



Northern Science and

Technology in Canada

Federal Framework and Research Plan

APRIL 1, 2000–MARCH 31, 2002



Government
of Canada

Gouvernement
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Northern Science and Technology in Canada:

Federal Framework and Research Plan

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Committee on Northern Science and Technology.

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Foreword

This report describes the key programs and activities of federal departments and agencies that support Northern science and technology.

The overall goal and objective of the *Northern Science and Technology in Canada: Federal Framework and Research Plan* is to maximize, in partnership with governments, universities and northern peoples, the return on federal investment in science and technology so that activities and results contribute to sustainable development, the advancement of knowledge, and the improved quality of life and environment in the Canadian North.

Photo: DFO



Canada's North cannot be seen in isolation. Our northern regions are part of a circumpolar world that shares physical and environmental characteristics, as well as challenges and opportunities.

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Preamble

The federal government has developed the *Northern Science and Technology in Canada: Federal Framework and Research Plan* to ensure that federally funded science and technology (S&T) continues to improve the quality of life and the environment, social and economic well-being, and the advancement of knowledge in northern Canada.

Photo: DFO

Recent years have seen dramatic changes in the North. The Territory of Nunavut has been established, new northern-based administrative and management institutions have been created, and northern Aboriginal people throughout Canada have proceeded with land claim settlements and regional self-government. At the international level, Canada has joined with other Arctic States to form the Arctic Council and new ties have been forged with non-governmental organizations concerned about Arctic issues. Recently, the federal government strengthened Canada's overall foreign policy by developing the *Northern Dimension of Canada's Foreign Policy*.

Throughout this period of intense northern political and policy evolution, federal and territorial governments have worked together to develop and carry out S&T activities that reflect northern aspects of the national strategy for S&T, as outlined in *Science and Technology for the New Century*. This strategy supports sustainable development, the advancement of knowledge, socio-economic objectives and improved quality of life. The federal government is the largest single contributor to S&T in Canada and supports these goals throughout Canada, including the Canadian North.



In order for Canada to meet its S&T needs in its North, we need to be able to draw on the global pool of knowledge. Implicit in drawing on this pool is the moral obligation to also contribute to it.

Canada's North cannot be seen in isolation. Our northern regions are part of a circumpolar world that shares physical and environmental characteristics, as well as challenges and opportunities. Understanding those characteristics, meeting those challenges and exploiting those opportunities requires cooperation and information sharing. In order for Canada to meet its S&T needs in its North, we need to be able to draw on the global pool of knowledge. Implicit in drawing on this pool is the moral obligation to also contribute to it.

Canada established a prominent place in the family of circumpolar nations as a founding member of the Arctic Council. Participating in such international organizations, maintaining diplomatic and scientific relations with our neighbours, and keeping Canada's place in the leading group of industrialized nations often requires the

support of Northern S&T activities. The *Northern Science and Technology in Canada: Federal Framework and Research Plan* details the Northern S&T activities of federal departments and agencies. While these address Canada's needs and interests, many of them also represent Canada's contribution to the global pool of knowledge about the circumpolar world.

Many federal departments support Northern S&T; each has priorities related to its mandate. The *Northern Science and Technology in Canada: Federal Framework and Research Plan* will assist in setting priorities for Northern S&T on an interdepartmental basis. It represents a coordinated federal basis for the promotion and enhancement of Canadian Northern S&T cooperation, as well as partnership and international linkages throughout the circumpolar region.

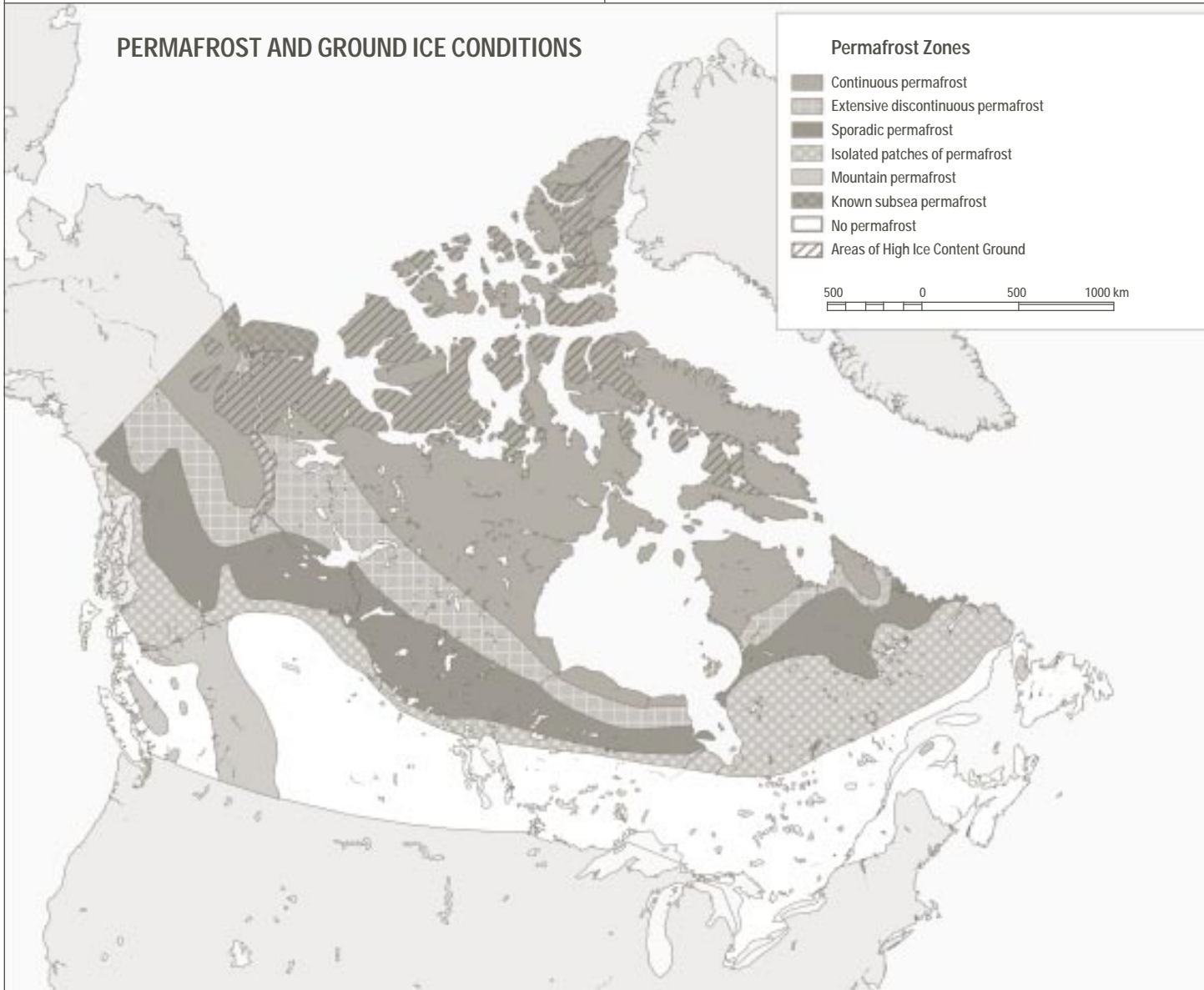
The *Northern Science and Technology in Canada: Federal Framework and Research Plan* is divided into two parts – Part 1: *Federal Framework for Northern Science and Technology* (the Framework), and Part 2: *Federal Northern Research Plan* (the Research Plan). The Framework outlines the guiding principles and objectives, as well as the key issues. The Research Plan describes the implementation of federal Northern S&T activities, from April 1, 2000 to March 31, 2002, to support the Framework. The Framework and the Research Plan will help to maximize investments in Northern S&T, and to focus on the scientific resources and expertise – as well as capacity building and training – that are needed to address the issues that are the most important to the Canadian North and to the rest of Canada.

Definition and Boundaries of Northern Canada

Canadian legislation, institutions, regulations, government programs and Canadians generally define the “North” in a variety of ways. As a result, the interpretation of the geographic location of the “North” or the meaning of “northern” issues may be different depending on the context or its use in different parts of the country.

Most “northern” issues and topics of scientific, research or technology development relate to common high-latitude environmental processes, socio-economic conditions and geographic location. Often, there are no exact geographic boundaries. In other cases, “northern” boundaries have been defined for specific jurisdictional purposes; distinct policies, regulations or programs may apply within these boundaries.

The Northern Science and Technology in Canada: Federal Framework and Research Plan does not recognize a specific “northern” boundary, rather it generally interprets Canada’s northern region as the land- and ocean-based territory that lies above the line of discontinuous permafrost, from northern British Columbia to northern Labrador. See the map below.



Source: Canada, Natural Resources. 1995. Canada – Permafrost. Map. Scale 1:7,500,000 (MCR4177). In: National Atlas of Canada. 5th ed. Ottawa: National Atlas Information Service, Geomatics Canada, and Terrain Sciences Division, Geological Survey of Canada. Ottawa. Plate 2.1.

Part 1: A Federal Framework for Northern Science and Technology in Canada

1.1 Introduction

The Framework outlines the guiding principles and objectives of federally funded Northern S&T activities. It also briefly discusses delivery, coordination, consultation, implementation, training and logistical support, as well as key issues, related to Northern S&T. The Framework establishes a new foundation for building on successful Northern S&T partnerships, federal coordination and cooperation, and Canadian involvement in international Northern S&T initiatives.

Photo: DFO



Understanding global climate change and its effects on northern Canada is a major federal research priority. Predictions on climate change scenarios draw attention to significant feedback interaction between conditions in the Arctic and elsewhere.

1.2 Principles

- Recognize the importance and distinctiveness of Northern S&T within Canada.
- Respect northern land claims agreements and political evolution in the North.
- Respect distinctive social, economic, environmental and cultural characteristics of northern regions in Canada.
- Respect, accommodate and promote the advancement of Aboriginal traditional knowledge and universal scientific traditions of inquiry.
- Interpret Northern S&T as an interdisciplinary mixture of the social, physical, natural and health sciences, including Aboriginal traditional knowledge.
- Encourage consultation with and participation of Northerners in federal Northern S&T activities.
- Support improving the quality of life and overall advancement of knowledge in Canada's northern regions.
- Support the promotion of Canadian leadership and cooperation in Northern S&T internationally.
- Support the protection and conservation of the northern environment, as well as environmentally sustainable northern economic development.
- Support the communication of Northern S&T to a wide range of users and the Canadian public, and support institutional cooperation in Northern S&T among the federal government and non-federal institutions within Canada and internationally.

1.3 Objectives

- Provide a federal government-wide perspective for Northern S&T.
- Enhance Northern S&T cooperation among the scientists and institutions who receive federal funding, as well as Northern S&T partnerships involving northern communities and institutions.
- Improve the effectiveness and efficiency of federally funded S&T programs, services and activities.
- Promote the involvement of Northerners and their knowledge in northern and national issues.
- Promote and enhance the contribution of Northern S&T for national goals and programs, and promote the integration of northern knowledge into national knowledge bases.
- Facilitate knowledge-based decision making in the North, as well as knowledge-based connections among community, regional, national and international issues.
- Encourage the development and transfer of technologies that support environmentally sustainable economic development in the North.
- Promote building scientific expertise in the North and about the North.
- Promote and facilitate the use of Aboriginal knowledge.

1.4 Coordination and Cooperation

Several departments and agencies share the delivery of federal Northern S&T; these activities are carried out to meet specific mandates, missions and policy objectives. Nevertheless, all federal departments and agencies involved in various Northern S&T activities share common goals, objectives and principles related to the conduct, impact and coordination of federally funded Northern S&T. The Framework and the Research Plan reflect these common values and objectives.

Development and maintenance of the Framework and Research Plan are coordinated by the Interdepartmental Committee on Northern Science and Technology, ADM Level, which includes representatives from Environment Canada, Health Canada, Department of Fisheries and Oceans (DFO), Department of Indian Affairs and Northern Development (DIAND), Industry Canada, Department of National Defence (DND), Natural Sciences and Engineering Research Council (NSERC), Natural Resources Canada (NRCan), Transport Canada and the Canadian Polar Commission (CPC).



Key areas of interest include improving the understanding of northern ecology and biodiversity, and the effects of anthropogenic stress on northern ecology.

1.5 Consultation

A variety of mechanisms are used for consultation among involved federal departments and agencies, northern governments and institutions, and northern stakeholders. Federal departments and agencies that fund or conduct Northern S&T are increasing the focus on the needs and interests of northern residents, including Aboriginal people, northern industries, communities, northern science institutes and co-management institutions. Special workshops have been held at Strathmere, Ontario, and Inuvik, Northwest Territories (NWT) to consult with scientists and Northerners on Northern S&T.

1.6 Implementation

The Framework outlines the key Northern S&T issues. It is implemented through the Research Plan which outlines activities being undertaken over the next two years in the key areas. These activities are undertaken by multiple, as well as individual, departments and agencies. The Research Plan also provides an overview of current and near-term federal support for Northern S&T training in Canada and logistical support for northern research.

Many northern and other institutional partners – including Canadian universities and colleges, northern government departments and agencies, northern research institutes and northern resource management boards – play important roles in implementing the Framework. These partners often provide logistical support, human resources and facilities to support federally funded northern research programs. In some cases, they carry out their own research programs which may involve federal participation. Implementing the Framework also includes outreach to northern communities.

1.7 Federal Expenditures on Northern Science and Technology

Federal expenditures in support of federally funded Northern S&T activities are difficult to determine accurately, because they are not classified by region and many of the activities are sub-components of larger national programs. In addition, many federal program expenditures are not specifically directed toward the development of research or technology but may have considerable impacts in these areas. The following table presents current federal approximate annual expenditures for Northern S&T.

CURRENT FEDERAL APPROXIMATE ANNUAL EXPENDITURES FOR NORTHERN S&T (2000-2002)

Federal Department or Agency	Approximate Annual Federal Northern S&T Expenditures (in Millions)
Canadian Museum of Nature	0.5
Canadian Museum of Civilization	0.3
Environment Canada ¹	25.0
Fisheries and Oceans Canada	6.0
Indian and Northern Affairs Canada ²	9.0
Health Canada	5.0
National Defence	0.5
National Research Council:	
Industrial Research Assistance Program	0.5
Natural Resources Canada ³	12.5
Transport Canada	4.4
Federal Granting Agencies: Natural Sciences and Engineering Research Council, Social Sciences and Humanities Research Council, Medical Research Council ⁴	2.0
TOTAL ⁵	65.7

1 Expenditures are for the area covered under the northern Ecosystem Initiative which includes northern Quebec and Labrador as well as the area north of 60° latitude.
 2 Expenditures include NCP, NSTP and those programs related to northern resource management.
 3 Expenditures are for the area north of 60° latitude.
 4 Awards are not tracked according to the geographical location of the research. Some information on northern relevance may be obtained from databases, but is not consistently collected for all projects. The figure quoted is based on available data and is an order of magnitude estimate. The actual figure could vary significantly from year to year, depending on which major projects are funded. In general, awards cover the direct costs of research (student stipends, supplies, travel, etc.), but not the salaries of professors or most of the infrastructure costs.
 5 This total does not represent all expenditures on Northern S&T; other departments or agencies may have expenditures as well and/or contribute other kinds of support.

1.8 Key Areas of Federal Involvement in Northern Science and Technology

The key areas for federal Northern S&T activities are presented below. The integrated nature of social, health, environmental, resource and economic issues in the North requires both interdisciplinary and multi-disciplinary knowledge. This knowledge is built on scientific research from many agencies and institutions, and on the traditional knowledge of northern Aboriginal people.

Canada's Northern S&T cannot be developed in isolation from that of other circumpolar nations or be confined to specific northern regions. Therefore, the key areas also reflect regional, national and international dimensions.

Key areas for Northern S&T activities include:

- contaminants and toxic substances,
- climate change,
- ozone depletion,
- human health and safety,
- northern ecosystems and biodiversity,
- sustainable development and management of natural resources,
- infrastructure development, maintenance and national northern services, and northern sovereignty.

1.8.1 Contaminants and Toxic Substances

Northern research on contaminants and toxic substances is predominantly coordinated and managed through the Northern Contaminants Program (NCP). The NCP is jointly funded by DIAND, DFO, Health Canada and Environment Canada. The NCP also involves S&T partnerships with five northern Aboriginal organizations (Council of Yukon First Nations, Dene Nation, Inuit Circumpolar Conference, Inuit Tapirisat of Canada, Métis Nation) and several territorial government departments.

Through NCP-funded activities, toxicological, environmental and other health studies assess the exposure of humans to contaminants in the North, with particular emphasis on mothers and the developing fetus. NCP data also quantify the nutritional and dietary importance of traditionally harvested food to Northerners.

Northern research on contaminants and toxic substances is also funded through the Toxic Substances Research Initiative (TSRI). This joint Health Canada and Environment Canada initiative supports research on the effects of heavy metals in the environment, persistent organic pollutants and endocrine disrupting chemicals on human health and the environment.

1.8.2 Climate Change

Understanding global climate change and its effects on northern Canada is a major federal research priority. Predictions on climate change scenarios draw attention to significant feedback interaction between conditions in the Arctic and elsewhere. In addition, climate change is likely to have the greatest effects on regions in high latitudes, and recent changes in climate are apparently evident in northern locations. Studying these provides valuable information to support global models for climate change. Such work will also lead to evaluating further the effects of climate change in Canada, as well as developing adaptive and mitigative strategies to minimize negative effects on Canadian society and the economy. Environment Canada and NRCan are lead agencies in climate change research. Research in this area is also carried out by many federal departments and Canadian universities.

1.8.3 Ozone Depletion

Federally funded research on stratospheric ozone depletion and its environmental effects is conducted primarily by Environment Canada, often in partnership with a number of Canadian universities. Scientific evidence of stratospheric ozone depletion and subsequent increases in ultraviolet-B (UV-B) radiation in the Canadian North have heightened concerns over the effects on the health of all Canadians, as well as on the environment. This issue has particular relevance for northern populations and ecosystems because they are subject to greater rates of ozone-layer depletion. Northern ecosystems may be especially vulnerable

to these changes. The effects of increased UV-B radiation on environmental systems is very complex and still poorly understood.

1.8.4 Human Health and Safety

Human health and safety in the North is a critical issue. Research in these areas is funded and carried out primarily by Health Canada, often in collaboration with northern governments, DIAND, other federal departments, Canadian universities and northern non-government research institutions. The advancement of knowledge in the health sciences and the development of new S&T-based health services are critical to improving the quality of life of northern Canadians, creating new jobs and stimulating economic growth. The Health Protection Branch and the Medical Services Branch of Health Canada carry out research to support human health and safety. Primary areas for this research include northern food science (e.g. foodborne microbiological contamination), therapeutics, disease surveillance and understanding the effects of northern-based environmental hazards (e.g. polychlorinated biphenyls [PCBs], mercury, lead, pesticides) on human health.

1.8.5 Northern Ecosystems and Biodiversity

Federal research on northern ecosystems and biodiversity involves multiple federal departments, many universities, and provincial, territorial and local governments, Aboriginal land claim organizations and northern community-based non-government organizations. Key areas of interest include improving the understanding of northern ecology and biodiversity, and the effects of anthropogenic stress on northern ecology (e.g. northern wetlands, wildlife, wildlife habitat). Many issues are circumpolar in nature (e.g. the effects of climate change on northern wildlife and wildlife habitat). Federal departments and agencies engaged in biodiversity and habitat research in the Canadian North include the Parks Canada Agency (Canadian Heritage), the Canadian Museum of Nature (Canadian Heritage), Environment Canada, DFO and DIAND.

1.8.6 Sustainable Development and Management of Natural Resources

Significant federal S&T resources are directed to providing the knowledge base to support the sustainable development and management of both renewable and non-renewable resources. Federal departments involved include NRCan, Environment Canada and DFO. S&T partnerships have been established in this area with researchers in other circumpolar nations, Canadian universities, northern government departments and Aboriginal management organizations. Key areas of interest include geosciences (e.g. geological surveys, infrastructure development and associated environmental protection studies), developing mineral technology, managing wildlife and sustainable harvesting, managing aquatic habitat, developing and conserving fisheries, developing renewable energy technologies, managing forests and oceans, and providing geo-spatial data infrastructures.

1.8.7 Infrastructure Development, Maintenance and National Northern Services

Federal S&T investments to support northern infrastructure and services are extremely important to northern residents. Many remote northern communities do not have access to highway connections and severe weather is frequent. In addition, community and residential infrastructure are provided under permafrost conditions. Forecasting severe weather and providing roads, ice roads, pipelines, port facilities

and cold-weather construction technologies are essential services. Federally funded and conducted research helps meet the challenges of providing services and improving the quality of life for northern residents and communities. Transport Canada, DFO, Environment Canada and NRCan deliver significant S&T programs to support northern infrastructure development, maintenance and services. For example, the federal Industrial Research Assistance Program assists local industries to conduct applied research and develop appropriate technologies. Environment Canada conducts research to support new weather forecasting techniques.

1.8.8 Northern Sovereignty

Northern S&T supports Canada's sovereignty in the Arctic by maintaining research stations at such locations as the Canadian Forces Station (CFS) at Alert, and Polar Continental Shelf Project (PCSP) bases at Tuktoyaktuk and Resolute Bay. Other northern-based research facilities include the stratospheric ozone monitoring station at Eureka. DND conducts research in the area of northern surveillance. Recent work has focused on underwater acoustic characteristics of the channels of the Archipelago and the Arctic Basin.

1.9 Northern Science and Technology Training and Support for Education

Northern research conducted by universities and the training of northern scientists are supported by the federal government through NSERC, the Social Sciences and Humanities Research Council (SSHRC) and the Medical Research Council. Many university and college students undertaking research in the North are supported by the federal Northern Scientific Training Program. This program uses a competitive peer review proposal process and is administered by DIAND. Various NSERC programs support Northern S&T training, including the Research Grants Program, the Research Partnerships Program, and a range of scholarships and fellowships. International and other special research collaborations are promoted through the International Opportunity Fund and the Collaborative Research Opportunities Program.

1.10 Logistical Support for Northern Science and Technology

Several federal departments provide logistical support for research in northern Canada. PCSP provides logistical and facility support services. These are provided through a coordinated cost-effective transportation, communications, logistical support and infrastructure designed to ensure the greatest physical safety and scientific productivity for its clients. At the heart of PCSP's logistical system are bases at Resolute Bay in the eastern Arctic and Tuktoyaktuk in the western Arctic.

DFO provides world-class icebreaker platforms for scientific studies in Canada's northern marine environment. Environment Canada and DND provide some logistical and research facility support through research and surveillance monitoring facilities in remote locations (e.g. Eureka, CFS Alert).

1.11 Knowledge and Information Management

Federal departments and agencies involved in northern research maintain extensive holdings of information and data derived from a wide variety of monitoring and research activities. A reliable way of accessing such resources is integral to Canadian research in the North and to Canadians' understanding of the importance of northern science and technology.

Part 2: The Federal Northern Research Plan

2.1 Introduction

The Research Plan describes how the Framework is being implemented. It summarizes the most significant programs and activities of each federal department in key research areas – first on the basis of integrated interagency activities and then on the basis of individual agency research. The Research Plan also addresses federal support for Northern S&T training, logistical support services, information management and communications planning.

Photo: DIAND



Northern research on contaminants and toxic substances is predominantly coordinated and managed through the Northern Contaminants Program (NCP). The NCP is jointly funded by DIAND, DFO, Health Canada and Environment Canada.

Future developments are mentioned in some areas. It is expected that the Research Plan will be renewed at two-year intervals.

With increased attention focused on economic, social and environmental issues in Canada's North, the Interdepartmental Committee on Northern Science and Technology has attached priority to an analysis of current and emerging research requirements, challenges, opportunities and gaps – with a view to determining immediate and future requirements, and establishing strategic directions for Northern S&T, both domestically and internationally.

2.2 Integrated Interagency Northern Science and Technology Activities

2.2.1 Contaminants and Toxic Substances

Northern Contaminants Program

Goal

To reduce and, where possible, eliminate contaminants in northern traditionally harvested foods while providing information that assists informed decision making by individuals and communities in their food use.

Background

The NCP was established in 1991 in response to concerns about contaminants in northern traditionally harvested foods. These concerns arose following cooperative studies by a number of federal and territorial government departments in the mid- to late-1980s on contaminants in the Arctic. The studies indicated a wide spectrum of substances – persistent organic pollutants (POPs), heavy metals and radionuclides – some of which had no Arctic or Canadian sources but were found in unexpectedly high levels in Arctic biota. These findings were of concern, particularly because of the potential human health implications for many northern Aboriginal people; many depend on traditionally harvested species that are high trophic-level consumers.

Under Phase I of the NCP, sources, pathways, fate, magnitude, geographic extent, trends and effects of POPs, heavy metals and radionuclides in the northern ecosystem (which includes humans) were determined. In 1997, the *Canadian Arctic Contaminants Assessment Report* published the findings. Phase II, which will continue into 2003, builds upon the work conducted under Phase I. It focuses on addressing the immediate human health and safety issues associated with contaminants in traditionally harvested foods and taking international action to control contaminants, in particular POPs.

Objectives

- Measure contaminant levels in the Canadian North.
- Determine sources, pathways and fate of contaminants found in the North.
- Assess the effects of contaminants on the health of the northern environment, including humans.
- Provide information to assist Northerners' decision making and to encourage their involvement in the NCP.
- Pursue international agreements and cooperation to control contamination at a global level.

Implementation Elements

The strategic action plan for Phase II was developed following northern consultation and with the full participation of the northern Aboriginal

organizations. The NCP addresses the above objectives and allocates funds for research and related activities through its five main sub-programs. The five main sub-programs listed below are interlinked and contribute to addressing immediate health and safety issues:

Human Health Research – to determine the risks to humans from consuming traditionally harvested foods, as well as the effects on the developing fetus through contaminant exposure from the mother's diet.

Education and Communications – to provide Northerners with the information needed to make informed decisions on their food use.

Monitoring the Health of Arctic Peoples and Ecosystems – to collect data necessary to support human health hazard assessments.

International Activities – to control the input of contaminants to the Arctic.

Aboriginal Partnerships – to ensure appropriate communications occur with northern Aboriginal communities.



Canada's northern citizens are concerned about the effect of exposure to toxic substances on current and future generations, as well as the effects of these substances on the environment.

The NCP also coordinates Canada's role in international Arctic cooperation on these topics and contributes significantly to negotiations for international contaminant controls of relevance to the Arctic.

Using NCP Results

Through NCP-funded research, toxicological and other health studies are used to assess the human health implications of exposure to contaminants in the North, with particular emphasis on mothers and the developing fetus. NCP studies also quantify the nutritional and dietary importance of traditionally harvested foods to Northerners. This provides context for the concerns engendered by contamination of the food chain. It also heightens the awareness of Northerners' dependence on these foods and therefore of the critical and immediate need for action to reduce contaminant levels in these foods.

The NCP ensures that the information communicated to Arctic communities is accurate and complete. This empowers communities to be involved in making risk-management decisions to protect human health as well as to respect the sociocultural, economic and spiritual benefits associated with the consumption of traditionally harvested foods. Northern Aboriginal organizations have taken the lead on developing and delivering communications strategies and educational materials – with NCP support and capacity building.

Research generated through the NCP represents leading-edge science in the field of environmental contamination with POPs. Data on the occurrence, abundance, sources, pathways, fate, spatial and temporal trends, and the effects of POPs, heavy metals and radionuclides in Arctic ecosystems have significantly contributed to the global knowledge base.

The information generated by the NCP has also been used to assist with the management and control of persistent and bioaccumulative substances on domestic and international fronts. Nationally, NCP data have strengthened, accelerated and substantiated domestic policies (e.g. the federal *Toxic Substances Management Policy*) and legislation on toxic substances, particularly those that are persistent and bioaccumulative. Data have also resulted in calls for international action on long-range, transported, persistent, bioaccumulative and toxic substances.

Photo: DIAND



Only with the best scientific knowledge can we begin to understand the effects of changing climate on the physical and biological environment, ecosystems and human population of the North.

Management Structure, Innovative Partnerships and Linkages to Other Programs

The NCP is directed by a management committee chaired by DIAND. It includes representatives from the five northern Aboriginal organizations (Council of Yukon First Nations, Dene Nation, Inuit Circumpolar Conference, Inuit Tapirisat of Canada, Métis Nation), territorial governments (Yukon, NWT, Nunavut) and four federal departments (Environment Canada, DFO, Health Canada, DIAND). The management committee is responsible for establishing NCP policy and research priorities, and for final decisions on the allocation of funds. Two regional contaminants committees in the NWT and Yukon support this national committee, and one will soon be formed in Nunavut. Through the NCP structure, the issue of Arctic ecosystem contamination is addressed using approaches that ensure scientific integrity and relevance, while responding to community concerns and priorities.

Funding for the NCP's \$5.4 million annual research budget comes from Treasury Board and participating federal departments (DIAND, Health Canada, DFO, Environment Canada). In partnership with the departments, northern Aboriginal organizations have been able to develop internal capacities to work on contaminants issues and other important environmental issues with their constituents. In addition, they have been able to participate at the national and international levels to ensure their positions are considered in policy development, including substantiating the need for control of contaminants. This is well illustrated by their active participation in the Arctic Council as well as by the

important role played by the Inuit Circumpolar Conference in lobbying the executive body of the United Nations (UN) Economic Commission for Europe to move forward with a protocol for POPs under the *Convention on Long-range Transboundary Pollution*. In addition, with the support of the NCP, northern Aboriginal organizations are coordinated in a united voice – the Canadian Arctic Indigenous People Against POPs – at the ongoing United Nations Environment Programme (UNEP) global negotiations on POPs.

The NCP works closely with the Arctic Council's Arctic Monitoring and Assessment Programme (AMAP). The eight Arctic countries, several observer countries, Aboriginal peoples' organizations and a number of international organizations cooperate through AMAP to monitor and assess anthropogenic pollution in the circumpolar Arctic. The results of NCP projects represent the main Canadian contribution to AMAP. These results were an integral part of the comprehensive *AMAP Assessment Report: Arctic Pollution Issues* published in 1998. Through the NCP, Canada has also played a leadership role in the UN Economic Commission for Europe negotiations for protocols on POPs and heavy metals in northern hemisphere countries under the *Convention on Long-range Transboundary Pollution*, as well as at the current UNEP negotiations for a global protocol on POPs.

Toxic Substances Research Initiative

Goal

To enhance Canadian environmental and health science capacity through a better understanding of toxic substances and their effects on environmental and human health.

Background

All Canadians are exposed to toxic substances to some degree through food, water and air. The nature and degree of exposure varies significantly from region to region and with eating habits. Although not fully quantified, significant economic and social costs associated with health and environmental problems are also attributable to toxic substances.

The TSRI is a joint project of Health Canada and Environment Canada. Its scope is national but it significantly contributes to research on toxic substances in Canada's North. This initiative supports research projects from the federal government and other sectors (e.g. universities, the private sector, non-government or community-based research organizations). The TSRI also supports multi-disciplinary team research in priority areas and emerging issues not adequately addressed by other programs in the federal government.

It promotes partnerships among the researchers in all sectors by stabilizing existing research partnerships and fostering the development of new collaborations. This approach enhances the Canadian environmental and health science capacity, and recognizes the importance of all sectors in developing new scientific knowledge. In addition, these partnerships help minimize the potential for duplication of research under other research programs on toxic substances.

Canada's northern citizens are concerned about the effect of exposure to toxic substances on current and future generations, as well as the effects of these substances on the environment. A variety of health problems are currently associated with toxic substances (e.g. various forms of cancer, respiratory and cardiovascular diseases, diseases of aging, reproductive problems). Effects on northern ecosystems include the contamination of wildlife, fish, plants, water and soil, and associated

wildlife disease, population reductions, reduced biodiversity and habitat degradation.

Objectives

The key objective of the TSRI is to enhance the knowledge base needed to define and reduce the ecosystem and health effects of toxic substances in Canada, including the North. This includes knowledge needed to conduct risk assessments, develop risk-management strategies, evaluate risk-management options and provide Canadians with the sound science on which to base their own decisions.

Implementation Elements

Between 1999 and 2002, the TSRI will invest \$40 million toward research on toxic substances to protect human health and the health of Canada's environment. It will focus strategic and applied research in the four key areas mentioned below. These efforts will also help Canada meet its commitments under the new *Canadian Environmental Protection Act*.

POPs – to strengthen and accelerate development of our scientific knowledge of POPs that may move long distances and cause significant effects on human health and the environment.

Metals in the environment – to accelerate research activities designed to understand metal sources, environmental loadings, human exposure and the toxicological significance of specific forms of metals in the environment.

Endocrine disrupting chemicals – to accelerate research activities designed to establish an adequate understanding of the implications of endocrine disrupting chemicals.

Cumulative effects of toxic substances – to accelerate research needed to improve understanding of the cumulative ecosystem and human health effects of toxic substances, address other emerging toxic substance research issues that arise over the lifetime of this program, and address toxic substance research issues that fall into more than one of the four areas listed above.

2.2.2 Climate Change

Goal

To predict and understand the extent and impact of climate change on the physical and biological environment of the Arctic and northern Canada, and the consequences for terrestrial and marine ecosystems and human activities of likely or possible climate change, by providing climate-related scientific information from the Canadian North and the Arctic Ocean together with improved knowledge of the processes of climate changes and ecological responses in polar regions.

Background

The single northern research issue that cuts across all scientific disciplines and federal mandates is that of climate change. Physical, biological and social scientists see climate change and the effects of climate change on Arctic ecosystems and human health as a primary concern. Climate change research and related scientific activities often require large-scale, long-term and multi-disciplinary research investment by the federal government and other stakeholders.

All activities in northern Canada and the Arctic regions are more sensitive to climatic conditions than those in temperate regions. Therefore, improved knowledge of climate change is essential for sound

policies, investment and practices for sustainable development in the North. Such information and knowledge will also contribute to predicting and understanding environmental and ecological change in all of Canada, as well as in other parts of the world. In addition, it will facilitate activities to reduce the anthropomorphic causes of climate change and to help in adapting human activities to the changes.

Past changes in global climate have been most pronounced at high latitudes in the Northern Hemisphere. Computer models predict that future warming – which is caused in large part by human activities and is likely to be very rapid in comparison to past changes – will also be greatest in this part of the globe.

As an Arctic country, Canada has good reason for interest in and concern about the character and rate of change in the terrestrial and marine climate in the Arctic. Only with the best scientific knowledge can Canadians begin to predict and understand the effects of changing climate on the physical and biological environment, ecosystems and human population of the North. Moreover, the Arctic plays a pivotal role in the global climate system, and its climate is closely linked to the climate of densely populated lower latitudes. Climate change in the Arctic will have direct or indirect effects on all Canadians.

Much of the total Arctic marine and terrestrial environment lies under Canadian jurisdiction; therefore, Canadians have an international obligation to identify and undertake research in the Arctic to understand the climate system and improve predictions of future conditions. The scale and the interrelatedness of the global climate problem demands coordinated international research and data collection. Canada cannot rely on the activities of other countries for guidance on policies related to the effects of and adaptation to global climate change.

Internationally, Canada is active in the Inter-American Institute for Global Change Research, the Intergovernmental Oceanographic Commission, the Intergovernmental Panel on Climate Change and other efforts designed to better understand the causes, effects and solutions to climate and global change. Canadian Arctic climate research is planned in order to address Canadian needs – within the collaborative context established by existing and planned international climate projects. In this way, the greatest leverage will be gained from international scientific spending on high-latitude research.

Mitigation measures designed to address the impacts of climate on the environment can, at best, only slow the effects of climate change. The key to the sustained social, economic and environmental health of Canada is promoting adaptations to climate change in positive ways. Research focuses on questions that address the following areas:

- Improve the understanding of climate processes and better knowledge of the links and feedbacks between physical and biological factors that affect variations in climate and ecological responses.
- Predict the effects of climate change impact.
- Identify options for adaptation to climate and environmental change.

Arctic climate reflects the operation of a complex system with physical, chemical, biological and human links. This system encompasses the atmospheric, oceanic and terrestrial environments. The Arctic climate system responds to and influences the global climate system via many pathways. Principal among these are the meridional transports of heat and freshwater by the atmospheric circulation and the oceanic global conveyor belt, the snow-ice-albedo feedback, the cloud-radiation feedback, the carbon cycle, ecosystem dynamics and the hydrologic cycle.

A high degree of variability over a wide range of temporal and spatial scales is an intrinsic characteristic of Arctic climate. Such variability may be attributed to the unstable character of feedback and different rates of response along these pathways, and to the proximity and shifting nature of sub-Arctic oceanic and atmospheric frontal zones.

Canada's position within the Arctic climate system is unique. Closely coupled marine, terrestrial, hydrospheric and atmospheric processes operate over an extensive area of land and sea that links the most important oceans of the populated world. Canada's Arctic extends from the Beaufort Sea, through the Canadian Archipelago and the broad swath of the Barren Lands to Hudson Bay, and across the tundra and boreal forest to the Labrador Sea. Each of these major regions has its distinct response to climate change and this, in turn, has a distinctive effect on the circumpolar and global climate. The cryosphere (permafrost, snow, sea ice, lake ice and glaciers) also plays a pivotal role in the Arctic climate system.

Canadian scientists seek to reliably predict the climate and evaluate the effects of climate change in the decades to come in Canada. Understanding changes in high latitudes is central to future capabilities of Canadian governmental and industrial organizations to develop adaptive and mitigative strategies to minimize potential negative effects on Canadian society and the economy.

Objectives

Long-term objectives

- Obtain knowledge of changes in the climate of northern terrestrial and oceanic areas, including variability from region to region, that are likely or plausible within the next century.
- Obtain knowledge of consequent expected effects on ecosystems, terrain, hydrological and marine conditions, and human activities.

This knowledge will be vital for public awareness, policy development, resource and environmental assessment, investment, technology development and decision making in adapting to changed conditions. It is also important to understand expected changes in the rest of Canada and globally that are strongly influenced by changes in the climate of the northern and southern polar regions.

Activities and results from individual and collaborative studies will include the following:

- Continued accurate data gathering on atmospheric and oceanic climate conditions across northern Canada and adjacent areas, linked to compatible data from the circumpolar regions, the rest of Canada and the world.
- Enhanced understanding of processes, rates and magnitudes of energy and moisture fluxes among the atmosphere, sea and land in northern Canada and the Arctic region at all seasons, and of their roles in regional, hemispheric and global environmental change.
- Increased knowledge of the roles of permafrost, glaciers, icefields, sea ice and the hydrology of northern Canada, and the boreal forest and wetlands in triggering or modifying local or regional climate in northern Canada, and of the interactive feedback among the characteristics of the northern environment, and atmospheric and oceanic climate and circulation.
- Acquired data and knowledge of the factors and processes that result in distinctly different climatic variations and responses to regional climate change in different typical parts of northern Canada.

- Increased ability to predict patterns, rates and magnitudes of variations and changes in the climates of the major regions of northern Canada, on scales of decades to a few centuries, to serve as a basis for assessing likely ecological consequences and human responses or adaptation, thereby also to increase knowledge and predictability of climate change in the rest of Canada and the world.

Achievement of these objectives entails, together with our national and international partners, the following:

- Continued and enhanced surface and upper-air observation networks in northern Canada.
- Improved long-term monitoring of the three-dimensional physical and chemical characteristics and movement of waters of the North Atlantic, North Pacific and Arctic Ocean, and within the Canadian Arctic Archipelago.
- Improved information on sea ice, snow cover and glaciers in northern Canada and changes in northern forests.
- Refined coupled ocean-atmospheric-ice climate models specific to high latitudes and northern Canada, together with the increased ability to factor ice and snow cover, coastal effects, sea ice, river and lake break-up and freeze-up, and the effects of vegetation into meso-scale predictive models.

Two-year objectives

The broad strategy over the first two years will be to determine the present understanding of Arctic climate in a Canadian context and to formulate, from this basis, an optimal plan for future sustained climate research. The appropriate paradigm is that of a "climate system" – a complex coupling of atmospheric, terrestrial and marine elements that collectively determines the Arctic climate.

The output of this system has changed noticeably over the last few decades. In the western Canadian Arctic, the climate has warmed, mainly because the winters have been warmer. In parts of the eastern Canadian Arctic, persistently colder summers have resulted in a cooler annual climate. At the same time, there have been important changes in the variability of the weather and precipitation. Such changes and their impacts, rather than the average annual climate, are the present concern.

In the first two years, the impacts to be addressed are those related to the natural environment. While in many cases these effects may have socio-economic consequences, the effects on human activities are not the primary goal of these initial studies of the Arctic Climate System Study (ACSYS) of the World Climate Research Program (WCRP). Policies and plans for the North must continue to be related to present knowledge of northern environmental conditions. However, research on the response of the physical environment must take place before formulating responsible, well-informed, long-term policies and adaptive measures for affected sectors of society.

Implementation Elements

Arctic Canada is remote and sparsely populated, and its climate is harsh; field research activity is challenging and expensive. Access to field sites in the Arctic is beyond the capabilities and financial means of most research teams unless coordinated and experienced logistical assistance is available.

Since the International Geophysical Year, 1957-1958, High Arctic Weather Stations and PCSP had provided for much of the field assistance for research in the Canadian Arctic. PCSP support for national and

international research is recognized as a model for economic, scientifically effective and safe logistical operations that support research in the Arctic.

At present, PCSP bases at Resolute and Eureka provide researchers with good logistical support for research within the Canadian Arctic Archipelago during the spring and summer months. A similar facility at Tuktoyaktuk on the Beaufort Sea coast provided support to researchers in the western Canadian Arctic until 1996. However, demand for the use of this base has declined in recent years. Former weather stations at Mould Bay and Isachsen in the western part of the Canadian Arctic Archipelago are closed. These, together with stations that still operate, have served as valuable sources of weather, climatic, geophysical and oceanographic data, and as logistical outposts for field teams.

Access by researchers to the ice-covered waters of the Arctic Ocean is more difficult and expensive and less safe than it was a decade ago. In the context of climate change research, the scarcity of facilities for research and data is of particular concern since warming is predicted to be the greatest in the western Arctic.

During 1997-1998, Canadian Coast Guard (CCG) icebreakers were pivotal in the successes of the United States-Canada Surface Heat and Energy Balance of the Arctic Ocean Project, and the Canadian North Water Project in Baffin Bay. Icebreakers can also provide valuable support to research activity in remote Arctic land areas, as the *Louis S. St-Laurent* did for the Tundra Northwest 99 Study (Sweden, DFO) in 1999.

The two-year initial phase of the Canadian Arctic Climate Research Program is planned to set in place an effective and continuing study. It is closely linked to international climate studies while tailored to Canadian conditions and needs. It also will optimize and build on continued support for logistics and university research in the Arctic.

Using Program Results

The information generated by Canada as part of national and international research initiatives in Arctic climate science is an important contribution to global research initiatives in the area of climate change. By developing time-series data on climate-related observations in the North, Canada is well positioned to improve the understanding of climate change processes and models for the Arctic.

Management Structure, Innovative Partnerships and Linkages to Other Programs

As Canada charts its course in Arctic climate study, it is very important that the research being pursued by other countries is recognized within the national research framework.

Many countries have already recognized the important role of the Arctic in the global climate system and have expanded their involvement in Arctic climate research. Predominant among these are the United States, Germany, Japan, Sweden and Norway. Japan and the United States have recently established a cooperative research centre for Arctic climate studies in Fairbanks, Alaska. Other players with increased support for Arctic research and facilities are Denmark, the United Kingdom and Poland. The European Union, through the European Science Foundation, has launched a major initiative in coordinated Arctic climate and oceanographic research. International attention is being given to support of science and data collection in the Russian and Siberian Arctic.

Canada has recently taken a larger role on the international scene through joint research initiatives such as the NorthWater Polynya Study (Université Laval), Joint Ocean Ice Studies (DFO) and the Tundra

Northwest 99 Study 99 (Sweden, DFO). As a strong member of the Arctic Council, Canada plays an important role in international Arctic climate research. Canada has contributed to international knowledge of the relations between climate change and the distribution, concentrations and effects of pollutants in northern regions through both AMAP and the Arctic Council.

The WCRP has taken a coordinating role in the Arctic, through implementing the ACSYS. Two Canadians sit on the ACSYS Scientific Steering Group. The WCRP Global Energy and Water Experiment (GEWEX) study also has significant Arctic interests, particularly in Canada where a GEWEX sub-study is focusing on the Mackenzie River drainage basin. Canadians sit on the GEWEX Scientific Steering Group as well. A new WCRP initiative, the Climate and Cryosphere Project, with important Canadian involvement, is also relevant.



During 1997-1998, Canadian Coast Guard icebreakers were pivotal in the successes of the United States-Canada Surface Heat and Energy Balance of the Arctic Ocean Project, and the Canadian North Water Project in Baffin Bay.

In addition, two global climate monitoring programs have recently been developed and approved by the international Global Climate Observing System – the Global Terrestrial Network for Permafrost and the Global Terrestrial Network for Glaciers. These are also linked to international research under the Mass Balance of Arctic Glaciers and Ice Sheets of the International Arctic Science Committee (IASC). This assemblage of international climate-related studies is additionally linked to the Global Terrestrial Observing System and in particular to its study of Global Change and Arctic Terrestrial Ecosystems. Canada has important involvement in these international initiatives.

The polar regions play a key and complementary role in the global climate system. Therefore, the changes in the Canadian Arctic and the northern and global consequences cannot be understood or assessed without reference to the climatic processes and developments in the southern polar regions. Canadian Arctic climate research is related to and supplemented by and, in turn, contributes to climatic, atmospheric, glacier and sea ice research in Antarctica – all these provide information of global importance. Canadians play a part through representation at the Antarctic Treaty Consultative Meetings and through membership in the Scientific Committee for Antarctic Research (SCAR) and its various scientific panels and working groups.

2.2.3 Ozone Depletion

Goal

To conduct scientific activities (research and monitoring) on changes in Arctic stratospheric ozone levels, the causes of these changes, and the environmental impacts of increased ultraviolet radiation resulting from reductions in the Arctic ozone layer.

Background

The federal government has actively participated in Arctic stratospheric ozone monitoring and research in Canada since the 1930s when scientists began to study the upper atmosphere as an aid to forecasting weather. Current federal activities in UV radiation and stratospheric ozone monitoring and research are a result of the concern over ozone depletion that came to light in the 1970s and 1980s when the scientific community first alerted the world of the danger to the ozone layer.

Ozonesonde Program that coordinates the launches of ozonesondes in Europe and Canada to probe the same air mass at different points as it travels around the Arctic vortex. Canada has also collaborated closely with the United States National Aeronautics and Space Administration in project *Polaris*, a campaign to investigate ozone chemistry in the Arctic.

The AES also operates the World Ozone and UV Data Centre, which collects data from networks around the world; these data are published by the World Meteorological Organization. Data collected and analyzed by this centre are essential for understanding changes in the ozone layer. Canada also participates in IASC; the effects of increased UV radiation in the Arctic have been identified as a priority area under the IASC science agenda. Studies coordinated by IASC are covering the effects on human health, aquatic and terrestrial ecosystems, as well as on societies and settlements. Integrative studies are being planned at a few selected UN International Research Centres in the Arctic.

Photo: DIAND



The Health Protection Branch is determining the safety and nutritional values of traditional northern foods. Work is being conducted on the health effects of chemicals, from airborne, natural or industrial sources, and on enhancing knowledge on vitamins.

Health S&T is critical to improving the quality of life of Canadians, advancing knowledge, and creating jobs and growth. It is even more so for Canadians living in the North.

In Canada, ozone depletion and UV radiation monitoring and research are conducted by the Atmospheric Environment Service (AES), Environment Canada and a number of Canadian universities.

Ozone depletion and the subsequent increase in UV-B radiation are of concern because of the effects on human health and the environment; these include a variety of skin cancers, eye damage, as well as damage to essential components of terrestrial and aquatic ecosystems. The impact of increased UV-B radiation on ecosystems is very complex and poorly understood. The issue has particular relevance for northern populations and ecosystems because they are subject to a greater rate of ozone-layer depletion than those in lower latitudes.

The AES operates the high Arctic Stratospheric Ozone Observatory built near the Eureka weather station as a base for international stratospheric experiments in the Arctic. The observatory is a primary component of an international Network on the Detection of Stratospheric Change, which has strengthened research efforts and created partnerships with academia and other countries. Researchers from Canadian universities, Japan, the United States and Environment Canada use it. Stratospheric ozone monitoring is also conducted by the AES at CFS Alert and PCSP at Resolute.

As a party to the *Vienna Convention* and the *Montreal Protocol*, Canada contributes to international research in joint programs with other nations. In 1992, for example, Canada participated in the Match

Objectives

- Maintain strategic federal involvement in collaborative international science efforts directed toward stratospheric ozone depletion in the Arctic and the environmental impacts of UV-B.
- Maintain current domestic measurements and analysis of stratospheric ozone levels currently recorded from three high Arctic research and monitoring stations located at CFS Alert, Eureka and Resolute.
- Continue to operate the World Ozone and UV-B Data Centre by Environment Canada in Toronto under the auspices of the UN World Meteorological Organization.
- Increase the ability of the federal government to report on stratospheric ozone monitoring results and distribute the information on a national and international level.

Implementation Elements

There are 13 ground-based stations where ozone and spectrally resolved UV measurements are made in Canada. Of these, three are in the Arctic at Resolute, Eureka and CFS Alert. Total ozone measurements are made using a Brewer spectrophotometer. Data are delivered in quasi-real time to the operational weather centres for use in producing the ozone watch program and the daily UV index forecast. Measurements of vertical profiles of ozone are also made at these Arctic sites by balloon-borne sondes. Data from the sondes produce a vertical profile of the ozone structure in

the atmosphere over the station. Partnerships in support of this work have been forged with DND and NRCan.

The Quebec regional office maintains a monitoring station, which records data on northern ozone levels, at Longue-Pointe-de-Mingan. National programs include measurements of stratospheric ozone taken in the Arctic at a number of sites.

2.2.4 Human Health and Safety

Goal

To help northern Canadians maintain and improve their health by supporting and conducting relevant science and technology.

Background

Health S&T is critical to improving the quality of life of Canadians, advancing knowledge, and creating jobs and growth. It is even more so for Canadians living in the North. They are geographically isolated, subject to harsh environmental conditions and generally live in difficult situations. Their environment is also affected by pollutants from far away.

Objectives

- Determine the safety and nutritional values of traditional northern foods.
- Determine the risks to health from environmental hazards.
- Identify genetic factors conferring susceptibility or resistance to adverse drug reactions in Inuit populations.
- Implement health strategies and surveillance programs for infectious and non-infectious diseases.
- Evaluate telehealth and develop, use and maintain health information systems for First Nations and Inuit peoples.
- Support comprehensive environmental health and contaminants programs in relation to First Nations and Inuit communities.
- Improve the health and well-being of, and increase the knowledge and understanding of sustainable development, among children and youth in the Arctic.

Implementation Elements

The Health Protection Branch (HPB) and the Medical Services Branch (MSB) are the two main branches that share the work related to Northern S&T. Key areas of activity under HPB include food science, radiation and environmental hazards, therapeutics, and infectious and chronic disease prevention and control, including surveillance. Key areas of activity under the MSB include National First Nations Telehealth Research Project, First Nations Health Information System, Aboriginal Health Institute, Native Environmental Health Services Program, NCP (Phase II), National First Nations Environmental Contaminants Program, and The Future of Children and Youth in the Arctic.

Safety and nutritional values of traditional northern foods

HPB is determining the safety and nutritional values of traditional northern foods. Work is being conducted on the health effects of chemicals, from airborne, natural or industrial sources, and on enhancing knowledge on vitamins.

Studies are also being conducted on such single pollutants as toxaphene and chlordane, and on mixtures that have accumulated in the northern food chain. Although not used on this continent for more than a decade, these POPs are believed to be transported atmospherically by

prevailing winds to the North from areas (e.g. South America and Europe) where they are still being used. One study, done in collaboration with universities and hospitals in Ontario and Quebec, is using animal models to ascertain the potential toxicological effects of toxaphene ingestion upon reproduction and immunological parameters. Currently, there is little toxicological data to assist in the assessment of the compound's potential risk to human health.

Mercury is a toxic heavy metal that originates from natural and industrial sources. It is found at elevated levels in marine mammals – a component of Inuit traditional diet. A project is under way to assess the toxicity of a mercury-selenium protein complex found in ringed seals. Selenium has been shown to afford protection against some of the toxic effects of mercury.

As part of an overall project to assess the benefits of traditional foods in the total diet of the Inuit and to enhance the Canadian Nutrient File, HPB scientists are working with colleagues at the Centre for Indigenous People's Nutrition and Environment, McGill University, to determine the levels of selected vitamins in traditionally harvested foods consumed by the Inuit.

The safety of traditional foods depends upon many factors, including the presence of radioactive chemicals. Exposure to alpha radiation from ingested natural polonium-210 is one of the most significant sources of radiation exposure in caribou and in northern human populations who are dependent on caribou for a major portion of their meat supply. A significant body of knowledge exists on the concentration of polonium-210 in caribou meat and organs, and in the amounts consumed by northern residents. It is not known if there are any health effects or biological changes resulting from these polonium exposures, either in humans or animals. To address the problem, HPB scientists, in collaboration with the University of Saskatchewan, the Saskatchewan Health Department and northern communities, are developing bio-monitoring techniques for measuring the effects of radiation on human and animal cells. Once established, the techniques will be used to determine if polonium-210 uptake from caribou is having an observable effect on human health.

Long-range transport of radionuclides is an important source of radio-activity in the Arctic. Concentrations of iodine-129, a product of nuclear fission, can serve as a marker for shorter-lived radionuclides that may have been released at the same time. HPB has teamed up with Environment Canada and the University of Toronto to assess the long-term effects on northern Canadians of radionuclide releases from remote nuclear facilities.

Risks to health from environmental hazards

Northern Canadians share with those from the other seven circumpolar nations (Denmark, Greenland, Norway, Sweden, Finland, Iceland, Russia, United States) many of the same risks to health from environmental hazards such as POPs, toxic metals, radionuclides, indoor and outdoor air pollutants, water contamination and UV radiation. Possible changes in traditional diets (e.g. fish, caribou, walrus, seal) may occur because of fear of contaminants; this is of concern to northern people and health agencies. Levels of contaminants have been measured in human tissues (e.g. blood, hair, breast milk) and an initial evaluation has been conducted. In Canada, initial studies have found levels of POPs in maternal blood of Aboriginal people who consume marine mammals that are threefold to tenfold higher than levels in southern Canada.

While this is a step in the right direction, an in-depth evaluation is required of data from all circumpolar nations. A study is being undertaken that will look at factors such as parity, age, smoking and traditional food consumption, and assess their respective contributions to the levels of contaminants found. The fact that the cadmium level in the liver of a smoker is 10 times that of a non-smoker illustrates the need for such studies. This is an example of an international endeavour involving several partners (e.g. Human Health Expert Group of AMAP). In Canada, the partners are the federal government (Health Canada), provincial and territorial governments, and Northerners.

HPB is also providing leadership internationally through the vice-chairmanship of the Human Health Expert Group. Following a workshop in Finland, in January 2000, to evaluate preliminary findings of the interrelated effects of various exposures, a report will be prepared for Arctic ministers by 2003.

Genetic factors related to adverse drug reactions in Inuit populations

Drug development is being revolutionized by the rapid advances in genomics. Established clinical trials to determine the safety of therapeutic products do not include representation from the distinct sub-populations of Aboriginal people in Canada. As drug metabolism in humans is affected by genetic variations, HPB is initiating a study in collaboration with academia, the private sector and clinical researchers to identify genetic factors conferring susceptibility or resistance to adverse drug reactions in Inuit populations.

Health strategies and surveillance systems

Aboriginal people are three times more likely to suffer from Type 2 (non-insulin dependent) diabetes than the general population. This disease is epidemic in some communities. Furthermore, Aboriginal people are prone to develop diabetic complications earlier and with greater severity. Over the next three years, HBP in collaboration with Aboriginal people, including those living in the North, other federal government departments, academics, clinicians, provincial and territorial governments, and others will complete an Aboriginal Diabetes Strategy and Implementation Plan under the National Diabetes Surveillance System. An Aboriginal Diabetes Research Program and a comprehensive Surveillance Program are two key areas of the strategy.

Infectious respiratory diseases cause significant morbidity and mortality in northern populations of Canada and the United States. HPB is participating in an International Circumpolar Surveillance (ICS) project to address this serious problem. This project links HPB's Laboratory Centre for Disease Control to the United States Centers for Disease Control and Prevention, the National Centre for Streptococcus in Alberta, the Laboratoire de santé publique du Québec, all laboratories and public health authorities of Yukon, NWT, Nunavut, northern Quebec, Labrador and Alaska.

The goals of the ICS project include:

- Improve the understanding of the epidemiology of infectious diseases in northern populations of Canada and the United States.
- Evaluate current prevention and control programs.

The short-term objectives of the ICS project include:

- Implement, monitor, maintain and report on laboratory-based surveillance of invasive *Streptococcus pneumoniae*.
- Explore mechanisms for adding cases of invasive *Haemophilus* species,

Group A streptococci and *Neisseria meningitidis*.

- Explore mechanisms for adding non-communicable diseases.

Telehealth and health information systems

Geographical isolation restricts the access of First Nations and Inuit to health specialists and services. Travel to urban centres for medical treatment, diagnostic tests and health monitoring is costly. In addition, new and unfamiliar surroundings are often difficult to deal with because of language barriers, different foods and customs, and treatment that is not in a familiar community context.

Telehealth is "the use of information and communications technology to deliver health and health-social care services and information over large and small distances." In 1998, MSB in collaboration with First Nations communities embarked on a National First Nations Telehealth Research Project. The goal of the project is to test and evaluate telehealth to see whether or not it improves access to high-quality health care and improves the delivery of health services in a cost-effective manner. This \$2 million project is funded from the Health Transition Fund. It addresses one of the five strategic objectives identified in Health Canada's Science & Technology Action Plan to mobilize S&T information, information technology and telecommunications.

Telehealth has the potential to provide First Nations and Inuit communities with new and valuable tools for advanced diagnostic tests and follow-up treatment. As an example, using the latest in two-way audio-visual equipment, local health care providers and medical specialists in urban centres will be able to carry out face-to-face consultations with community members. Although national in scope, this project has great relevance to northern Aboriginal communities.

Another national program is using information technology to improve health management and surveillance within First Nations and Inuit communities, including those in the North. The First Nations Health Information System program will be a key element of the Aboriginal Health Infrastructure. It will be integrated with other sources of health information (e.g. other Health Canada data), First Nations regional health surveys, core provincial databases, and chronic and reportable disease surveillance programs. MSB leads this \$40 million program.

In addition, a national Aboriginal Health Institute will be established in 1999-2000 to promote, analyze and disseminate Aboriginal health research and information, and work with partners (Assembly of First Nations, Congress of Aboriginal Peoples, Inuit Tapirisat of Canada, Métis National Council, Native Women's Association of Canada) on key Aboriginal health issues. It will provide a bridge between the Canadian health system and Aboriginal health issues, including those of the North. Other partners will include the Canadian Institutes for Health Research, the Canadian Health Services Research Foundation, the First Nations Health Information System, universities, and other provincial and territorial organizations. The Aboriginal Health Institute will accommodate Centres of Excellence focusing on Inuit, Métis and First Nations health issues.

Environmental health and contaminants programs

The Native Environmental Health Services Program provides a comprehensive environmental program to First Nations communities – including those in the North – and is delivered in the regions. Activities include surveillance, inspection, monitoring and control of environmental contaminants and communicable diseases, consultation, education and promotion. It deals with a number of issues including water and food

quality, communicable disease control, environmental contaminants and pest control. Others include sewage and waste disposal, recreational facilities, transportation of dangerous goods, and occupational health and safety. This program has extensive collaboration within the federal government (e.g. Health Canada, Environment Canada, DIAND, Canada Mortgage and Housing Corporation). Other collaborators include the provincial ministries of environment, health and natural resources. Further liaison work includes First Nations political organizations, contractors, consultants and private industry.

The goal of the National First Nations Environmental Contaminants Program is to assess the extent of environmental contaminant exposure and the potential for associated risks to the health and well-being of First Nations people across Canada, including the North. A model was developed in the early 1990s by MSB and the Assembly of First Nations to study the effects of pollutants (e.g. PCBs), organochlorine pesticides, toxaphene and heavy metals (e.g. mercury, lead) on First Nations populations of the Great Lakes environment. The model has since been used to monitor other contaminants (e.g. dioxins, furans, cadmium) as well and to conduct comprehensive environmental contaminants studies affecting First Nations in critical geographical areas (e.g. northern Ontario, northern Alberta). This program combines scientific and holistic approaches that include the potential impacts of contaminant exposure on the socio-economic, cultural and other determinants of health.

With specific regard to environmental contaminants in the North, the NCP is a multi-departmental research effort led by DIAND. MSB contributes to the human health component. It provides resources and also participates in the management committee. The NCP focuses on the immediate human health and safety issues associated with contaminants in traditionally harvested foods; it includes environmental monitoring, human health assessment, research, international activities to control global releases, and communications components. The human health component is limited to environmental issues; it does not address other health determinants.

The Future of Children and Youth in the Arctic

Canada is leading The Future of Children and Youth in the Arctic, an Arctic Council initiative developed to contribute to sustainable development in the Arctic. The eight Arctic Council members endorsed this initiative in September 1998.

During the first two years, the goals include:

- Improve the health and well-being of children and youth in the Arctic.
- Improve the basis for sound decision making by increasing the knowledge and understanding of sustainable development among Arctic youth and children.

The first of these goals will be achieved through the following:

- examining existing baseline data and studies in key areas that are related to the health of children and youth in the circumpolar region and identifying gaps therein;
- assessing processes and approaches used at international, national, regional and community levels that might provide models for actions in Arctic regions; and
- an action plan that takes into account the results of these two activities, the nature of the specific issues, and appropriate scientific and traditional knowledge that will lead to the elimination or mitigation of health-related effects.

The long-term objective of engaging and empowering youth will be supported by an internship program and by elders sharing information, knowledge and experiences relevant to sustainable development and health with youth and children. To the extent possible, the project will be linked with a number of existing initiatives of both the public and the private sectors.

Internationally, this project is in keeping with the 1998 *Iqaluit Declaration* in which the Arctic Council is committed to advancing sustainable development in the Arctic. Nationally, it is consistent with Canada's emerging northern foreign policy. The project also responds to recommendations from the Circumpolar Conference on Sustainable Development in the Arctic (Whitehorse, 1998) and the 1998 National Forum on Circumpolar Affairs.



Photo: DIAND

Canada is leading *The Future of Children and Youth in the Arctic*, an Arctic Council initiative developed to contribute to sustainable development in the Arctic.

2.2.5 Northern Ecosystems and Biodiversity

Goal

To undertake research and monitoring in areas of special federal responsibility (responding to national mandates and international obligations) to ensure that Arctic biodiversity is protected and conserved.

Key federal biodiversity and habitat research issues in the Arctic include:

- Assess climate change impacts on biodiversity.
- Assess potential adverse impacts on wetlands and wildlife habitat.
- Assess biodiversity/habitat in national protected areas and parks in the Canadian Arctic.
- Document species diversity.
- Understand and mitigate Snow Goose habitat destruction.
- Understand the impacts of forestry practices on nesting birds in the boreal forest.
- Understand the decline in populations of sea ducks across the North.
- Allocate priority attention to species at risk.

Background

Partners for biodiversity research in the Canadian Arctic are wide ranging and include many federal departments, as well as territorial and provincial governments, universities, Aboriginal land claim organizations and community-based non-government organizations. Many of the issues being studied are circumpolar in nature (e.g. climate interactions and their effects are significant factors affecting northern caribou populations).

Federal departments and agencies engaged in biodiversity and habitat research in the Canadian Arctic include Parks Canada Agency (Canadian Heritage), Canada Centre for Biodiversity (Canadian Museum of Nature, Canadian Heritage), Canadian Wildlife Service (Environment Canada), DFO and DIAND. Much of the federal research undertaken with respect to Arctic biodiversity and habitat conservation is mandated by federal laws and agreements, as well as northern land claim agreements (e.g. research conducted through resource co-management and conservation authorities created under various land claim agreements).

In 1992, the Canada Centre for Biodiversity completed the *Canada Country Study of Biodiversity*, a review of the state of biodiversity in Canada. The same year, Environment Canada led an assessment, *Biodiversity Science Assessment*, to review what is known about the effects of major human activities on biodiversity in Canada. The assessment

Photo: DFO



The North American Waterfowl Management Plan is another element for implementing biodiversity research in the Canadian Arctic.

also reviewed the adequacy of Canada's network of protected areas and the state of socio-economic evaluation of biodiversity. In addition, research and policy recommendations were put forward to improve the conservation of biodiversity.

In 1992, federal ministers responsible for parks, wildlife, forestry and the environment made a commitment to complete Canada's networks of protected areas by the year 2000. Biodiversity research (e.g. human impacts on biodiversity and habitat), monitoring (e.g. biodiversity mapping and assessment), and research coordination (e.g. local involvement in assessing biodiversity in national parks) by Parks Canada are key aspects of northern park operations. Three new Arctic parks in Nunavut have recently been announced; this will increase federal efforts to understand and monitor biodiversity and habitat in the eastern Arctic.

Habitat conservation in northern Canada is undertaken by the Canadian Wildlife Service and the northern national parks. The Canadian Wildlife Service's multi-faceted approach operates both nationally and internationally and is based on partnership arrangements. Two main approaches to wildlife habitat conservation involve (i) establishing protected areas for nationally and internationally significant wildlife habitats as national wildlife areas and migratory bird sanctuaries, and (ii) cooperating with others in maintaining wildlife habitats across Canadian landscapes and seascapes (e.g. through environmental assessments, promoting conservation-friendly land-use policies and practices, direct stewardship programs, and promoting public education and participation).

In 1994, Parliament amended the *Canada Wildlife Act* and the *Migratory Birds Convention Act* to reflect, in part, a broader national understanding of biodiversity. The scope of the *Canada Wildlife Act* was expanded from any non-domestic animal to all wild animals, plants and other organisms. Under the amended *Migratory Birds Convention Act*, the sperm, embryos and tissue culture of migratory birds are now subject to the Act, consistent with the *Convention on Biological Diversity*. It is anticipated that the introduction of the new *Species at Risk Act* will further increase support for Arctic research on biodiversity and habitat protection.

In 1997, under the *Oceans Act* – for the first time in Canadian law – authority was also established for the protection of marine ecosystems between 12 and 200 nautical miles offshore. This Act allows for further research on biodiversity. The *Marine Conservation Areas Act* is an additional piece of federal legislation that should relate to federal research efforts in the area of biodiversity.

Objectives

- Understand population dynamics of species, including migratory birds and endangered species, through studies of their distribution, abundance and productivity.
- Assess habitat contained in protected areas for wildlife and birds, or under the management of co-management boards.
- Understand the effects of climate change on Arctic wildlife.

Implementation Elements

The international *Convention on Biological Diversity*, signed at the 1992 UN Conference on Environment and Development, provides a legal foundation for biodiversity research in the Canadian North. The Convention has three key objectives – (i) conservation of biological diversity, (ii) sustainable use of its components, and (iii) fair and equitable sharing of the benefits arising from the use of genetic resources. The Convention requires the development of national strategies to attain these objectives. Following Canada's ratification of the Convention at the end of 1992, the Government of Canada developed the *Canadian Biodiversity Strategy*. The strategy provides a national agenda for Canadian biodiversity activities, including research in the Arctic.

The Conservation of Arctic Flora and Fauna is a key sub-program of the Arctic Council. It supports the *Convention on Biological Diversity*, uses Aboriginal knowledge, and has a protected areas network and strategies for murre and eider conservation. Canadian efforts to protect endangered wildlife involve governments as well as non-government organizations. The Committee on the Status of Endangered Wildlife in Canada produces an annual list of species at risk. Under the Recovery of Nationally Endangered Wildlife Program, teams of experts develop and implement recovery plans for land-based endangered species. Recovery action is currently under way for 35 species.

The national Ecological Monitoring and Assessment Network integrates environmental data collection across environmental issues and disciplines. A series of Ecological Science Cooperatives (ESCs) has been established across Canada, including the North, to represent environmental research and monitoring sites within characteristic ecozones. ESCs provide a forum for participants within the ecozones to communicate, share information sources, review projects and provide advice. ESCs participate in cooperative planning and integrating results from research and monitoring with other sites, disciplines and agencies.

Environment Canada has established the Ecological Monitoring

Coordinating Office to administer and coordinate the national Ecological Monitoring and Assessment Network and the joint activities of ESCs. The high Arctic ESC coordinates ecozone-wide environmental monitoring activities undertaken or funded by a variety of federal agencies in a variety of areas. Monitoring of terrestrial biodiversity – using international methods and standards recommended by the United Nations Education, Scientific and Cultural Organization (UNESCO) – has begun in Arctic tundra and forest ecosystems. Work is under way to select standards and methods for freshwater and marine aquatic ecosystems.

The North American Waterfowl Management Plan (NAWMP) is another element for implementing biodiversity research in the Canadian Arctic. The NAWMP was established in 1986 by the United States and Canada, and provides for joint ventures in habitat management. The Arctic Goose Joint Venture is a component of the NAWMP. Canadian federal, provincial and territorial governments, and American federal and state governments, as well as interest groups are involved. The Arctic Goose Joint Venture has developed a list of long-term research and monitoring needs. A Sea Duck Joint Venture has been proposed under the NAWMP and is being led within Environment Canada by the Atlantic Region office. The *Polar Bear Agreement* signed by Canada, Russia, the United States, Greenland and Norway in 1973 involves cooperative management projects and agreements between communities and governments, Inuvialuit and Inuit, and Canada and Greenland.

A number of co-management boards, composed of representatives of Aboriginal communities and government appointees, has been established. These boards have become the main instruments of wildlife management and biodiversity-related research in land claim areas. Some boards (e.g. Beverly and Qamanirjuaq Caribou Management Board) have been established to address species, population or area-specific issues. They may produce management plans, recommendations for amendments to legislation and study proposals. The Porcupine Caribou Management Board has played an active role in conserving the internationally important Porcupine caribou herd, the range of which extends into the state of Alaska.

Canada has made substantial progress toward its Arctic biodiversity research goals. However, key gaps exist in research information and public understanding. Continued research is required in many areas to overcome these gaps (e.g. compiling basic inventory data at species and ecosystem levels). Continued research is also required to improve the understanding of the dynamic character of the various northern ecosystems across Canada, especially those experiencing rapid or new development.

Management Structure, Innovative Partnerships and Linkages to Other Programs

The federal government is increasingly required to respond to a variety of issues related to biodiversity and habitat. The major issues in the Arctic related to biodiversity and habitat include research to assess the following:

- effects of development, particularly of mining, on wildlife and habitat;
- effects and interrelatedness of complex issues such as global climate change;
- effects of stratospheric ozone depletion and the presence of toxic contaminants on health of wildlife and sensitive habitat, as well as species diversity;
- self-government and what it means for cooperation and collaboration on biodiversity research; and
- communication of results of wildlife monitoring activities.

2.2.6 Sustainable Development and Management of Natural Resources

Goals

- Broaden and improve the information base on the sustainable development of natural resources and to ensure that all information is accurate, unbiased and professional.
- Promote meaningful participation by Aboriginal people and traditional and local knowledge in all areas of resource development and sustainability.
- Promote research on the environmental impacts of resource developments and on minimizing those impacts, including the principles of conservation and “no net loss.”

Background

Federal S&T programs and activities underpin sustainable resource development, thus providing much-needed support for the North's future economic and social viability. The programs also provide the federal government with the sound science base it requires to fulfill its responsibilities for developing the policies, and the standards and regulations governing northern development.

Objectives

- Improve the foundation of the knowledge required for sustainable renewable resource production.

The effects of some human activities are more severe and persistent in the North than those in southern regions. The knowledge and research into effects of extreme Arctic climatic conditions – including slower growth rates and reduced productive season lengths – are critical factors in formulating northern resource management decisions. The management of northern renewable resources should also be based on specific research and information that takes into account the knowledge and experience of Aboriginal people.

- Maintain a healthy sustainable non-renewable resource sector.

The sustainable development of non-renewable resources in the North is a special challenge due to environmentally sensitive terrain, infrastructure constraints, and a small and scattered population. Sustainable development of these resources must maximize economic and social benefits while safeguarding the environment. S&T is crucial to providing the basis for exploration for new resources, as well as understanding the way that the terrain will respond to potential development schemes.

Continuing development of databases on geographical, geological and geoscientific information about the Arctic landmass is required for mapping and resource exploration. This information will also provide baselines for assessing change, risk and sensitivity of the landscape, and help in developing policy, regulations and land-use management practices.

To increase the efficiency of mineral and energy production, research activities seek to support the application of advanced technologies to recover metal and hydrocarbons, optimize extraction and production mining processes and practices, and prolong the operational lifetimes of mines in northern communities. Research priorities include acidic mine drainage and effluents, and mine decommissioning and rehabilitation.

- Ensure regulations based on traditional knowledge.

Northerners are confident of the knowledge they possess about the land, marine environment, wildlife and their societies. At the same time, they are also aware of the need for science that contributes directly to the analysis of important public issues. Land claims settlements and beneficiaries give priority to decision making on management issues related to renewable resources.

Implementation Elements

Non-renewable resource development

The North is richly endowed with world-class mineral and energy resources having proven and potential reserves totalling \$100 billion. The recent opening of Canada's first diamond mine, coupled with an active exploration industry, is bringing jobs and growth to the North and represents significant revenues for Canada (e.g. \$2.3 billion projected over 20 years for the Ekati mine). The North contains about 18% of Canada's remaining discovered conventional oil and 25% of remaining discovered gas. But more importantly, Canada's northern basins are estimated to contain approximately 48% of Canada's undiscovered conventional light crude oil potential and 46% of its undiscovered conventional gas potential. However, conversion of undiscovered mineral and energy resources into reserves that can be developed economically can occur only with improved geoscience knowledge and enhanced exploration activity. Also, application of scientific knowledge and mineral technology innovation in these areas through effective and efficient transfer to the private sector is vital to economic growth.

> GEOSCIENCE

One of the major contributors to northern geoscience is the Geological Survey of Canada (GSC), NRCan. The GSC maintains a national geoscience database. It also conducts geoscientific research and surveys as part of its mandate to provide Canada with a comprehensive geoscience knowledge base that contributes to economic development, public safety and environmental protection. This work is done within the general framework of the 1996 *Intergovernmental Geoscience Accord*. The accord defines the relationships among the GSC and provincial and territorial governments. It also facilitates the planning and carrying out of government geoscience in Canada. In Yukon, NWT and Nunavut, geoscience is delivered cooperatively by the GSC, DIAND and territorial agencies. Universities also contribute to geoscience knowledge.

New information about all aspects of northern geology and landmass is needed for evaluating resource potential by industry and governments, land-use planning, and avoiding or reducing risk from natural hazards. Knowledge of the landmass and offshore regions plays a critical role in sovereignty issues and provides scientific underpinning of global policy initiatives (e.g. *UN Convention on the Law of the Sea*).

Program plans

Geoscience surveys

Regional geological studies of bedrock and surficial materials in strategic areas of known or anticipated high mineral content:

- multi-disciplinary mapping of Precambrian (for gold, diamonds, nickel, platinum group elements, etc.) and Phanerozoic (for lead, zinc, gold, etc.) terrains, and

- regional compilations of geoscience knowledge for focusing exploration strategies and supporting land-use planning and decision making.

Regional geophysical and geochemical surveys to provide regional context and detailed targets for mineral exploration:

- regional identification of anomalies in metal content in streams or soils,
- geophysical reconnaissance in unmapped and poorly mapped regions or those areas having poor rock exposure, and
- multi-parameter geophysical surveys in regions of high mineral potential.

Comprehensive mineral deposit models and new exploration concepts through mineral deposit studies and delivery of multi-disciplinary programs (e.g. exploration technology), focused on increasing the probability of exploration success and supporting land-use planning and decision making:

- initiation of a northern-focused exploration technology program in the Yellowknife area, and
- integrated, multi-parameter mineral deposit profiles and regional metallogeny studies.

Developing a precise three-dimensional picture of northern Canada's sedimentary basins and assessing hydrocarbon potential to help attract exploration investment:

- multi-disciplinary mapping and sub-surface analysis of Phanerozoic regions (for oil, gas, coal) including integration of seismic and well data and geophysical surveys (on- and offshore), and
- regional compilations of geoscience knowledge for focusing exploration strategies and supporting land-use planning and decision making.

Infrastructure development

Marine geoscience surveys and engineering studies that provide information for offshore oil and gas well sites, environmental impact assessment, pipelines, transportation, and loading and shipping facilities.

Studies on permafrost, active geological processes and hazards, and modern and past environmental changes to ensure sustainable development of northern resources and infrastructure development:

- along existing or proposed transportation corridors, pipelines and port facilities,
- in areas of existing or potential mining development,
- in and near rapidly developing communities,
- assessment of hazards in areas of existing or potential development (e.g. slope failure), and
- assessment of groundwater potential in areas of economic growth.

Environmental protection research in support of sustainable development

Environmental impact studies, including the cumulative impacts from exploration and production of natural resources, and the combustion of hydrocarbons and biomass-based fuels.

Geochemical surveys that will determine the distribution of potentially toxic, naturally occurring elements and the potential for their release as a result of future development strategies:

- targeted studies in areas of existing development, and
- baseline studies in areas of proposed or potential development.

Improve the understanding of the bio-geochemical cycle of metals and to ultimately ensure that there is a sound scientific basis for policy and regulatory decisions that will affect the production and use of metals (e.g. Metals in the Environment Initiative):

- resolve science issues related to sources, transport and fate of metals in the surficial environment,
- estimate flux rates from natural sources,
- develop criteria to differentiate metals from natural and anthropogenic sources, and
- assess the validity of historical records in natural materials.

Northern capacity building

Improve the accessibility of geoscience data and information in digital form:

- develop comprehensive, user-friendly, digital geoscience knowledge bases, and
- develop access tools and pathways (e.g. Internet, CD-ROMs) to facilitate access to geoscience knowledge.

Increase capacity and participation of Northerners in resource-based economic development through better education and skills training:

- student training and internships in geoscience, and
- community-based workshops to demonstrate access to and use of geoscience information.

> **MINERAL TECHNOLOGY**

To remain productive and competitive, Canada's minerals and metals industry must continue to adopt new technologies to offset high labour costs, enhance the efficiency of processing to maximize recoveries, and increase further processing of mineral and metal resources into value-added products.

As the national centre for mineral technology, the Canada Centre for Mineral and Energy Technology (CANMET) has a critical role to play in assisting the northern minerals and metals industry in meeting these technological challenges and thus promoting safe and efficient processing and sustainable mining operations.

Program plans

CANMET's research to increase the efficiency of mineral production will focus on the application of advanced technologies to recover metal, optimize mining processes and practices, and prolong the operational lifetimes of mines in communities that are largely dependent upon these.

CANMET's research will address acid drainage and effluents, monitoring aquatic effects, and mine decommissioning and rehabilitation.

> **AQUATIC HABITAT MANAGEMENT**

The loss or degradation of fish habitat is a crucial issue in the conservation of fish stocks. Habitat degradation through pollution or through harmful alteration, disruption or destruction of physical fish habitat can have a direct influence on fish production and on human use of fish.

Under the *Canadian Environmental Assessment Act*, the "no net loss" concept applies to non-renewable resource development. With respect to fishery habitat and productivity, any negative impact must be balanced by "compensation" in the form of comparable habitat or fishery productivity. This policy is applied to northern development projects in collaboration with other federal departments and the territorial governments.

Canada has constitutional responsibility for the sea coast and inland fisheries and for the habitats that support them. The *Fisheries Act* provides a comprehensive framework for the management and protection of fisheries resources and supporting habitats. The Act prohibits anyone from harmfully altering, disrupting or destroying fish habitat without authorization by the Minister of Fisheries and Oceans. Since nearly all the economic operations in a watershed alter fish habitat in some way, these provisions are very comprehensive. The



Photo: DFO

Canada's northern basins are estimated to contain approximately 48% of Canada's undiscovered conventional light crude oil potential and 46% of its undiscovered conventional gas potential.

provisions also provide a trigger for the federal environmental assessment process under the *Canadian Environmental Protection Act*. Habitat provisions under the *Fisheries Act* are administered in accordance with the *Policy for the Management of Fish Habitat* (1986). The overall objective of this policy is to achieve a net gain of the productive capacity of the fisheries resource through fish habitat conservation, habitat restoration and fish habitat development. Under the principle of "no net loss" of the productive capacity of fish habitats, actions are taken to balance unavoidable habitat losses with habitat replacement on a project-by-project basis.

Program plans

Research to assure a high level of fish habitat protection and improved regulatory consistency.

Monitoring and collecting baseline information in critical regions of the North.

Renewable Resource Development

> **ENERGY TECHNOLOGY**

The mission of the CANMET Energy Technology Branch, NRCan, is to work in partnership to develop and deploy energy-efficient, alternative energy and advanced hydrocarbon technologies. The Branch's activities focus on research and development (R&D) and programs in the areas of

energy efficiency, renewable energy resources, alternative transportation fuels and hydrocarbons. The Branch works in partnership with provincial and territorial governments, industry and all major stakeholders in the Canadian energy and R&D sectors to develop a wide range of energy technologies including:

- renewable energy, including solar, wind, small hydro and bio-energy;
- energy-efficient technologies for industry, communities and buildings;
- alternative transportation fuels, including natural gas, propane, ethanol, methanol, hydrogen, electric and hybrid vehicles;
- district heating and cooling and integrated energy systems;
- advanced low-emission combustion technologies;
- processing and environmental catalysis for fuels production and hydrocarbon conversion; and
- energy-efficient metallurgical fuel products and technologies.

> **FOREST MANAGEMENT**

The Canadian Forest Service, NRCan, through its national network of science-based establishments, delivers a research program that focuses on the two key issues of promoting the sustainable management of Canada's forests and competitiveness of the Canadian forest sector. It leads and coordinates the country's national and international forestry S&T activities, and undertakes a research program that is based on the principle of partnership with governments, industry and other stakeholders. In the North, Memoranda of Understanding between the Canadian Forest Service and Yukon, and NWT, facilitate sustainable forest management. The Service also carries out Northern S&T under the First Nations Forestry Program, the Model Forests Program, and Collaborative Research Agreements.

Photo: DFO



Renewable resource use of Arctic fisheries is based on the concepts of entitlements and conservation as outlined in land claims settlements. Safe harvest levels are based on both scientific and traditional knowledge.

Management of renewable resources is often the responsibility of co-management boards that balance government and land claim beneficiary responsibilities.

Program plans

Develop renewable energy sources (e.g. solar electricity, wind, small hydro) and district heating technologies for remote applications.

> **FISHERIES AND AQUATIC HABITAT MANAGEMENT**

Renewable resource use of Arctic fisheries (e.g. fish, marine mammals, invertebrates, plants) is based on the concepts of entitlements and conservation as outlined in land claims settlements. Safe harvest levels are determined, based on both scientific and traditional knowledge, when information is available (e.g. the stock status report and resource allocation plan for bowhead whales in northern Hudson Bay and the Foxe Basin). However, for most stocks there is insufficient information to make accurate assessments. Under these conditions, fisheries are run using basic rules (e.g. 2% of the survey estimate). Management of renewable resources is often the responsibility of co-management boards that balance government and land claim beneficiary responsibilities. These boards drive research priorities for government S&T and provide a significant amount of funding.

Program plans

- Research in support of stock assessment.
- Research to improve methods of assessing fisheries stocks.
- Research for protection and recovery of endangered species or depleted stocks.
- Research in biodiversity.

Program plans

- Understand the fundamental processes and dynamics of Canada's forest ecosystems.
- Provide leadership in forest ecosystem monitoring and analysis.
- Develop and promote better ways of protecting and enhancing the health, diversity and productivity of forest ecosystems.
- Develop the integrated knowledge, tools and techniques needed for sustainable management of forest ecosystems.
- Contribute to the future viability and competitiveness of Canada's forest-based economies through research and funding support, scientific and technical advice, and assistance in the application and commercialization of environmentally sound systems and technologies.

> **GEOSPATIAL DATA INFRASTRUCTURE**

Geomatics Canada, NRCan, provides a reliable system of surveys, maps, remotely sensed data and geographically referenced information on Canada's landmass. The science of geomatics provides essential tools to monitor economic and environmental objectives in the sustainable development of our natural resources. Geomatics also increases the capability to meet management challenges in the North in forestry inventory, environmental and agricultural monitoring, boundary delineation of land claim settlements, and topographic mapping at national and regional scales.

Program plans

Legal surveys will continue to survey the boundaries of Aboriginal lands, regulate and manage location of boundaries of Canada Lands, and delineate the international boundary with the United States.

Geodetic surveys will maintain the spatial reference system for Canada with high precision, using radio-telescopes and global positioning satellites, including the provision of the active control positioning system in the Arctic.

Developing and maintaining the national topographic database and topographic mapping are core functions of Geomatics Canada. These maps will be in computer-accessible format, an important new direction for topographic mapping. The development of computerized aeronautical charts and computer-accessible information for aviators will provide an even more efficient service than at present.

The Canada Centre for Remote Sensing will lead in collecting and analyzing satellite data. This Centre is developing new remote sensing technology for satellites (e.g. RADARSAT) and aircraft. With private-sector partners, projects will be used for determining forest health, ice conditions, transportation planning and for geological mapping in the North.

The GSC and Geomatics Canada will provide leadership in developing GeoConnections, a national Internet window on geographic data for sustainable development.

> OCEANS RESOURCE MANAGEMENT

DFO is responsible under the *Oceans Act* to provide a national role in the delivery of the federal Oceans Strategy. Therefore, DFO leads and facilitates the development and implementation of a national strategy for the management of estuarine, coastal and marine ecosystems. Combined with the network of resource information for the North, this new initiative manages the marine environment from an ecosystem perspective. It will help support the mandates of federal and land claims organizations by integrating sometimes competing requirements for resources.

To deal with the realities of change in the Arctic in the area of transport of resources, there is an expressed need for information related to marine transport and infrastructure. The Canadian Hydrographics Service provides nautical information to Canadians and is in the process of providing geo-referenced information to an expanding modern global fleet of cargo vessels.

Management Structure, Innovative Partnerships and Linkages to Other Programs

The above programs and activities are linked to Arctic environmental protection and the health and safety of Canadians in the following ways:

- The end-users of the maps and satellite data from Geomatics Canada will monitor ice movement and fire damage. Military and commercial pilots use aeronautical charts and publications to ensure flight safety.
- GSC will provide information on the response of the land, coasts and the sea floor to earthquake shaking, land disturbance including permafrost studies, and slope stability and landslide problems.
- GSC, through glaciological and other studies, will investigate the nature and the impact of climate change in the sensitive Arctic environment. The Canadian Forest Service will study how forests contribute to the

maintenance of global ecological cycles (e.g. carbon, water, air) that support life.

- GSC's geochemical surveys, combined with research on glacial, coastal, lake and river sediments, will determine the distribution of potentially toxic naturally occurring compounds and the potential for their release as a result of future development strategies.
- CANMET will work with mining inspectorates and companies to make these operations safer through improvements to workplace environments.
- CANMET will also apply its remediation technologies to help ensure the protection of the fragile Arctic ecosystem.
- Canadian Forest Service programs in ecosystem research, climate change, surveys of forest health and model forests are parts of the government strategy for sustainable resource management. The Model Forest Program addresses the use of forest lands for recreation, forest products and water.
- DFO is working in partnership with other circumpolar nations on issues related to shared fish stocks.
- DFO works in close collaboration with northern co-management boards in the area of fish stock assessment and management.
- DFO is developing a wide range of partnerships to implement the integrated management of oceans including the Arctic Ocean.

2.2.7 Infrastructure Development, Maintenance and National Northern Services

Infrastructure is extremely important to northern residents. At a recent Premiers' meeting, when the discussion turned to the need for infrastructure, particularly highway renewal, the new Premier of Nunavut stated that as there are only 25 kilometres of highway within all of Nunavut, it was not a question of renewal but creation. In southern Canada, choices in ways to travel, sources of information and means of communication are available. In the North, frequently no choice is available. In addition, travel routes, information sources and means of communication are often threatened by isolation, harsh climate or fiscal cutbacks. Infrastructure and weather in the North can often mean the difference between life or death of people, and the success or failure of potential developments that could improve their standard of living.

Transport infrastructure and services

Transport Canada has developed a network of airports and port facilities in the North. Most have been turned over to local or territorial control. As the population and economy of the North grow, expansion, improvement or even reconstruction of these facilities is likely to be required. The application of appropriate Northern S&T accompanies such development. Road and highway construction has not been discussed as these are normally territorial or municipal responsibilities. However, it is quite possible that the federal government could become involved in infrastructure creation. More experience is needed to develop best practices.

Transport Canada is also responsible for the delivery of services to the transport industry in the North, including aircraft, rail and marine inspections for safety and regulatory compliance, as well as accident and pollution incident investigations. As citizens, Northerners are entitled to the same level of service as residents of southern Canada, and the challenge is to find economic methods of delivering these services effectively.

Vital information

Accurate and timely weather information can be the determinant between success and failure for any operation or even the life and death of people in the North. Because of the unique nature of northern weather patterns, new methods of forecasting may be required. Also, the means of delivery will differ depending upon the location. Delivery of visual information has progressed from post to facsimile and now is Web-based. Information delivery to remote land sites equates to methods used for ships and aircraft. Improvements to forecasting techniques and delivery methods would be welcomed by all northern users of this information.

Information on the state of ice cover can be as vital to Northerners as weather forecasts. Land claim agreements dealing with land use often consider fast ice as part of “land” – residents often track game and fish for significant distances over the ice. Timely ice information is also important for safe marine navigation in the north. Sources of information have progressed from visual inspection on ships or aircraft to satellite sensors downloading data to receiving sites in the south where images are analyzed and then relayed to users. During the navigation season, ice conditions can change rapidly, often spelling the difference between an uneventful voyage and one involving significant delays because of pressured ice cover. Rapid turnaround of ice imagery can enable strategic and tactical decisions to be made on ships that often allow them to avoid situations that involve delay or even hull damage. Much work is currently being undertaken to advance this technology in which Canada is recognized as one of the world leaders.

Government vessel operations

The CCG operates icebreakers in the Arctic every summer. These ships assist commercial shipping and provide response in case of search and rescue or pollution incidents. The coast guard also operates vessels in the Mackenzie River system in connection with navigation aids and marine survey programs.

Ship operations are expensive in any body of water, but are especially so in the Arctic. Costs of all consumables are greater than in the south. Locations where repairs can be undertaken are rare or non-existent. Operational activities (e.g. air and marine), such as crew changes, are challenging because schedules depend on the weather; they can be very costly. The environment also places additional loads on every system in a ship, be it machinery, structure or the personnel on board. Research is presently being undertaken to increase the knowledge base in all these areas.

2.3 Individual Agency Northern Science and Technology Activities**2.3.1 Department of Indian Affairs and Northern Development Mandate**

DIAND’s mandate in the North is to help Northerners, both Aboriginal and non-Aboriginal, to develop the institutions they need so they can take responsibility for decisions that affect them directly.

Until responsibility is in the hands of territorial governments, DIAND’s responsibilities include:

- Support northern political development.
- Protect and rehabilitate the northern environment.
- Establish legislation and institutions of public government for the management of natural resources and environment pursuant to northern land claims agreements.
- Manage the sustainable development of the North’s natural resources

in a manner that will generate jobs, and foster social and economic well-being.

How DIAND Uses Northern S&T to Deliver on Its Mandate

DIAND works through the Northern Affairs Program to deliver on its mandate to serve Northerners. Northern S&T plays a vital role in enabling the program to function effectively. This is done through the Strategic Policy and Devolution Branch, the Natural Resources and Environment Branch, and regional offices in Nunavut, NWT and Yukon.

Strategic Policy and Devolution Branch

Northern S&T activities include assembling information on resource development in Canada’s territories to develop resource revenue-sharing models, in partnership with the territorial governments and Aboriginal organizations. Various studies and research projects are under way focusing on the areas of nutrition and food security in Nunavut and other areas of northern Canada. The Northern Scientific Training Program has supported the northern research of graduate students from Canadian universities for the past three decades; it also encourages them to develop commitment to northern research. Northern S&T also supports the work of the Circumpolar Liaison Directorate in collecting and evaluating information on the socio-economic and political developments of countries in the circumpolar region.

Natural Resources and Environment Branch, and Nunavut, NWT and Yukon Regions

The NCP was established in 1991 in response to concerns about human exposure to elevated levels of contaminants in wildlife species, particularly in those important in traditional northern Aboriginal diets. Key objectives of the NCP include measuring contaminant levels, determining sources and pathways, involving Northerners in decision making and pursuing international agreements to control substances of concern. The NCP addresses these objectives through the allocation of funds for research and related activities through its interlinked main sub-programs, all of which address immediate health and safety issues.

The NCP contributes significantly to international contaminant research and action to achieve international pollution controls (e.g. AMAP). The Nunavut General Monitoring Program is a collaborative effort between DIAND and the Nunavut Planning Commission. It is a very broad-scale, long-term environmental monitoring program which spans the bio-physical, socio-economic and cultural environment of Nunavut.

In the NWT, Nunavut and Yukon, the Northern Affairs Program carries out studies and investigations to support sound management of land and water resources, and the sustainable development of minerals, oil, gas and other natural resources. Ongoing activities include monitoring water quality and quantity in these regions, and developing a cumulative effects monitoring program for the Coppermine River. They also include land-use and granular resources research under the Panel on Energy R&D, the inventory of sand and gravel pursuant to the Inuvialuit Final Agreement, and the investigation of specific issues with development projects as they arise.

Recent Major Northern S&T Achievements

Research on food costs and affordability in northern Canada, and on changes in nutrition and food security in two Inuit communities have been completed.

Phase I of the NCP was completed in 1997. The sources, pathways, fate, magnitude, geographical extent, trends and effects of POPs, heavy metals and radionuclides in the northern ecosystem were determined. Findings were published in the 1997 *Canadian Arctic Contaminants Assessment Report*. Phase II builds on this work and will continue until 2003.

Recently, Northern S&T activities have included environmental monitoring programs for the Liard and Slave river basins, renewable resource baseline data studies under the interagency West Kitikmeot Slave Society, investigation of issues associated with arsenic pollution at Giant Mine, and the development of reclamation models to establish the costs of abandonment and reclamation for future mining projects.

Future Strategic Directions in Northern S&T

Future directions of Northern S&T in DIAND include the continuation of the Nunavut General Monitoring Program and Phase II of the NCP which will continue into 2003. Phase II focuses on addressing the immediate health and safety issues associated with contaminants in traditionally harvested foods, and on international collaboration and action to control contaminants, particularly POPs.

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2.3.2 Environment Canada

Mandate

- Improve the quality of life of Canadians through the preservation and enhancement of the natural environment, including water, air, soil quality, renewable resources, migratory birds and other wildlife.
- Provide weather forecasts and warnings.

How Environment Canada Uses Northern S&T to Deliver on Its Mandate

Environment Canada's Northern S&T is delivered through three major program areas – atmospheric environment, environmental protection and environmental conservation.

The AES delivers weather forecasting; prediction of water supply for hydro-electricity; rainfall, snowfall and icing outlooks; sea-ice information; natural hazard detection; and the study of atmospheric and climate changes.

The Environmental Conservation Program conducts scientific activities that enhance knowledge of northern wildlife, aquatic ecosystems, northern hydrology, wildlife habitat, and wildlife responses to harvesting, disturbance and contaminants. Environment Canada's scientific activities also provide information on the potential environmental effects of northern economic development.

Environment Canada also develops technologies that contribute to emergency preparedness, environmental prediction and sustainable economic development in the North.

Recent Major Northern S&T Achievements

Northern River Basins Study – a five-year study, from 1991 to 1996, to examine the effects and relationships between human development and aquatic ecosystem conservation in the Peace, Athabasca and Slave rivers basins. The study comprised 150 research projects in areas such as contaminants, drinking water, food chain, hydrology and hydraulics, nutrients, other river uses, synthesis and modelling, and traditional knowledge. An ecosystem approach, with community involvement as one of its central principles, was used.

Canadian Landbird Monitoring Strategy – two monitoring programs, the Migration Monitoring Network and the NWT Bird Checklist Survey, designed to gather data on northern nesting species. Research is currently directed toward increasing the knowledge of the status of northern land birds in Canada, and to increasing knowledge and understanding of factors affecting northern bird populations and their habitats.



Research partnered with Environment Canada and Canadian and American university researchers examines the sustainability of Arctic communities dependent upon migratory caribou for sustenance.

Mackenzie Basin Impact Study – a six-year research program, from 1990 to 1996, initiated by Environment Canada in 1990. Participants included representatives from Aboriginal groups, industrial firms, universities, northern colleges and research institutes, as well as municipal, territorial, provincial and federal governments. An integrated regional assessment of climate change scenarios for the entire Mackenzie River Basin watershed was produced; the assessment included terrestrial and freshwater ecosystems, as well as the communities that depend on them.

Oil spills and emergencies preparedness – research directed toward improving the understanding of oil spill behaviour and effects, as well as the development of sampling and analytical techniques, airborne remote sensing technologies, and in situ countermeasures for spills. Northern research has focused on the long-term fate of oil on northern shorelines, in situ detection and monitoring of hydrocarbon residues using fluorescence techniques, dispersant performance testing, and developing new emulsion breakers and dispersants.

Sustainability of Arctic communities dependent upon migratory caribou for sustenance – research partnered with Environment Canada, and Canadian and American university researchers to examine the sustainability of Arctic communities dependent upon migratory caribou for sustenance, and the possible effects of climate change on migratory caribou. This project has involved four communities, within the range of the Porcupine Caribou Herd that migrates annually between Yukon and

Alaska, in the design and conduct of the research to ensure that it meets community needs and concerns. Local, regional and national policies and practices have evolved as a result of the research to better reflect the changing environment and to ensure a continuing traditional relationship between Aboriginal communities and wildlife.

Future Strategic Directions in Northern S&T

Global Energy and Water Experiment – a WCRP initiative to observe, understand and model the hydrological cycle and energy fluxes in the atmosphere, at the land surface and in the upper oceans. Environment Canada will continue to participate in GEWEX. Research work will include studies at cold-region observatories and the analysis of precipitation data. Projects over the next two years will emphasize the unique characteristics of the water cycle in northern Canada and focus primarily on snow and ice.



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Northern Ecosystem Initiative – a new initiative, beginning in 1998, led by Environment Canada. It will undertake scientific activities to support and enhance the future health and sustainability of northern communities and ecosystems. Principal areas will include atmospheric change, biodiversity, contaminants and toxics, and impacts of major developments. The initiative will provide greater understanding of the ecosystems upon which Northerners depend, improve northern decision-making capacity, facilitate the use of traditional and scientific knowledge, address priority issues and produce results for use locally and elsewhere in the North.

Northern Rivers Ecosystem Initiative – a new initiative, commencing in 1998, with federal, provincial and territorial participation. It focuses on priorities such as pollution prevention, endocrine disruption in fish, drinking water and enhancing the monitoring of environmental effects. Studies will also continue into the incidence of fish abnormalities and the effects of land use, flow regulation and climate change on aquatic ecosystems.

Use of the cryospheric system to monitor global change in Canada – a Canadian-led interdisciplinary science contribution to the United States National Aeronautics and Space Administration Earth Observing System program. Environment Canada and NRCan will continue to participate in this initiative. The main variables to be studied include sea ice, lake ice, snow, glaciers and ice caps, frozen ground and permafrost. This information will provide improved capabilities for

monitoring the state of the cryosphere and a greater understanding of cryospheric processes and variability.

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2.3.3 Department of National Defence

Mandate

DND's mission is to defend Canada and Canadian interests and values while contributing to international peace and security. Within this mission, DND's responsibilities include:

- Provide strategic defence and security advice to the Government of Canada.
- Conduct surveillance and control of Canada's territory, airspace and maritime areas of jurisdiction.
- Respond to requests from provincial authorities under the Aid of the Civil Power.
- Participate in bilateral and multilateral operations with Canada's allies.
- Assist other government departments and other levels of government in achieving national goals.
- Provide support to broad federal government programs.
- Provide emergency humanitarian relief.

How DND Uses Northern S&T to Deliver on Its Mandate

DND uses Northern S&T to provide advice to the Canadian Forces on techniques and systems for surveillance of the Arctic Basin and the channels of the Canadian Arctic Archipelago. This Northern Surveillance Project is a research effort within a national surveillance program being conducted in support of the Canadian Navy. The Assistant Deputy Minister (S&T) is the main delivery agent for this work.

The primary outputs of the Northern Surveillance Project include:

- characterizing the underwater sound environment in Arctic waters to optimize the design of acoustic detection systems; and
- developing techniques for installing systems in the harsh Arctic environment.

The secondary outputs of the Northern Surveillance Project include:

- developing equipment suitable for use and deployment in the Arctic; and
- determining (in cooperation with American scientists) the feasibility of setting up an acoustic monitoring network to monitor the temperature of the Arctic Ocean.

The Northern Surveillance Project is essentially a stand-alone effort. However, its continued success will depend on close coordination of logistical support with other agencies. In addition, DND will continue to provide support to other organizations at CFS Alert and Eureka as directed or mutually arranged.

Recent Major Northern S&T Achievements

DND has been conducting research in the Canadian Arctic since 1959. Areas of research include investigations of the underwater acoustic environment, glaciology, oceanography, global warming, geotechnical

engineering, and clothing and protective equipment required for use in harsh environmental conditions.

Underwater acoustic investigations have resulted in a good understanding of the dominant mechanisms that affect under-ice ambient noise and sound propagation in the Arctic Basin and major channels of the Arctic Archipelago. Advances have also been made in equipment and techniques suitable for Arctic applications. Recent major achievements include the installation of a large acoustic research array and associated trunk cable to shore in the Lincoln Sea north of Ellesmere Island, and an initial assessment of the feasibility of using an acoustic monitoring system to monitor the temperature of the Arctic Ocean.

Future Strategic Directions in Northern S&T

Research efforts over the next two years will be focused in the Lincoln Sea area north of CFS Alert. Planned activities in the North include the following field operations:

- Investigate the feasibility of measuring background ambient noise and sound transmission from the water to geophone sensors mounted on the ice surface.
- Install a small acoustic array on the bottom with fibre-optic cable to shore, at a location approximately 14 km north of CFS Alert, to measure long-term ambient noise from an area near a shear zone.
- Recover a self-recording bottom-mounted acoustic array that was installed approximately 160 km north of CFS Alert in October 1998 as part of a joint Canada-United States project. The array was used over an 18-month interval to receive low-frequency sound transmissions from sources installed on the Russian side of the Arctic Basin. This effort is part of the Arctic Climate Observation Using Underwater Sound project which is a joint United States-Russia project to demonstrate that a monitoring network can be set up in the Arctic to monitor the temperature of the Arctic Ocean.
- Support the AES Polar Sunrise project with equipment and personnel to set up a remote environmental sensing camp and recording station at a location approximately 14 km north of CFS Alert.
- After spring 2001, field trials will be carried out every other year. The emphasis of the research will still be to investigate techniques for acoustic surveillance of the Arctic Basin and the channels of the Archipelago, but the focus of the work will shift from the Basin to the channels.

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2.3.4 Department of Fisheries and Oceans

Mandate

DFO's principal mandate stems from the *Fisheries Act*, the *Oceans Act*, the *Territorial Sea and Fishing Zones Act*, the *Arctic Water Pollution Prevention Act* and the *Canadian Environmental Protection Act*.

Responsibilities related to the following include:

- sea coast and inland fisheries,
- fishing and recreational harbours,
- hydrography and marine sciences, and
- coordination of federal policies and programs with respect to oceans.

DFO has a broad and diverse science program in the North – encompassing fisheries; biological, ecological, physical and chemical sciences; and hydrographic charting. Activities are driven by fishery and mammal conservation and management responsibilities, and stewardship of the marine environment through oceans ecosystem management. DFO conducts research to address the protection of marine and freshwater habitat, concern for the health and safety of northern residents, and the safe and efficient development of renewable and non-renewable resources in economic and sustainable ways.

How DFO Uses Northern S&T to Deliver on Its Mandate

DFO's vision is safe, healthy, productive waters and aquatic ecosystems, for the benefit of present and future generations, by maintaining the highest possible standards of service to Canadians, marine and environmental protection, scientific excellence, conservation and sustainable resource use. Northern S&T activities support all elements of this vision and include:

- Arctic fisheries and fish habitat assessment and understanding in support of resource management;
- chemical contaminants in the Arctic that affect marine ecosystems, fish, mammals and northern peoples;
- hydrographic charting, technology development and chart dissemination in support of marine transportation in the Arctic;
- maintaining healthy and productive aquatic ecosystems; and
- marine sciences to understand ocean variability, extremes and processes in a sensitive Arctic environment.

DFO also maintains a capability, primarily in partnership with other agencies, in areas of potential development that could affect the marine environment. Arctic development scenarios have tended to be in the area of hydrocarbon exploration and mining exploration, production and transportation; hydro-electric development (reservoir issues and potential downstream impacts on the marine environment); and emergency response issues related to spills, etc. DFO also participates in international Arctic science issues, particularly those dealing with climate change programs.

Recent Major Northern S&T Achievements

Resource management

DFO contributes to Northern S&T through a number of programs in response to its commitment to the understanding and awareness of northern fisheries and marine ecosystems – in relation to Northerners and all Canadians.

It provides management advice for 300 to 400 discrete fish and marine mammal stocks in the Arctic. Turbot and bowhead whale surveys were conducted in 1999. Some marine mammal studies are completed in partnership with other countries where migratory populations are found in the waters of more than one coastal state (e.g. Canada-Greenland Joint Commission on the Conservation and Management of Narwhal and Beluga).

DFO provides scientific information necessary for the conservation and sustainable use of Arctic fishery resources, particularly in response to increased demands for their harvest. Traditional knowledge, when available, is incorporated with the contemporary scientific data and supports the concept of integrating different kinds of data to enhance the overall results.

Oceans climate

All the major international and intergovernmental climate meetings of the 1990s identified oceans as a “weak link” in the ability to understand, describe and predict climate change and climate. A marine oceanographic program, Joint Ocean Ice Studies, led by DFO in the summer of 1998, involved CCG icebreakers and the participation of more than 50 scientists. In 1997, DFO worked on a joint climate program with the United States in



Chemical contaminants are widespread in the Arctic environment and reach Arctic people through dietary items, such as Arctic fish and marine mammals.

the Arctic Ocean (surface heat budget of the Arctic Ocean) and conducted a joint international study on the Northwater Polynya between Canada and Greenland in 1999. The overall Canadian objectives of these programs address issues related to climate change, contaminants and understanding of Arctic marine ecosystems.

Stock assessment research

Stock assessment research will continue to be a high priority within DFO's mandate to manage its fisheries in the North. This information provides valuable input to co-management boards and international organizations.

Contaminants

Chemical contaminants are widespread in the Arctic environment, and reach Arctic people through dietary items such as Arctic fish and marine mammals. Mercury, toxaphene, PCBs and other stable contaminants exist in Arctic people at levels higher than those in people from southern Canada. The potential effects on human health are being investigated through DFO's participation in the NCP.

The growth of human population will increase the need for municipal infrastructure. Sewage and garbage disposal will continue to be a major issue leading to environmental pollution and local contamination of fish and wildlife.

DFO is cooperating with several agencies in joint studies to define the geographical and temporal extent of these Arctic contamination problems, and to evaluate the biological significance of the current levels for aquatic animals.

Arctic hydrography

In 1998, the CCGS *Griffon* collected hydrographic data in Hudson Bay from the end of July to mid-September. A multi-beam survey along the wharf, the harbour channels and the offshore approaches to Churchill harbour was completed for the Hudson Bay Port Company. During the past three years, harbour and approach surveys were completed at the Keewatin communities of Arviat, Whale Cove, Rankin Inlet and Chesterfield Inlet. These surveys have been complemented by a coastal navigation corridor survey. In addition, a hydrographic survey of the harbour and approaches to the community of Coral Harbour on Southampton Island was completed. The data will contribute to several new charts.

Aquatic ecology

Arctic aquatic ecosystem research provides the information to meet departmental responsibilities for the co-management of Arctic fish and marine mammal resources, and to protect Arctic fish habitat. Recent developments, such as diamond mining and a renewed interest in frontier gas, have placed demands on DFO for information on aquatic ecosystems.

Future Strategic Directions in Northern S&T

Northern S&T is needed to understand how to conserve and manage ocean resources currently and in the future. Fisheries management must have a reliable base of scientific, traditional and local knowledge to ensure the accurate assessment of fish stocks and to improve understanding of marine ecosystems.

Ocean climate research – an emerging priority for DFO in the Arctic. Climate change and its effects will be greatest in high latitudes. Since regional warming occurs within the Arctic, positive feedback effects involving planetary albedo and the world ocean circulation give the Arctic significant potential to affect the global climate system. Further, there is growing awareness that the Canadian Arctic Archipelago is a key, but poorly understood, component of the climate system.

A national oceans strategy and oceans policy – direction and priorities for DFO with the creation of the *Oceans Act*. A national oceans strategy and oceans policy would improve linkages and capacity, within the federal government and with all of Canada, and lead Canada's involvement in international ocean issues. Progress has been made in the Inuvialuit Settlement Region, Nunavut and Manitoba to establish potential integrated management plans that recognize the competing interests for marine resources. Environmental and habitat research is required for decision making.

Contaminants – a continuing concern in the Arctic. Organochlorines will remain a major problem in fatty tissues of marine mammals, notably those that consume fish or other marine mammals. Hydrocarbons will remain an issue – firstly, because of the oil, gas and coal reserves in the Arctic that are being or may be developed; and secondly, because of the potential for spills during transportation.

Mercury – a major interest. Mercury occurs naturally, moves globally in the air and is mobilized in hydro-electric reservoirs. It is of special concern in the Hudson Bay and James Bay where there is considerable

hydro-electric development occurring or planned. Its presence in marine mammal tissues is a major issue for Aboriginal people.

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2.3.5 Industry Portfolio

Mandate

The Industry Portfolio of Industry Canada works to leverage resources and exploit synergies in a number of areas including:

- innovation through science and technology,
- trade and investment,
- growth of small and medium-sized enterprises, and
- economic growth of Canadian communities.

The Industry Portfolio has a broad range of organizations covering the entire spectrum of the economy including:

- research and development (National Research Council [NRC], Communications Research Centre, Canadian Space Agency),
- university research funding (NSERC, SSHRC),
- technology development (NRC, Technology Partnerships Canada),
- data collection and analysis (Statistics Canada),
- regional development (Atlantic Canada Opportunities Agency, Canada Economic Development for Quebec Regions, Western Economic Diversification), and
- financing (Business Development Bank of Canada).

How the Industry Portfolio Uses Northern S&T to Deliver on Its Mandate

The Industry Portfolio departments and agencies have few specific programs targeted toward Northern S&T. Most of the programs have national, or at least regional, scope. The Atlantic Canada Opportunities Agency, Western Economic Diversification, and Canada Economic Development for the Quebec Regions have specific regional mandates that include northern regions. Several of the Industry Canada regional offices have mandates for the North (e.g. British Columbia, Yukon, the Prairies, NWT, FedNor), but they mainly deliver national programs in those regions.

The major technology development and support programs (e.g. Technology Partnerships Canada of Industry Canada, Industrial Research Assistance Program of NRC) are demand-driven; they are based on submitted project proposals. Programs such as Community Access (Industry Canada) have mandates to ensure that rural and remote parts of Canada, including the North, are able to participate in the Information Highway. Aboriginal Business Canada (Industry Canada) encourages entrepreneurship in Canada's Aboriginal communities. Priority areas for Aboriginal Business Canada include innovation and technology development, trade and market expansion, tourism and youth entrepreneurship.

Typically, Industry Portfolio programs are aimed at strengthening linkages and information flows between S&T users (e.g. businesses,

communities, institutions, individuals) and those that can supply their needs (e.g. other businesses, government laboratories, universities, research institutions, foreign sources).

Recent Major Northern S&T Achievements

Industry Portfolio departments and agencies have been partners in numerous Northern S&T initiatives in recent years. Specialized S&T development and application expertise has been lent to such diverse projects including:

- Canadian Space Agency satellites and instrumentation that support AES and NRCan research, among others;
- NRC's Canadian Hydraulics Centre computer program to couple its ice-drift model with DFO oceanographic and Environment Canada atmospheric models into an operational package for the Canadian Ice Service; and
- NRC's research on icing of runways and aircraft in northern conditions, used by Transport Canada and Environment Canada.

Two Industry Portfolio agencies, NSERC and SSHRC, are leading providers of funding for university research in and on the North.

Future Strategic Directions in Northern S&T

The Industry Portfolio will continue as an important partner with many other departments and agencies to provide unique research equipment, facilities and technology demonstration opportunities. The major funding initiatives (Technologies Partnerships Canada and Industrial Research Assistance Program) for northern issues are tied to the Climate Change Action Fund.

NSERC and SSHRC are leading a Task Force on Northern Research to examine rebuilding northern research capacity in Canada. This could have important research and training implications for the broad northern research community (government, university, private sector), and could lead to the development of new research partnerships between the granting councils and federal departments and agencies, and private-sector firms that support research in the North.

The Industry Portfolio will continue to support demonstration projects of new technologies for communities in the North – in areas such as information technologies (e.g. Smart Communities, Telehealth) and building technologies (e.g. ventilation, heating, energy efficiency). Specialized equipment and facilities at Industry Portfolio laboratories (e.g. wind tunnels, wave tanks, research aircraft, satellites) will remain central to research partnerships with others carrying out northern research.

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2.3.6 Natural Resources Canada

Mandate

NRCan's vision statement is "As we enter the new millennium, Canada must become and remain the world's 'smartest' natural resources steward,

developer, user and exporter – the most high-tech, the most environmentally friendly, the most socially responsible, the most productive and competitive – leading the world as a living model of sustainable development.”

NRCan's mandate includes:

- Promote the sustainable development and responsible use of Canada's mineral, energy and forestry resources.
- Develop an understanding of Canada's landmass and offshore.
- Collect and disseminate knowledge on sustainable resource development.

How NRCan Uses Northern S&T to Deliver on Its Mandate

Earth Sciences Sector consists of three operational units – GSC, Geomatics Canada and PCSP. It is the predominant S&T sector of NRCan. The Canadian Forest Service, the Energy Sector, and the Minerals and Metals Sector also support Northern S&T.

Earth Sciences Sector: GSC – provides a comprehensive geoscience knowledge base. It contributes to economic growth, sustainable development, health and safety, and environmental protection by acquiring, interpreting and disseminating geoscience information about Canada's landmass and offshore territory. It conducts geoscientific research and surveys in the North to achieve the following:

- Provide a knowledge base for assessing mineral and energy potential, new technology for exploration in permafrost regions, and strategies for sustainable development of mineral and energy resources.
- Optimize mineral exploration strategies, to lead to the development of new mines and potentially to new energy sources (e.g. gas hydrates).
- Improve the geoscientific base to facilitate environmental and land-use decisions, and to respond to concerns related to climate change.

Earth Sciences Sector: Geomatics Canada – provides a reliable system of surveys, maps, remotely sensed data and geographically referenced information. Under the *Canada Lands Surveys Act*, the role of Legal Surveys Division is to facilitate orderly development of Canadian lands by maintaining a system to describe and identify the extent of property rights.

Earth Sciences Sector: PCSP – provides coordinated logistical support and advice to Canadian government and university groups and, on a cost-recovery basis, to private-sector and non-Canadian groups that conduct research programs in the North.

Canadian Forest Service – delivers programs to the North through the First Nations Forestry Program and through S&T activities (e.g. Collaborative Research Agreements, Fire Management Network, Canadian Interagency Forest Fire Center). It also delivers on a national basis. Ten research networks address a range of issues, including forest health, climate change, landscape management, forest ecosystem processes, fire and pest management, tree biotechnology and socio-economic research. In addition, model forests – such as the Waswanipi Cree Model Forest in northern Quebec and the McGregor Model Forest in British Columbia which implements a Wildfire Threat Analysis System – could provide the basis for further assistance and serve as working models for partnerships in the North.

Energy Sector – carries out Northern S&T activities. For example, the Office of Energy Efficiency makes businesses, communities and residences more energy efficient, and develops renewable energy pilot projects. In addition, the Energy Sector has experience in programs related to energy R&D and in the regulation of oil and gas activities in the North.

Minerals and Metals Sector – promotes sustainable development of Canada's minerals and metals resource industry, and provides a national perspective and leadership on mining and natural resource issues. This sector works with northern agencies on environmental reviews, land-use issues (e.g. regional land-use plans, establishment of national parks, protected areas strategies), economic development planning and regulatory reform. The Mineral Technology Branch (CAN-MET) provides R&D into innovative mining and mineral processing technologies to increase industrial productivity, to find cost-effective solutions to environmental problems, and to provide information and expert advice for environmental reviews.

Recent Major Northern S&T Achievements

In Nunavut, the Legal Surveys Division is responsible for surveying the Inuit Owned Lands parcels. This involves the survey and demarcation of approximately 1,155 Inuit Owned Lands parcels and 12 Jointly Owned Lands parcels. Currently, the division maintains northern regional offices in Whitehorse and Yellowknife. A Nunavut Client Liaison Unit has been established in Yellowknife and two Northerners have been hired as technical staff. The office will relocate to Iqaluit in 2000.

A socio-economic impact assessment of a significant northern government geoscience program (1991-1996), undertaken by Goss Gilroy and Associates Limited, showed that by late 1996, government geoscience programs resulted in a more than \$13.5 million increase in exploration expenditures. This is double the original program investment. In fact, the assessment credits government geoscience mapping and research in the area west of Rankin Inlet as the primary driver for enhanced gold exploration in the area. The area could be the location for Nunavut's first gold mine.

In 1988, the GSC released the results of the National Geochemical Reconnaissance Program stream sediment survey that was completed in the Finlayson Lake area of Yukon. The survey led directly to the discovery in 1993 of the Kudz-Ze-Kayah massive sulphide deposit by COMINCO Limited. This deposit has a gross in-place value of \$2.2 billion. Of greater significance, subsequent exploration has led to the discovery of several previously unknown base metal deposits (e.g. the Wolverine deposit by Atna/Westmin) in the area, and has defined the Finlayson Lake belt as a potential new base metal district.

Although not all government geoscience programs yield short-term benefits, mapping by the GSC, during 1995-1997, on Meta Incognita Peninsula of southern Baffin Island has led to more than \$6 million in private-sector exploration investment since 1996. This resulted in benefits to the communities of Kimmirut and Iqaluit. It also increased awareness of and participation in geoscience and prospecting activities by community members and the Qikiqtaaluk Corporation.

The GSC's mapping drew attention to potential gas fields in the Mackenzie Valley region. In early 1999, industry announced major finds of natural gas in the region with estimated reserves of 500 to 700 billion cubic feet – enough to trigger plans for linking the area to the national pipeline system. GSC's understanding of the regional geology played a significant role in private-sector decisions to risk investment in this development.

The NATMAP program, which began in 1990, has been highly effective in promoting cooperation and collaborative partnerships, and in creating integrated geoscience knowledge bases to address regional issues. For example, the Western Churchill NATMAP project will provide a

comprehensive geoscience knowledge base for the Rankin Inlet-Arviat-Baker Lake area of Nunavut. This area has significant gold, diamond and base metal potential – conservatively valued at over \$18 million in 1998-1999. Results of this project have directly influenced mineral exploration programs in the area.

The GSC, DIAND, the Qikiqtaaluk Corporation and the Government of the NWT recently undertook cost-shared partnership projects on Baffin Island to provide an enhanced geoscience knowledge base and assessment of the mineral potential of the respective study areas, to stimulate mineral exploration, to facilitate skills and services capacity building in northern communities, and to support informed land-use decision making. These initiatives represent a new model for northern geoscience program delivery. They have been instrumental in helping the GSC forge important new linkages with government, Inuit associations and Nunavut communities.

A major GSC study over the last 10 years has established the distribution of permafrost and ground ice. This research has developed a model that can predict the distribution, thickness and temperature of permafrost. This work is now directed toward assessing the impacts of climate change in the Mackenzie Valley.

The GSC, in collaboration with the Japan National Oil Corporation, led an international team that drilled Mallik 2L-38 in the Mackenzie Delta. This deep research well was the first field investigation of a gas hydrate deposit in the Arctic. It established the Mallik field as one of the world's most concentrated gas hydrate occurrences.

The Minerals and Metals Sector partnered with the Nanisivik Mine to maximize ore recovery while maintaining safe conditions for mine workers. With the sector's technical support, mining of the support pillars proceeded. This will allow ore extraction to continue until 2003.

Scientists at the Northern Forestry Centre of the Canadian Forest Service have developed a fire danger rating system for the North. They also conducted a large number of controlled burn experiments to develop better fire protection and suppression strategies.

Since 1984, the Canadian Forest Service has administered and delivered Aboriginal Lands Forestry Programs throughout Canada. Both the forestry S&T and Aboriginal Lands Forestry Programs currently operate in the NWT and Yukon.

In addition, NRCan is using new technology to improve the way information is delivered to Canadians. NRCan's ResSources knowledge initiative comprises a number of elements. In collaboration with stakeholders, the department is building an electronic Web-based knowledge infrastructure. It is building and adapting software tools to help manage access to its information holdings within that infrastructure. It is compiling an inventory of information assets that will be accessible using those software tools. And it is linking and fostering information-sharing across Canada's natural resources sector. ResSources is cooperating with other government departments, with Service Canada, and with GeoConnections, a Canadian-wide initiative to build a national geospatial infrastructure. One of ResSources' early success stories was the National Atlas of Canada's Nunavut project, incorporating information provided by Nunavut school children and elders into the Atlas' database.

Future Strategic Directions in Northern S&T

The Earth Sciences Sector will provide geospatial and geoscientific knowledge to achieve the following:

- Foster sound economic, environmental and social decisions.

- Develop and sustain economic benefits.
- Minimize the impacts of land use, natural resource development and climate change.
- Enhance the safety and economic security of Northerners.

The Minerals and Metals Sector will focus on safe, efficient mining and mineral processing, sustainable mining operations, and promoting northern mineral resources.

The Energy Sector will focus on renewable and alternate forms of energy and on energy efficiency in the North.

The Canadian Forest Service's northern program will focus on the most important aspects of forest ecosystems and on the viability and competitiveness of forest-based economies.

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2.3.7 Health Canada

Mandate

The legislative mandate of Health Canada is expressed in the Department of Health Act and some 20 other pieces of legislation, including the *Canada Health Act* and the *Food and Drugs Act* and the *Canadian Environmental Protection Act*. Responsibilities under these acts cover areas such as the safety of food, water, drugs, medical devices and consumer products; the sale and advertising of tobacco; the control of narcotics, pest control products and radiation-emitting devices; environmental and workplace hazards; and the application of quarantine measures. Among other responsibilities, Health Canada provides essential services to First Nations and Inuit people and works with them as they assume responsibility for delivering the services.

How Health Canada Uses Northern S&T to Deliver on Its Mandate

Health Canada, as part of its mission "To help the people of Canada maintain and improve their health," is supporting and conducting S&T of relevance to northern people. The activities which extend from the natural sciences to social sciences and humanities, benefit from multi-disciplinary and multi-partner approaches. Two main branches share the work – the Health Protection Branch and the Medical Services Branch.

Health Canada plays a leadership role in managing the risks to health posed by products and diseases. These risks, which originate from a wide range of sources, include contaminated food or water, unsafe drugs, medical devices or therapeutic products, industrial and consumer chemical products, pest control products, radiation and environmental hazards, existing and emerging diseases. Recent changes to *Canadian Environmental Assessment Act* regulations require environmental assessment of federal contaminated sites before cleanup. Health Canada participates in these assessments by providing advice on possible health impacts.

Health Canada also supports the government-wide agenda in *Gathering Strength – Canada's Aboriginal Action Plan* which calls for partnerships among Aboriginal people, governments and all Canadians

to address the needs of Aboriginal people and communities. Science and particularly technology play an important role in meeting those needs.

Recent Northern S&T Achievements

Progress has been made in better determining the toxicity of a number of single pesticides and mixtures of particular relevance to the dietary exposure of northern people. Among the chlordane-related pesticides, trans-nonachlor and oxychlordane have been shown to be the most toxic. Further investigation of effects on key target organs and potential sex-related differences in toxicity will be the subject of future studies of a longer duration.

PCBs are also of particular relevance in the North due to their presence in species used in traditional diets. PCBs and PCB-like materials (e.g. polychlorinated dibenzo dioxin and polychlorinated dibenzo furan) produce a range of toxic effects. Work is under way to examine if the toxic effects of combinations of these chemicals produce a simple additive toxic effect or if there are interactions that may alter (i.e. reduce or enhance) the

to various POPs contributed to the successful completion of a treaty limiting various POPs by the UN Economic Commission for Europe. The information supplied by NCP and AMAP is also used by the UNEP in support of the negotiations to complete a global treaty controlling POPs.

Future Strategic Directions for Northern S&T

Health Canada will continue to use partnerships in and outside Canada to advance Northern S&T. Studies into the safety and nutritional values of traditional northern foods will go on. The Laboratory Centre for Disease Control, Health Canada, with the Arctic Investigations Program of the United States Centers for Disease Control and Prevention, will expand the surveillance undertaken under the International Circumpolar Surveillance program to include other bacterial diseases, viral diseases and other public health issues of importance to these populations. Work will continue under the First Nations Health Information System program to improve health management and surveillance within First Nations and Inuit communities, through technical capacity and human skills development.

Photo: DIAND



A study of an Inuit population living in the high Arctic of Canada indicated that the frequencies of drug metabolism variants in the Inuit sometimes resemble those of Caucasian populations, sometimes those of Asian populations and, in some cases, are unique.

Among other responsibilities, Health Canada provides essential services to First Nations and Inuit people.

observed toxicity. The results of the study could alter the way in which risk assessments are constructed for these chemical mixtures.

A study of an Inuit population living in the high Arctic of Canada indicated that the frequencies of drug metabolism variants in the Inuit sometimes resemble those of Caucasian populations, sometimes those of Asian populations, and in some cases are unique. An example of the latter case is the frequency of some of the CYP2D6 alleles. CYP2D6 is an important member of the cytochrome P450 superfamily of drug metabolizing enzymes, and genetic variability of this activity has been implicated in adverse drug reactions.

Under the NCP, Health Canada monitored maternal and fetal blood and dietary contaminants. The department participated in the design, evaluation and communication of results to northern peoples. The *Canadian Arctic Contaminant Assessment Report* outlines the results of the first six years of the NCP; Health Canada staff were the lead authors of the human health chapter of this report.

Canada contributed to the circumpolar nations AMAP through its NCP activities. The *AMAP Arctic Assessment Report: Arctic Pollution Issues* outlined the results of the first phase of AMAP and indicated the concerns of all eight circumpolar nations about specific POPs and metals in the Arctic environment. Health Canada staff were significant contributors and co-editors of the human health chapter of this report. Information from the NCP and AMAP about elevated human exposures in the Arctic

HPB, in collaboration with First Nations and many governmental and non-governmental partners, will complete an implementation plan for the National Diabetes Surveillance System.

In parallel to the above work, Health Canada is reviewing its northern research activities within the context of the Canadian Institutes of Health Research. The department will be identifying partnership opportunities to better deliver its mandate.

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2.3.8 Transport Canada

Mandate

Transport Canada's mission is to develop and administer policies, regulations and services for the best possible transportation system for Canada and Canadians.

Its mandate includes:

- Develop up-to-date, relevant transportation policies and legislation.
- Maintain the highest level of safety and security possible.
- Commit to the principle of sustainable development in its own functions as well as those of the transport industry.

The departmental mandate is as equally applicable to the North as to the rest of the country. Access to efficient and economical transportation is necessary for any potential northern economic development (e.g. northern mineral deposits, far from salt water, not being developed because there is no linking road to a port).

How Transport Canada Uses Northern S&T to Deliver on Its Mandate

Transport Canada divides the industry it regulates into three modes – air, surface and marine. All three modes operate in northern Canada, some more than others.

Air mode – provides vital service to northern residents and enterprises. For large parts of the year, flying is the way of reaching many parts of northern Canada. Transport Canada sponsors research directed at the safety of air operations. Research specific to northern air operations and safety is largely unnecessary; results of research in this area are applicable to anywhere in Canada where aircraft operate. For example, the cruising altitude for most large airplanes and atmospheric conditions are the same over Montréal as they are over Tuktoyaktuk. Winter runway conditions in Saskatoon are similar to those in Rankin Inlet.

Surface mode – includes rail and road. The length of railway track in northern Canada is low compared to elsewhere in the country. The northern road network is more extensive. As with air operations, winter road conditions in other parts of Canada can be quite similar to those in the North. Problems encountered by surface transport operators in northern Canada relate more to the nature, or lack, of infrastructure than to northern climate or conditions.

Marine mode – the greatest difference in services between the North and the rest of the country. Currently, there are no winter marine operations in northern Canada. Summer and autumn operations are significantly affected by the northern environment, particularly the presence of ice in shipping lanes and harbours. Extreme environmental conditions place additional loads on ships' structures, and propulsion and auxiliary systems.

Knowledge of the nature and effects of Arctic shipping has increased dramatically since the first attempt to regulate the industry in 1970 – following the first Arctic passage of the American tanker Manhattan the previous year. Subsequent oil exploration and drilling activities in the Mackenzie Delta and Beaufort Sea resulted in a body of knowledge that has been used to modify and modernize Canadian requirements for Arctic Class Ships (i.e. Equivalent Standards). Ships built to the newer requirements will be lighter and therefore more economically viable than predecessors built to the original *Arctic Shipping Pollution Prevention Regulations* promulgated in 1972. Transport Canada's Arctic marine research program intends to make similar changes in the other vessels.

The department is currently engaged in an international cooperative venture to develop guidelines for the design of polar ships. The results of Canadian research have an integral part in the final outcome of this initiative. Other participants include some foreign maritime administrations, classification societies and private ship owners.

Recent Major Northern S&T Achievements

Transport's Arctic marine research addresses the concerns of those who navigate or operate ships in the Arctic. Because of the difficulties of ice navigation, these individuals often experience extreme fatigue thus creating potentially dangerous situations. Strategies are being examined to avoid this. A course curriculum, leading to a specific certificate endorsement, is being developed for ice navigators. In addition, the department is developing a virtual reality ice navigation simulator for training purposes. This will enable more candidates to become familiar with the problems and practices of ice navigation. The program will inevitably improve the safety and environmental record of ships operating in ice-affected waters.

Survival under polar conditions is often overlooked by marine research. No current Canadian regulation requires ships to carry specialized survival equipment on northern voyages. Transport Canada's research has examined Arctic survival and the results have been published in several documents, principally *Ice Navigation in Canadian Waters* and the *Marine Survival Handbook for Cold Regions*. The Polar Guidelines incorporate specific polar lifesaving and survival equipment to be carried by ships engaging in Arctic navigation.

The department has recently introduced an innovative ice regime-based system of controlling shipping in ice-affected waters. This partially replaces an older system based on rigid zone boundaries with entry and exit dates determined from historical ice data. Research is currently under way to provide a more scientific basis for defining specific ice regimes. This could result in a reduced level of risk associated with shipping and a more general acceptance of the possibility of extended shipping seasons

Future Strategic Directions in Northern S&T

Transport Canada's Arctic marine research is geared toward special goals that do not exist in any other department. Nevertheless, some aspects of this research may find application elsewhere. Much of the raw data generated as a result of the department's R&D activities is of great potential use to other organizations, inside and outside government and inside and outside of Canada. Efforts will continue to achieve a wide distribution of research results to attract partners, as well as buy-in by the industry the department regulates.

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2.3.9 Canadian Polar Commission

Mandate

The CPC's purpose is to promote the development and dissemination of polar knowledge.

How the CPC Uses Northern S&T to Deliver on Its Mandate

The CPC, in cooperation with organizations, institutions and associations

in Canada and elsewhere, supports Northern S&T with the following activities:

- Sponsor conferences, seminars and meetings on polar science.
- Publish and distribute studies, reports and other documents relating to polar research.
- Liaise with Canadian and international polar research communities.
- Develop on-line polar information resources.
- Monitor and report on the state of polar knowledge.
- Promote effective polar S&T policy in Canada.

At the international level, the CPC represents Canada on IASC and SCAR. It speaks on behalf of Canada in such fora and ensures that Canadian scientists are an integral part of the circumpolar research community.

The CPC has been working with Canada's northern research community in identifying data and information requirements, and encouraging the design and development of appropriate storage and delivery mechanisms. At the international level, the Commission promotes sound data management practices, establishes standards and protocols for polar metadata, and helps link Canadian research to global databases supporting international studies on phenomena such as global climate change, ozone depletion and transboundary pollution.

Recent Major Northern S&T Achievements

Under its *Strategic Roadmap 1999–2002*, the CPC has initiated several core projects designed to support northern S&T. These are described below.

Canadian Polar Information Network – being designed to provide the following:

- basic information products on polar research in Canada,
- linkages to information and data held by public- and private-sector organizations and agencies throughout Canada,
- linkages to international sources of data and information,
- appropriate and reliable mechanisms and technologies for the management of polar information and data in Canada, and
- a telecommunications infrastructure appropriate to Canadian objectives with respect to polar science and technology.

In the short term, the project will assess existing information and data resources in Canada to determine status, ownership and accessibility; identify gaps in information and evaluate community and public needs; assess requirements and design integrated search capabilities; schedule components for on-line implementation; and prepare basic information tools.

Over the longer term, the project will develop strategic partnerships, seek additional, dedicated funding in support of northern and polar science information requirements, and establish working linkages at the international level to ensure that Canadian metadata resources are available in global directories.

Information exchange for northern knowledge practitioners – establishing, within the context of the Canadian Polar Information Network, an on-line forum for use by northern and polar knowledge practitioners. The forum will complement the NORTHSCI listserv developed by the Association of Canadian Universities for Northern Studies and will be linked to the Northern Science and Technology Framework Web site and the CPC Web site. Designed as an interactive Web board, the forum will feature threaded discussions on key issues

relating to the conduct of polar research and will help support CPC monitoring and reporting functions.

Promotion of national policy for polar science – bringing about a broader understanding of polar issues, building an effective national and international presence in the field of polar S&T, and serving as an advisory body on polar science policy development. The CPC will continue to support its view on the need for a national policy on polar knowledge and research in consultation with Northerners and government agencies. It also will work to establish networks both within and outside the federal government toward this end.

Enhanced visibility throughout Canada – informing Canadians of CPC activities as well as those of key players in the area of polar study. This initiative will include a strong presence for the CPC in northern Canada, the promotion of the CPC's view on the need for a polar research policy, and a strong focus on public education and media relations. In these and other endeavours, the Commission will work closely with its partners and with appropriate agencies at the national and international levels. The *Northern Science and Technology Communications and Information Strategy* includes "promotion of the Canadian Polar Commission's mandate role in the development and dissemination of polar knowledge" as an objective.

State of Canadian polar knowledge reporting – reporting regularly on polar issues and the state of polar knowledge through the following initiatives:

Polar knowledge indicators: In June 1999, the CPC hosted a workshop on the development of polar knowledge indicators. The objectives of this initiative and follow-up meetings are to identify statistical and other data describing various aspects of polar research, and to select from these a set of key indicators to measure the state of polar knowledge in Canada. The initial indicators report is scheduled for publication in spring 2000.

Information products: The CPC provides information on Canadian research in the polar regions through various publications and on-line tools (e.g. *MERIDIAN* newsletter, *Newsletter of the Canadian Antarctic Research Network*, *Polaris Papers*, Northern Science and Technology Web site, Northern Science and Technology Framework Intranet, Polar Science Web board).

Arctic and Antarctic research: The CPC will produce regular profiles on the state of Canadian polar study based on feedback from conferences, workshops and meetings, and research undertaken by staff. Information will be synthesized and common issues areas highlighted in an occasional papers series. An annual report on the state of polar knowledge in Canada will be prepared for submission to Parliament.

Enhanced representation for Canada in international polar organizations – working, on behalf of Canada's polar research community, to enhance Canada's presence at the international level through a more active role in international organizations (e.g. IASC, SCAR, UNEP, UNESCO).

Future Strategic Directions in Northern S&T

The CPC's goal is to be central to the development and dissemination of northern knowledge through consultation, communication and partnership for the benefit of all Canadians and their responsibilities in the circumpolar world.

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2.3.10 Canadian Museum of Civilization

Mandate

The Canadian Museum of Civilization (CMC) was created as a corporation by the *Museums Act* of 1990. Its primary goal is to increase interest, knowledge, understanding and appreciation of Canada's cultural heritage and achievements.

How the CMC Uses Northern S&T to Deliver on Its Mandate

The CMC undertakes research, collects and maintains objects and information of historical and cultural interest, and develops programs for exhibition, education and provision of information to Canadians.

Recent Major Northern S&T Achievements

For most of the past century, the museum (and its antecedent agencies) has been the primary organization engaged in archeological and historical research in northern Canada. It continues to field archeological, historical and ethnographic research projects in northern Canada in association with local communities or other northern organizations.

The CMC also maintains the largest collections of archeological and historical collections relating to northern Canada and makes these available for research and exhibition. It also provides travelling exhibitions to communities in the North.

Through the Aboriginal Training Programme, the CMC provides instruction in museum-related fields to candidates from northern Canada as well as those from other regions. It also represents the federal government with relation to historical and cultural aspects of northern land claim negotiations.

Future Strategic Directions in Northern S&T

No changes in strategic direction are planned for 2000-2002.

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2.3.11 Canadian Museum of Nature

Mandate

The Canadian Museum of Nature (CMN) is the pre-eminent national institution for natural history in Canada, maintaining an effective program of scientific study and public education for over 100 years. The CMN's mandate is "To increase, throughout Canada and internationally, interest in, knowledge of and appreciation and respect for the natural

world by establishing, maintaining and developing for research and posterity a collection of natural history objects, with special but not exclusive reference to Canada, and by demonstrating the natural world, the knowledge derived from it and the understanding it represents."

How the CMN Uses Northern S&T to Deliver on Its Mandate

Activities are in the areas of natural history collections, collection-based systematics research and education. The North and the Arctic are a major portion of Canada and have always been addressed through CMN programs.

Natural history collections



The Canadian Museum of Nature is the pre-eminent national institution for natural history in Canada, maintaining an effective program of scientific study and public education for over 100 years.

Specimens in the national collection at the Natural Heritage Building, Aylmer, Quebec, consist of extensive mineral, fossil, plant and animal material. These include, for example, woolly mammoth fossils from Yukon, shark fossils from NWT and beaver remains from ancient environments on northern Ellesmere Island. These collections, together with thousands of mineral specimens, form an integral part of the earth history of Canada's North.

The CMN also houses important zoological and plant specimens from the Canadian Arctic. The most comprehensive Arctic fish collection in North America is at the CMN. A large number of the more than one million specimens in the herbarium are from the Arctic. An important role of the CMN is to preserve these scientific specimens and to make them accessible for research as long as possible.

Collection-based systematics research

Research is conducted within the following four projects:

Rare Elements – a mineralogy project specializing in boron, tantalum, niobium and the rare earth elements. The project addresses social concerns over the prediction of the future, wise use of non-renewable resources and the development of new methods for the location of undiscovered resources. Dealing with this concern scientifically requires the development and testing of models by which (i) the roles of rare elements in minerals can be discerned, (ii) new crystal structures and technological applications of rare element-bearing materials can be predicted, and (iii) the origin of rare-element deposits can be inferred and new deposits located. Studies in Yukon and NWT are ongoing.

Paleobiological Studies – investigates the conditions around many recent and distant large-scale extinction events to understand the effects of environmental conditions on faunal assemblages. The study of past biological diversity is critical to our understanding of the origin and evolution of living plants and animals. Thus, activities of this project include, among many others, discovery and analysis of mammal, bird and fish fossils and other paleo-environmental indicators from a 3.5-million-year-old beaver pond in NWT, the most northern site of its age in the world.

Issues in Biodiversity – botanical and zoological investigations into many aspects of systematics research, with a focus on applications for conservation. This project undertakes research to understand and manage biodiversity through basic systematics and ecology investigations linked with regional studies, with targeted management and with conservation activities leading, when possible, to specific recom-

program material at the CMN. The exhibit, *Arctic Odyssey*, showcases ways of knowing the North, with close to 800 square metres of exhibit area at the Victoria Memorial Museum Building in Ottawa. It includes a balance of scientific and traditional elements, and marine and terrestrial topics. There are interpretive programs related to this exhibit, a travelling exhibit on polar bears and a variety of other interactive events that have involved people in northern communities and the public.

Many other exhibits of the CMN display the flora, fauna and earth elements of Canada and rely upon northern material. The Victoria Memorial Museum Building has also been the location of the Centre for Traditional Knowledge for the past five years.

The CMN is active in publishing technical and popular scientific material, as well as articles in primary scientific journals. Publishing may also be done through co-publishing arrangements (e.g. *Lichens of North America* with Yale University Press, *Canadian Arctic Marine Fishes* with DFO). Much published material is available on the museum's Web site.

Recent Major Northern S&T Achievements

Recent major Northern S&T achievements include:

- publishing *Insects of the Yukon*;
- conducting multi-disciplinary fieldwork in the Yukon, Northwest Territories and Nunavut in marine zoology and ecology, paleontology and botany;
- completing a contract with DIAND for mineralogical investigations in the NWT, including an extensive report;
- beginning a publishing venture with DFO for a field guide to the marine fishes of the Canadian Arctic;
- representing Canada as part of the Biological Committee of the Scientific Committee for Antarctic Research (Partnering implications with PCSP and other Arctic interests exist through such involvement.);
- representing Canada as a partner in the Pan-Arctic Flora Project;
- exhibiting *Arctic Odyssey* for the second successful year at the Victoria Memorial Building; and
- completing the second year of a seven-year project to record and publish the complete data on the flora of the Arctic Archipelago.

Future Strategic Directions in Northern S&T

- Continue to advocate for the importance of basic, long-term scientific research in the North.
- Continue to produce a balance of quality collections, scientific research and education materials within a limited resource base.
- Work in multi-disciplinary teams.

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2.3.12 Parks Canada Agency

Mandate

The Parks Canada Agency (Parks Canada) is a federal organization dedicated to the special places that are an expression of Canada. Parks Canada is responsible to Parliament through the Minister of Canadian

Photo: DFO



Parks Canada manages nine national parks, one national park reserve, one Canadian landmark and several national historic sites north of 60° latitude.

mendations. The findings will be interpreted and disseminated for specialized and public audiences. Among the many northern activities is the multi-year Flora of the Arctic Archipelago work and the Arctic Marine Fishes of Canada work.

Collection Management and Conservation – studies on how to best preserve the scientific specimens and make them available. The mandate of this project is to establish, through research, the knowledge essential to optimize collection management and conservation of natural history collections and to disseminate this knowledge through publications, training and consulting services. This type of information is essential to the Canadian Museum of Nature which houses a large number of Arctic type specimens (plants and animals, both fossil and current). It is also information that will be important to the metal mining community, which through the Aquatic Environmental Effects Monitoring legislation will be required to voucher natural history specimens as data.

In each of these projects, multi-disciplinary activities occur, in the field (e.g. terrestrial, aquatic) and in laboratories, that relate to northern specimens and the environments they occur or have occurred in.

Education

Natural history science has long been a topic of educational display and

Heritage. Parks Canada administers a system of heritage areas and programs that includes national historic sites, national parks, heritage rivers, heritage railway stations and buildings, historic canals and national marine conservation areas.

Parks Canada in the North

Parks Canada manages nine national parks, one national park reserve, one Canadian landmark and several national historic sites north of 60° latitude. The territorial North is divided into four Parks Canada Field Units – Nunavut, Western Arctic (Inuvialuit Settlement Region and Gwich'in Settlement Area), South West NWT and Yukon.

Auyuittuq National Park, Sirmilik National Park and Quttinirpaq National Parks are in Nunavut. They became national parks through an Inuit Impact and Benefit Agreement with the Inuit of Nunavut.

In NWT, there are three national parks, one national park reserve and a Canadian landmark. Aulavik National Park, Tuktoyaktuk National Park and the Pingo Canadian Landmark are in the Inuvialuit Settlement Region. Nahanni National Park is in the Deh Cho and Wood Buffalo National Park straddles the NWT-Alberta border.

In Yukon, Parks Canada manages three national parks and several national historic sites. Ivvavik and Vuntut National Parks are contiguous in the north end of the territory, while Kluane National Park is in the south. National historic sites are at Dawson (*Klondike* NHS) and Whitehorse (*S.S. Klondike* NHS).

There are also national parks and historic sites in the provincial North – Chilkoot Trail National Historic Site in British Columbia, and Wapusk National Park and Prince of Wales Fort National Historic Site in Manitoba.

How Parks Canada Uses Northern S&T to Deliver on Its Mandate

Parks Canada uses transportation, communications, environmental observation, and small-scale energy technologies in the management of these remote parks. Parks Canada has been an early adopter of the iridium telephone, global positioning systems, geographical information systems and satellite imagery.

Parks Canada conducts research and monitoring programs related to the natural and cultural resources of the parks and historic sites. Such research includes:

- original biological studies of vegetation, wildlife and ecosystems;
- inventories of natural and cultural resources;
- monitoring weather, permafrost, climate indicators, water quality and flow, vegetation, wildlife, visitor impacts, cultural resources and others; and
- pre-establishment assessments of the proposed park area's mineral and energy potential.

Parks Canada has also installed technological infrastructure in some of the parks which include:

- rough air strips with fuel caches,
- radio systems including repeater towers,
- CR10 weather stations,
- iridium telephones, and
- photovoltaic and wind power systems for park facilities.

Each Field Unit has different needs and different budgets for research and technology. When new parks are established, there is a flurry of basic research to understand the park, its ecosystems and its operational

issues. Infrastructure is put in place. Older parks have ongoing programs and from time to time upgrade their knowledge and their infrastructure; however, in general there is a reduced level of spending on basic research after the first five or 10 years of a park's establishment.

2.4 Support for Northern Science and Technology Education and Training

2.4.1 Northern Scientific Training Program

The Northern Scientific Training Program (NSTP) is managed by DIAND as part of its mandate to foster S&T in the Canadian North. The NSTP supports scientific training that gives graduate and senior undergraduate students in Canadian universities the opportunity to conduct field work in the North and thus encourage the development of new scientists in the area of Northern S&T. The program is pivotal in ensuring that Canada has future generations of northern specialists.

NSTP funds support an average of 300 students at approximately 30 universities each year. The NSTP also provides the impetus for the establishment of northern institutes and committees at many Canadian universities. The Northern Studies Institute at the University of Saskatchewan and the Boreal Institute at the University of Alberta, for instance, originated in this way.

Although the NSTP was funded at \$825,000 for the 1984-1985 fiscal year, this level had decreased to \$636,000 by 1999-2000. For the 1999-2000 research year, 33 universities requested \$1,197,400 in supplemental funds. The demand currently exceeds the supply.

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2.4.2 Natural Sciences and Engineering Research Council & Social Science and Humanities Research Council

Natural Sciences and Engineering Research Council

Part of NSERC's mandate is to promote excellence in the creation and productive use of new knowledge, and to seek out ways to increase Canada's capability to do that – both in terms of the skills and knowledge of individual Canadians, and the number of Canadians with the necessary competencies. NSERC is concerned with training young researchers, while maintaining and improving the capacity to provide that training and to do excellent research.

Almost all of NSERC's programs provide training support. Young researchers are supported by stipends provided through grants, as well as through direct awards such as scholarships. NSERC plays a major role in the training of the next generation of Canadian northern researchers, although there are currently no programs or awards targeted specifically to northern research.

In the area of "capacity building," NSERC has two programs that support the creation of new university faculty positions – the University Faculty Awards Program and the Industrial Research Chairs Program. The University Faculty Awards Program is designed to decrease the under-representation of women in faculty positions in the natural sciences and engineering. The Industrial Research Chairs Program aims to build capacity in a particular research field in partnership with industry. There is no specific targeting to northern research in either of these programs, although some northern researchers do receive support.

Social Science and Humanities Research Council

SSHRC supports research and training in the North through its regular research grants and fellowships programs – Standard Research Grants, Major Collaborative Research Initiative, Community and University Research Alliances, and Doctoral and Postdoctoral Fellowships. Through these programs, SSHRC supports research and training in all disciplines of the social sciences and the humanities. All programs encourage collaboration among researchers and disciplines. SSHRC's strategic programs specifically promote partnerships among researchers and stakeholders from government, communities, organizations and the private sector.

Task Force on Northern Research

In response to concerns expressed by the research community about the decline of research in Canada's North, NSERC and SSHRC have established a joint Task Force on Northern Research to look into the problems facing the northern research community and to suggest recommendations to address these problems. The final set of recommendations is likely to primarily address capacity and training issues, and the high costs of doing research.

In its first phase, the task force found that Canadian northern research is in crisis. Canada will not be able to meet its international science and research obligations, or contribute to issues of global importance. Neither will it be able to meet basic national obligations to monitor, manage and safeguard its northern environment, or respond to emerging social issues in the North.

Problems highlighted include a decline in university-based northern research; rising costs of doing research in the North; and lack of funds, logistical support and renewal in the research communities. The task force found, however, that there is a pressing need for researchers trained in northern issues, and many opportunities exist for partnerships and alliances with federal departments and northern communities.

The task force has concluded that the single most important issue facing northern research is the lack of renewal in the university research community. Without a renewed, vibrant research community, northern research will decline and the training of the next generation of northern researchers will be in jeopardy.

The principal funding recommendations of the task force will focus on a package of joint NSERC-SSHRC initiatives designed to revitalize northern research. The most important element is the creation of 10 to 12 new Research Chairs specifically focused on northern research. These will serve to create a critical mass of research activity in several universities. The task force has also recommended new funding for graduate students and postdoctoral fellows engaged in northern research, in order to "fill the pipeline."

Further recommendations are concerned with providing adequate orientation and training to new researchers starting programs in the North, as well as a program of research grants that will require partnership with northern communities and organizations, and/or federal, provincial and territorial government agencies. All these recommendations, if accepted by NSERC and SSHRC and, if funding is available, will give a real boost to Canadian northern research and training.

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2.4.3 Polar Continental Shelf Project

PCSP has evolved from a federal scientific project into a logistical support network coordinating field requirements for a wide variety of users, including Canadian university research groups.

Initially, PCSP had no specific funding earmarked to support university research; its support, including training students, was based only upon informal criteria. With increased demand from government and university client groups, in the 1970s and 1980s, PCSP sought and was granted supplementary funding. This funding expanded its support services and, in part, increased support to university Arctic research programs.

Throughout the 1990s, PCSP has committed \$1 million per year on average to support university research programs, despite an overall decline in its budget. To date, during this decade, PCSP has provided \$9 million in logistical support to 492 Canadian research groups from universities from all regions of the country.

University research applications for support are reviewed annually by a peer scientific review committee. The committee comprises academic research scientists with Arctic field experience and members represent the major scientific disciplines supported through PCSP. Applications are assessed on three main criteria – the inclusion and training of students, the integrity of the research program proposed, and the publications record of the chief proponent(s) in the field of research for which support is sought.

On average, in excess of 85% of university applicants to PCSP are successful each year. Because participation by Canadian universities in northern research has declined, PCSP has been able to meet the bulk of demands from the Canadian university community. Any increase in demand will require new resources if PCSP is to continue providing near-full support at no cost to university research groups.

For further information, contact: E-mail: bhrycyk@nrca.gc.ca

2.4.4 Science and Technology Exchange Program

The Science and Technology Exchange Program of NRCan's Earth Sciences Sector provides opportunities to exchange expertise, build partnerships and share costs for mutually beneficial projects. For example, studies in the Arctic have been identified as a priority of the Earth Sciences Sector-NSERC research partnership agreement which addresses priority research areas in the earth sciences. This five-year program will invest \$1.5 million per year in partnered research among government, academia and industry groups. It has a training component that supplements the Professional Enhancement Program of the Earth Sciences Sector. This program is designed to share expertise, foster alliances and build capacity in the earth sciences and their execution in Canada.

For further information, contact: E-mail: brankin@nrcan.gc.ca

2.4.5 Fisheries and Oceans Canada

Within DFO, support and training exists for students (e.g. graduate, postdoctoral), visiting scientists from other countries (e.g. Japan, United States, Germany, Norway) and agencies. Support is essential to provide potential educators in the North, as well as in the rest of Canada, with the right background and skills to teach northern science to the next generation of Canadians. DFO and other federal departments provide an excellent training ground with some real field experience for future educators. DFO also has a small number of programs that provide northern college students with an opportunity to be involved in field trips with DFO staff as instructors.

ultimately supports a sustainable critical mass of scientific research which otherwise could not and would not be undertaken.

PCSP directly contributes to Canada's expertise in policy and science in support of sustainable development of Canada's natural resources. Knowledge of northern resource potential is becoming increasingly important – to maximize opportunities for investment and to develop sound development strategies to support the new governments in the North.

During the past 40 years, PCSP has helped thousands of scientists from government agencies and universities contribute to Canada's knowledge infrastructure. It has promoted learning about a region that comprises one third of Canada's landmass and offshore region. The knowledge gained has contributed to economic development and job



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2.5 Logistical Support

2.5.1 Polar Continental Shelf Project

Goal

NRCan's PCSP coordinates logistical support and provides related assistance to advance scientific knowledge of the Arctic region and contribute to the exercise of Canada's sovereignty in that region and its adjacent waters.

Background

PCSP manages a coordinated, cost-effective transportation, communications and logistical support infrastructure, thereby ensuring its clients maximum physical safety and scientific productivity. At the heart of the logistical system are bases at Resolute in the eastern Arctic and Tuktoyaktuk in the western Arctic.

PCSP stores, maintains, repairs and loans specialized field equipment to scientific research parties. It also operates a radio communications system to monitor contracted aircraft operations and to respond to the requirements of scientists in remote field locations. It undertakes contractual arrangements with private-sector air carriers on its PCSP clients' behalf, and coordinates aircraft use among a number of client groups in order to minimize the costs of services provided.

This system of horizontal management of logistical planning and coordination eliminates duplication of effort among user groups, allows for lower cost, bulk purchasing of supplies and services, and enhances efficiency and cost-effectiveness in delivery of services to clients. It

creation, and to a better understanding of the effects of development on humans and the environment – including the identification, assessment and protection of renewable resources that affect regional hunting and fishing economies.

Government and university researchers have relied upon PCSP for logistical support for research into contaminants in the northern food chain and their effects on the health of northern residents. As well, PCSP supports research on the potential effects of climate change on Arctic ecosystems and infrastructure, as well as consequent impacts on the global climate.

PCSP provides support to community-driven traditional knowledge studies, research programs that incorporate traditional knowledge, resource co-management committees managed through land claims, and science education camps involving northern youth. Its ongoing support for these research initiatives will become increasingly important as northern communities and governments seek to establish their own economic base. Research is regarded in the North as a cornerstone to sound policy development.

Circumpolar and other nations with active Arctic research interests have established the Forum of Arctic Research Operators to help better coordinate, collaborate and exchange information on support for northern research activities. Many of the countries involved in these discussions also have active Antarctic programs. PCSP, on Canada's behalf, currently chairs this forum.

Objectives and Linkages

In the coming two years, PCSP will continue to concentrate its efforts on consolidating long-term funding for Arctic logistics, as a follow-up to the \$1 million in bridge funding provided to PCSP in 1999-2000 by NRCan.

Leveraging outside funding and in-kind support, and cost-sharing and cost-recovery mechanisms will continue to serve as the cornerstone of PCSP's basic business practices. Building upon existing formal and informal bilateral arrangements with other federal government departments and northern agencies, PCSP will work closely with DND and the CCG to ensure that the Canadian science community has access to the widest range of services at the lowest possible cost.

For information on PCSP's Inventory of Science and Technology Facilities in Canada's North, contact:

Internet: <http://polar.nrcan.gc.ca>

For further information on PCSP, contact:

E-mail: bhryck@nrcan.gc.ca

2.5.2 Canadian Coast Guard

Background

In 1995, the CCG joined DFO. This merger brought world-class icebreakers together with a science department in the pursuit of a jointly mandated responsibility. The merger provided scientists with improved access to the northern marine environment. However, the CCG did not receive the funds required to support the use of icebreakers for science activities.

Objectives and Implementation

Most ship-based research activities take place during the open-water season from June to October because of severe ice and weather conditions during the rest of the year. Over the past few years, greater emphasis has been placed on using icebreakers for integrated, multi-tasked activities. This allows for more applied research projects within the federal framework and universities (nationally and internationally) to be carried out. An inventory of platforms used to carry out Arctic research is available – information (e.g. location, cost, services, availability) is available from DFO.

The number of multi-tasked platform opportunities for research has increased. This is because of an increased awareness of the importance of Arctic research and the need for vessels to operate safely and efficiently in remote areas of Canada. The limited communication network and access to backup equipment and repairs requires a strongly supported infrastructure.

Most of the scientific research carried out on CCG icebreakers has been part of large-scale, externally funded programs. Much of the DFO and Canadian Arctic marine science work has been accomplished as a result of this external funding, but the cost to the CCG Arctic ice-breaking program has been high.

Since 1997, DFO, along with a small number of researchers from NRCan and Environment Canada and some Canadian universities, has been able to undertake a limited number of marine- and terrestrial-based research projects in the Arctic. The success of these projects is due to the integration of project objectives with the research priorities of other nations which have shown an increased interest in working in the Canadian Arctic.

While much of Canada has pursued prosperity by looking landward, the Inuit and Inuvialuit communities are rooted in maritime traditions. Most communities in the Inuvialuit and all of those in the Nunavut

settlement regions are located on the Arctic coastline. Only a minority of these communities are accessible by sea or land year-round – testament to the harshness of the climate and the resourcefulness of their inhabitants. These communities continue to rely heavily on logistical support services proved by CCG and DFO.

DFO's logistical support for Arctic research is consistent with commitments under international marine science programs and agreements. Also, many of the science programs conducted by DFO directly support requirements set forth under the framework of the wildlife co-management boards that are established as part of the land claims agreements in the North.

Partnerships and Linkages

In the Arctic, joint scientific activities are carried out with other federal government departments, universities and international agencies. In addition to these, platform support is also required for Canadian Hydrographic Service activities.

The platform needs of the science community are broad and yet demand a high degree of detailed planning. They focus on extended cruises in near-shore and off-shore environments where continuous marine sampling protocols must be delivered under difficult conditions and always with a very reduced logistical base due to the remote nature of the area. Such conditions require a well-trained and self-contained science program that relies heavily on the capabilities of the vessel and technical crews.

Impacts

Before the merger with CCG, there was very limited use of icebreakers for scientific activities. Ice-strengthened ships were used on a limited basis, usually requiring many years of planning. Arctic cruises were usually not part of any long-term programs focused on fisheries or oceanographic studies.

Currently, there are no ongoing DFO program funds for science research vessel time. There are strong indications, both nationally and internationally, that the number of opportunities for icebreaker-based research will increase over the next few years.

Full cost-recovery is required for use of platforms for science activities in Canada. In the past few years, CCG has been able to take direct advantage of external resources (e.g. United States, Sweden, Japan). Alternate strategies to provide platform support to science programs are not available within Canada. The alternative to using Canadian icebreakers for DFO science research programs is using vessels from other countries. The availability of DFO research ships to carry out science activities in the North is limited.

The use of icebreakers for research and scientific activities means that the CCG complement of Arctic ships is reduced during these periods. It compromises CCG's ability to carry its other services in the North. A dedicated science vessel would avoid this. Icebreakers are expensive to operate; costs total about \$25,000 per day.

Conclusion

Over the past few years, DFO has provided icebreakers as platforms for research in Canada's North to support marine science, but federal initiatives for national and international research in the Arctic do not have program funds. Long-term strategies for platform support to Arctic Science Program activities could include the following:

- Without a fleet of dedicated science vessels, design an operational program with CCG to support the delivery of priority science programs in the Arctic. These programs would focus on nationally and internationally supported DFO science initiatives.
- Increase leveraging of science resources from other federal departments, universities and agencies, as well as other departments internationally, by developing an integrated science program using icebreakers as scientific support platforms within DFO Science.
- Increase the capability of traditionally non-science CCG vessels to support science programs.



Photo: DFO

Before the merger with Canadian Coast Guard, there was very limited use of icebreakers for scientific activities. Ice-strengthened ships were used on a limited basis, usually requiring many years of planning.

List of Acronyms	Members of the Interdepartmental Committee on Northern Science and Technology, ADM Level	
ACSYS	Arctic Climate System Study	Mr. James R. Moore, Assistant Deputy Minister, Department of Indian Affairs and Northern Development (Chairperson)
AMAP	Arctic Monitoring and Assessment Programme	Dr. Robert Slater, Senior Assistant Deputy Minister Environment Canada
AES	Atmospheric Environment Service	Ms. Karen Brown, Assistant Deputy Minister Environment Canada
CANMET	Canada Centre for Mineral and Energy Technology	Dr. John Davis, Assistant Deputy Minister Department of Fisheries and Oceans
CCG	Canadian Coast Guard	Mr. Andrei Sulzenko, Assistant Deputy Minister Industry Canada
CFS	Canadian Forces Station	Dr. Marc Denis Everell, Assistant Deputy Minister Natural Resources Canada
CMC	Canadian Museum of Civilization	Mr. David Murray, Regional Director General Transport Canada
CMN	Canadian Museum of Nature	Mr. Paul Cochrane, Assistant Deputy Minister Health Canada
CPC	Canadian Polar Commission	Dr. Joseph Losos, Assistant Deputy Minister Health Canada
DFO	Department of Fisheries and Oceans	Mr. Mike Robinson, Chairperson Canadian Polar Commission
DIAND	Department of Indian and Northern Affairs	Dr. John Leggat, Chief Research and Development, Department of National Defence
ESCs	Ecological Science Cooperatives	Dr. Nigel Lloyd, Director General Natural Sciences and Engineering Research Council
GSC	Geological Survey of Canada	Members of the Working Group for the Interdepartmental Committee on Northern Science and Technology
GEWEX	Global Energy and Water Experiment	Marty Bergmann, Department of Fisheries and Oceans Howard Powles, Department of Fisheries and Oceans Laure Benzing-Purdie, Health Canada David Malcolm, Department of Indian Affairs and Northern Development David Stone, Department of Indian Affairs and Northern Development Bonni Hrycyk, Polar Continental Shelf Project Ron DiLabio, Natural Resources Canada Laird Roe, Industry Canada Fred Roots, Environment Canada Richard Isnor, Environment Canada Peter Timonin, Transport Canada Victor Santos-Pedro, Transport Canada Jon Thorleifson, Department of National Defence Alan Saunders, Canadian Polar Commission Jean-Marie Beaulieu, Canadian Polar Commission Elizabeth Boston, Natural Sciences and Engineering Research Council France Landriault, Social Sciences and Humanities Research Council
HPB	Health Protection Branch	
IASC	International Arctic Science Committee	
ISC	International Circumpolar Surveillance	
MSB	Medical Services Branch	
NRC	National Research Council	
NRCan	Natural Resources Canada	
NSERC	Natural Sciences and Engineering Research Council	
NAWMP	North American Waterfowl Management Plan	
NCP	Northern Contaminants Program	
NSTP	Northern Scientific Training Program	
NWT	Northwest Territories	
POPs	persistent organic pollutants	
PCSP	Polar Continental Shelf Project	
PCBs	polychlorinated biphenyls	
R&D	research and development	
SCAR	Scientific Committee for Antarctic Research	
SSHRC	Social Sciences and Humanities Research Council	
S&T	science and technology	
TSRI	Toxic Substances Research Initiative	
UV-B	ultraviolet-B	
UN	United Nations	
UNESCO	United Nations Education, Scientific and Cultural Organization	
UNEP	United Nations Environment Programme	
WCRP	World Climate Research Program	

