to involve landowners in diverse ways. As wildlife and habitat areas always have, this involves crossing sectoral and jurisdictional lines. Developing familiarity with dedication programs, conservation easements and their associated tax incentives will enhance conservation opportunities for protected area managers, policy makers and partners alike.

Numerous examples and variations of park dedication programs exist in both Canada and the U.S. Landowners make a long-term commitment to protect all or a portion of their property in exchange for a range of benefits, including the following: exemption from expropriation, property tax reductions, recognition, and access to technical and financial support. Such a program could be developed in Ontario, and indeed the Ontario Nature Trust Alliance is investigating its own private system.

Conservation easements are voluntary agreements that become binding on future landowners. They can be useful in ensuring private commitments as in dedication programs and park inholdings. They also can be used for guaranteeing public purposes as private lands are transferred into public hands or vice versa as in Legacy 2000 or Pickering land dispositions.

The Need for New Tools for Protected Areas and Private Lands
There is a growing need to examine and apply new tools for protected areas, and especially to conserve private lands. This paper outlines two of these tools – conservation easements and private land dedication programs – and relates their application to protected areas primarily within the context of provincial jurisdiction in Ontario.

This need for expanding the conservation tool kit for protected areas can be identified on at least three levels: landscape, site and institutional. This will not be new information for many practitioners in the field who observe and experience such challenges. Nonetheless, it does deserve noting, for it establishes a context that demands creative approaches and increased effort.

At the landscape level, we have seen substantial losses in natural habitat across Ontario and Canada. Many of southern Ontario's wetlands have been converted or impacted and ecologically viable woodlands are few and far between in most of the province's settled areas. Only a small percentage of Canada's tallgrass
Prairie remains and pressures in the Okanagan Valley continue to endanger unique habitats. There are many such examples and growing data on such situations. We must acknowledge that we are losing habitats and associated species, despite long-standing protected area efforts on public lands.

At the site-specific level, protected area managers and planners are concerned with integrating resource management and maintaining ecological integrity. This is made manifest in several ways. Many protected areas have lands – inholdings – or partial interests such as utility corridors within their boundaries that affect the ability of authorities to manage the area as a unit. External lands may remain to be acquired to complete parks, while management agreements with neighbours are of limited term and may be terminated upon a land sale. With respect to ecological integrity, there are conservation biology issues of size, configuration, linkages and the like, as well as detrimental external influences such as pollution, noise, other disturbances and blowdown effects. Unless efforts are taken by protected areas authorities to overcome these management constraints, the site and system goals will not be fully achieved.

Institutionally, Ontario faces several challenges. Whether one adopts the analyses of Ontario Parks or that of the Endangered Spaces Report Cards, this jurisdiction has not achieved its protected area representation and other targets, especially in southern Ontario. Further, current initiatives, while in many cases making important contributions, together are not sufficient to achieve protected area goals identified in a succession of public statements and policies. A more comprehensive and innovative approach is required, yet remains largely indiscernible.

Indicative of current priorities, the Lands for Life initiative does not extend beyond Crown lands. Long-term items identified in the Nature's Best program that would have advanced protected areas in southern Ontario have largely been sidelined in order to feed the Lands for Life process (OMNR 1997). The government has abandoned traditional provincial funding and involvement for conservation authorities, and has thus limited opportunities to foster land acquisition and stewardship in southern watersheds. As a result of diminished resources and responsibilities, it thus appears that the Ontario government is neglecting a full private lands component within its protected areas mandate.

Two programs which stand as exceptions to this general rule are the Conservation Land Tax Incentive Program (CLTIP) and Legacy 2000. Each program makes a partial contribution to private natural heritage conservation. CLTIP exempts the most important categories of natural lands from property taxes, and thus provides an incentive to keep properties in their natural state. However, CLTIP has taken a back seat to the Managed Forest Tax Incentive Program. It lacks detailed criteria and, like planning policies, does not establish a long-term protected area.

Legacy 2000 is an agreement to support the Nature Conservancy of Canada's acquisition of lands, which are transferred to Ontario Parks as protected areas under a long-term lease. While adding to southern protected areas, this program does not encompass nor sustain good stewardship and planning within the hands of private individuals and organizations, like the nature reserves system carried out by the Federation of Ontario Naturalists. Except for the selling or
giving of land, *Legacy 2000* does not enable ordinary private landowners to contribute to long-term representation efforts.

If we accept the goal of representation of all natural features and functions, as well as the need to protect unique features – such as endangered and vulnerable species – then we must address these landscape, site level and institutional challenges on the southern lands that lie predominantly within private hands.

In Canada, biodiversity, human populations, arable soils, and access to resources are greatest on private lands. So too are consequent conflicts. As a result, the conservation community must devise new approaches and entertain new partnerships in order to reach their goals. Conservation easements and dedication programs provide only two possibilities. While these techniques may be somewhat familiar, their application in Ontario could benefit from a closer examination.

**Conservation Easements**

A conservation easement is an agreement between a landowner and a qualified organization or agency to place conditions on the use and management of the property. These conditions may involve limits on tree cutting, agriculture, road or structure building, or the means to manage wildlife. The signed agreement is registered in the land registry office, and thereby becomes legally binding on the current and any future landowner. Because easements are negotiated agreements, they can be tailored to the landowner's needs, the organization's objectives, and the features of the land. Easements can be purchased, but are often donated to a conservation charity such as a land trust, a conservation authority or a government agency. The terms of the easement are ensured through regular monitoring of the property by the holding organization, and by mediation or enforcement actions in court, if necessary.

A landowner who enters into a conservation easement may be able to achieve a variety of tax benefits. If an easement is given to a conservation charity or government agency, the organization will issue an income tax receipt which can then be used to claim a credit or a deduction to reduce income tax. The valuation rules proposed in new federal income tax legislation suggest that an easement will only be recognized as having substantial value where it is certified by Environment Canada to be ‘ecologically sensitive’. Where lands or easements are certified as ‘ecologically sensitive lands’, the donor can claim more of a donation in relation to income, compared to other donations such as cash.

Annual property tax reductions may also be possible, since an easement may reduce the property's value and thus the taxes paid on this assessment. In many circumstances, these tax advantages can result in significant benefits for donors. Since easements may reduce low density and inappropriate development, and protect neighbours’ amenity values, they may also lower servicing costs and taxes for municipalities.

Conservation easements can be used in a variety of situations to complement protected areas. First, by securing the appropriate use of inholdings or nearby parcels, they can help protect the core of a protected area. The process involves contacting the landowners, explaining and demonstrating the benefits of
easements to them, and then entering a process of negotiation. For example, one of my elderly clients wants to have an easement cover his forest and restoration efforts on tableland. The easement will thus help maintain ecological functions and ensure a buffer for a stream that forms the core of an Environmentally Sensitive Area (ESA). In sensitive situations, a short-term easement could establish trust and build the basis of a longer-term easement on the land, or perhaps its eventual acquisition.

Second, a conservation easement could be used to leverage other partners’ involvement in protecting a site as well as in contributing towards a larger protected area assembly. We have seen this approach raised by an American landowner on Georgian Bay. He wishes to place restrictions on his significant island and shoreline properties before transferring it to the land trust, and use this donation to spur other donations and negotiations for an adjacent establishment of a protected area on Crown land. He has been promoting the concept of joint management between the land trust and the provincial government for this larger assembly, and thus contemplates the integrated and ecologically-based management discussed above.

This Georgian Bay example also highlights a third opportunity for using conservation easements: the conditions of any transfers of land to governments to establish a protected area could be guaranteed by using these agreements. As government politics and policies change, landowners are less willing to donate property to public agencies, and increasingly are turning more to non-profit organizations that have a clear conservation mandate. The recent uproar over whether new legislation would cause conservation authorities to sell off lands either donated or purchased with public donations is a classic example. Thus, in order to generally instill confidence in the acquisition of parkland, or to complete arrangements with some landowners, a conservation easement could be granted to a third party conservation organization while the title was transferred to an agency to become a protected area. An interesting twist on this approach occurred along the Grand River, where a donor's estate transferred the historic site and ecologically significant land holdings to the Lower Grand River Land Trust Foundation to become Ruthven Park. However, the estate also granted a conservation easement to the Ontario Heritage Foundation to ensure that this important property would be appropriately managed by the land trust.

Fourth, a variation on the above could also be accomplished. As agencies streamline or privatize their operations, many may sell or otherwise dispose of their surplus land holdings. Important ecological or cultural features could be protected during this process by granting an easement to a third party, before transferring the title into less conservation-oriented hands. This enables the public interest to be secured in a flexible yet permanent fashion, so long as the usual monitoring and enforcement of easements is maintained. A recent example is the Ontario government's proposed sale of over 3,000 hectares of land in the Pickering Agricultural Assembly on Toronto's doorstep. Through a local conservation group, we convinced the municipalities to negotiate with the Ontario Realty Corporation to grant a combination of title and easements over significant streams and valleylands which included ESAs and the Rouge Park as a condition of receiving Official Plan Amendment approvals. The Region of Durham also required agricultural easements on the tableland before the land was sold to
remove speculation and urban development pressures, thus further protecting the valleys and streams that pass through this area.

These are only four of the ways that conservation easements can be creatively applied within the protected areas context; other arrangements may be possible. Park authorities need to be aware of such opportunities and be prepared to explain and explore them with their conservation partners in order to achieve their larger management goals.

Private Land Dedication Programs

A dedication program for private lands enlists landowners of significant properties to make a voluntary but long-term commitment to conservation for all or a part of their land. In this way, private landowners retain ownership and supervisory management, while the public interest in ensuring the conservation of significant sites is secured on private lands at little cost. The use of this voluntary technique also enhances landowners' pride and positive attitudes, and enables them to make a specific contribution towards conservation efforts without requiring disposition of the land or using a regulatory model. Dedication can involve not only individual landowners, but also corporate holdings and those of other institutions such as universities, school boards, cemeteries or agencies without a direct conservation mandate.

The technique is relatively straightforward. Legislation creates the authority to enter into agreements with landowners, likely with certain minimum standards and criteria, and also creates a reciprocal government responsibility back to the landowner. The government can be viewed as the trustee of such areas, assuming responsibility neither to harm their features nor to detract from their intended purpose. More tangibly, there are usually a number of direct benefits for the landowner, often graduated to correspond with the level of commitment made. Landowner benefits through a dedication program can include:

1. qualifying for one-time or annual property tax reductions or cash payments;
2. exemption from expropriation, except in the most extraordinary cases where an assessment demonstrates that a high threshold has been met, and that a high level of approval has been obtained;
3. protection from inappropriate resource development activities and approvals, such as those for mining or hydro-electric development;
4. recognition for land use planning purposes, with resulting procedural privileges;
5. access to government stewardship programs, such as those providing extension services, information, funding and other support; and,
6. public recognition through honour rolls or maps, plaques, gateway signs, annual dinners, newsletters and the like.

The landowner is provided with information on the program and how the site meets set criteria, then signs a standard form agreement and becomes entitled to the program's identified benefits. The agreement is given official status in some form, such as receiving high level government approval and being enrolled onto an official list. In at least one example, enrollment also involves granting a right of first refusal to the government to match any purchase offers. If the standard
agreement is a formal, binding and long-term commitment, it often is registered on the land title to ensure that the agreement binds not only the current but also future owners. This title registration is similar to that for conservation easements.

There are numerous examples of programs across North America that demonstrate the potential of such an approach to private land dedication. At least a dozen states in the U.S., mostly in the Midwest, have established ‘natural area’ programs that include such dedication or easement procedures, often with property tax and non-expropriation benefits (Endicott 1993). These programs often include many publicly- as well as privately-owned sites of natural heritage significance. Along with other examples in the U.S., Canada has numerous programs to encourage farmers to keep lands in agriculture and provide wildlife habitat benefits over the longer term. These programs include: the Permanent Cover Program; certain Prairie Conservation of Agriculture, Resources and Environment (CARE) initiatives; and proposals for an agricultural dedication program in New Brunswick (Greenfield and Richer 1996). The federal government has had its Landmarks program for national park dedications that recognizes non-federal interests in land.

From a protected areas perspective, perhaps the clearest example of private land dedication in Canada is Prince Edward Island’s (PEI) Natural Areas program. Like Ontario south of the Canadian Shield, PEI has a very high percentage of private land. Under the Natural Areas Protection Act, a PEI landowner may enter into an agreement, lease or conservation easement with the provincial government for significant natural areas. An easement may be registered on the land title, ensuring that it is binding on future landowners. Associated regulations may also be put in place to protect the land by prohibiting certain activities, unless the Minister has approved a management plan that specifies otherwise. Significantly for landowners, such natural areas are exempt from property taxation, and the Minister may erect an identifying plaque on the site. The provincial government also keeps a registry of such properties and may provide other services that assist landowners of these sites. As of 1993, a total of 96 properties had been designated under the Natural Areas Protection Act, including seven owned by the non-profit Island Nature Trust (PEI 1993). As another example, Nova Scotia’s Conservation Easements Act similarly provides for entering into conservation easements and designating natural areas by agreement with the landowner, while its Provincial Parks Act also provides for establishing a park by agreement with the landowner.

In Ontario, a number of private land initiatives exist or are unfolding. These include Legacy 2000, CLTIP, Areas of Natural and Scientific Interest (ANSI), and a land registry by the Ontario Nature Trust Alliance. Yet none fully accomplish a private land dedication program. Still, there are other Ministry of Natural Resources programs that could provide models and insights. For example, Ontario has had Woodland Improvement Agreements and the Agreement Forest program to secure long-term private and institutional commitment to maintaining productive forests. While these agreements are largely being phased out, this experience with land dedication could be considered in redesigning or expanding the programs discussed below.

As noted earlier, the Legacy 2000 program enables the Nature Conservancy of Canada (NCC), or in some cases a local land trust, to acquire properties and
then lease them to Ontario Parks to be regulated and operated as a provincial park or similar protected area with public access. Except for NCC and a few land trusts, private landowners cannot retain ownership and active management of their properties and still protect them under this program. There is also no direct government responsibility or on-going benefits back to original landowners in the community, and only a responsibility back to NCC through the terms of the lease.

CLTIP may come closer to a dedication program, since landowners of the most significant natural lands in Ontario can apply to be exempt from property taxes. On the application, a landowner must make the following declaration: "I intend to maintain my property as conservation land and not to undertake activities that will degrade or destroy the natural values of the site". Occasional monitoring may occur, and should inappropriate activities be discovered or reported, the property will be removed from the program and back taxes will become payable.

While it encourages conservation and is an important component of a stewardship package, CLTIP nonetheless has limitations. Technically, the declaration only relates to a conservation intention as of the date that it is made; of course, landowners can and do change this intention. There are no means to upgrade or secure a more detailed and long-term agreement that specifies the natural values involved and appropriate management activities – as managed forests require – nor is the agreement capable of binding future landowners. Enforcement is limited to removing the tax exemption and assessing back taxes, but these do not retain or remediate changed conditions at the site. Finally, CLTIP only applies to a few designated categories of land. This means that landowners of other habitats such as those of vulnerable or non-legislated endangered species, as well as non-forested areas, regionally important or restoration areas, or corridors between significant sites cannot make such a contribution to, or receive such benefits by sustaining Ontario's natural heritage.

The province's designation of ANSI or newer natural heritage areas identifies sites on public and private land that have life or earth science significance. Contrary to the perceptions of many, the ANSI designation really only identifies and describes the site, but otherwise does not protect it. Planning and other decisions which correspond to ANSI designations provide protection, but this is done through a regulatory rather than voluntary means. Typically, landowners can react negatively to ANSI identification or related zoning restrictions because of the imposition of regulatory constraints.

A more recent and private identification effort is the registry of the Ontario Nature Trust Alliance (ONTA) for lands, easements and other interests that meet certain management standards. While still under development, this registry may become a means to identify and dedicate private lands towards conservation. However, the program is only available for ONTA's member land trusts, not individuals or other corporations, and does not formalize government recognition and protection, nor direct reciprocal benefits to a diverse array of landowners.

Given the accomplishments of dedication programs elsewhere and limitations in current Ontario programs, a new system to commit private land towards conservation should be advanced. Such a program could be established under the province's Conservation Land Act, which already contains broad authority for conservation programs and easements. As once also existed for CLTIP's
predecessor, conservation programs under this Act are limited to certain types of designated lands. An amendment would be required to broaden them. Alternatively, a new statute could be introduced that more comprehensively and specifically addresses the needs of natural area stewardship and dedication on private lands.

Conclusions
Increasingly, park managers and conservationists must consider the administrative and ecological management implications of protected areas within a privately-held landscape in order to meet protection objectives. This requires examining new tools for existing, publicly-owned protected areas, but also for lands that will remain in private ownership and will, in specific and long-term ways, be committed towards conservation. Conservation easements and dedication programs are just two of these methods that have demonstrated their usefulness both in Canada and the United States. Both are cost effective, especially in comparison to direct acquisition and management. Also, both appeal to landowners' stewardship ethic and desire to make a contribution towards conservation.

The Ontario Ministry of Natural Resources calls for undertaking by the year 1999 "a review of available tools that encourage and acknowledge the contribution of private land stewardship programs with a view to furthering the contribution of private lands to natural heritage protection" (OMNR 1997, 32). Recognizing and addressing this need is important, particularly in light of the limitations and gaps in the current framework as suggested above. Such a review would do well to examine, and eventually implement, creative use of easements and dedication programs as part of a more comprehensive and innovative package. This would then foster administrative and ecological integrity, cost effectiveness, and wider partnerships. Perhaps most significantly, these techniques would further encourage the voluntary participation of private landowners in conserving the province's diverse – and increasingly stressed – natural heritage.

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Protecting Cultural Resources Through Forest Management Planning in Ontario

Luke Dalla Bona, Archaeological Research Scientist
Ontario Ministry of Natural Resources, 70 Foster Drive, Suite 400
Sault Ste. Marie, Ontario P6A 6V5

Abstract
The Ontario Ministry of Natural Resources (OMNR) identifies and protects known and presumed cultural resources through the forest management planning process. The problem that presents itself to cultural resource managers in northern Ontario, as well as in much of the rest of the Canadian boreal forest, is one where resources are known to exist, but their exact locations are unknown. So how does one manage a resource that we know exists but do not know where it is? In the late 1980s, archaeological predictive modelling was identified by the OMNR as a means of addressing this situation and, given available knowledge, providing the best statement on the likely existence of archaeological resources. The OMNR sponsored three years of research and development that led to a first generation predictive model. This was followed by three years of pilot projects which served to expand the applied base of the model from the original research and development area around Thunder Bay and also to develop various means by which existing Ontario government digital databases could be incorporated into the archaeological predictive modelling process. The OMNR is at a stage where it is ready to employ archaeological predictive models as a cultural resource management tool in all new forest management plans.

This paper will present the current progress of the Ontario Ministry of Natural Resources’ Cultural Heritage Inventory Protection Program (CHIPP) giving examples of archaeological predictive modeling efforts in northwestern and northeastern Ontario.

Background
In 1991, OMNR introduced the Timber Management Guidelines for the Protection of Cultural Heritage Resources. These guidelines outline the manner in which cultural heritage resources are protected through the forest management planning process. In addition to protecting known/verified archaeological sites, the guidelines explicitly state that areas determined to have a high potential for archaeological sites will also receive protection.

Forest Management Planning and Environmental Assessment in Ontario
In 1995, the Ontario government legislated the Forest Management Planning Manual that changed the manner in which forests were managed in the province. Among the many changes was the introduction of guidelines for the protection of numerous values that were not previously formally considered in planning. These included values such as woodpecker habitat, impact on tourism, and protection of cultural heritage values. While the protection of recorded archaeological sites has been a part of forest planning in Ontario for decades, it has never been formalized. It relies upon the personal interest of the plan author or the ability of
the regional provincial archaeologist to keep abreast of new forest management plans and schedules. It would be fair to say that in spite of honest efforts prior to 1995, cultural heritage protection was a low priority in forest management planning.

The new *Forest Management Planning Manual* identifies cultural resources as one of many values that must be considered and protected in the planning process. Seven steps are outlined in the guidelines to be followed when identifying and protecting cultural resources:

1. Prepare a thematic overview of the heritage for the management unit describing both the precontact and postcontact periods.
2. Assemble known site databases for all four categories of heritage resources: cultural landscapes, structural remains, archaeological remains and traditional-use sites.
3. Apply and document appropriate site potential models for the management unit or parts thereof. Assemble all relevant environmental and cultural data necessary to translate the models into maps showing areas of high potential for heritage resources.
4. Rank the importance of the various types of known resources.
5. Combine the maps of areas of high potential (Step 3) and of known sites (Step 2). The output of this step is the heritage component of the values map.
6. Identify where the areas selected for operations during the five year term of the Plan coincide with heritage resource components of the values map. These coincident areas are the areas of concern for cultural heritage.
7. Identify a specific prescription for each cultural heritage area of concern.

In summary, not only is the Ontario government committed to using archaeological predictive modelling to protect cultural heritage resources, it is required to!

**Research and Development**

In 1994, Lakehead University successfully completed predictive modelling research and development that was started in 1991, on behalf of OMNR. A steering committee that originally oversaw the development of the Cultural Heritage Guidelines provided advice and guidance on the research and development of the archaeological predictive modelling methodology.

Between July 1991 and March 1994, the OMNR and Lakehead University, through a memorandum of understanding, undertook research into the development of archaeological predictive models for use in forest management planning. This research took place through the Centre for Archaeological Resource Prediction (CARP), Department of Anthropology at Lakehead University. The project was geared to answer the question: “Can archaeological predictive modelling be done in northern Ontario?” In addition to the research and development work conducted, archaeological field surveys were carried out to collect baseline archaeological data and to provide initial indications of the predictive success of the archaeological predictive models.
The results of this work were presented to the OMNR in six volumes in March 1994 detailing a prototype predictive modelling methodology (Dalla Bona, 1994a; 1994b; 1994c; Hamilton and Larcombe, 1994; Larcombe, 1994; Hamilton, Dalla Bona and Larcombe, 1994). The Cultural Heritage Guidelines steering committee and OMNR accepted the report, acknowledging that this was simply the end of the beginning; more work needed to be done to take this research and development product and turn it into a tool for use in forest management planning across the province.

The OMNR has taken a staged approach to the introduction of this model as a management tool. Stage 1 involved small-scale testing to evaluate the effectiveness of the modelling methodology and the manner with which it fits into forest management planning schedules. Stage 2 involved applying the model to an entire forest management unit and evaluating the model in light of the new procedures required by the *Forest Management Planning Manual* (1996). Stage 3 involved applying the model to a large area – one or more management units – with a large heritage site database primarily for model verification and testing.

During the entire model staging process, field surveys were carried out to evaluate the strengths of the modelling assumptions; evaluate the relevance of the variables used; and conduct archaeological surveys in areas ‘not traditionally’ surveyed.

**Pilot Projects**

In April 1994, OMNR initiated pilot applications of the model. These pilot projects were undertaken in two management units: the Dog River/Matawin Management Unit and the Geraldton Management Unit (Figure 1). The purpose of the pilot project was to apply the prototype predictive model in a ‘real-world situation’ and to conduct field surveys in support of the model. Field surveys were carried out in both units with approximately 60% of survey time spent in areas of high archaeological potential and 40% of time spent in areas of less than high potential.

The primary goal of the pilot project was to confirm that predictive modelling is an appropriate means of identifying cultural heritage resource potential and that this information could be provided in a timely and effective manner to timber management planning teams. It also was expected that:

(a) The field surveys would provide information in determining the correspondence between areas of archaeological potential and verified precontact cultural resources;

(b) The geographical scope of the applicability of the model would be increased through field surveys further to the east of Thunder Bay District;

(c) The challenges of implementing precontact cultural heritage resource predictive modelling in the current timber management plan would be identified and discussed;

(d) The approximate costs of conducting precontact prehistoric cultural heritage resource predictive modelling as a component of the timber management planning process would be identified; and,
(e) The personnel necessary and the approximate time required to conduct prehistoric cultural heritage resource predictive modelling would be identified and discussed.

Figure 1: Location of Pilot Project Study Areas

The pilot study areas within the management units were selected according to one criterion. It was necessary that timber harvesting activities were to be scheduled within each area. This would provide an indication as to the overlap between areas identified as high potential for cultural resources, areas protected by existing forest management guidelines and areas scheduled for normal timber harvesting.

In the Burrows Lake study area (Geraldton Management Unit) approximately 50% of the land south and east of Burrows Lake was allocated for normal harvest and harvesting activities had been ongoing in adjacent areas for decades. In the Kashabowie study area (Dog River/Matawin Management Unit), the forest east of the lake was harvested as recently as 1992 and approximately 30% of the forest west of the lake was scheduled for harvest between 1995 and 2000. Both the Kashabowie Lake and Burrows Lake areas are in different management units and both are harvested by different companies. As a result, the shapes of the cuts, the amount of reserves and the density of the cuts vary. This proved to be an advantage to the pilot study because a greater range of variability in the interaction between forest management planning and archaeological predictive modelling could be examined and commented upon.
**Pilot Results**

The Kashabowie Lake application of the model proved to be successful. Two independent archaeological surveys identified eight archaeological sites in the study area. According to this model, high potential areas make up 10% of the landbase and located within this area are 75% of the known sites. Statistical tests support the observation that archaeological sites are associated with high potential areas in a manner that would not normally be expected by chance. If this predictive model had been used as a component of forest management planning, then there would have been 66 hectares of land in the study area that would have fallen within areas slated for forest harvest.

The Burrows Lake application of the predictive model also proved to be successful. Two independent archaeological surveys identified 37 archaeological sites in the study area. According to this model, high potential areas make up approximately 12.5% of the landbase and located within these areas are almost 90% of the known sites. Statistical tests support the observation that archaeological sites are associated with areas of high archaeological potential in a manner that would not normally be expected by chance. If this model had been used as part of the forest management planning process, then approximately 190 hectares of land, identified as high potential, would have fallen within areas slated for forest harvest.

Two of the questions asked quietly amongst those involved in the pilot projects were:

1. Are the cultural heritage guidelines necessary? and,
2. Does the application of the other guidelines already protect enough high potential area?

The pilot projects suggest that the application of the other forest management guidelines protects only 50% of those areas identified as high potential. The remaining 50% of high potential falls in areas that could be subject to forest management activities. Most importantly, the evaluation of the modelling results from the perspective of forest management planning activities suggests that incorporating high potential into planning does not introduce problems/issues not already encountered during planning.

**Management Unit Application**

The success of the pilot applications gave an indication that the model was reasonably successful and it would be appropriate to proceed to the next stage. The Caribou Management Unit (Figure 2) was the first management unit in Ontario to fully implement the new Forest Management Planning Manual. From a predictive modelling point of view, the Caribou Unit provide one end of the scale of challenges that face this program. There existed no digital data for the Caribou Unit with which to create a predictive model and there were no known archeological sites recorded to exist within the boundaries of the unit. These challenges necessitated that all archaeological predictive modelling work essentially be started anew.

In the end, a model was generated for 800,000 hectares of forest – for which all the digital data was created from "scratch". Archaeological surveys were initiated to: (a) obtain preliminary information about the types of artifacts/sites occurring in
the unit; and, (b) to gain information about the density/distribution of sites in areas "not normally surveyed." Approximately 15% of the landbase was identified as high archaeological potential. Twenty-three archaeological sites were discovered as a result of the surveys: 22 were found in areas of high potential and one was found in an area of medium potential. Although the surveys did not strictly follow the rules of sampling procedures, they do provide additional evidence that sites are being found in areas of high archaeological potential to a greater degree than in areas of less than high potential.

The Distribution of Archeological Potential

Conventional perceptions of the distribution of archaeological sites include the notion that cultural heritage can be protected by simply reserving areas around larger water bodies. Indeed many archaeological predictive models reflect this notion which may be termed the ‘hi-lighter effect’ where doughnuts of high potential may be found around all the major lakes in a given area. This may not be the most accurate reflection of where people conducted activities throughout the past and correspondingly where the evidence for these activities may be found – i.e., archaeological sites.

The methodology used in OMNR’s predictive modelling efforts is somewhat more representative of the notion that different parts of the landscape may have been attractive in the past – and not all of those parts are located next to a sandy beach on a lake. For example, in the west central part of the Caribou Management Unit, the manner in which archaeological potential is distributed is highly influenced by a glacial lake beach that circles through the centre of this
area. Across the rest of the area, potential is not evenly distributed with the bulk of “low potential” being found in northwest.

Just south of a major east/west river system near the south central part of the Caribou Management Unit, an area has been harvested during the past five years and bush roads are evident in aerial photographs. Archaeological potential is highly influenced by a series of eskers which dominate this area. These eskers trend northeast to southwest and according to archeological wisdom, eskers are highly significant features because: 1) they served as easily accessible, well drained travel corridors for both people and animals; and, 2) they serve as possible sources of raw material for stone tool manufacture. It is important to note, that although there is a major waterway flowing across the northern part of this area, the bulk of high potential is located well away from the water – in fact, the bulk of high potential is located within areas already having undergone forest harvesting.

Some 50 km to the east in the Fairchild Lake area, archaeological potential is distributed in a uniform manner across the area. This is due to the occurrence of uniform post-glacial geology. Still, there is a considerable block of high potential occurring behind the point of land, south of Fairchild Lake.

These three examples show that high archaeological potential is not found in similar places across the Caribou Management Unit. Indeed, in modelling reality, the results show that certain localized features influence the determination of potential in different ways in different parts of the management unit.

Full Application

The final step in staging in the use of this predictive modelling methodology involved applying it to an area where there was a rich cultural heritage database with which to gauge the success of the model. A most appropriate area in northern Ontario is Temagami. As a result of almost a decade of intensive land use planning and inventory collection, the Temagami region boasts a comprehensive cultural heritage database that includes traditional sites, spiritual sites, and pre-/post-contact archaeological sites. The Temagami region is also blessed with an abundance of digital data making the application of a predictive model a relatively straightforward process. As a result, the model was applied to two management units, an area of more than 1.75 million hectares.

The resulting model identified 18.2% of the landbase as high potential, 73.8% of the landbase as medium potential and 8% of the landbase as low potential. The model can be considered successful due to the number of known sites that are captured by areas of high potential. In this application, almost 84% of the known sites are accounted for in the high potential areas, which themselves only account for 18.2% of the landbase (Table 1).

Again, the introduction of the model into the forest management planning process poses no problems from a procedural or technical point of view. Indeed, the map of potential is presented as a straight yes/no map; either there is potential or there is not. In this respect there can be no confusion about whether a locality is considered to require protection under the guidelines.
Difficulties do arise however when every single location identified as high potential is equated with the existence of an archaeological site. High potential areas are an expression of probability – each mapped grid cell of high archaeological potential does not equate to an archaeological site. Rather, the map should be interpreted such that the likelihood of encountering an archaeological site is greater in areas identified as high potential than in areas not identified as high potential.

<table>
<thead>
<tr>
<th>Category</th>
<th>% of Landbase</th>
<th>% Known Sites (# of Sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Potential</td>
<td>18.2%</td>
<td>83.8% (186/222)</td>
</tr>
<tr>
<td>Medium Potential</td>
<td>73.8%</td>
<td>16.2% (36/222)</td>
</tr>
<tr>
<td>Low Potential</td>
<td>8.0%</td>
<td>0% (0/222)</td>
</tr>
</tbody>
</table>

Table 1: Results of predictive model application in the Temagami Management Unit

Summary of Model Development
The research and development of a predictive modelling methodology applicable to the boreal forest of Ontario resulted in an approach that the Ontario Ministry of Natural Resources could use to manage a resource that was known to exist – but the exact location was unknown. Over a four year period, a series of test applications slowly introduced the model into the forest management planning process. This phased introduction enabled the OMNR to gauge: the suitability of the model for the task; the requirements of the modelling methodology; and the suitability of existing data sources for archaeological predictive modelling. Also, this phased approach enabled further testing of the modelling methodology to take place in a wide variety of locations across the province and provided OMNR with a measure of confidence regarding the model’s predictive capabilities and success.

In addition to the above, the staged approach to the modelling identified some of the paths that OMNR can take in the full implementation of this model across the province in every new forest management plan that is written. Land use planning approaches, methods of writing prescriptions, and means of dealing with unverified resources are challenges that still confront this process and are being addressed at the present time.

Current Challenges/Future Directions
As the OMNR expands its application of this predictive modelling methodology, mistakes will be made. Heritage resources may be discovered in areas where they were not expected and sites may be accidentally impacted. If we learn from these mistakes, and evaluate why we are finding things outside our expectations, then our ability to predict these occurrences in the future will improve. This necessitates an excellent feedback loop where information gained from the application of a model in one area is fed back into the system to ensure the best possible application of the model in other areas.

While the model is currently a broad spectrum model, not specifically dealing with particular time periods or particular site types, this may evolve to be the case in the future as we gain more information about the density and distribution of sites in northern Ontario.
It will be a challenge to work with foresters and educate the profession and the industry to the various aspects of cultural heritage data. Concurrently, it will be a challenge to educate the cultural heritage community that various land uses, including forestry can be allowed to continue while ensuring the protection of cultural resources.

References


Use of Estimated “Pristine” Species-Area Relations as Null Models For Evaluating Size and Integrity Standards for Protected Areas: An Update

Thomas D. Nudds, D. Brent Gurd 1, Christopher P. Henschel and Christopher G. McLaughlin.
Department of Zoology, University of Guelph
Guelph, ON N1G 2W1
1Present address: Department of Biological Sciences
Simon Fraser University, Burnaby, BC, V5A 1S6

Abstract

Sizes and locations of protected areas often have been based on convenience and/or compromise with competing land-uses. Increasingly, protected area networks are required to conserve species diversity efficiently and to serve as ecological benchmarks against which to judge effects of anthropic disturbances. Yet, it is difficult to judge how large an area is large enough to meet this objective. We improved on earlier analyses that used species-area relations as null models – to control for the effect of habitat size on species diversity – for estimating minimum reserve areas (MRAs) for interior forest songbirds in woodlots and mammals in provincial and national parks. MRA is defined as the size of a protected area above which species richness is not distinguishable from that in non-fragmented habitat of the same size. Early null models violated statistical assumptions of independence because they were constructed by sequentially sampling species richness in nested plots of increasing area. Further, the forms of the models were assumed to be the same over all sizes of area, and were thus used to extrapolate expected species richness for areas much smaller than those used to generate the model. New null models for songbirds had steeper slopes and lower intercepts than previous models; for mammals, the reverse was true. Thus, earlier tests for faunal collapse in habitat fragments for birds were liberal and the estimate of MRA was conservative; the reverse was true for mammals. Nevertheless, the estimated MRAs were robust, if only due to the wide confidence intervals on the new estimates. For forest interior birds, the MRA was 55 hectares (95% CI: 22-138). This was 22% smaller than the 70 hectares estimated previously. Earlier analyses tended to overestimate the number of species locally extinct in fragments smaller than this. For mammals, estimated MRA was 505,800 hectares (95% CI: 272,500-1,190,400). Earlier analyses tended to underestimate the number of mammal species locally extinct in parks below this threshold.

Introduction

Sizes and locations of protected areas, like provincial and national parks, often have been based on convenience and/or compromise with competing land-uses (Pressey et al., 1993). Sometimes parks were designated “by default”, such as those with high topographic relief like Riding Mountain National Park and Turtle Mountain, Moose Mountain and Duck Mountain Provincial Parks and those unsuitable for agriculture in the prairies like Cypress Hills Provincial Park. These parks appear nevertheless to conserve intact, indigenous mammal faunas (Glenn and Nudds 1989). Still other parks, especially in heavily-settled regions like
southern Ontario (Glenn and Nudds 1989), and perhaps in other areas (Newmark, 1987, but see Van Riper and Quinn 1988), appear to have lost significant fractions of their initial mammal fauna in direct proportion to their sizes. The smaller the park, the greater the loss of species. Though the application of island biogeographic theory (MacArthur and Wilson, 1963) to reserve design has, in some respects, been controversial (e.g., Margules et al., 1982; Zimmerman and Bierregaard, 1986), this latter observation is entirely consistent with its predictions (Nudds, 1993).

Increasingly, protected area networks are required to conserve species diversity efficiently (Leader-Williams et al., 1990; Noss and Cooperrider, 1994; Pressey et al., 1993) and to serve as ecological baselines — i.e., intact and functioning natural areas — against which to gauge the effects of anthropocentric disturbance elsewhere (Nudds, 1998; Sinclair, 1983; Arcese and Sinclair, 1997). Yet, it is difficult to judge the adequacy of existing and proposed protected areas with respect to fulfilling these roles. This is because, though much research has gone into questions about representation in reserve systems, considerably less has addressed the thornier and perhaps more important issue of how big a protected area must be to enable what is represented to persist.

The research that has addressed this issue often comprises estimates of minimum dynamic, or minimum critical, areas based on population viability projections, or minimum viable population estimates (e.g., Wilcox, 1984; Nunney and Campbell, 1993) for individual rare, endangered, or 'flagship' species. If that single species happens also to be an 'umbrella species' — i.e., one whose viability in an area is considered to indicate that many others will also persist (Hager, 1997) — then an area deemed large enough to conserve it might be large enough to consider intact. This approach is controversial (Hager, 1997; Simberloff, 1997), however. For example, in Algonquin Provincial Park, a putative 'umbrella species' — timber wolves (*Canis lupus*) — and their associated mammal fauna appear to do quite well (Glenn and Nudds, 1989). But, Algonquin was once extremely altered by anthropic disturbance and is still exploited by forestry that might nevertheless have local-scale effects on other flora and fauna.

A different approach, not without its own controversial aspects, involves instead estimating the minimum size of a protected area above which any effects of area on the number of species in it are not detectable relative to an intact area the same size in a non-fragmented landscape (Nudds, 1993). This is referred to as the minimum reserve area (MRA) in order to distinguish it from other kinds of estimates of minimum areas. Estimating this area requires an appropriate 'null model' for the effect of area reduction and/or isolation of a protected area on the number of species in it — i.e., faunal collapse. For this purpose, we have used the species-area relation, referred to by Schoener (1976) as probably the closest thing to a 'law' in ecology.

The choice of an appropriate species-area relation to use as a standard for comparison is tricky. The parameters of such relations (i.e., the slopes and intercepts of plots of numbers of species against area) vary considerably by taxa, with scale (i.e., over areas from as small as 0.001 m$^2$ to whole continents), and geography (McLaughlin, 1997; McLaughlin and Nudds, in review). However, given an appropriate scale and taxon, species-area relations are robust null models for testing for faunal collapse (Glenn and Nudds, 1989; Schmiegelow,
Until recently, we were familiar with just three systems where this approach had been applied: plants at very small spatial scales (Cowling and Bond, 1991), mammals in Canadian provincial and national parks (Glenn and Nudds, 1989) and songbirds in woodlots in southern Ontario (Schmiegelow, 1990).

Each of these last two studies made novel use of large, existing databases to try to test rigorously for faunal collapse in natural habitat remnants. Nudds (1993) went further to infer from these studies the MRAs for each of the taxa. However, several aspects of these attempts required improvement before we could be confident that estimates of MRA were robust. Here we report on and synthesize recent studies (Gurd and Nudds, in review; Gurd et al., in review; Henschel 1998) in this regard.

Mammals in Parks

Glenn and Nudds (1989) constructed ‘null’ species-area curves, for the effects of isolation and area reduction on the numbers of species of mammals in provincial and national parks, using historical maps of species’ ranges from the period prior to widespread landscape alteration by European settlement. However, species’ distributions from these maps were removed by using a very coarse system of 100 x 100 km grid squares. Thus, the smallest area in which mammal species richness was estimated was 10,000 km² – much larger than many of the parks for which they had current estimates of numbers of mammal species. Glenn and Nudds assumed that the form of the relation was the same over all areas and extrapolated their null curve to the lower range of park sizes in order to compare the slopes and intercepts of their null model with that from the parks (Figure 1).

Further, the null curve was constructed by sampling sequentially larger aggregations of 1,000 km² plots, but mammal species counted in sequentially larger areas were added to totals from smaller areas nested within the larger areas. This presented two potential problems. First, the procedure violated assumptions of statistical independence and what effect this had on the estimates of slopes and intercepts of the null models was unknown. Second, the procedure resulted in inflated error degrees of freedom and biased the confidence intervals on the null model to being too narrow. Finally, Nudds (1993) did nothing more elaborate than to ‘eyeball’, very conservatively, the MRA as the intersection of the lower 95% confidence interval on the null model with the regression line for the parks.

Gurd and Nudds (in review) and Gurd et al. (in review) instead used finer grid resolution (10 x 10 km) and non-nested sampling of the historical range maps to avoid the problems of extrapolation and statistical non-independence. Further, they estimated the point of intersection of the regressions, and the confidence interval around that point, by more sophisticated statistical methods. Their analyses resulted in qualitatively similar results to those of Glenn and Nudds (1989) with respect to the hypothesis that parks in the Alleghanian-Illinoian mammal province had lost mammal species due to isolation and reductions in area.
Figure 1. (Upper). The null species-area relation for mammals in the Alleghanian-Illinoian mammal province, estimated by sampling historical geographical range data (smallest sampling unit = 1,000 km$^2$) and extrapolated to the sizes of provincial and national parks, with the species-area relation for parks. The smallest park is Point Pelee National Park and the largest is Algonquin provincial Park. The park curve appears to intersect the lower 95% confidence limit on the null model at about 100,000 ha. From Nudds (1993) after Glenn and Nudds (1989). (Lower) The null species-area relation for mammals estimated by sampling plots over the same size range as the parks (smallest sampling unit = 100 km$^2$), with the species-area relation for parks. The curves intersect at 505,800 ha (95% CI: 272,500-1,190,400). From Gurd et al. (in review). Redrawn from Gurd and Nudds (in review).

However, the new null model was based on fewer, but independent, data points, and consequently had wider confidence intervals (Figure 1). Further, the slope was less steep and the intercept larger, on the null model, than that

Songbirds in Forest Fragments
Schmiegelow’s (1990, 1992) approach to test for faunal collapse among songbirds in forest fragments in southwestern Ontario was analogous to that of Glenn and Nudds’ (1989) for testing for faunal collapse among mammals in parks (Figure 2). Further, however, she had to use relatively recent bird atlas data, collected from an already fragmented landscape. She corrected for the effect of remaining forested area in the grid squares she sampled, but had to assume – reasonably – that, for the songbirds of interest, species presence/absence had not changed since before widespread European settlement in Ontario – though abundances of individual species quite likely had.

Henschel (1998) instead studied in a landscape in eastern Ontario where he could find forest fragments and large contiguous forest blocks in close geographic proximity. He constructed a null species-area relation with data from areas of various sizes within the contiguous forest, assuring also statistical independence and thereby avoiding extrapolation, and compared it to a similar curve for adjacent forest fragments (Figure 2). As in the case for mammals, the results of the two studies were qualitatively similar; in particular both found evidence consistent with the hypothesis that songbirds undergo faunal collapse in small forest fragments. However, the slope of Henschel’s null model was less steep and the intercept lower than Schmiegelow’s.

Conclusion
The potential severity of the shortcomings of Glenn and Nudds (1989) and Schmiegelow (1990) notwithstanding, these studies were still among the first to attempt to investigate faunal collapse in a rigorous fashion by making reference to a ‘control’ state, thereby also allowing for inferences about MRAs. Many early studies asserted that faunal collapse happened in remnant patches of natural habitat, but they were compromised by the absence of appropriate controls for the effect of area on floral and faunal diversity in the absence of fragmentation. The mere observation that fewer species reside in smaller patches of remnant habitat than in larger patches is not necessarily indicative of species loss from the smaller patches as a result of area reduction and/or isolation; small patches are expected to have fewer species anyway (Nudds, 1993). To test adequately for an effect of fragmentation on species diversity in remnant patches requires knowledge of the shape of the species-area relation that would be obtained in a non-fragmented landscape. For landscapes already fragmented, this isn’t easy. Neither could many early studies – because of the absence of controls for the effect of area – be used to infer the MRA necessary to conserve natural species diversity in protected areas; in the absence of one of the species-area relations, it is not possible to estimate their intersection.
Still, inability to estimate well the species-area relation to which habitat fragments could be compared created potential for Type I or II statistical errors with respect to the hypothesis that protected areas, or other natural habitat remnants, might nevertheless undergo faunal collapse (Schmiegelow, 1992). These errors, in
turn, have important ecological and economic implications for management (Schmiegelow, 1992). Schmiegelow’s test for faunal collapse of songbirds in remnant patches of forest in southwestern Ontario was too liberal (i.e., biased to Type I error). Use of Henschel’s (1998) null model resulted in a more conservative test of the hypothesis that songbirds experienced faunal collapse in eastern Ontario woodlots. That is, it was more difficult for Henschel to conclude, for a given small woodlot, that it contained fewer species than it would have if it were part of a contiguous forest landscape, than it was for Schmiegelow. On the other hand, use of Henschel’s model resulted in a slightly more liberal estimate of the MRA (55 hectares) for forest interior birds. That is, Henschel estimated that a forest fragment could be slightly smaller than that inferred (70 hectares) by Nudds (1993) and still not contain fewer species than it would contain if it was part of a large, contiguous forest.

The opposite pattern obtained from the re-analysis of Glenn and Nudds’ (1989) test for faunal collapse among mammals in parks. Gurd and Nudds (in review) concluded that Glenn and Nudds’ test was biased to Type II error (too conservative) with respect to the hypothesis that small parks had undergone faunal collapse. That is, Glenn and Nudds had underestimated the extent to which mammals had gone locally extinct in small parks. Further, Nudds (1993) used a different, and much too liberal, definition of MRA than that used in subsequent analyses. He estimated the point at which the species-area relation for parks intersected the lower 95% CI on the regression for the null species-area relation to be approximately 100,000 hectares. Gurd et al. (in review) estimated the same point more rigorously at 169,000 hectares (95% CI: 43,000 - 745,000). Thus, even by that too-liberal standard, the new analysis indicates that a park large enough to contain the same number of mammal species that it would have had in a large, contiguous natural landscape would have to be larger than 100,000 hectares. If the intersection of the two regressions is instead used to estimate the MRA for mammals, then it is about five times larger, at 505,800 hectares (95% CI: 272,550 - 1,940,000) than that previously reported.

Despite re-analyses, MRAs for forest songbirds and mammals appear robust in the neighbourhoods of the old estimates, if only because the confidence intervals on the new estimates of MRAs are so wide as to include the old estimates. Nudds’ (1993) earlier estimate of MRA for mammals converged on others in the literature derived from consideration of minimally viable populations of large carnivores (Schonewald-Cox et al., 1988 [108,000 hectares], Belovsky, 1987 [100,000 hectares]), seeming to lend some legitimacy to it. However, those analyses appear also to seriously underestimate the minimum area to conserve entire mammal faunas, whether or not they would be sufficient to conserve populations of individual species of mammal.

We reached the same general conclusions about the relative sizes of MRAs for forest birds and for mammals, namely, that the MRA for mammals was several orders of magnitude greater than for songbirds. This difference is largely attributable to differences in dispersal abilities between the taxa; birds are better able to overcome the effects of isolation and distance among protected areas, so species loss from small protected areas is better offset by colonization than it is for mammals (Schmiegelow and Nudds, 1987). This has led to the notion that mammals should be the target taxon for estimating minimum sizes for reserves, since protected areas large enough to contain an intact mammal fauna should
also be large enough to contain intact faunas of everything else. Plants, by this score, would be a very poor target taxon for planning reserve designs. They typically have very shallow species-area relations (e.g., Nudds et al., 1996). A protected area of minimum size to include all plant species is unlikely to include viable populations of many other kinds of organisms, though protected area networks based on plants may include a large fraction of species of other taxa (Hager, 1997; Hager and Nudds, in review).

In the five years since Nudds (1993) first reported on the numbers of Ontario’s parks, in the regions corresponding to the Alleghanian-Illinoian mammal province, that met the MRAs for birds or mammals, a number of parks and conservation reserves have been added. 26 have been added (Ontario Ministry of Natural Resources, 1997), but only an existing park that was enlarged (Wabakimi Provincial Park, 892,061 hectares) exceeded the MRA for mammals. It is clear that there is virtually no opportunity to establish reserves that would meet the MRA for mammals in the south of the province. There, however, ecologically-justified reserve designs could still be based on MRAs for other flora or fauna, such as birds, with full acknowledgement that they could not be designed to conserve all of what was once naturally present.

However, in the Canadian shield region of Ontario, there is ample opportunity – indeed, there is a need in order to sustain a renewable resource industry there (Nudds et al., 1998) – to establish reserves large enough to satisfy the MRA for mammals. At this time, it is our best guess that this coarse-filter approach might result in reserves large enough to function as intact, ecological baseline controls against which to measure success at managing for sustained ecosystem function in the intervening matrix.

References


Snow Geese in Polar Bear Provincial Park: Implications of a Trophic Cascade

K. Abraham, Wildlife and Natural Heritage Science Section, Ontario Ministry of Natural Resources, 300 Water St., Peterborough, ON K9J 8M5
L. Jefferies, Department of Botany, University of Toronto, Toronto, ON M5S 3B2
K. Ross, Canadian Wildlife Service, Ontario Region, 49 Camelot Dr., Nepean, ON K1A 0H3
O. Leafloor, Ontario Ministry of Natural Resources, 2 Third Avenue, Cochrane, ON P0L 1C0

Abstract
The snow goose population in Polar Bear Provincial Park has increased exponentially since the park’s establishment. Over 400,000 adults were present in June 1996 and 1997 at the major nesting colony at Cape Henrietta Maria (CHM). This colony currently occupies over 400 km² and nearly 100 km of the coastline during nesting and 290 km during brood rearing. A second colony consisting of about 4600 adults in June 1997 has established itself at the park’s western end near the Shell Brook. Another area at the park’s southern end along several small rivers flowing into James Bay is used intermittently for nesting (7000 adults in June 1997). From late June to mid-August, 1993 - 1997, approximately 65% of the park’s Hudson Bay and James Bay coastline was occupied by snow geese during the brood rearing period. Based on these colony counts, over 1,000,000 geese including non-breeders and young of the year would have been present in the park in early August. Cumulative effects of severe grazing and grubbing in salt marsh plant communities were abundantly evident, and the geese increasingly have used the vegetation of fresh water sedge fens and tundra as a food source. Snow goose die-offs indicative of starvation or disease were recorded in 1996 and 1997. Although no recent intensive ground studies of fauna have been made at CHM, Shell Brook, or northwest James Bay, long-term research at another expanding snow goose colony in the Hudson Bay Lowland (La Perouse Bay, Manitoba) indicated local declines in several species of shorebirds, invertebrates and vascular plants. The same is likely to have occurred at the long occupied Ontario colonies. Of significance is the fact that this snow goose population growth is driven by off-site factors, especially the use by the birds of agricultural foods from September to April during migration through prairie Canada and the U.S. and on the wintering grounds in the southern U.S. The move to agricultural foods and expansion of winter and migration range began just after World War II and accelerated in the 1960s. This has permitted increasingly higher survival of adults outside the nesting period. The cumulative and continuing habitat damage has significant and immediate implications for other plant and animal species and long-term implications for the survival of some biological communities of this wilderness park.

Introduction
The lesser snow goose (Anser caerulescens caerulescens) population in the mid-continent region of North America has reached a record high number after a
sustained increase averaging 5% per year since the late 1960s (Abraham et al., 1996). The unprecedented increase has resulted in a substantial geographic expansion of most extant nesting colonies; the establishment and rapid growth of several new nesting colonies (Kerbes, 1994; Abraham and Jefferies, 1997); and, a terrestrial trophic cascade on nesting and spring staging (migration) areas in southern Hudson Bay (Jefferies, 1988; Kerbes et al., 1990). Trophic cascade, here, means the runaway consumption by a herbivore – the snow goose – of the primary plant species in the salt marsh community (Puccinellia phryganodes, Carex subspathacea). This results in a positive feedback system with subsequent degradation of soils (salinity, microbial activity), deterioration of water quality and quantity (higher evaporation rates, eutrophication) and loss of other ecosystem components (Srivastava and Jefferies, 1996).

Over-consumption has led to loss of vegetation in other habitats including fresh-water marshes. When these are heavily grazed, or suffer from selective ‘shoot-pulling’ of grasses and sedges, a moss carpet or other simplified plant community with very different functional characteristics develops. The consequences to geese are many, both to the individual and to the colony. Consider the example of a lesser snow goose nesting colony at McConnell River, West Hudson Bay, NWT, which was established in about 1940 (Kerbes, 1975). After growing to a peak of over 500,000 breeding individuals during the late 1970s and 1980s, the colony declined to about 150,000 individuals by 1997. This decline was accompanied by a contracted nesting area and a major northward shift of the occupied area (MacInnes and Kerbes, 1987; Abraham and Jefferies, 1997; Kerbes, unpublished data). During this period, serious goose mortality was documented (Gomis et al., 1996).

More importantly, plant communities along West Hudson Bay have been destroyed (Kerbes et al., 1990), exposing extensive peat lands devoid, or nearly devoid, of vegetation in an area about 10 km wide and 60 km long (Andrew Didiuk, pers. comm, 1997). This area is unlikely to recover quickly. Recovery time will be in the order of decades. New plant communities are unlikely to resemble the original communities. Already the plant communities found along a succession gradient from inter-tidal mud to inland fresh-water sedge assemblages is missing a seral stage: the salt-marsh plant community has been lost as a result of the foraging activities of geese (Kerbes et al., 1990; Jefferies, unpublished data).

In this paper, we describe the history and current status of snow geese nesting in Polar Bear Provincial Park, a wilderness park in the Hudson Bay Lowland of Ontario, and outline the implications of the trophic cascade to the park’s ecological values.

Snow Geese in Polar Bear Provincial Park

Polar Bear Provincial Park (PBPP) was established in 1969. It contains substantial and representative areas of the Hudson Bay Lowland physiographic region, including coastal salt marshes, beach ridges and sand dunes, eskers, tundra heath and fresh-water sedge and shrub fens. The importance of the Hudson Bay Lowland for geese has long been recognized (Thomas and Prevett, 1982) and the park has been designated a Ramsar Wetland of International Importance. The park includes a maritime-tundra biome which has unique
ecological characteristics for Ontario, associated with the presence of an arctic fauna and flora, that occur near their southern limit of distribution in North America.

**Nesting**

At the time of establishment, the park contained a significant nesting colony of lesser snow geese of about 20,000 nesting pairs (Hanson et al., 1972) just west of Cape Henrietta Maria (CHM). By 1973, the colony reached an estimated 25,000 – 30,000 nesting pairs, and the area occupied by nesting birds was 69.1 km$^2$ (Kerbes, 1975). By 1979, it contained about 60,000 nesting pairs and occupied 80 km$^2$ (Anghern, 1979). The colony’s size has not been tracked annually, but from 1994 to 1997 we undertook new surveys of the geographic size and number of nesting pairs. Our results show that the colony occupied from 350 – 450 km$^2$ and contained a minimum of 160,000 – 178,500 nesting pairs. A second colony became established in the early 1980s near Shell Brook at the western end of the park. In 1997, it contained approximately 2,300 nesting pairs. A third area in the park along the northwest James Bay coast, that incorporates several small river mouths from Nowashe Creek to Lakitusaki River, has had intermittent nesting for many years (Hanson et al., 1972; OMNR, unpublished data). In 1994, and again in 1997, several hundred to a few thousand pairs (up to 3750) nested in this area.

**Brood Rearing**

Even more startling has been the area occupied by broods for the 6 – 8 weeks after hatch and before goslings from the colony reached their flight stage. Although no exact numbers are given, Hanson et al. (1972) indicated that the 1957 brood range was concentrated in three relatively small areas, the total being less than 20 linear km of coastline. Other isolated broods were also recorded in the park between 1957 and 1970, especially near river mouths along the James Bay coast, but in total numbered only a few hundred birds (Hanson et al., 1972). During surveys in the CHM area from 1993 – 1997, we found broods along the coast from Wachi Creek on Hudson Bay (55° 14’ N, 85° 34’ W) to Nowashe Creek on James Bay (54° 06’ N, 82° 18’ W) – a distance of 290 km (a 15 fold increase since 1957). In the Shell Brook area, broods were spread from Shagamu River (55° 52’ N, 86° 45’ W) to Partridge Island, Severn River (56° 03’ N, 87° 30’ W) – a distance of 55 km.

**Migration**

Surveys of spring migration have been sporadic and infrequent. Surveys in 1972 and 1973 (Curtis, 1973; 1976) and later research on the bioenergetics and diets of geese (Wypkema and Ankney, 1979; Prevett et al., 1985) indicated that the northwest James Bay coast, north of Ekwan Point, had very high numbers of snow geese during the spring migration. From 1994 to 1997, our surveys throughout May documented hundreds of thousands of snow geese, small Canada geese and brant concentrated in a 125 km strip of coastal marshes between Ekwan Point and Lake River, 15% of which is in the park. In addition to birds that nest at CHM, some of the birds are destined for Baffin Island, Northwest Territories (Prevett et al., 1983). Surveys of waterfowl during fall migration along the Hudson Bay and James Bay coasts (OMNR, unpublished data, 1971 – 1986) have revealed areas of varying importance to snow geese, Canada geese, and tundra swans. In the case of snow geese, the relative value
as a staging area of PBPP in fall is lower than any other segment of the James Bay and Hudson Bay coasts of Ontario as a staging area. It has the lowest density of geese and the lowest proportion of young-of-the-year in flocks that stop over. We speculate that the situation is explained by the previously mentioned high use by spring staging birds, by the breeding birds (i.e., up to 84 million goose-days of use) and by populations of moulting Canada geese – all activities which have resulted in poor foraging conditions.

**Habitat use and foraging resources**

Above ground biomass is used as an index of plant production in arctic salt marshes (Cargill and Jefferies, 1984). We sampled the above-ground biomass in salt-marsh plant communities in 1993, 1994 and 1995 along the Hudson Bay and James Bay coasts from just north of Moosonee to the Manitoba-Northwest Territories border. The values from PBPP from late June and mid-July were among the lowest we found (ranging from six to 88, with most below 35 dry weight per m$^2$) (Jefferies and Abraham, unpublished data). Values below 35 gm per m$^2$ of dry above-ground biomass indicated high herbivore pressure (Hik et al., 1992) and represent a threshold that is likely to lead to adverse changes in community structure and composition. Values below 35 gm per m$^2$ also indicate damage to the productive capacity of the salt-marsh graminoid community (Jefferies, unpublished data).

Other quantitative measures of plant community condition have not yet been conducted in PBPP, but visual reconnaissance during our biomass sampling and during goose banding operations have confirmed the presence of several other features associated with the trophic cascade as documented at La Perouse Bay. These include a high percentage of bare ground which results from grubbing, algal mats on the soil surface, moss carpets, widespread occurrence of some indicator plant species such as *Senecio congestus*, (weedy species) and a shortage of fresh water (see below).

**Implications of the Trophic Cascade**

Several direct consequences arise from the high snow goose population. The most obvious is the greatly altered coastal plant communities from the period when the park was first inventoried and identified for protection. While we are not aware of the loss of any plant species from the park because no intensive surveys have been carried out, species composition has undoubtedly shifted, as is the case in other areas along the Hudson Bay coast. In addition, certain successional stages, such as the salt-marsh communities, have been lost or are badly damaged. As long as the populations of geese remain high, little recovery of any kind is likely. In addition, because the coastal salt marshes have an increasingly reduced capacity to support broods due to the loss of vegetation (see below), the geese are moving long distances, many tens of kilometres, in search of forage after hatch. They are making increasing use of more inland sedge meadow communities. Unlike salt-marsh plants, many of the dominant fresh-water plants do not have the growth characteristics such as the regrowth of leaves that allow them to compensate when intense grazing occurs. As in other areas, such as at McConnell River (Kerbes et al., 1990; Didiuk, unpublished data) and Queen Maud Gulf (Didiuk and Ferguson, 1998), these inland communities may suffer rapid and severe damage. A drop in water level in ponds devoid of vegetation in summer is accompanied by a rapid drying-out of the
exposed peaty sediment surface due to removal of the vegetation by geese. Wind erosion of this dried material may lead to the exposure of the underlying mineral layer, and where this occurs there is little likelihood of the re-establishment of aquatic vegetation. In intertidal areas, vegetation removal by geese and high evaporation leads to increasing soil salinity, and at some sites the soils become hypersaline (Srivastava and Jefferies, 1996; Abraham and Jefferies, 1997). Where geese in intertidal vernal ponds deposit large quantities of fecal material, extensive algal mats develop. When these ponds begin to dry out in the summer, dead algal mats decay. This results in anoxic conditions and loss of graminoid vegetation. Aquatic and terrestrial soil invertebrates, which are the primary foods for many shorebirds and passerines that nest and migrate throughout the park, can decrease in density and species diversity (Milakovic, unpublished data). Although no recent intensive ground studies of fauna have been made at CHM, Shell Brook, or northwest James Bay, long-term research studies at another expanding snow goose colony in the Hudson Bay Lowland (La Perouse Bay, Manitoba) indicate local declines in several species of shorebirds (Rockwell et al., 1997).

The geese suffer from the degradation of these coastal ecosystems. Declines in adult and gosling body size and high gosling mortality near the end of brood rearing have been implicated in low recruitment at La Perouse Bay (Cooch et al., 1991a, 1991b, 1993). On August 13, 1996, several hundred dead snow geese were discovered in a limited area near Mukatahship River, also known as Black Duck River, in the heart of the CHM colony (Hudson Bay Project, unpublished data). We examined about 50 carcasses, which were fairly uniformly distributed at about 20-30 m apart, rather than clustered. Gulls and foxes had scavenged some carcasses but many were intact. Both adults and goslings were found. Wing feather development showed adults to be in late stages of moult and replacement, thus the deaths had occurred just before that date. The month of July, and the two weeks prior to our observation were extremely hot and dry, with temperatures consistently over 30°C. We noted the virtual absence of fresh surface water over the entire area, with the exception of a few small pools in the river bed. This drying of the salt marsh is an indirect consequence of the degradation of the plant communities, as higher evaporation rates occur where vegetation has been stripped or grazed to the surface. We speculate that the deaths resulted from over-heating and dehydration in combination with other factors such as starvation and renal coccidiosis. Bruce Batt (pers. comm.) returned to this location in early August 1997 and recorded another high mortality event, but reported that only dead goslings were found. Many appeared to have died from starvation.

Research Recommendations for Polar Bear Provincial Park

Recommendations for snow goose population reduction have been made in a report of the Arctic Goose Joint Venture (AGJV) (Batt, 1997) and endorsed by several groups: National Audubon Society; Canadian Snow Goose Coordinating Committee; and International Stakeholder’s Committee (International Association of Fish and Wildlife Agencies). The recommendations emphasize broadly based and multi-agency, multi-partner involvement. They do not emphasize individual colony reductions, because nesting birds alone may not irrevocably alter the ecosystem. Instead, it is recognized that the additive pressure of destructive
foraging (grubbing) in spring and perhaps late summer by migrating and staging birds pushes the system beyond a threshold of sustainability.

As part of the monitoring of the success of any management actions, an evaluation and monitoring program is being established by the AGJV. There are three information priorities concerning the health and integrity of these coastal ecosystems in Polar Bear Provincial Park that could contribute directly to the overall evaluation and monitoring program. The first involves an investigation of the current plant and animal species composition and abundance in the park. The park’s establishment phase included several life science investigations of birds and plants. The records of these studies exist in internal reports and files that have been retained at several Ontario Ministry of Natural Resources offices. Subsequent faunal surveys – primarily of birds – occurred in 1981 - 1985 (Cadman et al., 1987) and 1990 - 1991 (Wilson and McRae, 1993).

We recommend that a trends analysis of these data be attempted, and that a new investigation be implemented, one designed to capitalize on the available historic information in a context of comparing the most damaged to the least damaged –hopefully even undamaged – areas within the park. The focus would be on birds, but where feasible, invertebrates would be included. The design of such biodiversity studies has been suggested as part of the AGJV monitoring initiative.

The second priority involves intensive surveys of plant communities along the coastline of the park, systematically encompassing important snow goose migration and nesting areas, and non-snow goose areas. Included are studies of the species composition as well as the physical conditions within the coastal zone plant assemblages, productivity estimates, use and impact of the geese by and on different plant assemblages, and soil and water conditions. In part, these studies will provide a current data baseline, which is sorely needed for the park. In part, these studies will allow a tracking of the recovery of plant communities following a reduction of snow goose populations. A sampling framework and standard protocol is being prepared for the AGJV monitoring initiative.

The third priority is the periodic re-surveying of the Cape Henrietta Maria, Shell Brook and northwest James Bay snow goose nesting colonies. These surveys would be designed to detect changes in population over time, using current estimates from Hudson Bay Studies in progress as the baselines. The Hudson Bay Project Team and the Moosonee Area office, along with the Canadian Wildlife Service, are well positioned to coordinate this work and undertake some components for the Ontario Ministry of Natural Resources and Ontario Parks.

References


Historical and Present Status of Woodland Caribou (*Rangifer tarandus*) in Pukaskwa National Park, Ontario and Implications for Metapopulation Management, a Review

*Keith Wade*
*Pukaskwa National Park*

**Abstract**

Population numbers of Woodland Caribou in Pukaskwa National Park have been regularly monitored from 1972 to the present. Fluctuations in numbers have been characterized as typical of a stable population regime (Bergerud, 1989). Nevertheless, the probability of extirpation of this disjunct local population may be high. Bergerud (1989) has elaborated on circumstances leading to such an event. Metapopulation theory poses challenges to protected area managers. Monitoring techniques, accumulated data and implications of metapopulation and minimum viable population size theory are elaborated upon for park managers mandated to maintain the woodland caribou in Pukaskwa National Park and resource managers in adjacent jurisdictions.

**Introduction**

Pukaskwa National Park and its greater ecosystem are within the southern boreal forest along the northeast corner of Lake Superior (Figure 1). Woodland Caribou are endemic to the area. Within Pukaskwa National Park the species is categorized as a high priority for conservation. Population levels have in recent history been low, ranging from a high of 31 animals in 1972 to a low of six in 1997 (Table 1, Figure 2). Managers always consider the possibility of extirpation with such a small population. Monitoring of population levels is important in this context but equally important is an understanding of some of the theory of population dynamics. A short summary of Pukaskwa caribou population monitoring and how it fits into the regional picture of a caribou metapopulation, as well as a discussion of two models proposed to explain the current situation are included in this paper.

Metapopulation theory and the concept of minimum viable metapopulation size in dissected landscapes have become increasingly sophisticated concepts used by ecologists. Pukaskwa National Park has a vulnerable population of woodland caribou for which there are large historical and current data sets. Habitat around the park is increasingly dissected by an elaborate and dense road network built by Domtar Forest Products Incorporated to access the White River Forest, Sustainable Forest License (SFM) in the Ontario Ministry of Natural Resources (OMNR) Wawa District (Promaine, in progress).

**Historical and Present Status**

Woodland Caribou numbers have been monitored and the species’ behaviour and habitat needs studied in Pukaskwa National Park since 1972 (Table 1, Figure 2). All population counts have been minimum population counts using aerial line transect techniques, (Burnham, 1980). Counts include animals seen by
observers and estimates of additional animals from track and other physical signs. Survey methods have been consistent year to year with some refinement over time (Moreland, 1991; Wade, 1995).

Caribou are native to the Greater Pukaskwa National Park Ecosystem. Bergerud (1989) has discussed and summarized historical population levels and has theorized that they were never at high densities. Bergerud estimated that the pristine – up to the early 1900s – density of caribou was 0.06 to 0.12 /km² or approximately 200 caribou for the area now within Pukaskwa National Park. Since the early 1900s caribou have been declining in numbers in the Pukaskwa area and their predominant range has retreated to the point where it is apparently concentrated on the coastal corridor along the shore of Lake Superior. This coincides with a similar trend of range contraction on the provincial scale. Generally caribou in the greater Pukaskwa ecosystem are found within five kilometres of the shore. Bergerud (1989) has characterized this as a predator avoidance strategy and suggests it is not controlled by lack of suitable habitat and food resources elsewhere in the Pukaskwa ecosystem.

Figure 1: Pukaskwa National Park and its Greater Ecosystem
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Table 1: Pukaskwa National Park Minimum Woodland Caribou Population Size

Caribou do range widely within the ecosystem. There are a growing number of confirmed observational records in the park database that suggest that our view of the animals as being strongly attached to the coastal habitat is not a completely accurate picture. Genetic exchange between Pukaskwa caribou, Pic Island/Coldwell Peninsula (Neys Provincial Park) caribou and perhaps the Slate Islands animals has been suggested by Bergerud, and may be confirmed by current work (Neale, ongoing). Bergerud (1989) documented the emigration from the Slate Islands and eventually to Pukaskwa by one ear-tagged male. He states that genetic exchange occurs among these disjunct populations at a low rate.

However it appears that what were thought to be separate disjunct populations – one in Pukaskwa National Park and another along the Lake Superior coast between Michipicoten River and the Pukaskwa River – might now have to be considered one local disjunct population as the result of accumulating data (Neale, ongoing; Pukaskwa National Park Data Base). Winter range for the southern shore disjunct population has historically been centred on Mountain Ash Hill, approximately 17 kilometres to the east of Point Isacor and 13 kilometres west of Michipicoten Harbour within the Ontario Ministry of Natural Resources Wawa District, (OMNR records; Eason, personal communication).
Long distance seasonal movements by caribou along the coast are documented as occurring over several days during the spring and fall (Neale in progress; Wade, 1993). A number of caribou have travelled outside their winter/spring range near Otter Island and Otter Head within Pukaskwa National Park to summer range more than 70 kilometres distant near the area south of the Eagle River Mine at Floating Heart Bay. The inference is that the caribou in the greater ecosystem may have greater exchange through immigration and emigration than previously thought or that they may actually be one population. This will remain speculative until more genetic interpretation can be done from existing blood samples.

**Theoretical Probability of Extirpation**

It has been suggested that possible extirpation of the Pukaskwa disjunct local population could occur as a consequence of several concurrent events (Bergerud, 1989). Bergerud reasoned that should deep snows in the interior of the ecosystem cause moose (*Alces alces*) to seek areas of lesser snow accumulation they would naturally migrate to the coastal zone of Lake Superior with lower snow depths. Since moose are the principal prey species of timber wolves (*Canis lupus*) this animal would follow its prey base and while hunting moose would encounter caribou at a higher rate than during winters of lower
interior snow pack depth when moose would theoretically be less inclined to move.

Bergerud (1989) states that the presence of solid shore-fast ice over extensive distances of coastline provides wolves an easy travel corridor in winters when this type of ice forms. Caribou are a more easily killed prey than moose and would suffer higher mortality rates during such winters as wolves moved through caribou winter range along the coast.

Bergerud argues that the controlling factor on this caribou population is predation by wolves. When the number of animals reaches 20 to 25 the population becomes more of a predation target for wolves than during those years when the population is at a low ebb of perhaps 10 to 15 animals. Thus Bergerud believes that the local disjunct population of Pukaskwa caribou are an example of a group in a classic predator pit cycle (Bergerud, 1984). Should there be three successive winters when the above described conditions coincide, caribou mortality could be high enough to cause a decline beyond the ability of the population to recover (Bergerud, 1989).

During the winter of 1993 known mortality of the Pukaskwa caribou population was 28.6% and recruitment was apparently 0%. In 1994, mortality was 20.0% with unknown recruitment, in an estimated population of 10 (Wade, 1995). Bergerud (1989) estimated population mortality averaged 15% from 1972 through 1988 and considered this a high mortality rate compared to other North American populations. Recruitment during this same 17-year period was estimated to be 16%. Recruitment during 1995 was 0% again but increased to 33% in 1996 and 27% in 1997 (Wade, 1997). Continued monitoring by radio telemetry relocation and other observational work suggest that recruitment will be relatively high again in 1998 and that mortality appears to have been very low since 1995. This follows a pattern well described by Bergerud (1989) of a stable population with changing equilibria.

Hanski (1997) has addressed another approach to determining the degree of extinction risk for the disjunct population(s) of caribou. He has discussed the relation between metapopulation dynamics and increasing habitat dissection and what this can tell us about the minimum viable metapopulation size and the minimum amount of suitable habitat necessary to perpetuate a metapopulation. Although it is arguable whether the Pukaskwa greater ecosystem has experienced or will experience the degree or type of dissection that could threaten the existence of the local caribou population there is accelerating dissection by roads of the landscape surrounding the park (Promaine, in progress). Pukaskwa may not fit the definition exactly, however important points to consider in Hanski’s analysis are that metapopulations with a high immigration rate will lower the rate of local extinctions. Further, metapopulations with multiple population size equilibria may go abruptly extinct even in those landscapes that are only slowly degrading and once they are gone, reestablishment may be difficult.

Generally metapopulations respond to the changes in landscape or habitat with a lag. Thus a rapidly changing habitat makes it problematic for a metapopulation to reach new equilibria. It is still unclear at present whether the populations we are discussing fit the criteria of a metapopulation as defined by Wells and Richmond.
Woodland Caribou within Pukaskwa National Park are a local population (Wells and Richmond, 1995) in the sense that they are a group of individuals within an area delimited by park managers which is smaller than the geographic range of the species in Ontario. They might be considered a disjunct population of a metapopulation – a set of spatially disjunct populations with probable immigration (Wells and Richmond, 1995). However to fit the definition and model there must be definite evidence of significant movement and subsequent genetic exchange between the greater ecosystem's local disjunct populations.

Some of the assumptions of Bergerud's model are currently being tested in the Pukaskwa Predator Prey Process Project. Neale (in progress) is investigating the spatial separation of moose and caribou on a seasonal basis. Are moose indeed in higher densities in the preferred coastal habitat of caribou during the winter months and is this the result of a general shift in the moose population to areas of lesser snow depths from zones in the interior with high snow depths? Is there, in any given winter a sufficient differential in snow depth gradient between interior highland areas and the coast to cause moose to move coastward? Preliminary results of this work suggest that there is not a significant correlation between moose densities along the coast in winter and caribou mortality.

Is the landscape of the greater ecosystem changing rapidly? Current information suggests that it is (Landsat TM image, 1984 and 1991/94). Is immigration high in this metapopulation? Although unknown, existing data suggests that immigration may be high (Pukaskwa National Park data base, 1972-1998). Can the greater ecosystem local disjunct populations be considered part of a metapopulation? I believe that the evidence is sufficient to conclude that they are part of a metapopulation. However, this is a question for debate, and hopefully some degree of consensus.

**Management Implications**

What are the implications for managers? Both Bergerud's model and Hanski's theory as related to our case of caribou in the Pukaskwa greater ecosystem suggest that local extinction or extirpation of caribou is possible.

Managers need to be aware of the genetic makeup of animals in a metapopulation. The question in the case of Pukaskwa greater ecosystem caribou is whether they have experienced any demographic bottlenecks resulting in decreased heterozygosity. Richards and Leberg (1995) caution that this genetic drift is likely to be underestimated in populations experiencing the most severe bottlenecks. They also caution application in management decisions when using small sample sizes, as is the case in the examples they cite and the current instance. It is therefore very important to obtain more data on the degree of immigration and presumably, genetic transfer, that may be occurring in this metapopulation. Currently genetic analysis is being done on Pukaskwa caribou blood samples taken during three capture projects in 1991, 1993 and 1996.

Parks Canada policy allows for direct intervention in a species' status, including reintroduction, if the reasons for the extirpation are well understood. The *Reintroduction of Native Animal Species* Parks Canada Directive states in part: "Native animal species once present but now absent are to be reintroduced into a National Park". Questions to be asked should extirpation occur and reintroduction
of a local population be attempted are complicated by intergovernmental – Federal, Provincial and First Nations – and interagency – Parks Canada, Ontario Ministry of Natural Resources and Ontario Parks – policies as well as the current genetic makeup of other potential donor local populations.

Caribou have been reintroduced by OMNR to areas in the greater ecosystem to the south and east of Pukaskwa National Park on Michipicoten Island, Montreal Island and Cape Gargantua in Lake Superior Provincial Park. Stockwell et al. (1995) found that refuge populations, such as a local reintroduced population, had significantly lower levels of heterozygosity or variability than the parent population. In a literature review of translocation projects worldwide they found that a translocated reindeer population (*Rangifer tarandus*) in Iceland had reduced heterozygosity (Roed et al., 1985) albeit on a very small sample. They recommend that reintroduced or translocated populations be periodically surveyed for genetic diversity. This in itself presents an expensive logistical problem to managers that must be considered in planning for any reintroduction.

In conclusion we as park managers are left with many scientific questions about the existing status of the caribou metapopulation and what to do about it, and how to do it in the event of an abrupt extirpation which current theory tells us is a distinct possibility.

We need to:
1. know what degree of immigration is occurring in the metapopulation, particularly to the local disjunct populations;
2. know what are the population limiting factors – i.e., disprove or support Bergerud's hypothesis or suggest a different hypothesis. This is currently being addressed by PNP Predator Prey Process Project;
3. further sample the several local disjunct populations in the metapopulation for genetic variability; and,
4. develop an integrated recovery or salvage plan with the several political jurisdictions and confirm the triggers that will activate such a plan, or, alternately, put forward a cogent argument for not interfering.

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Promaine, A. Masters of Forestry Degree. (In progress.) Lakehead University, Thunder Bay.


Seasonal Movement Patterns and Feeding Habits of Large Adult Male Black Bears in Algonquin Provincial Park, Ontario

Jeremy E. Inglis, and Mike L. Wilton
Ontario Ministry of Natural Resources, Whitney, Ontario, Canada, K0J 2M0.

Abstract
A five year study from 1992-97 of large adult male black bears (Ursus americanus) in Algonquin Provincial Park (APP), Ontario, Canada, yielded much information concerning seasonal feeding habits, movement patterns and intra-specific interactions. In excess of 1000 aerial and ground fixes were used to determine accurate estimates of breeding, mid-summer and late summer-fall ranges as well as denning locations of eight bears. Breeding territories range from 19.3 km$^2$ to 87.6 km$^2$, implying that there could be as many as 191 large males breeding within unhunted Algonquin Park annually. Twelve of 15 known den sites occurred within established breeding ranges. Predation by black bears on as many as six moose (Alces alces) and one black bear was documented during this study. Post breeding movements of collared bears to areas outside Algonquin Park were generally to lower elevations and may be learned, or coincide with either plant phenology and species abundance, or the presence of garbage dumps. Linear post-breeding movements varied between 18.8 km and 73.8 km and were repeated in successive years by four of six bears which implies directed rather than random movement. No collar related mortality occurred, although six of 18 bears lost their collars. Movements out of Algonquin Park occurred between July 4 and August 17 and lasted between 15 and 251 days. Return fall movements to breeding/denning range occurred between September 9 and October 17. Six of 11 collared bears that exited Algonquin Park died as a result of hunting. The importance and availability of various seasonal habitat needs – for example soft and hard mast – are discussed.

Introduction
Adult male black bears are usually responsible for the rare attacks on humans. Few studies in the past have concentrated on the behavioural aspects and feeding habits of the adult male segment of black bear populations in North America, and no black bear studies have previously been conducted in Algonquin Provincial Park. Inglis and Wilton (1994) and Wilton and Inglis (1996) discuss aspects of human fatalities caused by black bears. The objective of the study reported here was to examine the movement and feeding patterns of large adult male black bears in APP.

Study Area
Algonquin Provincial Park, located on the southern edge of the Canadian Shield in south central Ontario comprises an area of approximately 7,800 km$^2$. Most of the park is closed to hunting, although two townships of approximately 332 km$^2$ are open to limited hunting. A hunting agreement with the Golden Lake Native Band allows a limited harvest of moose in the eastern portion of the park, while the harvest of bears is considered negligible.
Park visitation averages approximately 600,000 people annually, with the majority of visitors concentrated along the Highway 60 corridor. The interior of the park is accessible only through hiking or canoeing and receives less visitation.

Algonquin Park contains two distinct habitat types. The western two-thirds of the park is made up of rolling hills of mainly deciduous forest, while the eastern third of the park is typically flat with a conifer/deciduous mixed forest. Elevations in the west commonly exceed 500 m while the eastern portion drops below 200 m. Hills in the west are comprised largely of glacial till while the east is made up of sandy outwash plains (Strickland, 1989). Because the elevation is higher on the west side of the park, it is cooler, with 84 frost-free days, compared to 105 on the east side. The west side also receives more precipitation with 100 cm of precipitation annually (33% as snow), as opposed to 90 cm (26% as snow) on the east side (Strickland, 1989). Snow typically remains on the ground from early December to early April.

Forests in the west consist of sugar maple (Acer saccharum), yellow birch (Betula alleghaniensis), American beech (Fagus grandifolia), eastern hemlock (Tsuga canadensis), and white spruce (Picea glauca). White pine (Pinus strobus), red pine (Pinus resinosa), jack pine (Pinus banksiana), white birch (Betula papyrifera), largetooth aspen (Populus grandidentata), trembling aspen (Populus tremuloides) and red oak (Quercus rubra) predominate in the park's east side (Strickland, 1989).

Other plant species found throughout the park that produce hard and soft mast important to bears are pin cherry (Prunus pensylvanica), choke cherry (Prunus virginiana), beaked hazel (Corylus cornuta), blueberry (Vaccinium angustifolium), red raspberry (Rubus strigosus) and wild strawberry (Fragaria virginiana).

Limited logging occurs in the park under a selective or uniform shelterwood cutting system, resulting in a harvest of approximately 1% of the forest annually (Mihell, pers. comm., 1994).

Methods

Trapping effort commenced in the fall of 1992 and has continued, primarily in the spring and fall until the present time, utilizing the protocol accepted by the OMNR Animal Care Committee. Bears captured in trailer-drawn culvert traps were immobilized with a 2:1 ratio of ketamine hydrochloride and xylazine hydrochloride (Addison and Kolenosky, 1979). Drug delivery was accomplished using a jab stick or a Cap-Chur rifle with a brown charge only. Barbs on darts were filed down for easy removal and minimal injury to bears.

Immobilized bears were weighed and sexed. Any physical markings or abnormalities were noted. A premolar was removed for aging purposes (Willey, 1974). Since 1995, hair samples from individual bears were collected for DNA analysis. All bears were tagged in both ears with yellow plastic rototags with an identifying number on each. Appropriate bears – i.e., males weighing more than 120 kg – were fitted with motion indicator radio collars (Lotek Engineering Inc.,
Newmarket, Ontario). Immobilized bears were given an intramuscular injection of the reversal agent yohimbine hydrochloride at dosages of 0.4 mg/kg.

Radio-tracking of collared bears was conducted at least three days per week from den emergence to den entry, at random times throughout both day and night. Hand-held two-element Yagi antennas with portable receivers of 150.0 - 151.9 megahertz (Suretrack - Lotek Engineering, and ATS - Insanti, Minnesota, USA) were used for ground locating collared individuals. Triangulation from known ground locations was used to locate a bear's position on 1:10,000 Ontario Base Maps or 1:50,000 topographic maps.

Aerial telemetry was accomplished primarily from a Luscombe 8-E fixed-wing aircraft utilizing a VHF radio antenna. Other aircraft used were a Turbo Beaver fixed-wing and a Bell Long Ranger helicopter, both tracking with two mounted Yagi antennas and a switchbox.

Breeding range analysis was accomplished using the minimum convex polygon method (Mohr, 1947). Post-breeding movements were extremely extensive and variable and therefore not included as part of a bear's regular territory.

Food sources were investigated by walking into areas frequented by collared bears for two or more days. Several observers walked transects looking for signs such as tracks, scats and beds or obvious sources of food. Den locations were confirmed by walking in on suspected denning bears.

Results

Eighteen large adult male black bears have been radio-collared, and more than 1000 aerial and ground fixes have been used to determine accurate estimates of breeding, mid-summer and late summer/fall ranges for those individuals. Ages of collared bears range from seven to 17 years (x = 10 years, n = 9) with weights from 130 to 185 kg (x = 148 kg, n = 11). Adult males greater than five years of age comprised 66.6% of all collared and uncollared captured males (n = 24), with a mean age of 8.8 years. Four collars were pulled off at 13, 45, 83 and 93 days after collaring. One collar was broken off and found in the den the following spring. Another collar was found broken beside the remains of a moose calf. It was presumed that a cow striking it with a hoof in an unsuccessful attempt to protect her calf from the bear broke this second collar.

Bears emerged from dens from late March to early April and started to wander within breeding ranges. One bear stayed in close proximity to his den for two to three weeks after emerging in early April. Most bears oriented to clearings where they were observed feeding on freshly emerging grasses. These areas were the most successful trapping locations in the spring. Bears also fed on poplar catkins and leaves. Another food source in May was white suckers (Catostomus commersonni) spawning in shallow creeks throughout APP. Numerous uncollared bears were observed feeding on suckers, and three collared bears spent between two and ten days at creeks containing spawning suckers.

Five cases of black bear predation on moose calves were observed as well as six eye-witness accounts of bears pursuing cow/calf groups in the past five years in APP. Shortly after den emergence, bear #985 proceeded to an area where he
remained for approximately three weeks. Investigation of the area revealed the carcass of a cow moose almost entirely consumed. Evidence of the carcass was virtually undetectable beyond a 50 m radius. The cow was in poor condition with red, jelly-like marrow and was quite old, as observed by tooth wear.

In July, investigation of the stationary location for three days of a nine year old collared male revealed the remains of a bear. Close examination of the area indicated that the collared bear pursued another bear of unknown sex and age approximately 15 m up a black ash (*Fraxinus nigra*) tree. As indicated by extensive claw marks some 3 m long and 1.5 cm deep, it then dragged the bear down, killed it and partially consumed it. A bed was located 8 m from the carcass and scats containing hair confirmed that a bear had eaten the carcass. The bear killed was determined to be a nine year old adult.

In early October 1995 – a particularly bad year for natural food – some forestry workers observed a large bear eating another bear. When we investigated the site several days later, all that remained of the carcass was the upper and lower jaw, some broken bones, and some claws. Although numerous bear scats containing hair were found around the remains, we were unable to determine whether it was a case of predation or scavenging.

Bears remained in well-defined breeding ranges from den emergence until July or August. Breeding territories ranged from 19.3 km\(^2\) to 87.6 km\(^2\) (x = 40.4 km\(^2\), n = 7). Territorial overlap of approximately 50% occurred in the breeding ranges of only two of the collared bears. Both were approximately ten years old. In another case, upon the death of bear #965, neighbouring male #954, moved more extensively and spent more time in the vacated. All large, adult males possessed some degree of facial scarring, with fresh wounds observed only during the breeding season.

Post-breeding movements out of breeding ranges by individual males (n = 12) occurred between July 4 and August 17 (x = July 25, n = 14), and lasted between 15 and 251 days (x = 82.7) (Figure 1). As an exception, bear #954 left his breeding territory in early September 1994, spent the winter at an unknown location, and returned in mid-May (1995). Bears left breeding territories earlier then normal in 1997 with an average date of dispersal of June 28 (x = 5). All such movements except two took bears outside the boundaries of APP (Figure 2). Linear distances moved from breeding territories ranged from 18.8 km to 73.8 km (x = 46.1 km, n = 11). Once out of the park, some males moved considerable distances (over short periods of time) with one bear moving 91 km in seven days. Movements from breeding territories were most often to lower elevations, with a mean elevational descent of 145.6 m (n = 11) (Figure 3).

Natural food sources found in areas frequented by collared bears in summer and fall included soft mast such as wild strawberry, red elderberry (*Sambucus pubens*), red raspberry, blueberry, skunk currant (*Ribes gladulosum*), chokeberry (*Aronia melanocarpa*), spikenard (*Aralia racemosa*), pin cherry, choke cherry and Juneberry (*Amelanchier canadensis*). These were found at lower elevations outside APP to the southeast. Hard mast species utilized in late summer and fall include beaked hazel, American beech and northern red oak. In the fall of 1993, coinciding with a beechnut failure, three collared males moved to oak stands containing a bumper crop of acorns. One bear moved more than 60
km east of his breeding territory. When beechnuts were available in or close to territories, males returning from summer feeding forays would spend an additional two weeks to a month feeding in beech stands. Bear #44, an uncollared five year old male captured in such a stand at the end of September weighed 97 kg at that time. When recaptured 17 days later the bear weighed 115 kg, a gain of 18 kg or 0.94 kg per day. Numerous other bears, including females with cubs, also utilized beech stands.

Nine of 15 males that exited APP utilized garbage dumps as a food source. Scats found around dumps contained mainly refuse remains but also contained seeds from various soft mast species. Bears travelled 21 km to 73.8 km ($x = 48.7$ km) from breeding territories to utilize dumps scattered around the entire perimeter of APP. Three collared males returned to and utilized the same dumps they had used the previous summer. Movements to dumps were sudden and direct. Bear #965 was still in his breeding territory at 1100 hours on August 8 but was observed at a dump 21 km away on August 9 at 2000 hours. Similarly, bear #994 was still in his territory on July 6 but had moved 56 km east to a dump by July 10. Smaller bears tended to utilize dumps diurnally, while large males tended to dominate dumps nocturnally. Females, solitary or with cubs, and smaller bears were not observed at dumps where large males were present. As many as ten large males could be observed feeding at one time. Although no direct physical contact was observed, much vocalizing, jaw-popping and ground slapping occurred between bears, with the largest bears usually maintaining dominance. During the days, collared males moved from 0.5 to 2.0 km ($x = 1.25$ km) away from dumps to bed down or feed on naturally occurring foods. Feeding at dumps usually ceased in early September when bears either returned to breeding territories to den or moved to areas of hard mast to feed.

![Figure 1: Elevation changes from breeding ranges to post-breeding locations of adult male black bears from Algonquin Provincial Park.](image-url)
Figure 2: Frequency of radio-collared adult male black bears in Algonquin Provincial Park (result of annual out-of-Park movements).

Figure 3: Post-breeding movements of adult male black bears from Algonquin Provincial Park
Following late summer/fall foraging, males returned to breeding ranges in all but one case. Return movements occurred between September 9 and October 17 (x = Sept 29). Twelve of 15 known den sites were located within established breeding ranges. Bears prepared and entered dens soon afterward, unless an abundance of food such as beechnuts was available within breeding ranges.

Hunting mortality occurred in 6 of 11 (54.5%) collared bears. Bear hunting seasons open on September 1 on the east and south sides of APP and on September 15 on the west and north sides of the park. Three bears were shot over baits – a legal spring/fall hunting practice in Ontario. One was fatally shot twice by a rifle hunter in an oak stand 55 days after being hit with an arrow; and one was shot on a trail, possibly over bait, leading to a dump. The latter case and another bear shot over a bait were both within 1 km of dumps.

Discussion

The age structure of the APP male black bear population suggests a relatively unexploited population, based on mean ages of other unexploited populations. Lecount (1982) found a mean age of 8.1 years for adults (i.e., >3 years) and 51.3% component of adult males in a self-regulating population in Arizona. Young and Ruff (1982) reported a mean age of 11.3 years for adult males (i.e., >4 years) in an unhunted population in Alberta.

Extrapolation based on a mean breeding range size of 40.4 km² indicates that there may be up to 191 adult males in excess of 120 kg within unhunted APP (7,730 km²) annually. Breeding ranges of adult males in APP are similar in size to those found in Tennessee where an average home range size was 42 km² for adult males (Garshelis and Pelton, 1981). Adult home ranges found elsewhere were substantially larger: 75 km² in Minnesota (Rogers, 1987); 119 km² in Alberta (Young and Ruff, 1982); and approximately 100 km² in Ontario (Kolenosky and Strathearn, 1987). However, ranges in APP that include post-breeding movements exceed 1,000 km² for several males that wandered after the breeding season. Similar movements were recorded with adult males in the North Bay area of central Ontario (Kolenosky and Strathearn, 1987). Smaller breeding ranges may have been a result of greater competition for breeding females. The extent of scarring on large adult males would indicate fighting over available mates and/or territory, as was evident in other unhunted populations (Lecount, 1982; Young and Ruff, 1982).

Although the importance of white suckers to bears was not found in the literature, spawning salmon are very important to some black bear populations in western Canada (Russell, 1994). This implies that fish are a valuable food source at a critical time of year, for example spring, for APP bears.

The predator/prey relationship of black bears and moose calves is suspected to be significant from mid-May to mid-June in APP (Wilton, 1983; Inglis and Wilton, 1994). Black bear predation on moose calves has been well documented elsewhere, particularly in Alaska (Franzmann et al., 1980; Franzmann and Schwartz, 1986; Ballard et al., 1990; Schwartz and Franzmann, 1991). Instances of predation are difficult to detect with radio-collared bears due to the remoteness
of stationary individuals, forest cover, the short time in which a moose calf is consumed and the concentration of signs only in close proximity to the kill.

Cases of intra-specific predation and cannibalism are apparently rare in most areas where hunting mortality is a significant cause of death of adult males (Rogers, 1983). However, in APP, where large numbers of adult males exist, predation of other smaller bears may still occur. This is the case particularly in a bad year for natural food from plants, as was the case in 1995.

Soft mast does not become available until mid-June in APP, when wild strawberries and red elderberries ripen. Ants also become available at this time. From late June to late August, bears consume other berries and fruits such as red raspberry, pin and chokecherries, blueberries, spikenard and Juneberries. Plant phenology and species diversity, affected by temperature and precipitation, may induce the post-breeding movements of adult males in July to lower elevations. Juneberry, for example, is scarce within the study area’s breeding territories but is found in abundance at lower elevations in southeast APP. Blueberries are found in greater abundance in the eastern and southern portions of APP. Collared bears were frequently located in areas where Juneberry and blueberries were abundant. Elevation shifts by black bears were found in Great Smoky Mountains National Park, Tennessee, from spring (x = 1,300 m) to fall (x = 700 m) and were believed to be caused by greater mast abundance and diversity, particularly oak (Garshelis and Pelton, 1981).

Hard mast, particularly red oak acorns and beechnuts, becomes very important to bears in APP in early September, resulting in large, rapid weight gain. An abundance of mast provides similar weight gains in males in other areas of Ontario (Kolenosky and Strathearn, 1987). Bears with home ranges in the western and central portions of the park, where climatic conditions are unsuitable for red oak growth, may be forced to leave the boundaries of APP to seek acorns. This is particularly common when there is a failure of beechnut production and an abundance of acorns, as was the case in 1993. Late summer and fall movements of black bears are a common phenomenon throughout their range where various natural food sources and critical weight gain govern such foraging (Garshelis and Pelton, 1981; Kolenosky and Strathearn, 1987; Rogers, 1987; Kolenosky and Obbard, 1991; Paquet, 1991).

Although some bears seemed to utilize only natural foods, 54.4% of males that exited the park and also descended in elevation used garbage dumps as a significant, if not main, source of food. In contrast to bears using dumps in Minnesota (Rogers, 1987) and Newfoundland (Payne, 1977), bears from APP used only one dump per season, even though other dumps were located within 10 km of each other. All feeding at dumps by large males was crepuscular or nocturnal. Five radio-collared adult males utilizing a dump in Manitoba did so between 21:30 and 5:00 hours, 90% of the time (Paquet, 1991). Similar to sex ratios at Algonquin dumps, in Minnesota Rogers (1987) noted that females outside their territories avoided unfamiliar adult males or congregations of males, even though an abundant food source was present. Females and smaller bears avoiding dumps is a common occurrence (Rogers, 1987; Stringham,1989; Paquet, 1991) except perhaps when large males have been removed through hunting and poaching (Young and Ruff, 1982). Collared males bedded down during the day an average distance of 1.25 km from dumps. Similarly, in
Minnesota during a particularly poor year for natural foods, a garbage-habituated male was found within 2 km of a dump on 11 of 12 occasions (Rogers, 1987). In Manitoba, adult males using dumps concentrated their activities within 1 km of the dump (Paquet, 1991). Examination of scats indicates that dumps are not the sole source of food, as Rogers (1987) found in Minnesota.

All of 11 males that exited APP were still located outside the park when bear hunting seasons opened. This resulted in the death of six (54.5%) of those bears. Three of these bears were shot over baits and two were shot within 1 km of a dump. Hunting of bears is prohibited within 400 m of a Crown (provincial) dump. In Manitoba, where baiting is also permitted, 18 (72%) of 25 human-caused mortalities among black bears in and adjacent to Riding Mountain National Park were a result of bears killed while hunting over baits (Paquet, 1991). Hunting pressure is considered high in areas adjacent to APP, where spring and fall black bear hunts take place (Strickland, 1992). In addition, First Nation hunters now acknowledge fall harvest of black bears in APP. Because APP adult males remain in breeding ranges throughout the spring hunt (April 15 to June 15) their vulnerability to hunting mortality remains low at that time, although bears with territories close to the park boundaries may be unprotected. In May 1997, bear #597, one of two bears whose territory extended beyond the park’s boundaries, was the first bear in the study to be shot during the spring bear hunt. Other parks and reserves also have increased hunting mortality at various times. Garshelis and Pelton (1981) noted increased mortality due to hunting when bears wandered out of Great Smoky Mountains National Park foraging for food during the fall.

Loss of resident adult APP males through hunting prompts questions regarding the effects of hunting on the total APP population. Presumably, high bear densities in the park are thought to support a high harvest rate outside the park through emigration (Strickland, 1989), even though a total population estimate does not exist. Garbage dumps, plant phenology and species abundance will continue to draw bears from APP. The effects of mortality of adult males on social structure and maintenance of dominant genetic integrity are poorly understood and warrant further study of the black bear population of Algonquin Provincial Park.

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References


Bird Species Richness and Composition in White Pine (Pinus strobus) Stands in Algonquin Provincial Park, Ontario in response to the First Cut of the Uniform Shelterwood Silvicultural System*

Andrea Kingsley and Erica Nol
Watershed Ecosystems Graduate Program and Biology Department
Trent University, Peterborough, ON K9J 7B8

Abstract
The response of birds and vegetation to the first cut of the white pine (Pinus strobus) uniform shelterwood sylvicultural system was examined in Algonquin Provincial Park, Ontario. Bird abundances and vegetation cover in stands which were logged during the period of 1970 - 1994 were compared to mature stands with no recorded logging history. Old-cut stands contained most (89%) of the 63 species recorded during the study. Of these, only seven showed significant differences in abundance among the treatments. The most important habitat variable for these seven bird species appeared to be the amount of understory vegetation and cover in the forest canopy. Open forest species such as white-throated sparrows (Zonotrichia albicollis), chestnut-sided warblers (Dendroica pensylvanica), and mourning warblers (Oporornis philadelphia) were more abundant in stands logged between 1970 and 1978, and between 1986 and 1994, where the canopy cover was the least dense. Bird species richness was greatest in unlogged stands and in stands logged between 1978 and 1986, the two treatments with the greatest structural diversity. Plant species richness was greatest in stands logged between 1970 and 1986 suggesting birds were selecting habitat based upon forest structure rather than plant species composition. We recommend longer rotation periods, preservation of super-canopy trees and some additional reserves for old-cut stands. We also recommend that private landowners adopt, when possible, this silvicultural technique.

Introduction
White pine (Pinus strobus) is an economically and ecologically important species in Canada’s mixed and southern boreal forests, especially in the Great Lakes-St. Lawrence Forest Region (Lowe, 1994; Naylor et al., 1994). The management of these forests has recently been the focus of debate, as it is estimated that 80% of Central Ontario’s forest-inhabiting wildlife use forests that contain red (Pinus rugosa) or white pine (Naylor et al., 1994).

Recent declines in neotropical migrant bird populations have been a cause for concern in both their breeding and wintering grounds, and habitat change is implicated as one of many possible explanations for the decline (Robbins et al., 1989, Thompson et al., 1995). Changes in the breeding and wintering habitats of

* Note: A modified version of this paper is also included in a special publication of the Society of Canadian Ornithologists on Forests and Canadian Birds (in press).
birds are due to a variety of factors, including logging and silvicultural practices. Logging causes habitat change that may significantly affect avian populations at both the landscape and stand level (Franzreb and Ohmart, 1978; Thompson et al., 1995). A great deal of information exists on how birds respond to clear-cut logging (Conner et al., 1979; Freedman et al., 1981; Steffen, 1985; Wetmore et al., 1985; Norton and Hannon, 1997), but there is very little information on the effects of other silvicultural systems on bird habitats (Franzreb and Ohmart, 1978; Freedman et al., 1981; Thompson et al., 1995).

The uniform shelterwood silvicultural system differs from other even-aged silvicultural systems by gradually removing the original forest rather than removing all or most trees in an initial cut. In theory, a series of four cuts – preparation, seeding, first removal, and final removal – done in twenty year intervals, gradually remove the original stand while regeneration becomes established under the existing stand’s canopy (Corbett, 1994; Algonquin Forestry Authority (AFA), 1995; Thompson et al., 1995). The entire process is repeated after the passing of a further 40 years when the regeneration is 80 years old (AFA 1995).

When uniform shelterwood logging was first employed in the early 1970s, it was at a trial stage. Tree removal techniques and marking requirements were unrefined, and the percentage of pine removed was greater than at present, resulting in poor pine regeneration and profuse deciduous growth (Pick, pers. comm.). The different harvesting techniques used in the early 1970s, and the unsuccessful pine regeneration that followed, have disallowed the use of stands logged at that time as reliable indicators. It cannot be determined with any precision, what a typical first cut in the uniform shelterwood silvicultural system will be like in 20 years, although results were included in the analysis for comparative purposes. Therefore, only the first stage of the cutting has been completed to date using the method as it has been refined. Our purpose was to determine the effects of this first cutting of the uniform shelterwood silvicultural system on the abundance and richness of breeding birds, and on the vegetation structure of logged and unlogged stands in the pine forests of Algonquin Provincial Park, Ontario.

**Study Sites and Methods**

The study was conducted on the east side of Algonquin Provincial Park, Ontario, Canada (44°10' N, 77°23' W). This area is dominated by white pine forests with trees between 80 and 100 years in age and 25-30 m in height (Martin, 1959). The white pine forests in the study area are relatively continuous, separated only by logging roads and water bodies.

Forest stands with different logging histories were divided into four treatments: those logged between 1986 and 1994; 1978 and 1986; or 1970 and 1978. These are hereafter referred to as “90s”, “80s” and “70s” treatments, respectively. The fourth treatment was composed entirely of stands without a written logging history – hereafter referred to as “old-cut” – although the entire region was known to have been logged between 80 and 100 years ago (Naylor et al., 1994). Stands logged prior to 1970 were not included in this study because logging techniques other than the shelterwood system were used during those years. Stands were chosen using Forest Resource Inventory (FRI) maps in addition to
Ontario Ministry of Natural Resources (OMNR) and AFA logging history records. For a stand to be chosen it had to be accessible by road, have a minimum stand composition of 50% white pine, contain trees that were a minimum age of 70 years, fall into one of the prescribed treatments, and be a minimum of 15 hectares in size.

Once stands were located, survey points for breeding birds were set up within each stand – hereafter referred to as ‘plot’. Points were flagged at least 200 m from roads, water bodies or stand boundaries to minimize possible effects of edge habitat on bird and vegetation communities. A total of 39 bird census plots were used in the spring of 1995 (14 old-cut, 8 70s, 10 80s) and 55 bird census plots were used in 1996 (15 old-cut, 12 70s, 11 80s, 12 90s).

Vegetation Survey
A total of 38 plots, ten in each of the 70s and 90s treatments, and nine in each of the old-cut and 80s treatments, were surveyed once in 1996, after the completion of the bird surveys in July. To determine the floristic characteristics present at each site, a square 400 m² quadrat was set up within each of the plots. It was centred at the point count station used during the bird surveys, with its sides parallel to the four compass directions. Diameter at breast height (dbh) measurements were taken for all trees and snags greater than 10 cm dbh in the quadrat. Percent cover estimates were also taken for six vertical forest layers: from 0 to 0.33 m in height; from 0.33 to 2 m; from 2 to 5 m; from 5 to 10 m; subcanopy; and canopy.

To measure percent cover of the first two layers – ground and less than 2 m – a smaller 1 m² quadrat was randomly placed within the 400 m² study quadrat and aided by a placed grid system. For each survey, this was repeated ten times, each placement exclusive of all others. The percent cover of each species was estimated within each of the 1m² quadrats. For each species present, the percent cover was estimated within each of these four quadrats for the remaining forest layers. As percent cover was estimated for each species and many species overlapped in space, total cover could be greater than 100%. All plants were identified to species. Plant species were grouped into broad categories – mosses, equisetums, ferns, herbaceous plants, shrubs and coniferous and deciduous trees – and were analyzed using one-way ANOVAs for each of the vegetation categories in each of the forest layers.

Surveys of Forest Breeding Birds
In both years, breeding birds were monitored using a ten minute, 50 m - unlimited distance point count as used by the Canadian Wildlife Service’s Forest Bird Monitoring Program (Cadman, 1995). Counts were done twice for each point and were performed in the morning between dawn and 9:30 am, and were done during weather other than rain, hail or appreciable wind, all of which would affect the ability to hear birdsong (Bibby et al., 1992). Both heard and sighted birds were counted. To reduce problems associated with observer bias, only two experienced observers performed surveys and were given approximately equal numbers of stands in each treatment to census, the same observer visiting the same set of plots for both of the two visits. The order in which the stands were surveyed was determined using a random number table. Totals of birds counted
beyond the 50 m circle (unlimited distance) were combined with totals from within the 50 m circle as an index of relative abundance for a stand (Bibby et al., 1992).

**Results**

1. The general features of vegetation changes through each stage of the first cut of the uniform shelterwood silvicultural system are outlined in Figure 1.

2. Few significant differences were found among treatments in the percent cover of different vegetative layers. Old-cut and 80s treatments had significantly greater amounts of coniferous and total cover in the canopy than the 70s and 90s treatments; the amount of deciduous cover in the 2-5 m layer was significantly greater in the 70s treatment than the other three treatments; and percent cover of ferns in the less than 2 m forest layer was significantly greater in the 90s treatment than the remaining treatments.

3. We found few weak (non-significant) trends in the other forest layers. The sub-canopy layer appeared to have greater cover in old-cut and 80s treatments; the amount of total cover in the 5-10 m forest layer appeared greatest in the 70s treatment ($P = 0.090$). At ground level, the 80s treatment had the greatest amount of total cover, but this only approached significance ($P = 0.069$).

![Figure 1: Diagram of change in forest structure from the old-cut to the resulting forest (80 years) under a uniform shelterwood silvicultural technique](image-url)
4. Plant species richness was highest in the 90s plots. The basal area of snags did not vary statistically between the treatments; however, the basal area of white pines and of all species combined was significantly greater in the old-cut treatment.

5. A total of 63 species of birds were recorded in the two years of study. Of this total the greatest number observed in any one treatment during one year was 52 in 1995 in the old-cut treatment. The old-cut treatment also had the largest total number of species observed – 89% of all species – and the greatest number of species unique to it. Four species – ruby-throated hummingbird, American crow, white-breasted nuthatch and wood thrush were found only in the old-cut treatment. The 80s treatment had the second highest richness, comprising 84% of all species observed.

6. Average avifauna richness of the plots among treatments – i.e., number of species/plot – was marginally higher in the 70s plots than in the old-cut and 80s plots (P=0.054) in 1995, but the data from 1996 did not support the first year’s results (P=0.325). When the data from the two years were combined – excluding the 90s treatment because of no replicates in 1995 – the 80s plots had the highest average species richness (P= 0.035).

7. Old-cut and 80s treatments were most similar in bird communities, with similarities in other treatments in decreasing order: 70s and 80s; 70s and 90s; 80s and 90s; old-cut and 90s; with old-cut and 70s treatments being the least similar (Kingsley, 1998).

8. Of the 28 species that were analyzed for differences in relative abundances among treatments – i.e., those species that occurred in at least five plots of each treatments – seven showed a significant difference among treatments for one or both years as follows:

- Black-capped chickadee: Old-cut treatments had significantly greater relative abundance than the other treatments (Kruskal-Wallis ANOVA, F=16.9745, P=0.0007).

- Veery: The abundance of veery differed significantly between the treatments (ANOVA, F=2.913, P =0.039). Veery were significantly more abundant in 70s plots compared to old-cut (LSD Multiple Comparison test, P=0.029) and 90s plots (LSD Multiple Comparison test, P =0.009), but were only slightly more abundant than 80s cuts.

- Chestnut-sided warbler: This species occurred with significantly greater abundance in the 90s treatments than the other treatments, with 70s and 80s treatments having smaller but good numbers. Low numbers were found in old-cut stands (Kruskal-Wallis ANOVA, F=22.3296, P=0.001).

- Ovenbird: The pattern of relative abundance was complicated by yearly variation. In 1995, no significant difference between the treatments was found (ANOVA, F=1.956, P=0.1595). However marginally significant differences among treatments were found in 1996 (ANOVA, F=2.805, P=0.051). The 80s treatment had significantly lower numbers than the old-cut treatment (LSD Multiple Comparison test, P=0.013) and the 70s treatment (LSD Multiple Comparison test, P=0.038). There also existed a significant difference between the two years with respect to overall abundance. In 1996 we found more ovenbirds, although the 80s treatment showed the least difference between years.

- Mourning warbler: This species was found in low numbers in all treatments except in the 90s treatment where mourning warblers
occurred in relatively high abundance (Kruskal-Wallis ANOVA, $F=13.0637, P=0.005$).

- **Canada warbler:** Canada warblers were few in number except in the 70s treatment, where they are found in significantly greater abundance than in the other treatments (Kruskal-Wallis ANOVA, $F=16.744, P=0.001$).
- **White-throated sparrow:** White-throated sparrows were significantly more abundant in the 90s treatment than in the old-cut stands (ANOVA, $F=4.685, P=0.004$, LSD Multiple Comparison test, $P=0.000$); 80s plots (LSD Multiple Comparison test, $P=0.038$); and the 70s plots (LSD Multiple Comparison test, $P=0.044$).

**Discussion**

Old-cut stands, that had no record of cutting, are presumably the closest in vegetation structure and bird communities to original old-growth white pine forests in central Ontario. These stands had bird communities very similar, sharing 94.3% of species, to those cut in the 1980s with the uniform shelterwood silvicultural system. Therefore, it appears that the ten to twenty years that have passed since active logging has allowed many of the layers of the white pine forest to expand to the degree present in old-cut stands. These two treatments differed in important ways from the more recently cut 90s plots and the 70s plots where this particular silviculture system was in its first experimental stage. In particular, the canopy layer of the 80s and old-cut treatments was significantly greater in cover than the other two treatments, and were not significantly different from each other, hence providing similar amounts of canopy habitat for canopy inhabiting birds.

The 80s and old-cut treatments also contained similarly low amounts of deciduous cover in the 2-5 m layer and fern cover – primarily bracken fern (*Pteridium aquilinum*) an open area species – in the less than 2 m forest layer. For both layers the amount of cover was lower than that found in the 90s and 70s treatments respectively. Old-cut and 80s treatments had the greatest total bird richness per treatment and the greatest structural diversity as indicated by the intermediate percent cover results in the different forest layers, and the presence of a well-formed canopy and sub-canopy. Lower structural diversity was inferred in treatments with little cover in one or more layers. For example, both the 70s and 90s plots had low amounts of canopy cover. The 90s treatment also had a low amount of shrub cover in the 2-5 m layer. Birds in our study, as in others (MacArthur et al., 1962; Karr and Roth, 1971; James and Warmer, 1981; Niemi and Hanowski, 1984; Steffen, 1985; Thompson et al., 1995) appear to be selecting habitat based on forest structure, rather than plant species composition. The old-cut and 90s treatments were most similar in plant species composition – sharing 82.4% of species while the 70s and 80s treatment shared 64.5% and 68.2% species respectively – but least similar in bird species composition.

The vegetation characteristics resulting from this mixture of treatments appeared to have positive and negative impacts on a relatively small number (seven) of the species observed in all treatment groups. We discuss these according to their primary habitat preferences and how they were affected by the changes in the forest structure.
Snag users: Snags – standing dead wood – are an important habitat component for many species (Quinby, 1988; Naylor et al., 1994; Naylor et al., 1996). A great deal of research and interest in snags has shown that increased numbers of snags in an area – including clearcuts – increases the numbers and diversity of birds significantly (Dickson et al., 1983). However, the number of snags is often negatively affected by forestry practices (Quinby, 1988). A total of nine snag dependent species – yellow-bellied sapsucker, downy woodpecker, hairy woodpecker, black-backed woodpecker, northern flicker, pileated woodpecker, black-capped chickadee, brown creeper, and red-breasted nuthatches – were observed in the study, five of which had sufficient numbers for analysis. Of this number only the black-capped chickadee showed a significant difference between the treatments and none of the others was exclusive to the old-cut treatments.

Chickadees are cavity nesters and prefer to excavate their nests in standing tree stumps with an average diameter of 10 to 18 cm at breast height (Peck and James, 1987). Chickadees also nest more frequently in deciduous tree snags, with birch trees as the most commonly used species (Smith, 1993; Peck and James, 1987). The greatest relative abundance of chickadees was found in old-cut stands in both years and this is possibly a result of the abundance of suitable snags in this treatment. Suitable nesting snags may be a limiting factor for black-capped chickadees (Smith, 1993). If these snags are not available or are in low numbers, chickadees will be in lower abundance. Although not significant, the basal area of snags is greatest in the old-cut and 80s treatments, followed by the 70s treatment and the 90s treatment. The greater number of snags, and possibly greater number of deciduous tree snags – though this was not measured – in old-cut stands may explain the abundance pattern of black-capped chickadees in the treatments.

Unlike chickadees, woodpeckers require larger snags for nesting. For example, yellow-bellied sapsuckers nest in trees with an average diameter of 25.5 to 33 cm at breast height (Peck and James, 1987). Because the number of snags greater than 10 cm dbh did not differ significantly between the treatments, woodpecker nesting trees were not negatively affected, possibly explaining why none of the woodpecker species showed a significant difference in abundance between the treatments. Larger snags required by woodpeckers were maintained by the provisions made by the AFA, but smaller ones (less than 10 cm dbh), appear to have been reduced by logging as indicated by chickadee abundance.

Canopy dependant species: For many species that directly use the canopy layer for foraging and/or nesting, or for species that require canopy cover as a general habitat feature, it appears that the first cut did not remove enough of the canopy to negatively affect their numbers. However, their requirements for canopy cover suggest that future cuts will probably have a negative effect upon these species. Golden-crowned kinglet, Swainson’s thrush, solitary vireo, black-throated green warbler, black-throated blue warbler, Blackburnian warbler, pine warbler, and black and white warbler were found in all treatments and showed no significant differences in their abundance. However, many showed lower numbers in the low canopy 70s and 80s treatments than the other two treatments.

Open shrubby habitats: Three species that prefer open habitats and a dense shrub layer were significantly more abundant in the 90s and 70s treatments than
the other treatments. These species were chestnut-sided warbler, mourning warbler and white-throated sparrow. This finding is shared with and confirmed by many other workers studying the impact of forestry on bird populations (Cadman et al., 1988; Falls and Kopachena, 1994). Although the amount of shrub cover was expected to be linked to the abundance of these species, no significant difference was found in the percent cover at the shrub layer despite the observed differences in chestnut-sided warbler, mourning warbler, Canada warbler and white-throated sparrow abundance. Although there was a significant difference in the amount of canopy cover between the treatments, with the 90s and 70s treatments having the lowest amount of canopy cover and thus a more open forest. The combination of an open forest and a sufficient shrub layer make the habitat in these two treatments more suitable than the 80s and old-cut treatments. Freedman et al. (1981) obtained a similar result to this study, showing in the case of the white-throated sparrow its preference for open areas. White-throated sparrows were found to be most abundant in clearcuts, followed by thinned stands and uncut areas (Freedman et al., 1981).

Dense understory habitat: Canada warblers and veeries prefer habitats with dense understory vegetation (Noon et al., 1979; Collins et al., 1982; Peck and James, 1987; Moskoff, 1995) and were both significantly more abundant in the 70s treatment than the other treatments. Ground cover did not differ significantly between the treatments and therefore the amount of ground cover does not appear to be the factor responsible for the large numbers of veeries and Canada warblers found in the 70s treatment. The amount of canopy cover is also not likely to be a factor because these species were not abundant in the 90s cut. The explanation for higher abundance indices for these species is probably due to the significantly denser understory found in the 70s stands. This treatment had a significantly higher total percent cover in the 2 to 5 m layer and higher cover in the 5 to 10 m forest layer that approached significance. In addition to the greater amount of total vegetation cover in the 70s treatment, there was also a much larger amount of deciduous cover at the 2 to 5 m level. The combination of a high percentage of deciduous and total cover created ideal habitat for Canada warblers and veeries in the 70s treatment.

Ground dwelling species: The winter wren was the only wren species observed, and was very abundant in all treatments. Winter wrens typically breed in dense, moist coniferous forests with a dense ground cover of shrubs, woody debris, herbaceous plants and mosses (Cadman et al., 1988). The first cut did not appear to negatively affect winter wrens. Woody debris remained abundant in all treatments although in different stages of decay (Kingsley, 1998). Ground cover vegetation and shrub species in the less than 2 m layer did not differ significantly. These are probably the most important habitat features for Winter wrens as they both nest and forage near the ground and would be influenced mostly by change in this microhabitat (Richard, 1988).

Ovenbirds breed in mature mixed forests with dense understory vegetation above the shrub layer (Cadman et al., 1988; Van Horn and Donovan, 1994). The nest is built on the ground in the shape of a dutch oven, with leaf litter and surrounding vegetation concealing it (Cadman et al., 1988; Van Horn and Donovan, 1994). Their need for leaf litter leads to their preference for nesting areas with relatively low amounts of ground vegetation (Burke and Nol, 1998). The high amount of ground cover observed in 80s treatments, although only
approaching significance \((P=0.069)\), may explain the significantly lower abundance of ovenbirds in this treatment in the second year of the study.

Generalists: These species did not show a significant difference in abundance between the treatments because of their general habitat requirements. These species included: ruffed grouse, blue jay, hermit thrush, American robin, red-eyed vireo, Nashville warbler, magnolia warbler, yellow-rumped warbler, rose-breasted grosbeak, and purple finch (Cadman et al., 1988).

Other: Many species were found in low numbers. In general, more of these were found in the old-cut stands. Although white pine forest was probably not the preferred habitat for some of these species, for example, olive-sided flycatcher, eastern wood pewee, least flycatcher, great crested flycatcher, gray jay, white-breasted nuthatch, yellow warbler, American redstart, common yellowthroat, northern waterthrush, scarlet tanager, chipping sparrow and song sparrow, or the study area was at the edge of their range, for example, wood thrush. It is illuminating that the landscape with old-cut forests provides more habitat for a greater variety of species overall, than the cut landscapes. However, this result is not seen when the average richness of the plots is examined.

Summary and Recommendations

The results of this study show that there are differences between the treatments in both vegetation characteristics and in the breeding bird species richness and abundances. The significant differences observed appear to be the result of a strong preference for one or more vegetation characteristics found in certain treatments. This study only examined the first cutting stage and future cuts will have different impacts on the vegetation structure and bird species composition.

Due to their dependence on mature coniferous trees and a well formed canopy, species such as red-breasted nuthatch, golden-crowned kinglet, Swainson’s thrush, solitary vireo, black-throated green warbler, black-throated blue warbler, Blackburnian warbler, pine warbler and red crossbill are considered vulnerable to population declines as a result of logging practices with short rotation periods (Reed, 1992). Some of these species had lower numbers in the 70s and 90s treatments – low canopy treatments – in the first cut, suggesting that future cuts will have an even greater impact on these species. Future cuts in the uniform shelterwood system will make the forest unsuitable as canopy trees will be removed and probably will not regenerate to such a degree as to maintain the integrity of the forest before the second cycle of cutting begins.

The rotation age of a stand strongly influences the vegetation structure of the forest. Thompson et al. (1995) believed that commercial rotations could result in a decline of species belonging to several guilds, such as cavity-nesters and foliage-gleaners, resulting in a lower diversity of breeding birds within a stand. Rotation times are often much shorter than the natural disturbance regime. This causes the future stand to lose structural characteristics associated with old stands that are needed for bird diversity (Thompson et al., 1995). This was also found in our old-cut stands where overall bird species richness was higher than for any of the more recently logged stands, when viewed collectively – rather than as individual stands – within the landscape of the eastern half of Algonquin Park.
We recommend an extension of the 80 year rotation period that is planned for these forests to protect against possible future loss of structural diversity. Rotations of 130 to 150 years appear appropriate for the white pine forests of Algonquin Provincial Park as this gives the forest enough time to regain its natural structure (Stiell, 1978). In addition to extending the rotation age, we also suggest that the final cut should not remove all remaining mature canopy trees but instead approximately 10% should remain so that there will always be a canopy component of the forest.

We also recommend that, because old-cut forests support more species in the landscape than the more recent cuts, that additional old-cut stands should be removed permanently from cutting in Algonquin Park to increase the beta diversity of the park overall. Finally, this silvicultural technique should be extolled as it has – based on stand by stand comparison – relatively minor impacts on the avifauna of the park. Private landowners should be strongly encouraged to adopt this method of logging as a means of ensuring the regeneration of pine throughout the privately held remnants of this ecosystem in Ontario.

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References


A Research Strategy for Algonquin Provincial Park

Norm Quinn, Biologist, Algonquin Park

Abstract

Algonquin Provincial Park has developed an issues-oriented and operational Research Strategy in the context of the principles of Ecosystem Management. A series of problems and issues related to the natural environment of the park are identified with a connected set of research projects. The projects are prioritized via a numerical ranking scheme and are available for on-the-shelf funding. Each specific project is described briefly. Three projects – two related to forest/wildlife and the other to amphibian decline – received funding in 1997.

Preface

This Research Strategy for Algonquin Park was developed subject to the Algonquin Park Ecosystem Management Strategy. The broader Ecosystem Strategy was developed to address a set of problems and issues related to the natural environment of Algonquin Park – one of which was the lack of a research policy itself. Each project described here is thus related directly to a specific problem/issue described in the broader strategy. For more details the reader is referred to the Terms of Reference of the Ecosystem Management Strategy. The project team members for the ecosystem and research strategies are described in Appendix 1.

The Problem

Algonquin Park has been a focus for research in the natural sciences for decades. Indeed it is said that more research has been done in Algonquin than any protected area anywhere. At any given time there are between 30 and 40 projects active at three research stations. The park has a well-developed administrative procedure for the application and approval process but no overriding research strategy. There is a pressing need to develop criteria to prioritize research and a comprehensive set of candidate projects. This need will become more relevant as funding may develop from Ontario Parks, Algonquin Forestry Authority (AFA), and other partners.

Solution

Develop criteria to set research priorities as well as a set of on-the-shelf projects available for funding.

Research is defined as the acquisition of new knowledge of interest to the broad community of a scientific discipline. A distinction should be made between research and resource monitoring. Monitoring is aimed at determining trends in ecosystem inventory, usually a population. Research is aimed at evaluating findings – including those from monitoring – temporally and spatially in an attempt to improve our understanding. Monitoring can thus be a component of research but is often done strictly for resource management purposes.
Algonquin Park has a well-developed procedure for the review and approval of unsolicited research applications, but this is essentially an administrative tool and makes only a cursory judgement of the scientific merit or relevance to park management needs. Staff essentially react to a set of unrelated proposals. There is no overall direction to research activities in the park. What is needed is a set of criteria for and the development of a set of candidate projects that are priorities to the Ontario Ministry of Natural Resources (OMNR), Ontario Parks and the park. These criteria would then guide the allocation of anticipated funding. Note that this strategy is not meant to preclude the approval of non-priority projects. Research in all disciplines is welcome in the park so long as restrictions in the established approval process are met.

It should be noted that Ontario Parks has developed a corporate research strategy to guide research across the entire park system. A strategy, specifically for Algonquin, should be consistent with the principles and priorities of the broader strategy.

The criteria for the Strategy will apply only to research directed at the natural environment of the park. Sociological research related to natural values will be considered but research that is strictly in the social sciences – while perfectly valid – will not be ranked by these criteria.

Specific Criteria
Criteria will be at two levels: A) criteria that must be met or are mandatory; and, B) criteria to rank the relative value of projects.

A) Mandatory Criteria
1. The project must be consistent with the objectives of OMNR, Ontario Parks, the Park Management Plan and the Ecosystem Strategy.

2. The project must be directed to at least one of the problems and issues identified in the Ecosystem Strategy. The problems and issues are as follows: 1) Research – Lack of Direction; 2) Monitoring; 3) Information and Technology Needs; 4) Introductions; 5) Water Control; 6) Fire Suppression; 7) Forest/Wildlife Diversity; 8) Recreation/Development; 9) Role of Nature Reserve Zones; 10) Atmospheric Pollution; 11) Hunting and Trapping; and, 12) Regional/Global Role. These issues are described in more detail in the Terms of Reference for the Ecosystem Strategy.

3. The research must not result in an unacceptable loss or diminution of any natural value. “Unacceptable” is a judgement call. Most research related losses result from the destructive sampling – i.e., collecting – of fish, plant or wildlife populations. A rule of thumb will be that no population will be impacted such that it can not recover to pre-sampling levels within two generations.

B) Criteria for Ranking Projects
The following are desirable features of proposed projects. Each project shall have points assigned as indicated and summed as a guide to ranking.
1. Relevance to Ecosystem Integrity: The extent to which a project addresses an issue of ecosystem health or integrity – structure, function, and
composition – or relates to principles of conservation or restoration biology will result in assignment of a point value perforce subjectively. As a discretionale guide, the established problems and issues are ranked and assigned points as follows relative to a subjective assessment of their overall ecosystem impact. Some problems, for example, Regional/Global Role, are not ecosystem perturbators as such and thus cannot be ranked here.

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<th>Problem/Issue</th>
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<td>Forest/Wildlife Diversity</td>
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<td>Fire Suppression</td>
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<td>Introductions</td>
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2. Resolution of Resource Management Issues: Projects that contribute knowledge to solving specific resource management issues, such as Lake Trout Slot Limit are assigned four points.

3. Social/Ecological Concerns: Projects that contribute knowledge to issues that have a high profile or level of concern for park users or Ontario society as a whole, such as ozone depletion and amphibian egg survival, or relate to a high profile issue of human use of a resource are assigned four points.

4. Resource Loss: Projects that relate to a specific and clearly identified resource or population loss or decline, such as Hemlock in Algonquin, are assigned four points.

5. Global Role: Projects that relate to the park's broader global role or utilize the park's unique features to address a question of universal interest, for example social behaviour of an unexploited ungulate population, are assigned four points.

6. Biodiversity/Conservation: Projects that advance knowledge of the park's biodiversity and its conservation are assigned four points.

7. Species at Risk: Research on any species at risk recognized by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or the Committee on the Status of Species at Risk in Ontario (COSSARO) is assigned two points.

An example of how the point scheme is applied is given in Appendix 2.

Candidate Projects
The Project Team developed the following set of projects. Each project is described briefly and the entire set is then prioritized. Again, the reader is referred to the Terms of Reference of the Ecosystem Management Strategy for a description of the problems and issues within which the projects are framed.

Problem/Issue: Forest/Wildlife Diversity
Title: Land Water Linkage for Spawning Brook Trout
Description: Algonquin Park is essentially the last area in southern Ontario with self-sustaining brook trout populations. This world-class resource depends critically on small near-shore seepage areas to maintain successful reproduction. Early indications are that associated groundwater recharge areas vary in size with areas measured in hectares of associated forest. For a subset of lakes (N = 10?) we should determine the extent of recharge areas needed to sustain groundwater seepage in brook trout lakes. These areas probably do not conform to simple boundary/border recommendations in forestry guidelines and can best be viewed as specific exemptions – recharge areas, that is – to forestry guidelines. After sites are located and initial groundwater monitoring is conducted, hydrologic and seismic methods will be used to delineate the recharge areas associated with the near-shore seepage areas. These sites will then be monitored to track variation.

Problem/Issue: Introductions
Title: Modelling the Long-term Effects of the Introduction of Non-Native Fish in Algonquin Park
Description: Algonquin Park contains the only major complex of intact native trout fisheries left in Southern Ontario. These fisheries are sensitive to ecological perturbation and in particular to the introduction of non-native, coarse fish which are effective competitors, particularly with brook trout. Such introductions are occurring at an alarming rate and may in time spell the doom of the park’s famed trout fisheries. A spatial and temporal model would shed light on the outcome of this problem.

A second project under this theme that is area-specific is described as follows:

Title: Distribution of New Piscivores in the Galeairy Lake - Lake of Two Rivers Watershed
Description: Two new piscivores, largemouth bass and walleye, have been reported from Galeairy Lake. These predators have the ability to alter fundamentally fish communities in general and brook trout/lake trout fisheries in particular. The appearance of these top predators presents the possibility of new fisheries developing in the highway corridor. In a more general context, their introduction presents an opportunity to track the expansion of these species in this watershed in a spatial context as well as upcoming changes in the lake food webs. The project would involve two phases. First, researchers would assess the distribution and growth of fish and track these over time. Second, they would conduct food habit and trophic-isotopic analyses of food web impacts.

Problem/Issue: Forest/Wildlife Diversity
Title: Stream Crossing and the Fish Movement
Description: Culverts and small bridges regularly cross over streams throughout the park, most often for purposes of forest management. Although crossings are constructed according to guidelines designed to control erosion, there are negative implications for fish populations. One such implication, which is particularly common when culverts are left in site, is obstruction of movement. This potential impact could be serious for species like brook trout that move seasonally to spawn or seek cold water refugia. The effect has not been studied in the relatively confined headwater drainage creeks of the park.
The next three projects are connected to the Problem/Issue of monitoring but have more than just monitoring as an end. All three involve researching the dynamics of population change.

**Problem/Issue:** Monitoring  
**Title:** Anuran Population Regulation  
**Description:** There is growing concern about an apparent global decline of Anuran amphibian (frog) populations. Studies are underway in the park to monitor certain frog populations but this work should be expanded to examine fully the process of population regulation and thus gain insight into why populations may be changing.

**Problem/Issue:** Monitoring  
**Title:** Population Dynamics of the Wood Turtle  
**Description:** The wood turtle, currently designated vulnerable in Ontario, has been recommended for upgrade to threatened status by COSSARO. As such, the wood turtle and two fish, the shortjaw cisco and deepwater sculpin, will have the highest official at risk status of any vertebrate breeding in the park. These are not endangered species. Algonquin, in fact, has three of five significant populations of the species in Ontario. Some preliminary assessment has been done but the population dynamics of the wood turtle in Algonquin is poorly understood.

**Problem/Issue:** Monitoring  
**Title:** Status of Rare Plants  
**Description:** The park has an extensive array of Nature Reserve Zones, many of which were established to protect representative floristic communities. Some of these contain regionally rare plants, though none are globally rare or endangered. In most cases, the status of these plant populations has not been evaluated since the zones were established. Surveys should be initiated to review the status and reproductive potential of these populations.

**Problem/Issue:** Regional/Global Role  
**Title:** Genetic Diversity of Wolves  
**Description:** The wolf as forest predator is one of the park’s enduring images. There is however concern that despite its considerable size, the park is too small to contain a wolf population large enough to have sufficient heterozygosity for genetic health. There is also uncertainty regarding the true genetic identity of the Algonquin wolf in the wolf-coyote-coydog continuum and with respect to subspecific status. The question of genetic diversity could be approached through either theoretical models or an assessment of the real genotype and genetic diversity in the wolf population.

**Problem/Issue:** Atmospheric Pollution  
**Title:** Acidification Impacts – Western Uplands  
**Description:** The issue of acid precipitation and its impact in Algonquin Park remains something of an enigma. Earlier predictions of the catastrophic loss of fisheries have not come to pass and it is indeed difficult to attribute resource loss to acidification definitively. There are however clearly depauperate aquatic communities in the lakes of the western uplands, which is an area subject to very high acid deposition. It would be most useful to determine the real extent of biotic loss in the area due to acidification and model the progression of events.
**Problem/Issue:** Forest/Wildlife Diversity and Fire Suppression

**Title:** Effect of Forest Management on Wildlife

**Description:** This project includes any of a potentially large set of studies that would shed light on how the terrestrial wildlife community of the park has been altered by forest management, including fire suppression, particularly with reference to its natural state. Any such research should lead to strategies for mitigation — such as the modification of current practice toward a more natural forest condition — and also add to the body of knowledge to allow for comprehensive modelling of forest management and wildlife diversity — a long-term goal. The studies may range from species-specific to the diversity of entire communities or may focus on featured or keystone species which act as barometers to guilds or community types. A consideration of the historic role of fire is an integral part of this research theme. There are seven specific projects as follows:

a) An evaluation of forest structure and wildlife diversity in managed versus relatively pristine stands. Practically all the forest in the park has been harvested at one point although there are isolated uncut stands and some areas which were only very lightly logged.

b) A model of the pattern and frequency of fire and windthrow on the pre-settlement landscape.

c) Research at large or small spatial scales of the extent to which modern logging practices emulate the effect of natural agents of change such as fire and gap recruitment on forest ecological integrity — i.e., composition, structure and function — and wildlife diversity. An example would be to examine the long-term effect of suppression of fire near shorelands.

d) The effect of logging on representative featured species such as the pileated woodpecker or keystone species such as the beaver.

e) The effect of logging on a species or group of species for which conservation is a concern such as the wood turtle and Neotropical songbirds.

f) The effect of logging roads on production and distribution of wildlife. Roads may lead to many positive habitat changes such as production of vernal pools, nesting habitat for turtles and excellent substrates for regeneration of yellow birch and berry-producing forbs. However, their role in increasing fragmentation and promoting local introductions of exotics is unknown. Both positive and negative changes need to be understood at a variety of scales to predict impacts of roads on the diversity and sustainability of local flora and fauna during the development of park management plans.

g) Significance of stand boundaries and transitional zones — ecotones — to diversity of flora and fauna. Many recommendations to forest managers for maintenance of diverse forest values are expressed as stand related recommendations. Many of the prescriptions are based on stand boundaries for Forest Resource Inventory (FRI) and forest operations do not change these boundaries. Furthermore, often the core of stands is very different than the periphery of stands in structure and composition. However, many species have home ranges spanning a number of forest stand areas and transitional zones. Similarly, natural disturbance does not respect boundaries as managers do. More functional guidelines to meet both forest operations and sustainability objectives may require testing hypotheses as to the relative contribution of core as compared to transitional components of stands and how important changing boundaries might be in the long-term for emulating natural disturbances.
Problem/Issue: Recreation/Development
Title: Impacts of Campsites, Landings and Portages on Soil, Vegetation and Wildlife Habitat
Description: In many ecosystems, including Algonquin, the impacts of humans at campsites, landings and portages can be locally severe. Particularly at campsites, present human usage may preclude long-term sustainability of sites for recreational use and lead to permanent exclusion of some flora and fauna. In Algonquin, except for moose in spring, there is presently limited knowledge of impacts of campsites on wildlife. Research is required on development of techniques to measure human effects followed by application of the techniques to assess sites for sustainability and monitor remedial actions.

Problem/Issue: Monitoring/Regional Global Role
Title: Status of Neotropical Migrant Birds
Description: There is evidence of a long-term decline of continental populations of certain Neotropical migrant passerine birds. Reasons for these evident declines are uncertain but habitat fragmentation – of forests for example – and the destruction of wintering habitat such as rainforests, are leading candidates. Large protected areas like Algonquin Park may be playing a key role in conservation of these species and in fostering the process of natural population regulation at the landscape level. The status of Neotropical migrants should be assessed in Algonquin Park in the context of the global problem and also with respect to landscape level habitat stability that is unique to places like the park.

Problem/Issue: Atmospheric Pollution
Title: Status of Gray Jay (Perisoreus canadensis) in Algonquin Park
Description: There is a long-term and ongoing study of the behavioural ecology of the gray jay in Algonquin Park. The work has led to insight into the unique adaptive behaviour that these birds use to cope with the harsh northern winter. Recent evidence suggests that gray jays are declining in the park as they recede to core optimum habitat. There is a hypothesis that this decline reflects an influence of a warming climate on the feeding ecology of the birds. Thus the gray jay may be a sensitive indicator of a global environmental problem and an object example of the role large natural areas can serve in providing benchmarks for research and monitoring.

Problem/Issue: Role of Nature Reserve Zones
Title: Big Crow White Pine
Description: The White Pine Nature Reserve Zone east of Big Crow Lake was the first such zone established in Algonquin and protects one of the very few sizeable stands of old growth pine left in the park. In recent years, it has become clear that these huge pines are disappearing as a result of senescence. The stand is a biological and historic treasure. In the absence of intervention, pine will be lost from the site. A management plan, based on sound silvicultural research, is required to perpetuate the stand in a manner that best mimics natural succession.

Conclusion
The foregoing projects have been priority ranked by applying the point values in the ranking criteria and are displayed by problem/issue category in Table 1.
Projects, such as “Genetic Diversity of Wolves”, which address a resource management issue but also relate to an issue of broader global concern are ranked highly. The ranking scheme will be used to allocate any funds the park may receive for research or to solicit proposals. The ranking is not absolute and may be viewed simply as a guide for decision making. However, project funding must not depart markedly from the ranking displayed in Table 1 without suitable justification. It also is recognized that projects could be combined. For example “Declining Neotropical Songbirds” could be assessed in terms of forest management as well as the global perspective.

<table>
<thead>
<tr>
<th>Problem/Issues</th>
<th>Project</th>
<th>Points*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductions</td>
<td>Non Native Fish</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Galeairy watershed</td>
<td>20</td>
</tr>
<tr>
<td>Forest Wildlife Biodiversity</td>
<td>Logging versus species of concern</td>
<td>23-25**</td>
</tr>
<tr>
<td></td>
<td>Wildlife – pristine vs. logged forest</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Brook trout land water interface</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Logging vs. natural change</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Logging roads</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>stand boundaries/diversity</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Logging vs. features/keystone species</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Stream crossings</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Fire model</td>
<td>8</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Neotropical songbirds</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Anuran pop. Regulation</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Wood turtle</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Rare plants</td>
<td>7</td>
</tr>
<tr>
<td>Regional/Global Role</td>
<td>Genetic diversity of wolves</td>
<td>23</td>
</tr>
<tr>
<td>Atmospheric Pollution</td>
<td>Acidification of western uplands</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Gray Jay populations</td>
<td>19</td>
</tr>
<tr>
<td>Rec./Development</td>
<td>Campsite impacts</td>
<td>10</td>
</tr>
<tr>
<td>Nature Reserve</td>
<td>Big Crow Pine</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 1: Candidate Research Projects in Order of Priority for Funding, Algonquin Park. (* points allocated according to criteria in text; ** 23 or 25 points depending on whether or not species is under COSSARO or COSEWIC)

Appendix 1: Algonquin Park Ecosystem Management Strategy

Project Team
Norm Quinn (Chair)  Algonquin Park
Peter Dawson       Algonquin Park
Dan Strickland     Algonquin Park
Dave Goodwin       Algonquin Park
Carl Corbett       Algonquin Forestry Authority
Bill Crins         South Central Region
Brian Naylor       South Central TDU
Dennis Voigt       Research
Tom Beechey        Ontario Parks

Affiliated
Brian O’Donoghue   South Central Region
Mark Ridgway       Research
Ed Addison         Research
Appendix 2: Examples of Project Ranking by Point Scheme

The following hypothetical projects will serve to illustrate how the point scheme is applied.

1) **Regional/Global Role** - “Status of Declining Neotropical Songbirds in Algonquin Park and the Importance of large Protected Areas”

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Integrity</td>
<td>3</td>
</tr>
<tr>
<td>2) Resource Issue</td>
<td>4</td>
</tr>
<tr>
<td>3) Social Concerns</td>
<td>4</td>
</tr>
<tr>
<td>4) Resource Loss</td>
<td>4</td>
</tr>
<tr>
<td>5) Global Role</td>
<td>4</td>
</tr>
<tr>
<td>6) Biodiversity</td>
<td>4</td>
</tr>
<tr>
<td>7) Species at Risk</td>
<td>0</td>
</tr>
<tr>
<td><strong>PROJECT TOTAL</strong></td>
<td><strong>23 points</strong></td>
</tr>
</tbody>
</table>

Note, the point scores for integrity in both cases depart from the scores recommended for each problem/issue (criterion 1 above). Regional/global role has no assigned project score but the specific project, “Status of Declining Neotropical Songbirds in Algonquin Park and the Importance of Large Protected Areas” clearly has an integrity impact, specifically one of composition. Thus it scored fairly high. Similarly, the second project “Effect of Soil Acidification on Regionally Rare Plants in Algonquin Park”, although clearly an atmospheric pollution issue and thus deserving 3 points was subjectively assigned only 1 point because rare plants, by definition, are not major ecosystem players and thus any effect on integrity is small. This illustrates that the point figures assigned for criterion 1 are only meant as guides.

2) **Atmospheric Pollution** - “Effect of Soil Acidification on Regionally Rare Plants in Algonquin Park”

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Integrity</td>
<td>1 (relatively minor composition)*</td>
</tr>
<tr>
<td>2) Resource Issue</td>
<td>4</td>
</tr>
<tr>
<td>3) Social Concerns</td>
<td>4</td>
</tr>
<tr>
<td>4) Resource Loss</td>
<td>0 (no known loss)</td>
</tr>
<tr>
<td>5) Global Role</td>
<td>0 (rare plants in Algonquin are not Globally rare)</td>
</tr>
<tr>
<td>6) Biodiversity</td>
<td>4</td>
</tr>
<tr>
<td>7) Species at Risk</td>
<td>0 (none recognized by COSSARO or COSEWIC)</td>
</tr>
<tr>
<td><strong>PROJECT TOTAL</strong></td>
<td><strong>11 points</strong></td>
</tr>
</tbody>
</table>
Priority Sites for Conservation Action in the Niagara Escarpment Biosphere Reserve

Jarmo Jalava, Natural Areas Ecologist
Helen Godschalk, Natural Areas Consultant
Natural Heritage Information Centre
P.O. Box 7000, Peterborough, Ontario, K9J 8M5

Abstract

In the spring of 1997, the Ontario Natural Heritage Information Centre (NHIC) was approached by Ontario Parks to discuss a scorecard system for important natural areas in the province to assist in prioritizing sites for the Ontario Parks/Nature Conservancy of Canada Land Acquisition Partnership Agreement (Ontario Parks, 1995). The NHIC was approached because it is a member of The Nature Conservancy (U.S.) (TNC) network of heritage programs and conservation data centres that spans much of the western hemisphere. Core functions of these centres include maintaining central databases on rare and endangered species and spaces, and assigning conservation status – or ranks – to species, natural communities and important natural areas, using a standard methodology. One of the goals of TNC methodology is to prioritize sites for conservation action.

Ontario Parks and NHIC staff agreed that an expedient approach to identifying priority sites would be to focus on ecological themes such as prairies and savannahs, alvars, Great Lakes coastal communities and the Niagara Escarpment. The Niagara Escarpment ecological theme has the benefit of having a great deal of accessible data, since the Ontario Ministry of Natural Resources (OMNR) and the Ontario Heritage Foundation co-funded the Ecological Survey of the Niagara Escarpment Biosphere Reserve. The survey summarizes the results of previous studies and six years of biological inventories at the most significant natural areas along the Escarpment. It identified or re-confirmed 62 provincially significant and 38 regionally significant natural areas, using the following standard OMNR criteria to identify areas of natural and scientific interest (ANSIs): 1) representation of landform and vegetation patterns; 2) site diversity; 3) site condition; 4) ecological considerations; and 5) special features (e.g., Crins, 1996; Lindsay, 1984).

Introduction

The site-specific data gathered on Niagara Escarpment ANSIs is sufficient to allow further ranking and prioritization of the 100 sites for conservation action based on the following:
1. the presence of exceptional diversity of natural communities and conservative plant species – i.e., species that display a high degree of fidelity to specific habitats (Oldham et al., 1995; Herman et al., 1994; Wilhelm and Masters, 1995);
2. the presence of globally and provincially rare vegetation communities, flora and fauna; and,
3. the presence of unique or high quality occurrences of natural communities.

Conservation concerns such as human disturbance, as well as the level of protection, contributed to the recommended conservation options for each site. This site prioritization exercise helps to focus parks and protected areas acquisition funds on specific priority sites, as well as to highlight specific management and biodiversity conservation issues at existing parks and protected areas.

Methodology
The site ranking methodology involved the following steps:

Data Preparation
1. The ANSI study sites were grouped into the most current ecological site districts along the Niagara Escarpment – site districts 7E-3, 6E-7, 6E-4 and 6E-14 (Jalava et al., 1997).
2. The vegetation community data in the ecological survey were harmonized with the most current Ecological Land Classification (ELC) for southern Ontario (Lee et al., 1997), thereby bringing the data to the OMNR and Nature Conservancy standard (Bakowsky, 1996). Each ELC type occurring at only one site in the ecological site district, as well as each best or high-quality example of an ELC type was noted wherever such data were available. Each occurrence of globally and provincially rare ELC types was also highlighted based on Bakowsky (1996).
3. Extant globally and provincially rare plant species – G1- to G3-ranked plants and S1- to S3-ranked taxa – were listed for each site based on Oldham (1996). Plant species with a coefficient of conservatism of seven and greater were also listed where 0 is assigned to very weedy species and 10 is assigned to species with a high fidelity to specific habitats (refer to Oldham et al., 1995).
4. Globally and provincially rare fauna species were also listed in a spreadsheet for each site based on standard NHIC ranking.

Calculation of Site Ranks
The sites were ranked from A to E according to their combination of vegetation diversity and diversity of conservative plant species (Table 1). The sites were also ranked according to the presence of rare elements such as types of ELC communities and flora and fauna, using a formula weighted towards globally rare elements and towards elements for which there are fewer than 20 occurrences in the province. A rare elements score was calculated as (number of G1-G3 elements X 3) + (number of S1-S2 elements X 2) + number of S3 elements. The Rarity Rank was derived from the rare elements score according to the following: 50 or greater = 1; 40 to 49 = 2; 30 to 39 = 3; 20 to 29 = 2; less than 20 = 1.

Finally, the sites were ranked according to the presence of unique occurrences of ELC types and “best” or “high-quality” examples of ELC types. The Uniqueness/Quality Rank was based on the sum of these two components according to the following: greater than 6 = High; 3 to 6 = Moderate; 1 to 2 = Present.

Additional Biodiversity Considerations
For each site, the total number of conservative plant species occurring at only
that one site in the site district was indicated. The total number of these species
that are common in adjacent site districts – i.e., taxa that occur at two or more
ANSI sites in the adjacent site district – was subtracted from this total. This step
does not consider common species that are at the edges of their ranges and
flags sites that are required to represent the range of conservative plant diversity
in the site district.

<table>
<thead>
<tr>
<th># of ELC Types</th>
<th># of Conservative Plant Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25</td>
<td>&lt;10</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>-</td>
<td>C</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1: Determining the Diversity Rank

**Prioritization of Sites**
Candidate sites were prioritized in the following order:
a) sites that scored highly by all three major criteria of high ecological diversity,
   high concentration of rare elements, and high number of unique or high-
   quality ELC element occurrences for the site district;
b) sites that scored highly on the basis of two major criteria;
c) sites that scored highly on the basis of one major criterion; and,
d) additional sites that did not score highly, but contain unique occurrences of
   ELC types or conservative plant species.

**Conservation Options**
Based on the biophysical sectional matrices in the ecological survey, other
ecological factors for priority sites were noted, such as site size, connectivity to
other sites, and watershed and hydrological functions. Land ownership, current
management practices, on-site and adjacent land uses, and the nature and
degree of threats to elements were considered. Specific conservation options for
each priority site were recommended based on the conservation priorities
derived from this comparative evaluation.

**Discussion**
Table 2 shows the Diversity Rank, Rarity Rank and Uniqueness/Quality Rank for
sites that scored highly by all three criteria. The seven sites that attained the
highest scores were Niagara Gorge, Cootes Paradise, Crawford Lake - Milton
Outlier Valley, Hope Bay Forest, Smoky Head - White Bluff, Cabot Head and
Little Cove - Cave Point. It is noteworthy that significant portions of each of these
sites are managed as national parks, provincial nature reserves, conservation
areas, or municipally-owned parkland, confirming the wisdom of past acquisition
efforts. Nine additional sites scored exceptionally well, and portions of each of
them are also part of the Niagara Escarpment parks system.
<table>
<thead>
<tr>
<th>Name</th>
<th>Province</th>
<th>Rank</th>
<th>Public</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niagara Gorge</td>
<td>7E-3</td>
<td>A</td>
<td>High</td>
<td>Public (100%)</td>
</tr>
<tr>
<td>Jordan Valley</td>
<td>7E-3</td>
<td>B</td>
<td>Moderate</td>
<td>Public (30%) Private (70%)</td>
</tr>
<tr>
<td>Coote’s Paradise</td>
<td>7E-3</td>
<td>A</td>
<td>Moderate</td>
<td>RBG (95%) Private (5%)</td>
</tr>
<tr>
<td>Medad Valley</td>
<td>7E-3</td>
<td>B</td>
<td>Moderate</td>
<td>Public (15%) Private (85%)</td>
</tr>
<tr>
<td>Crawford Lake - Milton Outlier Valley</td>
<td>7E-3</td>
<td>A</td>
<td>High</td>
<td>Public (90%) Private (10%)</td>
</tr>
<tr>
<td>Halton Forest South</td>
<td>6E-7</td>
<td>A</td>
<td>High</td>
<td>Public (75%) Private (25%)</td>
</tr>
<tr>
<td>Halton Forest North</td>
<td>6E-7</td>
<td>B</td>
<td>High</td>
<td>Public (5%) Private (95%)</td>
</tr>
<tr>
<td>Silver Creek Valley</td>
<td>6E-7</td>
<td>A</td>
<td>High</td>
<td>Public (82%) Private (18%)</td>
</tr>
<tr>
<td>Pretty River Valley</td>
<td>6E-4</td>
<td>A</td>
<td>Moderate</td>
<td>Public (82%) Private (18%)</td>
</tr>
<tr>
<td>The Glen</td>
<td>6E-4</td>
<td>A</td>
<td>High</td>
<td>Public (62%) Private (38%)</td>
</tr>
<tr>
<td>Hope Bay Forest</td>
<td>6E-4</td>
<td>A</td>
<td>High</td>
<td>Public (30%) Private (70%)</td>
</tr>
<tr>
<td>Lion’s Head Peninsula</td>
<td>6E-4</td>
<td>A</td>
<td>High</td>
<td>Public (50%) Private (50%)</td>
</tr>
<tr>
<td>Smoky Head - White Bluff</td>
<td>6E-14</td>
<td>A</td>
<td>High</td>
<td>Public (35%) BTA (15%) Private (50%)</td>
</tr>
<tr>
<td>Cabot Head</td>
<td>6E-14</td>
<td>A</td>
<td>High</td>
<td>Public (66%) Private (34%)</td>
</tr>
<tr>
<td>Little Cove - Cave Point</td>
<td>6E-14</td>
<td>A</td>
<td>Moderate</td>
<td>Public (40%) Private (60%)</td>
</tr>
<tr>
<td>Bear’s Rump Island</td>
<td>6E-14</td>
<td>B</td>
<td>Moderate</td>
<td>Public (100%)</td>
</tr>
</tbody>
</table>

Table 2: Niagara Escarpment ANSI Sites that Score Highly By All Three Major Criteria (Diversity Rank, Rarity Rank and Uniqueness/Quality Rank)

The preferred conservation options for each site depend in part on the ecological conditions at the site, on the biodiversity elements present as well as on land tenure. Table 3 is an example of a scorecard for selected sites in ecological site district 7E-3. The Niagara Gorge site is 100% publicly-owned, and has an exceptional concentration of rare elements and unique ELC types, but some of the vegetation communities are degraded and much of the site’s historic diversity has been lost. The recommended conservation options for this site relate primarily to restoration and management. At the other end of the spectrum among the high-priority sites, Medad Valley is 85% privately-owned. Options for this relatively-undisturbed site include education materials for the private land stewards, conservation easements and land acquisition. Conservation scorecards for all priority sites within the biosphere reserve are in preparation (Jalava and Godschalk, 1997).
Table 3: Conservation Priorities, Concerns and Options for Highly Ranked ANSI Sites in Site District 7E-3

<table>
<thead>
<tr>
<th>Site Name: Niagara Gorge</th>
<th>Site Name: Jordan Valley</th>
<th>Site Name: Coote’s Paradise</th>
<th>Site Name: Medad Valley</th>
<th>Site Name: Crawford Lake - Milton Outlier Valley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional concentration of rare elements; outstanding concentration of extant conservative plant species (113); several best/only examples of ELC types in the site district; 32 conservative plant species not found at other sites in site district</td>
<td>Exceptional concentration of rare elements; high number of conservative plant species (78); several best examples of ELC types; outstanding lakeshore marsh</td>
<td>Exceptional concentration of rare elements; exceptional number of conservative plant species (189); several best/only examples of ELC types in the site district; 24 conservative plant species not found at other sites in site district</td>
<td>High concentration of conservative plant species (78); several best/only ELC types and several unique conservative plant species for site district; moderate concentration of rare elements</td>
<td>High concentration of rare elements; high number of conservative plant species (108); numerous best/only examples of ELC types in site districts</td>
</tr>
<tr>
<td>Site Name: Jordan Valley</td>
<td>Watershed concerns including sediment- and nutrient-loading; reduction in water volume; pesticides; motorboat traffic in marsh; foot traffic in sensitive communities; introduced plants; fragmentation due to residential development and roads; selective logging</td>
<td>Fire-suppression likely resulting in loss of savannah communities and species; decline in quality and extent of wetland communities from sediment- and nutrient-loading and water level effects; introduced flora/fauna; adjacent land-uses; recreational uses</td>
<td>Adjacent land-uses include golf course and encroachment by residential development; fragmentation by two utility corridors</td>
<td>Past selective logging; moderate levels of recreational uses such as trail use and rock climbing; adjacent residential development on western portion of site</td>
</tr>
<tr>
<td>Limitations</td>
<td>Limiting recreational use of site; re-introduction of extirpated species; restoration of degraded communities; buffering natural communities; restoring links to surrounding natural areas</td>
<td>Public education regarding sensitivity of priority elements for park visitors and private land stewards; restriction of motorboat/personal watercraft traffic; watershed restoration; conservation easements; acquisition</td>
<td>Public education regarding sensitivity of priority elements, particularly with private land stewards; conservation easements; acquisition of key properties – this site is remarkably undisturbed</td>
<td>Public education regarding sensitivity of priority communities for park visitors and private land stewards; restriction and monitoring of activities such as rock-climbing; reversion from active forest management to natural disturbance cycles</td>
</tr>
</tbody>
</table>

Limitations

Site districts 7E-3 (Niagara to Halton), 6E-4 (Grey and Bruce) and 6E-14 (north Bruce) correspond closely with the Niagara Escarpment study area. Sites from
north Halton to Simcoe occur in site district 6E-7, which extends eastward along the Oak Ridges Moraine. The whole of site district 6E-7, including sites outside of the Niagara Escarpment study area, will need to be considered for a complete evaluation. However, Niagara Escarpment-related features are restricted to the sites considered in the present study, so their ranking within this thematic study is perhaps warranted. Additionally, three of the study sites contain Niagara Escarpment features but occur in adjacent site district 6E-5. These sites were considered in the context of adjacent site district 6E-4.

In some areas, the sites considered are connected to other sites by natural links, or are merely separated by roads. Contiguous or nearly-contiguous sites would score more highly if they were combined.

The results of this evaluation are not intended to diminish the importance of ANSI status recommendations made in Riley et al. (1996) where ANSI statuses are recommended on the basis of a broader range of criteria, with representation of landform-vegetation patterns being the primary criterion. The present evaluation focuses on a finer-scale set of criteria and is intended to complement ANSI status recommendations as well as assist government agencies and non-government organizations in focusing scarce conservation funds on sites with the greatest concentrations of ecological diversity, sensitive species and imperilled elements.

The importance of landscape-scale conservation planning cannot be overemphasized. This may include restoration of links between natural areas, preservation of natural corridors and sound watershed management. The integrity of the priority sites, the viability of the elements of concern, and the value of the investment by conservation groups will ultimately depend on the manner in which the surrounding landscape is managed.

Acknowledgements
Wasyl D. Bakowsky (Community Ecologist, NHIC) and Gary Allen (Ecologist, OMNR) reviewed the methodology used to rank sites in this study and provided valuable suggestions.

References


Investigation of Nutrient Sources to Point Pelee Marsh*

T. Mayer, R.A Bourbonniere, L. Zanini and S. Telford
National Water Research Institute, 867 Lakeshore Rd., Burlington, Ont.

Abstract
Eutrophic conditions were observed in some of the open-water ponds along the western margin of Point Pelee Marsh, located within the boundaries of the Point Pelee National Park (McCrea, 1993). The western margin of the park is the area of main human activity; hence input from anthropogenic activities was suspected. A multidisciplinary study was initiated to identify nutrient sources to the marsh.

Sedimentary records were investigated from two locations along the western margin of the Park. One location, with the highest nutrient concentrations in the marsh was the Sanctuary Pond, where spatial and stratigraphic differences in porewater chemistry and sediment composition were investigated. No differences were found between the porewater chemistry or sediment composition among the investigated sites at the Sanctuary Pond, suggesting an absence of external nutrient sources. The results indicate that at the Sanctuary Pond sediments, rather than external sources, are responsible for excessive nutrient inputs.

The second area investigated is situated in the proximity of the Blue Heron picnic area, where public washrooms serviced by the septic system are located. Here, nearshore-offshore differences in sediment phosphorus (P) concentrations and spatial differences in the sewage specific indicator coprostanol suggest that sewage-derived input, possibly from the park septic system, may contribute nutrients to the marsh.

Introduction
Poor water quality, resulting from elevated nutrient concentrations, was observed in some of the open-water ponds at Point Pelee Marsh, located within the boundaries of Point Pelee National Park (McCrea, 1993). Ponds along the western margin of the park were particularly affected. The western margin of the park is the main area of human activity; hence input from anthropogenic activities was suspected. A study was initiated to identify nutrient sources to the marsh.

Study Area and Methods
Sedimentary records from two locations along the western margin of the park were investigated. One location, with the highest nutrient concentrations in the marsh, was the Sanctuary Pond. Two sites were selected for the investigation at the Sanctuary Pond (Figure 1). Site #1- Middle was located in the middle of the pond, while Site #2 - Corner was located in the vicinity of once suspect sources. Sediment cores were collected at each site and they were sectioned immediately

* This paper arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
after retrieval into 1cm intervals. Sediments were freeze-dried and analyzed for various forms of phosphorus and for the organic content. Composition of sediment porewater was determined by deployment of in situ acrylic samplers, also known as peepers. The samplers were left in sediments for passive equilibration for two weeks. Porewater samples were withdrawn from individual cells, transferred to pre-acidified plastic tubes and analyzed by standard methods for PO$_4$-P, NH$_3$-N and major ions (Ca, Mg, Fe, Na, K, Mn, Al, Sr, Ba).

Figure 1: Point Pelee Study Areas (A) Boardwalk/Blue Heron; (B) Sanctuary Pond

Boardwalk / Blue Heron site was the second area investigated (Figure 1). This site is situated in the proximity of the Blue Heron picnic area, where public washrooms, serviced by the septic system, are located. Several inactive tile beds are also present in this area. Sediment cores were collected here from the nearshore (BH1, BW1) and offshore (BH2, BW2) areas. Similarly as for the Sanctuary Pond, the sediments were sectioned into 1 cm intervals and subsequently freeze-dried in the laboratory. Dry sediments were analyzed for total phosphorus, organic C, and for the sewage-specific molecular marker, coprostanol. Coprostanol was determined by liquid/liquid extraction, followed by high-resolution gas chromatography (GC). A detailed description of the study area and analytical procedures is provided in Mayer et al. (1997, 1998).
Results

Sanctuary Pond
The water quality data reveal a high turbidity (51 NTU) and nutrient concentrations (0.23 mg/L TP, 5.40 mg/L TKN) in the water column. At both sites, elevated concentrations (0.13 mg/L) of the NH$_3$-N were measured in the water column. High chlorophyll levels (~78 µg/L) suggest that primary productivity, in addition to silt, contributes to decreased water clarity. However, resuspension of benthic sediments by feeding and spawning carp and gas ebullition in the sediments are largely responsible for the high turbidity in the water column of the Sanctuary Pond.

The porewater profiles (Figure 2), as well as the levels of dissolved nutrients, were similar for both investigated sites at the Sanctuary Pond, suggesting little spatial difference in porewater nutrient chemistry. The levels of porewater PO$_4$-P and NH$_3$-N (Figure 2) were high and they were comparable with values reported for sediments of hyper-eutrophic lakes or wetlands receiving hyper-eutrophic lake water. High concentrations of PO$_4$-P and NH$_3$-N in porewater result likely from anaerobic decomposition of organic matter, which produces high concentrations of these constituents in interstitial water.

Like the porewater nutrient profiles, the benthic sediment P profiles (Figure 3), were comparable at both investigated sites. There were no differences in total
phosphorus (TP) concentrations between the nearshore site (Site #2 - Corner) and the offshore site (Site #1 - Middle) at the Sanctuary Pond. At both sites, there was a marginal decline in total phosphorus concentrations from sediment-water interface downward, mainly due to decreasing concentrations of the organic phosphorus. The lack of spatial differences in porewater and sediment nutrient concentrations suggests that sediments are the main nutrient source to the Sanctuary Pond.

**Boardwalk / Blue Heron**

The sediment phosphorus profiles reveal substantial spatial and stratigraphic differences between the nearshore and offshore sediments at Boardwalk and Blue Heron (Figure 3). The total phosphorus (TP) concentrations of nearshore sediments at Boardwalk and Blue Heron are substantially higher than those offshore. The differences between the nearshore and offshore data set are statistically significant at 95% confidence level. In all cores, the TP concentrations decline gradually from the sediment-water interface downward, however the differences between the nearshore and offshore sediments remain detectable.

To substantiate the assumption that the increased nearshore sediment P concentrations are attributable to sewage derived input, the distribution of a sewage specific molecular marker coprostanol was examined. Coprostanol (5β-cholestan-3β-ol) is one of the major fecal sterols excreted by man and higher mammals. It is produced primarily in the intestines by the microbial reduction of cholesterol. Because of the uniqueness of this process, coprostanol has been widely used for tracing sewage pollution in marine sedimentary environments.

Concentrations of sedimentary coprostanol range from 0.35 to 12.1 mg kg\(^{-1}\). The data (Table 1) exhibit a definite trend, revealing the differences in coprostanol concentrations between the nearshore and offshore sediments. The nearshore sediments have higher coprostanol concentrations than the offshore sediments. The highest coprostanol concentrations (10-12 mg kg\(^{-1}\), Table 1) were measured at the marsh edge (BH-W, Figure 1) and in the upper sediments close to the shore (BW1, BH1).

<table>
<thead>
<tr>
<th>Sample/Core Depth(cm)</th>
<th>Coprostanol (mg kg(^{-1})) nearshore</th>
<th>Coprostanol (mg kg(^{-1})) offshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10.08</td>
<td>7.19</td>
</tr>
<tr>
<td>5</td>
<td>12.13</td>
<td>3.17</td>
</tr>
<tr>
<td>9</td>
<td>6.16</td>
<td>3.07</td>
</tr>
<tr>
<td>BH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10.57</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>11.67</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>4.53</td>
<td>0.46</td>
</tr>
<tr>
<td>BH-W</td>
<td>11.50</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Coprostanol concentrations in sediments from Point Pelee

At the Boardwalk/Blue Heron area, the distribution of coprostanol is consistent with the distribution of P in sediments and supports the premise that the higher P concentrations in nearshore sediments may be a result of sewage derived input to the marsh.
Conclusions

At the Sanctuary Pond, the lack of spatial differences in porewater and sediment nutrient concentrations suggests that the sediments in this pond act as a nutrient source. However, the spatial differences in phosphorus and coprostanol concentrations at the Boardwalk/Blue Heron area, suggest that sewage-derived nutrients may contribute to natural nutrient loading to the marsh.

Figure 3: Concentrations of TP in sediments (Upper) Sanctuary Pond; (Lower) Boardwalk/Blue Heron.
Acknowledgements
We are grateful to L. Ziolkowski, L. Durham and J. Lee for capable assistance with laboratory analyses. We also thank C. Talbot and J. Vohralek for the field assistance, and A. Crowe, C. Ptacek and G. Mouland for valuable support throughout the study. Special thanks are due to R. McCrea, for introducing the problem for this study. This study was made possible by financial support from Parks Canada and Environment Canada Great Lakes 2000 Program.

References


Release of Nutrients from On-site Wastewater Disposal Systems, Point Pelee National Park, Ontario, Canada*

C. Ptacek1,2, J. Fitz Gerald1, A. Crowe1, J. Bain2, K. Waybrant2, and D. Thompson2
1National Water Research Institute, Environment Canada, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6
2Department of Earth Sciences, University of Waterloo, Waterloo, ON N2L 3G1

Abstract
Point Pelee National Park relies on the use of on-site methods to dispose of wastewater generated in the Park. The Park is located on the southern half of a 15 km long cuspate, consisting of two narrow barrier bars and a large interior protected marsh. There are more than 30 active tile beds, excavated directly into the native sands of the western barrier bar. These tile beds receive wastewater from more than 0.5 million day-visitor each year. Past methods of sewage disposal for up to one million day-visitor each year included direct disposal to the barrier bar, the use of holding tanks, and dispersed discharge through tile lines. Because of limited land mass, wastewater disposal often occurred close to the marsh. At two recent tile bed sites, located within 60 m of the marsh, concentrations of NO3 between 1 and 80 mg/L (as N) are present more than 40 m from the tile beds. In reducing zones at the marsh edge and at the base of the aquifer, bacterial denitrification processes lead to the removal of NO3 to concentrations < 0.01 mg/L N. Phosphate concentrations approach 3 mg/L P up to 10 m from the tile beds, and 0.1 - 1 mg/L P in a reducing zone at the base of the aquifer up to the marsh edge. Elevated concentrations of NH3 are present more than 60 m from the tile beds. At a site which last received sewage input two decades ago, NO3 is absent, but elevated concentrations of PO4 and NH3 are present in the groundwater zone close to the marsh edge. Monitoring at the groundwater/marsh interface indicates that nutrient-rich groundwater is seeping into the marsh for most of the year. The eutrophic conditions observed in several marsh ponds adjacent to the barrier bar are attributed to PO4 release from recent and past on-site wastewater disposal practices.

Introduction
The Point Pelee marsh is a major protected coastal wetland located on the north shore of Lake Erie (Figure 1). Several ponds within the marsh experience prolific algal blooms as a result of excess nutrient concentrations (total P > 0.3 mg/L) in the marsh water column (McCrea, 1993). At the end of the growth cycle, the biomass dies, settles to the marsh bottom, and decay processes begin. Mayer et al. (1998) reported elevated concentrations of nutrients in the upper 30 cm of marsh sediments below a hypereutrophic marsh pond. These nutrients, released from anaerobic decay processes, occur as dissolved phosphate and ammonia in

* This paper arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
interstitial pore waters and as accumulated phosphate solids. A portion of these nutrients re-enter the water column and are available for renewed algal growth.
This study was conducted to determine whether input of sewage-derived nutrients is a potential cause of the elevated nutrient concentrations observed in the marsh ponds and sediments. Point Pelee National Park, like many parks in Ontario, relies on the use of septic-tanks and tile bed leach fields to dispose of sewage generated in the Park. Sewage released to the subsurface from tile beds typically leads to the development of plumes of groundwater which contain elevated concentrations of nutrients and other dissolved constituents. These plumes are often many tens of meters in length, and, in some cases, discharge to surface water bodies.

At Point Pelee, there are more than 30 active tile beds, including conventional and raised beds, installed in the western barrier bar of the Park (Figure 1). These tile beds receive wastewater seasonally or year-round from comfort stations, the visitors' centre and Park support buildings. The Park receives approximately 0.5 million visitors each year. In the 1950s and 60s, the number of visitors to the Park was higher, approaching 1 million visitors each year. There were also a number of private dwellings which have been removed through a land acquisition and naturalization program.

The presence and persistence of sewage-derived components in the subsurface was evaluated by conducting hydrogeological studies at active tile beds, a tile bed which had been decommissioned for two years, and a site which last received wastewater more than two decades ago. Measurements of groundwater seepage and nutrient transport directly into the Point Pelee marsh were also made. These measurements assist in the determination of the current rate of release of nutrients to the marsh, and the potential for future release as a result of ongoing discharge of sewage.

**Study Methods**

Networks of stand-pipe and multilevel bundle piezometers were installed at the Blue Heron and Camp Henry active tile bed sites, and the formerly used Marsh-Boardwalk site (Figures 1 and 2). The Blue Heron tile bed receives about 10,000 L/day of blackwater year-round from a visitor comfort station. It was installed around 1980. The Camp Henry "old" tile bed received blackwater seasonally from an overnight camp for about 17 years. It was sampled while it was active, and two years after it was decommissioned. The Marsh-Boardwalk area had a number of cottages and other buildings, vault toilets, and possibly a tile bed. Buildings at the site were removed and wastewater disposal in the area ceased in the late 1970s. Samples of groundwater were collected from more than 300 locations at the three sites and analysed for concentrations of nutrients (NO₃, NH₃, PO₄, and DOC), major ions, and trace metals, and field pH, Eh, alkalinity and temperature. Groundwater flow directions and rates were measured at the groundwater/marsh interface using nests of minipiezometers and seepage meters (Figure 2).
The composition of effluent entering the active beds is typical of blackwater. It contains elevated concentrations of dissolved organic carbon (DOC), nitrogen, phosphorous, and pathogens (Table 1). When effluent is discharged to tile beds and allowed to infiltrate to the subsurface, a series of reactions occurs. In the unsaturated zone above the water table, DOC and ammonia ($\text{NH}_3$) are oxidized to carbon dioxide and nitrate ($\text{NO}_3$). Organic phosphorous and phosphate ($\text{PO}_4$) are removed through adsorption and precipitation reactions, and pathogens are removed through a variety of physical and chemical processes. If the residence time in the unsaturated zone is sufficient, large declines in concentrations of DOC and ammonia are observed, and some removal of $\text{PO}_4$ and pathogens occurs. Wastewater entering the saturated zone, however, typically has elevated concentrations of $\text{NO}_3$ and $\text{PO}_4$, and potentially elevated concentrations of $\text{NH}_3$, bacteria, viruses and trace contaminants.

At the instrumented active sites, elevated concentrations of $\text{NO}_3$, $\text{PO}_4$ and $\text{NH}_3$ were observed in the groundwater below and adjacent to the tile beds (Figures 3 and 4) (Ptacek et al., 1994; 1997; Ptacek, 1998). At the Blue Heron tile bed, concentrations of $\text{NO}_3$ ranged between 1 and 30 mg/L (as N) in a plume that extends more than 40 m from the edge of the bed. At Camp Henry, concentrations of $\text{NO}_3$ were higher, ranging between 1 and 80 mg/L in a plume that extends more than 40 m from the edge of the "old" bed. These
concentrations are well in excess of the World Health Organization (WHO) drinking water guideline of 10 mg/L NO3-N. At both sites, in reducing zones at the marsh edge and at the base of the aquifer, bacterial denitrification processes result in the removal of NO3 to concentrations < 0.01 mg/L N. At both sites, concentrations of NH3 are elevated to distances more than 60 m from the tile beds. These elevated concentrations of NH3 suggest oxidation of the septic tank effluent was incomplete during its transport through the unsaturated zone. Phosphate concentrations exceed 1 mg/L P up to 10 m from both beds. At the base of the aquifer at both sites, in a reducing zone, concentrations of PO4-P range between 0.1 - 1 mg/L, up to the marsh edge. These concentrations represent a large decline from approximately 5 - 10 mg/L in the original effluent (Table 1). The large volume of groundwater containing concentrations > 0.1 mg/L P, however, represents sufficient PO4 to be of concern if discharged to surface water bodies. Similarly, elevated concentrations of NH3 represent a potential input of N into the marsh.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration</th>
<th>Camp Henry</th>
<th>Blue Heron</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO2+NO3 (mg/L as N)</td>
<td>0.05*</td>
<td></td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>NH3 (mg/L as N)</td>
<td>97.9</td>
<td>36.4</td>
<td></td>
</tr>
<tr>
<td>P, total (mg/L)</td>
<td>11.8</td>
<td>4.12</td>
<td></td>
</tr>
<tr>
<td>DOC (mg/L)</td>
<td>31.8</td>
<td>34.7</td>
<td></td>
</tr>
</tbody>
</table>

* Concentration equal to analytical detection limit

Table 1: Composition of septic-system effluent collected from Camp Henry and Blue Heron holding tanks, May, 1996.

Recently-Decommissioned Tile Bed

In 1995, wastewater discharge at the Camp Henry site was switched to a new "raised" tile bed to enhance oxidation of the wastewater. The plume at the "old" tile bed was sampled two years after input had been terminated to evaluate the rate of dissipation of the sewage at the site. This sampling showed large declines in concentrations of NO3 and NH3, but virtually no change in PO4 concentrations (Figure 4). Analyses of PO4 conducted on core material collected from the site while sewage disposal was active indicated substantial accumulations of PO4 were present on the aquifer solids. The elevated concentrations of PO4 in the groundwater are consistent with release of PO4 into the flowing groundwater from these earlier accumulations on the aquifer solids.
Figure 3. Concentrations of nitrate, ammonia and phosphate in groundwater near the Blue Heron active tile bed. At the time of sampling, the bed had been in operation for 18 years.
Figure 4. Concentrations of nutrients in the groundwater near the Camp Henry tile bed. The bed was active for 16 years at the time of sampling.
Formerly-Developed Area

At the site where records show the presence of vault toilets, numerous buildings, and possibly a tile bed, elevated concentrations of PO₄ and NH₃ are present in the groundwater zone (Figure 5, NH₃ not shown; Figure 6). Very high concentrations of PO₄ (1-2 mg PO₄-P) were observed in isolated pockets close to locations of earlier discharges (Thompson et al., 1997). There are also very high concentrations of PO₄ in isolated pockets along the edge of the marsh (> 8 mg/L PO₄-P), close to the former location of a vault toilet.

The natural anaerobic degradation of organic matter results in the release of PO₄ and NH₃ into groundwater. The elevated concentrations of nutrients observed close to the marsh may be a result of this natural process or a result of past wastewater release to the subsurface. The highest concentrations were observed close to wastewater release sites. Elsewhere along the groundwater/marsh interface concentrations are much lower than in this zone where previous releases were known to have occurred. These results suggest that the elevated concentrations observed along the marsh edge away from the sewage disposal areas are a result of the degradation of natural organic matter, and the higher concentrations are the result of residual sewage. Therefore, it appears that even after 20 years, there is the potential for sewage-derived PO₄ and NH₃ to persist in the groundwater zone.

Discharge into Marsh

Hydraulic head and seepage meter measurements indicate groundwater flow is directed into the marsh for most of the year. For example, in May 1996 groundwater was observed to be discharging into the marsh at a rate of 0.02 and 0.13 litres/m²/day (Ptacek et al., 1997). Even higher discharge rates are expected to occur during periods of high infiltration (spring melt, autumn rains) or in response to large declines in the elevation of the marsh.

Implications

The results from the sampling at the active tile beds indicate that elevated concentrations of NO₃, NH₃, and PO₄ are present in the groundwater zone as a result of recent sewage discharge to the subsurface. Sampling at the site two years following decommissioning indicates concentrations of NO₃ and NH₃ declined, but high concentrations of PO₄ remain. At a location where sewage release ceased two decades ago, concentrations of PO₄ and NH₃ are elevated, suggesting there is a long-term potential for nutrient persistence.

Geochemical monitoring at the marsh interface shows elevated concentrations of nutrients in the groundwater zone near the marsh edge and in the marsh pond bottom sediments. Hydraulic head measurements show groundwater flows toward the marsh for most of the year. Groundwater seepage measurements indicate seepage of groundwater into the marsh for most of the year.

Many Parks in Ontario rely on subsurface disposal of wastewater. Groundwater plumes emanating from these sites typically contain elevated concentrations of nutrients. These plumes can discharge into surface water bodies increasing the nutrient pool. After tile bed abandonment, release of phosphate from previously accumulated solid-phases can lead to additional release to surface water bodies.
Figure 5. Concentrations of nutrients in the groundwater two years after the Camp Henry tile bed was decommissioned.
Sewage effluent typically contains between 5 and 15 mg/L P and loadings of 10,000 L/day are common at large park comfort stations. These comfort stations operate for many decades, therefore the total phosphorous released can be on the order of 100's to 1000's of kg over the life of a bed. Typical groundwater concentrations of PO₄ are in the range of 0.1 to 3.0 mg/L P. Even if only a portion of this phosphorous is eventually leached at these concentrations, the loadings can be sufficiently large to cause a significant increase in the nutrient pool of marsh ponds. Once nutrients are present in the marsh water column and sediments, a portion will be buried, but a portion can also be regenerated each year for renewed biomass growth.

Acknowledgements
Thanks are extended to R. McCrea for suggesting the study, and D. Blowes and W. Robertson for helpful discussions. Funding for the project was provided by GL2000, Environment Canada, Parks Canada and NSERC. We thank G. Mouland and B. Horan of Point Pelee National Park for their ongoing support.

References


An Overview of Environment Canada's Groundwater Research Activities at Point Pelee National Park, Ontario

A.S. Crowe¹, C.J. Ptacek¹, R. McCrea², P.A. Huddart³, F.J. Longstaffe³, J.P. Coakley¹, T. Mayer¹, D.L. Thompson⁴, and S.G. Shikaze¹

¹ National Water Research Institute, Environment Canada, Canada Centre for Inland Waters, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6.
² Ecosystem Health Division, Ontario Region, Environment Canada, Canada Centre for Inland Waters, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6.
³ Department of Earth Sciences, University of Western Ontario, London, Ontario, N6A 5B7.
⁴ Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, N2L 3G1.

Abstract

Most of Point Pelee National Park is comprised of a massive marsh consisting of cattails and open water ponds. The marsh is completely separated from Lake Erie by two barrier bars along the east and west sides of the marsh. Elevated concentrations of phosphorus, nitrate and ammonia were detected in a few of the open water ponds within the marsh. These high concentrations and continued nutrient loadings may lead to the deterioration of the health and natural biodiversity of the marsh. Because the highest concentrations of nutrients are located along the western barrier bar, which is also the main area of human activity within the park, it is suspected that nutrients from the septic system tile beds are leaching to the water table, and then into the marsh via groundwater flow. To enable Parks Canada to make informed decisions about water quality issues within the park, Environment Canada is undertaking a multi-disciplinary series of research and monitoring studies. These studies endeavour to characterize the following:

1. the sedimentology and glacial stratigraphy of the barrier bars;
2. the groundwater flow regime and its connection to Lake Erie and the marsh;
3. the relative contributions of the hydrologic components to the groundwater regime;
4. the fate and transport of septic system derived nutrients;
5. the historical impact of land use;
6. nutrient cycling within the marsh; and,
7. modelling groundwater flow and contaminant transport.

Introduction

Point Pelee National Park is located on the southern portion of a spit extending 15 km southward into the western end of Lake Erie. Approximately 70% of the park is comprised of a massive marsh consisting primarily of cattails and open water ponds (Figure 1). The marsh is completely separated from Lake Erie by barrier bars which run along the west and east sides of the marsh. The convergence of the barrier at the south gives Point Pelee its distinctive triangular
shape. The park is internationally known as a sanctuary for migratory birds because of its southward projection into Lake Erie and its large marsh. In addition to its highly diverse bird population, the Point Pelee marsh is a highly productive ecosystem, supporting many species of aquatic and terrestrial plants, fish, mammals, reptiles and amphibians.

Figure 1: Location of groundwater-related activities at Point Pelee National Park

<table>
<thead>
<tr>
<th>Research Activities at each Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>G - geology</td>
</tr>
<tr>
<td>GW - groundwater flow</td>
</tr>
<tr>
<td>I - stable isotopes</td>
</tr>
<tr>
<td>SS - septic systems</td>
</tr>
<tr>
<td>H - historical land-use impacts</td>
</tr>
<tr>
<td>M - marsh</td>
</tr>
</tbody>
</table>

Point Tip transect (G)
The Point Pelee marsh also acts as a metabolic regulator of contaminants, nutrients and organic matter that enter the system. Although plants within a marsh consume phosphorous which enters the marsh, too much phosphorous will overload the system, leading to the deterioration of water quality and natural biodiversity. The Ecosystem Health Division of Environment Canada detected elevated concentrations of phosphorous in a few of the open water ponds. Sanctuary Pond, located in the northwest corner of the marsh, has experienced excessive seasonal algal growth which has resulted in the pond presently experiencing hypereutrophic conditions. Phosphorus concentrations in the ponds near the Marsh Boardwalk area are not as high as at Sanctuary Pond, but are still sufficiently high to warrant concern about its water quality and ecosystem. These ponds are located immediately adjacent to the western barrier bar, which is also the area of the park accessible to visitors and contains services for the visitors, including washrooms. It is very common to have waste water from septic system tile beds migrating downward to the water table causing high concentrations of nutrients, including phosphates, nitrates and ammonia, in the groundwater. Because of the numerous septic system tile beds located relatively close to the marsh, and the very sandy nature of the soil in which the tile beds are placed, it was suspected that the park's septic systems may be a potential source of the nutrient loading via groundwater flow and discharge to the marsh.

Point Pelee National Park (Parks Canada) and the Ecosystem Health Division (Ontario Region - Environment Canada) asked the Groundwater Remediation Project (National Water Research Institute - Environment Canada) to help address this issue. The principal objective was to determine if nutrients from the park's septic systems were entering the marsh and contributing to the increased concentrations of phosphorus, nitrate and ammonia presently observed in the marsh. This objective was divided into two primary tasks:

1. understanding the groundwater flow regime in the western bar; and,
2. characterizing the nutrient discharge from the park's septic system.

Initially, addressing these tasks seemed like a relatively simple groundwater flow and contaminant transport problem. The septic systems are within a few 10's of metres of the marsh; tile beds are constructed in very sandy and permeable soil; the water table is quite shallow; and, the septic systems are situated between the marsh and an upland dune area. However, as the study progressed, it became apparent that the groundwater flow regime and the geochemistry of the septic-system nutrients in the subsurface were very complex. Further, it became apparent that undertaking this study over a few months or even 1 - 2 years would not provide an accurate understanding of the system, nor would it adequately address the objectives of the study.

The study has become long-term and is now entering into its fifth year. It has also adopted a multi-disciplinary perspective. Various components of the study now underway include:

1. understanding the groundwater flow regime;
2. developing a hydrologic budget of the groundwater flow regime;
3. characterizing the nutrient geochemistry of three septic system tile beds;
4. investigating the historical land-use impacts;
5. identifying sources of phosphorus in the marsh;
6. interpreting the sedimentary structure and geological evolution of Point Pelee; and,
7. developing a numerical model for groundwater flow and contaminant transport.

This paper presents an overview of these seven research activities. Some of these activities have been completed and some are currently being conducted at Point Pelee National Park.

**Geological Setting of Point Pelee**

The sediments and sedimentary structure in the subsurface largely control groundwater flow. Groundwater flow, and corresponding contaminant transport, favour sediments which offer the least resistance to flow. Sand and gravel are most conducive to groundwater flow, while clay and till are least conducive. Identification of those sedimentary zones – or hydrostratigraphic units – which are most likely to be the main pathways for groundwater flow as well as those which are least likely to permit groundwater flow, is required in order to focus efforts and resources in areas most likely to contain contaminants. In addition, characterization of the sedimentary structure, geometry, and extent of these hydrostratigraphic units aids in interpolation between boreholes and wells. The present subsurface structure is a direct result of past deposition and erosion of the sediments. Thus, a geological investigation of Point Pelee is an integral component of the park’s groundwater study. The specific objectives undertaken as part of the geological interpretation of Point Pelee are to:

1. identify subsurface sediment types (e.g., sand, gravel, till, clay);
2. define the structure, geometry and lateral extent of the hydrostratigraphic units;
3. interpret the geological evolution – depositional and erosional history – of Point Pelee; and,
4. determine the post-glacial shoreline evolution of western Lake Erie.

An extensive drilling program was undertaken to install wells and groundwater sampling devices along the western barrier bar at the Park Gate transect, the Northwest Beach transect, and the Camp Henry site. This drilling program provided valuable subsurface information which was used in the geological interpretation of Point Pelee. Subsurface sediments were brought to the surface for observation, collection and analysis, and yielded considerable information relevant to the interpretation of the type of sediments and lateral geometry of sedimentary units below Point Pelee. Additional drilling, specifically for the geological investigation, was undertaken along three additional transects: the De Laurier transect, the Visitor Centre transect and the Point Tip transect (Figure 1).

Four major sedimentary units were identified, three within the barrier bar and one within the marsh. The lower-most unit encountered was a clay-rich till which forms the main structural feature on which Point Pelee was formed. Fine-grained, gray glacio-lacustrine sand was encountered on the clay-till but it is present only south of the Marsh Boardwalk site. The uppermost sediment comprising the barrier bar is a medium-grained sand and gravel unit. It is subdivided into two sub-units. The first is a poorly sorted shoreface sand, composed of essentially the same material found along the present beach. It varies in thickness from 7 m at the beach to 1 m adjacent to the marsh. The second is an aeolian (dune) sand
derived from the shoreface sand. It varies in thickness from 0 m at the beach to 8 m within the largest dunes, and overlies the shoreface sand. The base of the marsh is composed of an organic marsh deposit of gyttja and peat, which sits on top of the clay-till.

The formation and evolution of the marsh and barrier bars at Point Pelee National Park is related to the depositional history and subsequent sedimentary processes that occurred at Point Pelee. As the last glacier melted and retreated northward, water began to fill the Lake Erie basin. Sediments were carried by the melt water into the western basin of Lake Erie. Subsequent reworking of these sediments altered the coastline and eventually resulted in the present shape of Point Pelee. Although there was an overall rising trend in Lake Erie levels from 10,000 years before present, two major intervals in which the lake levels were at a stand-still are documented by the sediments at Point Pelee. First, the surface of the till below the south end of Point Pelee was eroded by waves to a planar surface at about 164 m above sea level. Second, the upper portion of the glacio-lacustrine sand was also eroded by wave action forming a planar surface at an elevation of approximately 169.5 m above sea level. Radiocarbon dates on basal marsh deposits indicate that marsh formation was initiated around 3,200 years ago. The initial deposition of the sands forming the barrier bar at Point Pelee commenced at the same time as the formation of the marsh.

Groundwater Flow Regime at Point Pelee

Groundwater flow through the barrier bar is the principal mechanism through which contaminants would be transported from the septic system tile beds to the marsh. Thus, before an accurate assessment of whether the septic systems are impacting on the marsh, an accurate understanding of the groundwater flow regime is necessary. Further, because the groundwater flow regime is one component of the hydrologic cycle occurring at Point Pelee, an assessment of the groundwater flow regime must also address the relationship of groundwater flow to the marsh, Lake Erie, infiltration of precipitation and spring snowmelt, and evapotranspiration. The specific objectives of this phase of the project are to determine:

1. the direction of groundwater flow, that is towards the lake or marsh, or both;
2. the velocity at which groundwater moves through the barrier bar;
3. the nature and the extent of the link between groundwater, the lake and the marsh;
4. the importance of infiltration and evapotranspiration in the groundwater regime; and,
5. the potential for groundwater to transport contaminants to the marsh.

The groundwater flow regime at Point Pelee was investigated along two transects extending from Lake Erie to the marsh (Figure 1). The Park Gate transect is representative of a narrow portion of the barrier bar (80 m) with relatively low relief. The Northwest Beach transect represents a wider portion of the barrier bar (320 m) with considerably higher relief. Additional information was obtained from the Camp Henry site, located on a very wide portion of the barrier bar (420 m) with moderate relief. Transects were instrumented with shallow water table wells and deeper groundwater wells (piezometers). Multilevel bundle samplers were installed along the transects which enable groundwater samples...
to be collected at 1 m intervals vertically through the groundwater flow system. Water levels were taken at least monthly at these wells. Water level measurements of the surface of the marsh (measured by Parks Canada) and Lake Erie (measured by the Canadian Hydrographic Survey), and meteorological information (measured by Parks Canada) is also required as part of this assessment. By observing the changes in the water levels at an individual well and along a transect, and comparing these to changes in the lake, the marsh, and precipitation, a conceptual model of the groundwater flow regime can be developed.

Long-term monitoring of these data is required because the groundwater flow regime fluctuates on both a short-term and long-term basis. On a short-term basis, the groundwater flow system is affected by infiltration from the surface after major rainfall events and daily removal of water through evapotranspiration. On an annual basis, the groundwater flow regime changes due to seasonal fluctuations of Lake Erie and the marsh, as well as the major spring recharge event caused by the infiltration of melting snow. On a long-term basis, periods of very high lake levels – as is presently occurring – or very low lake levels – as occurred during the mid-1960s and late 1980s – also has a major impact on the groundwater flow regime.

Large changes in elevation of the water throughout the barrier bar occur due to infiltration of precipitation and spring melt and annual changes in the elevation of Lake Erie. A reversal in the direction of groundwater flow occurs twice each year in response to larger changes in the elevation of Lake Erie versus those in the marsh. Although there is considerable groundwater recharge each year, there is also a considerable loss of this recharge water throughout the summer and fall through evapotranspiration. The width of the barrier bar, which increases southward, governs the hydraulic gradient across the barrier bar. Thus, groundwater velocities, groundwater travel distances, and inflow of lake and marsh water into the barrier bar, all decrease southward. Where the barrier bar is 450 m wide, there is a negligible seasonal reversal in the direction of groundwater flow because of the very low hydraulic gradient across the barrier bar and the dominance of infiltration (Figure 2). Groundwater flows from the central portion of the barrier toward the marsh at a rate of only a few metres per year. Where the barrier bar is 300 m wide, groundwater flow exhibits a reversal in the direction of flow at a rate of 5-10 m per year towards the lake and 1-4 m per year towards the marsh, for a net annual travel distance of about 3 m (Figure 2). Hence, there is little movement of groundwater from the barrier bar into the lake and the marsh, and little corresponding movement of marsh and lake water into the barrier bar. The small net annual extent of movement due to the reversal in flow will result in long residence times. Where the barrier bar is 80 m wide, a strong seasonal reversal in groundwater flow towards the lake and marsh of 30-40 m and 20-30 m, respectively, occurs. This allows considerable discharge of groundwater into the lake and the marsh, as well as considerable inflow of water from the marsh and the lake. As a result of the reversal of groundwater flow and high rate of evapotranspiration, water from Lake Erie never flows through the barrier bar to the marsh, or vice versa.
Stable Isotope Analysis of the Groundwater Flow Regime

Stable isotopes are naturally occurring elements with the same number of protons but a different number of neutrons and consequently a different atomic mass. Hydrogen and oxygen each have two useful stable isotopes. These are: $^1$H (common or light) and $^2$H or D (rare or heavy), $^{16}$O (common or light) and $^{18}$O (rare or heavy). The most common water molecule is $^1$H$_2$$^{16}$O; heavier $^1$H$^2$O, $^1$H$^{18}$O and $^2$H$^{16}$O are rare. The process of evaporation causes an isotopic fractionation that affects the relative proportions of these isotopes in waters. Water comprised of the lighter isotopes of oxygen and hydrogen are preferentially evaporated. Hence water vapour is relatively enriched in the lighter isotopes and the remaining surface water is enriched in the heavier isotopes. The effect of this fractionation on the isotopic composition of the remaining body of water depends on its overall volume relative to the amount of water evaporated and the time in which the surface water has been exposed to evaporation. These factors make it possible to distinguish between different sources of water that
exist in the groundwater flow regime, including the marsh, Lake Erie, infiltrating rainfall, and snowmelt. The isotopic composition of the Point Pelee marsh and Lake Erie are quite similar in the winter. As the weather warms, evaporative processes cause marsh water to become isotopically heavier because the volume of water lost through evaporation represents a large portion of the volume of water in the marsh. The isotopic composition of Lake Erie remains relatively constant, because the volume lost through evaporation is small relative to the lake’s total volume. The isotopic signature of the lake and marsh become increasingly different during the summer months, making it possible to distinguish them. Local precipitation also has a unique isotopic composition that is much lighter than either the lake or marsh. The isotopic composition of precipitation vary predictably during the year in response to local air temperatures.

As a result of these isotopic differences, isotopic characterization of water samples taken from groundwater, the marsh, Lake Erie, and precipitation can be used to aid in the interpretation of the groundwater flow regime. The objectives for this study are:
1. to determine the relative contributions to groundwater by each of the sources over time;
2. to track the extent of movement of lake and marsh water into the barrier bar; and,
3. to observe the seasonal changes to the groundwater flow regime.

Water samples from the marsh and Lake Erie, as well as groundwater from the multilevel samplers along the Park Gate and Northwest Beach transects (Figure 1) were collected six times during the first year and seasonally since. Total monthly precipitation samples were also collected. All samples were analyzed for oxygen and hydrogen stable isotope measurements at the University of Western Ontario’s Stable Isotope Laboratory. There was similar isotopic evidence of infiltration into the shallow groundwater (0-2 m) at both transects. The isotopic compositions of deeper groundwater samples differed between transects, suggesting that the relative contribution to the groundwater flow regime from Lake Erie and the marsh are significantly different. A considerable proportion of the groundwater at the Park Gate transect is composed of marsh and the lake water. For example, during the winter of 1994, water from the marsh moved up to 27 m westward into the barrier bar, and during the summer of 1995, lake water moved up to 42 m eastward into the barrier bar. In contrast, water from neither the lake nor the marsh moved more than a few metres into the barrier bar at the Northwest Beach transect, thus groundwater here has essentially no marsh or lake component.

**Characterization of the Park's Septic Systems**
Although Point Pelee National Park is Canada’s smallest National Park, it receives over 500,000 visitors each year. The park currently has more than 30 active septic systems along the western barrier bar to service the park’s staff and visitors. Given the proximity of the septic systems to the marsh – many are within a few 10’s of metres of the marsh – and the favourable hydrogeological conditions for contaminant transport – tile beds constructed within highly permeable sand, and a shallow water table – it is conceivable that nutrients derived from the septic systems are moving towards the marsh. Most of the
park's septic system tile beds are installed directly into the native barrier bar sand. The objectives of this study are:

1. to determine whether or not nutrients reach the water table;
2. to characterize the extent of contamination spatially and in concentrations;
3. to identify processes controlling the contaminant migration, retention, and transformation; and,
4. to determine if septic system derived nutrients are entering the marsh.

Three sites were instrumented with water table wells, multilevel bundle samplers, mini-piezometers, and seepage meters (Figure 1). The Camp Henry site is representative of a septic system which has moderate and mainly seasonal use, is located at a very wide portion of the barrier bar (420 m), and was decommissioned in 1995. The Blue Heron site is one of the most heavily used septic systems within the park. It is used throughout the year and is located at a moderately wide portion of the barrier bar (300 m). A third site, at the Administration Building, has recently been instrumented. This is a moderate but continuous use site, located where the barrier bar is narrow (90 m). Extensive groundwater sampling was undertaken from over 400 sampling points at over 50 locations. The groundwater samples were analyzed for nutrients (NO₃, NH₃, PO₄), dissolved organic carbon, major ions, trace metals, dissolved oxygen, pH, Eh, alkalinity, electrical conductivity, and temperature.

Plumes of contaminated groundwater, containing elevated concentrations of nutrients, including NO₃, NH₃ and PO₄, and other dissolved constituents were observed below the tile beds at the Blue Heron and the Camp Henry sites. At the Camp Henry site, located where reversals in groundwater flow are negligible, a uniform plume has developed in one direction away from the tile bed and towards the marsh (Figure 3). The plume contains high concentrations of NO₃ (to 80 mg/L N) and NH₄ (to 50 mg/L N), and moderate concentrations of PO₄ (to 1.5 mg/L P). It is likely this plume will be eventually flushed to the marsh by continuously infiltrating water. At the Blue Heron tile bed site, located where strong seasonal reversals in groundwater flow direction occur, a bimodal plume has developed in both east and west directions of the tile bed (Figure 3). The bimodal plume contains high concentrations of NO₃ (to 30 mg/L N) and moderate concentrations of NH₄ (to 2 mg/L N) and PO₄ (to 1.5 mg/L P). This plume is likely to expand because of recharge, and will have a long residence time because of the reversals in flow. Near the Blue Heron site, nutrient-rich groundwater was observed to be discharging from the barrier bar into a marsh open-water pond. The discharge of this water is likely contributing to elevated nutrient concentrations observed in the adjacent open-water pond. One implication of the strong reversals in groundwater flow direction is that discharge of effluent to the marsh is expected to be less than if the groundwater flow was directed toward the marsh year-round. A second implication is that septic-system effluent is expected to remain in the barrier bar longer than if groundwater flow was in one principal direction year-round.
Historical Impacts of Land Use

The recent investigation of groundwater contamination from the park’s septic systems has revealed the presence of septic system derived nutrients in the groundwater flow regime. At the Blue Heron site, the reversal in the direction of groundwater flow has led to widespread contamination both east and west of the tile bed. Additional geochemical studies, groundwater flow calculations, and age dating of the groundwater, indicate that the deeper groundwater here dates to the early 1970s. Thus, there is neither a continuous movement of contaminant towards the marsh or the lake, nor is there a reasonably rapid flushing. The implication of this is that once contaminants enter the groundwater flow regime, they remain there for a long time.

Before the present parking lot, boardwalk, snack concession, and washrooms were constructed at the Blue Heron - Marsh Boardwalk area, a variety of buildings and activities occupied this site. A survey of past land use revealed that a store, a barn, a gun club, boat houses, a garage, and numerous permanent houses, summer cottages, hunting cabins and fishing cabins were situated here up until the mid 1970s. It can be assumed that most of the buildings would have had a sewage disposal system, either permanent or temporary. The efficiency of these waste disposal systems to attenuate phosphate and oxidize ammonia is questionable due to the shallow water table and the construction practices of the time. Thus, it is highly probable that groundwater contamination occurred and...
that this contamination still exists. A study is currently being conducted to determine whether past land use is responsible for present groundwater contamination. Specific objectives are:

1. to identify phosphate in the groundwater flow regime that originated from past land use;
2. to identify processes responsible for long-term retention and lack of mobility of phosphate;
3. to investigate geochemical processes occurring at these locations; and,
4. to quantify discharge to, and inflow from, the marsh at these sites.

Indications of past sewage disposal practices in the marsh boardwalk area were detected during drilling when pieces of tile were brought to the surface, and during a search of historical records and photographs which indicated that vault-styled toilets existed here. The presence and extent of sewage derived contaminants were assessed through analyses of groundwater collected from multilevel bundle samplers installed at the boardwalk site. Phosphate and ammonia were detected in the groundwater where there are not any present septic system tile beds but where former buildings were located. Very large areas have elevated concentrations that are similar to those found in the groundwater beneath the present tile beds. In addition, there are isolated areas close to the edge of the marsh which have concentrations of phosphate and ammonia even higher than untreated waste water.

**Phosphorus Cycling within the Marsh**

Marshes function as natural sinks for nutrients, including phosphorus. Benthic sediments – sediments at the base of the marsh – and plants represent important storage compartments of phosphorus within a marsh. There is a substantial cycling of phosphorus between the benthic sediments, water and the plants. Marshes typically exhibit a balance between the phosphorus consumed by plants and the phosphorus released by sediments. However, a major introduction of phosphorus from external sources would upset this balance and result in a steady deterioration in water quality and subsequent reduction in species biodiversity. Because many of the septic systems at the Point Pelee National Park are close to the marsh, it is conceivable that nutrients from these septic systems can enter the marsh. The main focus of the groundwater studies was to determine whether nutrients from the septic systems are entering the marsh via the groundwater flow regime. These studies, however, could not provide evidence that the septic system-derived nutrients actually enter the marsh, nor could they document their impact on the nearshore zone of the marsh. To determine if septic system-derived nutrients contribute to the natural loadings in the marsh, a marsh-focused study was undertaken having the following objectives:

1. identify differences in sediment phosphorus concentrations spatially and with depth;
2. relate sediment phosphorus concentrations to the chemistry of sediment pore water; and,
3. relate sedimentary phosphorus distributions to the sewage-specific marker, coprostanol.

Two areas of the marsh were investigated (Figure 1). Sanctuary Pond, which is the most eutrophic pond in the park, and the Blue Heron - Marsh Boardwalk site
which has poor water quality, but is not yet eutrophic. Sediment cores were
collected at these two sites from locations near the shore of the marsh and
further offshore. The sediments were analyzed for phosphorus and organic
content. Blue Heron - Marsh Boardwalk sediments were also analyzed for
coprostanol, a substance indicative of sewage input. The pore water within the
benthic sediments at the Sanctuary Pond, which influences the distribution and
the dynamics of dissolved nutrients in the water column, were also analyzed. No
differences in phosphorus concentrations in sediments or pore water were found
between the nearshore and offshore locations in the Sanctuary Pond, suggesting
that either there are no external sources of phosphorus to the Sanctuary Pond, or
the annual increase in nutrient concentrations from the contaminated
groundwater is a small component of the overall nutrient budget in the well-mixed
system of the Sanctuary Pond. At the Blue Heron - Marsh Boardwalk site,
concentrations of phosphorus and coprostanol at the nearshore locations were
significantly higher than those offshore, suggesting input of sewage-derived
nutrients to the marsh. However, these analyses can not distinguish between
nutrients entering the marsh from the present septic systems, or through past
waste disposal practices.

Computer Simulation of Groundwater Flow and Contaminant
Transport
Groundwater flow in the vicinity of coastal wetlands is often complex and can
exhibit reversals in flow direction. Due to the complexity of both groundwater
flow and hydrostratigraphy, the field studies required to adequately assess
groundwater conditions require considerable instrumentation, several years of
monitoring, and can be very expensive. Numerical models offer a cost-effective
and rapid means of obtaining considerable insight into the groundwater flow
regime at wetlands. A numerical model of the groundwater flow regime in the
barrier bars between Lake Erie and the marsh at Point Pelee National Park is
currently being developed. This model will extend the present studies beyond the
characterization of what is presently being observed, to being able to predict
what could happen to the system as a result of natural or man-made changes to
the park. The objectives for the modelling study are:
1. to provide insight into present hydrologic processes;
2. to investigate the impact of long-term changes to the system;
3. to quantify groundwater discharge to the marsh;
4. to investigate contaminant transport in the groundwater regime; and,
5. to assess potential remedial scenarios.

Although there are numerous groundwater flow models, these models can be
limited with respect to numerical and conceptual accuracy in their application to
coastal wetlands and groundwater flow within barrier bars. The groundwater-
wetlands model being developed will overcome limitations of existing models.
The model is designed to simulate groundwater flow and contaminant transport
in a two-dimensional cross section with a wetland and/or lake located at either
end of the cross section. The model will account for a fluctuating water table, the
formation of seepage faces, a heterogeneous sedimentary sequence, and time-
varying shorelines between the groundwater regime and the wetland and marsh.
These can fluctuate both vertically and laterally in response to changes in the
size and shape of the wetland, or annual lake level cycles within Lake Erie. Initial
modelling results show hydraulic heads respond relatively rapidly to lake-level
fluctuations, and the direction of the groundwater flow rapidly undergoes a reversal in response to the relative elevations of the lake and the marsh. However, the width of the barrier bar is the main factor controlling the extent and timing of the reversal.

Summary
Many parks located along coastal areas of the Great Lakes use septic system tile beds as their primary means of waste-water disposal. Because many of these systems are located in sandy soils, there is a high probability that septic-system derived nutrients will contaminate the underlying groundwater. Further, because many of these tile beds are relatively close to marshes, ponds or a lake, contaminated groundwater may discharge to these adjacent waters and detrimentally impact on the water quality and natural biodiversity. The complex nature of the groundwater flow regime in these coastal areas makes tracking of contaminants, determining the extent of contaminant, and understanding the geochemical processes occurring very difficult. At Point Pelee National Park, the groundwater flow direction within the northern portion of the barrier bar undergoes a complete reversal in the direction flow – towards the lake during the winter and towards the marsh during the summer. In some areas, the contaminants may be flushed from the barrier bar, but elsewhere the reversal causes the contaminants to remain trapped for decades. Because of the complexity of these coastal areas, understanding the nature of groundwater flow, the migration and persistence of contaminants, and their impact on an adjacent marsh or pond, cannot be accurately resolved over a few months or even 1 - 2 years. As experience at Point Pelee has shown, long-term monitoring and assessment are necessary. Further, all components of the system are closely inter-related including the geological setting of the park, the hydrology of groundwater and surface waters, the siting of the septic system, the characterization of contaminant migration and persistence, and nutrient cycling within the surface waters. Thus, a multi-disciplinary approach is essential for fully understanding processes before undertaking remedial action.

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Selected References
Coastal Geomorphology and Assessment of Proposed Dyke Construction at Lighthouse Point Provincial Nature Reserve, Pelee Island

Robin G.D. Davidson-Arnott and Jeffrey S. Doucette
Department of Geography
University of Guelph
Guelph, ON, N1G 2W1

Abstract
In winter 1972 - 73 the barrier and dyke on the west shore of Lighthouse Point, Pelee Island, were breached due to high lake levels and severe storms, resulting in the flooding of a drained marsh area and creating what is known locally as Lake Henry. Marsh and sub-aquatic vegetation has been slow to re-establish in most of the area exposed to the action of waves propagating through the breach. As a result, it has been proposed that some form of artificial barrier be put in place to reduce this wave activity and hasten the re-establishment of a natural pond and wetland. An assessment of the coastal geomorphology of Lighthouse Point was made using historical air photographs, and field observations including profile surveying, sediment sample collection and diver observation. The Lighthouse Point barrier system appears to be an erosional feature, reflecting diminished sediment supply over the past 5,000 years and gradual loss of sediment through longshore sediment transport to the south. It is likely that the long-term natural loss of sediment has been exacerbated in recent years by a reduction in sediment supply from the area to the west as a result of armouring of the shoreline and trapping of sediment behind docks. However, reworking of the existing barrier sediments should result in natural closure of the breach and thus permit re-establishment of a natural barrier and lagoon marsh, which would be able to adjust dynamically to the net negative sediment budget. Closure of the breach through building of an armourstone dyke would likely result in severe alteration to the remainder of the system.

Introduction
This paper is a summary of a report prepared under a contract with Ontario Parks which required the assessment of coastal processes in the vicinity of Lighthouse Point Provincial Nature Reserve. More specifically, the report considers the coastal processes and structures that have controlled the evolution of the landform as well as the influence of human activities in these processes. The probable future evolution of the landform over the next 20 years is assessed, assuming that present conditions, including the presence of artificial structures, remain constant. The probable impact of a new "dividing" structure or dyke is also assessed and suggestions are given for alternative approaches and future management of the coastline of the Nature Reserve.

Pelee Island is the largest of the Erie Islands and is located in western Lake Erie approximately 15 km southwest of Point Pelee, Ontario and 30 km north of Sandusky, Ohio (Figure 1). The island is about 4300 ha in area and has a permanent population of just over 200. The highest point on the island is only
about 12 m above lake level and much of it is at or below mean lake level and is protected by an extensive dyke system. The Erie Islands are formed primarily by outcrops of Devonian dolomitic limestones which have been upwarped through the Findlay Arch (Sly, 1976). The bedrock outcrops have been modified by glacial erosion and during the last glaciation – the Wisconsinan – thick layers of till were deposited between and over the bedrock outcrops (Holcombe et al., 1997).

Lighthouse Point is located at the northeast corner of Pelee Island and is 1.6 km long and 1.6 km wide at the base (Figure 2). It takes its name from a stone and wood lighthouse built at the tip of the point in the 19th Century, the base of which is still standing at the present shoreline. Most of the interior of Lighthouse Point, as well as other portions of Pelee Island, are below mean lake levels and were dyked and drained for agricultural use between 1888 and 1889 (Smith, 1899). In or just prior to 1972 the sand barrier on the west side of Lighthouse Point was breached and in November 1973 the western dyke was breached. This resulted in the flooding of the farmland on Lighthouse Point and the creation of what is known locally as Lake Henry. Armourstone was placed on the west side of the eastern dyke to protect it and cottages along the east shore of Lighthouse Point from flooding and erosion from the newly created Lake Henry.
Post Glacial Lake Levels
The post-glacial lake level history (Figure 3), particularly of the past 3000 years, is important to the evolution of Pelee Island. As water levels rose in the lake, the glacial tills that composed most of the lakebed and surrounding area were eroded and bluffs were formed. The fine material in the eroding till was transported offshore to be deposited in the deeper waters while the coarser sand and gravel were transported along shore to create the various beaches and spits present today (Sly, 1976). Since Pelee Island is composed of the same till that forms much of the shoreline of Lake Erie, the processes of erosion, bluff formation and deposition of spits which formed the present shoreline were similar to those active along the north shore today.
Figure 3: History of Post-Glacial Lake Levels

The presence of the resistant residual buttes of Devonian dolomite limestone near the four corners determined the present morphology of the island. The bedrock outcrops resisted erosion and protected the less resistant glacial till from erosive waves and currents. Sand and gravel eroded from till bluffs around the island and in the nearshore were transported alongshore to form barrier beaches which connect the higher areas of the resistant rock outcrops (McCutcheon, 1967). As lake levels rose they flooded the low lying areas between the bedrock outcrops and surrounding till leading to the formation of marshes in the zones protected from wave action by the barrier beaches.

Sand and gravel supply to the beaches of Pelee Island would have been quite high during the main period of transgression under rising lake levels. However, as the lake level has stabilized over the past 1,000 to 2,000 years, the supply of sand and gravel from erosion has decreased and there are no other substantial sources, for example from river inputs. As a result, redistribution of beach sediments has occurred through longshore sediment transport, leading to shoreline recession in many parts of the north and east of the island and deposition in areas such as Fish Point at the southwest corner.

Modern Lake Level Fluctuations
As is the case with the entire Great Lakes shoreline, the barrier system of Lighthouse Point is influenced by seasonal and yearly lake level fluctuations.
Annual lake levels fluctuate about 0.6 m. Over a period of a decade the mean monthly lake level can vary by as much as 1.5 m. During lower lake levels a wide beach is exposed providing a greater buffer to wave action on the shoreline. Sometimes lake levels are low enough to expose offshore sandbars such as the exposed sandbar at the tip of Lighthouse Point during 1933 - 34 (Kindle, 1936). During high lake levels and storm set-up, the beach is more narrow allowing waves to reach back beach areas more easily leading to erosion of dunes and overwash of barriers (Davidson-Arnott and Fisher, 1992).

**Wind and Wave Climate**

The prevailing winds are from the southwest with fetch lengths being restricted because of the numerous islands and shoals at this end of Lake Erie. While Lighthouse Point is sheltered from waves from the west and southwest (Figure 2) waves from these directions refract around Sheridan Point, generating west-to-east longshore sediment transport in North Bay. This then provides a source of sediment for the northern barrier of Lighthouse Point. Winds from the northwest blow over fetch lengths of only 25-50 km, limiting the size of waves produced. The longest fetch is to the northeast (>300 km). While winds from this direction are less frequent than those from the western quadrant, they generate the highest waves. Waves from this direction lead to a southerly transport of sediment along the eastern shoreline and are the primary control on ongoing erosion (Alexander and Knowles, 1985).

**Methodology**

Field work was conducted during July 23-26, 1996 to assess the current geomorphology of Lighthouse Point. The field work included a survey of 18 profiles around the Lighthouse Point barrier complex and along the eastern shoreline. Sediment samples were collected along each line for subsequent size analysis, and diver observation of bottom sediments was carried out beyond the offshore limits of the surveyed profiles. Survey lines around the barrier breach were tied in to prominent local control points to enable them to be used in producing a map of the area in 1996.

A 1:10,000 scale 1985 Ontario Base Map was digitized using the Atlas GIS software package. A number of the established control points were then used to digitize shoreline changes from vertical aerial photographs. Vertical aerial photographs of Lighthouse Point were obtained for the years 1955, 1972, 1978 and 1985. The shorelines for each of these years were then digitized using the same software and referenced to the 1985 OBM map using the common control points. Because of the focus on shoreline change, there is no distortion due to relief displacement. Radial distortion was minimized by using photographs with the shoreline near the centre of the photographs and the effects of this and tilt are largely compensated for by the software using the common control points.

Finally, a map of the 1996 shoreline was produced by combining the ground surveys with information derived from oblique aerial photographs taken on July 17, 1996. This then permitted examination of shoreline change over the period 1955 - 1996.
**Results**

**Shoreline Evolution: 1955 to 1996**

In 1955 the dykes surrounding Lighthouse Point were completely intact and the interior of the Point was almost entirely farmland (Figure 4a). High lake levels and severe storms over the winter of 1972 - 73 caused a breach in the dyke at the southwest corner of the lagoon (Alexander and Knowles, 1985). The beginning of this breach can be seen in Figure 4b where only the outer sand barrier has been breached. The total breach of the sand barrier and dyke and the resulting flooding and formation of Lake Henry, which occurred in 1973 is clearly evident in 1978 (Figure 4c). By 1985 the breach had widened significantly, exposing much of the west side of the lagoon to Lake Erie (Figure 4d). A sandy spit had extended the southwest shoreline northeast along the line of the old dyke. In the summer of 1996 two new spits were observed that began at the edges of the breach and projected into the lagoon (Figure 4e). The northern spit extended from the western barrier to within 100 m of the eastern shore of Lake Henry nearly enclosing the northern portion of Lake Henry.

**Present Shoreline of Lighthouse Point**

The eastern side of Lighthouse Point consists of beaches up to 20 m wide north of Lizard Point and armourstone shore with narrow beaches immediately south of Lizard Point. Armourstone revetments protect most of the cottages and the abandoned lighthouse at the northeast edge of the point. On this shoreline sand is found up to 100-125 m offshore. At this point, sand is replaced by a 30-40 m wide band of cobble-covered glacial till. Beyond the band of till is exposed bedrock in water depths of 3-4 m. South of Lighthouse Point the sand cover extends further offshore.

Sand dunes in the vicinity of the lighthouse rise to a height of 4-5 m above the lake level and are covered by large trees and undergrowth. The old dunes are preserved along the western shoreline in the vicinity of the lighthouse, but erosion here has resulted in narrow beaches developed in fine to medium sand. The sand is derived from the dunes as well as recent extensive deposits of zebra mussel shells. Further west the old barrier and western dyke are eroded. A narrow sandy barrier has developed some 30-40 m east (onshore) of the location of the old barrier apparently fed by sediments eroded from the old dunes near the point. There is a very gentle gradient offshore and dead trees are visible where the breached dyke was located. In 1996 the new barrier was rapidly being colonized by a variety of grasses and shrubs. The spit at the north end of the breach, which is building into Lake Henry, is fed by sediments moving westward into the breach and by the summer of 1996 this had extended almost to the eastern dyke.

At the south end of the breach a new barrier has also developed landward of the original barrier and dyke. Presently erosion of this barrier is supplying sediments to the southern spit which is also building into Lake Henry and enclosing a sheltered area at the southwest corner. The southern spit has a similar composition to the northern one, but is shorter and supports less vegetation than the northern spit. A 0.75 m high bluff has developed on the shoreline immediately to the southwest of the spit and trees are being undermined. Conditions offshore on the southern side of the breach are the same as the
northern side and water depths across the breach are fairly constant and remain under 2 m.

Figure 4: Evolution of Light House Point, Pelee Island (a) 1955, (b) 1972, (c) 1978, (d) 1985, and (e) 1996 with location of profiles 3-15.

Post Glacial Evolution of Lighthouse Point
Based on background information on the geology and geomorphology of Pelee Island, the history of lake levels in the Erie Basin, and information gathered for this study, it is possible to put forward a general picture of the evolution of the present coastal features at Lighthouse Point. Because of limitations in the amount of information available from previous work and of measurements carried out particularly for this study, such a picture is somewhat speculative and lacking in details, and thus should be treated with some caution. Nevertheless, the broad
conclusions seem reasonable in light of the evidence available and they may be helpful in assessing what is likely to happen in the next few decades.

The most significant feature of the evolution of the Lighthouse Point region is that it appears to be an erosional feature. The Point has probably undergone erosion and a reduction in size over the past 2,000 - 3,000 years as lake levels have risen slowly and as the sediment supply from erosion of the nearshore and beach has decreased. This is in contrast to Fish Point at the south end of the island, which has a similar shape. At Fish Point there was an abundant sediment supply leading to progradation of the shoreline, as is evident from the extensive beach ridge deposits in coarse sand and gravel. Fish Point thus appears to have formed as a cuspatte foreland similar to Point Pelee on the north shore of Lake Erie with continuous extension of the point and progradation of the sides.

Lighthouse Point, while superficially similar in shape to Point Pelee, has a number of features that indicate a relatively small sediment supply and a shoreline that is transgressive rather than progradational. These features include:

1. the absence of any extensive sand deposits forming a depositional platform lakeward of the tip of the point;
2. the low height of dunes on the east and west barrier systems and their narrow width even prior to the high lake levels in 1972 – the only area of significant dunes is near the tip where wave convergence creates somewhat wider beaches;
3. the absence of extensive sand deposits or dune ridge sequences in the area surrounded by the barriers – instead there was an extensive marsh which was at or below the mean lake level and thus was dyked; and,
4. the presence of bedrock and remnants of till deposits offshore along many of the profile lines on the point.

Over the past 3,000 - 4,000 years, the lake level at the western end of the basin has risen slowly due to isostatic adjustments. This rise in lake level has affected the whole of Pelee Island, resulting in the landward migration of barriers and the flooding of lowlying land between outcrops of the Devonian dolomite. This flooding created the extensive marshes that occupied so much of the island before they were dyked and drained about 100 years ago. At the beginning of the period the shoreline in the vicinity of Lighthouse Point probably extended further north and may well have been connected to a bedrock high point that now forms an extensive shoal northeast of the present point (Figure 2). It is likely that rising lake level and erosion of the till deposits covering the bedrock would have led to flooding of the low lying area, creating first an island and then, with further erosion of the till cover, a shoal. Meanwhile, flooding of the area behind the beach and dune system would have led to the development of the east and west barriers. Erosion of till deposits on the lake bed as water levels rose would supply sand and gravel to the beaches but this supply does not appear to have been particularly extensive, because of the absence of any large accumulations of gravel deposits. Instead, the sediments making up the barrier systems at Lighthouse Point and forming the beach and dune systems along the east coast are generally well sorted sands suggesting that there has been extensive reworking of sediments as the shoreline retreated, rather than the generation of a continuous new supply. This again is in contrast to Fish Point, where there has been continuous sediment supply from erosion of the nearshore and from low bluffs.
Controls on Breaching of the Western Barrier

The landward migration of the western barrier and breaching of the dyke in 1972 suggest a relatively limited sediment supply. In part, this is a reflection of the continued evolution of the Lighthouse Point barrier system by natural processes. As the surficial till cover in the nearshore has been eroded, exposing the underlying bedrock, supplies of sediment from this source have decreased over time. However, the extent of overwash and retreat of the Lighthouse Point barrier system during the recent high water periods may have been increased as a result of human activities over the past century. Offshore dredging, armouring of the shoreline and pier construction to the west of Lighthouse Point all reduce sediment supply.

At present there is a limited supply of sediment to Lighthouse Point from the west—perhaps in the order of a few hundred m$^3$/yr—which appears to be the direction of net sediment movement in North Bay. The volume of sediment in the south spit is on the order of 3,000-4,000 m$^3$, and it has been built over a period of at least 4 - 5 years, giving an annual sediment supply of less than 1,000 m$^3$. However, most of the sediment appears to have been derived from erosion of the barrier so that the net input from the west will be a small portion of this.

Both field observations and an analysis of historical aerial photographs indicate that sediment does move in both directions around the point, but net sediment transport is probably to the south along the east shore. Beaches become wider and quantities of offshore sand increase from Lighthouse Point towards Middle Point, suggesting that net sediment transport is to the south. This loss of sediment is small over the short-term, but over the long-term leads to a gradual reduction in the volume of sediment stored in the Lighthouse Point barriers and thus a gradual decrease in the size of the feature.

It is probable that under natural conditions—i.e., without the dyke and the cultivated land behind it—the western barrier would have responded to the high lake levels of 1972 and 1985 in a different manner. Instead of breaching completely and developing a wide inlet, the barrier might have migrated eastward through dune cliffing and overwash. The presence of cultivated land behind the dyke rather than marsh meant that when a breach occurred the flooding of the agricultural areas produced a large body of open water—Lake Henry. This lake lacked the dense stands of rushes and aquatic vegetation that would have been present in a more natural setting and which would have absorbed wave energy and promoted sand deposition. During periods of easterly winds, current outflows from Lake Henry probably led to scouring of a channel and there was insufficient sediment supply along the barrier to repair the breach.

Another factor that may have promoted the formation of the inlet is oxidation of organic matter during cultivation due to the lowered water table. This may have led to compaction of the largely organic sediments in the drained area, thus promoting a larger deeper water body. Once the area behind the barrier became flooded, it was expected that submergent and emergent vegetation typical of a protected pond and wetland area would soon establish. However, while this has begun to occur in the areas protected by the new spits growing into Lake Henry, there is little evidence to date of successful colonization in the main body of water. The primary cause of this is thought to be the effect of wave action...
propagating through the wide inlet entrance and the resultant high turbidity of water within Lake Henry. High turbidity results from wave and current action and may be exacerbated at times by carp, which can get into the ponds through the breach. Closure of the breach and the reduction of wave and current action would likely reduce turbidity. The protection from wave activity would also promote the establishment of sheltered aquatic and emergent vegetation. Consequently consideration has been given to the possibility of closing the breach artificially.

**Assessment and Recommendations**

**Dyke Construction**

The proposed dyke structure would close the large breach and cut off Lake Henry from wave action generated in Lake Erie. On the positive side, the dyke would stabilize the shoreline and likely lead to the acceleration of marsh re-establishment in the central section of the water body. However, since the dyke will be exposed to direct wave action it will have to be lined with armourstone and tied in to the area of hardened shoreline near the private docking structure just to the west of the nature reserve. While there is still considerable debate as to whether dykes/seawalls lead to an acceleration of erosion of the whole profile (e.g., Wood, 1988; Kraus, 1988) there is general agreement that reflection does result in deeper water close to the structure and an absence of a beach. This can be seen along the armoured area of the west coast of Pelee Island where beaches are absent and waves break directly on the dyke.

The disadvantage of the proposed dyke is that it will eliminate sandy beaches and areas of pioneer plant species along the west shore with all the attendant implications for the associated animal, insect, and bird population. Moreover, sand moving along the proposed dyke from the west will be deflected offshore and not continue on to nourish the beach on the east shore. Ultimately, this will require the dyke to extend around the point to protect this area, thus further reducing the sandy beach and dune habitat and threatening the cottages on the east shore. Thus, the presence of the dyke would eliminate the unique habitats provided by the sandy beaches and spits and replace them with one type of environment in the area behind the dyke. The environment would be different from that which existed before dyking and drainage of the area, and probably less diverse in flora and fauna compared to the current environment.

**Beach Nourishment**

While closure of the breach in the barrier system is likely to eventually occur under natural conditions, the rate of this process could be increased by sand nourishment to the western barrier in the vicinity of the breach, which could fill in the existing inlet opening creating an artificial beach. Such a course of action would speed up development of a new barrier and thus also the development of a wetland in the area behind it. This course of action would, however, require careful analysis of the amounts of sediment required and identification of a source for the nourishment material.

If the costs for nourishment are reasonable, this course of action is preferred. It cuts off wave energy from Lake Henry, thus promoting the re-establishment of marshes in this area; it establishes a natural sandy barrier shoreline that provides habitat for a number of bird and animal species as well as the vegetation that is
common to these areas; and it has very little potential to harm the environment, even if it fails.

**Natural Evolution**

There are a number of natural morphological changes that may occur in the next 20 to 40 years. It is possible that the continuous barrier may reform along the west shoreline if lake levels fall below the long-term mean for several years. With the absence of substantial supplies of sediment from the shoreline to the west, much of the sand for this rebuilding of the barrier must come from erosion of the shoreline and dunes in the vicinity of the lighthouse. If lake levels are low for a significant amount of time then colonization by vegetation and building of new dunes will occur. This may permit the new barrier to survive new periods of higher lake levels. The building of a relatively stable barrier could take ten or twenty years and it is possible that this may not occur in the foreseeable future.

In the meantime, the current northern spit will probably extend further eastward and attach to the eastern dyke by the end of 1997 and the southern spit may extend further to the southeast and attach to the southern shore of Lake Henry in the next few years. When this occurs, two naturally protected ponds will be formed within which submerged aquatics as well as emergent wetland species can be expected to colonize. The enclosed areas will also be protected from the activities of carp. The spits and the associated wetland areas behind them thus will form a diverse set of natural environments which can be expected to support a wide range of plants, aquatic life and habitat for waterfowl and shorebirds. The areas already protected by the spits show evidence of developing extensive marsh communities and some submerged aquatics while the spits themselves are being colonized by a variety of plant species.

Establishment of submerg ent and emergent vegetation in the remaining area of Lake Henry will be slow as long as it is exposed to wave action. Developments in this area will thus depend on when and if the breach in the barrier is infilled.

**Lighthouse Consideration**

If the barrier is left to evolve naturally over the next few decades then consideration will have to be given to the fate of the lighthouse at the end of the point. Increased armourstone protection of the lighthouse will be required over the next few years if it is to remain in its present location and condition. The addition of more armourstone would result in increased erosion of the surrounding beach and dunes due to wave reflection and eventually create a "lighthouse island" where the lighthouse and surrounding armourstone are separated from the receding shoreline. In these circumstances it would seem more cost-effective and environmentally responsible to preserve the lighthouse by relocating it to the base of Lighthouse Point. Here, restoration and incorporation of the structure into an interpretation facility would be possible. However, it is not clear that the value of the remaining structure can justify the cost of preserving it.

**Recommendations**

The present shoreline of Lighthouse Point is continuing to evolve following the breach of the natural barrier and west dyke in 1972. It is difficult to predict exactly how the area will evolve over the next two decades but it should continue
to provide a rich ecological environment based on increasing wetland development and maintenance of some form of sandy barrier system. There does not appear to be any threat to the existing dyke along the east shore or to the cottages along it. Allowing the barrier to continue to evolve under natural conditions seems to be the simplest and least costly course of action and one that is perhaps most desirable in terms of the preservation of the sandy barrier environments that are unique to Pelee Island. We conclude the following recommendations:

Recommendation 1: Leave the west barrier of Lighthouse Point alone so that it may evolve naturally.

Recommendation 2: If a structure is built to close off the present inlet on the west side of Lighthouse Point, it should be designed by a professional coastal engineer and the design should be reviewed by a committee which includes a biologist, coastal geomorphologist and local interests.

Recommendation 3: Give consideration over the next five years to removal of the lighthouse from its present position in order to avoid the continued need to protect it and the possible impact of this protection on the adjacent beaches.

Recommendation 4: The Ontario Ministry of Natural Resources should develop a management plan for the Lighthouse Point Nature Reserve before any decision is made on the construction of a structure to close off the breach in the western barrier.

Acknowledgements

We would like to thank Danika Van Proosdij for assistance with the field work, Jan Mersey for advice on carrying out the GIS and Marie Puddister for cartography and design. James Kamstra of Gartner Lee Associates provided considerable background on Pelee Island and Lighthouse Point in particular. We thank Tom Beechey of Ontario Parks for his help at all stages of this study.

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Amphibian and Reptile Conservation in Ontario: Guidelines for Parks and Protected Areas at Long Point, Rondeau and Point Pelee*

Anthony E. Zammit
School of Planning
University of Waterloo, Waterloo, Ontario, N2L 3G1

Abstract

Amphibians and reptiles are among the multitude of species increasingly threatened by human-induced and natural factors, globally and in Canada. Southern Ontario, Canada’s most biologically diverse region, comprises a unique assemblage of herpetofauna, including many threatened and endangered species not found anywhere else in the country. Three areas in particular, Long Point, Rondeau and Point Pelee, situated along the north shore of Lake Erie, have long been considered exceptional areas because of their rich natural and cultural histories. Parks and other protected areas at these three peninsulas and on Pelee Island in western Lake Erie represent strongholds for extremely rare Canadian herpetofauna species such as the threatened eastern spiny softshell turtle and the endangered blue racer. However, habitat fragmentation and a host of other impacts, such as persecution of snakes and inadvertent road kills, have resulted in population declines and local extirpations. Such causes are believed to be responsible for the loss of Blanchard’s cricket frog – now extinct in Canada – and nine additional amphibian and reptile species from Point Pelee National Park.

The purpose of this paper is to assess in terms of the population status and limiting factors of herpetofauna, the need for regional and site-based conservation within southern Ontario. Recent advancements in conservation biology and landscape ecology are employed in developing a strategy for integrated conservation action. This is achieved by focusing on the evolving role of key parks and protected areas at Long Point, Rondeau, and Point Pelee, and by identifying the need to strengthen and enforce existing monitoring and assessment programs, species recovery programs, land use policy, and legislation. Recommendations for successful conservation include a combination of habitat protection, species recovery and monitoring, research, and public education, all of which have implications for land use planning and management within this and other regions facing similar environmental challenges.

Introduction

The ecological status of amphibians and reptiles in Canada and around the world has become a topic of concern for many. An evolutionarily successful group of animals, existing for over 300 million years, herpetofauna - amphibians and reptiles - are increasingly undergoing population declines and range reductions, [This paper arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.]

* This paper arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
sometimes disappearing altogether, for many reasons but more commonly as a result of habitat loss caused by humans.

Herpetofauna are an important component of many ecosystems. They are effective predators of unwanted pest species such as rodents, and pose no threat to humans. Their value is also related to the fact that they are good indicators of ecosystem health or integrity and are appreciated by the scientific community and nature enthusiasts alike.

Considering the relatively small size of amphibians and reptiles and their unique set of ecological requirements (see Conant and Collins, 1991), this obscure and often maligned group of animals requires special planning considerations. The role of parks and protected areas is a key component in biological conservation. However, this role remains largely undefined.

**Purpose**

The purpose of this paper is to highlight the findings of recent research on the state of amphibian and reptile conservation in southwestern Ontario. The objectives are:

1. to demonstrate the importance of parks and protected areas at Long Point, Rondeau and Point Pelee; and,
2. to provide a set of guidelines for effective conservation of amphibians and reptiles within parks and protected areas in these three areas and elsewhere in the province.

**Study Focus and Approach**

This paper focuses on parks and protected areas at Long Point, Rondeau, and Point Pelee – three areas long considered important for herpetofauna in Canada (Figure 1). A literature review was conducted to assess research and conservation needs in these three areas in terms of existing information about the status of rare species, particularly those considered vulnerable, threatened, and endangered in Canada. Existing data and other information were obtained from a variety of sources, including the Ontario Herpetofaunal Atlas Data Base, the Committee on the Status of Endangered Wildlife In Canada (COSEWIC), and the Recovery of Nationally Endangered Wildlife (RENEW) Committee. Additional information was obtained from published and unpublished sources cited throughout this paper.

**Highlights of Research Findings**

- The significance of Long Point, Rondeau, and Point Pelee for herpetofauna can be expressed in terms of species richness (number of species), abundance of records (expressed for each species as a percentage of all Ontario records), and the presence of rare species (Figure 1; Table 1). The percentage of records may not reflect actual species abundance but may be more related to ongoing species inventories within parks and protected areas.

- A total of four COSEWIC species can be found at these three peninsulas (see Tables 2 and 3), though only two species – spotted turtles and eastern
spiny softshells – can be found at all three sites. Although many species are considered rare in Ontario and Canada, they are common or even abundant at Long Point, Rondeau and Point Pelee. An additional three COSEWIC species – smallmouth salamander, blue racer and Lake Erie water snake – are found on Pelee Island in Lake Erie.

- Table 4 indicates habitat preferences for species found at Long Point, Rondeau and Point Pelee. Sandy beach and dune areas are important for nesting turtles, whereas sloughs, ponds, tidal pools and other wetlands are important for breeding amphibians and foraging turtles. Several species occur in a variety of natural and human areas. At Point Pelee National Park, old fields are an important habitat component.

- Considerable baseline information is available for herpetofauna at Long Point and Point Pelee. In contrast, however, there is a lack of comparable information for populations at Rondeau (Table 5).

- Site specific threats include: road mortality along the Long Point Causeway; residential development in other areas adjacent to the Big Creek National Wildlife Area; and human activities at Rondeau and Point Pelee. At Point Pelee, five amphibians and five reptiles (all snakes) have disappeared (Table 1) because of possible contamination, human persecution and loss of habitat.

- Although amphibians and reptiles are threatened by several factors, both natural and human-induced, habitat loss is the most common threat for all herpetofauna species in Ontario.

- Species assessment programs (COSEWIC) and recovery planning (RENEW) represent a single species approach to conservation. Considerable effort is being allocated to study and protect threatened and endangered species (Table 6). However, there are several additional provincially and regionally rare species (Table 1), for which there is comparatively little information. Until their status is officially determined by COSEWIC, conservation action will not be considered under the RENEW program.

- Parks and protected area mandates and several additional land use policies, guidelines and provincial and federal legislation include provisions that are relevant to the conservation of herpetofauna and their habitat (Tables 7 and 8).
<table>
<thead>
<tr>
<th></th>
<th>Long Point National Wildlife Area</th>
<th>Big Creek National Wildlife Area</th>
<th>Rondeau Provincial Park</th>
<th>Point Pelee National Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mudpuppy (S4)</td>
<td>+</td>
<td>+</td>
<td>+(RE)</td>
<td></td>
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<tr>
<td>Red-Spotted Newt (S5)</td>
<td>+</td>
<td></td>
<td>(RE)</td>
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<tr>
<td>Blue-Spotted Salamander (S4)</td>
<td>+(RHN)</td>
<td></td>
<td>(RE)</td>
<td></td>
</tr>
<tr>
<td>Spotted Salamander (S4)</td>
<td>+</td>
<td></td>
<td>(RE)</td>
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<tr>
<td>Tiger Salamander (SX)</td>
<td></td>
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<td>E</td>
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<tr>
<td>Red-Backed Salamander (S5)</td>
<td>+</td>
<td>+</td>
<td>+(RE)</td>
<td></td>
</tr>
<tr>
<td>Fowler’s Toad (S2)</td>
<td>+</td>
<td>+</td>
<td>E(EE)</td>
<td></td>
</tr>
<tr>
<td>Gray Treefrog (S5)</td>
<td>+</td>
<td></td>
<td>E(RE)</td>
<td></td>
</tr>
<tr>
<td>Blanchard’s Cricket Frog (SX)</td>
<td>Extinct in Canada</td>
<td></td>
<td>E</td>
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<tr>
<td>Wood Frog (S5)</td>
<td></td>
<td>+</td>
<td>+(RE)</td>
<td></td>
</tr>
<tr>
<td>Pickerel Frog (S3)</td>
<td>+(RHN)</td>
<td></td>
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<td>+</td>
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<td>+(RE)</td>
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<tr>
<td>Spotted Turtle (S3)</td>
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<td>+</td>
<td>+(RE)</td>
<td></td>
</tr>
<tr>
<td>Eastern Spiny Softshell (S4)</td>
<td>+(RHN)</td>
<td>+</td>
<td>+(RE)</td>
<td></td>
</tr>
<tr>
<td>Five-Lined Skink (S3)</td>
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<td>+</td>
<td>+(RE)</td>
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<tr>
<td>Queen Snake (S2)</td>
<td>+(RHN)</td>
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<td></td>
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<tr>
<td>Eastern Hognose Snake (S3)</td>
<td>+</td>
<td>+</td>
<td>E(RE)</td>
<td></td>
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<tr>
<td>Black Rat Snake (S3)</td>
<td>+(RHN)</td>
<td>+</td>
<td>E</td>
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<td>Eastern Fox Snake (S3)</td>
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<td>+(RE)</td>
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<td>Blue Racer (S1)</td>
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<td>Eastern Massassauga (S3)</td>
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<td></td>
<td>E(RE)</td>
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<tr>
<td>Timber Rattlesnake (SX)</td>
<td>Extinct in Canada</td>
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<td>E</td>
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</tbody>
</table>

*Provincial Status:

S1 **Extremely rare**: usually five or fewer occurrences in Ontario or very few remaining individuals; often especially vulnerable to extirpation from Ontario.

S2 **Very rare**: usually between five and 20 occurrences in Ontario or with many individuals from fewer occurrences; often susceptible to extirpation from Ontario.

S3 **Rare to uncommon**: usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

S4 **Common**: usually more than 100 occurrences; usually not susceptible to immediate threats.

S5 **Very common**: demonstrably secure in Ontario under present conditions.

SX: Apparently extirpated from Ontario, with little likelihood of rediscovery. Typically not seen in Ontario for many decades, despite searches at known historic sites.

*Regional Status:

RHN = Rare in the Regional Municipality of Haldimand-Norfolk (Known from five or fewer locations *fide* Gartshore 1987)

RE = Rare in Essex County (Known from five or fewer locations *fide* Oldham, 1984)

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Table 1. Status* of Rare Amphibians and Reptiles at Long Point, Rondeau and Point Pelee (After Zammit, 1996)
Figure 1a: Percentage* of reptile records obtained in the Long Point (Haldimand-Norfolk), Rondeau (Kent) and Point Pelee (Essex) Regions (Weller and Oldham, 1988) (*Calculated, for each region and all regions combined, as a percentage of total number of records for Ontario)
Figure 1b: Percentage* of amphibian records obtained in the Long Point (Haldimand-Norfolk), Rondeau (Kent) and Point Pelee (Essex) Regions (Weller and Oldham, 1988) (*Calculated, for each region and all regions combined, as a percentage of total number of records for Ontario)
Extirpated: pygmy short-horned lizard (*Phrynosoma douglassii douglassii*) and timber rattlesnake (*Crotalus horridus*)

Endangered: blue racer snake (*Coluber constrictor foxi*), Lake Erie water snake (*Nerodia sipedon insularum*), leatherback turtle (*Dermochelys coriacea*) and Blanchard’s cricket frog (*Acris crepitans blanchardi*)

Threatened: eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*), Blanding’s turtle (*Emydoidea blandingi*) (Nova scotia population), eastern spiny softshell turtle (*Apalone spinifera spinifera*).

Vulnerable: eastern short-horned lizard (*Phrynosoma douglassii brevirostre*), northern prairie skink (*Eumeces septentrionalis*), eastern yellow-bellied racer (*Coluber constrictor flaviventris*), wood turtle (*Clemmys insculpta*), spotted turtle (*Clemmys guttata*), pacific giant salamander (*Dicamtonten nebrodus*), smallmouth salamander (*Ambystoma texanum*), Fowler’s toad (*Bufo woodhousei fowleri*).

Table 2a. Status of Amphibians and Reptiles Designated by the Committee on the Status of Endangered Wildlife in Canada. Species native to Ontario appear in bold type.

<table>
<thead>
<tr>
<th>Fowler’s Toad</th>
<th>Geographic range in Canada is restricted to sandy beach and marsh areas along the north shore of Lake Erie in Ontario (Green, 1985 and 1989).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanchard’s Cricket Frog</td>
<td>Last observed within a single locality on Pelee Island, Ontario (Oldham and Campbell, 1989; Oldham, 1992).</td>
</tr>
<tr>
<td>Eastern Spiny Softshell Turtle</td>
<td>Scattered and apparently not common throughout its Canadian range; affected by pollution, natural predators and other human impacts in Ontario (Campbell et al., 1991).</td>
</tr>
<tr>
<td>Eastern Massasauga Rattlesnake</td>
<td>Reduction of former range and abundance in Ontario due to direct persecution by humans and extensive wetland destruction (Weller and Parsons, 1991).</td>
</tr>
<tr>
<td>Blue Racer</td>
<td>Original range reduced in southwestern Ontario to verified populations occurring now only on Pelee Island, Ontario following habitat fragmentation and killing of snakes by humans (Campbell and Perrin, 1991).</td>
</tr>
<tr>
<td>Spotted Turtle</td>
<td>Scattered populations in Ontario remain following an increase in wetland destruction, poaching and natural predators (Oldham, 1991).</td>
</tr>
<tr>
<td>Lake Erie Water Snake</td>
<td>Population declines evident on Pelee Island due to human persecution and habitat (shoreline) destruction; also susceptible to genetic swamping by northern water snakes, <em>N. s. sipedon</em>, a mainland subspecies (Campbell and King, 1991).</td>
</tr>
<tr>
<td>Smallmouth Salamander</td>
<td>Very restricted range in Canada, though currently abundant within some secure habitats on Pelee Island, Ontario, the only locality for this species in Canada (Bogart and Licht, 1991).</td>
</tr>
<tr>
<td>Blanding’s Turtle (Nova Scotia population)</td>
<td>Occurs at the northeastern limit of the species range in a restricted area geographically isolated from other populations; the population is small and apparently declining because the age distribution is considered “top-heavy” as result of low recruitment rates and artificially increased predator pressure imposed mainly by raccoons (Herman et al., 1994).</td>
</tr>
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Table 2b. Justification for Status of Ontario Species
<table>
<thead>
<tr>
<th><strong>LONG POINT</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Land Ownership:</strong> Canadian Wildlife Service (federal), Ontario Ministry of Natural Resources (provincial), Long Point Regional Conservation Authority (regional) and other private areas.</td>
<td></td>
</tr>
<tr>
<td><strong>Site Description:</strong> Sand spit containing a variety of habitats including alternating dunes and savanna; dominated by freshwater marshes.</td>
<td></td>
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<tr>
<td><strong>International Designations:</strong> RAMSAR (1982); UNESCO/MAB (1986)</td>
<td></td>
</tr>
<tr>
<td><strong>COSEWIC Species:</strong> Fowler’s toad, spotted turtle, eastern spiny softshell, and Blanding’s turtle</td>
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</tr>
<tr>
<td><strong>Management Issues:</strong> road mortality along the Long Point Causeway, habitat alteration, natural predators, flooding and erosion</td>
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<table>
<thead>
<tr>
<th><strong>RONDEAU PROVINCIAL PARK</strong></th>
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<tbody>
<tr>
<td><strong>Category:</strong> Natural Environment Class Park</td>
<td></td>
</tr>
<tr>
<td><strong>Land Ownership:</strong> Ontario Ministry of Natural Resources (provincial)</td>
<td></td>
</tr>
<tr>
<td><strong>COSEWIC species:</strong> Fowler’s toad, spotted turtle, eastern spiny softshell and Blanding’s turtle</td>
<td></td>
</tr>
<tr>
<td><strong>Management Issues:</strong> No recent inventories apart from Ontario Herpetofauna Summary.</td>
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<thead>
<tr>
<th><strong>POINT PELEE NATIONAL PARK</strong></th>
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<tbody>
<tr>
<td><strong>Land Ownership:</strong> Parks Canada (federal)</td>
<td></td>
</tr>
<tr>
<td><strong>International Designation:</strong> RAMSAR Wetland of International Importance (1987)</td>
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</tr>
<tr>
<td><strong>Site Description:</strong> Sand spit containing dunes, sand plains, upland forests and freshwater marsh.</td>
<td></td>
</tr>
<tr>
<td><strong>COSEWIC Species:</strong> spotted turtle, eastern spiny softshell, Blanding’s turtle</td>
<td></td>
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<tr>
<td><strong>Extirpated Species:</strong> Fowler’s toad, bullfrog, gray tree frog, wood frog, Blanchard’s cricket frog, eastern hognose snake, black rat snake, blue racer, eastern Massassauga rattlesnake and timber rattlesnake</td>
<td></td>
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<tr>
<td><strong>Management Issues:</strong> Species monitoring, specifically anurans, eastern fox snakes and five-lined skinks; repatriation of extirpated species; monitoring the status of spotted turtles and effects of natural predators on reproduction.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Description and Analysis of Long Point, Rondeau, and Point Pelee
<table>
<thead>
<tr>
<th></th>
<th>Marsh L</th>
<th>Upland Forest R</th>
<th>Sloughs P</th>
<th>Beach and Dunes L</th>
<th>Cedar Savanna R</th>
<th>Old Fields P</th>
<th>Human Areas L</th>
<th></th>
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<tbody>
<tr>
<td>Amphibians</td>
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<td>Red-Spotted Newt</td>
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<td>Blue-Spotted</td>
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<td>Yellow-Spotted</td>
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<tr>
<td>Fowler's Toad</td>
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<td>Gray Treefrog</td>
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<td>Midland Chorus Frog</td>
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<td>Northern Spring Peeper</td>
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<td>Wood Frog</td>
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<tr>
<td>Northern Leopard Frog</td>
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<td>Green Frog</td>
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<td>Bullfrog</td>
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<td>Common Snapping</td>
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<td>Common Map Turtle</td>
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<td>Five-Lined Skink</td>
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<td>Eastern Garter</td>
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<td>Northern Water</td>
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<td>Queen Snake</td>
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<td>Brown Snake</td>
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<td>Eastern Hognose</td>
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<td>Black Rat Snake</td>
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<tr>
<td>Eastern Fox Snake</td>
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<tr>
<td>Eastern Milk Snake</td>
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</tbody>
</table>
| + - primary habitat; B - breeding habitat; N - nesting habitat
| Table 4: Current Distribution of Native Herpetofauna among Major Habitats at Long Point (L), Rondeau (R) and Point Pelee (P) (Natural Heritage Information Center, unpublished data) |
### LONG POINT

**Population Studies:**
- Published and unpublished reports to the Ontario Ministry of Natural Resources
- Published and unpublished reports to the Canadian Wildlife Service
- Melanism in eastern garter snakes
- Population and genetic studies of Fowler’s toads
- Reproductive strategies of Blanding’s turtle

**Community/Regional-Scale Monitoring:**
- Natural Areas Inventory of Herpetofauna in Haldimand-Norfolk (all species)
- Turtle study in Big Creek National Wildlife Area
- Ontario Herpetofaunal Summary (all species), IUCN/SSC Amphibian Population Monitoring Program (frogs and toads)
- Large Snake Survey, 1992-1993 (eastern fox snake, eastern hognose snake, black rat snake)
- Canadian Wildlife Service roadkill survey

### RONDEAU PROVINCIAL PARK

**Population Studies:**
- eastern spiny softshell nest survey (unpublished)

**Community/Regional-Scale Monitoring:**
- Species checklists and inventories (outdated)
- Ontario Herpetofaunal Summary (all species)

### POINT PELEE NATIONAL PARK

**Population Studies:**
- Published and unpublished research on eastern fox snakes and Five-lined skinks

**Community/Regional-Scale Monitoring:**
- Published and unpublished research on amphibians
- Ontario Herpetofaunal Summary (all species)

---

Table 5: Review of Research on Herpetofauna  (Zammit, 1996)
<table>
<thead>
<tr>
<th>Species</th>
<th>Areas of Importance</th>
<th>Recovery Team - Participating Institutions</th>
<th>Recovery Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softshell Turtle (Threatened)</td>
<td>Long Point, Rondeau, Point Pelee, and Sydenham and Thames Rivers</td>
<td>OMNR*, Upper Thames Region Conservation Authority, CWS, Univ. of Guelph, McGill Univ., Metro Toronto Zoo, private consultants</td>
<td>in draft</td>
</tr>
<tr>
<td>Massassauga (Threatened)</td>
<td>Georgian Bay Islands and Bruce Peninsula National Parks, Ojibway Nature Reserve, Windsor</td>
<td>Parks Canada*, OMNR, Metro Toronto Zoo, Brock Univ., Ojibway Nature Center, Ontario Field Herpetologists</td>
<td>in review</td>
</tr>
<tr>
<td>Blue Racer (Endangered)</td>
<td>Pelee Island, private and publicly owned areas</td>
<td>OMNR*, Pinery Prov. Park, Royal Ontario Museum, Univ. of Windsor, Metro Toronto Zoo, Univ. of Guelph, Gartner Lee Ltd., Herpetological Associates</td>
<td>in review</td>
</tr>
<tr>
<td>Lake Erie water snake (Endangered)</td>
<td>Pelee Island, private and publicly owned areas</td>
<td>OMNR*, Northern Illinois Univ., Ohio Univ.</td>
<td>in draft</td>
</tr>
<tr>
<td>Blanchard’s cricket frog (Endangered in Canada)</td>
<td>Proposed reintroductions on Pelee Island and at Pinery Provincial Park</td>
<td>OMNR*, CWS, Univ. of Guelph, private consultants</td>
<td>approved in 1997</td>
</tr>
</tbody>
</table>

*Lead Agency; OMNR and the Canadian Wildlife Service (CWS)

Table 6: Summary of Critical Areas and Institutions Responsible for the Recovery of Threatened and Endangered Herpetofauna in Ontario (RENEW)
<table>
<thead>
<tr>
<th><strong>Federal</strong></th>
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</table>
| Environment Canada: Canadian Wildlife Service | National Parks Act  
Canada Wildlife Act (National Wildlife Areas)  
Biodiversity Conservation Strategy  
Declining Amphibian Population Task Force in Canada (DAPCAN) |

<table>
<thead>
<tr>
<th><strong>Provincial</strong></th>
<th></th>
</tr>
</thead>
</table>
| Ontario Ministry of Natural Resources | Provincial Parks Act  
Endangered Species Act  
Game & Fish Act  
Public Lands Act  
Lakes & Rivers Improvement Act  
Ecological Reserves Act (Proposed)  
Guidelines for Wetlands Management in Ontario  
Endangered Spaces Action Plan  
Biodiversity Conservation Strategy |

<table>
<thead>
<tr>
<th><strong>Regional</strong></th>
<th></th>
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</thead>
</table>
| Long Point Regional Conservation Authority  
Catfish Creek Conservation Authority  
Kettle Creek Conservation Authority  
Lower Thames Conservation Authority (Rondeau)  
Essex Region Conservation Authority (Point Pelee) | Conservation Authorities Act  
LPRCA Watershed Plan  
LPRCA and ERCA Lakeshore Management Plan  
LTRCA Lakeshore Management Plan (In Progress) |

<table>
<thead>
<tr>
<th><strong>Amendments imposed by Bill 26 (Environmental Commissioner of Ontario - Annual Report, 1994-1995):</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All fees collected under this Act are to be held in a Consolidated Revenue Fund for purposes of fish/wildlife/ecosystem management, or related human activities.</td>
<td></td>
</tr>
<tr>
<td>2. Amendment to statute not indicated.</td>
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<tr>
<td>3. Government given power to make regulations prescribing circumstances in which approval is required to construct or improve a dam.</td>
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</tr>
<tr>
<td>4. Municipalities given power to dissolve Conservation Authorities.</td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Examples of Additional Institutional Frameworks Relevant to Species Conservation in the Long Point, Rondeau, and Point Pelee Areas (After Zammit, 1996)
### Ontario Game and Fish Act

**REPTILES**

- common snapping turtle: *Chelydra serpentina serpentina*
- spotted turtle: *Clemmys guttata*
- wood turtle: *Clemmys insculpta*
- western painted turtle: *Chrysemys picta bellii*
- Midland painted turtle: *Chrysemys picta marginata*
- Blanding’s turtle: *Clemmys guttata*
- common map turtle: *Graptemys geographica*
- common musk turtle: *Sternotherus odoratus*
- eastern spiny softshell turtle: *Apalone spinifera spinifera*
- queen snake: *Regina septemvittata*
- eastern hognose snake: *Heterodon platirhinos*
- black rat snake: *Elaphe obsoleta*
- eastern fox snake: *Elaphe vulpina gloydi*
- blue racer: *Coluber constrictor foxi*
- Lake Erie water snake: *Nerodia sipedon insularum*
- northern water snake: *Nerodia sipedon sipedon*
- timber rattlesnake: *Crotalus horridus*
- Butler’s garter snake: *Thamnophis butleri*
- eastern Massassauga: *Sistrurus catenatus catenatus*

**AMPHIBIANS**

- bullfrog: *Rana catesbeiana*
- Fowler’s toad: *Bufo woodhousei fowleri*
- Blanchard’s cricket frog: *Acris crepitans blanchardi*
- northern dusky salamander: *Desmognathus fuscus fuscus*

### Ontario Endangered Species Act

**REPTILES**

- blue racer: *Coluber constrictor foxi*
- Lake Erie water snake: *Nerodia sipedon insularum*
- timber rattlesnake: *Crotalus horridus*

**AMPHIBIANS**

- Blanchard’s cricket frog: *Acris crepitans blanchardi*

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**Table 8: Provincial Legislation Covering Amphibians and Reptiles**

**Conclusions**

Long Point, Rondeau and Point Pelee represent three of the most important areas for herpetofauna in Canada. Parks and other protected areas at these three peninsulas and on nearby Pelee Island are significant because they provide habitat for a diversity and abundance of amphibians and reptiles, many of which are rare in Ontario and Canada. They provide excellent opportunities for the conservation of herpetofauna and biological diversity in general.
An assessment of information relevant to these areas indicates the need for both site-based and regionally integrated conservation for herpetofauna along the north shore of Lake Erie. This can best be achieved by integrating existing species/habitat assessment and recovery programs, focusing these programs on parks and protected areas, and strengthening and enforcing public policy and legislation relevant to biodiversity conservation in Ontario and Canada.

**Conservation Guidelines and Recommendations**

**Research and Monitoring - the basis for conservation action**

- Conduct research on species biology, population abundance, distribution, demography, genetic variation – among and within populations as well as on social behaviour and habitat preferences.
- The effects of ultraviolet radiation, acid rain and other contaminants should be monitored in parks and protected areas, which are often subject to such environmental impacts.
- Collect, organize and maintain standardized data and other information necessary to fulfill existing species monitoring, assessment and recovery programs. Such data are necessary to improve knowledge of herpetofauna at Rondeau in particular. Existing data for populations at Long Point and Point Pelee provide a good ecological foundation for species conservation elsewhere in Ontario.
- Set conservation priorities, goals and objectives in accordance with global and sub-national (provincial) status rankings now available for habitats as well as for species through Ontario’s Natural Heritage Information Centre – a partnership consisting of The Nature Conservancy in Canada, Natural Heritage League and Ontario Ministry of Natural Resources.
- Stronger partnerships are needed to facilitate data and information exchanges among public, private and academic researchers. Representing both government and non-government environmental organizations, COSEWIC and RENEW have thus far taken a single species approach – assessing the status of very few species and planning for the recovery of even fewer. The Working Group on Amphibian and Reptile Conservation in Canada has the potential to broaden the scope of species conservation. The Canadian Task Force on Declining Amphibian Populations (DAPCAN), a subsidiary of the World Conservation Union’s Species Survival Commission Task Force (IUCN/SSC/DAPTF), has already implemented three volunteer-based projects across Ontario involving Road Kill Counts, Backyard Surveys and a Marsh Monitoring Program. In Ontario, the Canadian Wildlife Service of Environment Canada administers monitoring programs. The Long Point Bird Observatory oversees monitoring activities in the Long Point area.

**Reintroductions**

- As more information about species biology and habitat availability becomes known, it may be feasible to take specific actions. Reintroducing blue racers and Blanchard’s cricket frog at Pinery Provincial Park and on Pelee Island, respectively, are actions being considered by recovery teams. One way of repatriating the blue racer back into its natural habitat on the Ontario mainland is to translocate individuals from Pelee Island. However, removal of individuals from this remnant population may jeopardize the species
entirely in Canada. To prevent this, it may be necessary to relocate racers from source populations in the United States for use in a captive breeding program at the Toronto Zoo or another suitable facility in Ontario. Since Blanchard's cricket frog is extinct in Canada, translocation from the U.S. is the only option for this species.

- Reintroducing other species such as bullfrogs and Fowler's toads at Point Pelee could be achieved more readily by translocating individuals from areas that support healthy populations such as Long Point and Rondeau.

Reserves and Sanctuaries

- Small areas within or adjacent to parks and other protected areas should be designated as reserves or sanctuaries to protect breeding habitat. Buffer zones would be useful in areas adjacent to protected areas such as the Big Creek National Wildlife Area at Long Point, where the incidence of road mortality and habitat loss due to cottage and marina development is high. Existing preservation zones could be designated or created at Rondeau Provincial Park and Point Pelee National Park, where cottages have been or are soon to be eliminated and where habitat is gradually being restored. For example, such areas could be designed to protect nesting turtles and their eggs against natural predators and human disturbance.

Education

- Provide educational opportunities and other interpretive programs within parks and protected areas. The Backus Heritage Conservation Area could better represent the herpetofauna of the Long Point area by establishing a museum – or zoo-like display. Steps could be taken to improve the interpretive facilities at Rondeau Provincial Park and Point Pelee National Park. Educational programs at all three peninsulas should be augmented to include hands-on workshops related to herpetofauna conservation. For example, Bruce Peninsula and Georgian Bay Islands National Parks have used education to improve human attitudes toward rattlesnakes and other large snakes.
- Promote awareness of the international importance of Long Point and Point Pelee. Consider bioregional (ecosystem) approaches to conservation at Rondeau and Point Pelee, following the example of UNESCO's Man and the Biosphere program, which has established World Biosphere Reserves at Long Point and on the Niagara Escarpment for a total of six in Canada.

Acknowledgements

This research was completed as part of a Masters degree in the Faculty of Environmental Studies, University of Waterloo with support from Royal Canadian Geographical Society and Social Sciences and Humanities Research Council grants to Gordon Nelson.

References


REPORTS

St. Lawrence Islands National Park

Lake Superior Provincial Park
Economic Benefits of Provincial Parks in Ontario: A Case Study Approach

Peter Whiting, The Outspan Group
Dan Mulrooney, Ontario Parks

Abstract
The Government of Ontario’s recently initiated long-term planning program Lands for Life covers Crown lands in Ontario’s Boreal West, Boreal East and Great Lakes/St. Lawrence regions. Ontario Parks has an interest in this program and commissioned a study to provide estimates of the economic benefits produced by three classes of Provincial Parks within the area.

The purpose of the study was to derive an initial estimate of the magnitude of benefits generated by three parks: Quetico (wilderness), Lake Superior (natural environment) and Mattawa River (waterway). The economic assessment framework produced estimates of benefits attributable to each of the parks from two perspectives – the local area and the province – and recognized three types of benefits – personal, business and societal. Detailed analyses were conducted for each of the three provincial parks. The qualified results reflect only those benefits associated with the parks that could be estimated in monetary terms.

The study results for the three parks examined are significant. Quantified annual benefits to the local areas from each of Quetico, Lake Superior and Mattawa River were $2.7 million, $2.1 million and $0.3 million, respectively, and to the Province of Ontario $7.0 million, $7.7 million and $0.7 million, respectively. Benefits per resident at the local and provincial levels indicated their importance to these outlying communities.

The information provides a broader base to assess the benefits of provincial parks. Information on the broad range of benefits derived from provincial parks will facilitate their recognition as a highly beneficial land use alternative. This study showed that the quantifiable dollar benefits derived from these three parks are substantial, but that weaknesses in available data make it difficult to assess the full benefits of the provincial parks.

Introduction
The operation of a large park system, such as Ontario Parks, provides a host of social and economic benefits. Currently very little is known about the economic benefits generated by provincial parks. The Outspan Group was contracted to estimate these benefits for Ontario Parks. While there were specific objectives, the overall goal was to expand the socio-economic knowledge base of the organization.

Objectives
1. Estimate the benefits derived from three provincial parks – Quetico, Lake Superior and Mattawa River, each representing a different classification of park.
2. Assess benefits to Ontario from local and provincial perspectives.
3. Apply results to all parks in each class.

Economic Assessment Framework
Key to the success of any economic assessment is the application of the right framework. The one used (Table 1) was developed for National Parks and had the following features:

- It is conceptually simple: uses three categories – personal, business and society;
- It allows different perspectives of assessment: multiple account registers;
- It incorporates economic impacts within a “benefits” framework;
- It is additive across categories of benefits;
- It incorporates qualitative benefits; and,
- It generates a total value assessment.

The accounting of benefits changes with each perspective of assessment.

Summary Results

Quetico Provincial Park
Table 2 provides a brief summary of the benefits to the local area in Ontario. Table 3 provides a summary of the benefits to the province of Ontario from Quetico Provincial Park. Table 4 summarizes the dollar benefits associated with Quetico Provincial Park.

Conclusions
1. Each park generates substantial benefit. Some produce millions annually.
2. The results cannot be generalized to represent all parks in the same classification. More research specific to these other parks that takes into account the specific features and unique characteristics that make them important is needed to fully appreciate their value.
3. Value of the parks to society at large is substantially larger. Benefits exported from the province reflect an overall gain for society.
4. There are many advantages to the use of a consistent and additive framework for the assessment of park benefits.
5. The type of information presented in this report is important: it provides a broader base on which to assess the importance of provincial parks.

Overall Conclusions

Provisos
a) Preliminary results are an indication of the order of magnitude of benefits involved. The numeric results should be considered both conservative and preliminary. More research is needed.
b) Not all benefits of the parks have been quantified. Other benefits exist.
c) Exported benefits to other provinces and countries are not included.
<table>
<thead>
<tr>
<th>Benefit Category:</th>
<th>PERSONAL</th>
<th>BUSINESS</th>
<th>SOCIETAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition:</strong></td>
<td>benefits accruing to stakeholders (users and non-users)</td>
<td>Benefits derived from the net redistribution of commercial activity from one area to another</td>
<td>non-allocable benefits tending to be societal in scope</td>
</tr>
<tr>
<td><strong>Benefit Components:</strong></td>
<td>Use Values - direct use - indirect use - future use value</td>
<td>Impacts from spending by stakeholders and by location management for development and operations, as measured by increases in GDP (value added), labour income, employment and tax revenue</td>
<td>Ecological Functions: primary production, sequestering carbon dioxide, soil formation, herbivory, carnivory, oxygen production, population moderation, nutrient transport, moderation of macro- and microclimate, decomposition, maintenance of genetic diversity, and others</td>
</tr>
<tr>
<td></td>
<td>Non-Use Values - option value - existence value - bequest value</td>
<td>Resource integrity: maintenance of existing benefits; mitigate cumulative effects of human changes</td>
<td>Health effects – mental, physical, spiritual</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Worker productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Educational benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scientific benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>International responsibilities and agreements: NAWMP, CBD, RAMSAR, CITES, MAB, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Business location decisions (quality of life/business), community cohesion</td>
</tr>
</tbody>
</table>

Table 1: Generalized Framework for Estimating the Benefits of Provincial Parks
### Table 2: Summary of Benefits to the Local Area from Quetico Provincial Park, 1996

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Quantitative and Qualitative Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Benefits</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>$390,000</td>
</tr>
<tr>
<td>Non-Use</td>
<td>$585,000</td>
</tr>
<tr>
<td>Business Benefits</td>
<td></td>
</tr>
<tr>
<td>Value Added</td>
<td>$1,549,000</td>
</tr>
<tr>
<td>(Employment)</td>
<td>(34.5)</td>
</tr>
<tr>
<td>Societal Benefits</td>
<td>- business location decisions</td>
</tr>
<tr>
<td></td>
<td>- research benchmark for boreal forest ecosystems</td>
</tr>
<tr>
<td></td>
<td>- Lac La Croix economic development</td>
</tr>
<tr>
<td></td>
<td>- maintenance of local activity benefits</td>
</tr>
<tr>
<td></td>
<td>- educational resource</td>
</tr>
<tr>
<td></td>
<td>- $210,000 health cost savings</td>
</tr>
</tbody>
</table>

### Table 3: Summary of Benefits to the Province from Quetico Provincial Park, 1996

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Quantitative and Qualitative Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Benefits</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>Non-Use</td>
<td>$3,300,000</td>
</tr>
<tr>
<td>Business Benefits</td>
<td></td>
</tr>
<tr>
<td>Value Added</td>
<td>$1,800,000</td>
</tr>
<tr>
<td>(Employment)</td>
<td>(32.0)</td>
</tr>
<tr>
<td>Societal Benefits</td>
<td>- $400,000 in fees paid by out-of-province park visitors ecological functions/services valuable to all Ontarians ($150 million)</td>
</tr>
<tr>
<td></td>
<td>- research benchmark for boreal forest ecosystems</td>
</tr>
<tr>
<td></td>
<td>- natural and cultural heritage conservation</td>
</tr>
<tr>
<td></td>
<td>- diversified economic development opportunities in rural areas</td>
</tr>
<tr>
<td></td>
<td>- $345,000 in cost savings to Ontario Health Insurance Plan (OHIP)</td>
</tr>
</tbody>
</table>

### Table 4: Summary of Dollar Benefits Associated with Quetico Provincial Park, 1996

<table>
<thead>
<tr>
<th>Area and Benefit Type</th>
<th>Economic Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Local Area</strong></td>
<td></td>
</tr>
<tr>
<td>Personal Benefits</td>
<td>$975,000</td>
</tr>
<tr>
<td>Business Benefits</td>
<td>$1,549,000</td>
</tr>
<tr>
<td>Societal Benefits</td>
<td>$210,000</td>
</tr>
<tr>
<td>Dollar Total</td>
<td>$2,734,000</td>
</tr>
<tr>
<td><strong>2. Province of Ontario</strong></td>
<td></td>
</tr>
<tr>
<td>Personal Benefits</td>
<td>$4,500,000</td>
</tr>
<tr>
<td>Business Benefits</td>
<td>$1,800,000</td>
</tr>
<tr>
<td>Societal Benefits</td>
<td>$745,000</td>
</tr>
<tr>
<td>Dollar Total</td>
<td>$7,045,000</td>
</tr>
</tbody>
</table>

Note: Only those values that could be put in dollar terms are included in this table. Not all benefits associated with Quetico are included in these figures.
### Table 5: Summary Dollar Benefits for Quetico, Lake Superior and Mattawa River Provincial Parks, 1996

<table>
<thead>
<tr>
<th>Area and Benefit Values</th>
<th>Quetico</th>
<th>Lake Superior</th>
<th>Mattawa River</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Local Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Benefits</td>
<td>$975,000</td>
<td>$596,000</td>
<td>$205,000</td>
</tr>
<tr>
<td>Business Benefits</td>
<td>$1,549,000</td>
<td>$1,318,000</td>
<td>$36,500</td>
</tr>
<tr>
<td>Societal Benefits</td>
<td>$210,000</td>
<td>$170,000</td>
<td>$56,000</td>
</tr>
<tr>
<td>Total Benefits</td>
<td>$2,734,000</td>
<td>$2,084,000</td>
<td>$297,500</td>
</tr>
<tr>
<td>2. Province of Ontario</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Benefits</td>
<td>$4,500,000</td>
<td>$6,101,000</td>
<td>$593,000</td>
</tr>
<tr>
<td>Business Benefits</td>
<td>$1,800,000</td>
<td>$1,108,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>Societal Benefits</td>
<td>$745,000</td>
<td>$496,000</td>
<td>$110,000</td>
</tr>
<tr>
<td>Total Benefits</td>
<td>$7,045,000</td>
<td>$7,705,000</td>
<td>$709,000</td>
</tr>
</tbody>
</table>

Note: The values presented in this table are only those benefits that have been valued in monetary terms. Not all benefits associated with these parks are represented in these figures.

### Table 6: Benefit per Local Area and Provincial Resident for Quetico, Lake Superior and Mattawa River Provincial Parks, 1996

<table>
<thead>
<tr>
<th>Area and Benefit Values</th>
<th>Quetico</th>
<th>Lake Superior</th>
<th>Mattawa River</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Local Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Benefits</td>
<td>$2,734,000.00</td>
<td>$2,084,000.00</td>
<td>$297,500.00</td>
</tr>
<tr>
<td>Local Area Population</td>
<td>5,500.00</td>
<td>5,000.00</td>
<td>64,000.00</td>
</tr>
<tr>
<td>Benefits per Resident</td>
<td>$497.09</td>
<td>$416.80</td>
<td>$4.65</td>
</tr>
<tr>
<td>2. Province of Ontario</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Benefits</td>
<td>$7,045,000</td>
<td>$7,705,000.00</td>
<td>$709,000.00</td>
</tr>
<tr>
<td>Provincial Population</td>
<td>$10,753,573.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits per Resident</td>
<td>$0.66</td>
<td>$0.72</td>
<td>$0.07</td>
</tr>
</tbody>
</table>
Community Evaluation Methodology

Wasyl Bakowsky
Natural Heritage Information Centre, Ontario Ministry of Natural Resources
300 Water St., Peterborough, Ontario, K9J 8M5

Abstract

The Ontario Natural Heritage Information Centre (NHIC) collects and maintains information on occurrences of significant vegetation communities in the province. Significant occurrences include those of communities considered to be rare in the province as well as high-quality examples of non-rare communities. The conservation rank (S-rank) of vegetation communities are determined using standard criteria developed by The Nature Conservancy (TNC) in the United States. Communities are ranked from S1-S5, with S1 being the most rare, and S5 the most common. Only those communities ranked S1, S2 and S3 are considered to be rare. The ranking is based on the number of community occurrences, the total area of the community, and the geographic range it occupies in the province.

The quality of the community occurrence, referred to as Community Element Occurrence Rank, is also an important consideration. The occurrence rank is based on three considerations: size, condition and landscape context. Vegetation communities occur at different scales on the landscape. They may form a landscape matrix, or occur as large patches or small patches in an unaltered landscape. By considering the size of the existing community, in relation to its landscape patch size in an unaltered landscape, a size quality can be determined. The size quality can then be compared to the landscape context to determine a combined size/landscape context score. This score is then compared to a community quality score to determine a final community occurrence rank. The highest rank is A, this refers to a community which is large enough to maintain ecological processes and species interactions such that it is expected to have excellent predicted viability over time. A rank of B has good predicted viability over time, and a C rank has fair viability.

Together, the community conservation rank and occurrence rank are useful tools in conservation planning initiatives. In gap analyses where community representation is considered, not only can the occurrence of a community within an area be considered, but so can its quality. The selection of candidate areas for protection as parks or nature reserves should be weighted toward those with high-quality community examples. On the other hand, knowledge of the presence of poor or degraded communities, especially of rare types, can help focus restoration and rehabilitation efforts.

The Natural Heritage Information Centre (NHIC) is a provincial organization dedicated to protecting Ontario's biodiversity. It does this through its core function, which is to generate a permanent and dynamic atlas and data bank on the character, distribution and conservation status of natural areas, critical flora and fauna, vegetation communities and special features in Ontario.
The NHIC is part of a hemispheric network of heritage centres that are established in six Canadian provinces, Atlantic Canada, each of the 50 American states and in 14 Latin American and Caribbean countries. The centres all follow a common methodology for collecting, recording, evaluating, maintaining and storing information for the purpose of biodiversity conservation, which was developed by The Nature Conservancy (TNC) in the United States.

One of the great strengths of the common methodology shared by this natural heritage network is that information can be readily shared between programs. The central TNC office in Arlington, Virginia, receives status information for species and vegetation communities from each program annually, and by reviewing these data, is able to assign a global conservation status for each. Heritage centres can also work together sharing and collecting data for regional assessments, to maximize biodiversity conservation efforts.

Recently, ecologists in the Conservation Science Division of The Nature Conservancy and in various heritage centres have developed a community evaluation methodology for use by heritage centres. The NHIC collects and maintains information on communities that are rare in the province, as well as high-quality examples of communities that may not be rare. By using this evaluation methodology, communities may be assessed and ranked to prioritize and guide conservation efforts.

Vegetation community evaluation is based on two key items:
- **Conservation Rank** - a designation of rarity
- **Occurrence Rank** - a designation of quality

### Conservation Rank

The NHIC applies the following conservation ranks to vegetation community types:
- **S1** - Extremely rare in Ontario; usually five or fewer occurrences in the province, or very few remaining hectares.
- **S2** - Very rare in Ontario; usually between five and 20 occurrences in the province or with few remaining hectares.
- **S3** - Rare to uncommon in Ontario; usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with some large remaining hectares.
- **S4** and **S5** are considered to be common and widespread in Ontario

These conservation ranks are based on a number of considerations, primarily the estimated number of occurrences of the community – known as the community element since it is an ‘element of biodiversity’ – the total areal extent, and the distribution range within the province. The following letter codes are assigned to each factor, and together they are used to derive the conservation rank.

### Estimated Number of Community Element Occurrences

- **A** 1-5 occurrences
- **B** 6-20 occurrences
- **C** 21-100 occurrences
- **D** >100 occurrences
In some cases, such as when communities like tallgrass prairies have disappeared to the point that they now exist mostly as tiny fragments, only larger (i.e., > 2ha) occurrences are considered in the ranking.

Estimated Community Element Areal Extent
A <1,000 ha
B 1,000 - 5,000 ha
C 5,000 - 25,000 ha
D >25,000 ha

Estimated Range of Community Element
A Very small range in province, < 3% of provincial area
B Narrow range, < 10% of provincial area
C Moderately widespread, < 50% of provincial area
D Widespread, > 50% of the provincial area

Community Element Occurrence Rank
The community element occurrence rank indicates the quality of the occurrence. The basic element occurrence ranks include:
A excellent predicted viability
B good predicted viability
C fair predicted viability
D probably not viable

There are also some additional ranks that may be assigned in certain cases:
E verified to be extant (not enough information to rank properly)
H historical
F failed to find (site visit was made, not found)
X extirpated
<blank> unranked

Element occurrence ranks are based upon the following variables:
Size
Condition
Landscape Context

Size Considerations
Communities may be categorized into three broad functional groups based on their historical or current pattern of occurrence. The functional group to which a community belongs affects the assessment of the size quality rating. These groups are identified as:
• Matrix
• Large Patch
• Small Patch

The following general definitions and examples of these community categories have been developed to date. However, these specifications have only been recently developed, and only for a few community types. Work is ongoing by ecologists to develop specifications for the wide variety of communities that have been described in the TNC vegetation classification system for North America.
Matrix Community
- forms extensive and contiguous cover (2,000-40,500 hectares, as much as 75-80% of natural vegetation in an ecoregion)
- typically have wide ecological tolerances

Size specifications for Eastern Hemlock - Yellow Birch Mesic Forest (Faber-Langendoen, 1997):
- **A** Very large (>400 ha)
- **B** Large (40-399 ha)
- **C** Moderate (4-39 ha)
- **D** Small (<4 ha)

Large Patch Community
- forms large areas of uninterrupted cover (20-2,000 ha, as much as 20% of natural vegetation in an ecoregion)
- associated with environmental conditions that are more specific than those of matrix communities

Generic size specifications (D. Faber-Langendoen, 1997):
- **A** Very large (>260 ha)
- **B** Large (65-260 ha)
- **C** Moderate (15-65 ha)
- **D** Small (<15 ha)

Small Patch Community
- forms small, discrete areas of cover (<20 ha, generally less than 5% of an ecoregion)
- occur in very specific ecological settings

Size specifications for Great Lakes Coastal Meadow Marsh [a.k.a. Interdunal Panne, Shoreline Fen] (Comer, 1987):
- **A** Very large (>16 ha)
- **B** Large (8-16 ha)
- **C** Moderate (1-8 ha)
- **D** Small (<1 ha)

Community Condition
Many considerations determine the community condition, including many that are dependent on the community itself. Examples are:
- Are there “old growth” conditions present?
- Is the overstory and understory structure intact?
- Is the native species composition intact?
- What is the extent of introduced species in the community?
- Are ecological processes integral to the community occurring? (e.g., fire)
- What is the extent of human-induced disturbance?
- Are hydrological regimes still ‘natural’?
Landscape Context

A  highly connected – surrounding area is largely intact natural vegetation with species interactions and natural processes occurring across communities
B  moderately connected – surrounding area is moderately intact natural vegetation; landscape includes partially disturbed or semi-natural communities
C  moderately fragmented – surrounding area is combination of cultural and natural vegetation with barriers to species interactions and natural processes
D  highly fragmented – almost entirely surrounded by agricultural or urban land use

Determination of the community element occurrence rank is a two-step process. First, using a table, the community size is compared against the landscape context to determine a joint size/landscape context rating. The following table illustrates this. In this hypothetical example, the size rating is A, landscape context is B and condition is C.

<table>
<thead>
<tr>
<th>Landscape Context</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>D</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

The next step is to compare the combined size/landscape context rating against the condition rating:

<table>
<thead>
<tr>
<th>Size / Landscape Context Average</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>D</td>
<td>D</td>
<td>C</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

The final rank applied to this community is then “B”.

Together, the community conservation rank and element occurrence rank are useful tools in conservation planning. In gap analyses where community representation is considered, not only can the occurrence of a community within an area be considered, but so can its quality. The selection of candidate areas for protection as parks or nature reserves should be weighted toward those with high-quality community examples. On the other hand, knowledge of the
presence of poor or degraded communities, especially of rare types, can help focus restoration and rehabilitation efforts.

**References**


Faunal survey and inventory in Ontario Parks

S.A. Marshall
Department of Environmental Biology, University of Guelph

Abstract

Parks serve an important role as storehouses of biodiversity, but this role is substantially diminished by our ignorance about what is on the storehouse shelves. Although we have taken stock of the bigger items such as vertebrates and vascular plants, the great majority of the items on the shelves is small, like invertebrates, and has never been inventoried. I would like to argue that it is time we tackled the formidable task of all taxon biological inventory work in Ontario’s parks. I will discuss some of the problems involved using examples from preliminary survey work in Algonquin Provincial Park and Bruce Peninsula National Park.

The huge majority of species in Ontario parks are insects, but no Ontario park has yet undertaken or sponsored extensive surveys of insects or other arthropods. Several studies have dealt with butterflies and dragonflies, which together make up less than one percent of our insect fauna, and some studies have dealt with biting flies, ground beetles, and a few other relatively small taxa in Ontario parks. Considerably more data are available in the form of properly prepared specimens in the three large Ontario insect collections. For example, over 1,000 insect species from Algonquin Park are represented by pinned, labelled and identified specimens in the University of Guelph Insect Collection. These specimens, and other properly prepared and labelled specimens deposited in major insect collections, form the core of a species-level database which can be checked, corrected, and expanded as it is developed into a thorough inventory of selected Park faunas.

An important role of national and provincial parks is to serve as storehouses of biodiversity. As such, it is a good idea to take stock of what is on the storehouse shelves. It is, in fact, quite remarkable that no park in Ontario can boast adequate inventories of the majority of species they house, despite the fact that parks seem to be the logical place to pursue our commitment to the Biodiversity Convention, which explicitly calls for inventory and monitoring. Such inventories, or species lists, are needed to: establish a baseline fauna; monitor for changes from that baseline; recognize endangered habitats; recognize species of special interest; understand patterns of distribution and relationship; and provide accurate and park-specific interpretive information to feed the increasingly broad public interest in natural history.

Much research in parks has focussed on relatively few species of vertebrate animals, but the invertebrates which make up the overwhelming majority of our wildlife remain poorly known. Even though recent studies have dealt with butterflies and dragonflies of some parks, and several studies have dealt with biting flies in Algonquin Park and elsewhere, these groups together make up less than 1.5% of the arthropod fauna. What about the rest of our conspicuous arthropod diversity, especially the beetles, wasps and flies which dominate the
fauna? If you search the literature for recent insect “biodiversity” studies, you will find that many if not most deal with only one group of insects – the Carabidae or ground beetles. In fact, most of these only cover the small subset of the Carabidae taken in standard pitfall traps. Although documentation of a few dozen ground beetle species in a given park does not really seem like an adequate grasp on our “biodiversity”, most current “biodiversity” studies start and finish with the Carabidae. It may be useful to consider why this is the case before going on to look at the problems of broader arthropod inventory.

Ground beetles are relatively inconspicuous insects; generally nocturnal and found in concealed habitats out of the public eye. They are of minor economic importance and most species do not seem to be particularly vulnerable to habitat change. Yet, they are attractive for biodiversity studies for the following reasons:
1. they can be easily sampled with simple pit traps;
2. they can be sorted out of trap samples by unskilled individuals;
3. they are robust and require no special handling;
4. there are good keys to species;
5. there is a huge number of precedent-setting carabid diversity studies done throughout the world; and,
6. there are several good specialists available to assist with difficult identifications. Few other organisms exhibit this auspicious combination of attributes, and carabids are thus the easy choice for every sort of study from undergraduate projects through to major “biodiversity” programs.

Most carabid studies rely on simple pitfall traps or pan traps and only survey a fraction of the local ground beetle fauna. By way of illustration, a recent study of the Carabidae of the Lake Erie islands and adjacent mainland (Will et al., 1995) listed 241 species, of which only 15 were taken in pitfall traps. The balance were taken by light traps, other traps or “hand collecting”. More extensive pitfall trapping in that area would probably have taken around 50 species of ground beetle. My own pitfall and pan trap studies done in Bruce Peninsula National Park, along the edge of one lake in Algonquin Park, and in some local peatlands suggest that around 30 species per site is typical, with the number rising towards 50 as different habitats are added.

Many of the remaining 500 species of Carabidae found in southern Ontario require additional collection techniques, although we have a few specialized carabid groups which are easily collected by hand in circumscribed habitats. The diurnal tiger beetles are a good illustration of this, and comprise a very easily identified group which should be on the list of taxa to be inventoried and monitored for every park. With only 13 or 14 Ontario species, including vulnerable and habitat restricted species such as *Cicindela lepida*, the tiger beetles should join the butterflies and dragonflies in getting honorary bird status. Tiger beetles can be as easily monitored annually as butterflies or birds.

Having surveyed the Carabidae – or at least the easily caught species – and added that data to the butterfly, macro-moth, and dragonfly data being assembled by the growing cadre of naturalists diligently working on these groups, the total fauna inventoried and available for monitoring will still be less than 10% of the fauna of a given park. Further attempts at inventory will reveal that few other taxa are easily sampled, easily prepared, and easily identified, and it will be necessary to surmount obstacles in at least one of these areas.
The most obvious, and most serious, of these obstacles is identification, so the first choice might be a relatively easily identified group of beetles, true bugs, biting flies or stinging wasps for which there are good species keys. Perhaps the easiest of all insects to identify are the lady beetles, some of which – like the Coccinellini – are so characteristically coloured that the Canadian Nature Federation (CNF) has been utilizing the general public to survey the lady beetles of Canada. This survey was launched at my suggestion and was made partly because of data in the Guelph insect collection suggesting that two exotic lady beetle species, *Coccinella septumpunctata* and *Harmonia axyridis*, were displacing some native species.

The lady beetle survey has been a great public relations exercise for CNF, but some conflicts between the maps recently published by CNF and my inventory data serve to illustrate some important points. First of all, we have no real baseline data on the native species, and old specimens in collections like the University of Guelph’s provide our only data on where these species occurred in the past. Fortunately, there are a few specimens of the native species *Coccinella novemnotata* and *Coccinella transversoguttata* taken in Algonquin and Bruce Peninsula in the 1970s. Since neither of these species have shown up in survey work on the Bruce or in Algonquin over the past few years, and neither species has been collected anywhere in Ontario in many years, my data suggest that we should consider *Coccinella novemnotata* and *Coccinella transversoguttata* to be imperilled or even extirpated from the province.

The CNF, however, has recently published maps showing many observations of both species by southern Ontario participants in the lady beetle survey, suggesting that these species are secure. The CNF data are not vouchered by specimens or photographs, and could be based on misidentifications. The important points illustrated by this example are the need for voucher specimens to check records, the lamentable lack of historical baseline data on park insects, and the problem of misidentifications even in an easy group like coccinellines. Once we establish a baseline species lists for park sites, lady beetles will be an easy and profitable group to monitor, with appropriate deposition of voucher specimens.

Misidentifications are by no means confined to amateurs, but the problem of misidentification is a particularly serious one for inventory or survey work which is not linked to a major insect collection. Most identification work requires experience, appropriate literature, and access to a reference collection to check names. Even for relatively well-known groups, error rates are surprisingly high for identifications done without access to a reference collection. My experience suggests that non-systematists working on groups other than butterflies, moths and dragonflies are likely to have error rates of close to 40% at the generic level if they are working without reference collections. These claims are hard to quantify, but I have taught a fourth year course in insect taxonomy for 16 years, and students in that course find it a challenge to beat a 40% error rate keying insects to family during the first half of the course, and by the end of the course very few of them could do that well at the generic level without a really good reference collection.
Even systematists have a significant error rate using most keys, and accuracy is attained only by reference to an authoritatively identified collection. You might well ask, then, what is the error rate of existing surveys? For surveys done without a major reference collection it is probably very high, but unless the specimens from those surveys are permanently housed in a major reference collection we have no way of checking and the data are consequently of very little value.

One way to beat the identification problem is to work with taxa which have been recently revised and thoroughly illustrated to the species level. One such taxon is the family Sphaeroceridae, a group of small flies which are roughly equivalent to the Carabidae in species diversity, are invariably more abundant than Carabidae, show a considerable range of habitat specificity, and have virtually all been described and keyed in the past twenty years. Species determinations in this group do not require a reference collection since male genitalia are complex, species specific, and well illustrated in recent publications. Despite these advantages, few people are working with Sphaeroceridae since they lack the immediate appeal of shiny beetles, are not as easy to recognize in trap samples as big beetles, and are expensive to properly prepare. While one merely whacks a pin through a ground beetle, small flies need to be properly dried in an expensive critical-point drier and glued to paper points. I mention the Sphaeroceridae because they are my taxonomic specialty, but they are only one of more than a dozen fly families which exceed Carabidae in diversity in most survey projects. Diverse parks like Algonquin probably house around 2,000 species of flies in total, although many of those species are difficult to identify at this time. One small ecotone study in Algonquin Park, for example, has so far yielded around 650 species of flies in the suborder Brachycera alone, including 400 species in the higher dipteran families Empidae, Dolichopodidae, Phoridae, Syrphidae, Chloropidae, Sphaeroceridae, Ephydridae, and Muscidae.

Although most of these flies were taken using simple trapping techniques, working on them has involved tremendous problems of sample processing, specimen handling, and identification. Many could not be identified at the University of Guelph despite the active dipterology program and the good reference collection there. Many had to be identified by specialists in Ottawa, Montreal, Washington and elsewhere. Despite these problems, the identified Scott Lake specimens we have accumulated at the University of Guelph represent real progress towards a full survey of Algonquin’s most diverse group of insects. The physical collection of properly prepared and housed specimens at the University of Guelph constitutes a permanent, verifiable, and growing database on a significant part of Algonquin’s biodiversity.

The examples I have briefly discussed should serve to illustrate the following major points about the importance of linking survey and inventory work to major insect collections:

1. Identifications made with the benefit of a large reference collection, such as those of the University of Guelph, the Royal Ontario Museum or the Canadian National Collection are more reliable. Most insects have to be keyed out or identified using a vast literature of variable quality. Inexperienced identifiers, such as summer students, are likely to have a high error rate at the family level and an enormous error rate at the genus and
species level. Confirmation by specialists or checking against a reference collection is usually required.

2. Specimens housed in park collections tend to have a short shelf life, and often end up destroyed by museum pests in the absence of adequate curatorial care. Not only is that wasteful, but the loss of voucher material throws previous identifications into doubt.

3. Permanent deposition in a museum collection makes specimens available for future identification or re-identification, and also makes the specimens available for future studies on taxonomy and distribution.

Even though current resources may restrict biodiversity and inventory work to quick assessments of “easy” groups, placement of properly prepared and labelled specimens in permanent insect collections contributes to a continuously expanding, improving and verifiable database on species diversity in Ontario parks. I strongly recommend that long-term arrangements be made between those parks interested in species inventory and one or more insect collections able to house their material.

Reference:
The Identification of Candidate Protected Areas for the Lands for Life Planning Process by the Partnership for Public Lands*

John Riley  
Federation of Ontario Naturalists

One of the three major stated goals of the Ontario Lands for Life land-use planning process is the completion of Ontario's system of parks and protected areas, a project called Nature’s Best by the Ontario Ministry of Natural Resources (OMNR). The conservation community has taken up this challenge and has directly engaged the planning process in support of the Nature’s Best goal.

One of the stated goals of the conservation community, specifically the Partnership for Public Lands, is the identification, regulation or designation and appropriate management of a completed system of protected areas across the Lands for Life planning area.

This goal challenges the three partners – the Federation of Ontario Naturalists (FON), Wildlands League (WL) and World Wildlife Fund Canada (WWF) – to undertake an innovative analysis of the planning area. This analysis aims to identify both broad areas of conservation opportunity and areas of specific, multiple values for protection, recreation, tourism, scientific study and community legacy.

The objective of this work was to identify protected areas, as defined by the International Union for the Conservation of Nature (IUCN). IUCN states that a protected area is a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

Following the conventions established by the Canadian Forest Accord and WWF’s Endangered Spaces Program, the permitted uses of protected areas were defined as multiple-use, with the exception of industrial logging, mining and hydro-electric development, and with uses defined through management plans, land-use plans and similar procedures.

Early on in the planning process, the Minister of Natural Resources provided the Partnership with digital access to agency data bases on a wide variety of resources. These data are from many sources and have a wide spectrum of accuracy. At the same time, the decision was made to ground the analysis in resource “themes” that were based on government conservation policies, to the degree possible and defensible.

In general, the selection protocol that was adopted for identifying the general land-use designation “protected area” followed the goals outlined in OMNR’s Nature’s Best documentation, which laid out government policy for the Lands for Life planning: The complete range of natural heritage values is considered and

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
assessed in order to determine which areas most efficiently represent natural diversity.

This same OMNR document lists a number of criteria for designating a protected-areas system. These include representation, diversity, uniqueness, quality, sensitivity, rarity, corridors, landscapes processes and disturbance regimes, and the sustainability of areas. This listing was much broader than the single criterion – representation – that OMNR used in its gap-analysis of currently unprotected landforms and vegetation types in each ecological site district of the planning area. A broader array of criteria, as suggested by Nature’s Best, was considered in the analysis outlined below.

A method was adopted by the Partnership that could move from these broad concepts to the actual mapping of sites. Four specific and interactive approaches were taken. Each was mapped and presented for discussion and information to Round Tables, and each was used in a cumulative and interactive fashion to design a landscape-scale protected areas system. The four approaches were:

1. Landscape representation (large-scale);
2. Vegetation-landform representation (medium and local scales);
3. Protected-areas system design (interactive mapping); and,

**Landscape Representation (broad landscape scale)**

At the broad scale of landscape representation, three policy-based values and one efficiency-based value have been analyzed using OMNR data for the first three and OMNR, Environment Canada and Agriculture and Agri-Food Canada data for the last value.

Map data for the following landscape values were quantified for each of the three Lands for Life planning areas. These data were portrayed as individual themes and then added together quantitatively to portray their collective and overlapping distribution for each planning area. This was facilitated by gridding all resource maps into 1km X 1km grids, so that each of the following resource characteristics could be numerically added, subtracted or modified on a grid-by-grid basis.

- **Roadless Wilderness Areas**: Using OMNR mapping, areas more than 2 km and 5 km from roads, railways, hydro corridors, pipelines and other disturbance corridors were identified. (Policy basis: condition 106 of the Timber Class Environmental Assessment, 1992.)

- **Old-growth Forests**: Using OMNR Forest Resource Inventory summary data, areas with high proportions of forest ecosystems more than 90 and 120 years old were identified. (Policy basis: condition 103 of the Timber Class Environmental Assessment, 1992.)

- **Wetlands**: Using OMNR Provincial Land Cover Mapping, areas with more than 50% wetland cover, and other areas with wetlands, were identified. (Policy basis: Provincial Policy Statement under the Planning Act, and general government encouragement of wetland protection over the past decade or so.)
• **Landform Heterogeneity:** Using OMNR mapping of ecological site districts, and enduring features based on finer-scale “soil landscape units” (Environment Canada and Agriculture and Agri-Food Canada data), areas with high and moderate occurrences of multiple landforms/site districts within a radius of 18 km were identified. This approach identified landscape areas where efficient representation may be better achieved because multiple landform and site-district representation is possible within identified landscape areas.

Several other secondary, but important, landscape values were added or subtracted quantitatively from these four core landscape themes, in order to reflect other landscape values important in the identification of protected areas at a broad scale.

• **Representation Gaps in the Existing Park and Conservation Reserve System:** An additional conservation value was assigned to areas where there is presently little, no or only partial representation of landscape values for an identified enduring feature or soil landscape unit.

• **Species- and Communities-at-Risk:** Based on OMNR Natural Heritage Information Centre data, an additional conservation value was assigned to areas where rare native species and vegetation communities are documented. This data set is known to be incomplete at present and has been assigned a secondary value in comparing areas.

• **Cutover-Areas:** Based on OMNR forest harvest data, conservation values were lowered in areas that have been documented as cutover since the 1950s. Notwithstanding the immature condition of vegetation communities in such areas, the cutover state does not negate the value of such areas for long-term protected-area designation.

• **Old-growth White and Red Pine Stands:** Based on OMNR site data, an additional conservation value was assigned to areas identified as supporting old-growth white and red pine stands.

These overlapping and, in some areas, coincidental values were integrated as general landscape-scale “smudge” maps to illustrate the location of the best remaining opportunities for landscape-scale representation of natural-heritage values. To aid in the interpretation of these “smudge” maps, the map areas supporting the 20% of each site district with the highest overall landscapes conservation values – from the above analysis – were identified, to locate large, representation landscape areas.

**Vegetation-Landform Representation (medium and local scales)**

At the finer scales of landform and vegetation representation, two policy-based values and one community-based value have been analyzed, using OMNR data for the first two and community submission for the latter.
The following areas have been identified over many years by OMNR and individuals as candidate protected areas for their representative, unique, distinctive or experiential values.

*Present Slate of OMNR Representative-Area Candidates*

Based on OMNR data and documentation, these sites were identified as the “core minimum” areas needed to represent the life-science and earth-science diversity of the planning areas, at the mid-scale of vegetation-landform features and within the constraints of a definition of diversity based on Forest Resource Inventory (FRI) classes and Provincial Land Cover mapping (supervised satellite imagery) classes. The methodology used to generate this slate of sites varied from more classical site-district evaluations based on field studies (see below) to completely automated sorting of digital FRI or satellite-image data.

*Past OMNR Representative-Area Candidates*

Over the past 25 years, many OMNR field studies identified candidate life-science and earth-science representative areas for consideration as part of the protected areas system. Some of these were included in the present slate of OMNR representative areas but many of them were not. With regard to “representation”, many of these areas were earlier justified on the basis of representing the diversity of vegetation-landform features based on the site-type classification work of Angus Hills and Paul Maycock. These classifications were significantly more detailed than the classifications used in recent OMNR gap-analysis.

*Community Candidates*

Based on individual and group presentations to the Round Tables and to others, a large number of candidate protected areas were identified. Again, some of these coincide with areas identified by past and present OMNR studies, but others do not. These data are incomplete and do not reflect site-district or thematic analyses by their nominators. Community candidate sites strongly reinforced the conservation, recreation, scenic and diversity values associated with waterways, both rivers and lakes.

These candidate sites were reviewed in relation to core landscape-representation areas (above) and the slate of present OMNR candidates, augmented by a selection of past and community candidates.

Product: Identified core vegetation-landform representation sites.

*Protected-Areas System Design*

Several principles of protected-area design were considered in the integration of the above identified conservation values into protected-area system options.

*Adequacy:* Ecologically adequate representation is considered the international standard in the design of protected-areas systems. Representation at both coarse landscape scales and finer vegetation-landform scales should be achieved. Ecological processes, plant and wildlife population needs, successional patterns, disturbance regimes and landscape connectivity are among the concepts that should be addressed to the degree possible in the design of protected-areas systems.
Efficiency: Appropriate, coincident and neighbouring conservation values add to the overall conservation value of a particular area. The geographic location of a particular area on the landscape influences where maximum representation may occur.

In the design of protected-areas options, the following additional data were considered, which are complementary land-use or ecological values of design importance:
- headwaters position, watershed and valley-corridor position;
- Great Lakes shoreline position; and,
- potential for remote and semi-remote tourism.

Workshops were held by the Partnership for Public Lands and its supporters to develop, implement, test and review this selection protocol. Maps were produced outlining the values that were considered and draft candidate maps were produced for public distribution and comment, and for the use of Lands for Life Round Tables and OMNR support staff.

Product: Identified, adequate and efficient protected-areas system.

Impact Assessment and Adjustment
Available information and mapping of mineral potential areas, forest productivity values, tourism potential values, and other social and economic values are currently being assessed, to the degree possible, to balance the designed protected-areas system with other values and to determine a realizable protected-areas designation.

Product: Identified, proposed protected-areas system.

Self-education, transparency and consensus building were key elements of the method selected to identify a consensus-oriented, conservation-community mapping of candidate protected areas. The methods used and the mapped results have been widely presented in many forums and through tabloids, magazines, press conferences and other vehicles. A key goal, to apply innovative, creative and ecologically defensible methods to the identification of nature’s best remaining natural areas was achieved and delivered to the Lands for Life Round Tables over a period of less than three months, from December 1997 to February 1998.

Acknowledgements
This component of the Partnership’s intervention in support of Nature’s Best and Lands for Life was directed by the author and by Kevin Kavanagh of the World Wildlife Fund and Tim Gray of the Wildlands League. Angela Blasutti of the Federation of Ontario Naturalists and Tony Iacobelli and Korry Lavoie of WWF provided technical support. The Charles S. Mott Foundation, the Joyce Foundation, the Richard Ivey Foundation and the Robert Shad Foundation provided financial support.
Forest Fire Management Program at Pukaskwa National Park

Mark Crofts
Fire/Vegetation Management Specialist
Pukaskwa National Park, General Delivery, Heron Bay, ON. Canada P0T 1R0

Abstract
One role of protected areas is to act as an ecological baseline, a control site by which changes in surrounding lands can be measured. Parks Canada mandates sites to direct effort toward maintaining ecosystems in as natural a state as possible. The suppression of all forest fires has long been identified as a management practice that is not consistent with the aforementioned objective. Fire use has been advocated in the Pukaskwa National Park Management Plan, the Ecosystem Conservation Plan (Geomatics, 1997) and the Vegetation Management Plan (Lopoukhine, 1989). This paper will describe the park’s strategy, through the Forest Fire Management Plan (1997), to reintroduce fire to the park landscape. Planning is complete for a White Pine understory prescribed burn to be conducted in May or June 1998. The transition from fire suppression to fire management is a significant step. This paper will describe the park’s strategy to operationalize the ideal of fire management as an essential component of ecosystem integrity in the boreal forest.

The mandate of Pukaskwa National Park is to protect and present the natural and cultural resources within the park as a representative example of the Central Boreal Uplands Natural Region. The dominant natural process within the park, and the one that controls the park ecosystem, is fire. However, the area contained within the park has been under a fire exclusion policy for many decades, first under the jurisdiction of the Province of Ontario, and since 1978, under the jurisdiction of Parks Canada. While early attempts at fire control were not particularly effective, a significant number of fires have been suppressed in the last thirty – forty years. Given the documented role of fire in ecosystem dynamics, and the fire-adapted nature of much of the vegetation, the exclusion of fire has disrupted the health and the function of the park ecosystem. This is evidenced by a large age class gap in the younger forest stand age classes, and the dominance of mixed-wood stands with a strong representation of balsam fir in the canopy.

Reversing these changes and fulfilling the legislated mandate of the maintenance of ecological integrity of the park ecosystem requires the reintroduction of fire. The Pukaskwa National Park Fire Management Plan (Heathcott and Crofts, 1997) is designed to address these problems through the management of all fires – human caused and natural. For the purposes of fire management, the park is divided into three fire management zones:

- Zone 1 - Fire Exclusion/Mechanical Fuel Reduction
- Zone 2 - Wildfire Exclusion and Planned Ignition Prescribed Fire
- Zone 3- Random and Planned Ignition Prescribed Fire
A Fire Operations Plan describes the park’s fire management response in Zone 3 in more detail. Zone 3 is further divided into fire management units. A Decision Flow Chart determines the management action on each fire in each unit.

The park maintains an Initial Attack crew and an inventory of equipment including pumps, portable tanks, hand tools and an aerial ignition device. We have an excellent working relationship with the Forest Fire Operations staff at OMNR’s Wawa District Office. The park is linked to OMNR’s informatics system for fire weather, situation reports and other information, as well as to other Parks Canada sites through the Parks Canada Fire Information System. Parks Canada is a full member of the Canadian Interagency Forest Fire Centre (C.I.F.F.C.) and can loan or request resources through this agency.

Pukaskwa National Park maintains a network of three permanent weather stations. Data from these stations is used daily to determine fire preparedness levels. The park has a portable weather station for gathering/monitoring weather data at prescribed burn sites.

The park is updating its vegetation inventory following the OMNR Terrestrial and Wetland Ecosites protocol. The last comprehensive inventory, the Biophysical Resources Inventory, was completed in 1978. The updated inventory will be used to refine vegetation management objectives and will be a key tool in the fire management program. Ground truthing transects – of which 300 were completed to support this inventory – will augment a network of 90 more detailed permanent sample plots as baselines for fire effects monitoring. Thirty-five of these sites have been established to date.

Pukaskwa National Park is currently renegotiating its long-standing Fire Management Agreement with the OMNR. A prescribed burn, the first for Pukaskwa National Park, is planned for late May 1998. A red/white pine stand will be treated with low intensity fire as a means of reducing the balsam fir competition and encouraging the natural regeneration of the stand.

Science, public opinion, strong policy and the efforts of many park staff have guided the evolution from fire suppression to fire management. This year (1998) promises to be an important one for Pukaskwa National Park as the Fire Management Plan becomes operational. While ensuring the protection of life, property and other values at risk, this strategy will, over time, result in the restoration of the natural structure and dynamics of the park’s forest ecosystem.

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*Ed Snucins and John Gunn*
*Ontario Ministry of Natural Resources, Cooperative Freshwater Ecology Unit*
*Department of Biology*
*Laurentian University, Sudbury, Ontario P3E 2C6*

**Abstract**

For nearly thirty years, Killarney Park has been one of Canada's principal study sites for research into the ecological effects of acidification. Results of university and government-based research at Killarney contributed to major environmental improvements in North America including for example, the Clear Air Act Amendments. The area is now, once again, providing research opportunities unparalleled in the world. Only in the greater Sudbury area which includes Killarney, are acidified lakes showing substantial chemical and biological recovery as a result of implemented pollution control programs. In response to these opportunities, the Co-op Unit has initiated three major monitoring and research programs:

1. Killarney Biodiversity Survey;
2. EMAN designation for global change monitoring; and,
3. Canadian/Norwegian Joint Study of Biological Recovery

**Recent Inventory and Monitoring**

An inventory of water quality and biological communities was recently undertaken for the lakes and ponds of Killarney Provincial Park. Killarney Park is a 48,000 hectares wilderness area containing about 600 waterbodies (0.03-810 hectares). This report describes the methods, summarizes the data and presents some initial interpretation from this inventory work conducted from 1995 to 1997. The inventory project was supported as a partnership between university, government, industry and non-government organizations. It was designed not only to establish the current state of the park environment, but also as a baseline for future research, monitoring, restoration and educational programs.

Killarney Park is well known as a site of significant environmental damage from acid deposition. Bedrock geology and location relative to pollution sources combined to create this situation. The park is dominated by the La Cloche Mountain Range, a geological formation composed mainly of orthoquartzite, highly erosion-resistant bedrock that provides little buffering against acid precipitation. Killarney is located 40-60 km southwest of the large sulphide ore smelters in Sudbury, Ontario and within a continental zone of high acid deposition (> 20 kg/ha SO$_4$) originating from a vast array of long-range industrial sources. Not surprisingly then, the Killarney lakes were some of the first lakes in North America to be acidified by atmospheric pollutants. By the late 1970s, most Killarney lakes were damaged. This damage resulted in the loss of thousands of individual populations of fish, plankton, benthic invertebrates and amphibians.
In recent decades Killarney has again been noteworthy, but this time as a site where substantial recovery from acidification has been observed as a result of major reductions in emissions at local and long-range sources. The evidence of recovery was the principal reason for initiating a park-wide inventory of current conditions.

Water samples were obtained from 154 lakes (87.7% of lakes by surface area) in the eight major drainage basins, with most sampling occurring in the winter of 1996 and generally a single sample used to characterize the chemistry. The lakes exhibited a broad range in pH (4.3-7.6 with a median of 5.2). There was historic evidence that pH had risen by about 0.5 units for a well-studied set of 14 lake trout lakes. However, a large number of lakes remain acidic (110/154 lakes with pH < 6.0) and vulnerable to acidification (61/154 lakes with tip alkalinity < 0 mg/L).

Metals mobilized from acid deposition on watershed soils (Al, Mn, and Zn) were present in high concentrations in low pH lakes. The concentration of nickel (range 0-20 ug/L), a metal presumably deposited as particulates from the area smelters, showed elevations above expected background levels but was low relative to provincial water quality guidelines.

A special feature of the La Cloche Mountain lakes is their exceptional clarity. Relative to other Ontario lakes, an unusually high proportion (43/153) of Killarney’s lakes have a dissolved oxygen content (DOC) measurement of less than 2 mg/L. There was a strong negative correlation between DOC and Secchi depth and the depth of the late summer thermocline. Low DOC, high clarity (Secchi depth up to 30 m) lakes are generally located on the Lorrain and Bar River Formations. High DOC, brown-coloured waters (Secchi depth as low as 1.1 m) exist primarily in lowland lakes with wetlands.

Biological surveys targeting specific groups or indicator species – rather than attempting complete coverage – were completed on 119 lakes. Some methodological testing of gear and sampling intensity to detect rare specimens was conducted, but most lakes received a rather standard assessment using a broad range of proven sampling techniques for assessing species presence as opposed to abundance.

A total of 28 species of fish were caught during the survey. The two most common fish species were pumpkinseed and yellow perch. The ten species that were caught in at least one third of the lakes and accounted for 90.6% of the total catch by number were: bluegill, brown bullhead, golden shiner, largemouth bass, northern pike, pumpkinseed, rock bass, smallmouth bass, white sucker, and yellow perch. The most acid-tolerant species, as suggested by their occurrence in lakes with pH < 5.0, were bluegill, brown bullhead, brook trout, golden shiner, pumpkinseed, and yellow perch. Fish found only in lakes with pH > 6.0 were blackchin shiner, blacknose shiner, finescale dace, johnnie darter, mimic shiner, rainbow smelt and slimy sculpin.

The number of fish species per lake ranged from 0 to 14, with a mean of 4.1 and a median of 3.0. The species richness of lakes with pH > 6.0 was similar to that of non-acidified lakes in other parts of Ontario. Among the major drainage basins, the median species richness varied from 0 (Chikanishing River) to 6.5
Thirty-six percent (43/119) of the lakes did not have fish. All of the fishless lakes (pH 4.3 - 5.9) have watersheds underlain primarily by the Lorrain and Bar River Formations. The estimated number of fish populations lost from 55 of the biologically surveyed lakes (pH < 6.0, surface area > 3.4 ha) was 262.

The smallest waterbody in the province known to contain a native lake trout population - Teardrop Lake, 3.4 hectares - was discovered. It's lake trout population is notable for its unique gene assemblage and extremely slow growth rates. This lake is located on top of a ridge in the Bar River Formation and, unlike all other lakes situated on that bedrock type, was protected from acidification by an exposed vein of olivine diabase. The lake supports an undisturbed community of a wide variety of other native species, for example *Hyalella azteca*, *Stenonema femoratum*, and slimy sculpin, that may become the source of colonizers for nearby recovering lakes.

Natural recolonization by smallmouth bass and northern pike emigrating from neighbouring lakes was documented in Johnnie and Freeland Lakes. Evidence was also found in other lakes of successful restoration by recent stocking. The transfer of wild adults re-established a self-sustaining smallmouth bass population in A.Y. Jackson Lake and spawning by introduced hatchery-reared lake trout was documented in three lakes. A largemouth bass population was established in Great Mountain Lake by an unauthorized introduction. In 1997 smallmouth bass were reintroduced into George Lake.

We observed 11 species of amphibians, 24 species of aquatic or fish-eating birds, six species of reptiles, and five species of aquatic mammals.

Four crayfish species were captured. *Cambarus robustus* and *C. bartoni* were found in the most acidic lakes (pH 4.3-7.3). *Orconectes propinquus* and *O. virilis* were restricted to lakes with more moderate pH (5.2-7.6). The most common crayfish found in the 48 streams that were surveyed were the two *Cambarus* species. Only three streams, all in the lowlands, contained *Orconectes*. Natural recolonization by immigration of *Orconectes* has occurred in three recovering acid-damaged lakes.

Acid-sensitive species of mayflies and amphipods were generally restricted to the lowland lakes. Their absence from most high-elevation (i.e., > 250 m) lakes was probably due to acidity. The amphipod *Hyalella azteca* was found in 51 lakes (pH range 5.6-7.6), including some recovering acidified lakes. The most acid-tolerant mayfly species *Eurylophella temporalis* and *Leptophlebia* were found in lakes with pH as low as 5.0. Mayflies of the family Baetidae were not found in lakes with pH < 6.2. Moderately acid-sensitive species *Stenonema femoratum* (pH ≥ 5.6) and *Stenacron interpunctatum* (pH ≥ 5.3) were found in some recovering acidified lakes, indicating that natural recolonization is taking place. Invertebrate sampling of the Chikanissing River revealed that mayflies, absent in 1981, have recolonized the lower river in response to improving water quality.

The Killarney Biodiversity study is a partnership between: Ontario Parks; Ontario Ministry of Natural Resources (OMNR); Ontario Ministry of Environment and Energy (MOEE); INCO Ltd.; Falconbridge Ltd.; Laurentian University and Friends of Killarney. The study is designed to assess the species and genetic biodiversity
of fish, major invertebrates and waterfowl that survived the decades of acid-damage. Over the past three years (1995-97) chemical studies have been conducted in 150 lakes and biological studies have been conducted in 115 lakes. The GIS managed data from the surveys – organized by watersheds – will be used to create a web-site and other interpretive visitor service information on biological recovery and recolonization processes. Comparison of modern to post-glacial colonization events is planned.

As a newly established (1997) national Ecological Monitoring and Assessment Network (EMAN) site, our hope is that Killarney will become a long-term monitoring site for the study of biological recovery of disturbed ecosystems. EMAN also recognizes the site as having special status for the study of global changes in climate and UV-B for example, because it contains some of the clearest waters in Canada and is prone to El Nino and ozone depletion effects.

A cooperative project began with Norwegian University and government agencies in 1997 to study the details of recovery of acid-sensitive biota in Killarney as a surrogate site for European monitoring issues. Initial results of the assessment and modeling projects will be presented at the first Killarney Biodiversity Workshop, scheduled for Laurentian University on February 18, 1998. Finally, a World Wildlife Fund project is underway in Killarney to establish genetic refuge sites for endangered fish stocks such as Iroquois Bay lake trout, and OMNR continues to support research on species interactions to assist with fish community rehabilitation efforts. An overview of the scientific, management policy, visitor service and public education significance of the above studies will be presented.
Some Possible Causes of Fatal Attacks on Humans by Large Adult Male Black Bears - A Discussion*

Mike L. Wilton, Algonquin Eco Watch, RR#1, Spring Bay, ON  P0P2B0.  
Jeremy E. Inglis, Algonquin Eco Watch, Box 1947, Bancroft, ON  K0L1C0.

Abstract
As a result of five human deaths inflicted by two large adult male black bears (Ursus americanus) in Algonquin Park, Ontario, a long-term study is being conducted to examine certain aspects of bear anatomy, physiology and behaviour that might lead toward a better understanding of such attacks.

While it is extremely unusual to be attacked by a black bear, most such instances across North America (96.6%, n=29) involve adult males in excess of 120 kg body weight. Evidence at Algonquin Park kill sites indicated that the attacks were predatory in nature. Predation by large adult male black bears on Algonquin Park moose (Alces alces) and other bears in excess of 40 kg has been documented. This proves that these bears are capable of preying on and have developed a search image for prey equal to or larger in size than many humans.

Backcountry bears that normally avoid human contact become quite tolerant of human presence at dumpsites that they frequent for food during the non-breeding period. The presence of food at backcountry campsites however, may trigger unpredictable responses toward humans by these same bears.

Joint studies with the Ontario Veterinary College indicate that the black bear is relatively high on the mammalian evolutionary scale and therefore subject to many of the same types of aberrant behaviour as other mammals which result from commonplace brain dysfunctions such as viral infections or tumours. Trauma to specific locations in the brain such as the temporal lobe/amygdela area – which may control violent behaviour – as a result of defensive behaviour by a cow moose, or falling from a mast tree could occur in all segments of a black bear population. However, large adult males would be at greater risk of this type of injury because of their aggressive breeding behaviour – fighting with other males – and predation on other bears. The danger of heavy metal contamination to the brain of large adult males is increased at dumpsites where contaminants may have been discarded, owing to the dominant status and greater retention period – i.e., age – of such bears.

Elevated gonadotropin-releasing hormone (GnRH), luteinizing hormone (LH) and testosterone levels during the breeding season of May-July, or at other times due to pituitary malfunction, could lead to aggressive behaviour toward other species by large adult and especially dominant male bears. Testicular trauma such as cysts could also lead to such behaviour at other times of year. While all considered abnormalities would be expected to occur only sporadically in most bear populations, they would be more likely found in a population such as

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
Algonquin Park’s where large adult males are not hunted and consequently represent a larger proportion of the population.

Even though experiments have been conducted that indicate no relationship between human menstrual flow and black bear attacks, we feel that there is a need for further research into the matter. Sufficient evidence indicating similarities between the vaginal discharge components of various mammalian and primate species – especially at ovulation when pheromone production and excretion are maximized – exists to warrant further investigation.

The production of musk-like pheromone compounds by the adult males of some mammalian species including humans and the domestic boar (Sus scrofa) also suggests that further investigation of black bears in this regard should be given a high priority. There is documentation in the literature that pheromones have cross-species significance as attractant and/or agonistic cues.

Efforts will continue to collect tissue samples from Algonquin black bears, which will be subjected to DNA analysis to establish possible genetic links between individuals, particularly those displaying aggressive behaviour.
The Effects of Human Disturbance on Eastern Massasauga Rattlesnakes (Sistrurus catenatus catenatus) in Killbear Provincial Park, Ontario*

Chris Parent and Patrick J. Weatherhead
Department of Biology, Carleton University

Introduction

- Given the growing participation in outdoor recreation and the increasing popularity of parks and wilderness areas, animals are likely to encounter humans with increasing frequency. This suggests that an improved understanding of the effects of human disturbance would be prudent for conservation purposes, especially in relation to rare or endangered species.
- The Eastern Massasauga Rattlesnake is a small, venomous snake once found throughout much of southwestern Ontario. The snake has suffered pronounced range contraction due to human destruction of both individuals and habitat, and in 1991 was designated a threatened species by the Committee on the Status of Endangered Wildlife in Canada. Currently, four disjunct populations remain in Ontario; the largest occur on the Bruce Peninsula and the eastern shore of Georgian Bay, where their long-term viability is threatened by industrial, residential and recreational development.
- Protected habitat within the snake’s remaining Ontario range can be found in a number of national and provincial parks, though the impact of the increasingly heavy use of these parks on snake populations is not known. Thus, whether human disturbance affects Eastern Massasauga Rattlesnakes is a question of increasing significance to the conservation of this species in Ontario.
- Although several investigators have suggested that human disturbance may affect snakes, this is the first study to address this issue systematically.

Methods and Materials

Description of Study Site

- Killbear Provincial Park is located on a peninsula on the eastern shore of Georgian Bay, Ontario. The park is 1,756 ha in area and consists of mature second growth forest and scattered bedrock outcrops.
- The park attracts more than 200,000 visitors annually, primarily during the months of July and August. Human activity is concentrated in developed areas and along the shoreline, because park visitors engage in mainly aquatic-based recreation.
- Park visitors encounter rattlesnakes fairly frequently. For example, 21 snakes were captured on campsites from 1990-1993.
- The popularity of the park, and the frequency of human-snake interactions, make Killbear Provincial Park an ideal location to study the effects of human disturbance on Eastern Massasauga Rattlesnakes.

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
General Data Collection

- Most data for this study were collected from May-October in 1995 and 1996. All data were collected with the aid of a single field assistant in 1994 and 1995 and four field assistants in 1996.

Radiotelemetry

- Thirty adult Eastern Massasauga Rattlesnakes were captured in Killbear Provincial Park and surgically implanted with radio transmitters weighing 7.8 g or 9.4 g, with battery lifespans of 12 or 24 months, respectively.
- To minimize the effects of implantation, snakes were chosen in such a way that transmitter mass was less than 5% of body mass.
- All snakes were released within 15 m of their location of capture. Data collection did not begin until three days after release. When not in hibernation, snakes were generally located every second day.
- To determine whether snakes in disturbed areas increase their use of cover, we noted the visibility (not visible, partly covered or in the open) of transmitter-equipped snakes each time they were located.
- Similarly, to determine whether snakes in disturbed areas remain closer to potential refugia, we recorded the distance to nearest retreat site of transmitter-equipped snakes each time they were located.
- To assess the effects of disturbance on movement patterns, the distances and bearings between each transmitter-equipped snake’s subsequent locations were determined. Distances <100 m were measured in the field using a tape measure and compass. Positions of locations separated by >100 m were determined by GPS and differentially corrected to ± 2 m.

Quantifying Snake Exposure to Human Disturbance

- The locations of transmitter-equipped snakes were given a disturbance rating (dr) based on the distance (d) to the nearest source of human disturbance (road, trail, or campsite) (d>50 m, dr=low; 50 m to 10 m, dr=intermediate; d< 10 m, dr=high). These ratings accurately reflect relative levels of disturbance at any given time because visitors rarely stray from developed areas.
- Mark-recapture data were collected from snakes not implanted with transmitters, so their exposure to human disturbance could not be quantified directly. Instead, we defined two sites within Killbear Provincial Park (A and B) that are subject to different levels of human disturbance. Snakes captured in Site A were assumed to have a higher exposure to human disturbance than those captured in Site B.

Mark-Recapture

- To assess the effects of human disturbance on the relative condition and growth rates of Eastern Massasauga Rattlesnakes, snakes were captured, measured, marked and then released.
- Snakes were located by searching suitable habitat or were discovered and reported by park staff and visitors.
Adult snakes were marked by branding unique combinations of ventral scales or were injected subcutaneously with Passive Integrated Transponders (PIT tags). Neonate snakes were judged too fragile for either method and instead had their dorsal patterns photographed. These markings are unique to the individual and do not change over time.

To assess the effects of human disturbance on the reproduction of Eastern Massasauga Rattlesnakes, we used ultrasonography to determine the reproductive condition (gravid vs. non-gravid) of captured females and to estimate the brood size of those found to be gravid.

Results

Radiotelemetry

- We obtained a total of 1,217 radiotelemetry locations from 11 male and 19 female Eastern Massasauga Rattlesnakes.
- Snakes were tracked for variable lengths of time, and often not simultaneously. Many snakes were monitored for periods less than allowed by battery lifespan. For example, 10 snakes were killed during the course of the study. Two snakes were killed by predators, two were run over by cars, three died in hibernation, and three died of unknown causes. In addition, transmitters were removed from three snakes following complications, and three snakes could not be relocated due to transmitter failure.
- Neither ambient temperature or human disturbance affected the visibility of male and non-gravid females. Since snakes are known to avoid open areas, this apparent lack of response may actually reflect a perception of constant predation risk.
- Gravid females were significantly less visible in more disturbed areas. This result may reflect the tradeoff between these snakes' increased thermoregulatory requirements and their reduced ability to avoid predators through flight.
- Exposure to human disturbance did not affect the distance at which the snakes were found from potential retreat sites. This suggests that the antipredator behaviour of Eastern Massasauga Rattlesnakes does not emphasize flight, and is consistent with their apparently heavy reliance on crypsis and their potential for active defense (rattling and striking) if found.
- Gravid females moved significantly less per day than males and non-gravid females.
- The average distance moved per day by gravid females, non-gravid females, and males declined with increasing exposure to human disturbance. A number of investigators have noted that snakes remain motionless or freeze when approached by humans. In areas subject to heavy human disturbance, this response could disrupt normal snake movement patterns. We suggest that this behaviour explains the observed negative correlation between average distance moved per day and exposure to human disturbance by Eastern Massasauga Rattlesnakes in Killbear Provincial Park.

Mark-Recapture

- Exposure to human disturbance did not affect the condition or the growth rates of gravid female, non-gravid female or male Eastern Massasauga
Rattlesnakes. However, these findings must be accepted with caution, because none of the snakes used in these analyses were implanted with a transmitter. Thus, their exposure to human disturbance could not be determined accurately.

- Brood size (number of young) was positively correlated with female snout-vent length, but was not affected by female exposure to human disturbance. Again, these results must be interpreted with caution, due to small sample sizes and the concomitant low power of statistical tests.

Discussion

- This study suggests that snakes may respond to even apparently benign human activities, and that these responses may be subtle, and thus easily-overlooked. Identification of such impacts will undoubtedly become an increasingly important aspect of protected areas management, especially for rare or endangered species.

- The conclusion that snakes do not suffer fitness costs as a result of human disturbance must be viewed with caution. Other effects, not assessed in the course of this study, may be present. For example, increased crypsis in areas subject to heavy human disturbance could decrease individual male reproductive success by disrupting the long distance movements involved in mate-searching behaviour. Sufficient human disturbance could isolate populations and thus contribute to inbreeding. Ongoing characterization of Eastern Massasauga Rattlesnake population structure in Killbear Provincial Park will address this issue.

- Human disturbance could also affect the survival and dispersal of neonates, which in turn could affect population age structure. Investigation of this issue is currently hampered by technological limitations.

Acknowledgements

Financial support for this project was provided by a Natural Sciences and Engineering Research Council operating grant to P.J. Weatherhead; an Ontario Graduate Scholarship awarded to Chris Parent; Ontario Parks; and the Endangered Species Recovery Fund, sponsored by World Wildlife Fund Canada and the Canadian Wildlife Service of Environment Canada.
Natural Area and Land Use Planning Connections in the Carolinian Canada Zone*

Patrick Lawrence, Cynthia Lussier and Lori-Anne Riviere
Heritage Resources Centre, University of Waterloo
Waterloo, Ontario, N2L 3G1

Introduction
The aim of this project is to examine the natural and land use planning connections among the 38 Carolinian Canada sites in southern Ontario. Three tasks are currently underway. A review and evaluation of existing land use planning arrangements for each site and area municipality is being completed. The types of information required focus on the land use planning arrangements, current and future land use changes, the status of natural area planning by local municipalities, and potential impacts of recent changes to planning and government policies in the province.

A natural areas map for the Carolinian Canada Zone is being prepared by digitizing the forest cover from the 1:250,000 NTS maps for the region. This map will provide a preliminary and strategic assessment of the potential for natural connections among the sites and the basis for further detailed research and mapping. It will also provide information for technical and methodological considerations.

An examination is also underway of existing greenway and natural areas studies completed in the Carolinian Canada Zone by municipalities and other planning agencies. This will allow for comparison of criteria and approaches used to develop conservation and management strategies for natural areas in the region. The results of this study are intended to provide assistance to the Carolinian Canada organization in future research, decision-making and planning for natural areas in the region.

Study Area
The Carolinian Canada Zone is located in the eastern deciduous forest region of Ontario (Figure 1). The Zone runs south from the Rouge River valley in Toronto to Middle Island in Lake Erie. The area supports a diversity of wildlife and natural habitats including about 30% of Canada’s rare, threatened and endangered species. The Carolinian Canada Zone contains a number of significant habitats and vegetation communities such as prairies, savannahs, wetlands, and upland woodlands. Widespread clearing of the land for agriculture, and more recently urban growth, have reduced the natural forest cover of the zone to less than 20%.

The Carolinian Canada Program was established in 1984 as a partnership between government and non-government agencies to address concerns for appropriate management, conservation, and education. Through an inventory

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
and evaluation study 38 significant sites were identified as areas for priority action. Partners in the program undertook research including site inventories and conservation initiatives.

Since 1996, the Carolinian Canada Steering Committee has been preparing a new conservation strategy to identify goals and objectives and direct future programs and initiatives. The realization of a need for new direction and focus arose from a concern for the continued impacts of declining funding and new mandates of many partners in the program. It was felt that the program should be more community-oriented and that it should address issues related to the management and conservation of the entire Carolinian Canada area rather than individual sites.

Figure 1: Carolinian Canada

**Purpose of this Study**

In order to assist the Carolinian Canada Program, Parks Canada felt it necessary to prepare an analysis of the land use planning and natural area connectivity in the Carolinian Canada Zone. Such a study would allow for review of the current levels of conservation and protection of the 38 sites and examine their relationship to natural area planning in the surrounding landscape. The focus would be on the use of various regulations and designations by local municipalities to protect or conserve natural areas including forests, wetlands,
and rare and threatened species and wildlife habitat. The intention would be to
determine the potential for planning connections among the sites and other
important natural areas within a planning system for the entire Carolinian Canada
Zone.

In association with this research, another purpose of this study was to determine
the natural connections that occur among the 38 sites and examine the
possibility for natural linkages in the Carolinian Canada Zone. This aspect of the
project was to include a literature review of recent research and studies related to
natural corridors and connections and the various methods and techniques that
could be utilized to complete a natural area map for the Carolinian Canada Zone.

**Approach**

Three tasks are currently underway in this project:

1. Review and evaluation of existing land use planning arrangements for each
   site and area municipality. A questionnaire has been developed and
distributed to key contacts for each of the 38 sites with plans for follow-up
   phone interviews and meetings. The types of information required focus on
the current Official Plan and Secondary Zoning Bylaw designations for each
site, current inventory and assessment studies, natural area mapping, and
present and future land use stresses surrounding each site. The research is
intended to identify gaps in land use planning arrangements among the sites
and to assess the potential for development of a coordinated natural area
planning approach for the Carolinian Canada Zone.

Several key questions that are being asked include:

- What is the status of the existing official plan and zoning bylaws for area
  municipalities?
- What are the current land use planning designations?
- What is the potential for linking to other types of parks and protected areas?
- What are the current and anticipated land uses surrounding the site?

Questionnaires have been sent to the following:

- Essex Region Conservation Authority
- Lower Thames Conservation Authority
- Upper Thames Conservation Authority
- County of Lambton
- County of Middlesex
- Catfish Creek Conservation Authority
- Regional Municipality of Haldimand-Norfolk
- Grand River Conservation Authority
- Regional Municipality of Hamilton-Wentworth
- Regional Municipality of Niagara
- Regional Municipality of Halton
- Regional Municipality of Peel
- Ontario Ministry of Natural Resources-Central Region

2. Work has also begun on the preparation of a natural areas map for the
   Carolinian Zone by analysis of forest nodes and corridors as identified on
   1:250,000 NTS digital maps. The results will provide a preliminary and
strategic assessment of the potential for natural connections among the 38 Carolinian Canada sites, the major forest nodes and corridors, and the important barriers to connectivity including agricultural lands, urban development, roads and railways. The map will be the basis for further detailed research and mapping concerning natural connectivity in the region as proposed by the Carolinian Canada Program. A literature review of research on natural area corridors is also underway.

3. Finally an evaluation of existing greenway and natural area studies conducted in the Carolinian Canada Zone by municipalities and other planning agencies will be undertaken. This study will allow for the comparison of criteria and approaches used to develop conservation and management strategies for natural areas in the region.

It is anticipated that the research will be completed in the spring of 1998 with a summary report circulated to all contacts for review and comments. A follow-up workshop examining the results of the research and possible future initiatives is being considered for the fall of 1998. The project may be the basis for further work on examining natural connectivity in the Carolinian Canada Zone in 1998/1999.

Acknowledgements
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References
Assessing the Evolution of Marsh Management in Protected Areas: with special reference to Point Pelee, Rondeau and Long Point, Lake Erie, Canada

Lucy M. Sportza
School of Urban and Regional Planning, University of Waterloo

Abstract
There has been a growing awareness in recent years of the many ecological and other values of both protected areas and wetlands. This research was intended to provide a preliminary assessment of the state of planning and management of wetlands and aquatic ecosystems in national parks and protected areas and to make recommendations for future work. The focus was on the history of ideas and on awareness of wetland uses, planning, management and conservation with special reference to the Great Lakes and Lake Erie. Three protected areas were studied along the Canadian shore of Lake Erie: Long Point; Rondeau Provincial Park; and Point Pelee National Park. The most detailed work was done on Point Pelee due to the availability of historic documentation and the long history of planning and management for the national park, which was established in 1918.

A number of conclusions are discussed. For example, early recognition of the value of marshes to wildlife and private initiatives was crucial to the protection of these ecosystems. The ecology of the marshes has been negatively impacted by human activities both inside and outside of the protected areas, although these impacts are not fully understood. In general knowledge about marsh ecology is lacking, although interest in and work on these ecosystems has increased in recent years. Finally, research and monitoring activities have typically suffered from a lack of follow up. Recommendations include: clarification of several issues related to marsh ecology, such as the role of fire in marsh management; the development of an image of the natural state of Pelee Marsh to help guide future management; and, an outline of a research strategy on aquatic ecosystems in protected areas.

Introduction
The purpose of this research was to assess the state of planning and management of wetlands and aquatic ecosystems in national parks and protected areas, and to make recommendations for future work. The focus was on the historical development of ideas, uses, awareness, planning, management and conservation, with special reference to the Great Lakes and Lake Erie.

The study was undertaken within the broad context of the growing awareness of the many values of protected areas and aquatic ecosystems and concern over their long-term sustainability in light of human-caused stresses and impacts.

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
Methods/Approach
A "post hoc" or “after the fact” descriptive-analytic assessment approach was used (see Serafin et al., 1992 for an overview of some post hoc assessment methodologies). This involved a review and analysis of published reports and data and the use of appropriate criteria and judgement to recreate, interpret and assess the situation. An analytical framework (Figure 1) was developed to guide the review and subsequent discussion.

The framework was applied to case study sites at Point Pelee National Park, Rondeau Provincial Park and the Long Point protected areas, all located along the north shore of Lake Erie. These sites have significant marsh ecosystems, with Pelee Marsh and Long Point Marshes designated under the Convention on Wetlands of International Importance (Ramsar Convention) and Rondeau Marsh designated as a Class I provincially significant wetland.

The most detailed work was done on Point Pelee due to the availability of historic documentation and the long history of planning and management for the national park. Where possible, comparisons were made with Rondeau and Long Point. This study was part of the work leading to an MA degree at the University of Waterloo.

Figure 1: Analytical Framework
Overview of Research Results
The major findings are highlighted here. The analytical framework is described in Figure 1.

Ideas/Thoughts
- Early recognition of wildlife values was important to protection of these ecosystems; without this, it is highly likely that the marshes would have been lost.
- Private efforts were key to protection, as exemplified by the Long Point case (see Skibicki, 1993).
- Recreational values were also recognized as important in the early history of these areas, for example, waterfowl hunting.
- Marsh succession was long believed to be linear, with evolution to a dryland habitat inevitable; by the late 1980s/early 1990s, coastal marsh succession was viewed as cyclical, with maintenance of the ‘wet’ environment over the long term, rather than succession to a dry environment.
- Beginning in the 1980s, threats to the marshes have been increasingly recognized.

Activities & Uses
- All three areas have been subject to considerable landscape change.
- Drainage, especially around Point Pelee and Rondeau, has reduced the extent of the marshes and no doubt affected marsh ecology; the exact nature of these changes is not known due to the lack of historic documentation.
- A variety of uses are allowed in the different protected areas, reflecting their management objectives and purposes as noted below:
  - **Point Pelee**: passive recreational uses; hunting, as a pre-existing use, was allowed until 1988; sport fishing is still allowed – although it is contrary to park zoning – and catch-and-release is emphasized
  - **Rondeau**: passive and active hunting and fishing uses
  - **Long Point**: use varies considerably from area to area; very restrictive at Long Point National Wildlife Area, to a variety of public uses at Long Point Provincial Park

Ecology and Ecological Change
- Little appears to be known about the marsh systems in any of the study sites, although work is increasing at Point Pelee.
- Changes in marsh vegetation communities, noted in the 1970s and 80s were believed to be due to succession, the main ‘threat’ to the marsh.
- Water quality studies in the 1960s and 1970s found eutrophic conditions in marsh ponds; in the early 1990s, work on trophic status, heavy metals and agri-chemicals began in cooperation with the Canada Centre for Inland Waters, Environment Canada.

Research & Monitoring
• More work has been done at Point Pelee than at the other sites.
• Research accelerated in the 1970s, with studies as input into park planning; there appears to have been less emphasis on research in the 1980s, although efforts appear to be accelerating in recent years.
• Follow-up on research results and recommendations has been weak, at best.
• Work at Rondeau Provincial Park has focused on the Carolinian Forest and deer-forest interactions, to the exclusion of the marsh.

Park Management Planning & Conservation
• In the 1970s there was much debate over era versus evolutionary management at Point Pelee. Era management suggested for a section of Pelee Marsh would have required maintenance of the marsh ecosystem as it was at one point in time – actively halting succession; this approach was quickly criticized and abandoned.
• Successional control of Pelee Marsh was discussed in the 1970s and 80s; methods included water level control and dredging.
• Planning and management foci and approaches vary considerably at the different sites, in relation to the management objectives and purposes of the different protected areas. For example, at Long Point management and planning are highly restrictive at Long Point National Wildlife Area and intensive at Big Creek National Wildlife Area (Lee Brown Waterfowl Management Area) to enhance habitat for waterfowl.

Discussion & Implications
An idea or understanding can greatly influence a number of aspects of planning and management – it is important to realize this and attempt to understand the implications when making decisions.

For example:
idea/thought: early belief in inevitability of marsh succession to dryland activities & use: all three areas have been subject to considerable landscape change
ecology & ecological change: noted changes in vegetation communities (decline in some formerly common species, increase in cattails) attributed to succession; other possible causes (eutrophication, change in hydrological regime) not investigated
research & monitoring: generally focused on providing management options for controlling succession
park management planning & conservation: ‘era’ management proposals, successional control techniques

There is a need for close ties between research, monitoring, planning and management.

Scientific knowledge is a key component of ecosystem management, as is linking research and monitoring data with planning and management activities (e.g., see Lee, 1993; Noss and Cooperrider, 1994). With the spread of ecosystem management and a focus on ecological integrity, more effort should be spent on understanding the ecology of the systems to be managed, including careful
consideration of what is not known and the uncertainties – what do we not even know that we do not know?.

There has been a lack of follow up on research and monitoring results, as noted from the Point Pelee case study. For example, despite work done on both water quality and vegetation in the 1970s, it was noted in the early 1990s that little was known about these aspects of marsh ecology.

Careful attention should be placed on linking results of studies on different ecosystem components, for example, interactions between water quality degradation and changes in vegetation communities.

*Before undertaking active management or restoration, it is necessary to determine “to what?”. What is the goal?*

If restoration or active management of any of these marsh areas is to be attempted, attention should first be directed to determining what the ‘natural state’ of the ecosystem should be. In other words, what would a marsh such as Pelee Marsh look like today if it had not been subject to anthropogenic stress? What are the natural processes responsible for maintaining the marsh over the long-term, and how have these processes been altered by human stress? Although it may not be feasible or desirable to restore the marshes to a pre-settlement or other historic state, developing such an image may help to focus research efforts, by requiring that a broad, ecosystem view be developed.

*In general, there is a need for a research strategy for aquatic ecosystems in national parks and protected areas.*

Some important directions might be:

- development of a schematic model to help organize and describe marsh planning and management activities;
- an historical study of ecological change in park aquatic systems, if possible including linkages to recreation and other land use policy and changes;
- development of a comprehensive, carefully designed monitoring program;
- literature review and interpretation of water quality and marsh work in other locations, for example the Everglades, USA and the Broadlands, UK;
- study of other areas of marsh ecology not addressed in this study, e.g. value of wetlands to waterfowl and other birds, fish, herptiles and other fauna;
- study of the natural functions of coastal wetlands, e.g. their role in ameliorating lake water quality; and,
- a gap analysis of wetland/aquatic ecosystem types in the Lake Erie basin.

**Acknowledgements**

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**References**


Ecosystem Conservation Plans for Bruce Peninsula National Park and Fathom Five National Marine Park*

Patrick Lawrence, J. Gordon Nelson and Heather Black
Heritage Resources Centre
University of Waterloo, Waterloo, Ont., N2L 3G1

Introduction

The role of Ecosystem Conservation Plans (ECPs) is to maintain the ecological integrity of national parks and surrounding areas and to strengthen planning, management and decision-making for national parks and their Greater Park Ecosystems (GPEs). In 1997 the Heritage Resources Centre at the University of Waterloo, under contract with Parks Canada, initiated a project to prepare ECPs for Bruce Peninsula National Park (BPNP) and Fathom Five National Marine Park (FFNMP) (Figure 1).

The result of this project to date (February 1998) has been the preparation of three main products. The first is a Background Information Study (BIS) which identifies and reviews the existing knowledge and research concerning the two parks and surrounding area in order to assist with consultation and planning (Lawrence et al., 1997). The second is a Synopsis of the BIS which provides a summary and interpretation of the key results and recommendations of the BIS as a basis for the preparation of the ECPs (Lawrence and Nelson, 1997). Finally, a Communication Strategy was also prepared to develop means to contact, inform and secure information from local and other concerned people within the two parks and surrounding area (Black and Nelson, 1997).

Key results include: initial selection of problems, issues and concerns (PICs) to be addressed in the ECPs and their organization into Stresses, Effects and Responses; the mapping of significant natural features and processes and Areas of Concern which are to be the focus of future planning and management; and, the identification of a wide array of approaches and contacts to be used to assist with future public involvement in ecosystem conservation planning in the two parks and surrounding area.

Study Area

Following lengthy planning and public discussion, a federal/provincial agreement was signed in 1987 to establish BPNP and FFNMP on the Bruce Peninsula and nearby waters of Georgian Bay and Lake Huron. BPNP was established to protect a representative example of the Great Lakes/St. Lawrence Lowland Region. The park is located mainly on relatively flat-lying dolomitic rocks. The steep Niagara Escarpment runs along the Georgian Bay side and dips to the more gentle Lake Huron shore. Climates, soils and geological features are associated with a very diverse range of plant and animal species as well as habitats that play host to rare species.

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
FFNMP is intended to represent the Georgian Bay Marine Region. The mixing of Georgian Bay’s cold waters with Lake Huron’s warmer waters provides good habitat for numerous species. FFNMP also protects numerous shipwrecks within the current park area. Various animals are well-represented in both parks. A rich breeding bird population reflects the diversity of natural habitats. BPNP and FFNMP are also staging or resting areas for migratory birds.

Figure 1: The Bruce Peninsula
What is an Ecosystem Conservation Plan?

‘An Ecosystem Conservation Plan is a dynamic document which develops and proposes specific goals for the maintenance of park ecological integrity and management of the greater park ecosystem’ (Parks Canada 1992).

We see the ECPs as having several roles or purposes:
- Technical: provide assessment of resources in and around parks;
- Planning: provide information to assist decision-making in and around parks; and,
- Cooperation: provide means of exchange of information in and around parks

What is Ecological Integrity?

‘Maintenance of ecological integrity must be the first consideration in management planning’ (National Parks Act, 1988).

Basically we see ecological integrity as the conservation and enhancement of essential natural processes and features of the two parks and surrounding area. It is also important to understand the range of resources and land use stresses that occur and may impact the significant natural or environmental features and processes.

What is the Greater Park Ecosystem?

The ECP must consider the area of natural ecosystems that occur in and around the parks. Examples include streams and watersheds that extend beyond the park boundaries. Social, political, and economic factors, which influence ecological integrity, must also be considered. Our focus to date has been on the parks and surrounding area of the northern Bruce Peninsula based in a large part on the available information. More research will be required, including inventory and organization of existing information, in order to develop a better understanding of the GPE for BPNP and FFNMP

Problems, Issues and Concerns (PICs)

‘An ECP involves identifying natural resource problems, issues and concerns (PICs) and relating them to the park’s ecosystem conservation goals and objectives’ (Zorn et al., 1997).

We worked in association with Parks Canada staff, reviewed existing information, and met with other individuals, agencies and stakeholders including members of local communities to identify PICs. One of the challenges in the preparation of the ECPs is to organize and prioritize the large number of PICs that have been initially identified by Parks Canada and others (Tables 1 and 2). We are using maps to organize the PICs based on their extent in the two parks and surrounding area and on the basis of the following questions:
- What are the land and resource uses?
- What are the effects of these uses?
- What are the responses to the effects?
Bruce Peninsula National Park

<table>
<thead>
<tr>
<th>Abiotic Land Use</th>
<th>Biotic Vegetation</th>
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<tbody>
<tr>
<td>• transboundary issues (i.e., pollution, changes to habitat, etc.)</td>
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<td>• oversnow vehicle corridor (presence and usage)</td>
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<td>• cumulative impacts assessment for the park</td>
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<tr>
<td>• visitor use (i.e., impacts and level of resource protection required)</td>
<td></td>
</tr>
<tr>
<td>• shorezone protection (impacts from hikers and other users)</td>
<td></td>
</tr>
<tr>
<td>• cave management</td>
<td></td>
</tr>
<tr>
<td>• development of partnership agreements with outside agencies to work towards conservation of important sites</td>
<td></td>
</tr>
<tr>
<td>• Bruce Trail (visitor impacts)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biotic Vegetation</th>
<th>Aquatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• study/management of existing vegetation community structure</td>
<td></td>
</tr>
<tr>
<td>• factors affecting the decline in health of maple and white ash forests</td>
<td></td>
</tr>
<tr>
<td>• protection of rare plant species</td>
<td></td>
</tr>
<tr>
<td>• protection/management of alien plant species</td>
<td></td>
</tr>
<tr>
<td>• study/protection of rare alvar communities</td>
<td></td>
</tr>
<tr>
<td>• inventory of non-vascular plant species</td>
<td></td>
</tr>
<tr>
<td>• fire management</td>
<td></td>
</tr>
<tr>
<td>• COSEWIC identified plant species</td>
<td></td>
</tr>
<tr>
<td>• study of cliff edge old growth cedar forests and related vegetation communities</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aquatic</th>
<th>Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td>• study/management of inland recreational fishery</td>
<td></td>
</tr>
<tr>
<td>• aquatic management in general (i.e., angling, regulations/quotas)</td>
<td></td>
</tr>
<tr>
<td>• quality (i.e., pollution as a result of cottage development)</td>
<td></td>
</tr>
<tr>
<td>• COSEWIC identified species (i.e., Massasauga rattlesnake)</td>
<td></td>
</tr>
<tr>
<td>• study/management of Northern Peninsula black bear population</td>
<td></td>
</tr>
<tr>
<td>• study/protection of rare Southern bog lemming and associated habitat</td>
<td></td>
</tr>
<tr>
<td>• study/protection of various wildlife species including bobcat and the re-introducedisher</td>
<td></td>
</tr>
<tr>
<td>• inventory/analysis of arthropod species and associated indicators of ecosystem health</td>
<td></td>
</tr>
<tr>
<td>• white deer population management</td>
<td></td>
</tr>
<tr>
<td>• bird studies</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>• development of a cultural resource management program</td>
</tr>
<tr>
<td>• protection of identified archaeological resources</td>
</tr>
<tr>
<td>• identification of cultural landscapes</td>
</tr>
<tr>
<td>• development of intangible history database (i.e., sacred places)</td>
</tr>
</tbody>
</table>

Of particular importance to all of the above is the development of a Communication Strategy for the two parks. There is a definite lack of a social context to all the above. We either have to develop a specific community focused communication process or ensure that all work undertaken has a communication strategy initially identified and followed through upon.

Table 1: List of PICs for BPNP provided by Parks Canada (January 1997)
Fathom Five National Marine Park

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiotic Visitor Use</td>
<td>• visitor impacts to Flowerpot Island</td>
</tr>
<tr>
<td></td>
<td>• accessibility of Flowerpot Island</td>
</tr>
<tr>
<td></td>
<td>• increased boat usage and associated impacts</td>
</tr>
<tr>
<td></td>
<td>• litter presence</td>
</tr>
<tr>
<td></td>
<td>• land base issues (i.e., illegal camping, snowmobiling, etc.)</td>
</tr>
<tr>
<td></td>
<td>• cumulative impacts assessment</td>
</tr>
<tr>
<td></td>
<td>• anchorage in Larondes Harbour (i.e., bottom disturbance)</td>
</tr>
<tr>
<td></td>
<td>• geological survey of lake bed</td>
</tr>
<tr>
<td>Biotic Fisheries</td>
<td>• commercial/sport fishing</td>
</tr>
<tr>
<td>Birds Arthropods</td>
<td>• loss of species diversity</td>
</tr>
<tr>
<td>Vegetation</td>
<td>• introduction of alien species</td>
</tr>
<tr>
<td></td>
<td>• assessment of lake trout re-introduction</td>
</tr>
<tr>
<td>Birds</td>
<td>• colonial nesters (e.g., affects of cormorants)</td>
</tr>
<tr>
<td></td>
<td>• undertaking of an inventory</td>
</tr>
<tr>
<td>Vegetation</td>
<td>• introduction of alien species</td>
</tr>
<tr>
<td></td>
<td>• protection of rare plant species</td>
</tr>
<tr>
<td>Cultural Artifacts</td>
<td>• illegal removal of underwater and terrestrial resources</td>
</tr>
<tr>
<td></td>
<td>• identification and protection of underwater resources</td>
</tr>
<tr>
<td></td>
<td>• identification and protection of pre-historic resources</td>
</tr>
<tr>
<td></td>
<td>• interpretative potential of lighthouse property</td>
</tr>
<tr>
<td>Political Boundary</td>
<td>• analysis of boundary adequacy</td>
</tr>
</tbody>
</table>

Table 2: List of PICs for FFNMP provided by Parks Canada (January 1997)

Background Information Study (BIS)

This report provides a review and summary of existing information and knowledge on the two parks and surrounding areas (Lawrence et al., 1997). This review is based on available studies and current research. The BIS is intended to serve as a means for the identification of Problems, Issues and Concerns (PICs) to be addressed by the ECPs. The report also identifies key recommendations and actions for Parks Canada and other stakeholders to address the PICs in an effort to maintain the ecological integrity of the two parks and surrounding area. Areas of Concern are identified where land and resource stresses are impacting significant environmental features.

In order to evaluate the vast amount of information available on the large number of PICs initially identified by Parks Canada staff and the study team, the PICs were first organized into six main categories:

- Communication
- Recreation and Tourism
- Transport and Infrastructure
- Resource Uses
- Environmental Conditions
- Land Use Planning and Management

Using the existing Geographic Information System (GIS) database developed for BPNP and FFNMP by Parks Canada, with additional new information gathered...
from a review of completed and ongoing research and consultants, a series of summary maps were prepared for each of these categories. The intention of the mapping was to relate PICs to specific locations or areas within and outside of the two parks.

The magnitude and frequency of the various resource and land uses was indicated by the preparation of a summary map locating nodes and corridors of these activities within the two parks and surrounding area (Figure 2). The resource and land uses include trails and roads, camping and cottage areas, urban and residential areas, public access and recreation areas. This mapping involved determining where the greatest magnitude and frequency of the uses occurred. The nodes and corridors were then assigned a relative preliminary rank of high, medium or low.

Figure 2: Nodes and Corridors of Land Resource Uses

The next step was the identification of significant environmental features that are under stress from the effects of resource and land uses such as trails, roads, cottages, logging and other human activities. Abiotic significant features consist
of geological and surface landforms that are important to ecosystem conservation and the maintenance of ecological integrity and include alvars (exposed bedrock), caves, beaches and dunes, and cliffs and talus deposits. Biotic significant features are the natural species and features that are important to ecosystem conservation such as: fish habitat, Areas of Natural and Scientific Interest (ANSIs), provincially significant wetlands, rare species (e.g., Massasauga rattlesnake), and special or specialized habitats (e.g., deeryards).

The mapping of resource and land use nodes and corridors was then overlain on the abiotic and biotic significance maps to assist in the identification of Areas of Concern (Figure 3). These Areas reflect the presence of human activities in locations where natural features important to maintaining the ecological integrity of the two parks and surrounding area are also found. An initial list of the Areas of Concern for BPNP include: Little Cove to Rocky Bay, Cyprus Lake, Dorcas Bay, Hay Bay, and Johnson’s Harbour. These Areas should be a focus for future planning, management, research and decision-making by Parks Canada and other stakeholders.

Figure 3: Areas of Concern
Communication Strategy
In order to assist with the preparation of the ECPs it was decided to examine means to contact, inform and secure information from local and other concerned people in the area surrounding the two parks. The main reasons for preparing a Communication Strategy for the ECPs are:

1. to inform people about the plans and to let them know how they can become involved in the planning process;
2. to acquire relevant information from people about the parks and the GPE; and,
3. to develop networks of groups and individuals who can become involved in ongoing planning in the future.

The study team has used a wide range of approaches including meetings with the Park Advisory Committee, Public Open Houses, participation in community events and a series of interviews and informal consultations. This consultation has led to the identification of a wide range of PICs which have been organized into the six main categories used for the BIS.

The results of the Communication Strategy also have been used to assist in the identification of additional PICs that need to be addressed in the ECPs and to provide a set of fundamental recommendations for improving planning, management and decision-making. These recommendations include the need to:

- provide for a fuller and stronger role for the Parks Advisory Committee;
- make greater use of bridging arrangements to assist in the consultation with all stakeholders;
- consider the wider use of electronic approaches to improve understanding and communication efforts in regard to the PICs;
- improve interpretation programs to extend them to the wider community; and,
- assign a liaison or communications person to assist with stakeholder cooperation and bridging arrangements.

Discussion
Work continues with the integration of the results from the BIS and Communication Strategy into the preparation of the ECPs for BPNP and FFNMP. It is intended that the ECPs will identify the priority PICs to be addressed by Parks Canada and other stakeholders in an effort to maintain the ecological integrity of the two parks and surrounding area. The ECPs are intended to provide the basis for future research and other planning and management activities by Parks Canada over the next five years and to support the recommendations and actions as identified in the park management plans (Parks Canada, 1996a and 1996b). The ECPs will be completed by mid-1998 following further research and consultation by the study team and review of draft reports by Parks Canada and the Parks Advisory Committee.

Acknowledgements
This research was supported by a contract from Parks Canada.
References


Enhancing Trail Access for People with Disabilities*

P.E. Longmuir, PEL Consulting and P.W. Axelson, Beneficial Designs Inc.

Abstract

The purposes of this project were to introduce the Universal Trail Assessment Process (UTAP) in Ontario, utilize the UTAP to document trail conditions, identify trail conditions which significantly affect access, evaluate the benefits of the trail information for users with disabilities and identify additional information or changes required for users to make informed choices about which trails are appropriate to their abilities.

The most significant barrier to trail access for people with disabilities is a lack of accurate information about the conditions of particular trails. The resulting uncertainty about what will be encountered on the trail may discourage people from attempting a trail outing or may result in frustration or injury if the conditions encountered exceed the users’ abilities.

The Universal Trail Assessment Process (UTAP) was developed to provide objective information about measures of trail conditions. Preliminary UTAP research indicated that five factors significantly affect trail access: grade; cross slope; surface; trail width; and obstacles encountered. Trail assessments were conducted on the same trail at different times to establish the test-retest reliability of the UTAP. Different individuals also assessed the same trail to evaluate the inter-rater reliability. Validity of the assessment process was determined by comparing the objective measurements with user perceptions of trail difficulty.

The UTAP was implemented on six trails at an outdoor centre in Toronto. The data obtained (Table 1) from the trail assessments were provided to rehabilitation professionals who lead a hiking camp for adolescents with disabilities. Average trail grades ranged from 2% to 4%, with average cross slope values of 1% to 4%. In contrast, the maximum values for grade and cross slope were 26.0% for 7.3 metres and 21.0% for 3.1 metres, respectively. These examples illustrate the importance of recording maximum as well as average values for grade and cross slope. Four of the six trails maintained a width of 1.5 metres throughout, with a paved or firm surface. The other trails had portions which were slightly narrower (1.3 and 1.1 metres) or had a softer surface.

The staff and campers compared their expectations based on the UTAP information to the actual conditions that they experienced on the trail. Feedback received from the trail users indicated that the UTAP provided accurate, reliable information about the trail conditions which enabled the users to make informed decisions about which trails they wished to use. Trail users also indicated that the information encouraged them to participate and increased their ability to use the trails independently and safely. It also enabled them to plan for any...

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
assistance that they might require by increasing their knowledge of trail conditions and enhancing their ability to match the trail conditions to their personal abilities or desired trail experience. They indicated that the grade profile was very useful, particularly since it included a reference to the 1:12 grade, which is a used for a standard ramp. The top-view map that included trail access information and surface changes was also considered valuable.

<table>
<thead>
<tr>
<th>UTAP Measurements</th>
<th>BV Trail*</th>
<th>TR Trail</th>
<th>VC Trail</th>
<th>OL Trail</th>
<th>UW Trail</th>
<th>BW Trail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (km)</td>
<td>0.42</td>
<td>0.24</td>
<td>0.11</td>
<td>0.42</td>
<td>0.87</td>
<td>0.08</td>
</tr>
<tr>
<td>Ave. Grade (%)</td>
<td>4.0</td>
<td>2.0</td>
<td>2.0</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>(Max.(-)-metres)</td>
<td>(12.0-11.9)</td>
<td>(9.0-28.0)</td>
<td>(7.0-25.9)</td>
<td>(21.0-12.2)</td>
<td>(26.0-7.3)</td>
<td>(26.0-2.1)</td>
</tr>
<tr>
<td>Ave. Cross Slope (%)</td>
<td>4.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>(Max.(-)-metres)</td>
<td>(13.0-1.8)</td>
<td>(4.0-0.6)</td>
<td>(6.0-0.6)</td>
<td>(12.0-2.4)</td>
<td>(21.0-3.1)</td>
<td>(4.0-0.6)</td>
</tr>
<tr>
<td>Ave. Width (metres)</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>(Min. (m))</td>
<td>(1.3)</td>
<td>(1.5)</td>
<td>(1.5)</td>
<td>(1.1)</td>
<td>(1.5)</td>
<td>(1.5)</td>
</tr>
<tr>
<td>Surface</td>
<td>Firm (24.7)</td>
<td>Firm (0.0)</td>
<td>Paved (0.0)</td>
<td>Firm (59.1)</td>
<td>Firm (0.0)</td>
<td>Hard (0.0)</td>
</tr>
</tbody>
</table>

*Trails are identified using reference codes only.

Table 1: Trail Access Information for Six Trails in Ontario

The data were also provided to the interpretive and maintenance staff of the outdoor centre. Feedback from these trail experts was used to evaluate the effectiveness, accuracy and usefulness of the information obtained. The results indicated that the Trail Access Information (TAI) summary and the trail grade profile accurately reflected the current trail conditions and identified soft surfaces and/or drainage concerns of interest to the maintenance staff.

Benefits of the UTAP identified by land management staff related to both resource preservation and the delivery of services to trail users. The detailed maintenance logs generated through the UTAP provided the land managers with the ability to document and monitor trail conditions, plan and prioritize projects, budget more effectively, monitor the environmental impact of the trail and identify barriers which significantly affect access. Feedback indicated that these were identified as benefits that would assist land managers in enhancing the preservation and management of the resource. Increased user satisfaction and safety and the potential to increase opportunities for all trail users with and without mobility limitations resulted from the availability of detailed, objective and accurate information about trail conditions. The identification of access barriers allowed land managers to focus their plans for future work. It also gave them the ability to create signage and provide additional information. It was also felt that the detailed information provided by the assessment would enhance the agency’s search and rescue and emergency evacuation capabilities should these services be required.

In conclusion, the Universal Trail Assessment Process was successfully used to document conditions on six trails in Ontario. The accuracy of the information was verified by land managers and was made available for use in project planning and budgeting. Evaluation of the Trail Access Information (TAI) by staff and people with disabilities (n=12) supported the use of icons, maps and other graphics to convey trail access information. Users indicated that they require the TAI summary information and may also sometimes require additional details to
determine whether the trail conditions on a specific trail are suited to their ability. Overall, results of this project indicate that the UTAP provides accurate, objective information about trail conditions that benefits both park staff and trail users.

Recommendations from trail users for future work included expanding the use of the UTAP so that consistent information is available from trail to trail, park to park and region to region. Enhancing the use of icons and graphics to represent the trail data was also recommended, particularly for visual learners. As a minimum, information on conditions affecting access such as grade, cross slope, width, surface and obstacles should be available at all trails. In addition, information about other features such as stairs and railings should be provided. More detailed information like the presence of long grade sections which are less than the maximum value, should also be available from the park management for users who require more specific information.

Future project work will include completing additional UTAP assessments for trails throughout Ontario; providing training for land managers who wish to conduct UTAP assessments; refining and implementing signage and information formats and evaluating the use and impact of Trail Access Information for a larger sample of land managers and users of all abilities.

**Acknowledgement**

The Universal Trail Assessment Process was developed by Beneficial Designs, Inc. through the support of the National Centre for Medical Rehabilitation Research in the National Institute of Child Health and Human Development at the National Institutes of Health (Small Business Innovation Research Phase I Grant #R43-HD29992-01, Phase II Grant #R44-HD29992-02).
Building Community and Conserving Cultural Landscapes through Inventory

Nancy Pollock-Ellwand
School of Landscape Architecture
University of Guelph, Guelph, Ontario, N1G 2W1

Abstract
A timely landscape conservation and community-building exercise is taking place in the Ontario village of Blair in parallel with intensifying development pressures. Relationships within this small urban fringe settlement have been renewed and fortified as residents focus on their common landscape heritage – sharing stories about their river flooding, championship baseball games, and milling activities. The identification of this landscape and its stories serves as a model for others interested in engaging the public more effectively in the landscape planning process and protecting landscape resources that are not often highly valued in development decision-making.

Over a four-year period, a computerized inventory of Blair’s landscape heritage has been prepared. Using multi-media software, produced through both public and private efforts, the user can experience the landscape’s history through a narrative, vector-mapping, and volumes of historic and contemporary images. In addition, information can also be reviewed from a server located at the Grand River Conservation Authority, that provides ‘intranet’ access among twelve communities within the Watershed.

More important, however, than the technologically-enhanced organizations and delivery of this data is the manner in which it was collected by the community members themselves. Seeing the immense value of environmentally-based learning, local high schools incorporated this community-based data collection into classroom activities. Paired with long-term residents, students documented much of Blair’s landscape memories. Other students surveyed and mapped the town’s pioneer cemetery; and another group compiled photographs into a simulated “walking tour” of Blair.

Educational institutions are ideal centres for community data collection initiatives. Working closely with community coordinators, students provide the energy and enthusiasm needed for such a large task. And these institutions provide the necessary continuity for an ever-growing inventory; thus presenting monitoring opportunities for landscape change.

Blair shows us that landscape heritage relates at some level to all inhabitants of a community. Identification of heritage landscapes ensures their effective inclusion in the planning process. It can also help reacquaint neighbours; educate young citizens about their heritage; and validate the memories of older citizens – in short, building community while aiding in the conservation of its most common, yet treasured resource...landscape.
Figure 1: Map of the Village of Blair situated west of the City of Cambridge along the Grand River.

Figure 2: Compilation of the different screen entries of the software product that has been developed to record the information gathered by high school students about the landscape history of Blair. The multi-media database is accessed by 'clicking' on the map. The map serves as a menu to pull up textual and visual information of different elements in the landscape. The history of the Village's church is shown in this example.
Blair Cultural Landscape Inventory

**Product**
- multi-media software
- vector mapping
- map as “menu”
- images
- narrative
- searchable
- internet

**Process**
- schools leading
- community as partners

Figure 3: The Landscape Inventory for Blair is a prototype for other communities interested in collecting heritage data. This plate shows that the Inventory is both a multi-media software product and a process which is led by local high schools in partnership with the local community.

**Community-based Data Collection**

Schools → Community → Database

Database → Community Planning Process

Community Internet Connection

Figure 4: This plate further elaborates on the relationship of the schools with the community in the development of this heritage database. The diagram indicates this database can be accessed by the community in future landscape planning exercises; and the database can also be accessed external to the community via the internet.
Blair Cemetery

Figure 5: This plate is a further example of the multi-media nature of the software.

Benefits of Community-Based Data Collection

1. **Fills Gap** in times of shrinking government.
2. **Involves Young People in Landscape Heritage**
   - partnership of schools with larger community;
   - articulates heritage for larger community;
   - pedagogical value in research, analysis, writing and technology;
   - real world experience... learning to appreciate own environment and building environmental ethic.
3. **Validates Memories** of older citizens, preserving precious information.
4. **0MB Representation** -- present ‘soft’ landscape knowledge in a form that would be more acceptable in a quasi-judicial forum.
5. **Monitoring Environment** by going back annually to same landscape.
6. **Better Planning** -- before crisis; response to developers’ demand for ‘upfront’ process; avoids consultants ‘dropping in’.

Figure 6: The final plate lists the benefits that accrue to a community that becomes engaged in such a community-based data collection exercise.
From Inventory to Interpretation: A Definition of Process*

Cailin Clarke
Trent University, Peterborough, ON

Abstract
This paper is an outline of masters research in progress which will attempt to develop a strategy for interpretive planning for Trent University, Peterborough, Ontario. From the first stage of cultural and natural features inventory within the area of interest, there will be an overlay of other factors of importance using Geographical Information Systems (GIS) and matrices. The eventual result should be a reduction of options to succinct recommendations for an interpretation plan.

Interpretation can be defined as an “educational activity which aims to reveal meanings and relationships through use of original objects, by firsthand experience, and by illustrative media, rather than simply to communicate factual information” (Tilden, 1967). Interpretation is vital to parks and other protected area agencies for increasing tourism, educating visitors, guiding their actions and creating meaningful experiences. Given such weighty purposes, a well-defined process for developing interpretation plans must exist. To the contrary, much interpretation seems to occur on an ad hoc basis. There is little heritage agency documentation regarding the process of moving from the resources inventory stage to an interpretation plan.

This research will make use of the sixteen Nature Areas on the Trent University Symons Campus, Peterborough, Ontario (Figure 1). These areas, totalling approximately 300 hectares in size, have been inventoried for significant natural features and some historical features and designated as protected by Trent University. Notably, little interpretive use of the Nature Areas has occurred and no overall interpretation plan has been developed. This makes them an ideal pilot case for development of a process resulting in definition of interpretation opportunities. The anticipated result of this research in April 1999 is a practical and economically feasible natural and cultural interpretation plan for the Trent Nature Areas, complete with implementation strategies and budget requirements.

Ultimately, this step-wise process for development of an interpretation plan could be used for parks internationally. Times of fiscal restraint and increasing environmental awareness are resulting in a reassessment of the “meaningful experiences” that parks and protected areas are providing. A well-defined basis for planning interpretation should be a part of this shift.

* This report arises from a poster paper at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
Objectives

The objectives of this research are:

1. to develop a process of interpretive planning for parks and protected areas; and,
2. to make recommendations for implementation of an interpretation plan for the Trent University Nature Areas.

Figure 1: Trent University Nature Areas
Methodology
1. To develop a process of interpretive planning for parks and protected areas:
2. Literature review
3. Interviews with interpretation professionals
4. Development of a matrix/mapping overlay system

To implement an interpretive planning process for Trent Nature Areas:
1. Literature review
2. Field work in Nature Areas
3. Interviews with area professionals familiar with the Trent Nature Areas
4. Market opportunities survey
5. Use of matrix/mapping overlay system
6. Budget estimates for interpretation options

Factors to be considered for interpretive planning:
- natural and cultural features
- market opportunities
- safety hazards
- funding
- agency mandate
- areas of significance
- management/use conflicts
- interpretation potential
- interpretation techniques

Expected Results
1. A comprehensive strategy for interpretation planning
2. A practical and economically feasible natural and cultural interpretation plan for the Trent Nature Areas

Reference
Halfway Lake Provincial Park
Protected Areas and Other Land Uses – A Spacially Explicit Evaluation

Wolfgang Haider, Ontario Ministry of Natural Resources
Brian Hutchinson, Parks Canada — Ontario
Jim Duncan, Ontario Ministry of Natural Resources

Abstract
We will present the conceptual framework and associated methods for a generic land-use planning tool. This tool will allow resource managers, decision makers, and/or stakeholders to estimate the effects of proposed management initiatives on land use values for a defined area, such as a park, a protected area, or a timber management planning unit. The resulting decision support system will be based on the concept of trade-off and will be spatially explicit. It will consider the production capabilities, the net economic values, social preferences and the relationships between ecological processes, for a selected set of natural resources.

Implementation of the project will involve the following components: development of a framework for estimating the value of major natural resources including tangible products, consumptive and non-consumptive activities, and ecological services; development of a framework for estimating production capabilities – maximum as well as joint production functions; development of an activity/use/service interaction matrix; development of a balance sheet to illustrate how the total value of the natural resources of a landbase change under different management scenarios; and, development of a spatially explicit decision support system tied to existing GIS databases. The proposed approach will also ensure that the decision support tool is as generic as possible for easy transferability to other management units.

This decision support tool will constitute an important contribution to sustainable land management, and will be equally applicable to parks management and to integrated management on Crown land. It is proposed to conduct a pilot study in the greater Pukaskwa area in northern Ontario.
Research and Monitoring Needs Catalogue for Ontario Region National Parks*

Ken Van Osch, Heritage Resources Centre
University of Waterloo, Waterloo, Ontario, N2L 3G1
J. Gordon Nelson, Heritage Resources Centre
University of Waterloo, Waterloo, Ontario, N2L 3G1
Bill Stephenson, Parks Canada, Professional Services - Ontario,
111 Water St. East, Cornwall, ON K6H 6S3

Abstract
The Heritage Resources Centre (HRC), University of Waterloo, recently compiled a catalogue of Research and Monitoring Needs for National Parks in Ontario. The purpose of the Catalogue is to help facilitate better communication between Parks Canada and its existing and potential research and monitoring partners in the public and private sectors including: volunteer and interest organizations; students on work term or undertaking Honours, Masters, PhD or group/class projects; researchers in universities, non-governmental organizations and the private sector; and other federal, provincial and local government departments and agencies.

The Catalogue identifies research and monitoring needs in broad terms and includes projects relating to data collection, analysis and/or documentation as well as projects relating to revisions and updates of cyclical or ongoing research and monitoring activities. The research and monitoring projects are presented in tabular form and are organized by Park. For each Park, projects are organized according to the general categories of Abiotic, Biotic, and Cultural Heritage and Human Use. Within these categories, the research and monitoring needs are organized more specifically by grouping together projects with similar subject matters. For example, within the Biotic category, research and monitoring needs are grouped according to avifauna, mammal, vegetation and other such sub-categories. These sub-categories are listed on an Index Page which precedes the research and monitoring needs tables for each Park. Descriptions, information and details about individual research and monitoring needs are listed in the various research and monitoring needs tables. It is intended that the Catalogue will be updated by Parks Canada biennially. The Catalogue is available on-line via the HRC’s webpage at:
http://www.fes.uwaterloo.ca/Research/HRC

* This abstract is from a poster presentation at the 1998 Annual Meeting of the Parks Research Forum of Ontario.
Linking Geology to the Effects of Acid Precipitation on the Food Chain of *Gavia immers*.

Rachel Dunn, *University of Waterloo, Waterloo, ON N2L 3G1*

**Abstract**

Acid precipitation adversely affects daphnia, a lower link in the *Gavia immers* food chain. Daphnia die more quickly when exposed to water of pH 4.6 and 6.0 than water of pH 7.2. However, maintaining a predetermined pH in the water used for testing proved difficult. This may have been attributable to buffering minerals, which neutralized the sulfuric acid used to adjust pH. From this observation arose a new hypothesis. Buffers in surface water are leached from adjacent soil. With prolonged exposure to low pH, these buffering agents may be depleted until they are unable to protect a lake from increasing acidity. To test this, a mixture of rain water and acid at a predetermined pH was run through columns containing soil from the banks of four water sources with a range of diverse underlying geology. Annual rainfall determined the volume of test water used for each column, with five repetitions to approximate five years of rainfall. After each eluate the water was tested for pH, hardness, and alkalinity. When compared to parallel tests of water samples of the four water sources, these results showed a depletion in the soil buffering capability.

*This abstract is from a poster presentation at the 1998 Annual Meeting of the Parks Research Forum of Ontario.*
Spatial Relations between Migratory Algonquin Park Wolves and Resident Wolves in a Winter Deer Yard (Winter 1997 Preliminary Results)

John Pisapio  
School of Urban and Regional Planning  
University of Waterloo  
Masters Thesis in progress, completion date - June 1998

Abstract
This two year study identifies variable spacing patterns exhibited by migratory and resident wolves (*Canis lupus Lycos*) utilizing a winter concentration of white-tailed deer (*Odocoileus virginianus*) near the southeast boundary of Algonquin Provincial Park, Ontario. Nearest Neighbor statistical testing and GIS mapping analysis were applied to radio telemetry locations for 21 radio collared wolves representing two resident deer yard packs and six migratory packs from the eastern side of Algonquin Park. Also included in the analysis are three lone wolves also from the park. Territorial fidelity was strongest among resident wolves and weakest among lone wolves. The resident packs, totaling five individuals, exclusively occupied 45% of the mid-winter deer yard area. The remainder of the yard was temporally shared by a minimum of 23 migratory wolves. These animals made frequent extraterritorial excursions or seasonal migrations from their annual territories in the park to the deer yard. The duration of these visits ranged from two days to four weeks. Concurrent use of the yard by three or more migratory packs occurred in eleven of the seventeen weeks telemetry monitoring was conducted. Migratory packs occupied smaller areas of use than the resident packs and showed greater spatial and temporal tolerance towards other migratory wolves. Mean seasonal density of migratory wolves present in the yard was greater than the density of resident wolves within their exclusively held territories. Resident pack territories coincided with areas of highest deer density (Poszig 1998). Evidence linking wolf and deer distributions in the yard is discussed in relation to co-evolutionary anti-predator behaviour and management implications.

Reference
Overgrazed Ecosystems: Do Plant Communities Recover?

Saewan Koh, York University
Dawn Bazely, York University
Trudy Watt, Wye College, London University

Large herbivores, such as white-tailed deer (*Odocoileus virginianus*), are major determinants of the structure and composition of forest plant communities. Previous studies of herbivory have examined plant community response by focusing primarily on diversity indices or single plant species. Few studies have shown whether statistically significant changes in species composition have occurred. In this study we used ordination analyses (DCA, CCA and RDA) to examine the effect of biomanipulations including exclosures and removal of deer on plant species composition and the dynamics of southern Ontario forests in the Canadian region of the North American Eastern Deciduous Forest or Carolinian Zone. In 1992, 1995 and 1996, plant communities in forest stands with high deer densities (50 deer/km²) were compared with adjacent plots closed-off to deer in 1978, 1991 and other long-term ungrazed sites. Stands where deer were reduced in 1993 from 10 to 50 individuals/km² were also examined. Ordination showed that older exclosures were similar to ungrazed sites and dominated by native plant species. Both differed significantly from grazed sites, which were dominated by non-native species. Newer exclosures and stands where deer densities were reduced differed from both grazed and long-term ungrazed sites. This suggested an intermediate or alternate recovery trajectory with implications for management decisions about plant species conservation and re-establishment. Herbivore-mediated changes in light regimes at the forest sub-canopy may be a factor in preventing native plant communities in overgrazed sites from recovering and may also be determining the trajectory of some plant communities over time.
PART III:
WORKING GROUP REPORTS AND COMMENTARIES

WORKING GROUP REPORTS

Killarney Provincial Park
Note:

Following the keynote papers and panel commentaries on Day 1, working groups were formed and asked to consider the following questions.

1. What do you think are the strengths of research relating to parks and protected areas in Ontario and why?

2. What do you think are the research needs and why?

3. In particular, what do you think of our capacity to do research on parks and protected areas in Ontario? By capacity we are referring to research faculty or staff, field stations and facilities, funding, department or agency support, etc. – i.e. the things that enable and motivate or provide ability to do research.

4. Do you have any recommendations in regard to building research capacity in parks and protected areas in Ontario?

5. What might the Parks Research Forum of Ontario do?

Five working group reports were prepared, presented in a plenary session, and submitted for inclusion in these Proceedings. These reports were submitted by Ed Addison, Don Cuddy, Dan Mulrooney, Jim Cantrill and Lori Riviere. Reports are not available for Working Groups 5, 6 and 8.
Working Group 1 Report

Strengths of Research relating to Parks

- Relatively 'pristine' environments provide comparative, benchmark opportunities.
- Diversity of research topics done in parks.
- Opportunities for effective communication of research results back to the public because of the close interface between professional park interpreters and research staff.
- Research data give a predictive, anticipatory opportunity for park management decisions.
- Regarding the assumption that forming a park provides widespread protection of the local ecosystems within the park, research in parks can dispel this myth and provide the public with the 'wake up call' that many stressors (e.g. acid rain, deposition of mercury, etc.) have effects at a very large spatial scale; hence park areas are just as vulnerable to degradation as are other areas.
- Opportunity for continuity for longer periods of time than in sites outside protected areas.

Research Needs and Why

- Gap analysis approaches for decisions about location of additional protected areas or expansion of currently designated protected areas.
- Basic inventory (cataloguing) of flora and fauna. This is seen as very important despite the large proportion of previous research in parks being biological and despite our seemingly knowing so much already about flora and fauna in some parks (e.g. recent work in Algonquin has shown occurrence of perhaps 700 species of insects in the vicinity of one lake and the list is not yet exhausted).
- Basic monitoring of populations of biota. Monitoring is important, because: 1) to address biodiversity effectively one must have the baseline data, and 2) it will give a greater variety of biota of different taxa that could be effective sensitive indicators of ecosystem changes. Examples here of particular interest will include species near the limits of their range (either northern, southern, eastern or western)
- Long term research is needed. This need not be dedication to a single piece of research over decades but could be units of research conducted in a manner that they are complementary to research previously conducted. The long term research is needed to recognize differences between cyclical or intermittent events from long term trends, the latter being of particular potential importance with respect to management actions.
- Measure the effects of the presence and activities of humans on the behaviour of individual animals and the subsequent cumulative effects on animal populations. This will be a particularly important area of research with increased human use of natural systems in parks. Promotion of ecotourism should include investment in research on the associated incremental changes on the non-human components of the systems.

Our Capacity to Do Research on Parks/Protected Areas
• It is facilitated by the potential coordinating capabilities of government staff (parks, research) and by the attraction of researchers from diverse subject areas and locations to work at the same field station on the same land base.
• Enormous advantage of being able to build on the knowledge derived from prior research on the same sites.
• Park staff and park visitors contribute significantly to progress in many pieces of research in parks.
• Where available field research stations have immeasurably promoted research in parks to the benefits of parks, researchers, and our general understanding of natural systems.
• Other facilities are presently valued a great deal by researchers (e.g. use of staff houses off-season for lodging and lab use, use of workshops, etc.).
• Park staff often provide critical logistical support (e.g. repair of vehicles, loaning of tools, providing volunteer staff on a short term basis (e.g. for staff development).

Recommendations Re: Building Research Capacity
• Catalogue all previous research in the park (and at another scale in the parks system) and make it available to new researchers and park staff
• If park staff that change over time (e.g. seasonals) are collecting data, attempt to ensure consistently used, well documented methods so that data collected over time are not compromised for comparative purposes.
• Install and use a system for evaluating research proposals. Above all else, evaluate the potential impact of the research on the natural systems within the park. In some (but probably not all) instances, other criteria of evaluation might include price, effectiveness, researcher reputation, and if funded by park management, the potential utility of results to future park management.
• Provide field research facilities and the researchers will come.
• Obtain widespread acceptance among park staff of research being an important and integral park activity.
• Researchers need to know what opportunities are, and are not, available to them.
• Institute performance management criteria for park administrators that involve promotion of or progress on research in parks through to their superiors at the director or higher levels.

What might PRFO do?
• Expand on and communicate what is discussed in this forum.
Working Group 2 Report

Strengths
- Research that exists spans some decades and is helpful for studying trends
- Parks can be used as benchmarks because they are untouched by industry etc. - unaffected by the greater landscape
- Research and researchers are accountable to PM245 policy on research types
- PM245 policy seems to limit academic freedom in research yet personal research permits are still very available

Needs
- Human dimensions has not properly been represented in research studies
- Research has been/is mostly single item studies (e.g. wolves) and needs to be more encompassing of the ecosystem as a whole in order to monitor and understand the relationships that occur within that ecosystem
- Standardise as much as possible the methods of research in all studies in all places. If this proves impossible, the same method of study should be followed within a single study area to ensure accuracy of findings
- The general need for more data on issues in order to act with proper authority in environmental/economic/social venues

Capacity
- Poor – focus is (for whatever reasons) on mainly money and research as a secondary concern

Building Capacity
- Invest in working relationships that already work
- Invest in studies at the university level - justification: Parks need cheaply conducted research (university students are skilled, wanting to do field related work and cheap (free)).
- Search out partnerships

Role of PRFO
- In relation to the geographical dimension of the park issue - continue with the bio-regional perspective involving the Canadian Shield or Southern Ontario
Working Groups 3 and 4 Report

Strengths
- Joint efforts between Ontario Parks and Universities – help students gain experience and develop stronger research capabilities
- Until three years ago MNR was not committed to research, more corporate commitment now: a debate currently exists between research for research and research for a product
- Not all research is right: different mindsets/attitudes towards the land
- University involvement
- Different types of research accepted i.e., natural environment research more accepted than political or cultural heritage
- Balance between park agency and independent researchers wants/needs - need to find the balance – strength is that this balance is starting to be found
- Traditional research approaches - areas of strength
- Weakness is less focus on more abstract forms of research
- Focus on the growth of research efforts between Park agencies and universities – helps students gain experience and develop their research capabilities and filling park needs
- Strength in looking at traditional environment resource management, land use planning in mainstream types of research such as political or cultural heritage

Research Needs
- Qualitative research is lacking, could help visitor management studies
- Big gap – demographic research and values – no idea of people’s values i.e. why people visit
- Deal with park users, haven't really focussed on non-park users – research into marketers
- Traditional knowledge – often focus on white person's view
- Both sides breaking through saran wrap
- Where do you want to go in regards to resources – way of viewing the information researched
- Have the other viewpoints communicated to the mainstream
- Need to bring research out into the open
- Catalogue past research and make it available
- Awareness of research going on
- Gap in research on people's values which could help visitor management studies
- Dealing with park users not non-users

Research Capacity
- Focus on park managers especially those not interested in research – managers in old school of thought, workloads, attitudes – universities could tell managers the benefits of researchers
- Getting students interested – universities expect parks to pay for research, while parks feel they do not have a large enough budget
• Need formalized agreements in a MOU
• Students already paying for research need support – parks can provide service considerations – better communication
• "Campground managers" not "resource managers"
• Bureaucracy – getting through red tape to get permission – easier than before
• Focus on managers and let them see the benefits of research
• Parks can support students through the provision of services
• Concern about the quality of research done by students – do they have enough experience – need to make sure they have proper guidance

Building Research Capacity
• Need a clear well communicated idea of what needs to be done in a specific region/park
• Networking – need a node – a way to assure the networking is being done
• Avoid redundancy
• Internet – room for improvement
• Begin building research centres

Role of PRFO
• Break down disciplinary barriers
• PRFO a node for networking
• Small group sessions – letting students (university) network with the professionals helps with approaching the parks
• Parks Canada starting with mentor internship program
• MNR and Parks Canada should ask for research
Working Group 7 Report

Why research in parks?
- Control areas for studies elsewhere (e.g. bears)
- Benchmarks for studying natural versus artificial disturbances
  Question: Are parks appropriately located and sized for this?
- Functional relationships between protected areas and their surrounding landscapes: a) ecological; b) social
- Long-term "stability" of parks and protected areas: Management plans; policies, public accountability
- State of the Environment Reporting

What research should be done in parks and protected areas?
- What do park managers want? (specific focussed projects)
- What are park managers prepared to pay for?
- What do researchers want to do?
- What support can researchers get for their projects?
- Monitoring — universities ($ and research staff); volunteers; school course work

How?
- Ontario parks needs a management framework which clearly outlines the role for research and monitoring (This would permit the identification of general research needs).
- Ontario Parks have a role in leadership for 'greater ecosystem' initiatives (e.g., Frontenac Axis)
- Ontario Parks have a role in increasing community appreciation of their local landscapes and heritage.
- Promote "Research Tourism"; exchange programs; use of volunteers; investment of funds in training volunteer managers; assessment of critical mass (park size and staffing – i.e. large parks – Algonquin or National Parks or systems of parks – Frontenac Axis or Niagara Escarpment)
- Money: universities have bodies but need support; partnerships; reminder – researchers do research (not universities)
- Research Needs Catalogue
Working Groups 9 and 10 Report

Strengths:
- Size and "natural" (e.g. no hunting) representation of natural system or population
- Useful information for use in park, park management and beyond the park
- Catalogue for research needs (provincial and federal) - needs updating
- Involvement of local interest groups
- Facilitates partnerships within park environment
- Long term projects benefit from permanency of people

Needs:
- Inventory - catching up on the missing baseline information - we don't know even what we have and how it has changed since we took stewardship of them
- Inventory of park/parks within a regional context
- Identify assessment tools for above
- Standardize methodology
- Need to co-ordinate research outside NGOs, universities and government
- Balance case specific definition of ecosystem health with systematic health

Capacity:
- Capacity is there if not in hard faculties but possibly through in-kind contributions
- Every park has potential for research topics/needs
- Poor funding

Building capacity:
- Role for an Ontario Parks liaison between parks and universities within a geographic area
- Communication
- Standardize and identify needs approach
- Making research a legitimate goal or landuse or activity within park and system
- Recognise there are environmental impacts on ecosystem

PRFO role:
- Similar session with the expectation of a concrete product or outcome
- Facilitate session/workshop
- Learning workshops
- Communicate better
- Put the word out that there is an interest in getting research
RAPPORTEUR COMMENTS

Lake Nipigon Provincial Park

Jim MacLean
Director, Science Development and Transfer Branch
Ministry of Natural Resources
P.O. Box 7000, 300 Water St
Peterborough, Ontario K9J 8M5

I want to start by thanking the organizers for the opportunity to speak at this Annual Forum. I’ve enjoyed the talks immensely, and I’m delighted to see the high level of interest and commitment demonstrated by the audience’s questions and discussion. It’s been a great day.

My task is to provide a summary and a reaction to the talks we have heard. But, I’m not going to attempt a summary, because I don’t think that’s what we need at this moment. Instead, we need to talk about the future of this Forum, and what we will do together, to rise to the challenges that our speakers have given us today. I believe that this Forum, and the network of people involved, can be a powerful way for us to work together on those challenges. I want to talk about four of the many challenges we’ve been given, and how we can work together under the umbrella of this Forum.

The first challenge, touched on by several of our speakers, is the complexity of the issues we face. Nikita Lapoukhine and Warren Mitchell* in particular pointed out the complexities of scale and values that underlie the public negotiations about parks and protected areas. If we are to inform these public decisions, then we must deal with the complex needs for information and knowledge. None of us can address these needs on our own, but I believe that the diversity of expertise and experience that is required can be marshalled through cooperative action by this network of people.

The second challenge we have identified is that only limited resources are available to deal with these issues. Paul Eagles as well as several panel members and discussion groups pointed out the need for money and the impacts of lack of resources. One example that Jim Cantrill emphasized was the lack of socio-economic expertise and information. I believe that this Forum can help us focus our collective efforts on the most important problems and share resources to address these problems. I also believe this Forum can facilitate more effective efforts to obtain the money we need to work together.

The third challenge presented in today’s discussion is that differences in interest and values tend to pull us apart. Jay Leather’s remarks about research ‘hobby-horses’, Nikita Lopoukhine’s comments on the differences among partners’ mandates, and the diversity of values about parks and protected areas that

* Warren Mitchell, Director of Planning, Land Use Coordination Office, Province of British Columbia, presented the paper prepared by Derek Thompson, Assistant Deputy Minister, Land Use Coordination Office, Province of British Columbia.
people bring to the Forum can be seen as either a wedge between us or a potential strength for the development of an effective network. We need not set aside our differences in deciding to work together. A clear process of frank negotiations can, as suggested by Warren earlier today, result in cooperative action that spans the differing interests and values.

The final challenge that our speakers identified is that the need for action is urgent. The talks by Bart Feilders and the introductory remarks by Gordon Nelson pointed out that the public faces major decisions about parks and protected areas over the next 5 years, and that the science community needs to marshall existing science and develop new knowledge to inform these decisions. The current Lands for Life exercise has synthesized existing information and science, but the gaps in our understanding are demonstrated clearly. If we fail to rise to the challenge presented by today’s speakers, then we must accept some of the responsibility for the lack of adequate science input into decision-making. The choice for the science community, and for this network, has been given to us by our speakers. We must choose action.

I believe that this Forum is at a crossroads, and that our decisions in the next few months will determine the effectiveness of the network. We can choose to be a mechanism for information sharing and networking, which, while useful, will not deal with the challenges we’ve heard. I would argue that we must collectively decide what the highest research priorities are for parks and protected areas, and then develop and implement research programs to address those priorities. There is not an easy, objective way to establish priorities, and working together is fraught with all of the obstacles of personality, values and institutions. But, nothing short of collective action will address the urgent need for support of public decision-making. Let’s work together to ensure the Forum reaches its potential and find ways to work together.
Rapporteur's Remarks on 1998 Parks Research Forum of Ontario

D. Scott Slocombe  
Geography and Environmental Studies  
Wilfrid Laurier University  
Waterloo, Ontario N2L 3C5

So much has been said today, in a fine series of papers, that I cannot possibly be comprehensive. Like the parks system itself I can only seek to be representative and systematic, including a reasonable proportion of the important bits (12%?). I have organized my summary into four broad headings, with a series of points under each. The four main headings are: Why research and science?; What research and science?; What do we do with the results of research and science?; and, How can the process of science and research be improved?

Why Research and Science?

- To develop an understanding of the complex socioeconomic and biophysical systems that park managers can work with, humility in the face of this complexity and our limited ability to understand and control.
- To build bridges and support consensus among stakeholders based on shared understanding.
- To support planning, management, mitigation, restoration, and other activities whether anticipatory and preventative or aimed at issues and problems.
- To pre-empt political, reactive and reactionary management.
- To provide benchmarks, baselines and controls against other more disturbed areas.
- For state-of-the-environment and state-of-the-parks reporting, and generally as a basis for public accountability in parks management.
- To identifying priorities for future research.

What Research And Science?

- To identify what is going on in protected areas, for example, visitor activities, origins, effects; ecological processes and systems; fish and wildlife populations and dynamics.
- To identify what is going on around protected areas, for example, external stresses such as pollution, forestry and hunting.
- To identify cumulative effects of a range of stresses on parks.
- To identify new protected areas needed for representation, biodiversity protection, recreation, and other reasons.
- To identify public needs and demands for protected areas and how parks can better meet them.
- To identify new, and strengthen existing, ways of funding parks and protected areas.
- To avoid re-inventing the wheel; to ensure there is wide knowledge of innovations and what has worked in other places. Parks and park systems tend to address problems independently. We need to know
what has been tried, where, and what were the economic and ecological effects.

- Through it all we should remember: 1) the big picture – the context, whether global tourism trends, climate change, provincial politics or the state of the greater ecosystem; and, 2) the human dimension – socioeconomic factors are not really separate from the biophysical and pervade all other subjects.

**What Do We Do With the Results of Research and Science?**

- Seek to understand trade-offs, for example, by remembering lessons from environmental philosophy and ethics such as inter- and intra-generational equity, or the trans-specific dimensions of sustainability. Parks and protected areas are for ecosystems and tourists.
- Develop understanding and related humility, and seek a convergence of interests through, for example, adaptive management approaches.
- Build trust through knowledge sharing and agreement.
- Identify the right scales and scope for planning processes.
- Develop adaptive, experimental, mitigative, anticipatory management rather than reactive, issue-based responses to change.
- Insure information and knowledge are maintained, updated, used and shared, and not lost through neglect, aggregation and/or generalization.
- Implement education and communication campaigns based on success stories and environmental opportunities as well as risks and problems.

**How Can the Process of Science and Research be Improved?**

- Develop more partnerships – academic, local, Aboriginal, government, minorities and women – to gather and interpret qualitative and quantitative information.
- Ensure quality, access, retention and updating of research and data.
- Recognize that science is not deterministic. Good and useful results are often somewhat serendipitous; we cannot plan/manage the research process as a whole any more directly than we can ecological systems themselves.
- Devise a process framework for park science – as is done for landuse planning – that includes policy goals, standards, and strong terms of reference, as well as a vision and understanding of parks as part of a larger, multidisciplinary, sustainability plan and vision.
- Foster political leadership and support for parks research; ‘champions’ are needed!

**Final Comments: Challenges and Questions to Ponder**

- Will research and science needs change when the parks system is ‘completed’, if that can ever really happen?
- How can more research and science be encouraged in parks other than the biggest, best, highest profile and most complex?
- A huge amount of potential research and science needs to be done, covering the gamut from baseline data to topical, issue-oriented studies. Priorities need to be identified on a park-specific and system-wide basis.
• Research needs must be made more widely known, whether through regularly updated print catalogues or – even better – web sites.
• How can we make better use of existing knowledge on parks and protected areas and their surroundings?
• Remember to distinguish form and content in information and knowledge, especially in the context of new technologies such as geographic information systems and remote sensing.
• It would be useful to pursue consistency of data and research priorities across and within parks systems, for example in terms of the types of information and methods of collection for visitor data across all protected area systems in Canada.
• Can parks get more research done by Memorandums of Understanding with other government agencies, as well as university and other researchers?
• How can we facilitate a greater transfer of research results between different parks and park agencies?

In conclusion, it seems to me that future Parks Research Forums could most readily contribute to these goals by focusing future meetings on specific challenges. For example there might be meetings to foster the process of thinking about research and links between agencies and universities and parks; to strategize on raising the profile of research in and about protected areas; and to help personnel acquire research relevant skills and disseminate lessons of research.
POST WORKSHOP COMMENTARIES

Fushimi Provincial Park
Comments to Parks Research Forum

Mike Wilton  
Algonquin Ecowatch

Ecotourism has recently come to be regarded as the panacea that enables us to aggressively seek tourism dollars with no apparent damage to ecosystems, since wild populations are not being harvested.

There is accumulating evidence however, particularly in Africa and Asia, that increasing human tourist activity in natural ecosystems is negatively affecting the normal movement patterns of sensitive species, causing displacement to less suitable habitat and ultimately leading to reduced reproductive rates.

While the desire among area planners to set aside a specific percentage of Ontario’s land mass as parks and protected areas is indeed a laudable goal, this excellent foresight is aimed primarily at future generations of humans and may therefore fall short of the intended goal by not making adequate provisions for other species, the loss of which could ultimately diminish the quality of life presently enjoyed by Ontarians.

While park planners, having recognized that increasing human population is placing inordinate demands on available wilderness facilities, have introduced limits on human activity in some interior park facilities such as Algonquin, these restrictions are aimed primarily at preserving the quality of human wilderness experience, but have not taken into account the possibility that such controls may still allow excessive human activity from the standpoint of indigenous species.

Unfortunately human population is growing faster than human knowledge, and benchmarks against which to equate excessive human activity in natural ecosystems have not yet been thoroughly developed, although there is an increasing body of knowledge to indicate that the threat is very real.

I cannot offer an easy solution to this problem, but respectfully urge you to enlarge your horizons beyond the mere needs of the human species and to include the needs of our “fellow travellers” in your deliberations.
Note:

The following section contains a commentary on Protected Area Networks: Assessment of Ontario's 'Nature's Best' Action Plan and Recommendations by T. Nudds et al. which was submitted after the 1998 PRFO meeting in response to the general invitation by the Organizers for participants to submit comments related to the meeting if they wished. Crins and Kor's reply to Nudds et al. is included as well, followed by Crins and Kor's original draft which which drew the commentary from Nudds et al.
Protected Area Networks: Assessment of Ontario's ‘Nature's Best’ Action Plan and Recommendations*
A Submission to the Lands for Life Round Tables, February 1998

Thomas D. Nudds, Christopher P. Henschel, Jeremy Kerr, David Currie, Lenore Fahrig, Saewan Koh, Christopher G. McLaughlin

Introduction

Protected natural areas are deemed important for a variety of reasons including economic, ecological, ethical, and aesthetic. A great deal of discussion has focused on the last three of these. Ironically, less work has focussed on the economic justification for conservation of natural areas even though many consider this aspect to be a primary concern. The Lands for Life planning initiative must deal, fundamentally, with the sustainability of economic activity in northern communities and how to balance that with conservation of nature in protected areas.

In this paper, we first develop an economic rationale for a system of protected areas in Northern Ontario and point out that the protection of natural areas is not incompatible with the objective of sustained resource extraction and economic activity. Rather, we argue that protected areas can enhance progress to that objective. Then, we address whether the current methodology for selecting protected areas is likely to result in a reserve network adequate to the task. Finally, we propose some refinements to current methodologies that underpin proposals currently under consideration by the round tables.*

An Economic Rationale for Protected Areas in Northern Ontario

Northern Ontario’s economic viability and social stability will continue to depend, in large part, on the sustainability of resource-based industries – that is, forestry, fisheries, wildlife, and ecotourism. In turn, sustainable resource extraction and other uses are only compatible with the persistence of the ecosystems in which they are situated. That is, without a healthy ecosystem, there cannot be a healthy economy. Parks and protected areas, representative of unimpaired, natural ecosystems, should play a stronger and more important role in sustaining resource-based industries than they do presently, particularly by providing “targets and indicators to determine the long-term health of the resources” (Ontario Ministry of Natural Resources 1997a, 3). This is paramount if the parks system is to live up to its greatest potential for contributing to the viability of Ontario’s resource-based industries, and to government’s commitment to its “overriding principle” to ensure ecosystem health and to be accountable to that principle (Ontario Ministry of Natural Resources 1997b, 4).

How protection from resource extraction can contribute to sustainability of resource extraction is perhaps best illustrated by analogy. A factory wants to stay in business – that is, be sustained. It has to produce quality products. To

* Based on an original paper by C. P. Henschel (Department of Zoology, University of Guelph, Guelph, ON N1G 2W1). This paper is available on request from the author and contains full reference citations.
ensure that the products are sound, the plant devotes a portion of its productive space to quality control, where parts are periodically checked against standards. The factory could forego quality control and devote maximum floor space to production of more parts, but that would entail a great deal of risk. Floor space not devoted to production in the short term, nevertheless makes a substantial contribution to the long-term sustainability of the factory. Similarly, parks and protected areas are important, not just because they contribute to Ontario’s international reputation and obligations to the Man in the Biosphere Program, the Convention on Biological Diversity, the Convention Concerning the Protection of the World Cultural and Natural Heritage, and the World Conservation Union, nor just because of the revenue they provide the government, but also because they can act as "quality control sites" against which to measure the persistance, stability, and sustainability of Ontario’s renewable resource-based industries.

Sustainability depends on reliable information about the ecological processes that underpin the productivity of ecosystems and, in turn, the economic viability of resource-based industries. This information must be collected from an ecologically intact and functional natural site, hence a protected area. In some cases, obtaining International Standards Organization (ISO) certification, on which marketing success will depend, will in turn depend on the ability to properly assess the extent to which human activities are meeting the criterion of sustainability. Recent experience in New Brunswick showed that an unsuccessful bid for ISO certification by a large forestry company resulted in renewed political will to design and implement a protected areas system. Similarly, the Crown Forest Sustainability Act of Ontario sets out the legal requirement to practise forestry in a manner that emulates natural forest dynamics. Such assessments require that comparisons be conducted between areas in which resource extraction such as forestry and fish harvesting is practised and where it is either not practised or its effects appear minimal. For example, though extremely degraded by the turn of this century, and presently logged and used extensively for recreation, Algonquin Provincial Park currently shows little evidence overall of extinctions of vertebrate species. An important role for parks and other protected areas is to serve as these reference areas, or baselines, against which to assess the degree to which industries’ activities may be unsustainable, leading to their own demise, and the demise of the ecosystems in which they operate.

In Ontario, resource extraction is carried out in a variety of terrestrial ecoregions and ecodistricts – by definition, each is unique. Thus, the completed parks and protected areas system should encompass the variety of ecological systems in Ontario. It would be as difficult to compare areas with and without resource extraction, if those areas were in different regions of the province, as it would be to check the quality of parts from one factory to standards for different parts in a different factory!

Eco-tourism within protected areas, done right, may be compatible with the objective of maintaining protected areas as ecological reference sites. From a scientific perspective, if the objective is to obtain reliable knowledge about the effects of resource extraction for the sake of sustaining it, then a reference area with little human influence is crucial.
Selecting *Nature’s Best* for Economic Vitality

Here, we analyze the methodology for selecting ‘Nature’s Best’ for protection and ask a simple question: is the selection procedure for protected areas likely to meet the objective of providing for “targets and indicators to determine the long-term health of the resources” (Ontario Ministry of Natural Resources 1997a, 3). To achieve this goal, a network of protected natural areas must be based on our best current understanding of ecological principles, and be sensitive and adaptive to any new developments in this understanding. We first provide an explanation of the most relevant ecological concepts. Based on current knowledge about each of these concepts, we propose a minimal set of criteria for designing a protected natural area network. Finally, we evaluate the methodology in use by the Ontario Ministry of Natural Resources (OMNR) in the *Nature’s Best* action plan in light of these criteria, and provide recommendations for improvement.

**Relevant Ecological Concepts: Our Current and Best Understanding**

*Representation.* -- The numbers of species, and the types of species in any particular area, vary widely across the province. Hot spots are regions with relatively large numbers of species. Protecting these areas will ensure that the maximum number of species is represented in the minimum possible area. This is called a coarse filter technique. In addition to these hot spots, however, locations of endemic species, or rare and endangered species may also be identified. Identifying these areas is called a fine filter technique. GAP analysis employs both coarse and fine filters. Areas important for the representation of diversity that are not contained by existing protected areas are gaps which need to be added to the reserve network.

GAP analysis can be effective at identifying candidate areas for protection based on representation, but issues of *what* is represented must also be considered. There are two issues that are important. First, wildlands that exist now are not the only areas that should be considered for inclusion in a network of protected areas that is meant to be functional and successful well into the future. For instance, at the turn of the century, Algonquin Provincial Park was heavily disturbed by forestry activity, and would not have been a likely candidate for a nature reserve if only the most undisturbed areas had been considered. Today, however, it is a flagship of Ontario Parks, and protects an intact collection of mammals and birds. Algonquin Park teaches the important lesson that reserves need not be constrained to the least disturbed areas. Though less likely to be recognized in a search for ‘nature’s best’, such areas may be nevertheless crucial in achieving minimum size and connectivity goals for reserves. Likewise, neither should the sizes of potential reserves, and the degree of connectivity (see below) among them, be limited by the absence of adjacent, undisturbed land.

Second, enduring geological features can be represented in very small areas, and so can areas rich in plant species, but it is well known that areas in which plant species are well represented may nevertheless be devoid of many other invertebrate and vertebrate species. For example, though plant species diversity may be a good indicator of overall diversity in natural, intact ecosystems, these species are also much better able to persist than others such as large-bodied mammals as the natural ecosystems are decreased in size through human disturbance. Thus, GAP analyses that only identify hot spots of diversity for
conservation may be wholly incapable of allowing what is represented to actually persist, especially if these hot spots are too small. GAP analyses are most properly used to identify the location of candidate reserves, but not the reserves’ shape, size, or boundaries. Protected areas selected solely on the basis of GAP analysis will give a false sense of inclusion and representation, and will not be able to provide targets and indicators for the health of the resources because they will not be ‘healthy’ themselves. Thus, once establishing the location of a candidate reserve, it’s minimum size, boundaries, and connections must also be considered.

Size. -- The numbers of species in protected areas varies with size of the area. Minimum reserve sizes have been estimated in a number of ways, none of which, from a scientific perspective, is foolproof and all of which are potentially controversial. Together, however, they do represent the best attempts to establish a biologically meaningful, and effective reserve size. These are:

Minimum Critical Area (MCA), which is the smallest size of a reserve that would ensure persistence of a particular species, calculated using genetic or demographic criteria;

Minimum Dynamic Area (MDA), which is several times larger than the largest, foreseeable disturbance, such as fire and insect attack; and

Minimum Reserve Area (MRA), which is the size above which a protected area surrounded by a greatly altered landscape would nevertheless contain similar numbers of species as it would contain if it were not an isolated reserve.

MCAs are problematic to apply because they assume that protection of the single, target species will ensure protection of the rest. Such “umbrella species” have had limited testing in this regard, and may not function as such. MDAs may be impractical at large spatial scales, such as would be required in northern Ontario where natural, historical fires covered extensive areas.

Protected areas that are too small, in an otherwise altered landscape, often contain fewer species than they would in an unaltered landscape. Mammals are the vertebrate group most sensitive to area reduction; proportionately more species of mammals are absent from reserves that are too small than other kinds of species, like amphibians, reptiles, birds and plants. This has led to the idea that mammals may be an appropriate taxon on which to focus conservation efforts, and to monitor results of those efforts, since conserving the greatest fraction of mammal species should lead to conservation of the greatest numbers of other species. Conversely, for reasons outlined above, conserving the greatest number of plant species, or types of plant communities, would not ensure that the greatest number of other species is also conserved. The minimum reserve area (MRA) required to include the full complement of mammal species in a protected area is estimated to be 500,000 ha (5,000 km²), in the neighbourhood of the sizes of Algonquin, Wabakimi and Quetico Provincial Parks and others.

Boundaries. Inspection of the mapped boundaries of most parks and reserves reveals that they are most often artificial, have little to do with real biotic boundaries of the ecosystems involved, and result from the extent of crown ownership, neighbouring private land ownership, mining rights, forestry rights, and human constructs such as roads and railways. Despite the vast sizes of
some protected areas set aside for conservation, they are nevertheless unable to meet that goal because they are influenced by events outside of them and sometimes many thousands of kilometres away. Setting appropriate boundaries, perhaps based on inclusion of as much as possible of the watershed in which a protected area is established or expanded, may reduce the influence of transboundary effects on the integrity of the protected area.

Further, intensive land use outside protected areas often occurs right up to their borders, increasing the potential for negative transboundary effects. Thus, reserves should be designed with these components in mind: core areas, buffer zones, and the human-altered landscape. Core reserves are managed for maximum protection, and minimum intensity of human use. Intensity and type of use increases through one or more buffer zones to the landscape managed predominantly for sustainable resource use. This concept provides for better protection of species diversity by decreasing edge effects and human interference, and for managing and controlling disturbances, such as accidental fires.

Ideally, the managed landscape should itself be managed to provide habitat for as many species as possible. In northern Ontario, this would be accomplished by managing the landscape, for example, as dictated by the Crown Forest Sustainability Act to sustain native species and emulate natural disturbances. Again, the extent to which that objective is met could only be gauged against a benchmark for the natural state, namely, representative protected areas that are large enough to conserve natural diversity and dynamics.

Connections. -- Connections refer to the degree to which protected areas are functionally linked to each other. In order to be functional, connections between reserves must provide avenues for dispersal, daily movements, seasonal migration, genetic interchange, range shifts necessitated by changing climatic or environmental conditions, escape to refugia in the case of catastrophic disturbance within reserves, and recolonization following disturbance. Connections could take the form of corridors of similar habitat between reserves, or a hospitable landscape matrix through which flora and fauna can travel and disperse. Little research has actually demonstrated beneficial effects of connections among protected areas; some argue that it is the absolute amount of habitat that is conserved that is important in reserve design, and not necessarily the particular configuration in which natural protected areas might remain. At present, the scientific perspective on this issue is that, until more is known, corridors may be an appropriate precaution against the protected areas being compromised in their role to conserve a natural complement of native species. The extent to which reserves are connected is a measure of the extent to which a protected areas landscape has been conserved, rather than merely a collection of protected islands.

A Checklist of Criteria for State-of-the-Art Reserve Design

From the above discussion of relevant ecological concepts, the following principles are derived to guide a state-of-the-art approach to the design of any protected natural area networks.
Representation.-- A hierarchical approach should be taken to representing biodiversity. The components of this hierarchy are:
   a) Major community types should be identified, and more than one example of each should be represented.
   b) Within each community type, coarse and fine filter analyses should be used to identify hot spots of diversity.
   c) Coarse filters, whenever possible, should be based on the use of several umbrella groups representing different taxa. The most important of these groups to use is plants.
   d) Fine filters should identify the locations of rare or endangered species, or species and areas requiring special attention.
   e) Disturbed lands should not be excluded from protected natural area networks if they are necessary to meet the design requirements.

Size.-- Core reserves, whose locations are determined by the use of coarse and fine filters should, in general, be large enough to sustain viable populations of all species represented. This should be accomplished by setting minimum reserve size criteria based on one or more the following estimates, in descending order of preference:
   a) Minimum Reserve Area for inclusion of native mammal species diversity;
   b) Minimum Dynamic Area to include an area several times larger than the largest expected disturbance in the reserve in the foreseeable future.
   c) Minimum Critical Area to conserve the minimum viable population of a single species with the largest area requirements.

Boundaries.
   a) Reserves should have biophysical boundaries.
   b) Core reserves – that meet the minimum area requirement – should be surrounded by one or more buffer zones to minimize negative transboundary effects.

Connections.
   a) Core reserves should be functionally connected by undisturbed corridors.
   b) The intervening landscape matrix should be managed as much as possible to provide a hospitable wildlife environment.

Nature’s Best? The OMNR Approach to Reserve Selection
The component of the Lands for Life initiative that deals with selection/expansion of protected areas is Nature’s Best Action Plan. Nature’s Best is OMNR’s plan to "preserve our wilderness, landscapes, and natural features for future generations" (Ontario Ministry of Natural Resources 1997a, 4). Specifically, the plan aims to "maintain the health of our ecosystem, [and] provide protection of habitat for wildlife..." by regulating identified areas, [and] establishing new parks and conservation reserves..." (Ontario Ministry of Natural Resources 1997a, 5).

Completing a GAP analysis for the planning area is recognized as being a central task to the Nature’s Best Action Plan. GAP analyses are being done in site districts across the planning area for submission to the round tables in each
of three sub-regions: Boreal West; Boreal East; and Great Lakes-St. Lawrence. It is not possible to predict all the considerations that will eventually determine the outcome of the Action Plan, but some form of GAP analysis appears to be the primary source of ecological work to inform the planned expansion of the parks and reserves network in Ontario. A review of the ecological foundations for any proposed system of protected areas is therefore afforded by a review of the GAP methodology itself. We had a draft copy of Natural Heritage Gap Analysis Methodologies Used by the Ontario Ministry of Natural Resources (Crins and Kor. 1997) at our disposal.

*Representation* There are two main components of the OMNR GAP analysis: the life science GAP analysis, and the earth science GAP analysis. The earth science GAP analysis is aimed at identifying and representing the physical features of the province's landscape that are most indicative of its past and present environments. These analyses assume that there is a relationship between 'earth science diversity' and 'life science diversity', so that 'earth science diversity' might be used as a surrogate for selecting areas significant also for 'life science diversity', though OMNR recognizes that it is not the intent of the earth science GAP analysis to identify, represent, or preserve any elements of biodiversity.

The life science GAP analysis used landform units – based on surficial and bedrock geology – for a coarse filter analysis, and vegetation types based on Forest Resource Inventory (FRI) maps for a fine filter analysis. Referring to these two sources of information as coarse and fine filter, respectively, is a misuse of these terms. Indeed, the fine filter referred to by OMNR is even coarser than what is typically referred to in the GAP analysis literature as coarse filter information. Even a coarse filter, conventionally defined, would also use distributions of at least some 'umbrella taxa' as potential indicators of total species diversity (but see above).

The OMNR methodology makes no explicit consideration of any species distributions. This is especially inappropriate given that data on species distributions of various taxa are currently available in Ontario from the Atlas of the Breeding Birds of Ontario, the Atlas of the Mammals of Ontario, the Ontario Butterfly Atlas, the Ontario Tree Atlas (still in preparation), the Ontario Herpetofaunal Atlas, and the Atlas of Rare Vascular Plants of Ontario. All of these atlases have extensive coverage of the Great Lakes-St. Lawrence planning region on 10X10 km² UTM (Universal Transverse Mercator) grid squares. Though coverage in the two boreal planning regions is generally much more sparse, information combined from these six sources would certainly provide much better information on the representation of species in proposed protected areas than is attainable with the OMNR's methodology. Even the Ontario Tree Atlas, more than a year from completion, has species composition data for over 200 10X10 km² UTM grid squares and over 2000 species records from the boreal planning regions combined.

OMNR recognized the importance of special features or species – that is, actual fine-filter information – within the stated selection criteria, and correctly observed that information on rare and endangered species in the boreal planning regions is sparse. Still, there is limited attempt to employ what data are available in geo-
coded format and amenable to such analyses. The use of these data would move the analysis away from the tenuous assumption that earth science and plant community diversity are sufficient surrogates for the actual information.

Disturbed lands were omitted early in the area selection process, though it was acknowledged that, in some cases, it would mean that relatively small areas would be selected. However, OMNR did suggest that restoration of some areas may lead to their inclusion in a reserve system later.

**Size.** OMNR stated that "[n]o assumptions about minimum size requirements [were made] *a priori*" (Crins and Kor 1997, 2). This, coupled with the stated minimum representation criterion of 50 ha suggests that no consideration of the size requirements for populations (MCAs), sustained disturbance regimes (MDAs), or intact mammal faunas (MRAs) were made.

If the new parks and conservation reserves established in 1997, as a first step in OMNR’s commitment to the long-term protection of land are any indication, then their methodology does not adequately address the issue of minimum size criteria. Though Wabakimi Provincial Park is impressively large, and in excess of MCA requirements for mammals, all others fall far below this minimum size criterion. If this trend is continued by the *Lands for Life* process, protected areas in Ontario will only represent a limited fraction of current natural diversity.

**Boundaries.** No mention of boundaries is made within the OMNR Gap analysis methodology. Most of the 27 new parks and conservation reserves established in 1997 do not have biotic boundaries despite attempts to realize this goal. Once again, the expanded Wabakimi Provincial Park is an exception to this rule. Borders were based on tertiary watershed boundaries and caribou movements, though in some cases adjustments had to be made due to land ownership issues, and human constructs such as railways.

OMNR stated that, despite current debates regarding biological integrity in the discipline of conservation biology, the methodologies described by their report serve to identify core areas only and that the selection of areas must be done within the existing policies and principles. Interestingly however, though hunting, bait-fishing, and ecotourism are prohibited within the boundaries of the old Wabakimi Provincial Park, they are permitted within the park expansion – and within other new Conservation Reserves. Similarly, within the boundaries of the whole of Algonquin Provincial Park, there exist what amount to areas zoned as effectively core, wilderness reserves and other natural environment areas where controlled logging takes place. Insofar as evidence indicates that Algonquin Park appears large enough to have ‘absorbed’ the local-scale effects of these activities on the integrity of the park as a whole, parks like Algonquin and Wabakimi may serve as valuable models for the establishment of future large protected areas, especially if the alternative is less total land under protection. At any rate, the need for buffers to address boundary issues appears to be able to be well met within current OMNR policies.

**Connections.** There are no designated connections between any provincial parks, at any scale, and no mention of connectivity within the GAP analysis methodology for area selection.
OMNR advised that "resource management activities on intervening lands must be conducted in a manner that does not compromise the values of these core areas, thereby contributing to the ecological stability of these core areas as well as of the landscape as a whole" (Crins and Kor 1997, 2). This thinking may go a long way to ensuring a hospitable landscape matrix for wildlife, however, it remains to be seen how and to what extent this goal will be accomplished.

**Recommendations for Nature's Best Action Plan**

The following recommendations derive from the foregoing critique of the Nature’s Best Action Plan based on OMNR life science GAP analysis methodology and the example set by the 27 new parks and conservation reserves in the province:

1. Redo coarse filter analyses for identifying hot spots of species diversity using as many taxa as possible from the list of atlases described above in the section critiquing representation under the action plan. Groups of species within taxa rather than individual species should be used for this purpose. A preference should be given to the use of woody plants as an ‘umbrella taxon’. Evaluate the current assumption that ‘earth science diversity’ and ‘life science diversity’, delimited presently only by plant community types, are surrogates for evaluating gaps in the distribution of diversity of the many other groups of organisms.

2. Superimpose on the hot spots identified by the coarse filter analysis described above, protected core areas that meet an ecologically-justifiable minimum size criterion. This should be the lower limit of the confidence interval of the estimated MRA for mammals (200,000 ha). The minimum size for at least one protected area in every ecoregion should be based on the estimated MRA for mammals (500,000 ha) of which 200,000 ha could be the core area, and 300,000 ha could be lower-intensity use Conservation Reserves (see 4 below).

3. Areas included in reserves selected by this routine, if previously disturbed, should not be automatically excluded from a protected area network. Nor should they be excluded if they are required to meet adequate boundary or connection requirements.

4. Ensure natural boundaries to parks, and include at least one buffer zone (see 2 above) between the core reserve and the surrounding landscape matrix. Explore the idea of using Conservation Reserves around Provincial Parks in order to accomplish this objective within current OMNR policies.

5. Ensure that protected areas are connected to each other to the greatest possible extent.

6. Monitor the results of the established protected natural area network in terms of population persistence of species, and be flexible to change the network based on these observations.

7. Conduct research to understand the characteristics of a hospitable landscape matrix, and endeavour to achieve this matrix, perhaps through existing policy and law particularly regarding the practice of forestry in Ontario, to emulate natural disturbances.
Acknowledgements

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References:

Crins, W.J. and P.S.G. Kor. 1997. Natural Heritage Gap Analysis Methodologies used by the Ontario Ministry of Natural Resources (Draft). Ontario Ministry of Natural Resources, Lands and Natural Heritage Branch, Natural Heritage Section, Peterborough, ON


Response to Nudds et al. on: Protected Area Networks: Assessment of Ontario's ‘Nature's Best’ Action Plan and Recommendations

William J. Crins and Philip S.G. Kor
Ontario Ministry of Natural Resources
Natural Heritage Section, Peterborough, Ontario K9J 8M5

Several comments and questions have been raised in articles within these proceedings regarding the gap analysis approach used by the Ontario Ministry of Natural Resources. Some of these focus on the appropriateness of the data layers used at various steps in the analysis, the adequacy of representation achieved using the method, and the relationship between life science and earth science gap analysis. Although some of these questions and comments would require fuller responses than can be provided here, a few points should be reiterated about the methodologies presented above.

We agree philosophically with many of the points made by Nudds et al. However, it should be clear to all who conduct gap analyses that there are nearly as many differences in the details of how such analyses are conducted as there are jurisdictions and practitioners that are conducting them. There are commonalities in the general approach; i.e., coarse and (usually) fine filters of various sorts are applied to a set of natural heritage target features, and those features that are not yet protected are proposed for protection in new areas, according to a set of selection criteria. The variation in approach often is dependent on the features to be protected (targets), as well as the data sets available for analysis.

We state explicitly that the representation targets for life science gap analysis are the landform/vegetation features of each Site District within the province. We also state that the methodology is consistent with existing policies and approaches relating to representation. This is not to say that there are not other legitimate approaches. However, in Ontario, the representation focus has been on landform/vegetation features, rather than on species. The approach that has been described here for use in a GIS environment follows from the earlier work in the province, but makes the earlier approach more explicit, rigorous, and repeatable. Thus, given similar data sets, different practitioners could arrive at similar results.

It must also be recalled that the methodologies described here focus on core representative areas only. Nowhere has it been implied that these core areas are sufficient by themselves to complete a protected areas system. In fact, at a minimum, following identification, the core representative areas must be bounded by ecologically defined boundaries, as noted under the discussion of the Ecological Considerations selection criterion. In addition, where Special Features occur in close proximity to the core representative values, they also should be incorporated into the protected area boundaries. The combination of representative areas with the parks class targets and standards results in an array of protected areas within each Site District, some of which are large and some of which are smaller. This was the approach used in the “Lands for Life” project. Thus, the larger protected areas accomplish many of the goals and
principles expressed by Nudds et al. (perhaps even including representation of vertebrate faunas, although this requires examination of additional Site Regions), in addition to representation of the expressed landform/vegetation targets, while the smaller ones fill in the representation gaps.

It should also be noted that there are two distinct approaches to representation used by the OMNR. These are the life science and earth science approaches. The representation targets for these two approaches are entirely different, as described in the above paper. The results from the two types of analyses are complementary; one does not supercede the other, nor does the earth science analysis form the starting point for the life science analysis. The life science analysis includes a landform component, and when the best example of a given earth science theme element coincides with a landform type that is used in the coarse filter of the life science method, then there is a chance that both earth science and life science targets can be met in the same representative area. Otherwise, the two methods are independent, and sets of areas representing earth science and life science features are put forward for protection. Ontario is one of very few jurisdictions that explicitly protects earth science features in addition, and complementary, to life science features.
Natural Heritage Gap Analysis Methodologies Used by the Ontario Ministry of Natural Resources∗

William J. Crins and Philip S.G. Kor
Ontario Ministry of Natural Resources
Natural Heritage Section, Peterborough, Ontario K9J 8M5

Preamble:
The following draft of a paper dealing with gap analysis methodologies used by the Ontario Ministry of Natural Resources for life science and earth science features was the version of this paper available to authors of other papers in this volume (e.g., Nudds et al., Riley). For the sake of context and reference, it was felt by the editors that this version of the gap analysis paper should be published in these proceedings. It should be noted that it is the intent of OMNR to publish a more complete and revised version of this paper as a technical bulletin in the near future. The methodologies will remain relatively unchanged, since these were the methodologies used to identify core representative areas in the "Lands for Life" planning project, but the sections on limitations and assumptions will be greatly enhanced. [December 2, 1998]

Introduction
The goal of the Natural Heritage Areas Program is "to establish a system of protected natural heritage areas, representing the full spectrum of the province's natural features and ecosystems" (OMNR, 1997). For life science features, this is accomplished on a Site District basis, through an assessment of the landform/vegetation complexes in that Site District, and the selection of the set of areas that best meets a set of five selection criteria. For earth science features, the goal is accomplished through the development of environmental themes identified by the record of Earth history in the rocks, landforms and geological processes, both past and present, of Ontario. The best representatives of the life science and earth science features are denoted as provincially significant. Protective zoning designations in Provincial Parks (Wilderness, Nature Reserve, and Natural Environment zones), Conservation Reserves, and Areas of Natural and Scientific Interest (ANSIs), taken together, provide the mechanisms by which the natural heritage features of each Site District or earth science theme are represented and protected. The focus in site selection is on the best representation of the natural diversity of the Site District or earth science theme. In the case of life science values, both living and non-living components must be assessed; hence, the setting of representation targets is based on combinations of landforms and vegetation.

Gap analysis, in the conservation biology context, refers to an approach (or a set of methodologies) for setting and filling natural heritage targets. It facilitates the identification of features that are un-represented or under-represented within a natural heritage areas system. Different approaches have been used in different jurisdictions, but the underlying premise is common to all approaches: natural

∗ Draft Manuscript, August 1997
heritage features are assessed to determine whether or not some of those features require conservation.

The primary objective of life science gap analysis is the identification of the best representative areas that together contain the full array of natural landform/vegetation associations of a Site District. The selection of the representative areas must be conducted using as rigorous and objective an approach as is possible with qualitative or semi-quantitative site selection criteria. The purpose of this document is to outline the current gap analysis methodologies employed in Ontario, and to outline the application of the five site selection criteria.

While being cognizant of the current debates in the conservation biology community with regard to biological integrity, the selection of areas must be accomplished within the scope of existing policies and principles. The methodologies described here serve to identify core representative areas only, in as efficient a manner as possible. Resource management activities on the intervening lands must be conducted in a manner that does not compromise the values of these core areas, thereby contributing to the ecological sustainability of these core areas as well as of the landbase as a whole.

The objective of selecting the best representative sites carries with it the need to identify parts of the landscape that have been subject to limited recent human disturbance. The objective of identifying the best remaining examples of each landform/vegetation complex in a Site District means that, on occasion, relatively small remnants will be identified, although in other cases, large aggregations or assemblages of features will occur together. No assumptions about minimum size requirements have been applied a priori. Rather, the methodologies focus on the identification of the best examples of what exists. Restoration of areas, and other conservation biology objectives, potentially could be added to the system at some later date, if deemed necessary, but to avoid arbitrariness in site selection, the search for sites begins with the undisturbed and least disturbed areas.

**Life Science Gap Analysis**

Most gap analysis projects that have been conducted in various parts of the world have focused on life science features, and in particular, species and habitat representation. Almost all jurisdictions applying gap analysis have used a broad landform template, and some have superimposed habitat or vegetation onto the landform template. Most of the variation in approach occurs in the template on which natural heritage features will be assessed (landforms, soils, vegetation types, species, geographic units, etc.), in the resolution of the targets, and in the determination of adequacy of present conservation of the natural heritage values. The approach used by the OMNR is outlined below. Basically, the life science gap analysis method consists of four steps:

1. Coarse filter - landform units (enduring features)
2. Fine filter - vegetation response to landform
3. Assessment of existing representation
4. Identification of areas to fill the gaps.
General Approach for Life Science Gap Analysis

OMNR's gap analysis method consists of four steps:

- Identifying landform features
- Identifying vegetation features on each landform unit
- Assessing existing representation
- Identifying the gaps

Step 1: Coarse filter - landform units (enduring features)

For the ecological district being studied (in Ontario, the Site District is the unit of study), available landform maps are examined. Surficial geology, bedrock geology, and combinations of these themes, can be used to delineate the landform patterns of the district. Mapping at a scale of 1:250000 is suitable for analysis at the Site District scale. Sources such as the biophysiographic mapping produced by Noble (e.g., 1982, 1983) have been used in central Ontario. They were produced through interpretation of surficial geology, the biophysiographic units essentially consisting of aggregations and/or refinements of Ontario Land Inventory (OLI) units, taking account of mode of deposition, major and minor overburden, and raggedness or irregularity of the terrain. These maps are similar conceptually to the physiographic mapping produced by Chapman and Putnam for southern Ontario (1984), although produced at a somewhat finer scale.

All landform units within the Site District are tabulated in this first step of the method. The finest level of resolution in Noble’s biophysiographic unit classification system is used (i.e., la-1 and la-4 are considered to be different biophysiographic (landform units).

OLI units may also be suitable for use at this stage of the analysis, but may require some preliminary aggregation of units, to make them comparable to Noble’s units. All landform units recognizable at 1:250000 scale within the study area are tabulated and mapped in this step. Other alternative landform systems could include Chapman and Putnam's system for the south, a combination of the bedrock geology and surficial geology coverages produced by the Ontario Geological Survey, or the Northern Ontario Engineering Geology Terrain Study (NOEGTS) coverage in the north. However, some of these coverages are at a coarser scale than OLI or Noble's coverages, and less preferable.

Step 2: Fine filter - vegetation response to landform

Using available databases, reports, and literature, the natural vegetation types known to occur within the Site District are summarized, and are correlated with the landforms examined in Step 1. This may be accomplished by manual overlays of the landform units with vegetation mapping [e.g., Forest Resource Inventory (FRI) maps or classified LANDSAT imagery]. However, ideally, gap analysis should be conducted in a Geographic Information System (GIS) environment, where large data sets can be overlaid, analyzed and summarized much more efficiently. In section 2.5 of this document, a step-wise analytical procedure is described for the completion of gap analysis in a GIS environment.

Overlaying the landforms and vegetation types results in tabular and cartographic outputs for each landform/vegetation unit created within the study area. Summary statistics for each vegetation type and age class on each landform unit will be produced in matrix form.
In all cases involving the use of FRI data as the vegetation coverage, the codes representing rock outcrops, lakes, and wetland types will serve as a coarse classification system for non-forest vegetation types.

Step 3: Assessing existing representation
Examination of landform/vegetation complexes in existing protected areas (including protective zones within Provincial Parks (e.g., Wilderness, Nature Reserve, Natural Environment), National Parks, and other land designations (ANSIs, Conservation Reserves, etc.) is undertaken to determine which landform/vegetation features are currently protected. Only those areas regulated specifically for natural heritage protection are factored in to the assessment of existing representation.

The landform/vegetation features occurring within existing protected areas are compared with the landform/vegetation features found in the Site District as a whole (Step 2, above). The comparison of existing and expected vegetation types, for each landform, yields the representation targets, and identifies the gaps that still require representation in the natural heritage areas system. In the GIS version of gap analysis, guidelines are applied to ensure that features contained within inappropriate park classes or zones are not considered to be represented. These guidelines do not address the question of adequacy of representation, but simply provide a means of excluding features from Recreation and Historical Parks that might otherwise be factored into the existing representation calculations. In the manual version of the method, these classes of parks would be ignored when considering existing protection.

Step 4: Filling the gaps
Landform/vegetation features that are not yet represented in the natural heritage areas system serve as the focus for the search for new areas to fill those gaps. The focus of the method is to identify suitable sites to fill the representation gaps. Selection criteria for new sites conform to those used in existing MNR natural heritage programs (Parks systems planning, ANSI program). These include: representation (the basis for gap analysis, including broad age-class representation of forest types), diversity (the number of different vegetation or landform/vegetation features within a given area), condition (the degree to which anthropogenic disturbance has occurred), ecological considerations (e.g., local hydrological/watershed functions), and special features (presence of populations of vulnerable, threatened, and endangered species, localized or unusual features). The application of these five selection criteria allows for the assignment of relative significance levels to each example of the un-represented features (e.g., provincial, regional, or local significance), taking into account the surrounding landscape (other adjacent un-represented features, nearby special features, hydrological characteristics, etc.).

FRI or LANDSAT databases and landform maps serve as the background in which the search for un-represented features occurs. Previous disturbance of the landbase by human influences (logging, mining, road-building, hydro development, agriculture, settlement) reduces the value of certain portions of the landbase for the achievement of natural heritage representation targets. Thus, such disturbances are taken into account in the search for areas to represent required features. MNR District/Area Offices should be canvassed for cut-over
maps and other information relevant to the determination of impacts on the landbase.

The entire Site District is scanned for potential representative areas. On each landform (biophysiological) unit, each area that is still relatively intact, in the sense that it does not contain extensive cut-overs, road networks, or other developments, is compared with respect to the forest types (working groups) that it contains. An assessment of diversity within a block is made on the basis of the number of working groups, since no other site-specific measures of diversity generally are available. Other parameters relevant to the five selection criteria also are assessed, including juxtaposition with high-quality (relatively undisturbed) blocks of other landforms or existing protected areas, size, and special features. In the case of special features, since very little information is available on these, the criterion often cannot be applied with any rigor, but when information is available, it should be used.

The final result of the gap analysis will be a set of provincially significant areas that, taken together, provide the best representation of the array of landform/vegetation associations known to occur in the Site District. It will also identify additional sites that fulfill all or some of the selection criteria, but that are not deemed to be the best representatives. These sites would be assigned lower levels of significance (regionally or locally significant).

**Site Selection Criteria**

Five site selection criteria are employed to assist in the determination and delineation of provincially significant sites. These are: 1) representation, 2) condition, 3) diversity, 4) ecological considerations, and 5) special features.

1) **Representation**

The most important selection criterion is representation, since the entire natural heritage areas system is based on the principle that the areas containing the best representatives of each landform/vegetation complex are to be conserved. If an area does not contain a high-quality example of at least one landform/vegetation feature, then it should not be considered further, in this context. However, determination of the best representative examples may require comparisons among several potential alternatives, and this is where the additional selection criteria become necessary.

Ontario's approach to life science gap analysis can be considered to be a 'feature-representation' approach. An alternative view of representation, that of proportional representation of landscape features, is not applied in the OMNR's methodology. Firstly, this concept is inconsistent with the existing systematic approach for identifying natural heritage areas in Ontario. Secondly, the determination of an appropriate percentage of any given feature to be represented in a system is an arbitrary process. Thirdly, a given percentage may prove to be more than adequate for some features, and inadequate for others. Thus, a method that attempts to represent the best examples of all features is more likely to capture the full array of values than the application of a percentage target. The application of a standard percentage ignores the reality that some landscapes are more diverse than others, and that the land use history differs among landscapes or landform units. As Harris (1984, p. 109) notes "... the
question of how much is enough can only be fairly addressed in the context of surrounding forest conditions."

2) Condition
In the gap analysis method described above, the landbase under consideration for contribution to representation is screened by considering existing and past land uses (but not proposed future uses), including cut-overs, road networks, mining areas, and other unnatural corridors (hydrolines, railways, etc.). In effect, condition, or the degree of anthropogenic disturbance, has already been used as a selection criterion at this point. Potential sites for consideration as natural heritage areas are screened early in the selection process for their relative condition or quality.

Sites that remain under consideration after this criterion has been applied must then be compared using the remaining three criteria. Because there is often a lack of information about special features (populations of rare, threatened, or endangered species, unusual or localized geological features or habitats, etc.), especially on the Precambrian Shield, the special features criterion is best used as a supplementary or supportive one. Thus, all else being equal with regard to representation and condition, the diversity and ecological considerations criteria can be used to determine which of several sites should be regarded as the best site for a given feature or set of features.

3) Diversity
A site is considered to be more diverse than another if it contains more high-quality, representative features. Diversity can be achieved at several scales. However, in a landscape (Site District)-scale gap analysis, assessments of diversity should be made at the landform and vegetation community scales, rather than at the species scale. In most cases, species richness is unknown in these sites anyway. Thus, a site that straddles several landform units will be more diverse than a site that is entirely confined to one unit. If the sites being compared are all situated on a single unit, then, again all else being equal, the site with the greatest range of vegetation types would be preferred. If information sources permit (e.g., FRI data), age-classes within vegetation types also are considered in the assessment of relative diversity. This should be done with broad age-class ranges (young, medium, old), defined for each forest vegetation type (classed as working groups in the FRI database) [see Table 1].

Unfortunately, most databases available for use in life science gap analysis in Ontario do not do an adequate job of classifying non-forested vegetation types. Nevertheless, an attempt should also be made to consider rock outcrops, shorelines, non-treed wetlands and other non-forested vegetation types in the assessment of diversity, even if only broad categories and presence/absence can be determined.

4) Ecological Considerations
Ecological considerations relate to such attributes as hydrological function, and connectivity (aquatic and terrestrial). An area that provides connections with other nearby significant areas, or an area that contains headwater lakes, ponds, springs, or streams, will fulfil this criterion. Other limiting components of habitat, such as important moose aquatic feeding areas, bat hibernacula, spawning beds, etc., could also fulfil this criterion.
These features are used to refine boundaries where they occur in close proximity to the core representative areas.

5) Special Features
Special features include populations of rare, threatened, or endangered species, and unusual or localized geological features or habitats. Some parts of Ontario are extremely rich in such information (e.g., southwestern Ontario). However, in other areas, there is a lack of information. This lack of information may be due to difficulty of access or limited survey effort, rather than an actual absence of these features. Therefore, this criterion is best used in a supplementary or supportive role. Areas should not necessarily be penalized or downgraded if they lack special features, unless areas against which they are being compared do contain known special features.

Assumptions
The life science gap analysis described here requires several assumptions:
- due to limitations of data sets (see sect. 2.4) assumptions about non-forested vegetation types are required (rock outcrops, wetland types, meadows, etc.);
- least disturbed is best;
- disturbed areas generally excluded from site boundaries;
- intervening land management; and,
- intervening land provides ecological functions which reduce 'island' effect.

Limitations
Two data sets have potential applicability for the vegetation component of life science gap analysis. These are classified LANDSAT TM imagery, and the Forest Resource Inventory (FRI). Each has advantages and disadvantages. The current classified LANDSAT data set does not provide adequate resolution of most vegetation types. For example, it is not possible to distinguish between spruces, or between intolerant hardwoods, nor is it possible to distinguish between ecotypes of a particular species (e.g., upland versus lowland Black Spruce). This is possible to some degree with FRI, by examining the stand composition, and understanding the ecological preferences of the species associated with Black Spruce. Both LANDSAT and FRI data sets do not classify non-forested lands adequately. However, the FRI does contain general categories for rock outcrops and various lake and wetland types. Thus, it is necessary to make some assumptions about non-forested vegetation communities that may be included within the sites recommended for protection in gap analyses using these data sources.

Ideally, gap analysis should be conducted with proper spatial analytical tools, such as a Geographic Information System (GIS). Manual analysis of data sets is possible, and has been employed in the absence of the necessary digital data sets, but it is extremely time-consuming and inefficient. However, even with GIS, the size of some of the data sets to be analyzed, especially for the larger Site Districts, can stretch the capabilities of the existing technology.
Up-to-date forest history data (cut-overs, roads, etc.) often exist only in paper (not in digital) form, although some data are available in the LANDSAT and FRI data sets. Often, it is necessary to update disturbance coverages by digitizing the newer information, and by vetting the results of gap analyses with knowledgeable staff from the district and area offices. It may be necessary to revise the boundaries of proposed protected areas in the light of these additional disturbance data.

It is also possible that boundary revisions may be warranted at such time as site-specific inventories are conducted, or as information becomes available, either from staff or from members of the public who may visit these sites.

Since gap analysis is extensive, dealing with large land bases, field inventories likely will be limited. However, the results of gap analyses will always benefit from field visits to the sites, even if these occur at some time after the analyses are completed, for the purposes of confirming the results, providing additional details on the vegetation communities of the sites (particularly with regard to understorey species and non-forested communities), refining boundaries, and acquiring data on special features.

Most of the information on populations of rare, threatened, or endangered species is found in OMNR files, and most of it relates to a few "featured species", such as Bald Eagle. Virtually nothing is known of the botany of large portions of the province.

Additional Limitations:
- roads layer limitations
- parks layer limitations

**Step-wise Methodology for Life Science Gap Analysis**

This section outlines an algorithm for data analysis which will lead to the identification of the best representative core areas that, taken together, will contain the full set of landform/vegetation features found in a given Site District.

**Part 1: Assessment of unrepresented features, and options for filling gaps:**
- For each Site District, overlay landform and vegetation layers
- Summarize proportions and amounts of each landform unit within the Site District (output = table);
- Summarize proportions and amounts of each FRI Working Group by three broad age classes, as per specifications, on each landform unit (output = table); each Working Group age class equals a vegetation type;
- Overlay existing Protected Areas layer
- Summarize proportions and amounts of landform/vegetation types for existing protected areas (output = table)
- Subtract landform/vegetation types found in protected areas from total set of landform/vegetation types in Site District; produce table of unprotected types

Rules for determining minimum levels of representation in protected areas:
1. At least 50 ha of any landform/vegetation feature must be contained within a protected area in order to be considered represented, at this stage in the analysis

2. At least 1% of each landform/vegetation feature must be represented contained within protected areas in order to be considered represented, at this stage in the analysis

- Overlay disturbance layers for Site District
- Remove disturbed areas from Site District land base
- Identify all areas having unprotected landform/vegetation types (polygons), subject to the minimum adequacy rules applied above
- If there are landform/vegetation types within the Site District that do not occur in undisturbed areas, re-examine the disturbed landbase for those types; examination of the disturbed areas may occur in a step-wise manner until suitable polygons are found
- Delineate clusters of contiguous unprotected landform/vegetation polygons, including single polygons
- Tabulate and sum the number of polygon types in each cluster; produce a table summarizing the numbers, types and sizes of polygons for each cluster
- Overlay Special Features data, where available, for the Site District
- Produce a map of clusters, using the above layers, including labels in hard copy and digital formats, and categorize the clusters on the map according to the number of un-represented features contained in them - the digital file will be the plot file used to create the hard copy map

Part 2: Identification of "best" representative areas

Using an iterative approach, identify those clusters that, together, best represent the features not yet represented in protected areas within the Site District. This will be accomplished by searching for the clusters that contain the most un-represented landform/vegetation features, subject to the minimum representation rules noted above.

- Select the cluster identified in Part 1 that contains the most un-represented landform/vegetation features, subject to the minimum representation rules used above (50 ha and 1%);
- subtract the features contained therein from the list of un-represented features in the Site District;
- Select the next cluster identified in Part 1 that contains the most un-represented landform/vegetation features from the revised list, subject to the minimum representation rules used above (50 ha and 1%);
- subtract the features contained therein from the revised list of un-represented features in the Site District;
- Continue this iterative analysis until all landform/vegetation features are represented in a set of areas.
- Re-do the above iterative analysis, using the clusters that contain the second largest set of un-represented features, assuming that the sites containing the most un-represented features cannot be protected (development of planning scenarios)
- Re-do the above analysis, using the clusters that contain the third largest set of un-represented features (these three levels of diversity would correspond roughly to Provincially, Regionally, and Locally significant sites).
Earth Science Gap Analysis

Introduction
The earth sciences encompass a range of interconnected but quite distinct subdisciplines which together help to explain how the Earth formed and changed through time, at depth and at the surface. Earth heritage conservation is concerned with the maintenance of landforms, natural and artificial exposures of rocks, and sites where geological processes can be seen in action today.

The primary objective of the earth science gap analysis process is the identification of the representative features of the province's physical landscape that best define its past and present environments. These environments are interpreted through scientific study of the rock record, the surface morphology of the province, and geologic processes active in the province today.

Geological history as interpreted from observations from rocks, unconsolidated sediments and landforms consists of three fundamental components: time, stratigraphy and environment. Earth science representation thus attempts not only to identify an example of all the known geological features in the province (bedrock units, landforms and geological processes), but to identify the march of time as defined by these geological features (lithostratigraphy, biostratigraphy, morphostratigraphy). Thus earth science representation requires protection of the elements of the physical makeup of the province, as well as geologic time as defined by complexes of the physical features of the province.

In the bedrock record, this means finding one best representative example of each lithological unit through the full range of lithological units that we know to occur in the rock record (this is classification by physical feature). It also means identifying examples of each lithological unit as it represents a particular time event or environment within the sequence of events in the geologic time scale (this is classification by time). A similar approach is required for the representation of landforms, which, in Ontario, are predominantly glacial in origin. Representation targets will consist of the identification of the best examples of each landform (and its derivatives) as individual features (i.e., esker, moraine, drumlin, kame, et cetera), as representatives of a process of formation (beneath the glacier, at the ice front, at the edge of a lake, et cetera), and in their significance to the glacial history of the province.

Also required is feature representation tied to geologic events in time within each environmental theme. Representation of the best examples of the major elements of each theme will therefore ensure representation of examples of each type of landform feature, as well as representation of the formation of the landscape through time. This inevitably results in feature duplication.

What constitutes "best", as in the "best example" of a geological feature? By virtue of its location, history, et cetera, each outcrop and landform may be considered unique. Depending on the level of research and study of the geology of a specific region, each unit or feature may have several known, and some or many unknown, exposures or occurrences. Thus the "best example" of a geological element is chosen first from one that is known to occur, and second, one which adequately displays a range of typical characteristics by which the
element is recognized. Such a best example is often chosen by the consensus of many geoscientists, as reflected by its use in the literature, in field trip guidebooks and by the academic community. Other best examples will be determined through a literature search and field work by an individual earth science surveyor after he/she has been directed to sites by the above sources.

The geologic record in Ontario has been classified into 43 environmental themes, each of which represents a particular and discrete environment of formation. The elements of each of these themes, that is, the features which serve to characterize the environment which identifies each theme, make up the representational targets of the gap analysis process.

**The Gap Analysis Process**

Earth science (geological) conservation concerns the protection of selected, representative features of the geological history and its physical expression in a system of protected areas, and the monitoring of the remainder of the physical land base to provide alternate sites for scientific and educational opportunities.

In order to determine what is important to be set aside it is necessary to describe the earth science diversity of the land base and to determine the minimum portion of that diversity that has to be set aside for representation purposes.

The classification of earth science diversity is based on concepts of time, geomorphic form and process. It is essential to represent at least one best example of each geological feature in the province, be it a rock type, fossil locality, landform or geologic process. It is equally essential to represent the changing environments that occurred in the province through geologic time by representing a sample of each individual event exhibited in the rock record or by landforms.

For the purposes of representation, earth science diversity in Ontario is classified into 43 *environmental themes*. Each environmental theme contains the evidence for an event, a sequence of events or a geological process. The features which make up this evidence are referred to as the elements of a theme. Elements might consist of rock types (lithostratigraphy), organic remains (fossil record), rock-time units (formations, members), landforms, landform associations or particular geological processes (active or ancient). The basis of the environmental themes as used in Ontario are broadly defined and described in the *Earth Science Framework* (Davidson 1981).

The scale of representation of the elements of an environmental theme varies considerably. Individual bedrock outcrops may need to be only very small, less than 1 hectare in size. Individual landforms and some process themes need only be a few 10s of hectares in size. Large associations of landforms may require many 100s of hectares to adequately represent the features within them. The representation of active geological processes often encompass large areas, sometimes including the management of areas beyond the process area in order to assure the continued natural functioning of that process.

Earth science classification is not comparable to life science classification systems. However, the cornerstone of biodiversity conservation is the identification and classification of the physical substrate of the land base. With
complete representation of the physical diversity of an area comes significant completion of biodiversity targets. In this way, earth science and life science goals are connected.

The methodology of determining the best candidate area for representing the diversity within an environmental theme is called "gap analysis" because it determines what is already represented in a system of protected areas, and the "gaps" that exist in representation of that diversity. The process is normally carried out in two phases: a broad analysis of the possible representational targets of a theme (steps 1-4), and a subsequent detailed inventory of specific features and locales required to complete representation (step 5). These steps are summarized:

- Step 1: Identification of significant elements of a theme;
- Step 2: Distribution mapping of the significant elements;
- Step 3: Existing representation within protected areas;
- Step 4: Identification of gaps of features not in protected areas;
- Step 5: Comparison of selected sites required to fill the gaps.

**Step 1: Identification of significant elements of a theme—Representation targets**
For the selected environmental theme, this step identifies the significant elements that make up the theme. Included in this step is the identification of the complexity of the theme, including the variations that may exist in the significant features. This is done through literature review, discussion with experts and original field work. The suite of elements identified in this step constitute the representation targets of the theme.

**Step 2: Distribution mapping of the significant elements**
The second step requires spatial mapping of all elements of the selected theme. This is done from geology maps, literature review and discussion with experts. The scale and complexity of features that make up each theme is dependant on the state of knowledge about its component geology and distribution. Some environmental themes consist of only a few known occurrences of features, whereas others encompass a large portion of the province and constitute many features.

**Step 3: Existing representation within protected areas:**
The next step is the identification of the elements of the theme that already occur in protected areas (provincial parks, conservation reserves, ANS1s). For an element to be considered represented, it must be provincially significant, and it must be protected by appropriate park class or zoning, or have relative protection outside parks through landowner agreements or the relative stability of non-destructive present land uses. This step involves literature review (especially of earth science inventories of parks and checklists of all other sites), original field work and discussion with experts.

**Step 4: Identification of gaps of features not in protected areas**
Elements of the environmental theme that are not considered already protected constitute the gaps in representation that require filling. In this step, the identification of potential candidate sites where the un-represented elements of the theme are found is conducted. This is done through literature review, discussion with experts and, to some extent, original field work. A gross filtering occurs at this stage to remove sites that have a history of disturbance (primarily...
for the glacial, landform and process themes). Disturbance consists of any activity which has altered or removed a feature from its natural state. This stage does not generally apply to bedrock features, which are commonly best displayed in highly altered sites such as road cuts and quarries.

**Step 5: Comparison of selected sites required to fill the gaps:**
A comparison of like elements from the list produced in Step 4 is the next step in the process. The list of priority sites for protection is achieved with the application of a set of six primary criteria which are applied to each site. These criteria are: representation, type sections (including reference sections, type morphologies, type localities), diversity, integrity (condition), life science values and special values. These are described in more detail in the following section of the report. The comparison stage is accomplished through original field work in order that the most up-to-date site conditions (quality, integrity, condition) are recorded.

The end result of the gap analysis process is the selection of a suite of sites that best complete the representation of the selected environmental theme. These are ranked provincially significant within the context of the theme.

The minimum requirement of a system of protected earth science features is to represent the complete suite of elements that define each of the 43 environmental themes in Ontario. This "one of each" approach represents the minimum "line" required to achieve complete representation. This approach is not ideal in that it fails to provide for unforeseen events which may negatively impact this minimum. It also fails to provide the flexibility needed in a fluid science in which concepts and associated significant sites can change with time. In a large province like Ontario, there is also a need to provide for the protection of sites of regional and local significance for the benefit of scientific study and educational opportunities. These sites also serve as a back-up to the provincially significant sites in case of mishaps. As such, in addition to the provincially significant sites, a suite of regionally and locally significant sites should be identified and protected.

The attached flow chart summarizes the steps discussed in this report.

**Selection Criteria for Choosing Significant Sites**
The following site selection criteria may be used to assist in the determination and ranking of earth science features. Due to the nature of very different types of earth science features, the application of the criteria will vary on a per site basis.

**Representation:**
The primary criterion for choosing earth science features is representation. Representation refers to a feature that best displays its make-up and its condition(s) of formation. A representative feature of the geological record can be thought of as one that is typical, or normal, or one that shows "classical" elements of the feature. In the context of features exposed in bedrock outcrop, representation refers to the best available (or known) examples of each type of lithological unit (rock type) that occurs in a given area, as well as examples of each geological time unit as exhibited in the rock record (chronostratigraphy). In order to achieve chronostratigraphic representation the best example of some units may be less-than-ideal because the only known examples are of poor quality or have been disturbed. In these cases,
representation will still be sought in order to satisfy the representation of geologic time in the physical record.

In the landscape perspective, representation is also applied to both the physical form of a selected feature, and the morphostratigraphy (change with time) of a theme. Representation of the physical form of a feature should best display an "ideal" morphology or the best example of the deviation from the "ideal" form. Morphostratigraphy refers to representation of like features as they relate to events and time through the geologic record (e.g., an ice retreat phase of a glacial theme will produce similar features at several stages in its history; all of these may require representation).

Representation also refers to the range of features that identifies a geologic event or process, both active today and in the rock and landform record through time. It seeks to identify the best example of each element of the 8 landform/process themes that are considered essential to its identification.

Type Sections: Type sections provide standard definitions for all representative lithostratigraphic and biostratigraphic units. In simple terms, type sections represent the sites where rock units were first identified, described and formally named. They are the localities against which all other occurrences of the unit are generally compared. Type sections are generally of the highest scientific value, and may also have historical value as locations where the geology of a region was first described and ranked. In Ontario, type sections are only applied to stratified rocks with sedimentary and volcanic layers which have been only slightly altered by metamorphism.

Related features such as reference sections and type localities represent units for which a type section has yet to be defined. This situation is common in central Ontario, where type sections have not been formalized for most of the Paleozoic stratigraphy of Manitoulin Island (most correlative units have type sections described on the Ontario mainland), or for the sedimentary units of the Huronian Supergroup. Reference sections may also be identified to supplement the type section by representing some variation or additional feature(s) of the original.

The primary elements of the surficial geology of a region are defined by its stratigraphic makeup (morphostratigraphy) and type and pattern of landforms (type morphology). These have not been used in either a formal or consistent manner. In Ontario, and particularly in central Ontario, these classifications are not well developed, and are not used to define representational values.

Diversity: A feature or site that incorporates more than one element of the identified geologic unit (i.e., an outcrop of a unit formation that exhibits its range of lithologies and its contact relations with adjacent units), or incorporates an association of features (such as a glacial landscape of drumlins, eskers and meltwater channels), usually in an area more compact than several separate areas, will be ranked more favourably than a collection of individual sites.

Integrity: Integrity refers to the wholeness or completeness of a geological feature, and the lack of significant external impacts or alteration by natural or man-induced activities on its form. This applies particularly to landforms, where
morphological completeness may be required for their adequate definition. Examples of landforms for which complete morphological representation is desirable are usually relatively small and discrete (e.g., drumlins, perched deltas, aeolian dunes, landslides and their ancient scars, et cetera).

Very large landform features require a different approach. Their size generally prohibits representation of a complete feature or association of features. This applies to features with extensive linear elements and those with broad areal extent. Examples of linear geological features include bedrock faults and shear zones, glacial features such as meltwater channels, end moraines, eskers and raised shorelines, and geomorphological elements such as bedrock escarpments and riverine environments. Features with a broad areal extent include bedrock domes, glacial features such as ancient lake plains, dune fields, and outwash plains, and topographic forms such as ancient meteorite impact craters.

The approach taken to representation focuses on the identification of the major elements which make up the large feature, and seeking representation of the best examples of each of these elements. For example, the Cartier Moraine belt across the north shore of Lake Huron consists of a series of mounds and ridges of ice-contact sediment, anchored to bedrock knolls, and associated with shoreline elements of glacial Lake Algonquin, such as now-abandoned (raised) beach terraces on perched deltas. Representation of this complex of features focuses on the identification of the best examples of each of these elements: an irregular mound element of ice-contact debris; a ridge element of ice-contact debris, preferably intact (i.e., identified by topography along natural boundaries); the bedrock component integral to the story of formation of the moraine; and, a perched delta with its associated beach elements. Where several elements occur together, and their form adequately display the mode of formation of the features and their link to the ice stand position marked by the moraine, an area boundary encompassing this association of elements is desirable. Such feature associations are preferred because they exhibit the inter-relationships within a diverse morphology.

The selection of sites with multiple values also has a practical reason. Such sites limit the size of protected area identified, therefore minimizing impacts on competing land uses. This does not constitute a scientific method for determining site quality or significance, but given the political realities of the day, where these associations can be grouped together, a compact site with multiple representation is preferable.

Site integrity is not as important a factor in the representation of bedrock sites. Adequate representation of a particular lithological (bedrock) unit requires a clear face or surface which exhibits all the elements used to define the unit. These may occur in a natural setting, such as on bare bedrock surfaces (the French River mouth area is an excellent example of this) or in cliff face exposures (the Niagara Escarpment is the best example of this). Here, site integrity may be excellent due to the extent of exposure (vertically and horizontally), and constitutes an aesthetic component due to the natural setting.

In many cases, however, bedrock representation occurs in man-made exposures such as highway or road cuts and pits and quarries, where aesthetic qualities are very low, but representational values are high because of the freshness and
quality of exposure. In such cases, site integrity is not a consideration of representational rank. Site integrity may in some cases be enhanced by one-time or occasional re-exposure or "freshening" of exposures.

**Life Science Values:** When comparing sites where earth science values are similar, overlapping life science values may be used to choose a site. This approach is generally only relevant to landscape sites (landforms, landform associations and/or process features) which are large enough to support significant vegetative stands or communities. Small sites (outcrop or some landform scale features) generally do not constitute a large enough area to protect most life science values. Smaller geological features can however, form a component of a larger life science site, and would constitute a preferable site choice given equal values elsewhere. The evaluation of overlapping life science values depends on the level of existing life science information or the availability of life science input to site selection.

**Special Features:** Where two or more sites have similar geological values, the presence of special features may determine site selection. Special features may be geological, such as the inclusion of unusual or unique elements of a theme not represented elsewhere. Special features may also constitute less scientific values such as the quality of a feature’s setting or the aesthetic values of a site.

Geology, and particularly geomorphology, often determines the overall effect of the landscape on the culture that inhabits it. It may be integral to that culture, be it local, regional or national, and any change in its integrity might have detrimental effects. Where the scientific values are equal, a choice between two or more sites may thus be determined by a natural setting or degree of impact by external forces.

In some cases, the sensitivity of a particular feature(s) to change, from either natural or man-made impacts, may also influence site selection, more sensitive features presenting a higher priority. In addition, features that are more immediately threatened with natural or man-made impacts may also be a higher priority for selection.

**Other Considerations:** Where known occurrences of a particular unit are already included in the system of protected areas, the selection of discrete bedrock and unconsolidated sediment sites (e.g., road-side outcrops, quarries, aggregate pits, etcetera) popular with the geoscience community (i.e., documented in field trip guidebooks), in addition to the sites identified in protected areas, may be of importance because they are accessible, known to geologists, and serve to protect significant occurrences for further research and educational values. This duplication has many values, as described earlier.

**Comparisons with Life Science Representation**
There continues to be confusion about the relationship and differentiation between earth science representation targets and life science representation targets. How does earth science representation compare to life science representation?

Earth science classification systems, based on physical features and, importantly, on time, cannot generally be correlated with the life science
classification system, which is based on macroclimate, landforms, microclimate, moisture regime, and substrate (Angus Hills' division of the province into Site Regions and Site Districts, with classification of site conditions within each Site District). Earth science classification is not related at all to present patterns of climate and moisture. This is particularly true of the bedrock geology component of the province.

For example, Precambrian Grenville Province rock types and environments are associated in time and event geologically to a specific area of exposure, in south-central Ontario. The diversity of features which reflect the history of evolution of the Grenville Province can only be found within this specific area of exposure. The geological diversity within the area of exposure of the Grenville Province, and its significance, is not affected at all by the vegetation patterns which occur on its surface, or by the classification schemes devised to arrange that vegetation diversity. Therefore, the distribution of significant earth science sites to represent the Grenville Province geological theme is not affected by life science values. However, the type and aspect of the bedrock substrate may have a significant influence on the composition of the vegetation communities and species that grow on that substrate. Obvious examples are the different effects of carbonate versus granitic substrates on the vegetation communities growing on them.

Although earth science and life science classification schemes are not compatible, there is an interconnectedness between the two disciplines at the landform level. The diversity of earth science features at the Site District level will determine the diversity of life science representation targets for vegetation communities and species. Earth science diversity in a Site District presents the biological environment with a range of temperature, exposure, aspect, moisture regime, substrate types and habitat on which vegetation develops. The land base of an area determines the diversity of the life forms that occupy and characterize that area.

Where all other factors are equal however, it is a goal of the earth science system plan in most cases to combine earth science and life science values in order to achieve biodiversity in which a number of natural values are protected.

A comparison of the gap analysis process and the site selection criteria for earth science representation and life science representation shows that these are very similar in approach.

**Assumptions**
- we know everything geologically about a region
- geological interpretations and definition of significant sites only reflect the current state of knowledge and/or follow current understanding and theories of concepts

**Limitations**
As already mentioned, geological mapping scales and coverage vary wildly across the province. We therefore know a lot about the geology of selected regions and/or geological environments, and hence selected environmental themes, and very little about others. The effect this has on representation targets
is that the environmental themes with a good base of knowledge may have a
great number of representational targets, whereas those environmental themes
about which relatively little is known will have fewer representational targets. It
must be understood that as the knowledge base in these under-represented
themes improves, with new, more detailed mapping of a region, new
representational targets will present themselves, and the number of candidate
sites may increase.

References
Science Features. Ontario Ministry of Natural Resources, Parks and
Recreational Areas Branch, Open File Earth Science Report 8101.
Press.
Noble, T. W. 1982. Life Science Report, Site Region 4E within Northern Region
(Abridged). OMNR, Northern Region, Cochrane.
OMNR, Sudbury.
Protected Areas: The Framework & Action Plan; Ontario Ministry of Natural
Resources, Lands and Natural Heritage Branch, Natural Heritage Section,
Peterborough.
PART IV

APPENDICES

Frontenac Provincial Park
APPENDIX 1


The Parks Research Forum of Ontario (PRFO) held its 1998 Annual Meeting in Peterborough, Ontario on February 5 and 6, 1998. Over 100 people attended the meeting. Participants were asked to complete a questionnaire which sought information on their research and occupational background, expectations and evaluation of the 1998 meeting, and view of the strengths of and capacity to do parks and protected areas research in Ontario. Participants were also asked to provide suggestions for future PRFO meetings.

Twenty-five evaluation forms were returned giving a response rate of about 25%. Responses to each question on the Evaluation Questionnaire are given below. The number in brackets indicates the number of times that a response was given. Please note that for a number of questions, multiple responses were given (e.g. respondents listed more than one field of interest).

PRFO welcomes your comments on this report. Comments can be forwarded to the PRFO Coordinator by mail (Heritage Resources Centre, University of Waterloo, N2L 3G1), e-mail (hrc@fes.uwaterloo.ca) or fax (519 746-2031).

What is your field of special interest (ecology, geography, economics, land use, recreation, tourism, large mammals, birds, etc.)?

- planning (7)
- geography (4)
- interpretation/education (4)
- recreation/tourism (4)
- wildlife (4)
- resource management (3)
- ecology (3)
- wetlands/aquatic ecosystems (3)
- visitor management (2)
- economics (1)
- no response (1)

What is your experience with parks and protected areas, with particular reference to research?

The affiliation of respondents was given to provide some context for their experience. Where possible, the experience of respondents was elaborated on, e.g. what type of work within parks.

Affiliation

- Ontario Parks/ MNR (9)
- Universities (9)
- Consulting groups (4)
- NWRI-CCIW (2)
- Parks Canada (1)
Experience

- within parks –
  - ‘research’ (5)
  - interpretation/education (3)
  - monitoring, inventory (3)
  - naturalist (1)
  - recreational use research (1)
  - fish and herptiles (1)
  - gap analysis (1)
  - preparing research strategy (1)
- student (5)
  - visitor management research (3)
- Consultants/NGOs/Non-Park Government –
  - water/aquatic research (at Point Pelee National Park) (2)
  - social/economic planning (1)
  - trails (1)
  - research around Algonquin, not specified (1)
  - research in parks (1)
- none (1)
- no response (3)

How did you hear about this meeting?

- word of mouth, e.g. through e-mail or contacts (18)
- HRC mailings, e.g. the workshop flyer or invitation for papers (8)

Why did you choose to attend?

- make contacts/network (13)
- get information/learn about current research (11)
- relevant to own work/personal interest (6)
- share information (4)
- get help or research ideas (3)
- required to attend as part of a course at Trent University (3)

What did you expect to learn and get from this meeting?

- current information (21)
- needs and opportunities (10)
- contacts/networking (5)
- ideas for own site (1)
- trends in ecotourism (1)
- no response (2)

What do you consider to be the major strengths of research in parks and protected area in Ontario?

- variety of sites/long-term availability of sites (8)
- availability of baseline or past data (6)
- diversity of research, researchers (5)
- willingness of parks to provide support, and their interest in research (4)
- natural science research (2)
- no response (3)
What do you consider to be the major research needs in regard to parks and protected areas and why?
- basic inventories/baseline data (8)
- monitoring, including development of indicators (6)
- social/economic (4)
- communication, access to information (3)
- development of research strategies (2)
- visitor-related (1)
- impacts of ecotourism (1)
- impacts of humans on parks and protected areas (1)
- benefits of protected areas (1)
- no response (3)

There were 3 responses to ‘why?’ – little appreciation of value of research; to understand what is being managed; and, to assist management.

What do you think of our capacity to do research on parks and protected areas in Ontario?
- partnerships are increasing capacity (5)
- low funding is reducing capacity (5)
- ‘very good’ (2)
- lots of parks in which to do work (1)
- no response (12)

Do you have any suggestions in regard to building capacity for research?
- develop partnerships, seek resources (8)
- develop database, research catalogues (5)
- improve communication (4)
- expand number research sites, e.g. don't focus only on a few parks, such as Algonquin (2)
- improve in-kind support (1)
- educate park managers of value of research (1)
- research coordinators at each zone office (Ontario Parks) (1)
- no response (6)

What do you consider to be the strengths of the organizational arrangements for this meeting?
- variety of presenters, topics, participants (16)
- well-organized (4)
- size (1)
- informal atmosphere (1)
- good attendance (1)
- no response (3)

What suggestions would you make for future efforts of this kind?
- larger facilities (5)
- broaden perspectives, e.g. national, international, native, community, public (4)
- more notice/spread word e.g., to the MNR offices (2)
• eliminate working groups (2)
• provide working groups with different questions, rather than have all
groups work on same set of issues (1)
• keep working groups, they are very useful (1)
• have a debate, rather than panel discussion (1)
• spread day 2 to a full day and have at most 2 concurrent sessions (1)
• try to develop concrete actions (1)
• no response (2)

How do you feel about the meeting in terms of its usefulness for:

a) research on parks and protected areas?
• broaden ideas/understanding/good for getting information (9)
• useful/very useful (7)
• networking (1)
• no response (6)

b) your work on parks and protected areas?
• good because got information/reinforced own ideas/future
  opportunities (10)
• relevant/good/useful (6)
• good for networking/sharing information (3)
• not too great (1)
• no response (8)

Are you interested in attending meetings of the PRFO in the future?
• yes (19)
• no (0)
• perhaps, e.g. depending on continued involvement in the parks area,
  relevance to work at the time (6)

Can you suggest topics?
• park planning and management techniques, including holistic
  approaches to sustaining protected areas (3)
• research strategy development (2)
• ecotourism, positives and negatives (2)
• monitoring, including cumulative effects (2)
• social/human (2)
• native involvement in parks and protected areas e.g. North Ontario (2)
• historic research (1)
• coastal parks and protected areas in the lower Great Lakes (1)
• funding and support sourcing (1)
• balancing research needs and research interests (1)
• communication (1)
• technology (1)
• data management, protocols, archiving (1)
• integrating environmental and economic research (1)
• no response (10)
Additional Comments

- should expand second day (2)
- day 1 was too long (1)
- try to get people to stay for the second day (1)
- should require all park superintendents from natural environment and wilderness parks to attend as part of base training (1)
- hold annually, e.g. no need for smaller meetings (1)
- expand participants, e.g. to include more public, community members (1)
- no response (15)
APPENDIX 2

Parks Research Forum of Ontario 1998 Annual Meeting Program
February 5 and 6, 1998, Peterborough, Ontario

Program for Day One
Morning Session: Parks and Protected Areas in the Canadian Shield:
Information and Research Needs
Moderator: Norm Richards, Ontario Parks

9:00-9:15 The Idea of the Parks Research Forum of Ontario
Gordon Nelson, Chair, Parks Research Forum of Ontario

9:15-9:45 Information and Research Needs for Parks and Protected Areas
Barton Felders, Manager, Planning and Research, Ontario Parks

9:45-10:15 Economic Perspectives on Parks and Protected Areas
Paul Eagles, Recreation and Leisure Studies, University of Waterloo

10:15-10:45 Ecological Perspectives on Parks and Protected Areas
Nik Lopoukhine, Natural Resources Branch, Parks Canada

10:45-11:15 Break

11:15-11:45 Human Dimensions and Communication Perspectives on Parks and Protected Areas
Jim Cantrill, Communications Studies, Northern Michigan University

11:45-12:15 An Ecosystem Approach to Parks and Protected Areas in British Columbia
Warren Mitchell, Land Use Coordination Office, British Columbia

12:15-1:15 Presentation of Ontario Parks Heritage Protection Award to Lunch
George Priddle, Ph. D.

Afternoon Session
Information and Research Needs for Parks and Protected Areas
Moderator: Gordon Nelson, Heritage Resources Centre

1:15-2:15 Panel Discussion, George Priddle, Chair
Panelists: John Riley, Federation of Ontario Naturalists
Jay Leather, Northwest Zone, Ontario Parks
Peter Carruthers, Ministry of Citizenship, Culture and Recreation
Patrick Lawrence, Heritage Resources Centre, University of Waterloo
Gary Pots

2:15-3:30 Working Group Sessions

3:30-4:00 Break

4:00-5:00 Plenary with Working Group Reports and Discussion

5:00-5:30 Rapporteurs:
Jim MacLean, Science Development and Transfer Branch, OMNR
Scott Slocombe, Geography Department, Wilfrid Laurier University

5:30-7:30 Dinner Break
7:30-9:30 Poster Session
List of Poster Presentations

Black Bear Attacks.
Mike Wilton and Jeremy Inglis, Algonquin Ecowatch

Catalogue of Research and Monitoring Needs for Ontario Region National Parks.
Ken Van Osch, Bill Stephenson and Gordon Nelson

Identifying a Protected Areas System for Central Ontario.
John Riley, Federation of Ontario Naturalists

Candidate Protected Areas for Lands for Life Planning Regions.
Partnership for Public Lands / Wildlands League.

Public Support for Protected Areas.
Partnership for Public Lands / Wildlands League.

Natural Areas and Land Use Planning Connections in the Carolinian Canada Zone.
Patrick Lawrence, Cynthia Lussier and Lori-Anne Riviere, Heritage Resources Centre, University of Waterloo.

Patrick Lawrence, Gordon Nelson and Heather Black, Heritage Resources Centre, University of Waterloo.

From Inventory to Interpretation: A definition of Process.
Cailin Clarke, Trent University

Release of Nutrients from On-Site Wastewater Disposal Practices, Point Pelee National Park, Ontario, Canada.

Investigation of Nutrient Sources to Point Pelee Marsh.
T. Mayer, L. Zanini and R. A. Bourbonniere, National Water Research Institute, Canada Centre for Inland Waters

Enhancing Trail Access for People with Disabilities.

Linking Geology to the Effects of Acid Precipitation on the Food Chain of Gavia immer.
Rachel Dunn, University of Waterloo.

Amphibian and Reptile Conservation in Ontario: Parks Perspective.
Anthony Zammit, University of Waterloo.

Assessing the Evolution of Marsh Management in Protected Areas, with special reference to Point Pelee, Rondeau and Long Point, Lake Erie, Canada.
Lucy Sportza, School of Urban and Regional Planning, University of Waterloo.

Protecting Cultural Resources Through Forest Management Planning.
Luke Dalla Bona, Cultural Heritage Inventory Program, Ministry of Natural Resources.

Effects of Human Disturbance and Eastern Massasauga Rattlesnakes.
Chris Parent, Biology Department, Carleton University
Program for Day Two

Session One: Social Perspectives

9:00-9:25 Economic Benefits of Ontario Provincial Parks: Wilderness, Natural Environment and Waterways Ñ A Case Study Approach
Peter Whiting, The Outspan Group and Dan Mulrooney, Ontario Parks

9:25-9:50 Using Dedication and Easement Programs for Parks and Private Lands.
Ian Attridge, Peterborough

9:50-10:15 Protecting Cultural Resources Through Forest Management Planning
Luke Dalla Bona, Archaeological Research Scientist, Cultural Heritage Inventory Protection Program, Ontario Ministry of Natural Resources

10:15-10:40 Break

10:40-11:05 Building Community and Conserving Cultural Landscapes through Inventory
Nancy Pollock-Ellwand, School of Landscape Architecture, University of Guelph.

11:05-11:30 Protected Areas and Other Land Uses Ñ A Spatially Explicit Evaluation
Wolfgang Haider, OMNR, Brian Hutchinson, Parks Canada and Jim Duncan, OMNR

Session Two: Research and Monitoring

9:00-9:25 Snow Geese in Polar Bear Provincial Park: Implications of a Tropic Cascade
Ken Abraham, (OMNR), Bob Jefferies (University of Toronto), Jim Leafloor (OMNR) and Ken Ross (Canadian Wildlife Service).

9:25-9:50 Coastal Geomorphology of Lighthouse Point Provincial Nature Reserve
Robin Davidson-Arnott, Department of Geography, University of Guelph.

9:50-10:15 An overview of Environment Canada's groundwater research and monitoring activities at Point Pelee National Park, Ontario

10:15-10:40 Break

10:40-11:05 Use of Estimated “Pristine” Species-Area Relations as Null Models to Estimate Size and Integrity Standard for Protected Areas: An Update
Thomas Nudds, Brent Gurd, Christopher Henschel and Christopher McLaughlin, Department of Zoology, University of Guelph

11:05-11:30 Multi-Disciplinary Research and Monitoring in Killarney: Biodiversity, Recovery and Global Changes
John M. Gunn and Ed Snucins, OMNR, Aquatic Ecosystems Science, Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Ont.
Session Three: Inventory, Assessment, Planning and Management

9:00-9:25  *Faunal survey and inventory in Ontario Parks*  
Steve Marshall, Department of Environmental Biology, University of Guelph

9:25-9:50  *The Forest Fire Management Program at Pukaskwa National Park*  
Mark Crofts, Pukaskwa National Park

9:50-10:15  Community Evaluation Planning  
Wasyl Bakowsky, Ontario Natural Heritage Information Centre

10:15-10:40 Break

10:40-11:05  *Priority Sites for Conservation Action in the Niagara Escarpment Biosphere Reserve*  
Jarmo Jalava and Helen Godschalk, Ontario Natural Heritage Information Centre

11:05-11:30  *Historical and Present Status of Woodland Caribou (Rangifer tarandus) in Pukaskwa National Park, Ontario, and Some Implications for Metapopulation Management, a Review*  
Keith Wade, Pukaskwa National Park

Session Three: Research, Planning and Management

9:00-9:25  *Seasonal Movement Patterns and Feeding Habits of Large Male Black Bears in Algonquin Provincial Park, Ontario*  
Jeremy Inglis and Mike Wilton, Algonquin Ecowatch

9:25-9:50  *Spatial Relations between Migratory Algonquin Park Wolves and Resident Wolves in a Winter Deer Yard*  
John Pisapio, School of Urban and Regional Planning, University of Waterloo

9:50-10:15  *Response of Birds and Vegetation to the First Cut of White Pine (Pinus strobus) in Algonquin Park, Ontario*  
Andrea Kingsley and Erica Nol, Trent University

10:15-10:40 Break

10:40-11:05  *Overgrazed Ecosystems: Do plant communities recover?*  
Saewan Koh, Biology Department, York University.

11:05-11:30  A Research Strategy for Algonquin Provincial Park  
Norm Quinn, Algonquin Provincial Park

**Plenary Discussion**

11:30-12:30  The Role and Future of the Parks Research Forum
## APPENDIX 3

### List of Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Address 1</th>
<th>City, Province</th>
<th>Postal Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ken Abraham</td>
<td>Wildlife and Natural Heritage Science</td>
<td>300 Water St., Peterborough, ON</td>
<td>K9J 8M5</td>
<td></td>
</tr>
<tr>
<td>Ian Attridge</td>
<td>Planning and Research, Ontario Parks</td>
<td>575 Gilchrist St.</td>
<td>Peterborough, ON</td>
<td>K9H 4P2</td>
</tr>
<tr>
<td>Tom Beechey</td>
<td>Planning and Research, Ontario Parks</td>
<td>Bronte Creek Provincial Park</td>
<td>129 Burloak Rd, Burlington, ON L7R 3X5</td>
<td></td>
</tr>
<tr>
<td>Valerie Blazeski</td>
<td>Biology Department</td>
<td>York University</td>
<td>Toronto, ON</td>
<td>M3J 1P3</td>
</tr>
<tr>
<td>Maggie Bowman</td>
<td>Recreation and Liesure Studies</td>
<td>University of Waterloo</td>
<td>Waterloo, ON</td>
<td>N2L 3G1</td>
</tr>
<tr>
<td>Yvette Bree</td>
<td>Sandbanks Provincial Park</td>
<td>R.R. 1 Cloyn, ON</td>
<td>K0H 1K0</td>
<td></td>
</tr>
<tr>
<td>Peter Briand</td>
<td>Killarney Provincial Park</td>
<td>General Delivery, Killarney, ON</td>
<td>P0M 2A0</td>
<td></td>
</tr>
<tr>
<td>Jim Cantrill</td>
<td>Communications Studies</td>
<td>Northern Michigan University</td>
<td>Marquette, Michigan, USA 46855</td>
<td></td>
</tr>
<tr>
<td>Peter Carruthers</td>
<td>Archaeology and Heritage Planning</td>
<td>Citizenship, Culture and Recreation</td>
<td>77 Bloor St W., Toronto, ON M7A 2R9</td>
<td></td>
</tr>
<tr>
<td>Michelle Cowan</td>
<td>Trent University</td>
<td>Trent University</td>
<td>Peterborough, ON</td>
<td>K9J 7B8</td>
</tr>
<tr>
<td>Joanne Atkinson</td>
<td>Trent University</td>
<td>300 Water St., Peterborough, ON</td>
<td>K9J 7B8</td>
<td></td>
</tr>
<tr>
<td>Elyse Blanshette</td>
<td>Trent University</td>
<td>K9J 7B8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barb Boland</td>
<td>Lands for Life</td>
<td>Great Lakes - St. Lawrence Round Table</td>
<td>300 Water St., Peterborough, ON K9J 8M5</td>
<td></td>
</tr>
<tr>
<td>Ann Maire Braid</td>
<td>Niagara Escarpment Commission</td>
<td>232 Guelph St.</td>
<td>Georgetown, ON L7G 4B1</td>
<td></td>
</tr>
<tr>
<td>David Bree</td>
<td>Bon Echo Provincial Park</td>
<td>R.R. 1 Cloyn, ON</td>
<td>K0H 1K0</td>
<td></td>
</tr>
<tr>
<td>Mark Browning</td>
<td>Wildlife and Natural Heritage Science Section</td>
<td>Ministry of Natural Resources</td>
<td>P.O. Box 7000, Peterborough, ON K9J 8M5</td>
<td></td>
</tr>
<tr>
<td>Barbara Carmichael</td>
<td>Geography and Environmental Studies</td>
<td>Wilfrid Laurier University</td>
<td>Waterloo, ON N3K 2G3</td>
<td></td>
</tr>
<tr>
<td>Cailin Clarke</td>
<td>Trent University</td>
<td>Peterborough, ON</td>
<td>K9J 7B8</td>
<td></td>
</tr>
<tr>
<td>Terry Crabe</td>
<td>Pinery Provincial Park</td>
<td>R.R. #2, Grand Bend, ON</td>
<td>N0M 1T0</td>
<td></td>
</tr>
</tbody>
</table>
Mark Crofts  
Pukaskwa National Park  
Hwy 627, Heron Bay, ON  
P0T 1R0

Don Cuddy  
Science and Technology  
Ontario Ministry of Natural Resources  
P O Bag 2002, Kemptville, ON K0G 1J0

Luke Dalla Bona  
Ontario Ministry of Natural Resources  
Suite 400, 70 Foster Drive  
Sault Ste. Marie, ON P6A 6V5

Robin Davidson-Amott  
Geography Department  
University of Guelph  
Guelph, ON N1G 2W1

Gordon Dibb  
York North Archaeological Services  
Peterborough, ON

Paul Eagles  
Recreation and Leisure Studies  
University of Waterloo  
Waterloo, ON N2L 3G1

Bart Feilders  
Planning and Research, Ontario Parks  
P.O. Box 7000  
Peterborough, ON K9J 8M5

Deborah Freeman  
Wildlands League  
380-401 Richmond St. W.  
Toronto, ON M5V 3A8

Paul Gray  
Natural Heritage Section  
Ontario Ministry of Natural Resources  
300 Water St., Peterborough, ON K9J 8M5

John Gunn  
Aquatic Ecosystems Sciences  
Ontario Ministry of Natural Resources  
300 Water St., Peterborough, ON K9J 8M5

George Holborn  
Terrestrial Assessment Unit  
Hwy101E, South Porcupine, ON  
P0N 1H0

Allan Crowe  
National Water Research Institute  
Canada Centre for Inland Waters  
Burlington, ON L7R 4A6

Craig Cunningham  
Central Zone, Ontario Parks  
c/o Arrowhead Provincial Park  
R R #3, Huntsville, ON P1H 2J4

Bob Davidson  
Planning and Research, Ontario Parks  
P.O. Box 7000, Peterborough, ON  
K9J 8M5

Kirsty Dickson  
Heritage Resources Centre  
University of Waterloo  
Waterloo, ON N2L 3G1

Rachel Dunn  
University of Waterloo  
Waterloo, ON N2L 3G1

Lara Ellis  
Wildlands League  
380-401 Richmond St. W.  
Toronto, ON M5V 3A8

John Fisher  
Planning and Research, Ontario Parks  
P.O. Box 7000  
Peterborough, ON K9J 8M5

Kim Gavine  
Wye Marsh Wildlife Centre  
Box 100, Midland, ON  
L4R 4K6

Sim Grewal  
Trent University  
Peterborough, ON  
K9J 7B8

Mary Heaman  
Planning and Research, Ontario Parks  
P.O. Box 7000  
Peterborough, ON K9J 8M5

Arthur Horn  
Ontario Ministry of Natural Resources  
R R #1, Lakefield, ON  
K0L 2H0
Peter Whiting
The Outspan Group
North Shore Rd, Amherst Island
Stella, ON K0H 2S0

Mike Wilton
Algonquin Eco Watch
R.R. #1, Spring Bay, ON
P0P 2B0

John Winters
Algonquin Provincial Park
Box 219, Whitney, ON
K0J 2H0