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POLAR CONTINENTAL SHELF PROGRAM

SCIENCE REPORT 2015

Logistical support for leading-edge scientific research in Canada and its Arctic

Canada

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Polar Continental Shelf Program Science Report 2015: Logistical support for leading-edge scientific research in Canada and its Arctic

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Cover photograph: Researchers collect data from an automatic weather station on Agassiz Ice Cap, Ellesmere Island, Nunavut. This project is examining long-term variability in glacier ice mass across the Queen Elizabeth Islands.

Section header image: An aircraft prepares to take off after resupplying a GEM-2 field camp beside Lorillard River, Nunavut.

Photograph contributors (alphabetically):

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Seismic studies are conducted at Barry Inlet in Haida Gwaii, British Columbia.

A bird colony in Prince Leopold Island Bird Sanctuary

Minister's Message

Canada's North is a vast and diverse region full of tremendous natural resource potential and opportunities for new scientific discoveries.

Through the Polar Continental Shelf Program (PCSP), the Government of Canada provides critical support for research and discovery in Canada's North. By enabling research and training activities in Canada's Arctic, the PCSP is helping to advance the prosperity and security of this region.

The work of PCSP-supported scientists informs an important array of subjects, including climate change, sustainable resource development, cultural history, environmental integrity and northern transportation. Since 1958, the PCSP has supported thousands of scientists from both Canadian and international research organizations working on projects in scientific fields ranging from anthropology to zoology.

Last year, the PCSP provided logistics support to 188 Arctic research projects involving over 1,600 participants. This support included the coordination of chartered aircraft, field equipment and accommodations at the PCSP's Arctic logistics hub in Resolute, Nunavut. Client researchers came from more than 50 federal and territorial government departments, Canadian and international universities, and a host of international research organizations.

I hope you enjoy this report, which highlights the important field research and training activities supported by the PCSP. These activities are vital to improving our collective knowledge of Canada's North and supporting the science and research base so vital to making sound, evidence-based decisions that foster economic opportunities and resilience in the North.

The Honourable Jim Carr, P.C., M.P.
Minister of Natural Resources

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The Honourable Jim Carr
Minister of Natural Resources

ᑲᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᐊ ᐊᖖᒋᓂᖅᐹᖑᔪᖅ ᐊᒻᒪᓗ ᐊᔾᔨᒌᖖᒋᑦᑑᑎᑦ ᐊᕕᒃᑐᖅᓯᒪᔪᖏᓐᓂ ᓄᓇᒥᑦ ᐱᔾᔪᑎᒃᓴᖅᑕᖃᖅᑐᖅ ᐊᖏᔪᒥᒃ ᐊᒻᒪᓗ ᐱᕕᖃᖅᑎᑦᑎᕗᑦ ᓄᑖᑦ ᖃᐅᓴᐃᓂᒻᒪᕆᖕᒥᑦ ᓇᓂᔭᐅᕈᓯᑦᓯᐊᔪᓂᑦ.

ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᕕᐊᓗᒃᑎᒍᑦ, ᑲᓇᑕᐅᑉ ᒐᕙᒪᒃᑯᖓᓐᓂᑦ ᐋᖅᑎᖃᓪᒪᓇᒃᑐᒥᒃ ᐃᑲᔪᖅᓯᒪᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᐅᔨᕗᑦᓕᐊᓂᕐᒧᑦᑐ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᐊᓂ. ᖃᐅᔨᓴᕈᓐᓇᖅᑎᑦᑎᓂᒃᑯᑦ ᐱᔭᕇᖅᓴᑎᑦᑎᓂᒃᑯᑦᑐ ᖃᓄᐃᓕᐅᖅᑎᑦᑎᑐᑎᒃ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᐊᓂ, ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᕕᐊᓗᒃ ᐃᑲᔪᖅᑐᖅ ᐱᕙᓪᓕᐅᑎᑦᑐᓂ ᐊᑦᑕᕐᓇᖅᑐᒌᖅᑕᐃᓕᑎᑦᑎᑐᓂᓗ ᑖᒪᓂ ᐊᕕᒃᑐᖅᓯᒪᓂᐅᔪᒥ.

ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᕕᐊᓗᔫᑉ ᐃᑲᔪᖅᓱᖃᑦᑕᖅᑕᖏᑦ ᖃᐅᔨᓴᖅᑎᒻᒪᕇᑦ ᓴᓈᓇᖃᑦᑕᕐᓂᕆᔭᖏᑦ ᖃᐅᔨᒪᓐᓇᕈᑕᐅᕙᒃᑐᑦ ᐊᔾᔨᒌᖖᒋᑦᑐᓄᑦ ᐱᒻᒪᕆᐅᔪᓄᑦ ᐱᔾᔪᑕᐅᕙᒃᑐᓂᑦ, ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᓯᓚᐅᑉ ᐅᕐᑰᓂᖓᑕ ᐊᓯᑦᔨᕐᓂᖓ, ᐱᕙᓪᓕᐊᑎᑦᑎᓂᖅ ᓄᖑᑕᐅᑎᑦᑎᑕᐃᓕᓂᒃᑯᑦ ᐃᑲᔪᕈᑎᒃᓴᓂᒃ, ᐱᐅᓯᑐᖅᑲᑦ ᐃᒻᒪᑲᓪᓚᓂᓴᐃᑦ, ᐊᕙᑎᒥᒃ ᐸᐸᒋᔭᖅᑲᑦᑎᐊᕐᓂᖅ ᐊᒻᒪᓗ ᐅᑭᐅᖅᑕᖅᑐᒥ ᐃᖏᕐᕋᔾᔪᑎᓕᕆᓂᖅ. ᑕᐃᒪᖓᓂᑦ 1958, ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᕕᐊᓗᒃ ᐃᑲᔪᖃᑦᑕᖅᓯᒪᔪᖅ ᑕᐅᓴᓂᑦ ᖃᐅᔨᓴᖅᑎᒻᒪᕆᖕᓂᒃ ᑕᒪᐃᓐᓂᑦ ᑲᓇᑕᒥᙶᖅᑐᓂᒃ ᓄᓇᕐᔪᐊᒥᓗ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᑎᒥᐅᔪᓄᑦ, ᐱᓕᕆᐊᒃᓴᖃᖅᑐᓂᒃ ᖃᐅᔨᓴᐃᓂᒻᒪᕆᒃᑯᑦ ᐊᔾᔨᒌᖖᒋᑦᑑᑎᓂᒃ ᐃᑕᕐᓂᓴᓕᕆᓂᕐᒥᑦ ᓂᕐᔪᑎᓕᕆᓂᕐᒧᑦ.

ᐊᕐᕌᓂ, ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᕕᐊᓗᒃ ᑐᓂᓯᓚᐅᖅᑐᖅ ᖃᓄᐃᓕᐅᕆᐊᖃᖅᑐᓄᑦ ᐃᑲᔫᑎᒃᓴᓂᒃ 188ᓄᑦ ᐅᑭᐅᖅᑕᖅᑐᒥ ᖃᐅᔨᓴᖅᑕᐅᔪᓄᑦ ᑕᒪᒃᑭᖅᓱᒥᑦ ᐅᖓᑖᓂᓚᐅᖅᑐᑦ 1,600 ᐃᓚᐅᖅᑕᐅᔪᑦ. ᑕᒪᑐᒪᓂ ᐃᑲᔪᕐᓂᕐᒥ ᐃᓚᖅᑲᖅᑐᖅ ᑲᒪᒋᔭᓂᖓ ᐊᑐᖅᑕᐅᓂᖓᑕ ᖃᖓᑕᓲᖅ, ᓄᓇᒥ ᐱᓕᕆᓂᕐᒧᑦ ᓴᓇᕐᕈᑎᖃᖅᑎᑦᑎᓂᖅ ᐊᒻᒪᓗ ᐃᓂᖃᖅᑎᑦᑎᓂᖅ ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᕕᐊᓗᔫᑉ ᐅᑭᐅᖅᑕᖅᑐᒥ ᖃᓄᐃᓕᐅᕈᑕᐅᔪᓄᑦ ᐃᓂᖓ ᖃᐅᓱᐃᑦᑐᕐᒥ, ᓄᓇᕗᒻᒥ. ᐃᑲᔪᖅᑎᐅᔪ ᖃᐅᔨᓴᖅᑎᒻᒪᕇᑦ ᑕᒪᒃᑯᓇᙶᖅᑐᑦ 50-ᓂᑦ ᒐᕙᒪᒃᑯᑦ ᐊᐅᓚᑦᓯᔨᖏᓐᓂᑦ ᐊᒻᒪᓗ ᑎᐅᓕᑐᐊᓕ ᒐᕙᒪᒃᑯᖏᓐᓂᑦ, ᑲᓇᑕᒥ ᐊᒻᒪᓗ ᓄᓇᕐᔪᐊᒥ ᐃᓕᓐᓂᐊᕐᕕᒃᔪᐊᑦ, ᐊᒻᒪᓗ ᐃᓂᖃᖅᑎᑦᑎᔪᑦ ᓄᓇᕐᔪᐊᒥ ᖃᐅᔨᓴᖅᑕᐅᔪᓄᑦ ᐊᐅᓚᑦᓯᔪᓄᑦ.

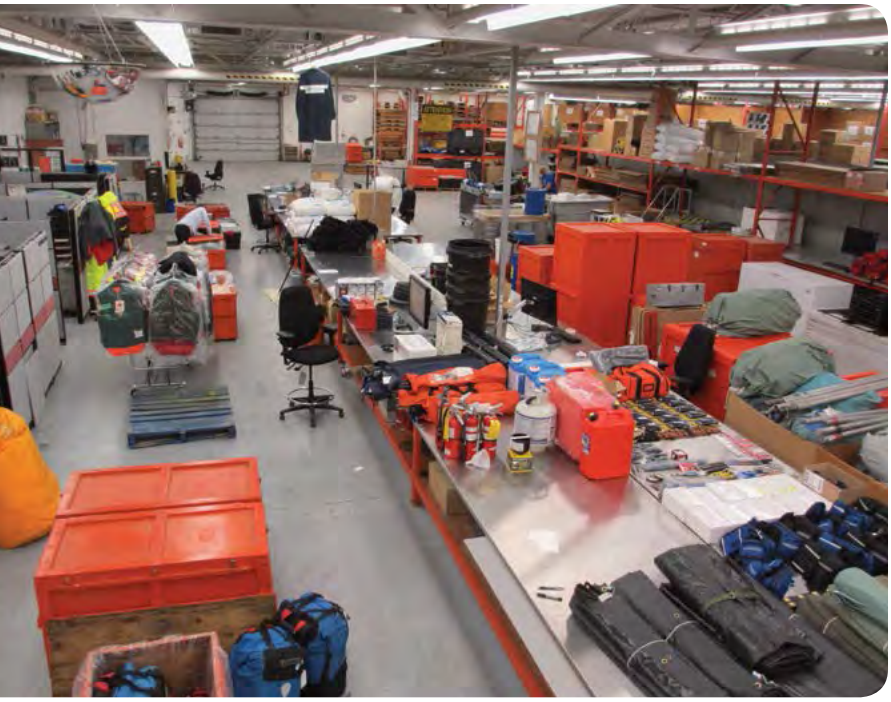
ᑕᐃᒪᑐᖅ ᖁᕕᐊᒋᓂᐊᖅᐸᐃᑦ ᑖᓐᓇ ᐅᓂᒃᑳᓕᐊᖅ ᓴᖅᑮᔭᖅᑎᑦᑎᔪᖅ ᐱᒻᒪᕆᐅᔪᓂᒃ ᓄᓇᒥ ᖃᐅᔨᓴᕈᑕᐅᔪᓂᒃ ᐱᓕᒻᒪᒃᓴᕐᓂᕐᓴᐅᔪᓂᒡᓗ ᐃᑲᔪᖅᓯᖅᑕᐅᔪᓂᒃ PCSPᒃᑯᓐᓄᑦ. ᐅᑯᐊ ᖃᓄᐃᓕᐅᕈᑕᐅᔪᑦ ᐱᒻᒪᕆᐅᔪᑦ ᐱᐅᓯᕚᓪᓕᖅᑎᑕᐅᓂᖓᓄᑦ ᑕᒪᐃᑦᑕ ᖃᐅᔨᒪᓂᕆᔭᑦᑎᓐᓄᑦ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᐊᓂᒃ, ᐊᒻᒪᓗ ᐃᑲᔪᖅᓯᖅᑕᐅᓂᖓᓄᑦ ᖃᐅᔨᓴᐃᓂᒻᒪᕆᖕᒧᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᓯᓂᖕᒧᑦ ᑐᙵᕕᐅᔪᑦ ᐱᕐᔪᐊᒻᒪᕆᐅᑦᑐᑎᒃ ᐃᓱᒪᓕᐅᑦᑎᐊᕐᓂᕐᒧᑦ, ᑐᙵᕕᖃᖅᑐᓂᒃ ᓇᓗᓇᐃᕈᑎᒃᓴᓂᒃ ᐃᑲᔪᖅᑐᓂᒃ ᐅᑭᐅᖅᑕᖅᑐᒥ ᕿᓇᐅᔭᓕᐅᕈᑕᐅᔪᓐᓇᖅᑐᓄᑦ ᐱᕕᒃᓴᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᒻᒪᓗ ᓱᖏᐅᓴᕈᓐᓇᕐᓂᕐᒥᒃ ᐅᑭᐅᖅᑕᖅᑐᒥ.

ᒥᓂᔅᑕ ᔨᒼ ᑳ, ᑲᓇᑕᐅᑉ ᒥᓂᔅᑕᖓ ᓄᓇᒥᐅᑕᓕᕆᔨᒃᑯᓐᓄᑦ

The Polar Continental Shelf Program

Since 1958, researchers working in the Canadian Arctic have trusted Natural Resources Canada's (NRCan) Polar Continental Shelf Program (PCSP) to provide safe, efficient and cost-effective logistics for field work. The PCSP has become recognized as Canada's centre of excellence for field logistics, contributing to the advancement of scientific knowledge across Canada and the exercise of sovereignty in the Canadian North. The program offers planning, coordination and delivery of logistics for field research throughout the Canadian Arctic that is conducted by Canadian government, university, northern, independent and international research organizations. Field equipment is also offered for federal government field research at non-Arctic locations across Canada. With its partners, Polar Knowledge Canada (POLAR), NRCan's Geo-mapping for Energy and Minerals (GEM) Program and ArcticNet, the PCSP plays an important role in helping researchers to develop knowledge that improves our collective understanding of the Canadian land mass and in supporting federal operations in the field. Additionally, through its partnership with the Department of National Defence (DND), the PCSP assists with training activities for military personnel through the Canadian Armed Forces Arctic Training Centre (CAFATC) at the PCSP facility in Resolute, Nunavut.

Each fall, during the Arctic logistics request submission period, researchers may apply to the PCSP for logistics planning and coordination for field work to be conducted during the following year's field season. Possible logistics include chartered aircraft transportation to and from remote field camps; accommodations and laboratory work space at the PCSP facility in Resolute; field equipment; fuel for aircraft and camps; and a communications network. The PCSP also can offer expert advice about conducting field studies in Canada's North. Federal government researchers requiring field equipment for studies in non-Arctic locations across Canada can apply to the PCSP at any time during the year.



Field equipment being prepared for shipment at the PCSP Ottawa logistics hub

Did you know?

It takes a team with a wide range of skills to deliver the PCSP's program each year. The PCSP's staff includes professionals and specialists in the following areas:

- logistics operations
- field equipment life cycle management
- mechanics
- administration
- science and policy
- facilities
- food services

Highlights of the 2015 field season

- Total Arctic projects supported: **188**
- Participants in all projects: **>1600**
- Percentage of PCSP-supported projects that transited through Resolute: **46**
- Nights of accommodation provided at the PCSP Resolute facility: **>10,500**
- Meals served at the PCSP Resolute facility: **>32,000**
- Chartered aircraft hours flown: **5,077**
- Aircraft under contract: **52**
- Field equipment requests fulfilled by the PCSP Ottawa depot: **335**
- Weight of equipment and fuel shipped by sea, road and air: **395 tonnes**

A helicopter on the Svartfjeld Peninsula, Ellesmere Island, Nunavut, during wildlife surveys

PCSP's partners

The PCSP is a central component of the Government of Canada's efforts in the North. Using a whole-of-government approach, the PCSP and its partners optimize the use of resources and expertise and capitalize on efficiencies. By working with the PCSP, each partner does not need to replicate PCSP's field logistics capabilities, thereby enhancing its ability to conduct research or training in the Arctic or, in the case of federal scientists, to conduct field work across Canada.

Through its partnerships, the PCSP achieves efficiencies in its program delivery and facility operations that benefit other PCSP clients. For example, the PCSP is providing terrestrial logistics support for science programs that are a part of ArcticNet (a Network of Centres of Excellence of Canada), NRCan's GEM Program and POLAR's Science and Technology Program. These partnerships improve the ability of scientists to carry out research across the Canadian Arctic and provide key contributions to informed decision-making for a range of issues including environmental integrity, climate change, resource investment and land use in Canada's North.

By collocating offices in Ottawa, the PCSP and POLAR have achieved efficiencies in program delivery and collaboration. In addition to providing terrestrial logistics to POLAR's scientists, the PCSP is developing a new depot for field equipment at the Canadian High Arctic Research Station (CHARS) being constructed in Cambridge Bay, Nunavut.

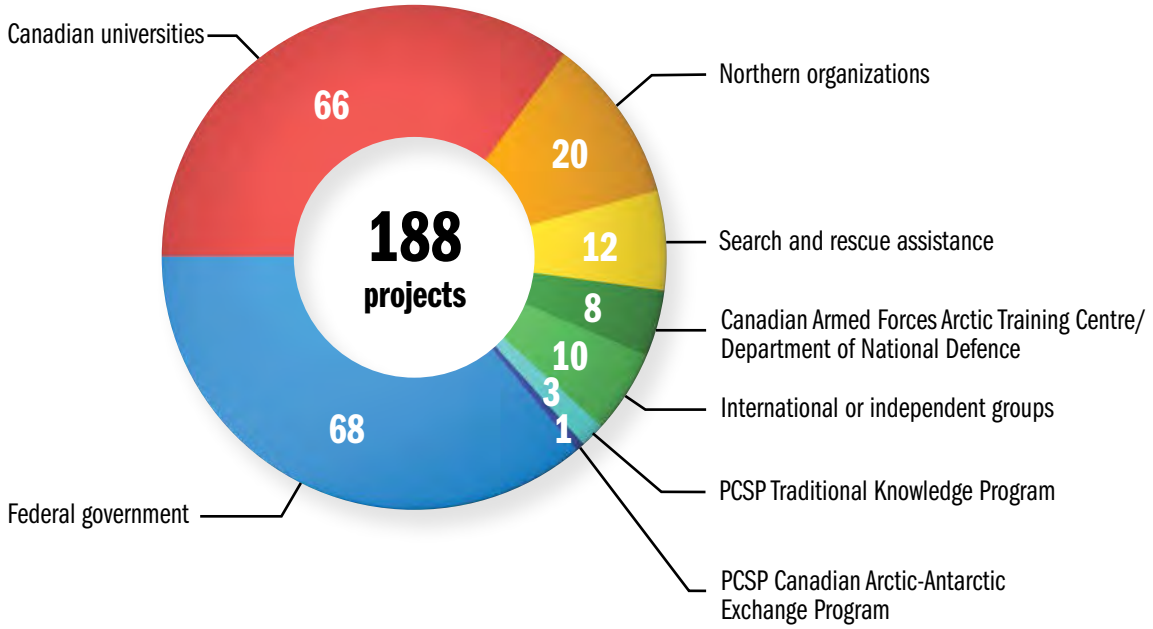
The PCSP's partnership with the DND has led to improved Arctic training opportunities for military personnel. By sharing operating costs for the PCSP facility in Resolute with the DND, the PCSP has achieved cost-savings that have improved PCSP's logistics support for all clients. Enhanced communications technology and work space at the facility have also benefited all clients who use it. By working with the PCSP, the DND is achieving cost-savings by using existing Arctic infrastructure for its CAFATC capability in Resolute and PCSP logistics expertise in conducting its training exercises.

In addition to its work across the Arctic, the PCSP partners informally with other federal government organizations, providing them with field equipment for a range of federal government field work needs

The Public Health Agency of Canada's Ebola Rapid Response team wears winter gear from the PCSP during their training activities in Nunavut.

at locations throughout Canada and, sometimes, abroad. For example, the PCSP has recently provided field equipment to the Public Health Agency of Canada's Ebola Preparedness and Response Team for a preparedness simulation exercise in Iqaluit in February 2015; to the Surveyor General of Canada for field work in British Columbia; to International Border Commission field parties working at locations along the Canadian border with the United States of America; to Fisheries and Oceans Canada for field work in Newfoundland and Labrador; and even to a NRCan program in Africa. The PCSP also supports territorial governments and the DND in Arctic search and rescue efforts, including 12 requests in 2015, by providing aircraft support in emergency situations.

Breakdown of PCSP-supported projects in 2015



Did you know?

The PCSP is participating in the Build in Canada Innovation Program (BCIP) run by Public Services and Procurement Canada (PSPC). Through this initiative, PSPC procures goods and services from Canadian companies for participating federal government organizations to test and provide feedback. As part of the BCIP, the PCSP will distribute 50 light-emitting diode (LED) tent light kits to field parties for field testing in 2016.

International Boundary Commission crew conduct surveying work on the British Columbia-Washington border.

A researcher conducts a mass balance survey on Devon Ice Cap, Nunavut, as part of a study that has been ongoing since 1961.

PCSP heritage spotlight

Remembering Dr. George Hobson: A true champion of Canada's North

Dr. George Hobson

Dr. George Hobson, who passed away in April 2015, had a great passion for Canada's North that he shared generously with all who knew him. After years spent as a geophysicist, Hobson became the PCSP's second Director from 1972 to 1988. During this time, Hobson oversaw the involvement of PCSP scientists in a range of Arctic studies, including major programs to study Canada's Arctic continental shelf such as the Lomonosov Ridge Experiment (LOREX) and the Canadian Expedition to Study the Alpha Ridge (CESAR). He also managed the transition of the PCSP from a science-focused project to a logistics-focused program, laying the foundation for today's PCSP operations.

In the early 1980s, several ice islands (large, tabular icebergs that form when huge pieces of an ice shelf break free) split away from the Ward Hunt Ice Shelf on the northern coast of Ellesmere Island. Hobson saw the opportunity to use one as a stable platform from which to conduct studies of the Arctic continental shelf, similar to ice island research platforms operated by other countries. He oversaw the construction of a research station on the largest ice island, known as "Hobson's Choice," and the development of a major, multidisciplinary research program based from the station. As Hobson's Choice drifted along the northern edge of the Queen Elizabeth Islands, scientists collected a wealth of information about the seafloor and ocean that remains pertinent to present-day studies in the region.

Dr. George Hobson at the research station on Hobson's Choice ice island in 1985

After retiring from the Department of Energy, Mines and Resources (the predecessor of Natural Resources Canada), Hobson remained active in promoting Arctic science by participating in scientific expeditions, public lecture series and Arctic cruises. He has left a lasting impression on the Arctic through his significant contributions to support science and advocate community involvement and engagement in northern research.

Hobson's Choice: Canada's ice island research platform

In 1984, the PCSP began building a research station on Hobson's Choice ice island in support of a new initiative to study Canada's Arctic continental shelf. The ice island had dimensions of about 8 kilometres (km) by 3 km and was up to 45 metres (m) thick. The infrastructure required to set up PCSP's research station on the ice island was significant and required airlifting materials to the site for semipermanent structures and, each year, using a bulldozer to construct an airstrip that could support large aircraft and helicopters. By 1985, scientists were using the station and nearby sea ice areas to conduct a range of studies that built on previous major continental shelf programs, including LOREX and CESAR.

The research station on Hobson's Choice ice island in 1985

During the operational season (March to September), up to 45 federal government, university and private sector researchers and students were at the station at any given time. Much ingenuity was required to handle bitter winter conditions that created difficulties for constructing the airstrip each year, opening snowed-in buildings and setting up fuel caches. In summer, surface water and rough ice presented challenges for using the airstrip, and camp buildings had to be protected from flooding using pumps and insulated skirts around their bases. Other challenges included accurately tracking the ice island's movement, handling waste disposal, and dealing with polar bear and Arctic fox visits.

The research done on Hobson's Choice included studies to examine the geophysical and geological properties of the sediment and rock below the seafloor; heat flow through the Earth's crust; the record of pollen transport to the Arctic; contaminants

Qamutiks were used to transport field equipment at the ice island research station.

in ice and water, including Chernobyl nuclear disaster fallout; life on the seafloor under 7 m of sea ice cover; ice structure; ocean bathymetry; and meteorology. This research generated many important results. Canada's Arctic continental shelf was found to be much wider than previously known, and an unexpected world of life was found in the dim seafloor conditions up to 350 m below the ocean's surface, including reefs made of sponges. Geophysical data were used to determine the hydrocarbon potential of the area, and the results of ice structure research have helped to determine icebreaker design requirements and assess ice hazards to offshore oil platforms. The record of regional sea ice cover since the end of the last ice age was also developed, with applications for predicting future sea surface conditions.

Hobson's Choice was an effective research platform from 1984 to 1989, enabling the first large-scale survey of Canada's eastern Arctic continental shelf area below pack ice not navigable by ship. Scientific knowledge developed through research on the ice island remains important today for the determination of the outer limits of Canada's extended Arctic continental shelf under the United Nations Convention on the Law of the Sea (UNCLOS). The experience gained from working from Hobson's Choice built Canada's capacity to conduct studies from an ice platform, providing a key foundation for recent Arctic field campaigns in support of its submission to the UNCLOS.

Researchers sample through a hole in the ice on the ice island (1985).

A researcher supervises a planned explosion as part of geophysics studies conducted from Hobson's Choice ice island (1985).

Winterlude's mascots, the Ice Hog family, visit the PCSP Arctic field camp display at Cool Science Sunday.

Outreach events

Winterlude "Cool Science Sunday" in Ottawa

The PCSP worked with scientists from the Geological Survey of Canada (GSC) to welcome local residents and visitors to Ottawa to a mock Arctic field camp at the National Capital Commission's Winterlude "Cool Science Sunday" held on February 15, 2015, in Ottawa. Using PCSP field equipment, tents were erected outside NRCan's buildings near Dow's Lake, complete with camp kitchen supplies, field work tools, a latrine tent and a snowmobile for children to pretend to ride. PCSP staff and GSC researchers spoke to visitors about Arctic field camps, the equipment needed for field studies and ongoing GSC research. The cold and windy weather on the day of the event gave visitors a realistic experience of what it might feel like to be in an Arctic field camp.

Did you know?

Dr. Fred Roots, the PCSP's founder and first director (from 1958 to 1971), was a guest of honour when he toured the PCSP facility in Resolute in August with a group of more than 100 students, educators and staff from Students On Ice (SOI). This organization focuses on educating youth from around the world about the polar regions, supporting their growth as global citizens and fostering the development of initiatives that support sustainability of the Arctic and Antarctic. The PCSP facility tour was held at the end of the two-week 2015 SOI Arctic Expedition that brought participants by ship to locations in western Greenland, in the eastern Canadian Arctic and along the Northwest Passage to experience and learn about the North. Roots was with the expedition as a renowned polar scientist, explorer and leader who was part of the expedition's educators team. At the PCSP facility, Roots and PCSP staff taught students about the PCSP's origins and current operations, and Roots gave a lesson on regional geology using rocks on display at the facility.

Resolute School Science Fair

On May 27, 2015, the Qarmartalik School in Resolute hosted its second annual science fair. As in 2014, the PCSP supported this community event, which was attended by many residents. The PCSP arranged for judges (including PCSP-supported researchers and PCSP staff), provided certificates for all participants and prepared a snack for students. NRCan's mascot, NRCat, was a welcome visitor who entertained children throughout the event. There are approximately 50 students enrolled at the school and all classes participated in the science fair. The younger grades presented their group projects and students in older grades presented posters to science fair judges. The range of great science projects presented was impressive, and everyone enjoyed the enthusiasm of the participants.

NRCat congratulates a student for participating in the science fair.

ArcticNet Annual Scientific Meeting 2015

ArcticNet holds an Annual Scientific Meeting (ASM) that provides an opportunity each year for the PCSP to interact with current and prospective clients and liaise with polar research and logistics organizations. In December 2015, PCSP staff ran an information booth at the ASM in Vancouver, where they had the opportunity to speak with delegates about PCSP's logistics, the application process for PCSP logistics support and ongoing Arctic research.

A Twin Otter aircraft is unloaded on Melville Ice Cap on Melville Island, Northwest Territories.

Did you know?

The Twin Otter aircraft is widely known as the workhorse of Canada's North, transporting people and supplies to and from remote locations. These versatile airplanes can takeoff and land in places many other aircraft cannot because they require surprisingly short takeoff and landing distances. They can carry sizable loads, and their landing gear, which can include wheel skis, tundra tires or floats, can be configured in a number of different ways to suit airstrip conditions, whether on land, glaciers, lakes, sea ice or airport runways. While known for their usefulness in the Arctic, Twin Otter aircraft are also used extensively in Antarctica, as well as many other locations worldwide.

Many PCSP-supported scientists depend on Twin Otter aircraft each year to conduct their field work in remote northern areas. In 2015, the Twin Otter aircraft celebrated its 50th anniversary and was recognized for its important role in the history of transportation in the Arctic.

Arctic field sites supported by the Polar Continental Shelf Program (2015)

Legend

- 2015 Field Site
- Featured Story Location
- Polar Continental Shelf Program Arctic Logistics Hub
- • Arviat — Community
- ○ *Eureka* — Weather station or Place of interest
- AULAVIK — National Park
- Median sea ice extent

Land Cover

- Ice and Snow
- Tundra
- Barren Land
- Transitional Forest
- Forest
- Farm Land

Scale: 1:7 000 000

Projection: Vertical Near Side Perspective, centred at 85°N 79.57°W, altitude 3 000 000 metres.

Sea Ice Information: Canadian Ice Service, Environment Canada, Ottawa, Canada (www.ice-glaces.ec.gc.ca) with data from the National Snow and Ice Data Center, Boulder, CO, U.S.A. (nsidc.org) outside of Canadian waters.

Geographical Names: Canadian Geographical Names Data Base (NRCan.gc.ca), Natural Resources Canada.

Land Cover Data: "AVHRR [Advanced Very High Resolution Radiometer] Land Cover Data, Canada-Vegetation 35 meters", from GeoGratis (GeoGratis.gc.ca), Canada Centre for Mapping and Earth Observation, Natural Resources Canada.

Produced by: J. Monette, Canada Centre for Mapping and Earth Observation, Natural Resources Canada.

Science and training highlights from 2015

The work done by PCSP-supported scientists informs a wide range of issues, including climate change, environmental integrity and conservation, cultural history and sustainable resource management. Many studies are collaborative, involving individuals from different organizations and scientific disciplines who work together to connect their studies and take advantage of the efficiencies of joint field work efforts. PCSP-supported research projects also often involve students and postdoctoral fellows who receive valuable field training as future and early-career Arctic professionals. The following stories feature some of the PCSP-supported research projects and training activities that took place in the Canadian Arctic in 2015. Note the featured story location number to locate each highlighted project's study or training activity area(s) on the report's map.

Coastal erosion monitoring in the western Canadian Arctic

Dustin Whalen (Natural Resources Canada)

Featured story locations on the map: 1

The western Canadian Arctic has one of the most rapidly changing coastlines in the world. Warming temperatures in the region are affecting permafrost, causing melting of ice-rich coastal cliffs and warming of ocean water, which is increasing the length of ice-free periods each year. Erosion caused by permafrost thawing and wave action is leading to slope collapse along the coastline. This erosion may result in a higher amount of sediment in coastal waters and greater sedimentation (when sediment in water settles to the seafloor) in harbours, which could affect northern ports. GSC researcher Dustin Whalen is examining coastal processes from the Yukon/Alaska border to Cape Bathurst, Northwest Territories, building on 40 years of GSC data collected from more than 50 coastal monitoring sites in the western Arctic. His research is contributing to the development of adaptation strategies to reduce the impacts of climate change in the region.

In summer 2015, Whalen's field team examined erosion at 22 sites and took time-lapse imagery at locations experiencing notably high rates of erosion. They also collected sediment cores, water samples and bathymetry data in Kugmallit Bay to examine sedimentation in the harbour at Tuktoyaktuk. Aerial photographs from the past 60 years and the GSC's monitoring data indicate that the average rate of erosion for much of the coastline in the study area has remained stable at 1–2 m per year (m/yr). However, Whalen's research has shown that some locations have experienced much higher erosion rates in recent years. For example, from 1950–1985, portions of Pelly Island's coast receded approximately 315 m and, from 1985–2013, the coastline receded another 650 m, primarily because of the increased melting of permafrost in coastal cliffs and undercutting by waves (where the base of the cliff is eroded). In 2015, some locations on the island receded 40 m in only two months. This rapid rate of erosion had not previously been observed in the study area. Time-lapse photography from a coastal monitoring site on Pullen Island revealed massive thaw slumps (slope collapse caused by melting permafrost) occurring during warm periods in 2015. These slumps caused large amounts of sediment to be carried out to sea during storms. The research team has also found that ice-rich cliffs along the coast of Ivvavik National Park, Yukon, are beginning to show increased rates of erosion.

This research is done in close consultation with communities in the Inuvialuit Settlement Region to ensure that research priorities align with community concerns and interests. Whalen's research team also collaborates with Fisheries and Oceans Canada to study conditions in Kugmallit Bay in summer, when belugas are abundant in the bay, and with Parks Canada to monitor coastal conditions at Canadian Pingo Landmark. Future research plans will focus on gaining a better understanding of coastal processes that drive coastal erosion in permafrost and studies of seafloor deposition in the harbour at Tuktoyaktuk. The results of this work will be used to model future coastline responses to climate change in support of developing management and adaptation strategies for coastal areas in the region.

"A better understanding of coastal change and its relationship to the changing morphology of coastal and inland waterways will aid future decision-making for development and management of one of the most rapidly changing coastlines in the world."

– Dustin Whalen

Coastal erosion on Pelly Island, Northwest Territories

Ice core reconstructions of historical climate and sea ice variability

Alison Criscitiello (University of Calgary)

Featured story locations on the map: 2

Satellites have been used to observe Arctic sea ice, polynya (an area of open water surrounded by sea ice) and ice cap (a large, dome-shaped ice mass less than 50,000 km² in size) conditions since the 1970s, but prior to these records our understanding of how these features have changed over time is limited. Researchers must use proxy (indirect) records of environmental conditions to extend knowledge of marine and ice cap conditions into the past and place observed changes into a long-term context. Alison Criscitiello, a post-doctoral fellow, is using ice cores from Canadian High Arctic ice caps to reconstruct changes in regional sea ice cover and Arctic climate during the past century and their influences on ice cap mass balance (the difference between annual accumulation and loss of ice).

Marine aerosols (tiny liquid particles in the air that come from the sea) are transported with air masses moving over ocean water. As an air mass moves over an ice cap, aerosols are deposited when it snows and eventually become part of the ice. A record of aerosol deposition can be developed using the chemical signatures of different aerosols in each layer of an ice core. At some locations in the Arctic, a strong relationship exists between sea ice conditions and marine aerosols, such that an increase in regional aerosols in an ice record indicates reduced sea ice cover and a decrease indicates greater ice cover. Aerosols from distant locations can also be identified in an ice core record and used to study atmospheric circulation patterns.

In 2015, Criscitiello collected ice cores from Devon Ice Cap (Devon Island) and Prince of Wales Icefield (Ellesmere Island), Nunavut. She is analyzing the chemical data from these ice cores on a seasonal scale to develop marine aerosol records. She plans to drill another core on Ellesmere Island's Agassiz Ice Cap in 2016. By comparing the aerosol records from the three study sites to satellite records, she plans to identify regional variability in marine and ice cap conditions over time and, ultimately, develop detailed reconstructions of sea ice and polynya conditions in the High Arctic during the past century. This work includes assessing variability in the extent of the North Water Polynya in northern Baffin Bay, which is the largest and most biologically productive Arctic polynya. Understanding long-term changes in this polynya's size is important for accurately predicting future variability that could impact the marine life that depends on it. She will also study the connections among global atmospheric circulation patterns, sea ice and ice cap conditions in the study area over time.

Researchers analyze an ice core collected from Devon Ice Cap, Nunavut.

"The new ice core records will allow us to investigate how global atmospheric dynamics affect local marine conditions and ice cap behaviour."

– Alison Criscitiello

Want to learn more?

See snapshots of Alison Criscitiello's 2015 field season on NRCan's E-postcards from the Arctic blog, an outreach initiative on www.science.gc.ca.

Peary caribou and muskoxen population studies in the High Arctic

Morgan Anderson (Government of Nunavut)

Featured story locations on the map: 3

The Government of Nunavut's Department of Environment collects scientific knowledge about Nunavut's animal populations and integrates it with Inuit qaujimajatuqangit (indigenous knowledge) to inform management decisions made jointly with wildlife co-management partners. Because of the remoteness of study areas, conducting animal population surveys in Nunavut is challenging, and available survey data is often outdated. Morgan Anderson's research seeks to fill existing knowledge gaps about wildlife population dynamics to support the development of effective wildlife management strategies in Nunavut. The communities of Resolute and Grise Fiord contribute substantially to Anderson's research by helping to set project goals, design the project and conduct field work.

Peary caribou populations decreased significantly in the 1990s after several difficult winters, and the species was listed as an endangered species in 2011. Anderson's work on Peary caribou is driven by the need to define critical caribou habitat to support the development of a recovery strategy. For muskoxen in Nunavut, a management plan is in place with defined management area boundaries and harvest quotas, but it must be updated regularly with current information about muskox abundance (number of animals in a population) and distribution across the landscape. In March 2015, Anderson's research team, which included 10 Grise Fiord residents, conducted an aerial survey of Peary caribou and muskoxen on southern Ellesmere Island and Graham Island to update estimates from a 2005 survey. They flew along transects (straight lines) over the study area, counting each animal seen and recording details such as approximate age and gender. Results show that the estimated number of Peary caribou in the study area remains low but stable since the last survey, while muskoxen numbers have increased. These findings support observations by residents of Grise Fiord, who have seen no notable changes in caribou population size in the area.

Anderson's research team is also part of a collaborative project to study Peary caribou genetics, including 2015 work on Bathurst Island, Byam Martin Island and Melville Island, using fecal pellets. DNA (deoxyribonucleic acid) on the outer layer of the pellets is used to understand how Peary caribou are related across their range, how they are related to other types of caribou, and where they move. Results to date are supporting local Inuit qaujimajatuqangit of caribou movements in the region. Caribou and muskoxen pellets are also being used to identify parasites. Genetic analyses will indicate how repopulation in the region occurred after population declines in the 1990s. For muskoxen, the team is determining whether parasites that are currently contributing to population declines in the western Arctic are present in High Arctic populations.

Peary caribou fecal pellets are collected on Melville Island, Nunavut.

Future aerial survey work will focus on Peary caribou to fill data gaps regarding population size and distribution at the southern limit of their range, and genetic studies will continue to improve understanding of Peary caribou ecology to support the development of a recovery strategy for this species.

"It is an exciting region to work in, since almost everything we learn is new, and getting basic information like abundance estimates is a challenge. It is important, however, for informing management decisions and policy."

– Morgan Anderson

Greenhouse gas and heat flux studies in the Taiga Plains, Northwest Territories

Oliver Sonnentag (Université de Montréal)

Featured story locations on the map: 4

The Taiga Plains Ecozone (a large area with distinct ecology) covers roughly 48 percent of the Northwest Territories and is underlain by sporadic, discontinuous or continuous permafrost, depending on location. This ecozone transitions from boreal forest in its southern areas to subarctic tundra at its northern limits. Permafrost conditions in this area are observed to be changing with increasing temperatures in recent years. These changes have the potential to cause both increased greenhouse gas (e.g. carbon dioxide and methane) release from the ground and increased carbon dioxide uptake by increased vegetation cover. The net result of greenhouse gas exchanges in these northern environments will affect both the global and regional climate systems. To assess current conditions and forecast future responses to environmental change, Oliver Sonnentag is studying greenhouse gas and heat fluxes (the exchange of gases and heat between the ground and the atmosphere) at four study locations in the Taiga Plains, including Scotty Creek, Havikpak Creek, Trail Valley Creek and Smith Creek. This research supports informed decision-making regarding infrastructure and resource development in the region and climate change adaptation policies.

Solar-powered instruments on the tower at Scotty Creek, Northwest Territories, collect data on greenhouse gas and energy fluxes.

Since 2013, Sonnentag and his research team have used towers, up to 15 m tall, mounted with solar-powered instruments to collect detailed information about the exchanges of carbon dioxide, methane, water vapour and heat between the land surface and the atmosphere at the Scotty Creek, Havikpak Creek and Trail Valley Creek sites. A recently constructed tower at Smith Creek will begin taking measurements in 2016. This network of four towers spans 1,000 km and covers gradients in latitude, permafrost type, vegetation and climate, which permits the research team to examine how boreal, peatland and tundra ecosystems in the Taiga Plains are responding to ongoing environmental change. The research team uses the eddy covariance technique, which examines the vertical movement of gases, water vapour and heat in the atmosphere near the ground, to examine ecosystem processes and functions.

Results to date show that permafrost thaw at Scotty Creek, a boreal forest site underlain by discontinuous permafrost, is causing vegetation that typically stores water to shift to releasing water. With collaborators, the research team has also determined that permafrost thaw in the Taiga Plains is equally important to wildfire activity in causing changes to vegetation cover in recent years. With the addition of the Smith Creek site, the research team will expand the extent of their ecosystem-scale studies to understanding better how carbon, water and energy cycles in different northern environments are affected by changing permafrost conditions and how they may respond in future.

"The overall goal of this research is to provide a better process-based understanding of how boreal forest, peatland and tundra ecosystems, under the influence of rapidly changing permafrost conditions, function as integral parts of the global and regional climate systems."

– Oliver Sonnentag

The impact of climate change on flowering and seed dispersal times of plants in the Canadian Arctic Archipelago

Zoe Panchen (Carleton University)

Featured story location on the map: 5

In recent decades, temperate regions have seen their greatest increases in temperature in the spring, while the most notable temperature increases in the Arctic have been in late summer, autumn and winter. Much information is available regarding the impacts of climate change on plant phenology (timing of plant life cycle events) in temperate regions, but knowledge of the response of Arctic vegetation to warming conditions is limited. For her doctoral research, Zoe Panchen is examining the phenology of flowering plants at Lake Hazen on Ellesmere Island and Iqaluit on Baffin Island, Nunavut, to identify influences on the timing of Arctic plant flowering and seed dispersal.

Panchen and her field team, which has included northern residents and Parks Canada staff, recorded the timing of the start, peak and end of flowering and seed dispersal for plants in study plots at each study site and created a photographic record of study plants throughout the growing season. Over three field seasons, they collected data for 35 plant species at Lake Hazen and recorded the flowering and seed dispersal times of six plant species at study plots along a gradient from low to high elevation. The gradient makes it possible for Panchen to examine climate influences on the life cycle of plants that are experiencing warmer (lower elevation) to colder (higher elevation) conditions. Herbarium specimens (pressed and dried plant samples) were also collected at Lake Hazen to add to long-term records of Arctic vegetation. Results to date indicate that plant species found at both study sites typically flower earlier at Lake Hazen than at Iqaluit and the flowering period for Iqaluit plants is significantly longer than for Lake Hazen plants.

Panchen has also analyzed phenology data collected by Parks Canada since 1994 at Tanquary Fiord, located 75 km west of Lake Hazen. Results show that the flowering times of the spring-flowering purple saxifrage have not significantly changed over the past two decades, but flowering times of the mid-summer-flowering mountain avens have become earlier. These findings are opposite to those in temperate areas, where spring-flowering plants are showing more rapid shifts to earlier flowering times than summer-flowering plants.

Future research plans will involve using herbarium specimens from the last 120 years to examine changes in the flowering and seed dispersal times of Canadian Arctic plants and the impact of climate change on these plants over the long term.

"The different pattern of plant phenological responses to ongoing climate change in Arctic versus temperate regions suggests that ecological and community-level interactions could play out differently in the Arctic than in temperate regions."

– Zoe Panchen

Purple saxifrage (*Saxifraga oppositifolia*) flowers are counted at McGill Mountain near Lake Hazen, Ellesmere Island, Nunavut.

Ecological surveys to establish Canadian High Arctic Research Station monitoring and research in the Cambridge Bay area

Donald McLennan (Polar Knowledge Canada)

Featured story locations on the map: 6

Through its partnership with POLAR, the PCSP provides terrestrial logistics assistance for scientists who are delivering POLAR's Science and Technology (S&T) Program. As part of this program, POLAR is establishing an Experimental and Reference Area (ERA) that includes marine, freshwater and terrestrial ecosystems in the vicinity of Cambridge Bay, Nunavut, where CHARS is currently being constructed. Baseline and environmental monitoring research has begun in the ERA, including studies on terrestrial ecosystem classification, arthropod monitoring, snow science, freshwater and marine ecology, and indigenous knowledge of muskoxen and caribou populations.

Since 2013, a team led by POLAR scientist Donald McLennan has been studying the terrestrial ecosystem of eastern Victoria Island, Nunavut, and adjacent mainland areas to conduct ecological classification and mapping and establish long-term environmental monitoring sites in the proposed terrestrial/freshwater ERA. The Cambridge Bay area has a strong gradient in climate, resulting in a range of terrestrial ecozones (regions with distinct ecology). The sub-Arctic forest environment that exists in the southern part of the terrestrial/freshwater ERA transitions northward through treeline to dwarf shrub cover. This diversity of environmental conditions results in a variety of habitats with distinct soil conditions and plant and animal communities. Ecological classification in this ERA is important for describing ecological communities in a standardized manner to ensure accurate comparisons with other monitoring sites across the circumpolar Arctic. By monitoring study sites across the ERA over the long term, the responses of various ecological communities to environmental changes over time can be identified, and future changes may be predicted.

Researchers count fecal pellets as part of a wildlife study near Cambridge Bay, Nunavut.

McLennan's research team has documented soil characteristics, surficial geology and vegetation at study sites throughout the terrestrial/freshwater ERA. This data is being used in a terrestrial ecosystem classification approach, the Arctic-Subarctic Terrestrial Ecosystem Classification system, which is proposed for implementation across the circumpolar Arctic. With this information, the team is developing ecological maps that show the distribution of the various terrestrial ecosystems in the Cambridge Bay area. The ecological maps will also be used to assess potential locations for future CHARS research infrastructure within the ERA and for future research project design and implementation, as certain ecological communities or habitats may be targeted for study. The maps are also vital for the continued development of the network of long-term environmental monitoring plots to achieve effective coverage of the varied environments of the terrestrial/freshwater ERA. This research is setting the foundation for long-term monitoring of ecological change in the ERA and developing an improved understanding of the factors influencing the terrestrial ecosystems of the Cambridge Bay area.

"A standardized classification of Arctic terrestrial ecosystems provides a common language for Arctic researchers to implement their experiments, creates a comprehensive ecological template for conducting and communicating research results, and serves as a strong basis for modeling ecosystem change into the future."

– Donald McLennan

Natural attenuation as an oil spill response strategy in the Arctic

Principal investigator: Charles Greer (National Research Council Canada)

Featured story location on the map: 7

Recent reductions in sea ice cover in the Canadian Arctic are opening northern waterways, including the Northwest Passage, to increased shipping traffic for industry and tourism. With sizable oil and gas reserves in the region, shipping activity may increase to support future natural resource development, which creates an increased risk of oil spills. The remoteness of Arctic shipping corridors and their fragile ecosystems make effectively handling an oil spill particularly difficult. Plans for mitigating oil spills in the North are required, but little is known about how oil spills would impact northern environments.

Charles Greer has been examining bacteria in Resolute Bay, Nunavut, to identify if they can biodegrade (naturally decompose) petroleum hydrocarbons (the main components of oil and gas) and assess the capacity of Arctic marine ecosystems to attenuate an oil spill. Each year, his research team, which includes residents from Resolute, collects sea water from a set of coastal stations and examines microbes (tiny organisms) to develop detailed information about their community structure and capabilities. In 2015, samples were collected in spring and summer to determine if hydrocarbon-degrading bacteria are a normal part of the microbe community at different times of the year and how conditions in different seasons might affect the ability of bacteria to degrade hydrocarbons.

Seawater samples are also used in microcosm experiments, where the natural marine environment is simulated in small tanks under controlled conditions. Oil is added to the tanks to assess how bacteria respond to being exposed to oil and how the process of hydrocarbon degradation occurs at certain water temperatures. Greer's research team is also developing baseline metagenomic datasets (complete sequences of the total DNA from an environment) from the seawater samples to understand how microbial communities in Resolute Bay function and how they respond to changing environmental conditions, including exposure to oil.

The research team has found that hydrocarbon-degrading bacteria are typically found in very low numbers in Arctic seawater and sea ice, but when oil enters the environment, these bacteria multiply rapidly and hydrocarbon degradation activity increases. Hydrocarbons are rapidly decomposed by Arctic marine bacteria, even at water temperatures below 0°C, which is possible in a salt water environment. Within two weeks, over 50 percent of hydrocarbons in test environments can be biodegraded, which is similar to the level of degradation activity that occurs in temperate regions.

Seawater samples are collected on Resolute Bay, Nunavut, for use in microcosm studies to examine how bacteria in seawater biodegrade hydrocarbons.

Future research plans include examining other Arctic locations and conducting studies at other times of the year to assess the potential of Arctic marine bacteria, on a regional scale, to biodegrade hydrocarbons throughout the year. The results of this work are contributing to understanding the potential impacts of industrial development on Arctic marine ecosystems and developing corrective measures for dealing with oil spills in this sensitive environment.

"The outcome of this research will provide stakeholders with information on the potential of microbial populations to respond to oil inputs in an Arctic environment, which will help direct oil spill countermeasure development."

– Charles Greer

Holocene climate of the Canadian Arctic

Konrad Gajewski (University of Ottawa)

Featured story location on the map: 8

The Arctic experienced substantial climate variability (temperature shifts above and below average conditions) during the Holocene epoch (the past 11,700 years), which began as the last ice age ended. However, details of the region's climate history throughout the Holocene are not well understood. Proxy (indirect) indicators of climate, such as plant and insect fossils in lake sediments, can be used to reconstruct the climate history of an area prior to instrumental records of temperature and precipitation. These proxy climate records enable researchers to place recent changes into context and forecast future environmental conditions.

A lake sediment core is collected from a lake on Victoria Island, Nunavut.

Fossil pollen in lake sediments can be used as a proxy record for climate and vegetation cover. As plants disperse pollen, it can be deposited in a nearby lake and become part of the lake's sedimentary record. Since each plant species requires certain temperature and moisture conditions to thrive, researchers can count the different types of pollen grains in each layer of a dated sedimentary record and use this information to estimate temperatures over time. Konrad Gajewski and his research team are using pollen and other types of fossils in lake sediment records to quantify climate variability during the Holocene epoch in the Canadian Arctic and determine its impacts on freshwater and terrestrial ecosystems.

Gajewski's research team recently used pollen records from 39 lakes across the Canadian Arctic and Greenland to develop regional records of July temperatures during the Holocene and examine ecosystem responses to past warm periods. This synthesis showed that the western and central Canadian Arctic were warmest from 10,000 to 7,000 years ago and the eastern Canadian Arctic and most of Greenland were warmest from 8,000 to 5,000 years ago. Most locations studied showed relatively cooler summer conditions after 3,200 years ago, not including the past 200 years. Results also showed that Holocene warm periods caused increased plant productivity (growth) and a rapid spread of vegetation across the Canadian Arctic. The research team expects that vegetation would respond in a similar manner during future warm periods.

In a study that began in 2015, Gajewski's field team, which included northern residents, collected lake sediment and peat cores on Banks Island, Northwest Territories. Using multiple types of proxy records from these cores, including pollen and insect fossils, the research team will reconstruct summer temperatures in the study area over the past 2,000 to 3,000 years. The team will also examine the impacts of the relatively warm Medieval Warm Period (approximately A.D. 950 to 1250) and relatively cold Little Ice Age (approximately A.D. 1450 to 1850) on Banks Island ecosystems and assess how quickly plants migrated to the island after the last ice age. Future research plans involve conducting more detailed analyses of Arctic climate trends during the Holocene using climate reconstructions developed from fossils in lake sediments at central Canadian Arctic sites. These studies will allow Gajewski's team to determine the timing of major environmental changes in the area more precisely.

"We have, for the first time, a quantitative reconstruction of the postglacial climate history across the entire Canadian Arctic Archipelago and coastal Greenland that illustrates how the warm conditions of the early- to mid-Holocene impacted terrestrial and freshwater ecosystems and helps us to assess future ecosystem responses to climate change."

– Konrad Gajewski

Constraints on glacier form and flow in southwest Yukon Territory

Principal investigator: Gwenn Flowers

Featured story location on the map: 9

The St. Elias Mountains of southwest Yukon have the largest icefields (ice masses less than 50,000 km^2 in size in mountainous terrain) outside of the polar regions. Of the many glaciers that flow out of the icefields, a high number are surging glaciers, which periodically advance downslope at a rapid rate for a short period of time. Glaciers in this region are retreating, but knowledge gaps about the relationship between climate and glacier processes create challenges for predicting how these glaciers will respond to ongoing environmental changes. To address this issue, Gwenn Flowers is studying the internal flow dynamics (processes of ice deformation and movement within a glacier) of glaciers in the Donjek Range of the St. Elias Mountains and examining their responses to temperature and precipitation changes over time.

Flowers and her research team recently completed a 10-year project in the Donjek Range where they established automatic weather stations on two glaciers and measured their snow accumulation, summer melt, ice flow processes, ice thickness and ice temperature. The results of this study indicate that the study glaciers have been losing ice at rates similar to other glaciers in the region, but there were notable differences in winter snow accumulation and summer melt on glaciers located only 10 km from each other. By modelling the surface energy balance (energy arriving at and leaving a glacier's surface) of each glacier, the team found that these differences were due, in part, to glacier aspect (the direction a glacier faces).

They also found that climate is driving changes to the thermal structure (temperature throughout the ice) of several glaciers. Meltwater is trapped in the snowpack on the surface of these glaciers and refrozen, which releases enough heat to keep a large amount of each glacier's ice at the melting point. The team's computer models predict that these glaciers will actually get colder as they lose mass and become thinner because the surface snowpack, and its ability to trap meltwater, will be reduced. Additionally, the team observed a glacier that was known to surge having a "slow surge" event, where its flow rate was high but still much slower than usual surging glaciers. Slow surges are known to occur in surging glaciers after a long period of ice loss, and the results of computer modelling suggest that this glacier will stop surging in the future if it continues to lose ice.

Building on this work, Flowers's research team began a collaborative project with Christian Schoof and the University of British Columbia in 2015 to examine ice flow dynamics of the Kaskawulsh Glacier in the St. Elias Mountains and water drainage processes of a lake whose outflow is blocked by this glacier. Future research plans involve conducting detailed studies of snow accumulation processes on several glaciers in the region. The team plans to measure the distribution of snow accumulation and relate these patterns to local and regional precipitation processes to improve model accuracy when forecasting glacier responses to environmental changes.

A University of British Columbia/Simon Fraser University solar-powered global positioning system (GPS) tower stands on an unnamed glacier in the St. Elias Mountains, Yukon.

"We are studying the direct response of glaciers to temperature and precipitation, as well as the complex internal dynamics of these glaciers, which can lead them to respond differently to the same climate conditions."

– Gwenn Flowers

Arctic Operations Exercise for Search and Rescue Technicians

Master Corporal Carl Portman (Royal Canadian Air Force)

Featured story location on the map: 10

In 2015, the PCSP provided logistics support for eight CAFATC courses that focused on training military personnel in conducting military operations and related activities in the Canadian Arctic. As more people visit and work in the North, the potential for incidents requiring a military response increases. Bitter cold conditions, remote locations, sea ice and the full darkness of winter provide unique challenges for working in a northern environment. Arctic training is necessary to ensure that members of Canada's Armed Forces are properly prepared to respond to emergency situations in the North.

In February 2015, the Arctic Operations Exercise for Search and Rescue Technicians course was held for the first time, based from the facility in Resolute. It provided an opportunity for members of the 435 Transport and Rescue Squadron from 17 Wing Winnipeg to enhance their skills for conducting rescues in Arctic conditions. By holding the course in the middle of winter, participants were subjected to the full range of weather and darkness challenges that could hinder rescue efforts, preparing them to handle some of the extreme conditions they could potentially face in an Arctic search and rescue mission.

During the course, participants responded to mock emergency situations, planned and conducted traverses across unmarked Arctic landscapes and practiced providing medical assistance under difficult winter conditions. Part of the training involved parachuting from an aircraft in the dark of winter to a site on Cornwallis Island where participants carried out a medical exercise. Another excursion involved travelling by snowmobile away from Resolute on a three-day exercise to practice winter survival skills.

Through these exercises, the participants tested various types of equipment and procedures, which provided insight into what did and did not work in extreme conditions. Equipment issues, such as having a broken snowmobile, camp equipment that will not function properly at -50°C or jacket zippers without lanyards that cannot be operated by a person wearing mittens, could create major difficulties for search and rescue technicians trying to save a life in extreme weather. Being aware of what equipment and clothing works best in a northern environment is of utmost importance when survival is at stake.

The course participants gained valuable experience in how best to conduct effective and safe search and rescue missions in the Arctic. This course is expected to be offered in future for military search and rescue teams across Canada to enhance their ability to respond to emergencies in the North.

While setting up camp on Cornwallis Island in difficult weather conditions, course participants test the use of a quick set-up tent (in red) that can be used to shelter an injured person during an emergency.

> *"This level of training would not be possible without the support of the PCSP."*
>
> – Master Corporal Carl Portman

Muskoxen at Eureka on Ellesmere Island, Nunavut

List of supported Arctic projects in 2015

The following list indicates science projects, operations work in support of federal government initiatives and training activities that received PCSP logistics support in 2015.

Assessing the impact of Lesser Snow Goose and Cackling Goose competition on breeding Atlantic Brant

Principal investigator: Kenneth Abraham (Trent University)
Location: East Bay (Southampton Island), Nunavut

Karrak Lake assessment of continental efforts at population reduction of Light Geese

Principal investigator: Ray Alisauskas (Environment and Climate Change Canada)
Locations: Atkinson Point, Karrak Lake, and Perry River, Nunavut

Qikiqtani field operations inspections

Principal investigator: Erik Allain (Indigenous and Northern Affairs Canada)
Locations: Alert, Eureka, Alexandra Fiord and Tanquary Fiord (Ellesmere Island) and locations on Baffin Island, Nunavut

Interactions between the gut microbiome and dietary contaminants from traditional food

Principal investigator: Marc Amyot (Université de Montréal)
Location: Resolute (Cornwallis Island), Nunavut

Detecting muskoxen on Bathurst Island with high-resolution satellite imagery

Principal investigator: Morgan Anderson (Government of Nunavut, Department of Environment)
Locations: Locations on Bathurst Island and Resolute (Cornwallis Island), Nunavut

Peary caribou landscape genetics

Principal investigator: Morgan Anderson (Government of Nunavut, Department of Environment)
Locations: Locations on Bathurst Island, Lougheed Island, Byam Martin Island, and southern and central Ellesmere Island, Nunavut

A helicopter releases a sling load in the Blue Mountains on Ellesmere Island, Nunavut.

South Ellesmere Peary caribou and muskox aerial survey

Principal investigator: Morgan Anderson (Government of Nunavut, Department of Environment)
Locations: Grise Fiord and locations on southern Ellesmere Island, Nunavut

Northwest Territories ice patch monitoring program

Principal investigator: Tom Andrews (Prince of Wales Northern Heritage Centre)
Locations: Locations in the Mackenzie Mountains and Mile 222, Northwest Territories

Fox-C Ekalugad Fiord long-term monitoring program

Principal investigator: Lilianne Arsenault (Indigenous and Northern Affairs Canada)
Location: Ekalugad Fiord (Baffin Island), Nunavut

Kane Basin polar bear population assessment

Principal investigator: Stephen Atkinson (Government of Nunavut, Department of Environment)
Locations: Coastal sites near Alexandra Fiord (Ellesmere Island) and sea ice locations in Kane Basin, Nunavut

The changing tundra: Quantifying the role of shrub patch species composition, structure and function to changing ground conditions and ground vegetation richness

Principal investigator: Jennifer Baltzer (Wilfrid Laurier University)
Location: Trail Valley Creek, Northwest Territories

Assessment of soil moisture retrieval from active/passive microwave sensors in the sub-arctic boreal and Arctic

Principal investigator: Aaron Berg (University of Guelph)
Location: Trail Valley, Northwest Territories

A sling load is attached to a helicopter on Banks Island, Northwest Territories.

Ecology of Arctic and red fox on Bylot Island

Principal investigator: Dominique Berteaux (Université du Québec à Rimouski)
Locations: Locations on Bylot Island, Nunavut

Ecology of insectivorous birds on Bylot Island

Principal investigator: Joël Bêty (Université du Québec à Rimouski)
Locations: Locations on Bylot Island, Nunavut

Snowy owl documentary filming

Principal investigator: Jean-Claude Bellefeuille (Bellefeuille Production Ltd.)
Location: Bylot Island, Nunavut

Developing new tools for assessing legacy pollutants and their ecological consequences in lakes near Northwest Territories mines

Principal investigator: Jules Blais (University of Ottawa)
Locations: Lakes in the Yellowknife area, Northwest Territories

Arctic Secrets

Principal investigator: Sharla Bonneville (White Pine Productions)
Locations: Devon Ice Cap (Devon Island), Nunavut

National Aerial Surveillance Program

Principal investigators: Steve Buckles (Transport Canada) and Dominic Carino (Environment Canada)
Location: Resolute (Cornwallis Island), Nunavut

Surveying is done by the International Boundary Commission on the British Columbia-Alaska border at Tar Inlet.

State and evolution of Canada's glaciers / ECV mass balance – Queen Elizabeth Islands, Nunavut and Northwest Territories

Principal investigator: David Burgess (Natural Resources Canada)
Locations: Agassiz Ice Cap (Ellesmere Island), Devon Ice Cap (Devon Island), Meighen Ice Cap (Meighen Island), and Grise Fiord, Nunavut, and Melville Ice Cap (Melville Island), Northwest Territories

Investigations of permafrost and climate change, western Arctic Canada

Principal investigator: Christopher Burn (Carleton University)
Locations: Garry Island, Pelly Island, and Illisarvik, Northwest Territories

Monitoring of glaciers and ice shelves across the northern Queen Elizabeth Islands

Principal investigator: Luke Copland (University of Ottawa)
Locations: Expedition Fiord and Purple Valley (Ellesmere Island), Nunavut

Mass balance, dynamics and recent changes of glaciers in Kluane National Park, Yukon

Principal investigator: Luke Copland (University of Ottawa)
Locations: Kaskawulsh Glacier and Kluane Lake Research Station, Yukon

Hudson-Ungava GEM-2 Core Zone

Principal investigator: David Corrigan (Natural Resources Canada)
Locations: Locations northwest of Kuujjuaq, Quebec

Shallow ice core reconstructions of historical climate and sea ice variability

Principal investigator: Alison Criscitiello (University of Calgary)
Locations: Locations on the Prince of Wales Icefield (Ellesmere Island) and Devon Ice Cap (Devon Island), Nunavut

The diversity and dynamics of wild viruses in the Canadian High Arctic

Principal investigator: Alexander Culley (Université Laval)
Locations: Resolute (Cornwallis Island) and Ward Hunt Island, Nunavut

EcoSystem Change in Arctic PErmafrost (ESCAPE): Ecological effects of permafrost disturbance on stream ecological condition

Principal investigator: Joseph Culp (University of New Brunswick)
Locations: Sachs Harbour and Johnson's Point areas (Banks Island), Northwest Territories

Terrestrial geoscience studies of earthquake (seismic) hazard in the Mackenzie-Beaufort area

Principal investigator: Scott Dallimore (Natural Resources Canada)
Locations: Locations on Richards Island, Northwest Territories

Influence of increased abundance of sub-Arctic marine forage fish (Capelin) on subsistently harvested marine mammals and fish populations by communities of the Eastern and Western Canadian Arctic

Principal investigator: Gail Davoren (University of Manitoba)
Locations: Paulatuk and Darnley Bay, Northwest Territories

State and evolution of Canada's glaciers / ECV – mass balance – Northern Cordillera, Northwest Territories

Principal investigator: Michael Demuth (Natural Resources Canada)
Location: Bologna Glacier, Northwest Territories

Annual inspection and servicing of various automatic weather stations across the Arctic Archipelago

Principal investigator: Rich deVall
Locations: Sachs Harbour, Polar Bear Cabin and Green Cabin (Banks Island), Cape Providence (Melville Island), Uluhaktok (Victoria Island), and Mould Bay (Prince Patrick Island), Northwest Territories, and Eureka, Grise Fiord (Ellesmere Island), Svaarteveag (Axel Heiberg Island), Fort Ross (Somerset Island), Isachsen (Ellef Ringnes Island), Rae Point (Melville Island), Gateshead Island and Stefanson Island, Nunavut

High Arctic Large Igneous Province: Western Arctic Geo-mapping for Energy and Minerals (GEM) project

Principal investigator: Keith Dewing (Natural Resources Canada)
Locations: Mokka Fiord, Bunde Fiord, Middle Fiord, Geodetic Hills and Strand Fiord (Axel Heiberg Island) and Diener Creek, Hare Fiord, Smith Creek, Otto Fiord, Hvitland Peninsula, and Eureka (Ellesmere Island), Nunavut

Study of the acceleration of permafrost thawing by climate-induced changes in snow physical properties

Principal investigator: Florent Domine (Université Laval)
Locations: Locations on Bylot Island, Nunavut

Estimating the abundance of polar bears in M'Clintock Channel using genetic mark-recapture

Principal investigator: Markus Dyck (Government of Nunavut, Department of Environment)
Locations: Sea ice locations near Cambridge Bay (Victoria Island), Cape Sidney (King William Island), Fort Ross (Somerset Island), and Sydney Webb Point (Prince of Wales Island), Nunavut

Estimating the abundance of polar bears in the Gulf of Boothia subpopulation

Principal investigator: Markus Dyck (Government of Nunavut, Department of Environment)
Locations: Sea ice locations in the Gulf of Boothia and Fort Ross (Somerset Island), Franklin Bay, Kugaaruk, and Thom Bay, Nunavut

State and Evolution of Canada's Glaciers / ECV – Mass balance – Baffin Island, Nunavut

Principal investigator: Mark Ednie (Natural Resources Canada)
Locations: Locations on Penny Ice Cap and Coronation Glacier and Pangnirtung (Baffin Island), Nunavut

A longhouse tent and sample pails are part of a field camp at Johnson Point on Banks Island, Northwest Territories. The pails contain stream sediment and till samples that are used to recover kimberlite (diamond) indicator minerals as part of a regional provenance study.

Teleseismic investigations of the crust mantle interface beneath Banks Island, Northwest Territories

Principal investigator: Barrett Elliott (Northwest Territories Geological Survey)
Locations: Johnson Point (Banks Island), Northwest Territories, and Resolute (Cornwallis Island), Nunavut

Adaptation to an ice-free summer by Arctic seabirds

Principal investigator: Kyle Elliott (McGill University)
Location: Coats Island, Nunavut

Sirmilik National Park Operations – 2015

Principal investigator: Carey Elverum (Parks Canada)
Locations: Arctic Bay and Mala River (Baffin Island) and Aktineq Glacier and other locations on Bylot Island, Nunavut

Investigating the structural and metallogenic implications of the March Fault, Mackenzie Mountains, Northwest Territories

Principal investigator: Hendrik Falck (Northwest Territories Geological Survey)
Locations: Locations in the Mackenzie Mountains and Tungsten, Northwest Territories

Bedrock mapping and stratigraphic studies of the Colville Hills region

Principal investigator: Karen Fallas (Natural Resources Canada)
Locations: Locations in the Colville Hills region and Colville Lake and Norman Wells, Northwest Territories

Western Hudson Bay beluga (*Delphinapterus leucas*) survey

Principal investigator: Steven Ferguson (Fisheries and Oceans Canada)
Locations: Areas of western Hudson Bay and Churchill, Manitoba

Executive Inuit Arctic Training Program 2015

Principal investigator: Erin Filliter (Inuit Tapiriit Kanatami)
Locations: Iqaluit, Pond Inlet and Pangnirtung (Baffin Island), Nunavut

Movement and trophic interactions of fish and marine mammals in the Resolute Bay Area

Principal investigator: Aaron Fisk (University of Windsor)
Location: Resolute Bay, Nunavut

Tracking the migratory behaviour of searun Arctic char in the Cambridge Bay area using acoustic telemetry

Principal investigator: Aaron Fisk (University of Windsor)
Locations: Ekalluk River and the Ferguson Lake area (Victoria Island), Nunavut

An antenna for a high-frequency (HF) radio stands at a field camp at Camp Five Creek on Axel Heiberg Island, Nunavut. Field parties use HF radios for twice daily scheduled contact with PCSP staff in Resolute.

Observational constraints on glacier form and flow, southwest Yukon, Canada

Principal investigator: Gwenn Flowers (Simon Fraser University)
Locations: Kaskawulsh Glacier, Kluane Glacier, and Maxwell Glacier, Yukon

GEO-NEIGE: Geomorphology of Northern Ellesmere Island in the Global Environment

Principal investigator: Daniel Fortier (Université de Montréal)
Location: Ward Hunt Island, Nunavut

REP-ARC2: Responses of Arctic periglacial ecosystems to climate change

Principal investigator: Daniel Fortier (Université de Montréal)
Locations: Locations on Bylot Island, Nunavut

Past modes of Arctic climate variability from varved sediments from Ellesmere Island

Principal investigator: Pierre Francus (Institut National de la Recherche Scientifique, Eau Terre Environnement Research Centre)
Location: Strathcona Fiord (Ellesmere Island), Nunavut

Arctic cultural heritage at risk: Climate change impacts on the archaeological record in the western Canadian Arctic

Principal investigator: Max Friesen (University of Toronto)
Locations: Coastal locations on the Tuktoyaktuk Peninsula, Richards Island and Inuvik, Northwest Territories

A marine sediment core is collected from Kugmallit Bay, near Tuktoyaktuk, Northwest Territories.

The evolution of meltwater drainage along the northwestern Laurentide Ice Sheet

Principal investigator: Duane Froese (University of Alberta)
Locations: Locations in the Camsell Range, Franklin Mountains, and Hare Indian River area, Northwest Territories

Fishing Branch River Chum Salmon Habitat Assessment – Year 2

Principal investigator: David Frost (Vuntut Gwitchin Government)
Locations: Fishing Branch River and Dawson, Yukon

Radio tracking of chum salmon in the Porcupine River, Canada

Principal investigator: David Frost (Vuntut Gwitchin Government)
Locations: Locations along the Porcupine River and Dawson and Old Crow, Yukon

Radio tracking of Chinook salmon and genetic sampling in the Porcupine River, Canada

Principal investigator: David Frost (Vuntut Gwitchin Government)
Locations: Locations along the Porcupine River and Dawson and Old Crow, Yukon

Postglacial climates of the Canadian Arctic

Principal investigator: Konrad Gajewski (University of Ottawa)
Locations: Locations on Banks Island and Sachs Harbour (Banks Island), Northwest Territories

Biology of bird and small tundra mammal populations: Demographics, trophic interactions and climate change

Principal investigator: Gilles Gauthier (Université Laval)
Locations: Locations on Bylot Island, Nunavut

A stream sediment sample is collected on Banks Island, Northwest Territories.

Population studies of Common and King Eider ducks breeding at East Bay, Southampton Island, Nunavut, 2015

Principal investigator: Grant Gilchrist (Environment and Climate Change Canada)
Location: East Bay (Southampton Island), Nunavut

Natural attenuation as an oil spill response strategy in the Arctic

Principal investigator: Charles Greer (National Research Council Canada)
Location: Resolute Bay, Nunavut

Permafrost measurements in Lac de Gras region

Principal investigator: Stephan Gruber (Carleton University)
Location: Lac de Gras region, Northwest Territories

Northern Watch 2015

Principal investigator: Bruce Grychowski (Defence Research and Development Canada)
Location: Gascoyne Inlet (Devon Island), Nunavut

Canadian Arctic Sea Ice Mass Balance Observatory (CASIMBO)

Principal investigator: Christian Haas (York University)
Locations: Sea ice locations near Inuvik, Northwest Territories, and Isachsen (Ellef Ringnes Island) and Resolute (Cornwallis Island), Nunavut

Mapping thin landfast ice for model validation (ArcticNet)

Principal investigator: Christian Haas (York University)
Locations: Sea ice locations near Crozier Island, Nunavut

Development and application of paleolimnological methods to assess pollution of aquatic ecosystems downstream of the Alberta oilsands

Principal investigator: Roland Hall (University of Waterloo)
Locations: Fort Chipewyan and locations in Wood Buffalo National Park, Alberta

The end of an era: Evaluating paleoenvironmental change in the latest Mesoproterozoic (ca. 1.1 billion years old) Bylot Supergroup, Baffin Island

Principal investigator: Galen Halverson (McGill University)
Locations: Charles Yorke River, Nanisivik, Elwin Inlet, and Mala River (Baffin Island) and locations on Bylot Island, Nunavut

Fisheries and Oceans Canada's real-time Arctic ocean observatory

Principal investigator: Jim Hamilton (Fisheries and Oceans Canada)
Locations: Resolute (Cornwallis Island) and locations in the Northwest Passage, Nunavut

Quttinirpaaq National Park

Principal investigator: Emma Hansen (Parks Canada)
Locations: Fort Conger, Lake Hazen and Tanquary Fiord (Ellesmere Island) and Ward Hunt Island, Nunavut

Hornaday River Monitoring Program 2015

Principal investigator: David Haogak (Parks Canada)
Locations: Hornaday River and Anderson River, Northwest Territories

Fishery independent biological sampling of Cambridge Bay Arctic Char (*Salvelinus alpinus*) stocks: Completion of the Jayko and Halovik Rivers

Principal investigator: Les Harris (Fisheries and Oceans Canada)
Locations: Halovik River and Jayko River (Victoria Island), Nunavut

Retrieve old fuel barrels

Principal investigator: Christopher Harrison
Location: Vendom Fiord (Ellesmere Island), Nunavut

Species and ecosystem constraints on increasing vegetation cover in the High Arctic

Principal investigator: Greg Henry (University of British Columbia)
Locations: Alexandra Fiord, Eastwind Lake, Eureka, Princess Marie Bay, and Sverdup Pass (Ellesmere Island), Nunavut

Ikaahuk Archaeology Project: A community-based approach to sharing archaeological artifacts

Principal investigator: Lisa Hodgetts (University of Western Ontario)
Location: Yellowknife, Northwest Territories

Population assessment of Dolly Varden 2015

Principal investigator: Kimberly Howland (Fisheries and Oceans Canada)
Locations: Babbage River, Yukon, and Big Fish River and Rat River, Northwest Territories

Long-term monitoring of Great Bear Lake fisheries and the aquatic ecosystem

Principal investigator: Kimberly Howland (Fisheries and Oceans Canada)
Location: Dease Arm, Great Bear Lake, Northwest Territories

The paleoenvironmental and structural evolution of the Sverdrup Basin, Canadian Arctic Islands

Principal investigator: Peter Hulse (CASP, Cambridge University, United Kingdom)
Locations: Ekblaw Lake, McKinley Bay area and Tanquary Fiord area (Ellesmere Island), Nunavut

Assessing risks of wildlife diseases in the Canadian North

Principal investigator: Emily Jenkins (University of Saskatchewan)
Location: Karrak Lake, Nunavut

Measuring the strength of cold hummocked multi-year ice (MYI) and second-year ice (SYI) in spring

Principal investigator: Michelle Johnston (National Research Council Canada)
Locations: Sea ice locations near Bathurst Island and Cornwallis Island and Resolute (Cornwallis Island), Nunwavut

Researchers collect a sediment core from Grenier Lake near Cambridge Bay, Nunavut.

Assessment of habitat degradation at snow goose breeding colonies in the Eastern Arctic

Principal investigator: Todd Kemper (Environment and Climate Change Canada)
Locations: Locations on Southampton Island and Coral Harbour (Southampton Island), Nunavut

VHF radio antenna installation

Principal investigator: Marty Kuluguqtuq (Iviq Hunters and Trappers Organization)
Location: South Cape (Ellesmere Island), Nunavut

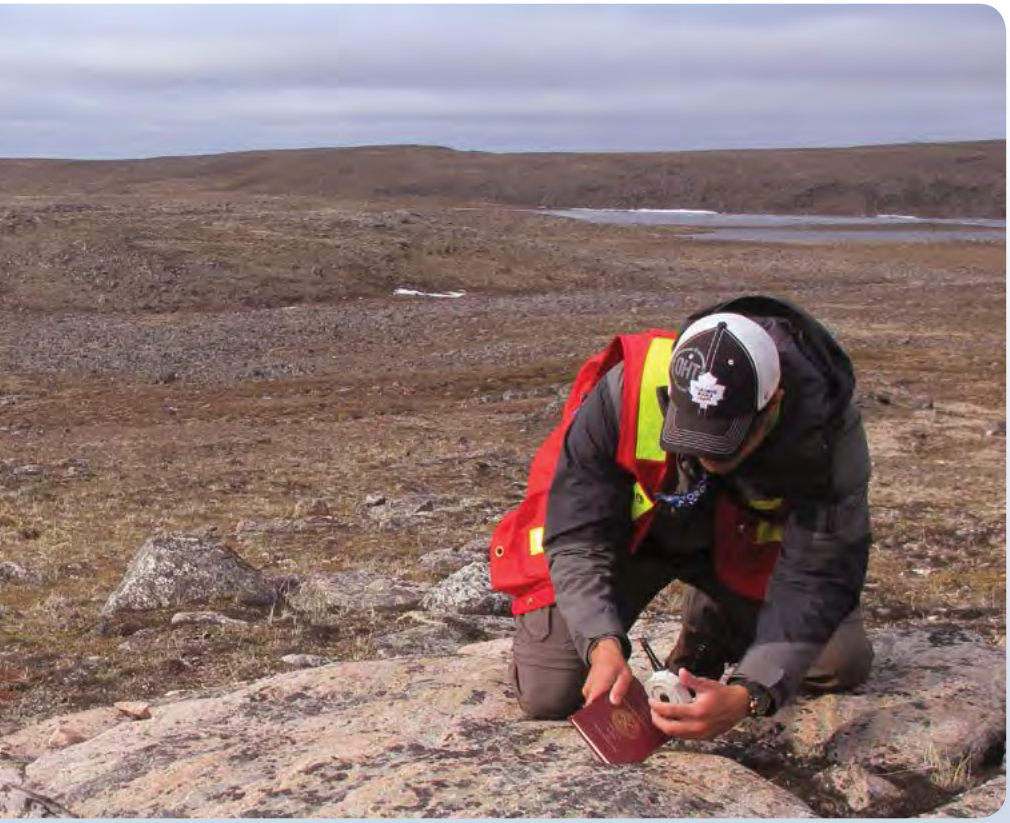
Impacts of thermokarst disturbances on the hydrological regimes, sediment load and geochemistry of streams and lakes, Banks Island, Northwest Territories

Principal investigator: Denis Lacelle (University of Ottawa)
Locations: Locations on Banks Island and Sachs Harbour (Banks Island), Northwest Territories

Permafrost change impacts on terrestrial and aquatic system processes

Principal investigator: Scott Lamoureux (Queen's University)
Location: Cape Bounty (Melville Island), Nunavut

A field assistant takes structural measurements on an outcrop after collecting a sample of granitic gneiss west of Lorillard River, Nunavut.



Causes and consequences of Arctic environmental change: A multiscale approach

Principal investigator: Trevor Lantz (University of Victoria)
Locations: Sachs Harbour (Banks Island), Husky Lake, Jimmy Lake, Johnson Point and Sitidgi Lake, Northwest Territories

Greenhouse gas emissions from Arctic lakes and ponds: Influences of geomorphology and carbon lability

Principal investigator: Isabelle Laurion (Institut National de la Recherche Scientifique, Eau Terre Environnement Research Centre)
Locations: Locations on Bylot Island, Nunavut

Hudson Bay-Ungava GEM-2 project: Stratigraphy and source rocks on Akpatok Island

Principal investigator: Denis Lavoie (Natural Resources Canada)
Locations: Akpatok Island, Nunavut, and Kangirsuk, Quebec

Hudson Bay-Ungava GEM-2 project: Diagenetic evolution of Upper Ordovician reefs, Southampton Island

Principal investigator: Denis Lavoie (Natural Resources Canada)
Location: Coral Harbour area (Southampton Island), Nunavut

Southampton Island goose banding

Principal investigator: Jim Leafloor (Environment and Climate Change Canada)
Location: Coral Harbour area (Southampton Island), Nunavut

Baffin Island goose banding

Principal investigator: Jim Leafloor (Environment and Climate Change Canada)
Locations: Nikku Island and locations on southern Baffin Island, Nunavut

Survival in Arctic geese (Perry River, Queen Maud Gulf Bird Sanctuary)

Principal investigator: Jim Leafloor (Environment and Climate Change Canada)
Location: Perry River, Nunavut

ARCTIC IMPACT: Arctic Integrative Monitoring of Predators in the Arctic Tundra

Principal investigator: Nicolas Lecomte (Université de Moncton)
Locations: Locations on Igloolik Island, Bylot Island and Melville Peninsula, Nunavut

Population dynamics of Greater Snow Geese in relation to habitat

Principal investigator: Josée Lefebvre (Environment and Climate Change Canada)
Locations: Locations on Bylot Island, Nunavut

Climate change impacts on mercury and methylmercury sources to Arctic ecosystems

Principal investigator: Igor Lehnherr (University of Toronto Mississauga)
Location: Lake Hazen (Ellesmere Island), Nunavut

Ecology and distribution of Arctic grayling populations in the Little Nahanni River watershed in the Northwest Territories

Principal investigator: Brent Lewis (Parks Canada)
Locations: Mac Creek and Tungsten, Northwest Territories

Stress-mediated mechanisms linking individual state, climatic variation and population health in Arctic-breeding birds

Principal investigator: Oliver Love (University of Windsor)
Location: East Bay (Southampton Island), Nunavut

Researchers examine an Ordovician limestone cliff on Akpatok Island, Nunavut.

Contaminant and population research on High Arctic marine birds

Principal investigator: Mark Mallory (Acadia University)
Locations: Whaler Point (Somerset Island), Prince Leopold Island, and Tern Island, Nunavut

Effects of overabundant Arctic geese on freshwater ecosystems

Principal investigator: Mark Mallory (Acadia University)
Location: East Bay (Southampton Island), Nunavut

Nearshore waves, currents, and coastal change: Yukon coast 2015

Principal investigator: Gavin Manson (Natural Resources Canada)
Locations: Pauline Cove (Herschel Island) and the Komakuk Beach and Stokes Point areas, Yukon

Northern Hudson Bay narwhal (*Monodon monoceros*) population survey

Principal investigator: Marianne Marcoux (Fisheries and Oceans Canada)
Locations: Western Hudson Bay and Repulse Bay, Nunavut

Hydrological studies of Mackenzie Delta region

Principal investigator: Philip Marsh (Wilfrid Laurier University)
Location: Trail Valley Creek, Northwest Territories

Hydrological and ecological monitoring in Old Crow Flats, Yukon, 2015

Principal investigator: Ian McDonald (Parks Canada)
Locations: Old Crow Flats and Old Crow, Yukon

Ecological surveys to establish CHARS monitoring and research in the Cambridge Bay area

Principal investigator: Donald McLennan (Polar Knowledge Canada)
Location: Cambridge Bay area (Victoria Island), Nunavut

Research infrastructure development for environmental baseline information in Hudson Strait and Foxe Basin

Principal investigator: Donald McLennan (Polar Knowledge Canada)
Locations: Areas in Foxe Basin and Hudson Strait, Nunavut

A geologist takes a sample of monzogranite south of Wager Bay, Nunavut.

Hazardous sea ice in the Canadian Archipelago

Principal investigator: Humfrey Melling (Fisheries and Oceans Canada)
Locations: Sea ice locations in Byam Martin Channel and Resolute (Cornwallis Island), Nunavut

Dating early Holocene moraines

Principal investigator: Gifford Miller (INSTAAR, University of Colorado Boulder, U.S.A.)
Locations: Allan's Cabin and locations on the Cumberland Peninsula (Baffin Island), Nunavut

Chert sourcing and Paleo-Eskimo lithic technology: An archaeometric approach to understanding technological organization on southern Baffin Island

Principal investigator: Brooke Milne (University of Manitoba)
Locations: Locations on southern Baffin Island, Nunavut

A watershed-scale sampling protocol for distribution and trend assessments of Bull Trout populations in the Northwest Territories

Principal investigator: Neil Mochnacz (Fisheries and Oceans Canada)
Location: Prairie Creek, Northwest Territories

Understanding the distribution and ecological thresholds of chars in the Canadian western Arctic

Principal investigator: Neil Mochnacz (Fisheries and Oceans Canada)
Locations: Noell Lake, Parsons Lake, Rat River and Sitidgi Lake, Northwest Territories

Hydrodynamics of permafrost-glacier systems

Principal investigator: Brian Moorman (University of Calgary)
Locations: Locations on Bylot Island, Nunavut

Dynamics and habitat use by lemmings under climate change

Principal investigator: Douglas Morris (Lakehead University)
Locations: Cambridge Bay (Victoria Island) and Walker Bay, Nunavut

Investigating the role of ocean dynamics and meltwater input on the fate of Ellesmere Island ice shelves, ice tongues and epishelf lakes

Principal investigator: Derek Mueller (Carleton University)
Locations: Milne Glacier, Milne Ice Shelf and Purple Valley (Ellesmere Island), Nunavut

Investigating potential regional effects of climate warming on mercury and other contaminants in landlocked Arctic char

Principal investigator: Derek Muir (Environment and Climate Change Canada)
Locations: Lakes in the Resolute area (Cornwallis Island), Boomerang Lake (Somerset Island) and Cape Bounty (Melville Island), Nunavut

Community-based seawater monitoring for organic contaminants and mercury in the Canadian Arctic

Principal investigator: Derek Muir (Environment and Climate Change Canada)
Locations: Locations in Barrow Strait near Resolute Bay, Nunavut

Aircraft support for Auyuittuq National Park operations

Principal investigator: Matthew Nauyuk (Parks Canada)
Locations: Windy Lake repeater station, Penny Ice Cap and Gateway Glacier (Baffin Island), Nunavut

Effects of overabundant Arctic geese on other tundra nesting birds

Principal investigator: Erica Nol (Trent University)
Locations: Locations on Coats Island, Nunavut

White Wolves: Ghosts of the Arctic

Principal investigator: Ivo Nörenberg (Gulo Film Productions)
Location: Eureka (Ellesmere Island), Nunavut

Testing the antiquity of the East Arm basin, Great Slave Lake

Principal investigator: Luke Ootes (Northwest Territories Geological Survey)
Locations: Blatchford Lake, Great Slave Lake, Union Island and Wilson Island, Northwest Territories

Slave Craton and Slave-Wopmay Orogen transition

Principal investigator: Luke Ootes (Northwest Territories Geological Survey)
Locations: Colomac site, Yellowknife and Courageous Lake, Northwest Territories

Jones Sound narwhal movement study

Principal investigator: Jack Orr (Fisheries and Oceans Canada)
Locations: Makinson Inlet, Starnes Fiord and Grise Fiord (Ellesmere Island), Nunavut

An interdisciplinary investigation of the Tunnunik impact structure and surrounding terrains, Victoria Island, Northwest Territories

Principal investigator: Gordon Osinski (University of Western Ontario)
Location: Tunnunik impact structure (Victoria Island), Northwest Territories

Sustaining hydroecological monitoring to assess state of the park in Wapusk National Park, Manitoba – 2015

Principal investigator: Chantal Ouimet (Parks Canada)
Locations: Locations in Wapusk National Park and Churchill, Manitoba

Impact of climate change on flowering and fruiting times of Arctic plants in the Nunavut Arctic archipelago

Principal investigator: Zoe Panchen (Carleton University)
Location: Lake Hazen (Ellesmere Island), Nunavut

GEM-2 – Hudson Ungava Project, Core Zone Surficial

Principal investigator: Roger Paulen (Natural Resources Canada)
Location: Schefferville area, Quebec

Banks Island

Principal investigator: Nelson Perry (Parks Canada)
Locations: Johnson Point, Green Cabin, Kusrhaak, Polar Bear Cabin and Castel Bay (Banks Island), Northwest Territories

A crew works to locate an international boundary marker on the Quebec-Vermont border.

Examining the impacts of climate and environmental change on aquatic and terrestrial ecosystems of the Mackenzie region, Northwest Territories

Principal investigator: Michael Pisaric (Brock University)
Locations: Fort McPherson and Inuvik areas, Northwest Territories

Evaluating diversity and spatial organization of caribou in the Sahtu Region

Principal investigator: Jean Polfus (University of Manitoba)
Location: Dél̨ı̨ne area, Northwest Territories

McGill Arctic Research Station science program

Principal investigator: Wayne Pollard (McGill University)
Location: Expedition Fiord (Axel Heiberg Island), Nunavut

The vulnerability and resiliency of High Arctic permafrost to climate change

Principal investigator: Wayne Pollard (McGill University)
Locations: Expedition Fiord (Axel Heiberg Island) and Eureka and locations on the Fosheim Peninsula (Ellesmere Island), Nunavut

Cache clean up

Principal investigator: Jodie Pongracz (Government of Northwest Territories, Department of Environment and Natural Resources)
Locations: Liddon Gulf and Cape Providence (Melville Island), Northwest Territories

Permafrost water isotopes and thermokarst basin evolution in Old Crow Flats through the Holocene

Principal investigator: Trevor Porter (University of Toronto Mississauga)
Locations: Old Crow and locations in Old Crow Flats, Yukon

Baffin Island caribou fall composition surveys (October 2015)

Principal investigator: Troy Pretzlaw (Government of Nunavut, Department of Environment)
Locations: Iqaluit, Mary River area, Kimmirut, Meta Incognita Peninsula, Hall Peninsula, Nettilling Lake area (Baffin Island), Nunavut

Hydroecological effects of changing lake ice regimes

Principal investigator: Terry Prowse (Environment and Climate Change Canada)
Locations: Cambridge Bay and Greiner Lake area (Victoria Island), Northwest Territories, and Kluane Lake, Yukon

The influence of landscape condition on biotic production in a warming Arctic environment

Principal investigator: Roberto Quinlan (York University)
Locations: Lakes on the Mackenzie Delta north of Inuvik, Northwest Territories

Slugs are sampled as part of biological studies near Cambridge Bay, Nunavut.

Researchers carry a stream sediment sample pail back to a helicopter at Parker River, Banks Island.

Elu Basin Geoscience Project

Principal investigator: Robert Rainbird (Natural Resources Canada)
Locations: Crocker Point and Fishers Island, Nunavut

Darnley Bay-Brock Inlier – GEM-2

Principal investigator: Robert Rainbird (Natural Resources Canada)
Location: Darnley Bay area, Northwest Territories

Arctic Shorebird Monitoring Program (Arctic PRISM) – Tier 1 surveys

Principal investigator: Jennie Rausch (Environment and Climate Change Canada)
Locations: East Bay (Southampton Island) and Arviat, Baillie River and Baker Lake, Nunavut

Population studies of shorebirds at Polar Bear Pass National Wildlife Area, Nunavut (Arctic PRISM Tier 2 Site)

Principal investigator: Jennie Rausch (Environment and Climate Change Canada)
Location: Polar Bear Pass National Wildlife Area, Bathurst Island

Coastal fish communities off Cape Parry and in the Anguniaqvia Niqiqyuam Area of Interest (ANAOI) in the western Arctic

Principal investigator: Jim Reist (Fisheries and Oceans Canada)
Locations: Browns Harbour and Bennett Point, Northwest Territories

Watershed biogeochemical changes in Arctic environments under a changing climate

Principal investigator: Sherry Schiff (University of Waterloo)
Location: Lake Hazen (Ellesmere Island), Nunavut

Kluane Lake Research Station (KLRS): USArray Instrument Deployment and KLRS High Speed Internet

Principal investigator: Michael Schmidt (Arctic Institute of North America, University of Calgary)
Locations: Kluane Lake Research Station and locations in the St. Elias Mountains, Yukon

Observational constraints on glacier sliding and subglacial hydrology

Principal investigator: Christian Schoof (University of British Columbia)
Location: Kaskawulsh tributary glacier, Yukon

Dynamics and change of the Devon Ice Cap

Principal investigator: Martin Sharp (University of Alberta)
Locations: Summit Camp and Sverdrup Glacier, Devon Ice Cap (Devon Island), Nunavut

Wolf den inventory of the southern eskers of Tuktut Nogait National Park

Principal investigator: Peter Sinkins (Parks Canada)
Locations: Paulatuk and locations in Tuktut Nogait National Park, Northwest Territories

Ecological integrity monitoring of tundra and freshwater ecosystems in Aulavik National Park

Principal investigator: Peter Sinkins (Parks Canada)
Locations: Southern Aulavik National Park and Castel Bay (Banks Island), Northwest Territories

Permafrost monitoring in the Mackenzie Valley

Principal investigator: Sharon Smith (Natural Resources Canada)
Locations: Locations in the Inuvik and Norman Wells areas, Northwest Territories

Geo-Mapping for Energy and Minerals Program – Banks Island project

Principal investigator: Rod Smith (Natural Resources Canada)
Location: Johnson Point (Banks Island), Northwest Territories

Van Tat Gwich'in Historical Lifeways Project

Principal investigator: Shirleen Smith (Vuntut Gwitchin Government)
Locations: Teetl'eenjuu and Zhoh Drin Choo/White Snow Mountain, Yukon

Population studies of shorebirds at East Bay Mainland and Coats Island, Nunavut

Principal investigators: Paul Smith and Jennie Rausch (Environment and Climate Change Canada)
Locations: Coats Island and East Bay Mainland (Southampton Island), Nunavut

Establishing a meso-network of micrometeorologial towers for eddy covariance measurements along a latitudinal permafrost and climate gradient across the Taiga Plains, Northwest Territories

Principal investigator: Oliver Sonnentag (Université de Montréal)
Locations: Scotty Creek and Trail Valley Creek, Northwest Territories

The effect of Arctic marine traffic on air quality and climate

Principal investigator: Ralf Staebler (Environment and Climate Change Canada)
Location: Resolute Upper Air Station (Cornwallis Island), Nunavut

Fuel caching in support of GEM-2 Tehery-Wager mapping project

Principal investigator: Holly Steenkamp (Canada-Nunavut Geoscience Office)
Locations: Locations near Chesterfield Inlet, Nunavut

The Lake Hazen watershed as a sentinel of Arctic environmental change

Principal investigator: Vincent St.Louis (University of Alberta)
Location: Lake Hazen (Ellesmere Island), Nunavut

GEM-2 Southern Baffin Bedrock Mapping

Principal investigator: Marc St-Onge (Natural Resources Canada)
Locations: Iqaluit and McKeand River (Baffin Island), Nunavut

Fishery Resource Management Science investigation of sustainable harvest in Nettilling Lake: The largest single system commercial Arctic Char quota in Nunavut

Principal investigator: Ross Tallman (Fisheries and Oceans Canada)
Location: Outflow of Nettilling Lake (Baffin Island), Nunavut

Land-water linkages and the fate of terrestrial carbon in aquatic ecosystems of the western Canadian Arctic

Principal investigator: Suzanne Tank (University of Alberta)
Locations: Locations on the Peel Plateau, Inuvik, and Fort McPherson, Northwest Territories

The ultra-warm Arctic ca. 90 million years ago

Principal investigator: John Tarduno (University of Rochester, U.S.A.)
Locations: Bunde Fiord, Expedition Fiord and Agate Fiord (Axel Heiberg Island) and Hansen Point and locations along Yelverton Bay (Ellesmere Island), Nunavut

Surficial mapping and sampling in South Baffin

Principal investigator: Tommy Tremblay (Canada-Nunavut Geoscience Office)
Locations: Lakes on southern Baffin Island and McKeand River (Baffin Island), Nunavut

Wild Canada Year

Principal investigator: Jeff Turner (Wild Canada Year Productions)
Locations: Karrak Lake and Perry River, Northwest Territories

Evaluating the influence of climate and land cover changes on water and carbon balance in Old Crow Flats, Yukon, Canada

Principal investigator: Kevin Turner (Brock University)
Locations: Old Crow and locations in Old Crow Flats, Yukon

Northern Ellesmere Island in the Global Environment – Northern Frontier

Principal investigator: Warwick Vincent (Université Laval)
Location: Ward Hunt Island, Nunavut

Beaufort Sea Coastal Geoscience – Ports and Coastal Infrastructure Monitoring Program Northwest Territories

Principal investigator: Dustin Whalen (Natural Resources Canada)
Locations: Inuvik, Tuktoyaktuk, and coastal locations on the Mackenzie Delta, Kugmallit Bay, Richards Island, Tuktoyaktuk Peninsula and Cape Bathurst, Northwest Territories

DND Bandvagn 206 (Bv 206) amphibious vehicles at the PCSP facility in Resolute are used for CAFATC training activities.

Microbial investigations of permafrost and cold saline springs in the High Arctic

Principal investigator: Lyle Whyte (McGill University)
Location: Expedition Fiord (Axel Heiberg Island), Nunavut

Tuktut Nogait National Park Operations

Principal investigator: Renee Wissink (Parks Canada)
Locations: Uyarsivik Lake and Canoe Lake, Northwest Territories

Tehery-Wager geoscience mapping

Principal investigator: Natasha Wodicka (Natural Resources Canada)
Location: Lorillard River, Nunavut

Great Slave TRACS (Transportation Risk in the Arctic to Climatic Sensitivity)

Principal investigator: Stephen Wolfe (Natural Resources Canada)
Locations: Locations along the Tibbitt-to-Contwoyto winter road, White Beach Point, and Yellowknife, Northwest Territories

A monitoring framework to assess changes in hydroecological conditions and sources, distribution and toxicity of contaminants in lakes of the Peace-Athabasca Delta

Principal investigator: Brent Wolfe (Wilfrid Laurier University)
Locations: Fort Chipewyan and locations in Wood Buffalo National Park, Alberta

Aerial surveys of Pacific Common Eiders in the central Canadian Arctic

Principal investigator: Cindy Wood (Environment and Climate Change Canada)
Locations: Cambridge Bay (Victoria Island), Kugluktuk and coastal areas in Coronation Gulf and Queen Maud Gulf, Nunavut

Western Arctic snow goose management

Principal investigator: Cindy Wood (Environment and Climate Change Canada)
Locations: Inuvik and Siksik Lake, Northwest Territories

Canadian Armed Forces Arctic Training Centre training activities based in Resolute (Cornwallis Island), Nunavut in 2015:

- Amalgam Dart radar testing
- Arctic Operations Advisor course
- Arctic operations exercise for search and rescue technicians
- Canadian Armed Forces Arctic Training Centre support group
- Canadian Forces School of Survival and Aeromedical Training
- Royal Canadian Artillery Band Arctic survival training and community outreach
- HF radio inspection
- NOREX

Annex

PCSP Advisory Board

The PCSP is a division of the Strategic Policy and Operations Branch (SPOB) within the Earth Sciences Sector at NRCan. The PCSP Advisory Board provides the Director General of SPOB with recommendations and advice regarding the PCSP's operations. The Advisory Board is composed of Arctic experts from federal government organizations, academia, Indigenous peoples' organizations and territorial governments.

PCSP Advisory Board Members 2015

Bernard Funston (Chair)
Northern Canada Consulting

Andrew Applejohn
Department of Environment and Natural Resources
Government of the Northwest Territories

Elizabeth Boston
Research Grants and Scholarships Directorate
Natural Sciences and Engineering Research Council of Canada

Eric Gagné
Science and Technology Branch
Environment and Climate Change Canada

Drikus Gissing
Department of Environment
Government of Nunavut

Donna Kirkwood
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Natural Resources Canada

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Inuit Tapiriit Kanatami

Søren Rysgaard
Department of Geological Sciences
University of Manitoba

Brent Wolfe
Department of Geography and Environmental Studies
Wilfred Laurier University

Robert Young
Arctic Aquatic Research Division
Fisheries and Oceans Canada

PCSP Project Review Committee

The PCSP Project Review Committee (PRC) reviews and evaluates logistics requests submitted to the PCSP from university applicants. The review process is based on the PRC Scoring Guide, which includes four criteria: feasibility of the requested logistics; quality of the application; scientific recognition of the applicant; and student and local community involvement and engagement. For more information regarding the PCSP's review process for university applicants, please contact the PCSP.

PCSP Project Review Committee Members 2015

Mark Mallory (Chair)
Biology Department
Acadia University

Christopher Burn
Department of Geography and
Environmental Studies
Carleton University

Michael Kristjanson
Polar Continental Shelf Program
Natural Resources Canada

Maribeth Murray
Arctic Institute of North America
Department of Archaeology
University of Calgary

Roger Paulen
Geological Survey of Canada
Natural Resources Canada

Johann Wagner
Polar Knowledge Canada

A helicopter supports wildlife surveys on southern Ellesmere Island, Nunavut.

Researchers pack up after a day of coring on Lac Dasserat, Quebec. The core was collected to date submarine landslide deposits buried within the sub-bottom of the lake as part of a study that is investigating evidence of ancient earthquakes in the region.