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Polar Continental Shelf Program

SCIENCE REPORT

2018

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

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Polar Continental Shelf Program Science Report 2018:
Logistical support for leading-edge scientific research in Canada and its Arctic

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Cover photographs: (Top) The field camp at the Cape Bounty Arctic Watershed Observatory on Melville Island, Nunavut. (Bottom} Taking a break on some 900 million-year-old sedimentary rocks in the Wernecke Mountains, Yukon, to make notes on a geological map. Section header image: Recording temperature data at the Dr. Neil Trivett Global Atmosphere Watch Observatory in Alert, Nunavut, as part of a permafrost monitoring program that has been ongoing since 1979.

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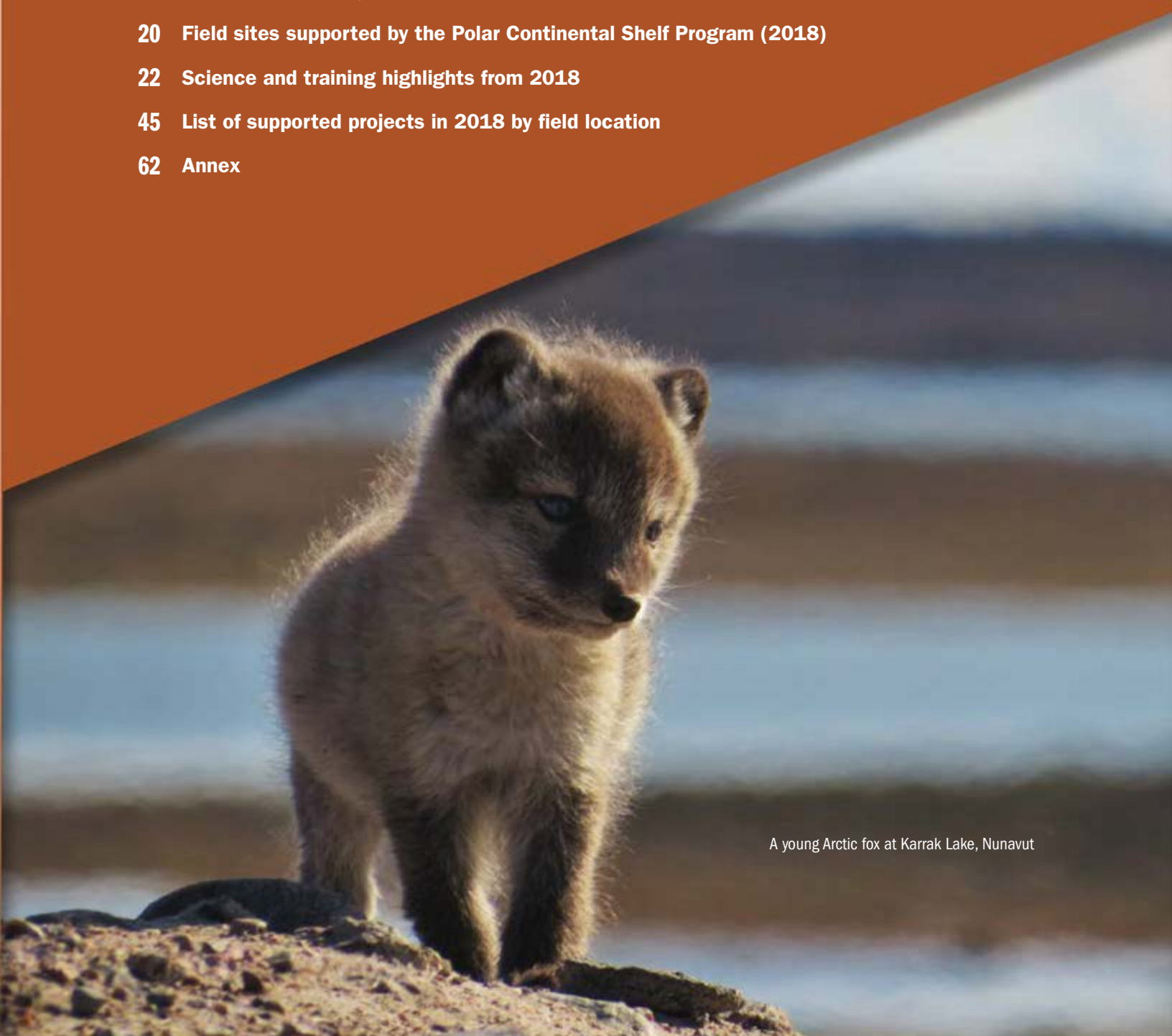
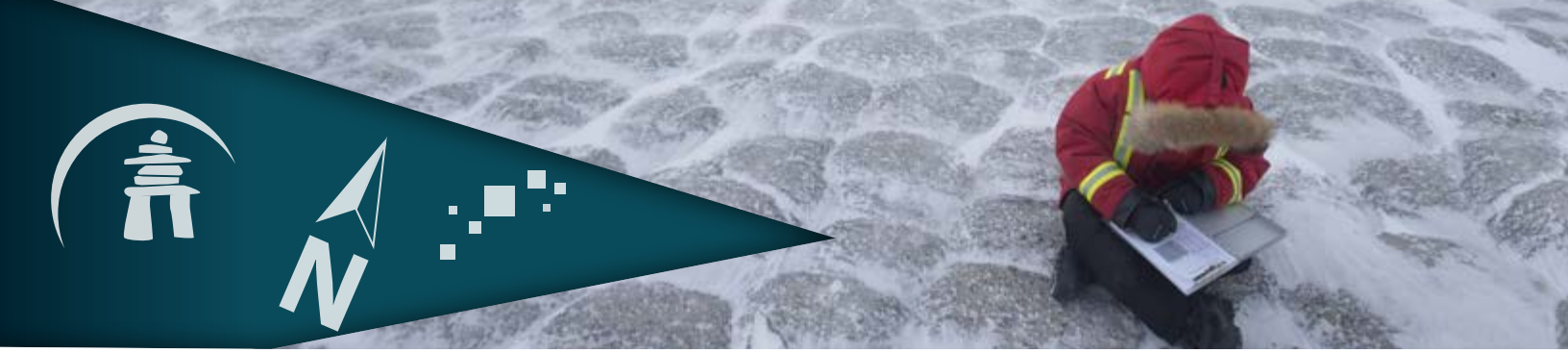


A young Arctic fox at Karrak Lake, Nunavut



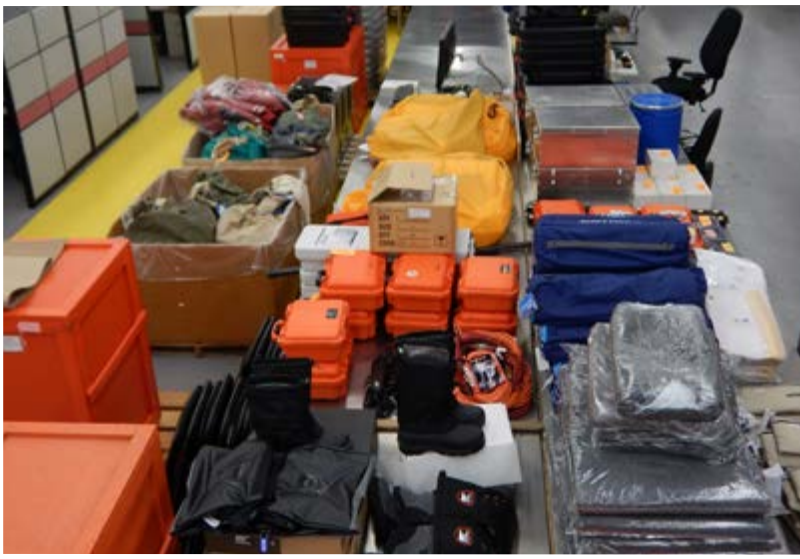
Polar Continental Shelf Program

Since 1958, the Polar Continental Shelf Program (PCSP) at Natural Resources Canada (NRCan) has been providing safe, efficient and cost-effective logistics in support of field research in Canada's Arctic. The program contributes to increased knowledge of the Canadian landmass and the exercise of sovereignty in Canada's North. In recent years, the PCSP has extended its logistics support for science to federal government researchers working at locations across Canada by providing field equipment. Given the difficulties of conducting fieldwork in remote and often inhospitable locations, the PCSP acts as an essential support that enables field research. The PCSP's clients can focus on planning their science and operations projects, while leaving many details of logistics for their fieldwork to the PCSP.

In 2018, the PCSP celebrated 60 years of contributing to Arctic science conducted by researchers from across Canada and around the world. From its early years of conducting major scientific studies through its transition in the mid-1980s to focusing on providing expert logistics for science, the PCSP has evolved into a centre of excellence for scientific logistics. Whether working on a glacier, sea ice, tundra or an outcrop, researchers can rely on the following PCSP logistics services to help them conduct their field studies:

- Planning and coordination of chartered aircraft for transportation to and from Canadian Arctic field sites and for conducting field studies

The Dr. Roy M. "Fritz" Koerner Laboratory provides modern laboratory space for PCSP clients staying at the PCSP Resolute facility.



The PCSP Ottawa office includes a warehouse with a wide variety of field equipment.

The PCSP's Food Services team oversees the preparation of all meals for clients and staff at the PCSP Resolute facility.

- Accommodations, meals, and laboratory and work space at the PCSP facility in Resolute, Nunavut
- Provision of field equipment
- A communications and safety network for remote field camps
- Fuel for aircraft and field camps
- Logistics advice for field studies in Canada

The PCSP offers a cost-effective means for researchers to organize logistics for their field studies in Canada, particularly in the North where the cost of research logistics is typically high. Logistics planning and aircraft coordination support from the PCSP enables researchers to reach field sites that would otherwise be inaccessible. In addition, the PCSP offers opportunities for multiple field projects to share aircraft, when feasible, which reduces project costs.

The PCSP's Resolute facility offers clients effective workspace, access to a modern laboratory and accommodations in a central location in the Canadian Arctic Archipelago. The PCSP's inventory of field equipment offers a wide range of goods that supports fieldwork and is maintained annually. Through this model, researchers can reduce their field equipment costs by borrowing some or all of their required field equipment.

The PCSP provides whole-of-government logistics support for science and training projects in a wide variety of scientific disciplines. These projects are conducted by universities; federal, territorial and provincial government departments and agencies; northern organizations; and international research groups. The science conducted by PCSP clients contributes to informed decision making on a range of issues. The issues include climate change impacts and adaptation, sustainable natural resource and infrastructure development, food security and public health, preservation of Indigenous traditional knowledge and cultural history, natural hazards and ecosystem monitoring, and conservation. Researchers may apply for logistics support for the subsequent field season through the PCSP website during a one-month logistics request submission period each fall.

Sunrise in March over Twin Otter aircraft at the PCSP Resolute facility

Highlights of the 2018 field season

936
Participants in all Arctic science and operations projects

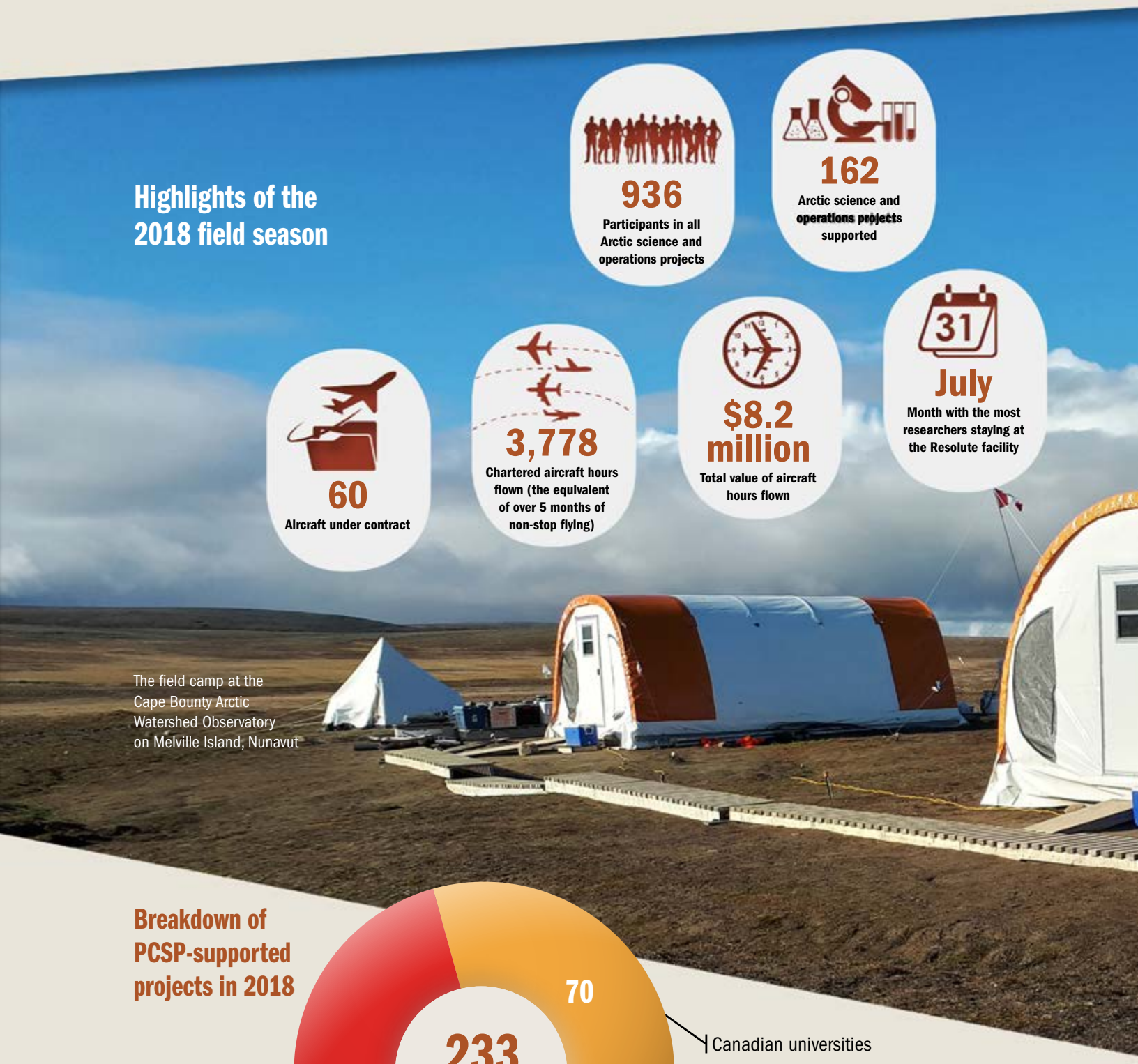
162
Arctic science and operations projects supported

60
Aircraft under contract

3,778
Chartered aircraft hours flown (the equivalent of over 5 months of non-stop flying)

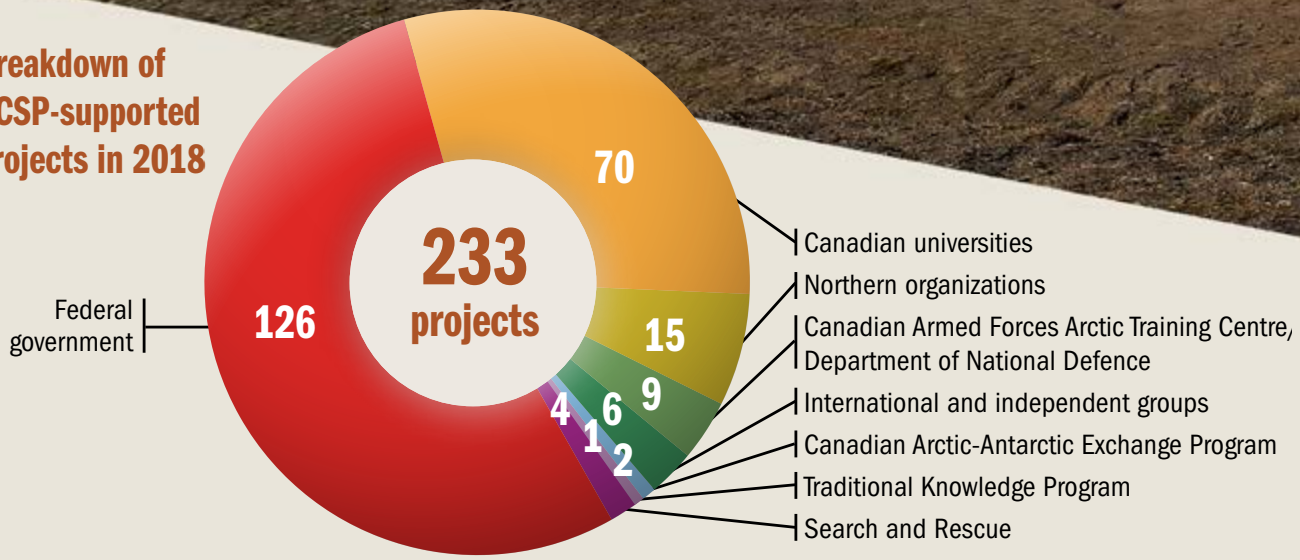
$8.2 million
Total value of aircraft hours flown

July
Month with the most researchers staying at the Resolute facility



The field camp at the Cape Bounty Arctic Watershed Observatory on Melville Island, Nunavut

Breakdown of PCSP-supported projects in 2018



39,961
Meals served at the PCSP Resolute facility (the equivalent of three meals a day for one person for 36.5 years)

1,463
Field equipment transactions completed by the PCSP Ottawa and Resolute depots

58
Federal projects using PCSP field equipment across Canada

26%
Percentage of Arctic projects that transited through the PCSP Resolute facility

13,390
Nights of accommodation provided at the PCSP Resolute facility (the equivalent of nearly 37 years' worth of nights of sleep)

550,763 kg
Weight of equipment and fuel shipped by sea, road and air (the equivalent in weight to 290 adult beluga whales)

59%
Percentage of all projects that required field equipment

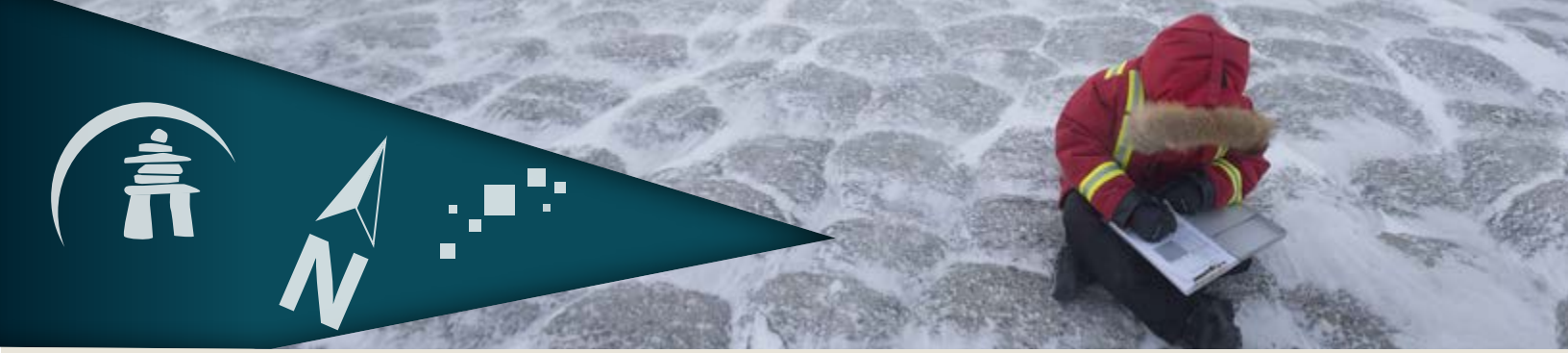
PCSP-supported projects in 2018 by field location*

ALBERTA	4
BRITISH COLUMBIA	6
MANITOBA	5
NEW BRUNSWICK	1
NEWFOUNDLAND AND LABRADOR	1
NORTHWEST TERRITORIES	49
NOVA SCOTIA	1
NUNAVUT	114
ONTARIO	15
QUEBEC	11
SASKATCHEWAN	3
YUKON	22
INTERNATIONAL	1

*Projects with field locations in more than one province and/or territory were placed in the location where most of the project took place.

Did you know?

The PCSP communicates with remote field camps in Canada's North through twice daily, scheduled calls (known as "sked" calls) by using high-frequency radios and satellite telephones. These calls provide a vital safety and communications network for clients. Through this network, the PCSP can ensure that each field camp is safe, important messages can be relayed, and field teams can share weather conditions to help plan for aircraft dispatch. This service provides field teams with a sense of security, knowing that the PCSP is available to help if assistance is required.



2018: A year in review

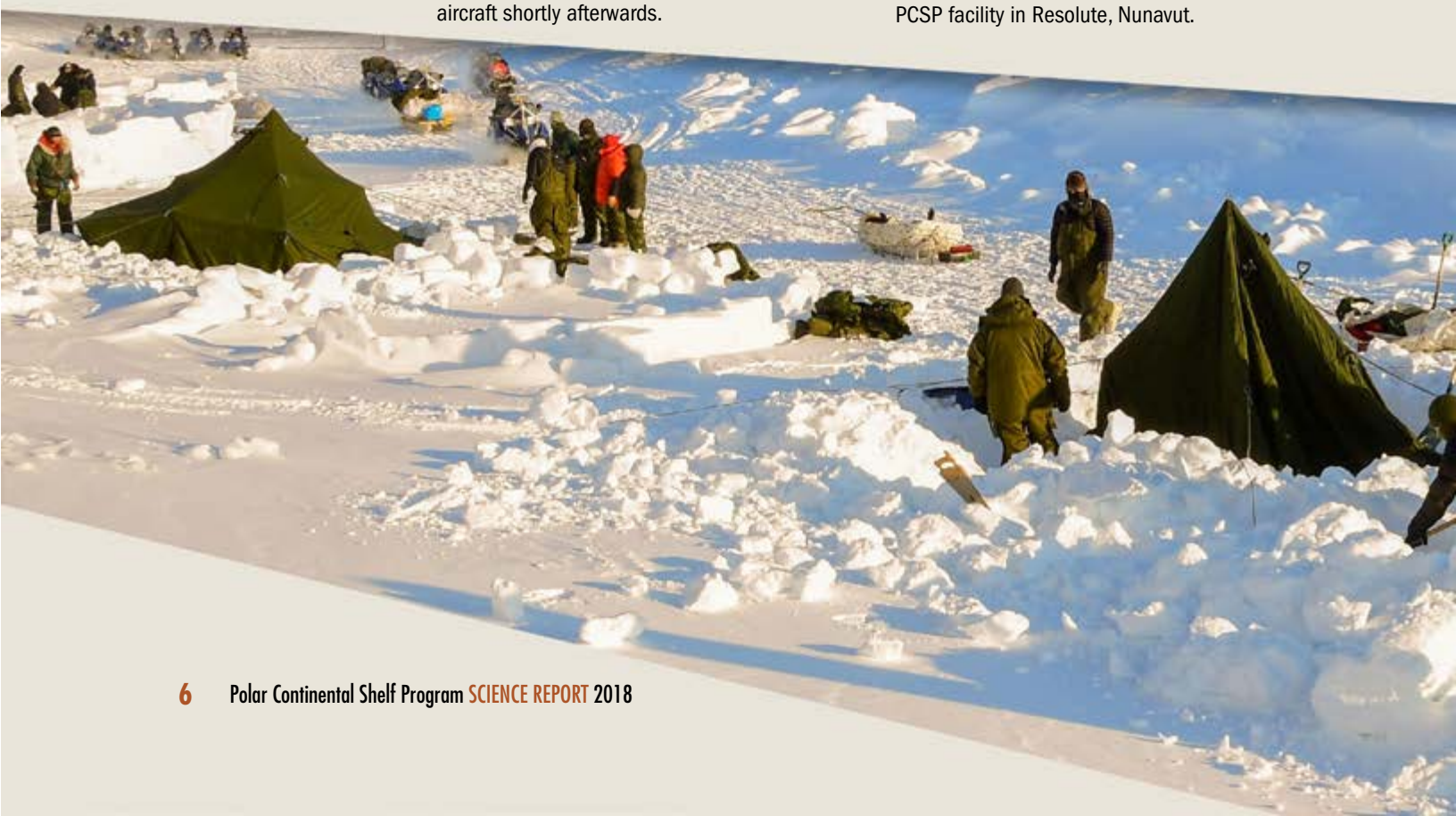
The Martin Bergmann Complex houses accommodations, a dining hall, lounges, workspaces and a gym at the PCSP Resolute facility.

January

- PCSP staff arrived in mid-January to begin annual operations at the PCSP Resolute facility, and the first major delivery of supplies for the facility arrived by chartered aircraft shortly afterwards.

February

- The Department of National Defence conducted military operations and related training activities at the Canadian Armed Forces Arctic Training Centre hosted at the PCSP facility in Resolute, Nunavut.



March

- The first PCSP-supported science projects began field studies. These projects were focused on permafrost and hydrology research in the western Arctic.

April

- The PCSP began supporting science projects from its facility in Resolute. The studies were focused on High Arctic glaciology.
- The PCSP celebrated 60 years of being a key part of Canadian Arctic field science.

May

- The PCSP Field Equipment Unit began preparing for sealift by loading equipment into sea containers for transport by sea to Resolute in the summer. The annual sealift allows the program to ship large quantities of goods and items between Resolute and Ottawa, including field equipment, items for facility operations and maintenance and non-perishable food items. Field equipment that needs to be serviced is returned to Ottawa.

June

- On June 1, the PCSP participated in the annual science fair at Qarmartalik School in Resolute. Students worked in small groups to develop their projects for evaluation by science fair judges. This event helped students to explore scientific topics of interest and gave them the opportunity to present the results of their work to judges and community members. The PCSP supported this initiative by providing a healthy snack for participants and arranging for judges from the PCSP, the University of Texas and the W. Garfield Weston Foundation.

July

- The PCSP's sealift freight that was bound for Resolute was transported to a cargo ship in Valleyfield, Quebec, where it began its journey north.
- This month saw the most researchers transiting through the PCSP Resolute facility in 2018.

Members of the Arctic Response Company Group set up tents near Resolute, Nunavut, in preparation for an overnight stay during Operation NUNALIVUT 2018, which received PCSP logistics planning and coordination support.

Snowmobiles are lined up to be loaded onto a BT-67 aircraft outside the PCSP Resolute facility.

August

- The annual sealift arrived in Resolute. However, unloading was delayed because of ice conditions preventing the off-loading vessels from operating. Once these ice conditions improved a few days later, the items were unloaded and transferred to the PCSP facility and the community.
- The 2018 field season offered some difficult weather conditions in the High Arctic for transportation and fieldwork. Many aircraft were delayed heading to and from field camps because of cool, foggy and snowy conditions, which can create flying hazards.

September

- The last researchers staying at the PCSP Resolute facility left for their home institutions. Some PCSP-supported projects continued into the fall in other locations in Canada's North.
- Attention turned to program delivery and field project planning for the 2019 field season. Beginning in late September, clients had a one-month period in which to submit their requests for logistics support for projects in the 2019 field season.

Geologists collect samples from a rock outcrop in the Monster River area, Yukon.

October

- The last PCSP-supported camps left the field, and the deadline arrived for clients applying to the PCSP for logistics support during the 2019 field season.
- The annual sealift delivery of items returning from Resolute arrived in Ottawa, bringing many pieces of equipment for servicing and repair.

November

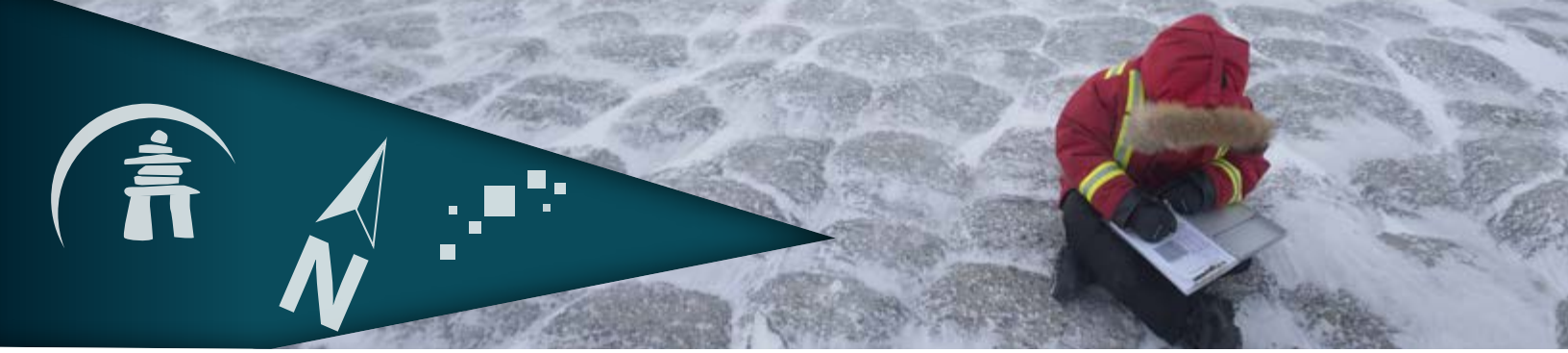
- All logistics requests submitted to the PCSP for the 2019 field season were reviewed internally as part of the annual project vetting process.

December

- Over the course of a two-day meeting, the members of the Project Review Committee jointly reviewed all logistics requests to the PCSP from university applicants. The results informed the process to determine the level of in-kind support that was available to eligible projects for the 2019 field season.

Did you know?

The PCSP's parkas are keeping federal government scientists and officials warm around the country and the globe! In 2018, clients used parkas from the PCSP's field equipment inventory at sites including Alert, Cambridge Bay and Iqaluit, Nunavut, in Canada as well as in Russia and in Kazakhstan.



Northern studies by northern residents: The essential roles of Northerners in Arctic science

Northern Indigenous peoples have studied the world around them for thousands of years and passed down scientific and cultural knowledge to younger generations through oral traditions. Their experiences on the land and waterways of the North have made them experts on their regions.

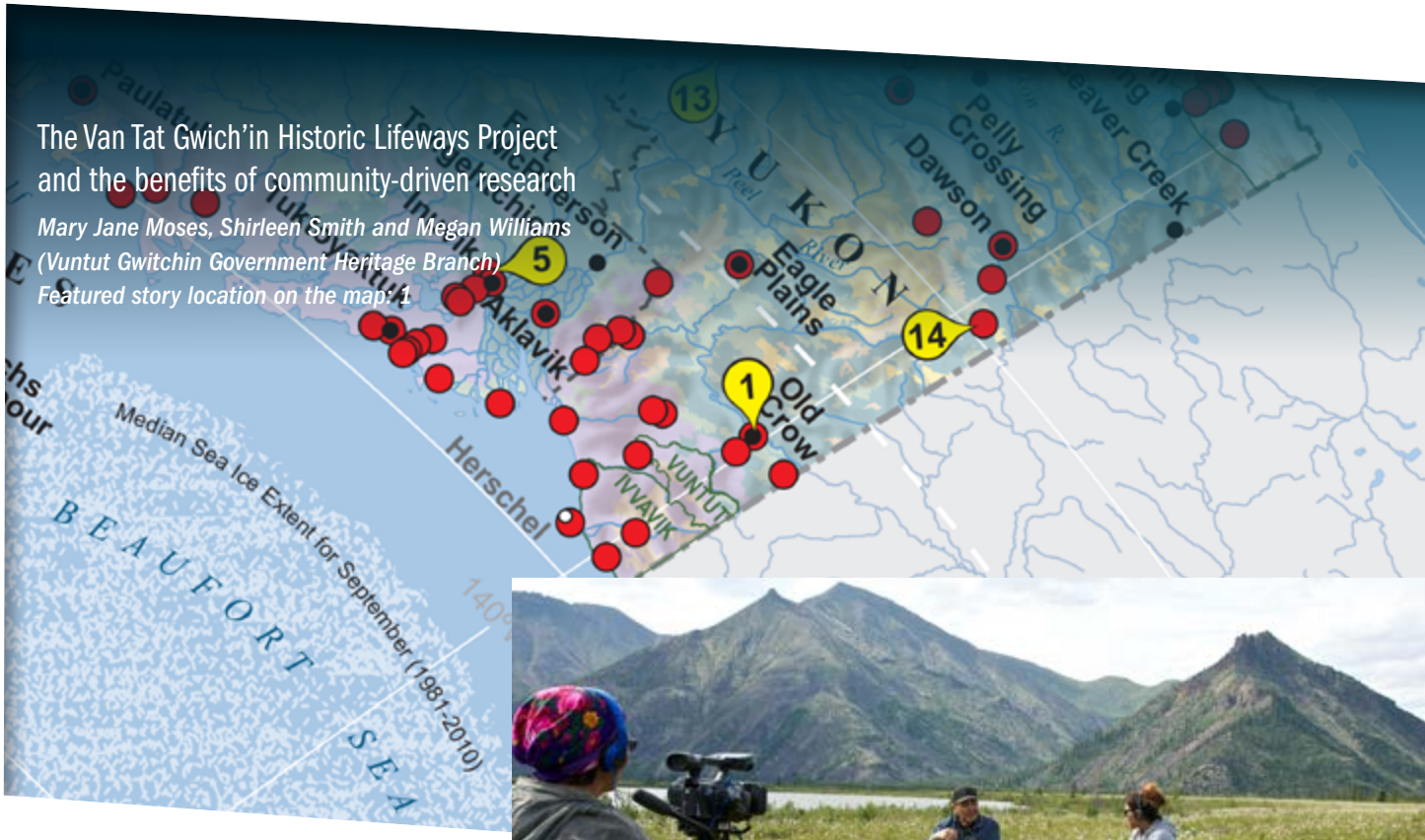
Northern communities and Indigenous organizations have unique research needs and priorities that they are addressing independently or through collaborations. Some projects are conducted by northern organizations to address community research needs, while others bring together northern and non-northern partners. Some projects include northern scientists and field assistants as field team members. Through this involvement, northern residents are playing significant roles in Canadian Arctic science.

Meaningful community involvement and engagement is a key component of northern research, enabling community members to provide important input and advice, offer new perspectives and ideas, and raise community research questions. Each year, the PCSP supports many projects that involve northern residents, including some that are part of the PCSP Traditional Knowledge Program. The PCSP established this program in 1996 to support the preservation of the wealth of Indigenous traditional knowledge in Canada's North. It offers field logistics support customized for research projects focused on the collection and intergenerational transmission of traditional knowledge.

> ***"The experts are the people themselves. I believe that research should benefit the community, not only contribute to academic agendas. It doesn't have to be a dichotomy."***
>
> – **Shirleen Smith**,
> Vuntut Gwitchin Government Heritage Branch

The Van Tat Gwich'in Historic Lifeways Project and the benefits of community-driven research

Mary Jane Moses, Shirleen Smith and Megan Williams
(Vuntut Gwitchin Government Heritage Branch)
Featured story location on the map: 1



The Van Tat Gwich'in of northern Yukon have a rich oral and cultural history that has been passed down through generations. This traditional knowledge is priceless because it documents events of the past, traditional ways of living and, ultimately, the history of a people. The Van Tat Gwich'in have long worked to maintain their way of life, culture and language. However, as their elders aged, the community found a growing need to record the elders' wealth of knowledge for future generations. The elders wanted to impart their knowledge to youth while out on the land and share Van Tat Gwich'in culture with the world. To ensure the preservation and intergenerational transfer of Van Tat Gwich'in oral history, the Vuntut Gwitchin First Nation (VGFN) of Old Crow, Yukon, began a series of multi-year cultural heritage research projects in 1999.

The Vuntut Gwitchin Government Heritage Branch has led five cultural heritage projects under the direction of the community's Heritage Committee, which is composed of three elders.

Filming an interview between an elder and a youth at Daadzall Van (Summit Lake), Yukon

The committee of elders provides guidance to Heritage Manager Megan Williams, Heritage Coordinator Mary Jane Moses and Research Coordinator and anthropologist Shirleen Smith as they conduct each project and coordinate the required fieldwork. The projects focus on knowledge-sharing among community members while out on the land at culturally significant locations. This work has brought together community members and outside researchers of diverse backgrounds to document a traditional way of life that has changed rapidly in recent decades, while also encouraging the continued use of the Gwich'in language.

> ***It's about a community coming together to compile the rich culture, traditions and history of our people. It's about us working together for the benefit of the young people so they take this information and go forward that much stronger by remembering and holding onto the words of our Gwich'in elders, ancestors and today's knowledge keepers who have travelled on this great land, being in tune with the land and animals for their survival and sustenance.***
>
> – **Mary Jane Moses,**
> Vuntut Gwitchin Government Heritage Branch

The first cultural heritage project focused on recording the oral history of elders who were the last generation to have spent most of their adult lives on the land. The next project recorded place names and related geographical information about key sites on Van Tat Gwich'in lands. Subsequent projects examined Gwich'in cultural technology for survival, travel routes and navigation techniques. Through the current Historic Lifeways Project, the community is working with a new generation of elders to capture detailed knowledge about Van Tat Gwich'in lands, history and culture. This project is also bringing together past knowledge with present-day observations of environmental changes caused by climate change and modern land use.

Fieldwork for these projects received PCSP logistics support through the PCSP Traditional Knowledge Program. Over many field seasons, helicopters coordinated by the PCSP have been used to transport members of the Old Crow community to and from field camps and places of cultural importance on Van Tat Gwich'in lands.

This logistics support has enabled opportunities for elders to impart their traditional knowledge to youth and for the Heritage Branch to record this valuable information.

All knowledge and artifacts collected through the projects are documented and archived at the John Tizya Centre in Old Crow. This facility was built in part in response to the success of the research projects and the need for dedicated space for collections and Heritage Branch offices. At the end of each fieldwork project, Mary Jane Moses translates, transcribes and archives the interviews and images recorded. She finds her work keeps her rooted in her culture and helps her to retain her abilities in the Gwich'in language. The Heritage Branch staff create a catalogue of information and photographs from each project for public display. They also produce maps showing project data across Van Tat Gwich'in lands.

A community presentation is also given at the end of each project to provide results and gain feedback. The collections are used to develop interpretive materials, books, educational resources and films. Outside researchers may request permission from the Heritage Committee to use the collections and are welcome to provide data and images from their studies for the collections.

In 2009, the VGFN and Shirleen Smith published a book, *People of the Lakes: Stories of our Van Tat Gwich'in Elders*, which synthesized key components of the oral history collected over 10 years of research. The book won multiple awards, allowed results to reach a broader audience and was a model of what could be achieved through community-driven research.

The cultural heritage projects have built a local, experienced research team, enhanced the cultural knowledge base of the community's youth, and promoted Van Tat Gwich'in culture and history. Community members have received training in videography and interviewing techniques and, through its youth mentoring program, the Heritage Branch has fostered

youth participation in research and training. The processes followed for the cultural heritage projects have been replicated for other community research projects and have built local capacity for reviewing proposed studies in the Old Crow area.

The community has constructed a laboratory for use by local and visiting researchers, with the aim of keeping more of the research process in the community. As Shirleen Smith has observed, "The VGFN's attitude toward other researchers – collegial, collaborative and helpful – has meant Old Crow has always been a welcoming and stimulating research environment." As Megan Williams noted, the community looks to support research that is mutually and equally beneficial. While visiting scientists benefit from the data collected and subsequent publications developed from their research in the Old Crow area, the community benefits from working with them to design research projects, gain technical skills for field research and obtain relevant data that can support local decision making.

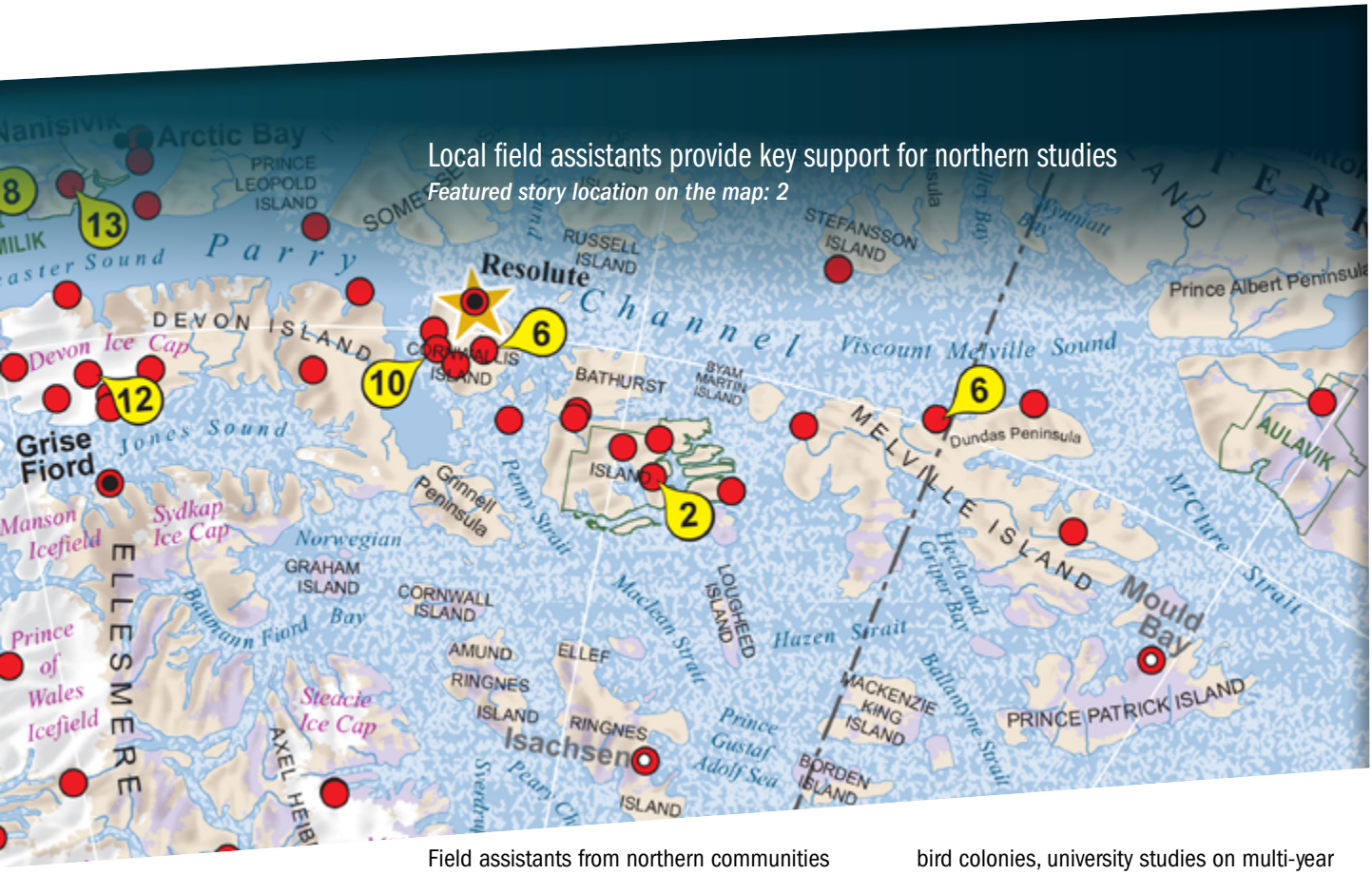
> ***"The Canadian Arctic is currently one of the strongest and, at the same time, most vulnerable places on Earth. Relevant community-based research has never been more important than now. Research projects have to be directed and led by communities as local people have the best understanding of their needs, their history and their land to ensure that research projects are relevant, practical and build on work that has already been done."***
>
> – **Megan Williams,**
> Vuntut Gwitchin Government Heritage Branch

Examining an antler fragment at a caribou fence (traditional enclosure used to harvest caribou)

The community-driven research of the VGFN is a shining example of Northerners and visiting researchers working together toward common, community-defined goals. Those goals are to meet their research needs, inspire and train youth, and generate a valuable collection of knowledge that strengthens and nurtures Van Tat Gwich'in cultural identity. Many elders who were part of the early projects have now passed but their legacies live on through the knowledge they shared, which is available to all who would like to learn from their wisdom. As Mary Jane Moses observes, "Those stories of the past are our stepping stones to the future."

Want to learn more?

Read about the John Tizya Centre in Old Crow, Yukon, through the Parks Canada website: www.pc.gc.ca/en/pn-np/yt/vuntut/visit/serv/tizya.



Local field assistants provide key support for northern studies

Featured story location on the map: 2

Field assistants from northern communities can provide valuable support to field studies for northern and visiting researchers. Beyond employment opportunities, these experiences also foster knowledge sharing, skills training and research mentoring. Some field assistants are hired directly by project leaders while others are employed through programs designed for hiring local residents for fieldwork assistance.

Valerie Amarualik, a resident of Resolute, Nunavut, has been a field assistant for several research projects, and through this work she has supported scientific studies in a range of disciplines and locations. Coming from a family that is heavily involved in Arctic science, she grew up seeing her family members working with visiting researchers. When an opportunity came in 2008 to be a field assistant for a PCSP-supported hydrology study on Bathurst Island, Amarualik began her career in Arctic science. After this experience, Amarualik was eager to head into the field again and assisted several other PCSP-supported research projects. These included Environment and Climate Change Canada (ECCC) studies of High Arctic bird colonies, university studies on multi-year sea ice, and a bird monitoring project in the Mackenzie Delta.

For the bird studies, Amarualik was employed through the Inuit Field Research Assistant Program. This program was created in 2008 under the Inuit Impact and Benefit Agreement for National Wildlife Areas and Migratory Bird Sanctuaries in the Nunavut Settlement Area. The agreement was signed by ECCC, Nunavut Tunngavik Incorporated and the Qikiqtani, Kitikmeot and Kivalliq Inuit associations. Through this ongoing program, Inuit from communities across Nunavut have opportunities to support ECCC field studies on northern bird species.

Jennie Rausch, a shorebird biologist at ECCC's Canadian Wildlife Service, has worked with Amarualik and several other northern residents during field studies. Rausch's work is part of the Arctic Shorebird Monitoring Program, which has prioritized the hiring of local youth as field assistants to encourage community capacity-building. Since 2000, Rausch's field teams

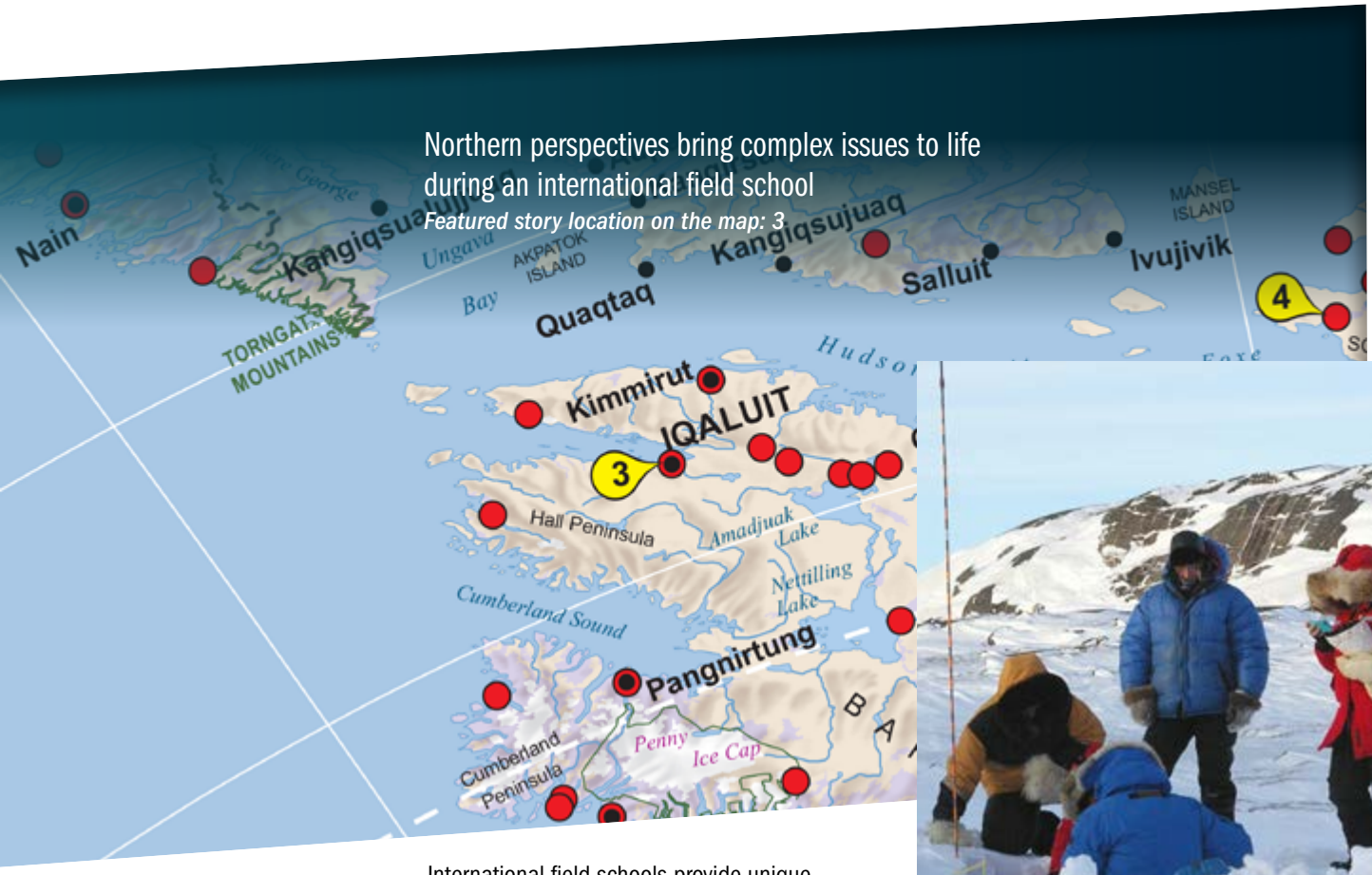
Valerie Amarualik working in Qausuittuq National Park, Nunavut

> ***Having local people, whether as a guide, assistant, scientist, coordinator or project leader, is very beneficial. The researcher benefits from the locals' knowledge, assistance and experience. The locals benefit from the knowledge, experience and scientific results.***
>
> – **Valerie Amarualik,**
> Parks Canada

have included 33 high school and post-secondary students from communities in the Northwest Territories and Nunavut, including many hired through the Inuit Field Research Assistant Program.

These field assistants have had the opportunity to build their scientific and field skill sets through bird surveys, nest monitoring, data recording and camp responsibilities. Rausch also sees employing local field assistants as an opportunity for mentoring northern youth who are interested in science. She has spent her life in the North and learned from a young age the value of having female mentors in science within her school and community. These mentors helped to shape her educational and career paths. Now as a northern scientist, Rausch recognizes the importance of mentoring and encouraging young northern women to learn more about Arctic science and consider a career in the field. Her annual field projects provide opportunities for Rausch to mentor youth and support their skills development.

Amarualik benefitted beyond the field training and mentoring she received through her field assistant experiences. She found that the experiences gave her an enhanced understanding of the science happening in the North, the importance of this work and the dedication of the people conducting it. Amarualik's involvement in field research led her to find new opportunities, including her current position in resource conservation with Parks Canada. Her work focuses on supporting science initiatives and operations in one of Canada's newest protected areas, Qausuittuq National Park, located on northern Bathurst Island and its adjacent islands. Amarualik's previous involvement with research on Bathurst Island and at other Arctic locations prepared her for her current role working to protect key wildlife habitats and archaeological sites on lands close to home.



Northern perspectives bring complex issues to life during an international field school

Featured story location on the map: 3

International Arctic Field School students examine snow layers in a snow pit near Iqaluit, Nunavut.

International field schools provide unique opportunities for students to learn about different areas of science and to gain practical fieldwork experience while working with fellow students and leading experts from a range of backgrounds and nationalities. Interacting with others who have diverse perspectives can foster better understanding among early-career scientists and help them to evaluate how they approach their research. Sentinel North is a program based at Université Laval that supports collaborative, interdisciplinary research focussed on environmental change, human health and the use of new technologies in Canada's North. It provides training opportunities for graduate students to study in northern environments and learn about effective community engagement, networking and collaboration.

In March 2018, the first Sentinel North International Arctic Field School (IAFS) was held in Iqaluit, Nunavut. The participants included university professors and local experts, 19 graduate students from 17 universities in 7 countries, and 11 students from the Environmental Technology Program (ETP) at Nunavut Arctic College. They came together for a week to learn about the changing Arctic cryosphere and its impacts on people and the environment through lectures, case studies and field excursions. High-quality outerwear from the PCSP's field equipment inventory kept participants warm and enabled them to participate fully.

The IAFS was developed in conjuction with Nunavut Arctic College's Nunavut Innovation and Research Institute to create a comprehensive program that incorporated northern perspectives in the academic curriculum. Inuit Traditional

Knowledge and culture and the realities of life in the North were integrated into presentations, discussions and activities throughout the IAFS. For example, ecology presentations included the nutritional and cultural value of country foods, while sea ice activities incorporated discussions of the importance of sea ice to Inuit cultural identity.

Marie-France Gévry is the Training Programs Coordinator for Sentinel North. She observed that the northern students made the complex issues facing the Arctic more concrete for the visiting students by sharing their knowledge and experiences. This sentiment was also noted by Sappho Gilbert, a doctoral student at Yale School of Public Health who is studying food security, nutrition and chronic disease in Nunavut. She found that the northern students and mentors provided a personal context for many topics discussed, which enriched the program and fostered communication among all participants. She made many valuable northern contacts during the field school for her community-based research and will be able to apply the knowledge she gained to her interdisciplinary studies.

Jason Carpenter is a senior ETP instructor at Nunavut Arctic College and a mentor for the field school. He saw that the visiting students were keen to ask questions and learn more about life in the North. The northern students had the opportunity to share their firsthand experiences about climate change impacts on their daily lives and their knowledge of northern science from their experiences working on research projects during their ETP training. Inuit participants were also able to impart the cultural importance of many aspects of life in the North through discussions, field excursions and events such as a Qulliq (traditional oil lamp) lighting ceremony, throat singing and traditional Inuit games.

Yukari Hori is a post-doctoral fellow at the University of Toronto Scarborough who is studying the impacts of climate change on northern environments and communities.

> ***"Our students were able to share first-hand knowledge and experiences of their changing environment and land and how these changes are already impacting their lives, especially some of the traditional aspects of their lives such as travelling safely on the land and hunting. They were also able to express the importance of hunting and other traditional activities to the health and survival of their culture."***
>
> – **Jason Carpenter,**
> Nunavut Arctic College

She found that her experiences with northern students during IAFS helped her to develop a multidisciplinary approach for her research in Nunavut. She appreciated the opportunity to work with northern students who were highly knowledgeable of the land and participate in activities such as building an igloo and eating country foods. These learning opportunities improved her understanding and appreciation of northern culture and will benefit her continued research.

As Carpenter noted, the field school provided visiting and northern students an important opportunity to build relationships, while also helping to demystify some of the research happening in the North for the ETP students. The IAFS demonstrated how people from different backgrounds can bring their diverse knowledge and skill sets together to achieve higher goals, while broadening participant's perspectives. Sentinel North continues to offer field school opportunities, which will enable further dialogue among northern early-career scientists and those who live outside the Arctic and will enhance collaboration and understanding in conducting Arctic research.

The Inuit Field Training Program: a community-driven, skills development initiative

Grant Gilchrist, Bronwyn Harkness, Bonnie Taparti and Paul Smith (Environment and Climate Change Canada)

Featured story location on the map: 4

Inuit Field Training Program participants record location data while training in environmental monitoring field methods.

The Inuit Field Training Program (IFTP) was launched in 2018 through a partnership between the community of Coral Harbour, Nunavut, and ECCC. ECCC and the community of Coral Harbour collaborated to identify community needs for the program, decide how it would be managed, and determine how best to integrate it into ongoing, nearby research. ECCC biologists Grant Gilchrist and Paul Smith initiated the program after hearing residents of Coral Harbour express the need for formalized training in field research for Inuit youth during community consultations for their long-term bird studies at nearby East Bay. The community wanted opportunities for their youth, who were eager to work, learn and become skilled field assistants.

Building on their long-standing relationship with the community, Gilchrist and Smith worked with the community to create a training program that would provide hands-on field experience for Inuit youth, including living and working in a remote field camp. A community-based steering committee was created to oversee the program and work with ECCC to deliver it. The steering committee played a lead role in selecting the participants for the program. This program model ensures that the IFTP is directed by local residents and is relevant to the community. The program fosters opportunities for ECCC scientists to engage with Inuit youth about northern research, builds participants' field skill sets and makes them aware of training and career opportunities in Arctic science.

In August 2018, a group of youth from Coral Harbour flew to the ECCC field station at East Bay, Nunavut, for the first IFTP 10-day field camp.

Participants observe birds at East Bay, Southampton Island, Nunavut.

> ***The Inuit Field Training Program is an innovative and focused approach to address a real need – helping Inuit youth succeed in making the transition from secondary school to further opportunities. In the long term, this initiative could make a meaningful contribution to the Government of Canada's objective of meaningful inclusion of Inuit in environmental research and monitoring in the North.***
>
> – **Paul Smith,**
> Environment and Climate Change Canada

Participants learned about environmental monitoring techniques; skills for living and working in field camps; and educational and employment opportunities in environmental science fields. The field program leaders included a team of ECCC scientists and Inuit mentors, including a local elder who shared Inuit traditional knowledge with the participants.

During the camp, the field team leaders noted which participants expressed interest in working with ECCC in the future as field assistants for northern projects, in pursuing post-secondary studies, or in a career in the environmental sciences. The leaders then offered guidance and directed them to resources to help them pursue their interests.

The PCSP coordinated chartered aircraft for the IFTP program, which included transporting participants and field team leaders to and from camp at East Bay. In addition, Polar Knowledge Canada established cabins at the field station that will continue to be used by future IFTP participants.

The first year of the IFTP was considered such a great success by the steering committee, program participants and field program leaders that the program will continue in 2019. There are plans to broaden the scope of the IFTP and offer opportunities at additional ECCC field stations, with the potential to partner with other federal government departments that conduct northern research. As Gilchrist noted, having a community-based steering committee is key to the success of the program, which is supporting youth training and employment in the short term and educational and career development in the long term.

Discovery!

Fossil of a fang from a scimitar cat

In July 2018, Grant Zazula (Government of Yukon) and his field team discovered a wealth of fossils from Pleistocene (last ice age) creatures in riverbank sediments along the Old Crow and Porcupine Rivers in northern Yukon. The biggest finds included a fang from a scimitar cat (a relative of the sabre-toothed cat) and teeth from a species of beaver that grew to 2 metres in length. Modern beavers are only about half that size.

Two filmmakers accompanied the field team to develop a documentary film that will be used for outreach purposes. This PCSP-supported project is a collaborative initiative of the Government of Yukon, the Vuntut Gwitchin First Nation Government and the University of Alberta. The project's goal is to examine the evolutionary biology of ice age animals in the area, as well as extinctions and environmental change during the Pleistocene. A community workshop is planned in Old Crow, Yukon, to allow residents to examine and identify the fossils before they are added to the fossil archive at the Old Crow Arctic Research Facility.

Field sites supported by the Polar Continental Shelf Program (2018)

Projection: Vertical Near Side Perspective, centred at 81°N 90°W, altitude 10 000 000 m.

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

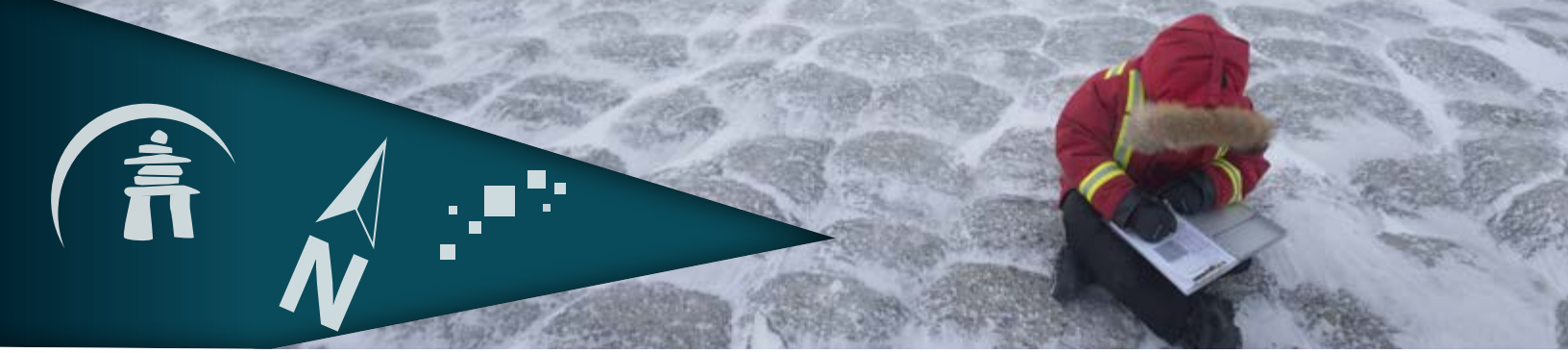
Sea Ice Information: Median sea ice extent for September (1981-2010) compiled by Canadian Ice Service, Environment and Climate Change Canada, 2013.

Geographical Names: Canadian Geographical Names Data Base (NRCan.gc.ca), Natural Resources Canada, 2019.

Land Cover Data: 2010 Land Cover of Canada, Canada Centre for Mapping and Earth Observation, Natural Resources Canada, 2018.

Air Distance in Kilometres

						Victoria
					St. John's	5069
				Resolute	3611	3217
			Ottawa	3408	1770	3581
		Inuvik	4119	1502	4847	2292
		Iqaluit	2845	2100	1581	2044	3659
	Edmonton	2794	1971	2857	2527	4216	895
Alert	3621	2100	2287	4172	1098	3903	4275



Science and training highlights from 2018

In 2018, the PCSP provided logistics support for 233 projects, including 162 science and operations projects in the Canadian Arctic. Many of these projects involved students conducting their own research, participating in field schools or working as field assistants. Through these experiences they received important training opportunities to develop their expertise as the next generation of researchers.

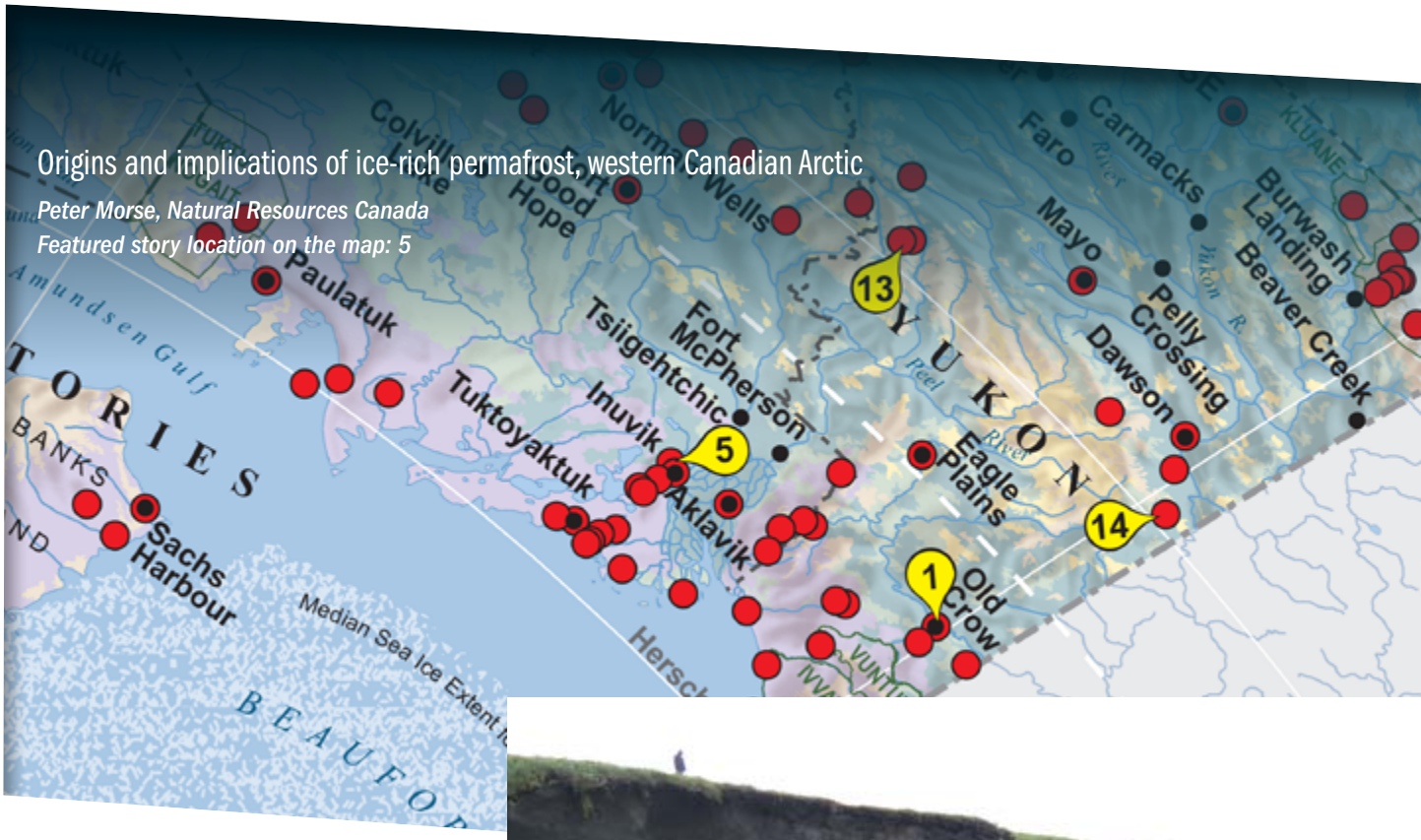
The following section lists a sample of the PCSP-supported research projects from 2018 and their important findings, which are informing decision making on climate change, northern infrastructure stability, geoscience and sustainable development of natural resources, environmental integrity, the evolution of life in Canada's North, and emergency preparedness.

Researchers head to sampling sites in the Nick Prospect area, Yukon.

Origins and implications of ice-rich permafrost, western Canadian Arctic

Peter Morse, Natural Resources Canada

Featured story location on the map: 5



Scientists examine a ground ice exposure and slump deposits from thawing permafrost.

Permafrost underlies most of Canada's North. This defining feature of the Arctic is experiencing accelerated thawing because of warming air temperatures in the region, which is resulting in ground surface changes that can destabilize overlying infrastructure. Northern infrastructure development, such as road construction, can also impact permafrost by disturbing the exchange of heat between the ground and the atmosphere, causing ground ice to thaw.

Determining the distribution of ice-rich permafrost in an area and its formation processes are of particular importance because ice-rich permafrost thaw will cause the ground to subside, which can destabilize soil and cause slumping. Thus, improving our understanding of ongoing landscape responses to climate change and disturbance caused by human activity will inform risk-management decisions about natural resource and road developments and lead to improved sustainability of northern infrastructure.

Peter Morse and his collaborators from the Geological Surveys of Canada and the Northwest Territories, have been studying natural (undisturbed) and disturbed areas of ice-rich permafrost. They examined an area between Inuvik and Tuktoyaktuk, Northwest Territories, where a highway connecting the two communities was recently built. The research team is assessing the area's ground ice conditions to compare natural landscapes with those that have been affected by highway construction. Their work also involves developing new surficial geology maps and maps of landscape features that indicate ice-rich permafrost areas.

> ***This research will enable better predictions of how the landscape will change as permafrost thaws and how these changes may be expected to impact the environment of the Inuvialuit Settlement Region.***
>
> – Peter Morse,
> Natural Resources Canada

In 2018, Morse's team took aerial photographs of the study area, visited several sites to examine ground ice exposed at the surface and drilled boreholes to collect permafrost cores. The aerial photographs will be used to test the accuracy of surficial geology mapping and to compare with future aerial photographs that will be taken to examine landscape changes over time. The team is also monitoring permafrost conditions and rates of thaw by collecting temperature data from instruments placed in the boreholes. Morse's team will use the permafrost cores to examine permafrost structure and the origin and development of the area's permafrost since the last ice age. Through this work, they will identify how different types of ground ice are responding to warming temperatures and how infrastructure development is influencing these responses.

This project has involved several graduate students and a post-doctoral researcher who are conducting related research. Morse and his team used helicopters coordinated by the PCSP to access key study sites and take aerial photographs. In addition, the team used PCSP field equipment to support field safety, communications, and camp and coring activities.

In future field seasons, Morse and his team plan to conduct detailed studies at key sites identified in 2018 to continue to document and monitor permafrost thaw and corresponding landscape changes. Understanding the varied responses of permafrost to thaw and disturbance by human activity will improve the ability of researchers to forecast landscape changes in the area and their potential effects on existing infrastructure. These findings will support risk mitigation and climate change adaptation strategies for future developments in the region.

Want to learn more?

A geologist examines ground ice structure in a permafrost exposure.

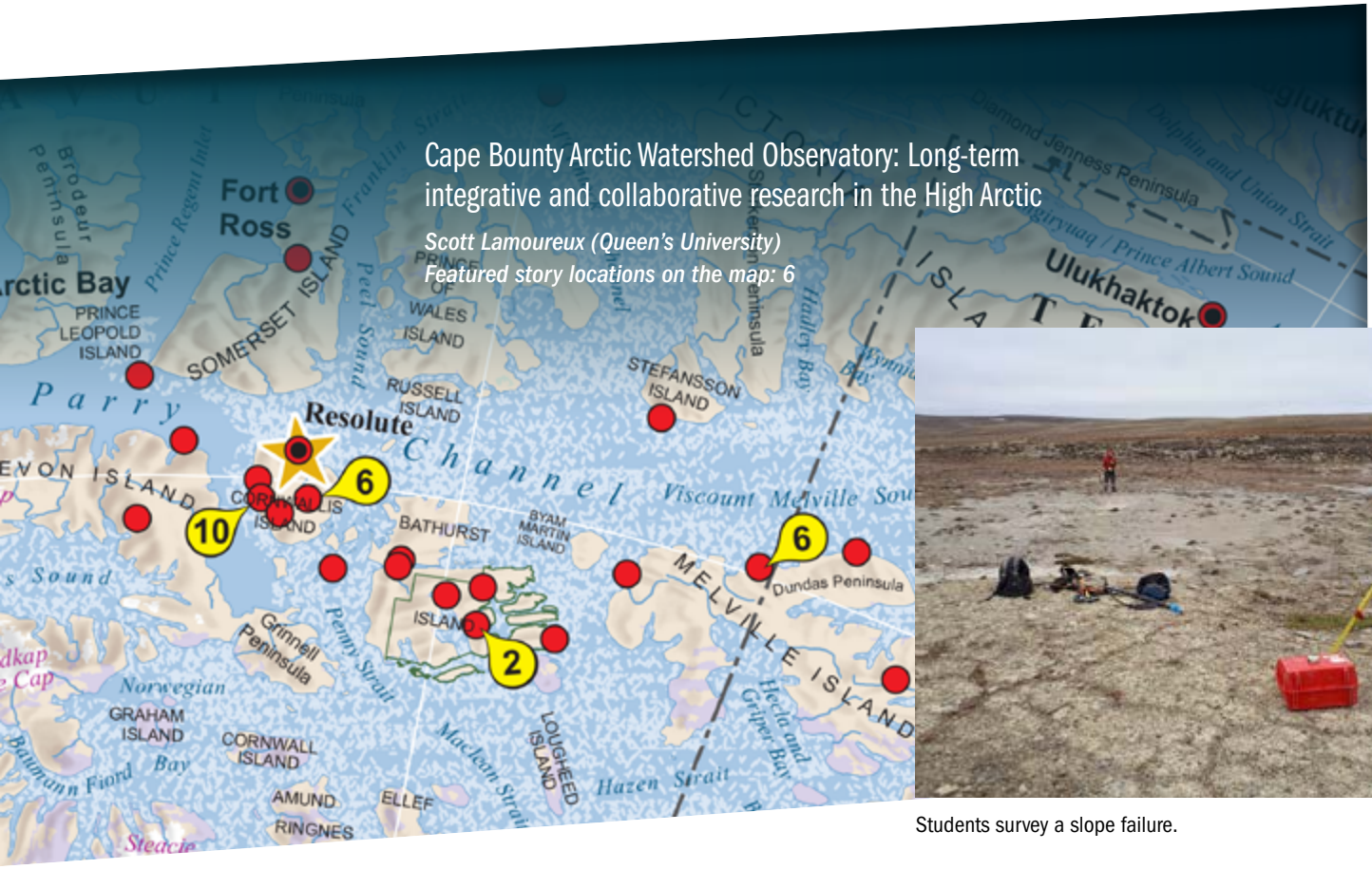
Listen to an interview with Peter Morse on an NRCan Simply Science podcast, available here: www.nrcan.gc.ca/simply-science/20376. Watch a video about this research here: https://app.frame.io/reviews/b9d70967-2383-43f4-8f3a-d150377bc11b/586423ba-a16b-4521-82ef-0e1e15ef5ef4.

Researchers examine ice-rich permafrost exposed at the surface and erosion caused by permafrost thaw.

Cape Bounty Arctic Watershed Observatory: Long-term integrative and collaborative research in the High Arctic

Scott Lamoureux (Queen's University)

Featured story locations on the map: 6



Students survey a slope failure.

Understanding environmental change, especially climate and related permafrost change, are critical research gaps in the Arctic. Learning about the impacts of these changes on natural systems is necessary for predicting future environmental change and supporting decision making on issues such as land use, water security and environmental management. To support this research, Scott Lamoureux established the Cape Bounty Arctic Watershed Observatory (CBAWO) in 2003 on southern Melville Island, Nunavut, to carry out integrated, multi-disciplinary research linking climate, water, land and ecosystem science.

CBAWO is comprised of two adjacent watersheds (a river system's drainage area) that are similar in size and setting. The design has allowed scientists a rare opportunity to conduct paired watershed experiments in which the same studies are conducted in each watershed to investigate different responses of similar systems. Over the past 16 years, researchers at CBAWO have examined the impacts of climate and permafrost change on surface water, erosion, water quality, soil processes, gas fluxes, vegetation and lake processes. Studies at CBAWO have taken place through the coldest and warmest melt seasons

Sediment is transported downriver toward West Lake, Melville Island, Nunavut.

East Lake and its surrounding drainage basin form part of the Cape Bounty Watershed on Melville Island, Nunavut.

on record for the region, which has allowed the researchers to observe environmental responses to a full range of melt season conditions.

The research has captured the short- and long-term effects of a major landscape disturbance in 2007 and 2008. In those years, high melt season temperatures caused permafrost thaw and the development of over 100 slope failures, including one that was 600 metres long. These permafrost disturbances caused major changes to water quality on slopes and in the downstream rivers and lakes. The CBAWO studies have created the first multi-year data sets of the fluxes of water, sediment and dissolved material (including nutrients and contaminants such as mercury) from High Arctic rivers and lakes. The data sets have enabled the scientists to model these systems and predict how they may respond to future environmental change.

Without logistics support from the PCSP, long-term field studies, such as those ongoing at CBAWO, would not be feasible in the Canadian Arctic. Over the years, the PCSP has supported research at CBAWO through the coordination of chartered Twin Otter aircraft and helicopters to transport field team members and equipment, accommodations at the PCSP Resolute facility, field equipment loans, and fuel for camp needs.

A recent multi-disciplinary study at CBAWO, led by former graduate student Kaitlyn Roberts, combined a decade of water chemistry data from Cape Bounty's two lakes with permafrost chemistry data. The data indicated that both lakes showed a rapid build up of dissolved material from 2008 to 2013 when deep permafrost thawing resulted in large sediment inputs to local river systems. By examining Arctic char otoliths (ear bones), the research team found that fish health in the lakes improved because of changes in water chemistry, nutrient inputs and ice conditions during this period.

This research revealed how rapidly Arctic watersheds and lakes can respond to permafrost changes and how the impacts can be measured in aquatic ecosystems. It also demonstrates the strength of an integrative team approach to research that draws on expertise from many partners, including northern community members. Future CBAWO research will focus on soil processes, soil-water interactions and contaminants in Arctic ecosystems, as well as on prediction of permafrost disturbances and their impacts on water quality.

> ***"This facility, supported by PCSP logistics, has supported 115 university, government and community researchers and represents the only comprehensive hydrological research program in the Canadian High Arctic."***
>
> – **Scott Lamoureux,**
> Queen's University

A key to the success of the long-term research conducted at CBAWO is the ongoing partnerships that have grown over the years with researchers from ECCC, universities and the Hamlet of Resolute. The research team recently initiated a watershed study on the McMaster River near Resolute to apply knowledge gained at CBAWO to a new setting. They are building a partnership with the community with the aim of supporting community research priorities regarding water security. CBAWO has diversified its science by involving researchers with different scientific expertise. CBAWO continues to foster integrated and multi-disciplinary studies that are building a comprehensive, long-term knowledge base for northern watersheds in a rapidly changing Arctic environment.

Want to learn more?

To learn more about the long-term research at Cape Bounty, visit the research team's website (https://capebountyresearch.com) and follow them on Facebook (https://www.facebook.com/CBAWO/).

Diversity, habitats and conservation of chars in Coronation Gulf

Tracey Loewen (Fisheries and Oceans Canada) and Heidi Swanson (University of Waterloo)

Featured story location on the map: 7

A student tags a char with an acoustic transmitter near Kugluktuk, Nunavut.

Many northern communities and fisheries depend on char as a key food source. Traditionally, the range of Dolly Varden char was understood to be limited to rivers west of the Mackenzie River, while its close relative, Arctic char, was thought to live in water bodies to the east. Recent evidence suggests, however, that Dolly Varden char may coexist with Arctic char in large river systems in the Coronation Gulf region of Nunavut.

In 2010, Dolly Varden char in the western Arctic was assessed as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada. It is now listed under Canada's *Species at Risk Act* and a collaborative integrated fisheries management plan has been developed. However, this plan does not cover Dolly Varden char that may exist in Nunavut, which makes them particularly vulnerable to possible impacts from planned resource developments, fishing activity and ongoing climate change. Confirming the range, species diversity and habitat use of Dolly Varden char in this area is important. This information is needed to ensure that effective conservation strategies and management practices are developed for their populations and to support the sustainability of local subsistence fisheries.

Tracey Loewen, Heidi Swanson and their research team are studying char populations in river systems in the area of Kugluktuk, Nunavut, to confirm if Dolly Varden char are present and examine how they share habitat with Arctic char. This project focusses on fish populations that are anadromous, which means they spend the summer in coastal waters and migrate upstream into freshwater habitats to spawn and overwinter. If Dolly Varden char and Arctic char are sharing habitat, it is possible that a hybrid of these two species may also exist in the area's rivers. Through the work of graduate student Rosie Smith, the team is also examining how changes

The field crew downloads data and prepares to redeploy equipment to track the movement of char in the Coppermine River, Nunavut.

in river flow caused by climate change and isostatic rebound (the upward movement of land since the last ice age) are affecting the ability of char to migrate between their saltwater and freshwater habitats.

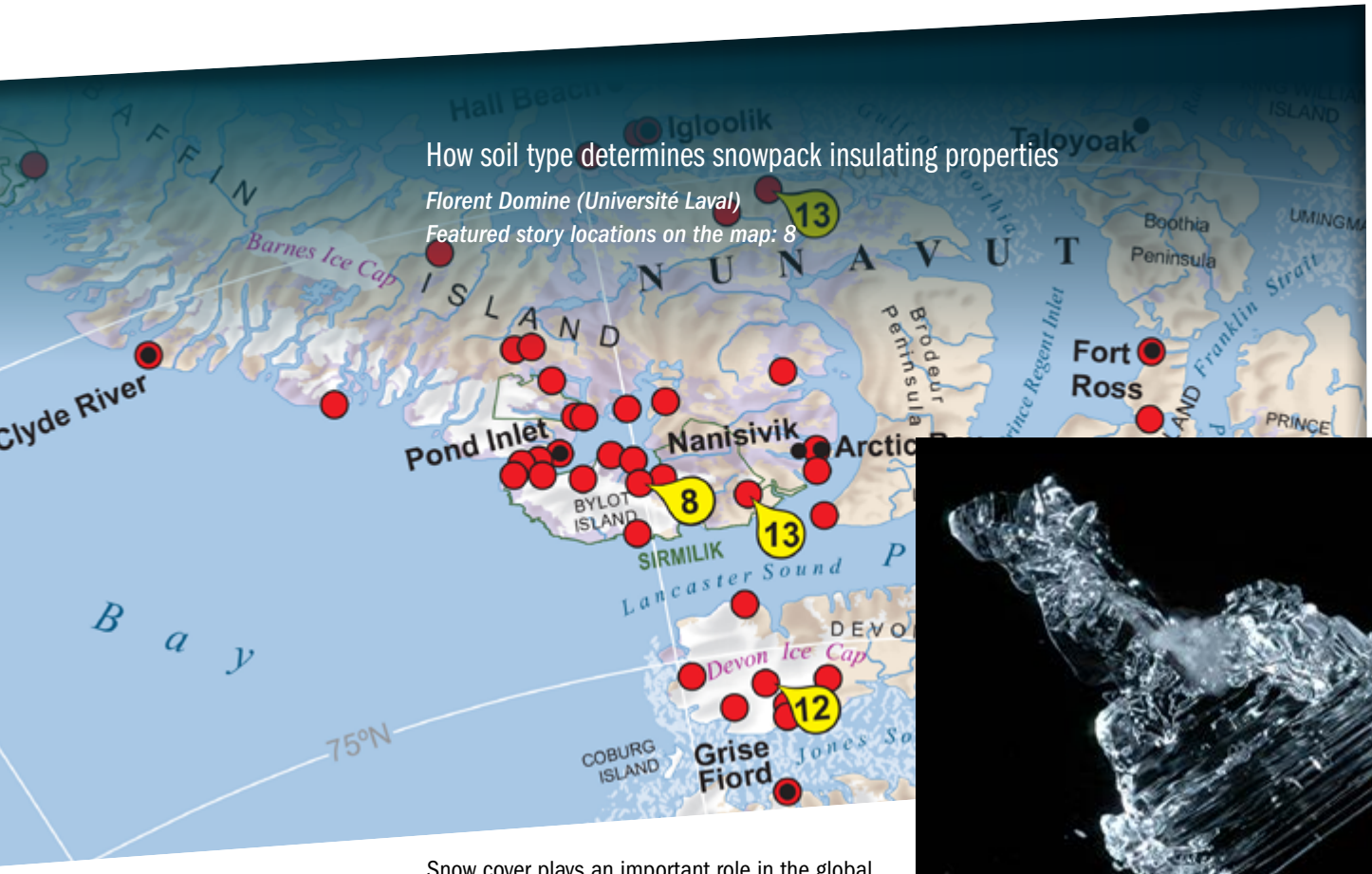
This research is conducted in close collaboration with the Kugluktuk Hunters and Trappers Organization, whose members have shared their knowledge to help direct project activities to align with community research needs. Community members have also been involved in all fieldwork activities and have been integral to the project's success.

Fieldwork in 2018 included tagging char by attaching acoustic (sound wave) transmitters to them, installing equipment to track fish movements and collecting water samples from the Coppermine, Kugaryuak, Tree and Richardson rivers. PCSP-chartered helicopters made this work possible by enabling the field team to reach multiple study sites along the rivers with their required equipment.

The Kugluktuk Hunters and Trappers Organization also ran a community-based donation program that collected 190 otolith (fish ear bone) and tissue samples from fish that were harvested by residents. These samples are being used to determine fish age, migration history and species. Results to date show that all tracked char use habitat in the Coppermine River during August and September, which demonstrates the importance of this waterway for the fish. This river is also vital for subsistence fisheries, therefore understanding the diversity of char species in the river and their habitat use will contribute to maintaining a sustainable fishery for local residents.

> ***"Understanding char diversity and how particular areas and habitats are used is crucial in starting to develop effective conservation strategies and sustainable stewardship plans."***
>
> – **Tracey Loewen,**
> Fisheries and Oceans Canada

This ongoing project will include more fish tagging and tracking to collect more information on how char use rivers in the Kugluktuk area. Through this study, the research team aims to improve understanding of species diversity, fish migration patterns, and habitat use in the Coronation Gulf region, as well as behavioural differences among char species. By identifying critical habitats for local char, the team will determine priority areas for future species management and conservation efforts.



How soil type determines snowpack insulating properties

Florent Domine (Université Laval)

Featured story locations on the map: 8

A typical depth hoar crystal formed in low-density snow (the white scale bar is 1 mm long).

Snow cover plays an important role in the global climate system. During the 8 to 10 months per year that snow is present in most Arctic locations, it helps to keep the temperature balance between the ground and the atmosphere by reflecting solar energy. The snow keeps the surface cool and shelters permafrost, vegetation and small burrowing animals from harsh atmospheric conditions.

The ability of the snowpack (the combined layers of snow and ice on the ground at any one time) to insulate is based on its structure, which is influenced by several processes. In the Arctic, depth hoar (large, unconsolidated ice crystals that form at the bottom layer of the snowpack) provides most of the snowpack's insulating ability. It forms primarily through water vapour transfer from the base to the top of the snowpack and can be as effective at insulating as goose down. Understanding the conditions needed to form depth hoar and the impacts of climate change on its formation will provide insight into its influences on permafrost temperatures, vegetation growth and wildlife population dynamics.

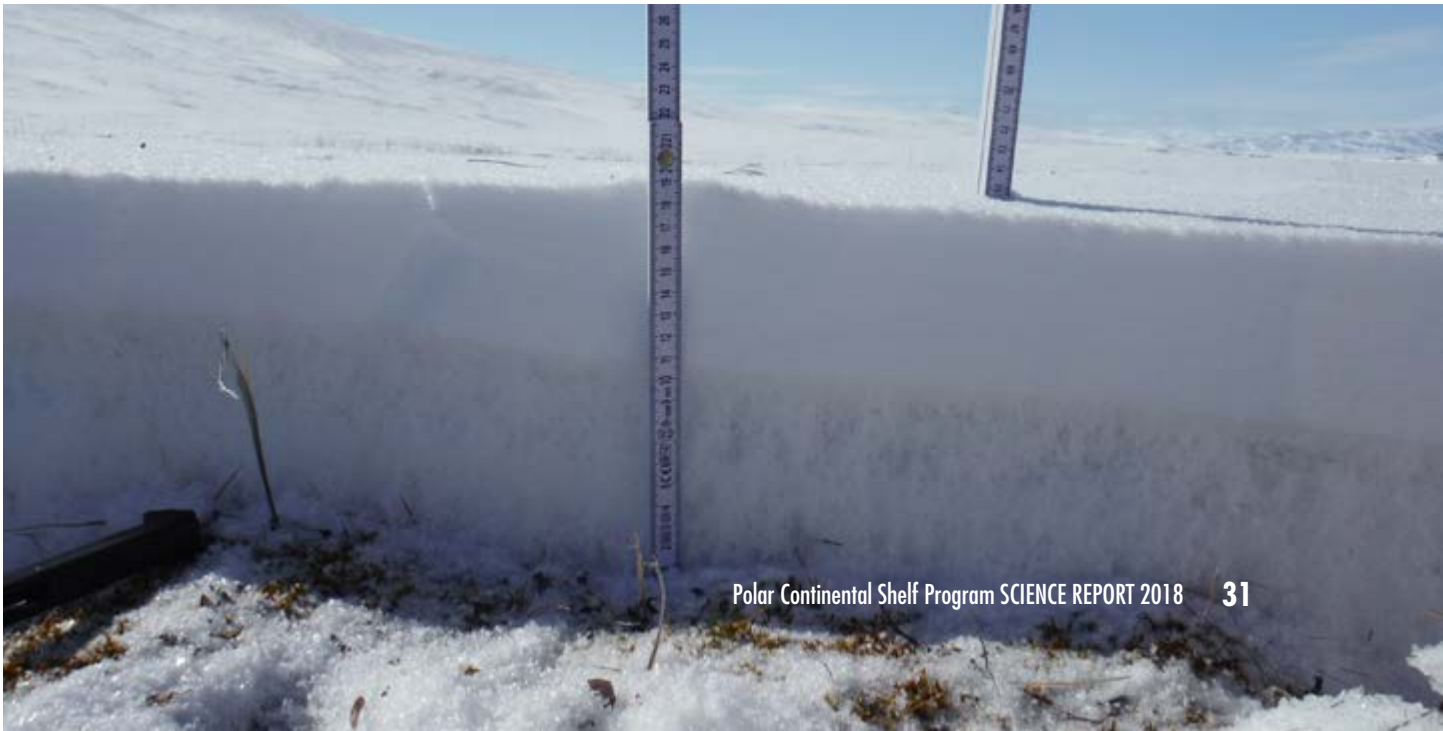
Florent Domine and his research team are examining the formation, structure and distribution of depth hoar on Bylot Island and Ward Hunt Island, Nunavut, to investigate its development in different environmental conditions. Using snow pits, the research team observes snow layers and performs physical measurements of snow density, thermal conductivity (a measurement of how well heat passes through a material) and snow grain size at each study location. They also use data recorded year-round by weather and soil moisture monitoring equipment, as well as time-lapse imagery to observe snowpack development. Based on fieldwork in 2016 and monitoring data from 2016 and 2017, the research team has found that soil type and wind speed have major impacts on the formation of depth hoar in the Canadian Arctic.

The PCSP supported this research by coordinating aircraft to transport the research team and their equipment to and from their remote field sites including Ward Hunt Island, which is one of the most remote places on Earth. With the PCSP's assistance, clients can reach study locations that would otherwise be highly difficult to access but are important for their research.

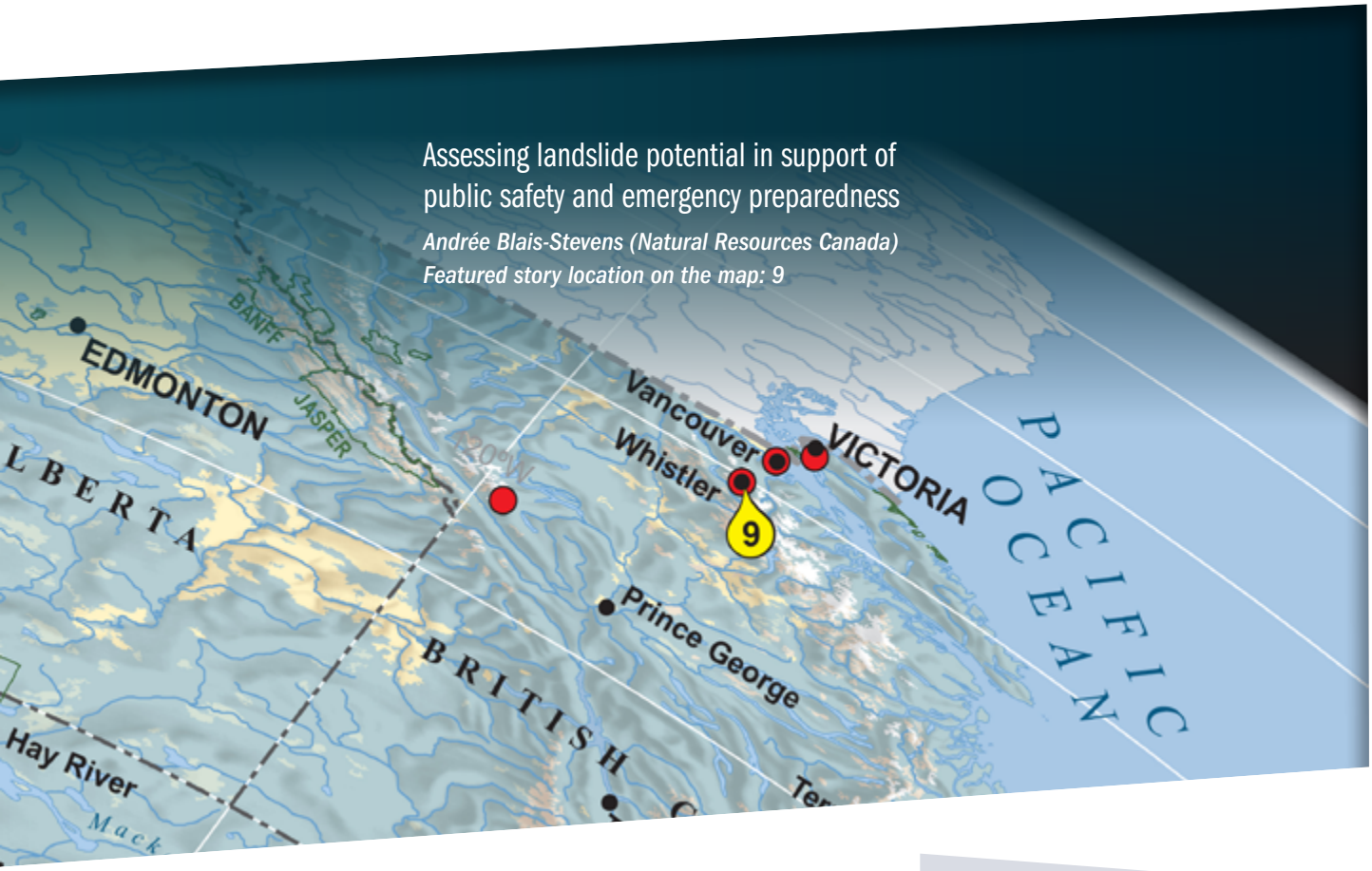
> ***"Large uncertainties in the future magnitude of climate change stem from poorly known or undiscovered feedbacks. Because snow properties are highly sensitive to climate and vegetation, snow is expected to be responsible for many climate feedbacks that have yet to be incorporated in global climate models."***
>
> – **Florent Domine,**
> Université Laval

After observing well-developed depth hoar in the snowpack of Bylot Island, the research team was surprised to find none on Ward Hunt Island. In the polar desert environment of Ward Hunt Island, the soil takes only three days to freeze in autumn because of its dryness. In contrast, areas with moist soils on Bylot Island take over two months to freeze completely. The results suggest that when the ground freezes quickly, a strong temperature gradient does not form between the soil and the atmosphere. Also, the transfer of water vapour is limited at the base of the snowpack, which prevents depth hoar formation. In addition, persistently high winds at Ward Hunt Island in autumn were observed to form a wind slab (a hardened snow layer), which also inhibited water vapour transfer within the snow.

Based on these results, the research team proposes that warmer temperatures would enhance soil moisture, water vapour transfer and depth hoar formation in Arctic snowpacks, which would increase ground insulation and permafrost temperatures. This situation would result in greenhouse gases that are held within the permafrost being released and contributing to more climate warming. Enhanced vegetation growth expected throughout the Arctic under warming conditions could also amplify this process by increasing litter buildup. Consequently, the soil's ability to retain water increases, resulting in enhanced depth hoar formation and permafrost warming. In future field seasons, the team will investigate this hypothesis further to better understand the long-term implications of climate change on the Arctic snowpack and the potential for accelerated warming in Canada's North.



The wall of a snow pit shows an upper hard wind slab overlying a layer of depth hoar.



Assessing landslide potential in support of public safety and emergency preparedness

Andrée Blais-Stevens (Natural Resources Canada)
Featured story location on the map: 9

Landslides can present significant risks to people and infrastructure. These natural hazards include rock, soil or debris that moves downslope after becoming unstable, forming rockslides, debris flows, slumps or other types of landslides. Although gravity is the main force that causes landslides, many other factors may contribute, including earthquakes, heavy rainfall, erosion and human disturbance. Slope failure is also influenced by the type of rock or sediment involved, which makes understanding the surficial geology of areas vulnerable to landslides particularly important. Determining areas that are at high risk for landslides is essential for mitigating risks to people and infrastructure and reducing the economic and environmental impacts that these mass movements can cause.

Andrée Blais-Stevens and her colleagues at the Geological Survey of Canada examine landslide potential in populated areas of British Columbia by conducting landslide assessments. These studies involve compiling an inventory of existing landslide deposits by using satellite imagery and aerial photographs. This work is followed by examining mass movement paths and collecting rock and sediment samples from landslide deposits to determine their ages, structures and the types of rock and sediment involved. This information can indicate what caused a landslide and how it moved downslope. It is used to develop landslide susceptibility maps, which show the risk potential of different areas to landslides. This research is conducted as part of the Public Safety Geoscience Program, which develops geoscience knowledge to support land-use planning and reduce risk from natural hazards, including landslides, earthquakes and tsunamis.

> ***"The ultimate reason for this type of work is to try to keep Canadians safe from landslide hazard and risk. We provide baseline geoscience information on landslides to inform stakeholders and decision makers."***
>
> – **Andrée Blais-Stevens,**
> Natural Resources Canada

Analyzing a sediment core from a landslide deposit to determine when the landslide occurred along the Soo River, British Columbia

The PCSP has supported field studies for this research with field equipment loans, including camera equipment, wet-weather clothing and insect repellent. The PCSP offers field equipment services for federal government research across Canada, including areas outside of the Canadian Arctic.

Blais-Stevens and a colleague are part of an ongoing project examining landslide potential in areas near the Sea to Sky Highway, in British Columbia. In 2018, they used a drone to examine the structure of a large rock avalanche along the Soo River, north of Whistler. They also collected samples from a nearby landslide deposit that had blocked a river to determine its age, structure and relationship to neighbouring large landslides. They will use this information to examine triggers for the landslides as part of their landslide assessment for the area.

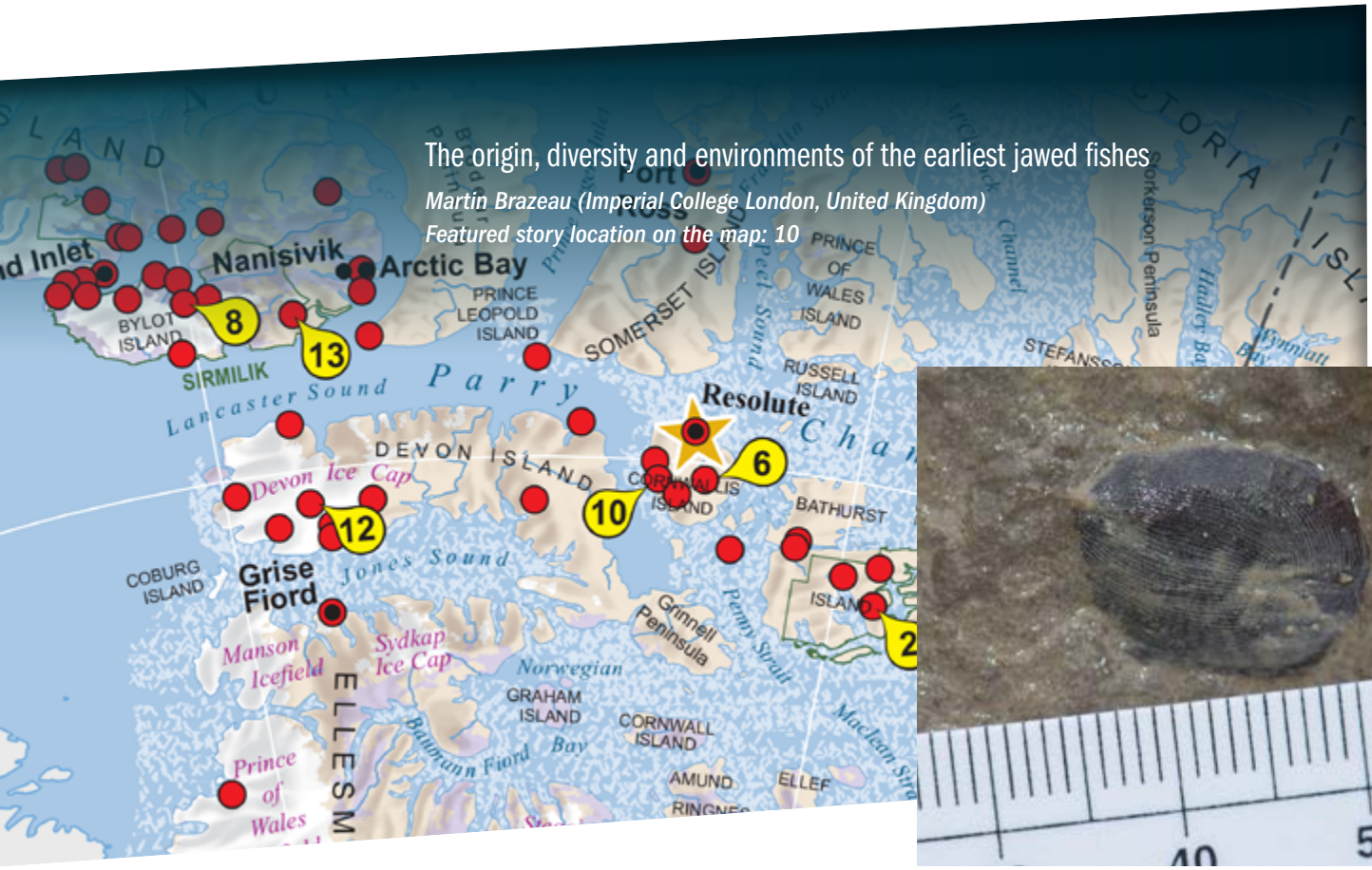
Blais-Stevens is also working with colleagues at the Canada Centre for Mapping and Earth Observation at NRCan to monitor steep slopes on mountains east of Kitimat, British Columbia, by using satellite imagery to detect slope changes. Having completed surficial geology mapping and a landslide inventory for this area, she is able to use this information to focus monitoring efforts on slopes that are vulnerable to instability. Recently, Blais-Stevens and her colleagues also created an historical map of all landslides in Canada that were documented to have caused fatalities since 1771. This research indicated that landslides have caused at least 767 deaths in Canada during the past 250 years, predominantly in British Columbia and Quebec.

Blais-Stevens's work often involves presenting information to public safety groups and communities in British Columbia that are concerned about local landslide hazards. The results of her work help municipalities to understand their risks and make informed decisions about infrastructure development, while also supporting emergency preparedness organizations to plan for and respond to landslide events. Geoscience knowledge developed from landslide assessments informs governments at all levels about possible hazards, contributes to building codes and environmental assessments and reduces the risk of loss of life and infrastructure damage caused by slope failures.

The origin, diversity and environments of the earliest jawed fishes

Martin Brazeau (Imperial College London, United Kingdom)

Featured story location on the map: 10



A jawless fish head plate from a late Silurian tidal flat deposit on Cornwallis Island, Nunavut (The scale is in millimetres).

Vertebrates (animals with backbones) emerged as creatures resembling fish early in the Paleozoic Era (about 540 to 450 million years ago) and subsequently diversified into many species. One important feature that developed in early fish was the jaw. Jawed fishes came to dominate the world's oceans during the late Silurian and early Devonian periods (about 440 to 393 million years ago), which is believed to have led to a collapse in jawless fish diversity. When jawed fishes evolved into two main lineages in the early Devonian period, the long progression began toward the development of 99% of all modern-day vertebrates, including humans.

It is unclear why jawed fishes developed when they did and what processes influenced their rise to dominate over jawless fishes. Martin Brazeau and his research team are examining the early history of vertebrates during a key period in the development of life on Earth. They are investigating the rise of jawed fishes, including the evolution of their anatomy, impacts they made on their habitats and the reasons for their success.

In 2018, Brazeau's team sampled limestone from rock formations on eastern Cornwallis Island, Nunavut, which were deposited in an ancient marine continental shelf environment about 420 million years ago. By sampling through rock sequences across the ancient continental shelf, the research team could examine changes in the fossil assemblage in the rocks over time and from different marine environments.

The field team included graduate students and two local residents who were guides for the fieldwork. Local involvement in the field activities created a valuable opportunity for mutual knowledge-sharing about the land and northern science. PCSP logistics support for this project included logistics planning and aircraft coordination for Twin Otter aircraft and helicopter transport of the field team and their field equipment to their study area. In addition,

Paleontologists examine rocks for fossils on Cornwallis Island, Nunavut.

> ***A key aspect of this work is the ancient environment in which the fossils were formed. If we can know something about this, then we can see whether or not early fishes were changing their habitats in response to competitors or predators.***
>
> – **Martin Brazeau,**
> Imperial College London

the PCSP provided field camp, communications and safety equipment from its field equipment inventory, fuel for camp purposes, and accommodations for the field team at the PCSP Resolute facility before and after their field studies.

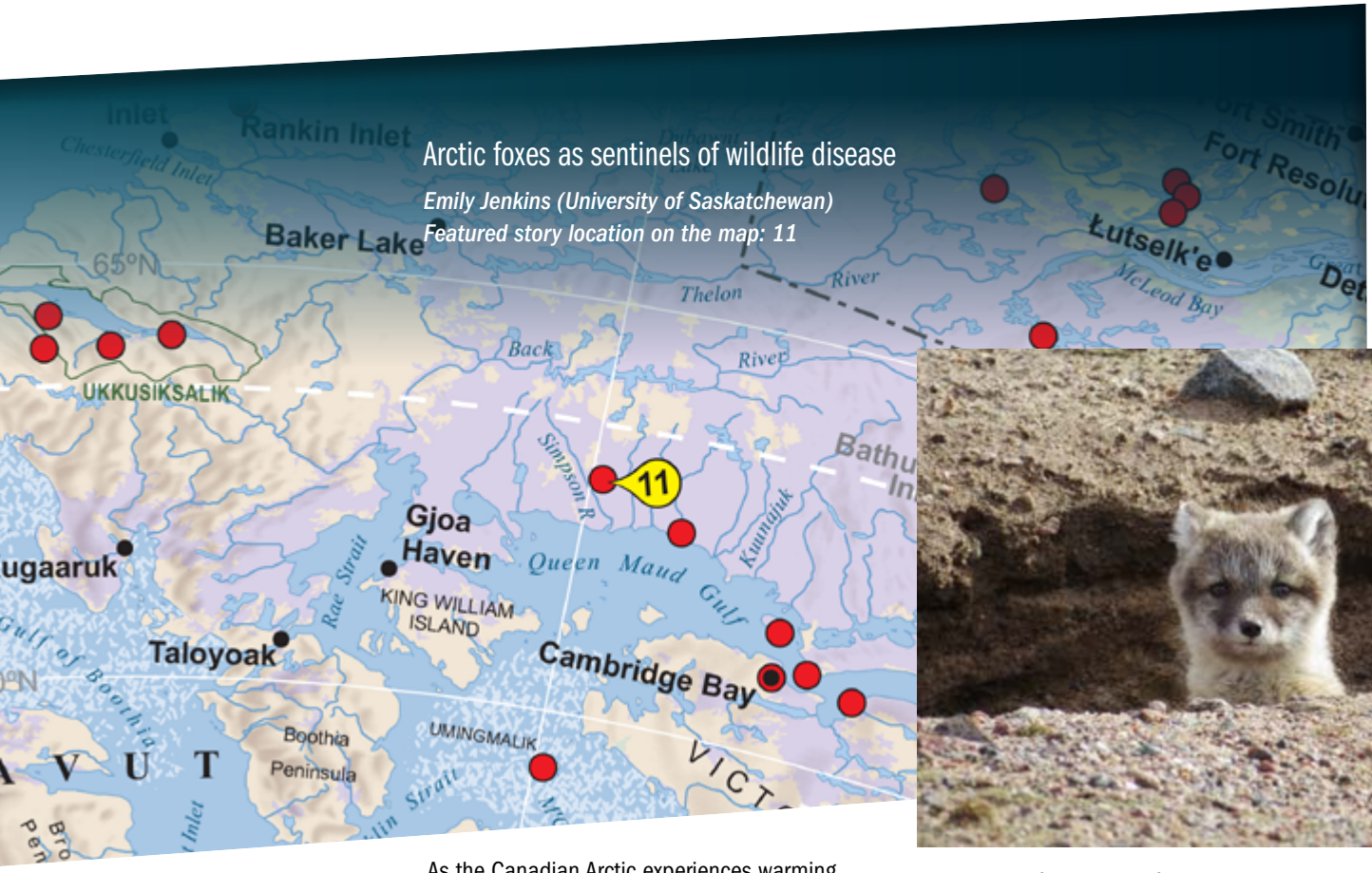
In the laboratory, the research team is breaking down the rock samples by using weak acids and is collecting an abundance of fragmentary fish fossils. They are identifying the fossils and building a database to document how fish diversity changed as jawed fishes appeared in ancient coastal waters. The team will use this data to determine if jawed fishes drove jawless fishes toward extinction through predation, competition for food or a combination of factors. If early jawed fishes were predatory as modern day sharks are, they may have increased predation of jawless fishes, which could have significantly reduced their numbers.

To test this hypothesis, Brazeau's research team will use fish head shields (bony head coverings) to determine if the body sizes of jawless fishes increased as jawed fishes arrived, which would indicate an evolutionary response to increased predation. The team will also investigate the changing anatomy of early jawed fishes and the relationships among their species from an evolutionary perspective.

In addition, an early predatory fish with an armoured body (bony covering), *Lophosteus canadensis*, is believed to have existed during the Silurian period, based on previous fossil studies. Armoured jawed fishes were very rare during this period, therefore fossils of this species could provide insights into the early evolution of jaws, teeth and skull bones. In the rock samples collected, Brazeau hopes to find higher-quality fossils than those currently available for this species. The team has already discovered numerous fragmentary fossils that may have come from this fish. While further analyses will confirm the species, this type of fish would have been part of a lineage that led to land-based vertebrates, including humans. The early development of this lineage is largely a mystery and the research team would like to learn more about this ancient fish to fill knowledge gaps on the evolution of a key group of vertebrates.

Want to learn more?

Discover more about early vertebrates and the work of Martin Brazeau and his research team through this blog: www.palaeocast.com/the-expedition/.



Arctic foxes as sentinels of wildlife disease

Emily Jenkins (University of Saskatchewan)
Featured story location on the map: 11

A young Arctic fox peeks out from its den near Karrak Lake, Nunavut.

As the Canadian Arctic experiences warming temperatures and associated environmental changes, new wildlife species are moving north and with them, new pathogens (viruses, bacteria and parasites) that can cause disease in humans. Improved understanding of these zoonotic diseases (illnesses that can be transmitted from animals to humans) and the influences of climate change on them is required. This knowledge will help develop public health strategies to mitigate disease risk for northern communities, improve country food safety, and inform wildlife management strategies related to disease control.

Emily Jenkins and a broad research team have been examining wildlife at Karrak Lake, Nunavut, for over a decade. Their goal is to determine baselines for zoonotic disease and to predict and mitigate disease risk to public health and wildlife in this rapidly warming region. This project is part of the Polar Knowledge Canada Science and Technology Program. It involves long-term collaboration with Ray Alisauskas and Dana Kellett at ECCC, Gustaf Samelius at the

An Arctic fox at Karrak Lake, Nunavut

Snow Leopard Trust, and new collaborations with Patrick Leighton at Université de Montréal. The research is focused largely on Arctic foxes, which act as sentinels of change (early indicators) to disease threats in the North. Arctic foxes' opportunistic nature leads them to a higher likelihood of being exposed to new diseases, they lack immunity to the new diseases, and they are widely distributed across the region.

The team has been collecting samples from foxes, geese and rodents to test for zoonotic diseases such as cat scratch fever, toxoplasmosis and rabies. Mosquitoes have also been collected to examine which pathogens they carry. With this information, the team will model how climate change is influencing the movement of new diseases northward and enabling the transmission of illness throughout the region.

The PCSP has supported wildlife studies at Karrak Lake through logistics planning for aircraft requirements, including coordinating Twin Otter aircraft flights to transport field team members and their required equipment to and from the study area.

The project team includes students Émilie Bouchard, Stacey Elmore, Julie Gailius and Kayla Buhler. Their results show that some Arctic foxes at Karrak Lake carry *Bartonella henselae*, a bacterium that is typically carried by cats and fleas and can cause cat scratch fever in humans. Although cats are uncommon in the North, Karrak Lake is home to the world's largest colony of snow and Ross's geese, which have been found to carry nest fleas infected with *Bartonella henselae*. The research team has found that 39% of fleas collected from fox den entrances and goose nests carry these bacteria, suggesting that they may be a vector to transmit the disease.

The geese were also found to carry *Toxoplasma gondii*, a cat parasite that can cause toxoplasmosis, and about 60% of Arctic foxes at Karrak Lake are exposed. Further studies at Karrak Lake are exploring how the geese at Karrak Lake carry these two pathogens from their winter habitats and transmit them to foxes as they hunt and scavenge on the birds. This work will enable the team to determine current and emerging public health risks related to toxoplasmosis and cat scratch fever, as well as the influences of these diseases on fox reproduction and survival.

Jenkins's team works closely with territorial and federal government health agencies to develop public messaging about disease risks and ways to mitigate them. By monitoring sentinel northern species, such as Arctic foxes, the research team will be able to detect diseases and vectors arriving in the Canadian Arctic and follow the progression of those already in the region, while also identifying current and emerging risks to country food security and safety in the North.

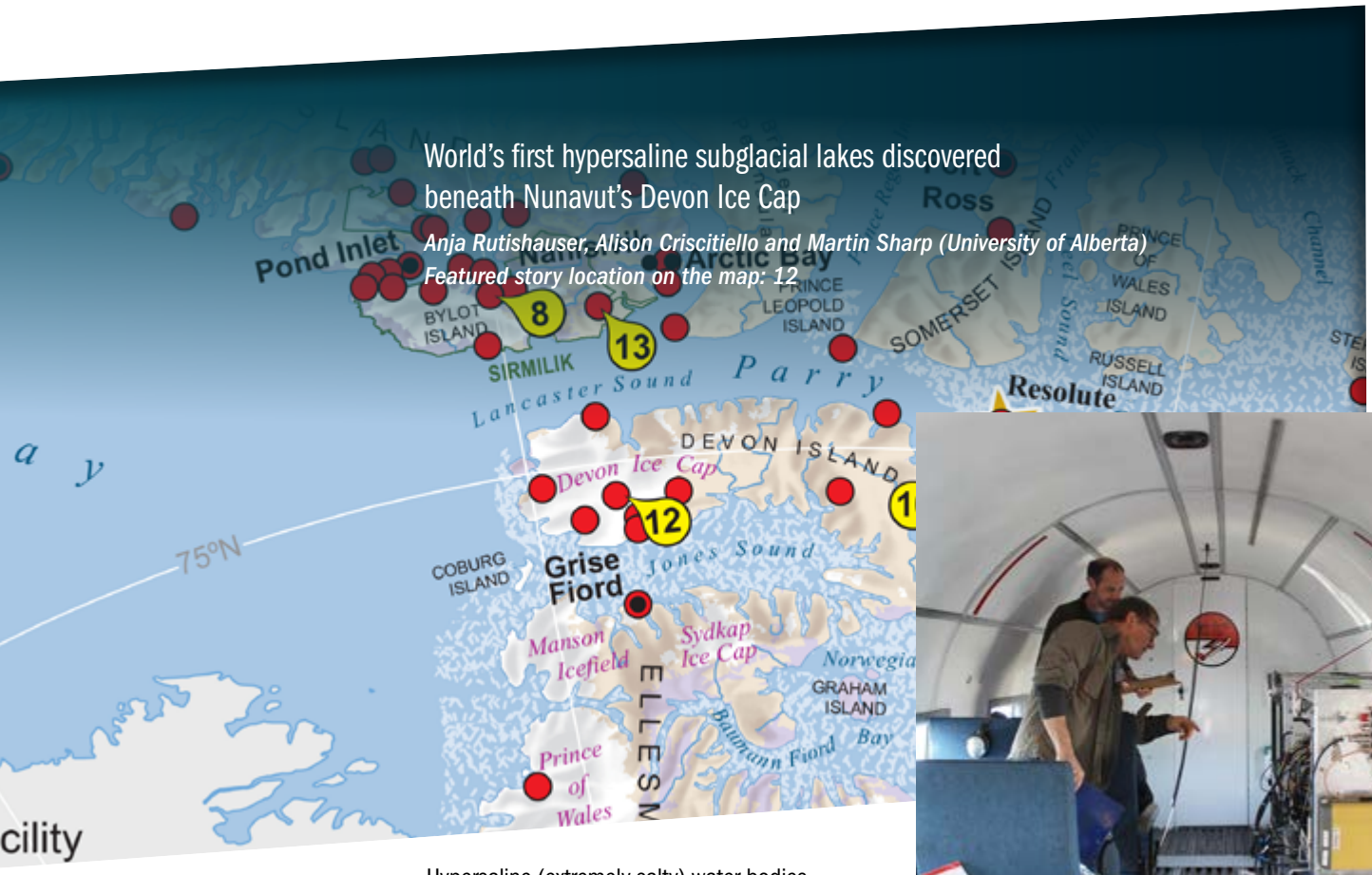
Setting up a motion-activated camera at the entrance to a fox den at Karrak Lake, Nunavut

> ***"Northern residents rely on healthy, stable populations of wildlife for food security and cultural continuity. Therefore, we will build on long-term monitoring studies based at Karrak Lake to develop baselines and model the future patterns of vector-borne and wildlife diseases with significance for human and animal health."***
>
> – **Emily Jenkins,**
> University of Saskatchewan

World's first hypersaline subglacial lakes discovered beneath Nunavut's Devon Ice Cap

Anja Rutishauser, Alison Criscitiello and Martin Sharp (University of Alberta)

Featured story location on the map: 12



Checking geophysical survey instruments installed in a BT-67 aircraft before a survey flight over Devon Ice Cap, Nunavut

Hypersaline (extremely salty) water bodies are thought to exist below ice masses on other planets and moons in our solar system, including under ice caps on Mars and Europa (one of Jupiter's moons). Until recently, no large accumulations of hypersaline water had been found under Earth's ice sheets or ice caps, though hypersaline groundwater had been noted beneath Taylor Glacier in Antarctica. The world's first two hypersaline subglacial lakes were recently discovered under the central part of the Devon Ice Cap on Devon Island, Nunavut. The groundwater beneath Taylor Glacier is known to contain microbial life (microscopic organisms), and therefore, these newly discovered subglacial lakes may also provide a unique environment for microbial communities. Understanding the formation of the subglacial lakes and examining any life present in them will provide insight into how life survives in the isolated, cold, dark environment of the lakes, and by extension, whether such life might exist in similar environments elsewhere in the solar system.

Doctoral student Anja Rutishauser discovered evidence of the subglacial lakes while analysing data collected during past airborne geophysical surveys of the Devon Ice Cap. Each survey had used ice-penetrating radar instruments mounted on an airplane to transmit energy through the ice cap and measure the energy reflected by layers within the ice and the bedrock below it. The vertical profiles through the ice cap created from the data indicated the presence of liquid water in two troughs in the underlying bedrock. Rutishauser and her collaborators estimated temperatures at the bottom of the ice at these two locations to be -14.3°C and -15.5°C, respectively, and determined that the water must have high salt concentrations to remain in liquid form.

> ***The subglacial lakes beneath the Devon Ice Cap are extremely unique, with the cold temperatures and expected salinity of the water making them tantalizing analogs for brine bodies that are inferred to exist on other planetary bodies such as Europa and Mars.***
>
> – **Anja Rutishauser,**
> University of Alberta

The research team looked to the geology of Devon Island to determine how the lakes could be hypersaline and created a 3D geological model of the bedrock under the ice cap. They found that the Bay Fiord Formation is likely exposed around or beneath the two subglacial lakes. This rock formation contains layers of salts, which could dissolve into the lake water to create hypersaline conditions. The salinity needed for liquid water to exist in the subglacial lakes was found to be similar to the salinity of the groundwater beneath Taylor Glacier.

The initial discovery of the subglacial lakes was based on historical geophysical data with relatively sparse coverage. Consequently, further geophysical data was needed to determine the full extent of each lake and understand the hydrology and geology of the surrounding area. In spring 2018, Alison Criscitiello led an airborne survey over the Devon Ice Cap that focussed on the subglacial lake area and collected detailed geophysical data along 4,365 kilometres of survey lines. Preliminary results support the existence of the subglacial lakes and indicate that one of the lakes is larger than first thought.

This fieldwork was made possible through the PCSP's coordination of a BT-67 aircraft, which provided sufficient cabin space to house and operate the required geophysical equipment as the airplane flew along the survey lines.

The research team plans to conduct further targeted geophysical surveys and use the data to refine their models of the lakes' depths, circulation, hydrology and geology. They are also investigating the feasibility of using new technologies to reach the lakes through 560 and 740 metres of ice, respectively, to sample water and assess the lakes' chemical, physical and biological properties without contaminating them. Further studies of these isolated water bodies will improve understanding of the conditions needed for hypersaline subglacial lakes to exist on Earth and possibly enable researchers to use them as analogs for similar water bodies on other planets.

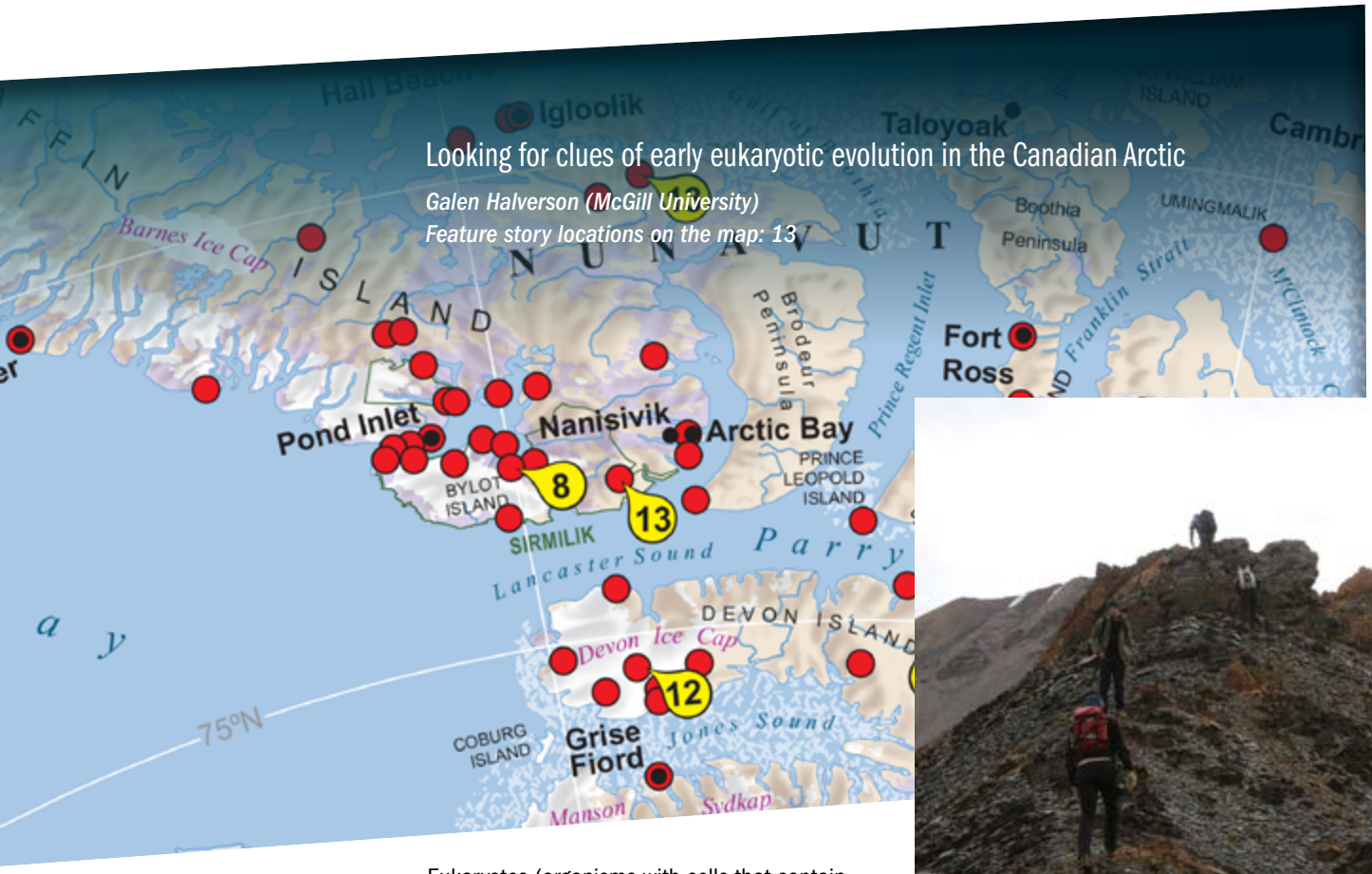
(left)
Researchers check instruments before a survey flight over Devon Ice Cap, Nunavut.

(right)
View from the aircraft during a survey flight to Devon Ice Cap, Nunavut

Looking for clues of early eukaryotic evolution in the Canadian Arctic

Galen Halverson (McGill University)

Feature story locations on the map: 13



A team of researchers scrambles up a shale ridge near Hematite Creek in the Wernecke Mountains, Yukon.

Eukaryotes (organisms with cells that contain nuclei, including plants, animals and fungi) likely emerged on Earth about 1.8 billion years ago as early forms of complex life. They subsequently evolved and diversified into different groups, which led to the development of plants and animals. However, the early history of eukaryotes and their impacts on ancient environments is largely unknown.

Northern Canada has an unusually complete and well-preserved stratigraphic record (rock layer sequence) that spans this poorly understood chapter in the evolution of life during the middle Proterozoic Eon (about 1.8 to 0.8 billion years ago). By investigating the geological record of the early life on Earth, researchers can improve understanding of the development of complex organisms. They can also learn more about the environmental conditions that supported their development and the timing of key events leading to the origin of animals and plants.

Galen Halverson and his research team have been examining the geological history of the Proterozoic Eon on northwestern Baffin Island, Nunavut, to improve understanding of ancient environments and early eukaryote evolution. They have conducted geological mapping of the area in addition to logging stratigraphy and collecting rock samples for dating, determining chemical composition and analysing fossils. Such geological field studies often require sampling at many locations across a large study area. The PCSP coordinated helicopters and fuel caching to allow Halverson's field team to reach key sites for sampling and to transport samples back to camp.

The research team specifically focused on microscopic *Bangiomorpha pubescens* fossils within their samples, which represent a species of ancient red algae. These fossils are remarkable because they closely resemble modern red algae, while other early eukaryotes do not look like their present-day relatives.

A student examines rocks formed on an ancient seabed in the Fury and Hecla Basin, Baffin Island, Nunavut.

> ***"This project is providing additional fossil data, as well as geological and geochemical constraints on when key eukaryotic lineages emerged, in what environments they appeared, and how they may have altered biogeochemical cycles."***
>
> – **Galen Halverson,**
> McGill University

Previous estimates for the age of *B. pubescens* fossils in rocks from Nunavut could only narrow down their age to a 500 million year span between about 1.2 and 0.7 billion years old, leaving much uncertainty about the chronology of early photosynthesizing eukaryotes. Having more precise dating of this fossil was needed to determine its importance in evolution, as well as improve analyses of eukaryote diversification.

The research team used a recently developed process, Rhenium-Osmium dating, to date the rocks containing *B. pubescens* fossils. They were found to be 1.05 billion years old, which is 150 million years younger than previous estimates for these fossils. Since no other fossils of complex organisms older than 800 million years can be identified using plant taxonomy (classification), *B. pubescens* represents the oldest complex lifeform in the geological record. It was the first multicellular organism to use photosynthesis and known to reproduce sexually, which makes this fossil particularly important for understanding the evolution of early plants and animals.

The new precise date for the appearance of *B. pubescens* also provides greater accuracy for analyses that determine the timing of important diversification events for different species of plants and animals. Using the new date, the research team conducted molecular clock analyses (computer modelling that examines changes to DNA [deoxyribonucleic acid] in organisms over time). This determined that the first algae appeared on Earth about 1.25 billion years ago.

These precise ages for the emergence of this algal lineage will enable enhanced modelling of their diversification into different lineages. They will also improve knowledge about the introduction of photosynthesis to the eukaryotes realm and the impacts of this biological innovation on the environment. The research team plans to continue studying Proterozoic-aged rocks in Nunavut, Yukon and Greenland to improve understanding of the early development of eukaryotes and the environmental conditions that fostered their development and diversification.

Investigating the origin of precious metal-bearing metalliferous black shales of the Yukon

Jan Peter and Michael Gadd (Natural Resources Canada)

Featured story location on the map: 14

Collecting samples from a rock outcrop in the Ogilvie Mountains, Yukon

Yukon has some of the best examples of highly metalliferous (metal-containing) black shales in the world. In this region, these organic-rich sedimentary rocks have layers that are strongly enriched with metals including zinc, nickel, molybdenum, selenium, uranium, vanadium, gold, platinum, and palladium. Known as hyper-enriched black shales (HEBS), these deposits are of potential economic interest to Canada, but a lack of information about how they form is hindering exploration activity. Similar HEBS are being mined in Finland and China. Studies of HEBS formation processes will enable further exploration and possible future development of these valuable metal deposits in Canada.

The HEBS in Yukon formed when the present-day region was part of an ocean basin. Several theories exist on how metals are deposited to form HEBS, including seafloor hydrothermal vent activity, meteor impact and precipitation from ocean water. Jan Peter, Michael Gadd and their collaborators at the Geological Survey of Canada, Yukon Geological Survey and Queen's University are investigating the properties of the HEBS in the Ogilvie Mountains and Wernecke Mountains, Yukon. The goal of this research is determine the formation processes of the HEBS in this region.

In the summer of 2018, the research team examined exposures of HEBS and their host (surrounding) rocks in cliff faces along rivers and creeks in two study areas. They found thin layers (<10 centimetres thick) of metal sulphides, including pyrite, within black shale deposits and sampled rock from stratigraphic sections (rock layers). The samples are being analysed for chemical composition, conodont elements (part of an extinct hagfish that can be used to date rock layers) and metals and minerals present in the rocks. As part of this project, graduate student Mikael Haimbodi is comparing the HEBS of northern Yukon with others in British Columbia to determine if they were formed by similar processes.

Determining sampling locations along a river channel in the Nick Prospect area, Yukon

Examining a metalliferous shale horizon (distinctive layer) in the Nick Prospect area, Yukon

Geologists determine sample points on a rock face near Monster River, Yukon.

Helicopter support, arranged by the PCSP, was vital for this fieldwork because it allowed the research team to move efficiently among sampling sites across a large area where roads are not present. The PCSP also provided field equipment, including field communications, safety supplies, clothing and camp items, and organized shipment of these goods for the project.

The research team found that the stratigraphy and properties of HEBS at different locations across Yukon are notably similar, suggesting that they formed at the same time and under similar conditions. They also found fossils of an ancient woody plant, thought to be a lycopsid, in HEBS at the two study sites and at Peel River, Yukon, where they conducted previous fieldwork.

The team is now investigating if these plants played a role in HEBS formation or if they indicate the environmental conditions at the time. Dating of conodont elements within the sulfide deposits of HEBS samples collected at Peel River indicated that the rocks are of Middle Devonian age (386.9 to 389.2 million years old). Further dating of samples from 2018 will refine the age of HEBS and enable the research team to determine if mineralization (the deposition of metals) occurred over a single period or at different times across the region.

> ***"Unraveling the origin of this shale could have major economic implications, as well as offer clues into the atmosphere and hydrosphere during a critical juncture in Earth's history."***
>
> – **Jan Peter,**
> Natural Resources Canada

Findings to date suggest that the HEBS in Yukon likely formed after metals were deposited on the seafloor during a relatively brief period of about 2.3 million years under anoxic conditions (no oxygen was present). The anoxic conditions limited the breakdown of organic material and permitted metals to precipitate from ocean water. The research team also found that different types of sulfides in the HEBS hosted different metals, with pyrite hosting more precious metals than other sulfide minerals. Identifying the formation processes of HEBS over large areas will improve understanding of ancient atmosphere-ocean interactions and support further HEBS exploration in Yukon and other locations in western Canada.

Surveying a drained lake bed to determine water flow out of the lake during outburst floods at the Kaskawulsh Glacier, Yukon

A glaciology field camp on the summit of Agassiz Ice Cap, northern Ellesmere Island, Nunavut

A muskox stands on Herschel Island, Yukon.

List of supported projects in 2018 by field location

*Projects with field site locations in multiple territories and/or provinces are listed under each applicable region.

ALBERTA

Unmanned Aerial Vehicle (UAV) trials
Principal investigator: Richard Fortin, Natural Resources Canada (CFB Suffield)

Paleolimnological studies to distinguish the roles of river regulation and climate change on persistent low water levels in the Peace-Athabasca Delta
Principal investigator: Roland Hall, University of Waterloo (Fort Chipewyan)

Video series: Wildlife science in the oil sands region
Principal investigator: Danny Kingsberry, Environment and Climate Change Canada (Fort Chipewyan)

Lakes of the Peace-Athabasca Delta: hydrology and carbon balance
Principal investigator: Brent Wolfe, Wilfrid Laurier University (Fort Chipewyan and the Peace-Athabasca Delta)

BRITISH COLUMBIA

East-central British Columbia field program
Principal investigator: Bill Arnott, University of Ottawa (Castle Creek)

Landslide assessment potential
Principal investigator: Andrée Blais-Stevens, Natural Resources Canada (Whistler)

Annual field equipment request for training and fieldwork
Principal investigator: Michelle Côté, Natural Resources Canada (Sidney)

Haida Gwaii seismic network upgrade phase 2
Principal investigator: Scott Dodd, Natural Resources Canada (Haida Gwaii)

Annual training – Geological Survey of Canada, Vancouver
Principal investigator: Steve Irwin, Natural Resources Canada (Vancouver)

Liard Basin 2018 fieldwork
Principal investigator: Andrew Mort, Natural Resources Canada (Stone Mountain and Besa River)

MANITOBA

On-ice ecology of polar bears in Hudson Bay
Principal investigator: Andrew Derocher, University of Alberta (Churchill)

Lake ice fieldwork in the Experimental Lakes Area 2018*
Principal investigator: Hugo Drouin, Natural Resources Canada (Winnipeg)

TGI-5 Lynn Lake
Principal investigator: Christopher Lawley, Natural Resources Canada (Lynn Lake)

Sustaining hydroecological monitoring to assess state of the park in Wapusk National Park, Manitoba – 2018
Principal investigator: Chantal Ouimet, Parks Canada (Wapusk National Park)

A field camp on eastern Cornwallis Island, Nunavut

Assessing the extent and impact of lesser snow goose at larger spatial scales in Wapusk National Park: Parks Canada and Hudson Bay Project collaboration, rapid assessment protocol, and the combination of existing and new sampling sites – 2018
Principal investigator: Chantal Ouimet, Parks Canada (Wapusk National Park)

Interactions between red foxes and Arctic foxes at the Arctic's edge
Principal investigator: James Roth, University of Manitoba (Wapusk National Park)

NEW BRUNSWICK

Assessing groundwater vulnerability to deep industrial activities in a shale gas prospective area, southern New Brunswick
Principal investigator: Christine Rivard, Natural Resources Canada (Sussex)

NEWFOUNDLAND AND LABRADOR

GEM-2 North Atlantic Craton, Labrador
Principal investigator: David Corrigan, Natural Resources Canada (Hopedale and Nain)

Estimating the abundance of polar bears in Davis Strait*
Principal investigator: Markus Dyck, Government of Nunavut (St. John's Harbour)

NORTHWEST TERRITORIES

Teleseismic structure of the crust and mantle beneath Banks Island, Northwest Territories
Principal investigator: Pascal Audet, University of Ottawa (Ulukhaktok and Inuvik)

Assessing terrain sensitivity to permafrost thaw and fire to understand and predict boreal caribou habitat and forage quality in the Sahtú
Principal investigator: Jennifer Baltzer, Wilfrid Laurier University (Norman Wells)

Remote sensing and modelling of hydrology-permafrost interactions
Principal investigator: Aaron Berg, University of Guelph (Trail Valley Creek)

State and evolution of Canada's glaciers/Essential Climate Variable (ECV) mass balance – Queen Elizabeth Islands, Nunavut and Northwest Territories*
Principal investigator: David Burgess, Natural Resources Canada (Melville Ice Cap)

Investigations of permafrost and climate change, western Arctic Canada
Principal investigator: Christopher Burn, Carleton University (Garry Island and Illisarvik)

Synthesis of Glacial History and Dynamics in the Rae Geological Province
Principal investigator: Janet Campbell, Natural Resources Canada (Aylmer Lake)

Tombstone Park bioblitz and species at risk surveys in the northern Yukon*
Principal investigator: Syd Cannings, Environment and Climate Change Canada (Inuvik)

Investigation into the extent of slumping and its impact on landscape morphology within the Thomsen River Watershed in Aulavik National Park (Northwest Territories)
Principal investigator: Hayleigh Conway, Parks Canada (Aulavik National Park and Inuvik)

Geohazards and methane release in coastal permafrost settings*
Principal investigator: Scott Dallimore, Natural Resources Canada (Tuktoyaktuk)

Annual maintenance of Environment and Climate Change Canada's automatic weather station array – Arctic Archipelago*
Principal investigator: Rich DeVall, Environment and Climate Change Canada (Cape Providence and Mould Bay)

Delineating and characterizing habitats critical for Arctic char, Dolly Varden, and Pacific salmon in the lower Hornaday River watershed
Principal investigator: Karen Dunmall, Fisheries and Oceans Canada (Paulatuk)

State and evolution of Canada's glaciers: mass balance northern cordillera, Northwest Territories
Principal investigator: Mark Ednie, Natural Resources Canada (Bologna Glacier)

Unloading a Twin Otter on eastern Cornwallis Island, Nunavut

Site visit to allow for the transfer of a remediated site on federal land to territorial land – Johnson Point, Northwest Territories
Project lead: Andrea Ellis, Department of Environment and Natural Resources, Government of Northwest Territories (Inuvik and Johnson Point)

Sub-Arctic Metal Mobility Study (SAMMS)
Principal investigator: Michael English, Wilfrid Laurier University (Whatǰ and Yellowknife)

Shale Basin evolution in the Northwest Territories mainland
Principal investigator: Kathryn Fiess, Northwest Territories Geological Survey, Government of Northwest Territories (Carcajou River, Dodo Canyon, Powell Creek and Rumbly Creek)

Stratigraphic history and sources of geochemical anomalies in the southern Misty Creek embayment
Principal investigator: Beth Fischer, Northwest Territories Geological Survey, Government of Northwest Territories (Mile 222, Mackenzie Mountains)

Deglaciation of the Mackenzie Valley and meltwater routing to the Arctic Ocean
Principal investigator: Duane Froese, University of Alberta (Katherine Creek, Little Bear River and Hare Indian River)

Population assessment of Dolly Varden 2018*
Principal investigator: Colin Gallagher, Fisheries and Oceans Canada (Big Fish River and Rat River)

Understanding changes in aquatic ecosystem health and water quality in the Fort Good Hope (Ramparts area)
Principal investigator: Kirsty Gurney, Environment and Climate Change Canada (Fort Good Hope)

GEM-2 Richardson Mountains
Principal investigator: Thomas Hadlari, Natural Resources Canada (Aklavik)

Impacts of natural and anthropogenic disturbances on the aquatic health of tundra lakes in the Upland region northeast of Inuvik, Northwest Territories
Principal investigator: Erika Hille, Aurora Research Institute, Aurora College (Pingo Bluff, Noell Lake and Inuvik)

Mountain peaks in the Bonnet Plume Range near Goz Creek in the Wernecke Mountains, Yukon

Beaufort Sea coastal restoration: the potential for using native plant species to stabilize coastline affected by permafrost thaw slumping
Principal investigator: Erika Hille, Aurora Research Institute, Aurora College (Pelly Island, Ellice Island, Water Lake and James Creek)

The effects of muskox on caribou in the Yukon North Slope and Richardson Mountains*
Principal investigator: Murray Humphries, McGill University (Richardson Mountains)

Comprehensive bedrock mapping of the Central Slave Province, Northwest Territories
Principal investigator: Bernadette Knox, Northwest Territories Geological Survey, Government of Northwest Territories (Dragon Lake, Jolly Lake and Mohawk Lake)

Integrated methods to monitor permafrost geohazards, northwestern Northwest Territories
Principal investigator: Steve Kokelj, Northwest Territories Geological Survey, Government of Northwest Territories (Inuvik)

Lake ecosystem change at the southern limit of permafrost
Principal investigator: Jennifer Korosi, York University (Fort Simpson)

Vegetation change in the western Arctic
Principal investigator: Trevor Lantz, University of Victoria (Sachs Harbour, Deep Creek Cabin and Tuktoyaktuk Peninsula)

Beluga habitat work at East Whitefish and Hendrickson Island
Principal investigator: Lisa Loseto, Fisheries and Oceans Canada (East Whitefish and Hendrickson Island)

Eastern Beaufort Sea beluga: Prey interactions and habitat use
Principal investigator: Lisa Loseto, Fisheries and Oceans Canada (Ulukhaktok and Hendrickson Island)

Northwest Territories Ice Patch Monitoring Program
Principal investigator: Glen MacKay, Prince of Wales Northern Heritage Centre (Norman Wells)

Bedrock mapping and stratigraphic studies, Mackenzie Mountains, 2018 (GEM program)
Principal investigator: Robert MacNaughton, Natural Resources Canada (Poacher Lake and Dal Lake)

Hydrological studies of the Mackenzie Delta region
Principal investigator: Philip Marsh, Wilfrid Laurier University (Trail Valley Creek)

Tectonostratigraphy of the Nonacho Group basin and nature of basement rocks of the Rae Craton, Northwest Territories
Principal investigator: Edith Martel, Northwest Territories Geological Survey, Government of Northwest Territories (Hjalmar Lake, Nonacho Lake and Sparrow Bay)

Examining the genetic adaptation of white spruce to climate change on a latitudinal transect in Northwest Territories
Principal investigator: Jean-Philippe Martin, Brock University (Inuvik and Norman Wells)

Identifying essential habitat and defining the thermal niche of Dolly Varden in the Canadian Western Arctic
Principal investigator: Neil Mochnacz, Fisheries and Oceans Canada (Fish Creek)

Transportation Resilience in the Arctic informed by Landscape Systems (TRAILS): permafrost and terrain research
Principal investigator: Peter Morse, Natural Resources Canada (Inuvik)

Vulnerabilities of Arctic cod early life stages to changing oceanographic conditions in Arctic coastal embayments
Principal investigator: Andrea Niemi, Fisheries and Oceans Canada (Inuvik and Franklin Bay)

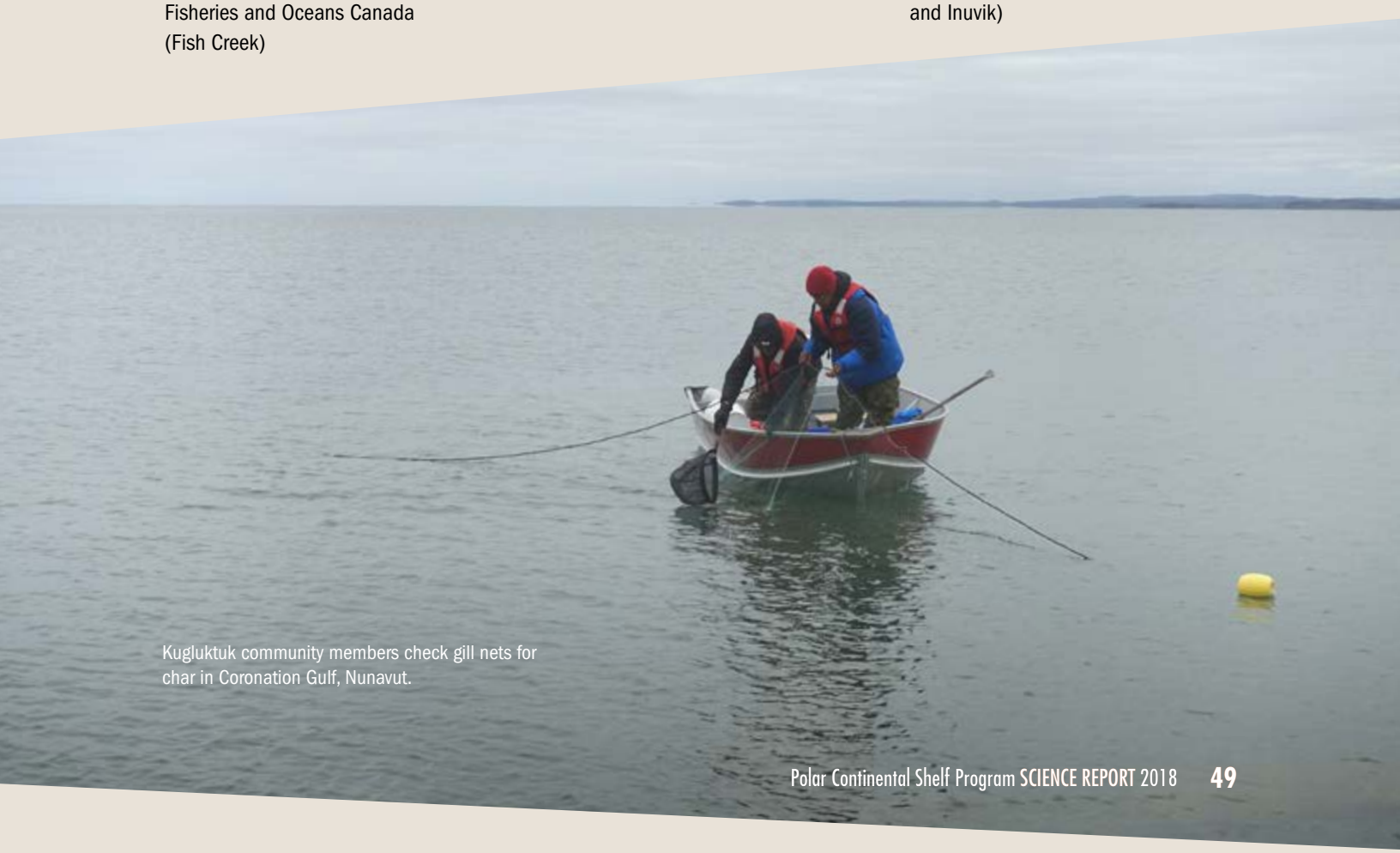
The Quaternary stratigraphy and placer gold potential of the Redstone River, Northwest Territories
Principal investigator: Philippe Normandeau, Northwest Territories Geological Survey, Government of Northwest Territories (Wrigley Lake)

Southern MacKenzie Surficial (GEM-2)
Principal investigator: Roger Paulen, Natural Resources Canada (Hay River)

Paleoecological studies of forest fires and climate change in the Canadian Subarctic
Principal investigator: Michael Pisaric, Brock University (Yellowknife)

Collecting digital imagery of significant cultural sites in Aulavik National Park
Principal investigator: Ashley Piskor, Parks Canada (Aulavik National Park and Inuvik)

Western Arctic snow goose management and habitat assessment
Principal investigator: Eric Reed, Environment and Climate Change Canada (Sachs Harbour, Siksik Lake and Inuvik)



Kugluktuk community members check gill nets for char in Coronation Gulf, Nunavut.

Integrating fixed-wing and helicopter surveys to improve detection and species identification of breeding scoters
Principal investigator: Eric Reed, Environment and Climate Change Canada (Lynx Lake)

Abrupt change within the discontinuous zone
Principal investigator: Wendy Sladen, Natural Resources Canada (Yellowknife)

Changing permafrost conditions in the Mackenzie Valley
Principal investigator: Sharon Smith, Natural Resources Canada (Inuvik and Norman Wells)

GEM-2 - Western Arctic: Smoking Hills project
Principal investigator: Rod Smith, Natural Resources Canada (Smoking Hills)

COnstrained Productivity Estimate (COPE)
Principal investigator: Oliver Sonnentag, Université de Montréal (Scotty Creek, Smith Creek and Trail Valley Creek)

Land-water linkages and the fate of terrestrial carbon in aquatic ecosystems of the western Canadian Arctic
Principal investigator: Suzanne Tank, University of Alberta (Inuvik and Fort McPherson)

Producing an accurate forage quality map for barren-ground caribou using UAV and satellite images
Principal investigator: David Tavares, Parks Canada (Uyarsavik Lake and Melville Hills)

Beaufort Sea coastal dynamics: Climate-driven change*
Principal investigator: Dustin Whalen, Natural Resources Canada (Pelly Island, Tuktoyaktuk and Inuvik)

Abrupt change within the discontinuous permafrost zone
Principal investigator: Stephen Wolfe, Natural Resources Canada (Yellowknife)

NOVA SCOTIA

Atmospheric deposition
Principal investigator: Philippa Huntsman, Natural Resources Canada (Goldenville)

NUNAVUT

Impacts of ship-source air pollutant emissions on lake ecosystem health in the Arctic
Principal investigator: Julian Aherne, Trent University (Iqaluit)

Karrak Lake assessment of continental efforts at population reduction of light geese
Principal investigator: Ray Alisauskas, Environment and Climate Change Canada (Karrak Lake and Perry River)

Long-term monitoring at FOX-C Ekalugad Fjord
Principal investigator: Jean Allen, Crown-Indigenous Relations and Northern Affairs Canada (Ekalugad Fiord)

Environmental change in aquatic ecosystems of northern Ellesmere Island
Principal investigator: Dermot Antoniades, Université Laval (Stuckberry Point)

Telehealth Program Development
Principal investigator: Glenn Austin, Health Canada/Indigenous Services Canada (Iqaluit)

Arctic housing demonstration towards net-zero
Principal investigator: Carsen Banister, National Research Council Canada (Iqaluit)

Arctic ventilation collaborative research project
Principal investigator: Carsen Banister, National Research Council Canada (Iqaluit)

Ecology of Arctic and red fox on Bylot Island
Principal investigator: Dominique Berteaux, Université du Québec à Rimouski (Bylot Island)

Ecology of Migratory Birds in the Canadian Arctic
Principal investigator: Joël Bêty, Université du Québec à Rimouski (Bylot Island)

Arctic Sea Ice Training (SmartICE)
Principal investigator: Eric Bing, Transport Canada (Qikiqtarjuaq)

A researcher examines a bluff along the Old Crow River, Yukon, to look for fossils.

Palaeoecology and evolution of Early Palaeozoic fishes
Principal investigator: Martin Brazeau, Imperial College London, United Kingdom (Read Bay and Snowblind Bay)

Lake ice in the Canadian High Arctic
Principal investigator: Laura Brown, University of Toronto Mississauga (Resolute and Polar Bear Pass)

State and evolution of Canada's glaciers/Essential Climate Variable (ECV) mass balance – Queen Elizabeth Islands, Nunavut and Northwest Territories*
Principal investigator: David Burgess, Natural Resources Canada (Agassiz Ice Cap, Devon Ice Cap, Meighen Ice Cap and Grise Fiord)

Glacier monitoring on Axel Heiberg Island
Principal investigator: Luke Copland, University of Ottawa (Expedition Fiord)

Hudson-Ungava Project: shallow geophysical imaging of the Paleozoic Hudson Platform in Manitoba
Principal investigator: Jim Craven, Natural Resources Canada (Coral Harbour)

Diversity, dynamics and dispersion of wild viruses in the Canadian High Arctic
Principal investigator: Alexander Culley, Université Laval (Ward Hunt Island)

Annual maintenance of Environment and Climate Change Canada's automatic weather station array – Arctic Archipelago*
Principal investigator: Rich DeVall, Environment and Climate Change Canada (Svarteveag, Cape Liverpool, Isachsen, Rae Point, Eureka, Grise Fiord, Fort Ross, Umingmalik and Stefansson Island)

Climate change in the High Arctic: impact on wildlife and permafrost carbon stocks
Principal investigator: Florent Domine, Université Laval (Bylot Island)

Estimating the abundance of polar bears in Davis Strait*
Principal investigator: Markus Dyck, Government of Nunavut (Jackman Sound, Kimmirut, York Sound and Allen Island)

An Arctic fox with an ear tag at Karrak Lake, Nunavut

Fuel cache clean up for Baffin Bay polar bear project
Principal investigator: Markus Dyck, Government of Nunavut (Cape Hunter)

Impact of year-round ice conditions on Arctic seabirds
Principal investigator: Kyle Elliott, McGill University (Coats Island)

A weather station network near Cambridge Bay to support safe travel and fundamental boundary layer meteorology research
Principal investigator: Brent Else, University of Calgary (Cambridge Bay, 30-Mile River, Qikirtaarjuk Island and Melbourne Island)

Sirmilik National Park operations 2018
Principal investigator: Carey Elverum, Parks Canada (Sirmilik National Park)

Disturbance and transformation of permafrost Arctic geosystems
Principal investigator: Daniel Fortier, Université de Montréal (Bylot Island)

Inuinnait Heritage: a collaborative approach to archaeological research in the Canadian Arctic
Principal investigator: Max Friesen, University of Toronto (Bathurst Inlet)

Population biology of tundra birds and small mammals: demography, trophic interactions and climate change
Principal investigator: Gilles Gauthier, Université Laval (Bylot Island)

Shared Services Canada set-up at the Canadian High Arctic Research Station
Principal investigator: Heather Geddes, Shared Services Canada (Cambridge Bay)

Sentinel North International Arctic Field School
Project lead: Marie-France Gévry, Université Laval (Iqaluit)

Population studies of eider ducks breeding at East Bay Island and thick-billed murres breeding at Coats Island, Nunavut
Principal investigator: Grant Gilchrist, Environment and Climate Change Canada (Coats Island, East Bay and East Bay Island)

Connections between the Arctic and distant ecosystems through animal migrations: Consequences on trophic interactions in the Arctic
Principal investigator: Marie-Andrée Giroux, Université de Moncton (Igloolik Island)

Periglacial geomorphology investigation study in permafrost at the Haughton impact structure and surrounding terrains, Devon Island, Nunavut
Principal investigator: Etienne Godin, University of Western Ontario (Haughton impact structure)

Canadian Arctic Sea Ice Mass Balance Observatory (CASIMBO)
Principal investigator: Christian Haas, York University (Alert)

Onshore stratigraphic studies, northwest Baffin Bay
Principal investigator: Jim Haggart, Natural Resources Canada (Clyde River and Pond Inlet)

Ocean-forcing of marine-terminating glaciers in the Canadian High Arctic
Principal investigator: Andrew Hamilton, University of Ottawa (Talbot Inlet and Grise Fiord)

Species and ecosystem constraints on increasing vegetation cover in the High Arctic in a warming climate
Principal investigator: Greg Henry, University of British Columbia (Alexandra Fiord, Sverdrup Pass and Princess Marie Bay)

Assessing risks of food- and vector-borne diseases in wildlife in the Canadian Arctic
Principal investigator: Emily Jenkins, University of Saskatchewan (Karrak Lake)

Repeater tower sites to support SAR in Arctic Bay
Project lead: Deborah Johnson, Hamlet of Arctic Bay (Admiralty Inlet)

Joint Arctic Experiment
Principal investigator: Martin Kegel, Natural Resources Canada (Cambridge Bay)

Canadian Northern Economic Development Agency visit to Iqaluit for Inuit Qaujimajatuqangit Days
Project lead: Janet King, Canadian Northern Economic Development Agency (Iqaluit)

Dynamics and climatic sensitivity of a High Arctic ecosystem: study of spatial heterogeneity of soil-snow-vegetation interactions
Principal investigator: Christophe Kinnard, Université du Québec à Trois-Rivières (Bylot Island)

Integrated watershed and terrestrial research to improve water security in the High Arctic
Principal investigator: Scott Lamoureux, Queen's University (Cape Bounty, Eleanor River and McMaster River)

Greenhouse gas emissions from Arctic lakes: processes that accelerate the mineralization of organic matter released by thawing permafrost
Principal investigator: Isabelle Laurion, Institut national de la recherche scientifique (Qarlikturvik Valley)

Baffin Island goose banding
Principal investigator: Jim Leafloor, Environment and Climate Change Canada (Koukjuak River and Nikko Island)

Southampton Island goose banding
Principal investigator: Jim Leafloor, Environment and Climate Change Canada (Coral Harbour and East Bay)

Survival in Arctic geese (Perry River, Queen Maud Gulf Bird Sanctuary)
Principal investigator: Jim Leafloor, Environment and Climate Change Canada (Perry River)

Nunavut transportation & transmission
Principal investigator: Anne-Marie LeBlanc, Natural Resources Canada (Rankin Inlet)

Arctic IMPACT: Arctic Integrative Monitoring of Predators in the Arctic Tundra
Principal investigator: Nicolas Lecomte, Université de Moncton (Bylot Island and Igloolik Island)

Population dynamics of the greater snow goose in relation to habitat
Principal investigator: Josée Lefebvre, Environment and Climate Change Canada (Bylot Island)

Climate change impacts on mercury and methylmercury sources to Arctic ecosystems
Principal investigator: Igor Lehnherr, University of Toronto-Mississauga (Lake Hazen)

Coronation and Amundsen Gulf chars: Essential elements of diversity, habitats and conservation in northern sea-run fishes
Principal investigator: Tracey Loewen, Fisheries and Oceans Canada (Kugluktuk)

Stress-mediated mechanisms linking individual state, climate variability and population health in Arctic breeding birds
Principal investigator: Oliver Love, University of Windsor (East Bay and East Bay Island)

Quttinirpaaq National Park operating season 2018 and federal infrastructure initiative
Principal investigator: Jennifer Lukacic, Parks Canada (Quttinirpaaq National Park)

Canadian Arctic Underwater Sentinel Experimentation (CAUSE) Project
Principal investigator: Erin MacNeil, Defence Research and Development Canada (Gascoyne Inlet)

Contaminants in Arctic seabirds – Prince Leopold Island
Principal investigator: Mark Mallory, Acadia University (Prince Leopold Island)

Determining bycatch of seabirds in Arctic fisheries: updating colony census data
Principal investigator: Mark Mallory, Acadia University (Pond Inlet)

Tracking annual movements of Arctic terns from the Canadian High Arctic
Principal investigator: Mark Mallory, Acadia University (Tern Island)

Ecosystem Approach in Tremblay Sound (EAT) 2018
Principal investigator: Marianne Marcoux, Fisheries and Oceans Canada (Tremblay Sound and Bylot Island)

Gascoyne Inlet
Principal investigator: Eric McDonald, Natural Resources Canada (Gascoyne Inlet)

Joint Arctic Experiment
Principal investigator: Eric McDonald, Natural Resources Canada (Cambridge Bay)

Multidisciplinary Arctic Program (MAP) – Last Ice
Principal investigator: Christine Michel, Fisheries and Oceans Canada (Alert)

Disappearing ice
Principal investigator: Gifford Miller, University of Colorado Boulder (Pond Inlet)

PACEMAP
Principal investigator: Gifford Miller, University of Colorado Boulder (Qikiqtarjuaq)

The analytical quandary of chert quarries: A multi-scalar approach to understanding Palaeo-Eskimo technological organization and novice skill on southern Baffin Island
Principal investigator: Brooke Milne, University of Manitoba (Mingo Lake, Mingo River and Hone River)

VHF radio repeater maintenance
Project lead: Mona Milton, Mittimatalik Hunters and Trappers Organization (Eclipse Sound and Milne Inlet)

Milne Fiord ice-ocean interactions: Implications for the stability of ice shelves and glaciers in the polar regions
Principal investigator: Derek Mueller, Carleton University (Purple Valley Strip, Milne Ice Shelf and Milne Glacier)

Investigating potential effects of climate warming on trends of mercury and persistent organic pollutants in arctic aquatic and terrestrial environments
Principal investigator: Derek Muir, Environment and Climate Change Canada (Cape Bounty and Resolute)

Effects of overabundant Arctic geese on other tundra nesting birds
Principal investigator: Erica Nol, Trent University (East Bay)

Nunavut transportation & transmission
Principal investigator: Greg Oldenborger, Natural Resources Canada (Rankin Inlet)

Geological framework of the northern Rae Province on eastern Devon and southeastern Ellesmere Islands
Principal investigator: Gordon Osinski, University of Western Ontario (Dundas Harbour)

Igloolik engagement visit
Project lead: Lashawna Phillips, Natural Resources Canada (Igloolik)

Evolution of postglacial landscapes and hydrological gateways in the Foxe Basin-Nettilling Lake region, Nunavut
Principal investigator: Reinhard Pienitz, Université Laval (Pangnirtung)

A view to the west in the Bonnet Plume Range of the Wernecke Mountains, Yukon

A field camp on eastern Cornwallis Island, Nunavut

GEM Program Creswell Camp Site Visit
Project lead: Michel Plouffe, Natural Resources Canada (Creswell Bay)

McGill Arctic Research Station (MARS) Science Program
Principal investigator: Wayne Pollard, McGill University (Expedition Fiord)

The McGill Arctic Research Initiative: MARI 2018
Principal investigator: Wayne Pollard, McGill University (Resolute and Expedition Fiord)

The vulnerability of High Arctic permafrost to climate change
Principal investigator: Wayne Pollard, McGill University (Eureka and Expedition Fiord)

Functional, structural and biodiversity studies of Arctic freshwater watersheds: validating protocols for monitoring and cumulative impacts assessment
Principal investigator: Michael Power, University of Waterloo (Cambridge Bay)

Arctic Shorebird Monitoring Program (Arctic PRISM) – Tier 1 surveys
Principal investigator: Jennie Rausch, Environment and Climate Change Canada (Mingo Lake and Pond Inlet)

Population studies of shorebirds at Nanuit Itillinga (Polar Bear Pass) National Wildlife Area, Nunavut (Arctic PRISM Tier 2 Site)
Principal investigator: Jennie Rausch, Environment and Climate Change Canada (Nanuit Itillinga (Polar Bear Pass) National Wildlife Area)

Polar Knowledge Canada 2018
Project lead: Grant Redvers, Polar Knowledge Canada (Cambridge Bay)

GEM Program Meadowbank site visit
Project lead: Linda Richard, Natural Resources Canada (Baker Lake)

GEM-2 Boothia-Somerset: integrated geoscience of the Northwest Passage
Principal investigator: Mary Sanborn-Barrie, Natural Resources Canada (Creswell Bay)

Paleoeskimo demography of Foxe Basin, Nunavut
Principal investigator: James Savelle, McGill University (Jens Munk Island)

Dynamics and change of Canadian Arctic ice caps
Principal investigator: Martin Sharp, University of Alberta (Devon Ice Cap and Lake Hazen)

Qausuittuq National Park operations 2018
Principal investigator: Jovan Simic, Parks Canada (Qausuittuq National Park)

GEM-2 North Baffin bedrock mapping
Principal investigator: Diane Skipton, Natural Resources Canada (Isortoq River)

Population studies of shorebirds at East Bay Mainland, Nunavut
Principal investigators: Paul Smith and Jennie Rausch, Environment and Climate Change Canada (East Bay)

The Lake Hazen watershed as a sentinel of Arctic environmental change
Principal investigator: Vincent St. Louis, University of Alberta (Lake Hazen)

The effect of Arctic marine traffic on air quality in Arctic communities
Principal investigator: Ralf Staebler, Environment and Climate Change Canada (Resolute)

Fury and Hecla Geoscience Project
Principal investigator: Holly Steenkamp, Canada-Nunavut Geoscience Office (Gifford River)

Northern Ellesmere Island in the Global Environment – Sentinel North
Principal investigator: Warwick Vincent, Université Laval (Ward Hunt Island)

Northern Hudson Bay narwhal population aerial survey
Principal investigator: Cortney Watt, Fisheries and Oceans Canada (Naujaat)

Microbial investigations of permafrost and cold saline springs in the High Arctic
Principal investigator: Lyle Whyte, McGill University (Expedition Fiord)

2018 Ukkusiksalik National Park operations
Principal investigator: Monty Yank, Parks Canada (Ukkusiksalik National Park)

Canadian Armed Forces Arctic Training Centre (CAFATC) training activities based in Resolute, Nunavut, in 2018:

- Arctic Operations Advisor Course 2018
- Canadian Armed Forces Arctic Training Centre Operations 2018
- Canadian Forces School of Search and Rescue 2018
- Canadian Forces School of Survival and Aeromedical Training
- Command Visit to the Canadian Armed Forces Arctic Training Centre
- Joint Task Force North Operation Nunalivut
- NOREX 2018
- Opening Maintenance Visit Canadian Armed Forces Arctic Training Centre
- Operation Nanook 2018

ONTARIO

TGI-5 Activity, NC-1.3: Controls on the localization and timing of mineralized intrusions in intra-continental rift systems
Principal investigator: Wouter Bleeker, Natural Resources Canada (Lake Superior area)

Paleoseismic studies in eastern Canada
Principal investigator: Greg Brooks, Natural Resources Canada (Ottawa and Matheson)

Lake ice fieldwork in the Experimental Lakes Area 2018*
Principal investigator: Hugo Drouin, Natural Resources Canada (Experimental Lakes Area)

Canadian Geodetic Survey – Active control system general fieldwork 2018
Principal investigator: Stuart Elson, Natural Resources Canada (Algonquin)

Allan Lake – Algonquin Park
Principal investigator: Richard Fortin, Natural Resources Canada (Algonquin Provincial Park)

Lands and Minerals Sector occupational health and safety courses 2018
Project lead: Mohamed Habbane, Natural Resources Canada (Ottawa)

International Boundary Commission monument maintenance: West Line and St. Lawrence River*
Project lead: Joe Harrietha, Natural Resources Canada (St. Lawrence River area)

TGI-5 Cr-Ni project, summer 2018*
Principal investigator: Michel Houlé, Natural Resources Canada (Esker Camp)

A field camp to support paleontology research along the Old Crow River, Yukon

Natural Resources Canada international meeting
Project lead: Jennifer Pelley, Natural Resources Canada (Ottawa)

Health Portfolio Operations Centre Mobilizations
Project lead: Violaine Pilote, Public Health Agency of Canada (Ottawa)

Climate change -- suspended sediment studies
Principal investigator: Carrie Rickwood, Natural Resources Canada (Clearwater Lake, Junction Creek, Kelly Lake and Richard Lake)

TGI-5 Origin of Ni-Cu-PGE mineralization, mid-continent rift, western Ontario
Principal investigator: Jennifer Smith, Natural Resources Canada (Thunder Bay)

QUEBEC

Paleoseismic studies in central Canada
Principal investigator: Greg Brooks, Natural Resources Canada (Rouyn-Noranda)

Geoenvironmental characteristics of Canadian critical metal deposits
Principal investigator: Lori Campbell, Natural Resources Canada (Oka)

EGP Critical Metals – Oka Activity
Principal investigator: Alexandre Desbarats, Natural Resources Canada (Oka)

International Boundary Commission monument maintenance: West Line and St. Lawrence River*
Project lead: Joe Harrietha, Natural Resources Canada (Stanstead)

TGI-5 Cr-Ni project, summer 2018*
Principal investigator: Michel Houlé, Natural Resources Canada (Raglan)

Coastal oceanography of the east coast of James Bay
Principal investigator: Urs Neumeier, Université du Québec à Rimouski (James Bay area)

Characteristics of Canadian critical metal deposits
Principal investigator: Michael Parsons, Natural Resources Canada (Oka)

Geo-environmental study of the St. Lawrence Columbium Mine
Principal investigator: Jeanne Percival, Natural Resources Canada (Oka)

International Boundary Commission vista clearing contracts
Project lead: Joel Petit, Natural Resources Canada (Lac-Mégantic)

Survey fieldwork in the highlands, Quebec
Principal investigator: Rodger Reid, Natural Resources Canada (Lac-Mégantic)

Forestry operations
Project lead: Steve Thibeault, Natural Resources Canada (Baie-Comeau, La Tuque and Ottawa River areas)

SASKATCHEWAN

Canadian Geodetic Survey gravity and global positioning system fieldwork, Canadian Base Network, Saskatchewan
Principal investigator: Jason Silliker, Natural Resources Canada (Saskatoon)

TGI-5 U1.3 MT survey in the Patterson Lake corridor
Principal investigator: Victoria Tschirhart, Natural Resources Canada (Patterson Lake)

Uranium fluid pathways
Principal investigator: Victoria Tschirhart, Natural Resources Canada (Patterson Lake)

YUKON

Multi-scale assessment of environmental changes impact on sub-Arctic glacierized watersheds hydrology
Principal investigator: Michel Baraer, École de technologie supérieure (Upper Duke River and Grizzly Creek)

Tombstone Park bioblitz and species at risk surveys in the northern Yukon*
Principal investigator: Syd Cannings, Environment and Climate Change Canada (Tombstone Territorial Park and Eagle Plains)

Mass balance, dynamics and recent changes of glaciers in Kluane National Park, Yukon
Principal investigator: Luke Copland, University of Ottawa (Kaskawulsh Glacier and North Glacier)

Geohazards and methane release in coastal permafrost settings*
Principal investigator: Scott Dallimore, Natural Resources Canada (Herschel Island)

Northern and visiting students from the Sentinel North International Field School build igloos in Iqaluit, Nunavut.

A comprehensive analysis of surging glacier dynamics and controls in the Yukon Territory, Canada
Principal investigator: Christine Dow, University of Waterloo (Lowell Glacier)

Observational constraints on glacier form and flow, southwest Yukon, Canada
Principal investigator: Gwenn Flowers, Simon Fraser University (Kaskawulsh Glacier and Kaskawulsh Lake)

Population assessment of Dolly Varden 2018*
Principal investigator: Colin Gallagher, Fisheries and Oceans Canada (Babbage River)

Getting to the bottom of the ca. 900 Ma Hematite Creek Group, Wernecke Mountains, Yukon
Principal investigator: Galen Halverson, McGill University (Corn Creek and Mount Profeit)

The effects of muskox on caribou in the Yukon North Slope and Richardson Mountains*
Principal investigator: Murray Humphries, McGill University (Komakuk Beach, Babbage River, Herschel Island and Shoalwater Bay)

Fishing Branch River chum salmon habitat assessments
Principal investigator: William Josie, Vuntut Gwitchin Government (Eagle Plains)

GEM Cordillera Yukon tectonic evolution
Principal investigator: Dawn Kellett, Natural Resources Canada (Atlin)

Hydrological and Ecological Research in Vuntut National Park, Yukon
Principal investigator: Ian McDonald, Parks Canada (Old Crow)

Origin of hyper-enriched black shale Ni-Zn-PGE deposits, Yukon Territory
Principal investigator: Jan Peter, Natural Resources Canada (Dawson and Mayo)

Carlin-type gold mineralization, Rackla belt, Yukon
Principal investigator: Nicolas Pinet, Natural Resources Canada (Mackenzie Mountains)

Climate warming in northwest Canada during the Eocene "greenhouse" interval: field research in northern Yukon
Principal investigator: Alberto Reyes, University of Alberta (Fifteen Mile River and Johnson Creek)

GEM-2 Cordilleran Project: crustal structure, southeast Yukon
Principal investigator: Jim Ryan, Natural Resources Canada (McEvoy Lake and Whitehorse)

Subglacial drainage dynamics in the St. Elias Mountains
Principal investigator: Christian Schoof, University of British Columbia (Kaskawulsh Glacier and North Glacier)

Van Tat Gwich'in Historic Lifeways Project 2018–2019
Principal investigator: Shirleen Smith, Vuntut Gwitchin Government (Upper Johnson Creek and Upper Caribou Bar Creek)

Assessment of Dolly Varden stocks in Ivvavik National Park
Principal investigator: David Tavares, Parks Canada (Ivvavik National Park)

Identifying impacts of changes in climate and landscape on lake and river chemistry and hydrology in Old Crow Flats, Yukon, Canada
Principal investigator: Kevin Turner, Brock University (Old Crow)

Beaufort Sea coastal dynamics: Climate-driven change*
Principal investigator: Dustin Whalen, Natural Resources Canada (Herschel Island)

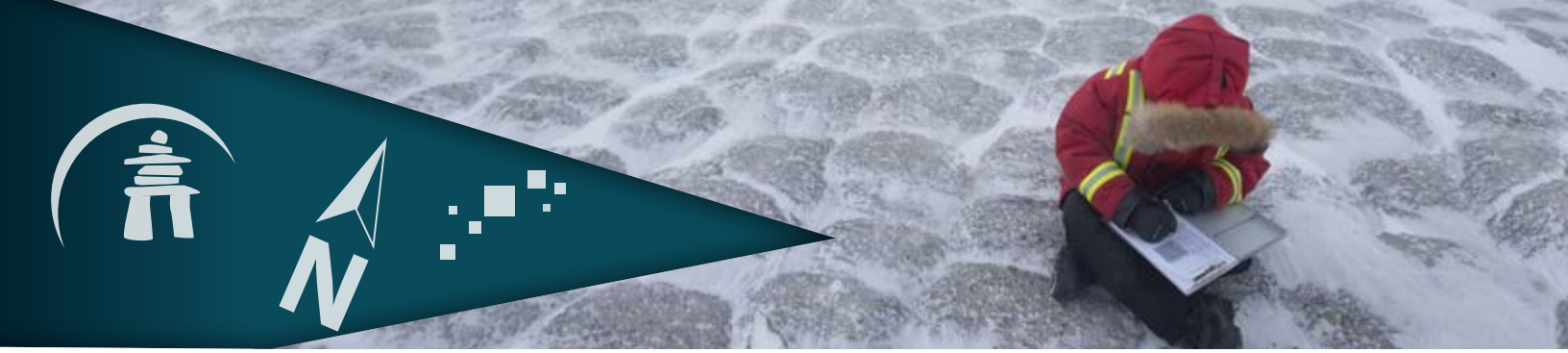
Are kokanee salmon spawning earlier in Kluane National Park and Reserve?
Principal investigator: Carmen Wong, Parks Canada (Sockeye Lake)

Pleistocene palaeontology and palaeoenvironments of the Old Crow Basin, northern Yukon
Principal investigator: Grant Zazula, Department of Tourism and Culture, Government of Yukon (Old Crow River)

INTERNATIONAL

Field equipment to support the launch of a Canadian Space Agency astronaut in Kazakhstan
Project lead: Canadian Space Agency (Moscow, Russia, and Baikonur, Kazakhstan)

Releasing a tagged char into the Coronation Gulf, Nunavut



Annex

PCSP Project Review Committee

The PCSP Project Review Committee (PRC) reviews and evaluates all logistics requests submitted by university-based researchers based on the PRC Scoring Guide. The guide includes four criteria: feasibility of the requested logistics; quality of the application; scientific recognition of the applicant; and student and local involvement and engagement. For more information regarding the review process for university applicants, contact the PCSP.

Members (2018)

Christopher Burn (Chair)
Department of Geography and
Environmental Studies
Carleton University

Michael Kristjanson
Polar Continental Shelf Program
Natural Resources Canada

Micheline Manseau
Landscape Science and Technology Division
Environment and Climate Change Canada

Erica Nol
Biology Department
Trent University

Roger Paulen
Geological Survey of Canada
Natural Resources Canada

Lyle Whyte
Department of Natural Resource Sciences
McGill University

A wide range of Pleistocene fossils found along the Old Crow River, Yukon