

Parks Canada Science: Providing Knowledge for Better Service to Canadians

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Introduction

ON BEHALF OF THE PEOPLE OF CANADA, the Parks Canada Agency protects and presents nationally significant examples of Canada's natural and cultural heritage and fosters public understanding, appreciation, and enjoyment in ways that ensure their ecological and commemorative integrity for present and future generations (Parks Canada 2000). This mandate is carried out on federal lands that include national parks, national historic sites, and national marine conservation areas, collectively referred to as "parks and sites" in this document. Central to delivering on this mandate is the need for sound science to provide a good understanding of the nature, condition, and significance of the resources under the stewardship of the agency; their uniqueness, susceptibilities and threats; and the needs and expectations of the people on whose behalf they are managed. Consequently, whether the agency is establishing a national park, a national historic site, or a marine conservation area; developing policies; managing wildlife diseases; developing species-at-risk recovery plans; restoring archaeological sites or resources; or looking for ways to facilitate meaningful visitor experiences and public engagement, science advice is required to guide or support decisions.

In Parks Canada's context, science is used in the inclusive sense, and includes natural, social, and archaeological sciences. Hundreds of research projects are conducted every year by scientists from Canada and abroad with specialization in areas such as anthropology, archaeology, art, biology, climatology, ecology, economics, education, engineering, environmental sciences, geography, geology, history, hydrology, law, linguistics, marketing, political science, recreation and leisure, social science, sociology, soil science, statistics, terrain science, and veterinary science, among others. The quality and usefulness of the knowledge generated depends on whether the science is properly conceived, conducted, analyzed, and communicated. This paper discusses the set of principles used by Parks Canada to ensure that the contributions of science are strategic, relevant, and focused on the agency's priorities. Examples of programs, policies, and management decisions that have benefited from science advice are described by Jager and Sanche, Langdon et al., McNamee, Ostola, Rosset, Woodley, and Yurick elsewhere in this issue.

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The diversity and extent of areas and issues for which science is needed

Parks Canada's science needs are as broad as its mandate, management priorities and challenges. The needs are compounded by the complex mix of actors and jurisdictions involved, and the diverse geographical, environmental, social, cultural, spiritual, and economic contexts within which parks and sites exist. The changing face of Canada—as evidenced by changing demographics, technologies, value systems, leisure patterns and economic trends—calls for new information to guide the agency on how to keep parks and sites as a living legacy, connecting the hearts and minds of Canadians to a stronger, deeper understanding of the very essence of Canada. Science advice is needed to help create greater public awareness and appreciation of parks and sites, enhance greater ecological and commemorative integrity gains, and connect or re-connect Canadians to their heritage places. Below is a brief overview of the special heritage places for which science information is needed. More details on parks and sites are provided by McNamee, Murray, Ostola, and Yurick in this journal.

National parks form a country-wide system of representative natural areas of Canadian significance. By law, they are protected for public understanding, appreciation, and enjoyment, while being maintained in an unimpaired state for present and future generations. These wild places, located in every province and territory, range from mountains and plains, to boreal forests and tundra, to lakes and glaciers, and much more. They conserve and protect geologic splendors, cultural landscapes, recreational spaces, lakes and seashores, long-distance trails, free-flowing rivers, and places that chronicle the nation's history. They range in size from just under 9 square kilometers (St Lawrence Islands) to almost 45,000 square kilometers (Wood Buffalo), and include world-renowned names such as Banff, Jasper, and Nahanni, among others.

In order to provide full benefits to Canadians, the parks must be well protected. Science provides managers with information on the type, nature, and condition of the resources under their stewardship; the biotic and abiotic components that must be maintained to support healthy ecosystems; the threats to the resources; methods and approaches for intervention; and means to monitor and evaluate the effectiveness of the intervention. In addition, it provides information on how protection can be harmonized with public expectations, and ways in which Canadians can use and enjoy these places without impairing them.

National marine conservation areas protect and conserve a network of areas representative of Canada's marine environments (Parks Canada 2007). These areas are managed for sustainable use and contain smaller zones of high protection. Where they exist, they protect the seabed, the water column above it. They may also encompass wetlands, estuaries, islands, and other coastal lands. National marine conservation areas are protected from activities such as ocean dumping, undersea mining, and oil and gas exploration and development, but are open to selected and controlled human uses, such as traditional fishing and shipping. Understanding threats to ecological sustainability and how protection and conservation practices can be harmonized with resource use in marine ecosystems, including identifying appropriate governance approaches and innovative ways to engage Canadians in understanding and appreciating national marine conservation areas, constitute some of the key science needs.

National historic sites are places that bear witness to Canada's defining moments and illustrate human creativity and cultural traditions. They exemplify thousands of years of human history and hundreds of years of nation-building, and reflect a diversity of cultures, geographical settings, and time periods as vast as Canada itself. National historic sites embrace the entire spectrum of nationally significant historic places, ranging in size from the gravesites of the Fathers of Confederation to extensive cultural landscapes in urban, rural, and wilderness settings. These places may contain surface and subsurface remains, individual buildings or complexes of buildings and other works, artifacts, natural features, and combinations thereof. Where individual national historic sites do not constitute cultural landscapes in their own right, they form part of a larger cultural landscape (Parks Canada 1994a). They exist as sacred spaces, battlefields, archaeological sites, buildings, or streetscapes. Each site tells its own unique story, part of the greater story of Canada, contributing a sense of time, identity, and place to the understanding of the country as a whole. Many sites are still used today for work and worship, commerce and industry, habitation and leisure, and provide Canadians with a sense of wonder, pride, and reverence as they feel and learn about the past human activities that laid the foundation of their country (Parks Canada 1994). Cultural resources in parks and sites face threats from human impacts such as looting or vandalism, degradation due to natural forces, corrosion, inappropriate presentation and display, and development, recapitalization, or maintenance activities (Parks Canada 2005a). Some of the science needs include identifying innovative ways of safeguarding these places, addressing the challenges and threats they face, increasing their relevance to Canadians, strengthening public support, and reaching and responding to new audiences.

Diverse sources of knowledge

For decades, the typical research design relied heavily on natural science to generate information on how ecological systems work, with little or no regard to the human dimension of heritage area management. It is now clear that successful stewardship of heritage areas does not rest solely on biological or archaeological data, but on how the Canadian public values and perceives these areas. Disregarding the human dimension of heritage area management risks reduced public support. Today, Parks Canada science is designed to provide comprehensive understanding of the biological, cultural, and social issues necessary to enhance the protection and presentation of parks and sites, and to foster public understanding, appreciation, and enjoyment in ways that ensure their ecological and commemorative integrity for present and future generations.

Alongside natural, social, and archaeological sciences, the agency recognizes the significant role of naturalized knowledge. This includes Aboriginal knowledge and community experiential knowledge, all of which can contribute to the information base needed to understand and manage parks and sites. In national parks for example, this knowledge provides valuable information on historic and current ecosystem conditions, and long-term human ecological interactions based on hundreds or even thousands of years of experience. The incorporation of these knowledge systems for purposes such as park or site establishment, ecological or site restoration, species-at-risk recovery initiatives, management of hyperabundant wildlife populations, resource harvesting and ecological restoration, and enhancing vis-

itor experience, has been on the increase over the last ten years.

Research is coordinated to ensure that the knowledge generated is relevant for management, and that it addresses the needs of Parks Canada managers not only at an appropriate level of detail, but also in a way that supports an integrated approach to management.

The agency has a set of principles that helps provide science advice that is timely, meaningful, usable, and relevant to achieving planned results, while ensuring that the attainment of one goal does not undermine the achievement of another, but contributes to it. These principles include the requirements that science must be (1) needs-driven, (2) partnered and integrated, (3) credible, (4) coordinated nationally, and (5) effectively shared and communicated (Parks Canada 2001). Each of these principles is briefly discussed.

1. Science should be needs-driven

Parks Canada science is strongly linked to the agency's foundational elements of its mandate: resource protection, public education, and visitor experience. The focus of each of the three science disciplines is summarized below (Parks Canada 2001; 2005b; 2005c).

Natural science. The focus of the natural sciences is on understanding the structure and function of natural systems and their response to change. It involves the broad fields of biology and ecology, but also includes relevant areas of geology, geography, terrain science, climatology, hydrology, and soil science. Research on ecosystems, species, and ecological processes has applications in many varied management decisions. The development of species-at-risk recovery plans, management of invasive species, wildlife diseases, pollution, remediation of contaminated sites, identifying indicators of ecosystem health, and understanding use impacts are some of the focal areas of research. Monitoring and reporting on ecosystem condition, and progress towards attainment of management objectives are priorities for the agency (see paper by Woodley in this issue).

Social science. Social science research involves the systematic process of gathering and analyzing information and data directed at understanding people and their relationships with their environments. Drawing on disciplines such as sociology, economics, statistics, psychology, recreation, geography, and political science, social science involves qualitative and quantitative techniques to understand and explain people's knowledge, understanding and behavior, including their perceptions, values, attitudes, and motivations. Over the last few years, social science research has focused on (a) audience research to help understand the external audiences and stakeholders/partners in order to attract them, communicate with them, and to engage and connect with them; (b) research to understand the people who visit, contact, or use the agency's facilities and services, in order to continue to attract visitors, engage and connect with them, and maintain their support; (c) socioeconomic research to help understand the economic and social value of programs, services, and places, and the economic and social costs, benefits, and opportunities of policy, regulatory, and investment decisions related to them; (d) human dimensions research to help understand the physical, social, and cultural aspects of people in wildlife and cultural resource management, including how they use and behave in different environments, and their perceptions and attitudes towards resource management issues; and (e) heritage communication research to help understand the meaning, interpretation, and effectiveness of on-site, community and nation-

al information, outreach, and heritage products to relay messages, inform and educate, and connect with people. Research aimed at understanding the value people place on parks and sites, and the barriers to their participation in environmental issues, is conducted on targeted audiences, including youth, urban populations, ethnocultural communities, and families.

Social science provides an important entry point for many natural or cultural resource management projects that require public support. Social science helps to clarify various human-related issues, concerns, and perspectives; explore mechanisms for increasing public understanding and appreciation of issues; identify management approaches that would be socially acceptable; and provide strategies for public engagement.

Archaeological science. Equally important for achieving Parks Canada's corporate mandate is archaeological research, a discipline that contributes to the understanding of the cultural resources in parks and sites. Archaeology incorporates elements of human sciences such as history, art, geography, linguistics, and anthropology; and applied sciences such as building sciences, landscape, geology, material culture, and engineering. Archaeological research involves excavations, surveys, and inventories in parks and sites with tangible evidence or potential tangible evidence of past human activities. Research activities are conducted on historic sites, features, or structures, including stone tool manufacturing locations, campsites, rock art sites, fishing stations, places of spiritual and religious experience, fur trade and military sites, transportation and industrial sites, battlefields, shipwrecks, villages, homesteads, dumps, trails, and landscapes. Archaeological research also provides insights into people's relationship with the environment and human influences on the evolution of ecosystems. In certain sites, research focuses on multicultural and socioeconomic issues that are a part of the complex set of elements that influence the analysis and understanding of past human groups and societies. Archaeological science aids in enhancing the commemorative integrity of national historic sites, preserving sites' cultural resources, communicating heritage values and their national significance, and kindling the respect of people whose decisions and actions affect the site.

Science is linked to management. The complex ecological, social, cultural, and economic contexts within which parks and sites are managed often require information that is unavailable. In some instances, the information may be available but insufficient to provide the insights and predictions needed to achieve planned results. Some issues such as the management of rare, sensitive or hyperabundant populations; species reintroductions; control of alien species; prescribed fires; establishment of wildlife corridors; management of wildlife diseases; or reducing human-wildlife conflicts can generate debate, with those opposed to the prescribed action often citing lack of sufficient information as a reason not to take action. However, the science needed to provide advice can be time-consuming and costly, while the desired management action may not wait until all possible options are fully understood. In such situations, Parks Canada uses the adaptive management framework, an objective, scientifically sound approach that serves the dual purpose of achieving management goals while gaining reliable knowledge.

Science is also used to determine the risk associated with pursuing a desired outcome, and in some cases, the precautionary approach is applied to guide how and when to take action. The precautionary principle is particularly important in the management of cultural

resources, as they cannot be duplicated or replaced if lost, damaged, or destroyed. The model for scientific inquiry used for cultural resources management is closer to the medical science model: anamnesis (in this context, establishing the patient's medical history), analysis and diagnosis, development of options for intervention, prognosis, therapy, and monitoring. In a conservation context, anamnesis is the process used to assemble the relevant information, such as historical and archaeological research and physical condition assessment. The outcome of analysis and diagnosis outlines the cultural resource values (physical, symbolic, geographical, etc.), the condition and threats to the resource, and the messages of national historic significance that are to be communicated. The development of options and prognosis constitutes the core of the strategy to safeguard and present the cultural resource. Therapy is the actual implementation of the recommended option(s), while monitoring is the follow-up to measure long-term condition of the resource. This process is incremental and iterative. Whenever new relevant information is collected, the conservation and presentation strategy needs to be confirmed and adjusted accordingly.

Science is expected to help extend the life cycle of cultural resources (Canadian Heritage 1994; Parks Canada 2001), a quest that involves challenging new scientific grounds, and the use of new non-destructive technologies and tools to assess and monitor the condition of the resources. Unfortunately, this is a domain where field tests and research results are limited. Site-specific monitoring is needed to acquire a better understanding of the properties and performance of the resource. Unlike the adaptive management approach described above, each site constitutes a unique experiment in itself, with potential to lose historical material. Consequently, action must be preceded by rigorous investigation and testing.

2. Science should be integrated and partnered

The use of an integrated scientific approach is based on the understanding that ecological and commemorative integrity, as well as visitor experience, are not different ends of a management spectrum but are inextricably entwined and symbiotic in nature, and that fostering understanding through experience and education is fundamental to maintaining and restoring ecological integrity in national parks and the commemorative integrity of national historic sites (Figure 1).

An average of 400 new science projects are initiated in parks and sites every year, adding to hundreds of other multi-year research and monitoring projects. Integration of science advice into the management of parks and sites is enhanced by developing strategic, multidisciplinary partnerships with a broad spectrum of science providers such as universities, research institutes, governmental agencies, non-governmental organizations, industry, science advisory boards, stakeholders, Aboriginal peoples, and the public. In the last five years, over 2,000 research projects have been initiated in parks and sites by researchers from over 100 universities from Canada, Australia, Belgium, Brazil, Britain, Finland, France, Germany, Japan, Norway, Portugal, Sweden, and the United States of America. In 2009 alone, there were nearly 400 new research projects undertaken by scientists from over 250 organizations. Their combined skills and resources enhance our capabilities, diversify our perspectives, strengthen the reliability of our science, and help to accelerate the rate of generation of information—and in turn enable speedy responses to priority management issues. The participat-

Figure 1. Parks Canada's way of demonstrating its integrated approach to management as key to promoting public outreach and education, facilitating visitor engagement and experiences, and protecting natural and cultural heritage.



ing institutions make a significant contribution not only in generating new information, but also in enhancing the value of Canada's heritage places to a broad spectrum of Canadians and the international community.

Use of citizen science is another growing effort that involves volunteers or networks of volunteers to perform or manage research-related tasks such as observation, measurement, or computation. Citizen science programs connect participants to nature, enhance their understanding of the natural world, help build a growing constituency of volunteers and supporters within the communities in and around national parks and sites, and generate knowledge to support management decisions.

3. Science should be credible

The agency has established high standards to ensure the quality, integrity, and objectivity of the research conducted in parks and sites. In order to generate scientific knowledge that is derived from well-designed studies, research proposals must be peer reviewed by a multidisciplinary team consisting of biologists, social scientists, archaeologists, species-at-risk experts, and, if necessary, by other internal or external specialists. Every proposal for conducting research that has the potential to impact natural or cultural resources is reviewed by an environmental impact assessment specialist to ensure that the project is designed in a manner that avoids or reduces adverse impacts on these resources. The review ensures technical soundness and compliance with the applicable legislation, policies, and corporate priorities while ascertaining that, whenever possible and appropriate, research integrates the requirements of natural, social, and archaeological sciences. The objective of the rigorous review process is to ensure that science is undertaken in a manner that is defensible, open, transparent, and inclusive, allowing for the demonstration that policy, management, or operational decisions are made based on information that can withstand objective scientific and public scrutiny. This underpins the need for a significant internal science capacity working alongside decision-makers.

4. Science should be coordinated nationally

Parks Canada research is conducted under nationally consistent guidelines and procedures and is centrally processed through the research and collection permitting system (RCPS), an on-line system that provides a single, common portal for processing research permit applications (www.pc.gc.ca/apps/RPS/page1_e.asp). The system provides researchers with a comprehensive on-line information package consisting of a researcher's guide, a list of research coordinators for each park and site, research policy, frequently asked questions, a

feedback mechanism, listings of research priorities, and other support tools. It ensures that both external and internal researchers use consistent guidelines and procedures, and, through the mandatory peer-review process, enhances the reliability of the results. It has an Internet-intranet interface that allows research applications to be conveniently reviewed and approved on-line. The system allows researchers to request a single permit to conduct research in multiple parks and sites for up to three years, while incorporating mechanisms to ensure that research activities comply with the applicable policies, legislation, and other corporate requirements.

The on-line system creates a single multidisciplinary research database that provides information to support the integration of science with planning. In addition, the system strengthens research partnerships and collaborations while enhancing the capacity of the agency to more effectively contribute to and build on the larger government-wide science initiatives.

5. Science should be shared and communicated

Science is not complete if it is not shared, reported and otherwise communicated, and acted upon. To enhance the sharing and communication of science, the agency requires scientists to submit their findings in a written report to the superintendent, in addition to presenting their results, in person, to communities adjacent to the study site. Individual parks and sites make efforts to communicate the science through various channels, including regional research forums, visitor interpretation programs, print media, newsletters, television, various publications, and the Internet. Community and stakeholder workshops are normally held to create public appreciation and understanding of the complexities involved in protecting and presenting natural and cultural resources, and to explore the public's views on the management implications of the research. This approach strengthens participatory decision-making and promotes management processes that incorporate and respond to the interests of Canadians. Every park publishes a "state of park report" every five years that presents a comprehensive evaluation of the state of the three key elements of Parks Canada's mandate: resource protection, visitor experience, and public education. A corporate "state of protected heritage areas report" is produced every two years and contains highlights of corporate achievements, some based on science advice. Other venues for communicating science include reports to Parliament and to Canadians. Recent examples include the "action on the ground" publications (Parks Canada 2005d; 2008).

Conclusion: Science advice is an enduring need

Parks Canada's ability to manage parks and sites will continue to improve with advances in science. New information is facilitating the timely development of policies, contributing directly to improved planning, better natural and cultural resource management, public education, visitor experience, public safety, and reporting. The agency's story about parks and sites is changing from that of ecological and commemorative integrity in decline to a story of renewal and restoration. We are telling stories that demonstrate how effective we can be when we work together toward a common cause, providing information that will help us to maintain and restore our parks and sites so that they continue to hold a special place in the hearts

of Canadians for generations to come, while remaining models of sound natural and cultural resource protection and management. We are far from understanding the full range of intricacies involved in protecting and presenting Canada's heritage places and resources, but the science program is helping chart the way into a successful future.

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