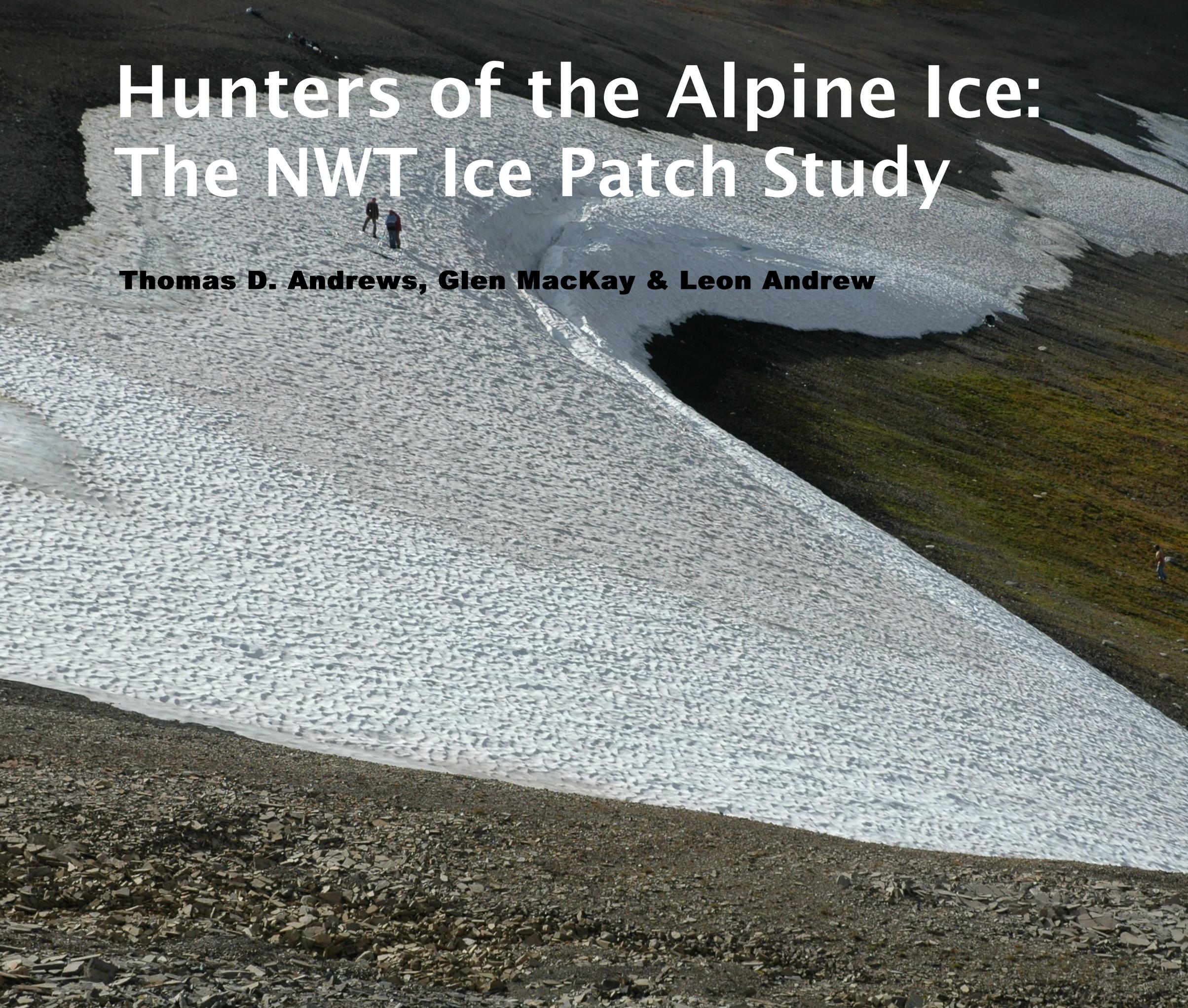


Hunters of the Alpine Ice: The NWT Ice Patch Study

An aerial photograph of a large, textured ice patch on a mountain slope. The ice is white and appears to be melting, with a dark, rocky foreground at the bottom. To the right, a grassy area is visible. Two people are standing on the ice patch in the upper left quadrant.

Thomas D. Andrews, Glen MacKay & Leon Andrew

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Caribou on a valley ice patch. These types of ice patches, though important to caribou, were not usually used for hunting because it is difficult to approach the animals without being seen.



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Some ice patches, like the ones shown above, can be very large, wrapping the north face of a mountain. On the facing page, note the black dung band around the ice patch and caribou trails approaching it.

The NWT Ice Patch Study

Drawing on the expertise of archaeologists, Aboriginal elders, biologists, geologists and educators, the NWT Ice Patch Study is a collaborative effort to learn and share knowledge about the human and environmental history of the Northwest Territories by investigating permanent ice patches in the Mackenzie Mountains. The pictures presented in this book represent over five years of research carried out in partnership with the Tulita Dene Band and many talented scientists. Our team has strived to conduct our work in a context that actively engages Aboriginal students in traditional knowledge and cutting edge northern science. The NWT Ice Patch Study is an International Polar Year Project funded by the Government of Canada.

More than mere lenses of ice, ice patches are frozen repositories of well-preserved archaeological artifacts and biological specimens. As illustrated in the pages of this book, truly exceptional archaeological artifacts are emerging from the ice as these features, which have persisted for nearly 5000 years, are increasingly under pressure from warming climates. Ice patches are providing exciting opportunities to learn about the precontact hunting weapons used by the ancestors of the Shuhtaot'ine (Mountain Dene), and provide a myriad of biological samples to study changes in mountain caribou ecology through time.

Our research team endeavors to collect and conserve these scientific treasures and to find innovative ways to unlock the secrets they hold. We also endeavor to share the exciting stories told by these objects with the people of the North in a way that includes the voices of Aboriginal elders, youth and scientists.

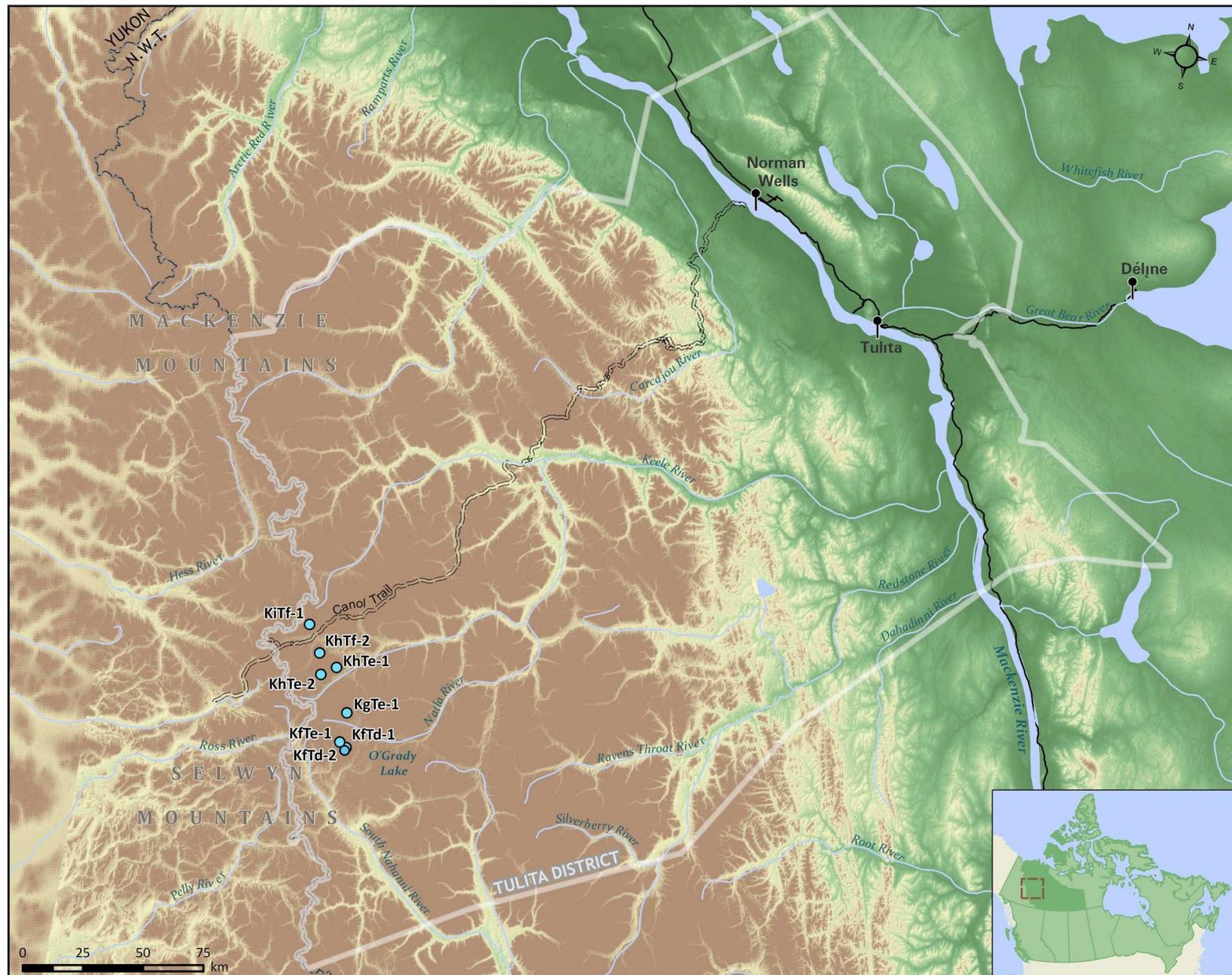
What is an Ice Patch?

An ice patch is an accumulation of annual snow that does not melt entirely away during the summer. Each year new snow is added to the previous accumulation and as the patch grows, it begins to compress into ice. Studies have shown that they are up to 5000 years old, though they do not grow at a constant rate. Instead, they grow in "fits and starts", with years of accumulation separated by numerous melting episodes.

Usually located above 1500 metres (5000 feet), ice patches form on the north-facing side of mountains, often in bowl-like features. They can range in size from a few metres to more than a kilometre long and can be up to 5 metres thick. In cross-section they show layers of ice or snow separated by bands of caribou dung.

Most importantly, ice patches are important caribou habitat in spring and summer. Since caribou are a cold-adapted species, when the weather begins to warm, melting the winter snow cover, they seek out these high elevation snow patches to keep cool. In summer, when mosquitos, blackflies, and warble flies are at their peak, the ice patches provide some relief from these biting insects. Because ice patches are used so intensely by caribou, they become covered in dung which becomes trapped in the ice as layers. When it melts, the dung pellets, sometimes still perfectly formed even though they can be thousands of years old, roll to the bottom edge creating thick mats of composting fecal matter.

Thousands of years ago hunters noticed that caribou use ice patches and began making special trips to hunt them. Sometimes they would lose a piece of hunting equipment which would be covered by the next winter's snow and eventually preserved in the ice patch. Today, because of global warming, the NWT's ice patches are melting, revealing well preserved ancient artifacts.



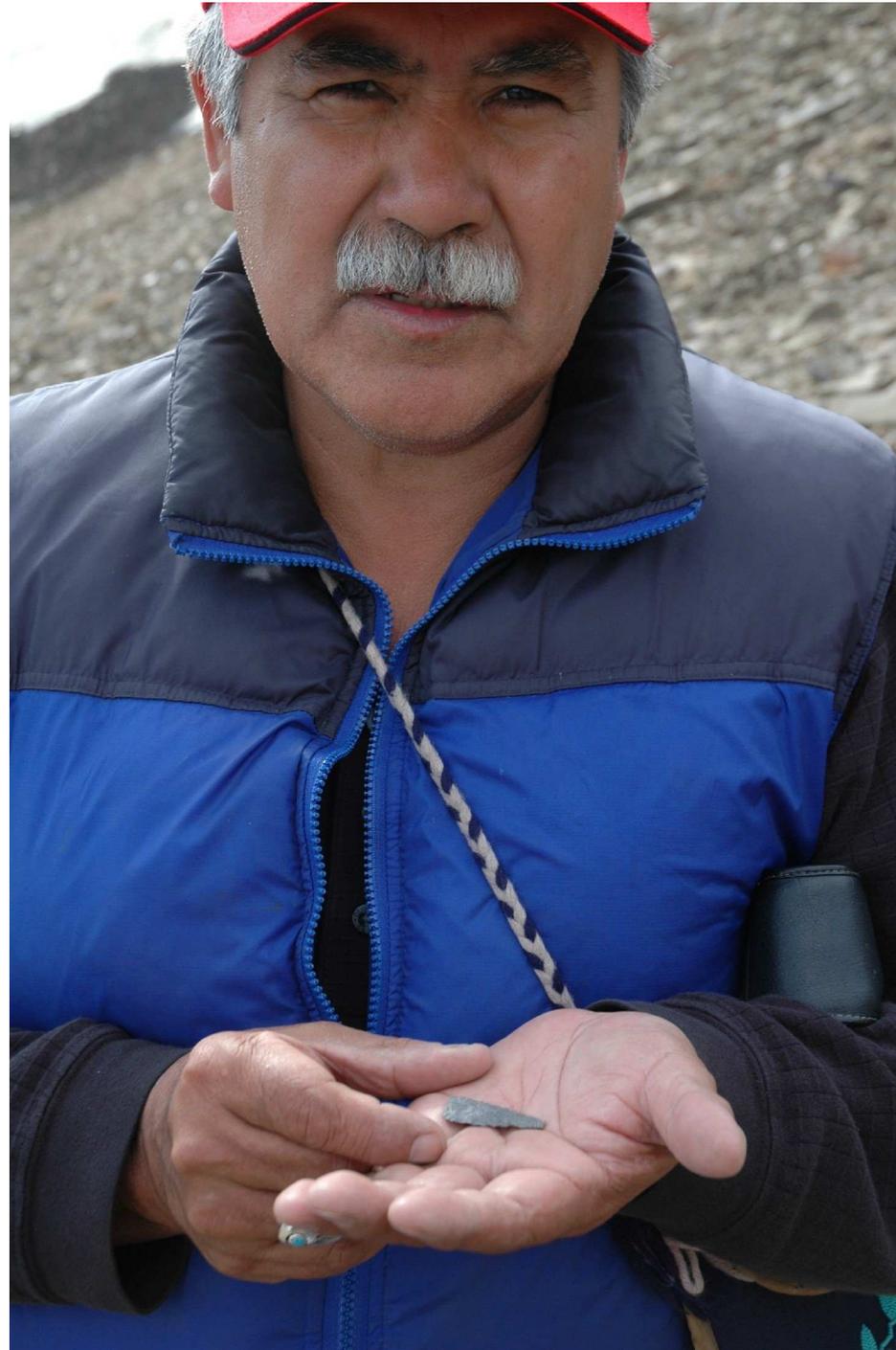
The study area is located in the Mackenzie and Selwyn Mountains north of O'Grady Lake close to the Yukon border, near the Canol Trail. The region is within the Tulita District of the Sahtu Dene and Metis Land Claim Settlement Area. The blue dots mark ice patches that have produced artifacts.

How do we do our research?

The research methods of the NWT Ice Patch Study range from wading through composted caribou dung at the base of an ice patch to peering through a microscope in a laboratory at minuscule plant remains, pollen and insect parts. We have spent several seasons surveying by helicopter to find permanent ice patches containing archaeological artifacts and biological specimens. We conduct our surveys in mid-August. This timing allows the ice patches to melt for most of the summer but also ensures that we get there before fresh snow falls and covers the exposed artifacts. We collect the fragile artifacts we find and return them to the Prince of Wales Northern Heritage Centre for conservation.

Our research team uses ground-penetrating radar and ice cores to understand the structure of ice patches to learn how ice patches formed over the past several thousand years, and how long it will take them to completely melt now that the climate is warming.

The samples our field team collect are studied by scientists with diverse interests. Radiocarbon dating of artifacts, bones, and layers of dung extracted from the ice patches tell us how long caribou and people have used the ice patches. Pollen, plant remains, insect parts and caribou parasites found in caribou dung are studied to learn about the diet and health of caribou over time, and environmental change. Small samples taken from artifacts are analyzed microscopically to determine what types of wood were used to make hunting weapons in the past. Collectively, these studies are helping us to learn new and exciting things about the human and environmental history of the Mackenzie Mountains.



Leon Andrew examining an arrowhead.



Glen MacKay carefully checking the lower margin of an ice patch. In this photo, the skirt of snow in front of him is unmelted from last winter and obscures the dung band beneath.



Helicopter support is needed to reach the ice patches, which are located at high elevations.



Haley Peterson and Brian Moorman use a ground-penetrating radar transmitter/receiver to study the ice structure. Can you see the caribou on the far end of the ice patch?



Tom Meulendyk and Brian Moorman with an ice core and their coring tool. Ice cores show that the patches are stratified, or banded, with layers of ice interspersed with layers of dark dung.



Brian Moorman with an ice core sample. Taking samples back to the lab allows us to study the structure of the ice. By radiocarbon dating the dung layers we can understand how old the ice patch is and how long it has been used by caribou.



Glen MacKay carefully recording an artifact find at the ice margin. Note the thick band of caribou dung that he is standing in.



When they melt from the ice, artifacts begin to dry and crack, and are susceptible to being blown away by the wind.



Sometimes we find ice patches that have melted entirely, leaving only a band of dung to mark their former presence.



Dung is a treasure trove of information and must be carefully sampled in the field.

Science on Ice

Ice patches in the Mackenzie Mountains are complex features that have formed through numerous cycles of freezing and melting over the past 5000 years. Their very presence raises many exciting research questions that our team is attempting to address using innovative scientific techniques. Why did permanent ice patches form in some places in the alpine region but not others? What is the internal structure of ice patches, and what does this tell us about climate change over the past 5000 years? As we face global warming, how long will these ice patches last?

We are using two methods to peer into the interior of ice patches. Ground-penetrating radar and ice coring enable us to visualize the layered structure of the patches. Using these techniques, we have determined that the ice patches consist of up to eight layers of caribou fecal matter separated by lenses of ice.

Providing a 5000 year record of caribou ecology in the alpine region, these layers of caribou dung are also of great value to scientists that study changes in caribou diet and disease, climate, and vegetation patterns over long time spans. As the photographs in this section of the book illustrate, we are making significant progress in unlocking the microscopic secrets held in caribou dung extracted from ice patches in the Mackenzie Mountains.

Other studies have just begun and will take years to complete. For example, by using DNA analysis to examine dung and bone samples, scientists are trying to understand changes in caribou population genetics over time. Results from this research may help manage caribou that range in the Mackenzie Mountains.

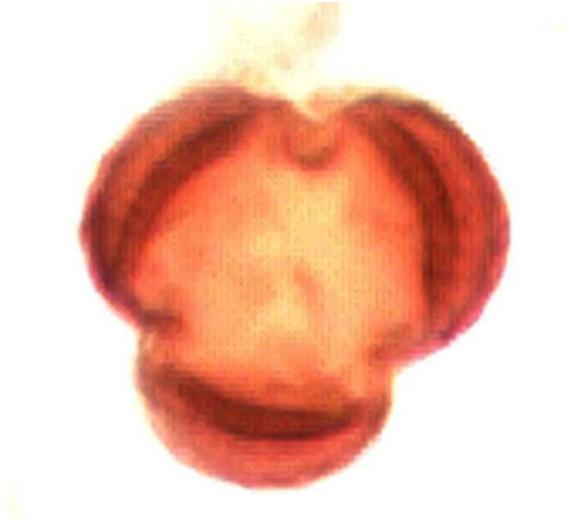
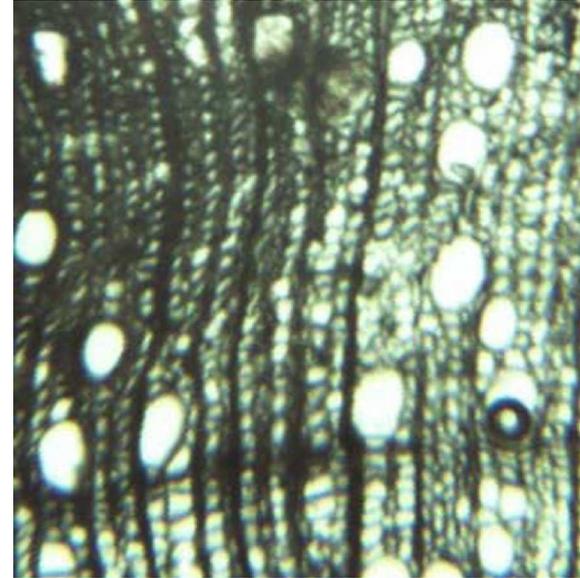


Chandra Venables, using a microscope to search for insect parts in a dung layer dating to over 2000 years ago. Since most insects don't travel long distances they can tell us much about what the local environment was like. On the computer screen you can see a midge wing that she found.

Claire Alix, a specialist in identifying wood species from archaeological sites, examines a wood fragment from one of the ice patch tools.



Below is a section of a microscopic fragment of a piece of willow (*Salix sp.*). Willow was used to make bows, but also for setting ground squirrel snares.

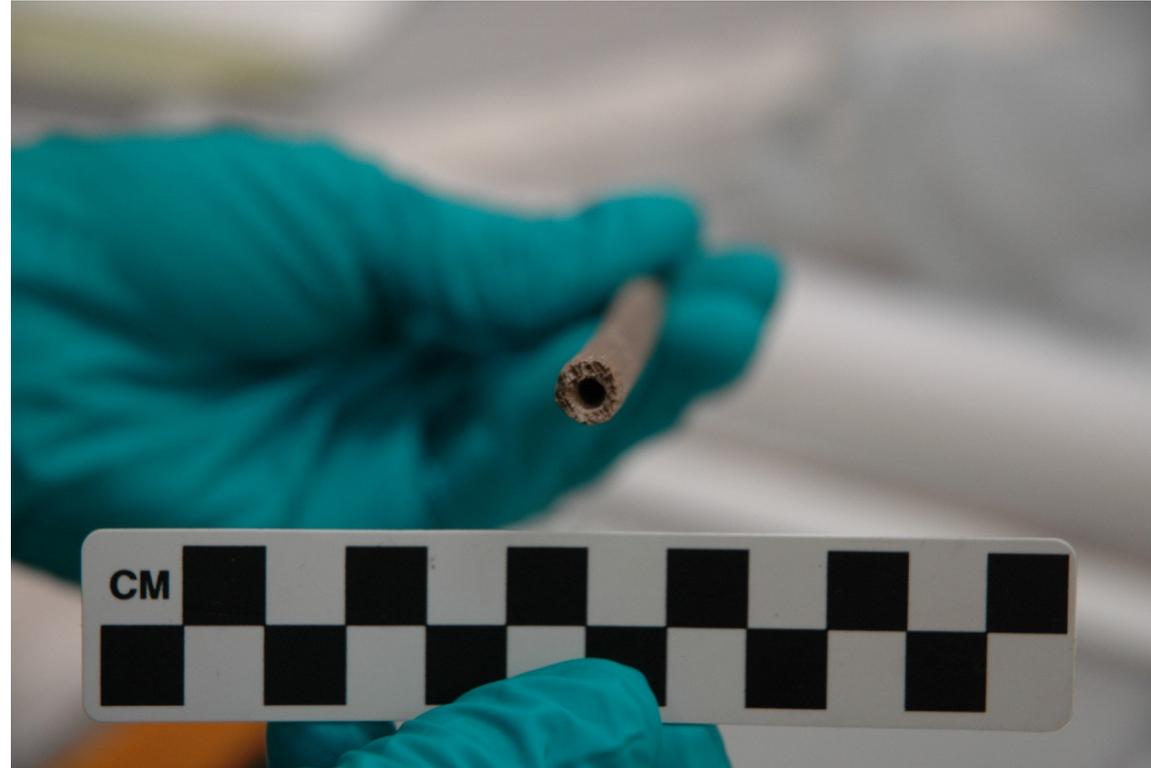


A pollen grain from a species of artemisia identified from a dung layer dating to 1700 years ago. The pollen grain tells us that caribou ate this plant, but also that the environment of the time was suitable for its growth.

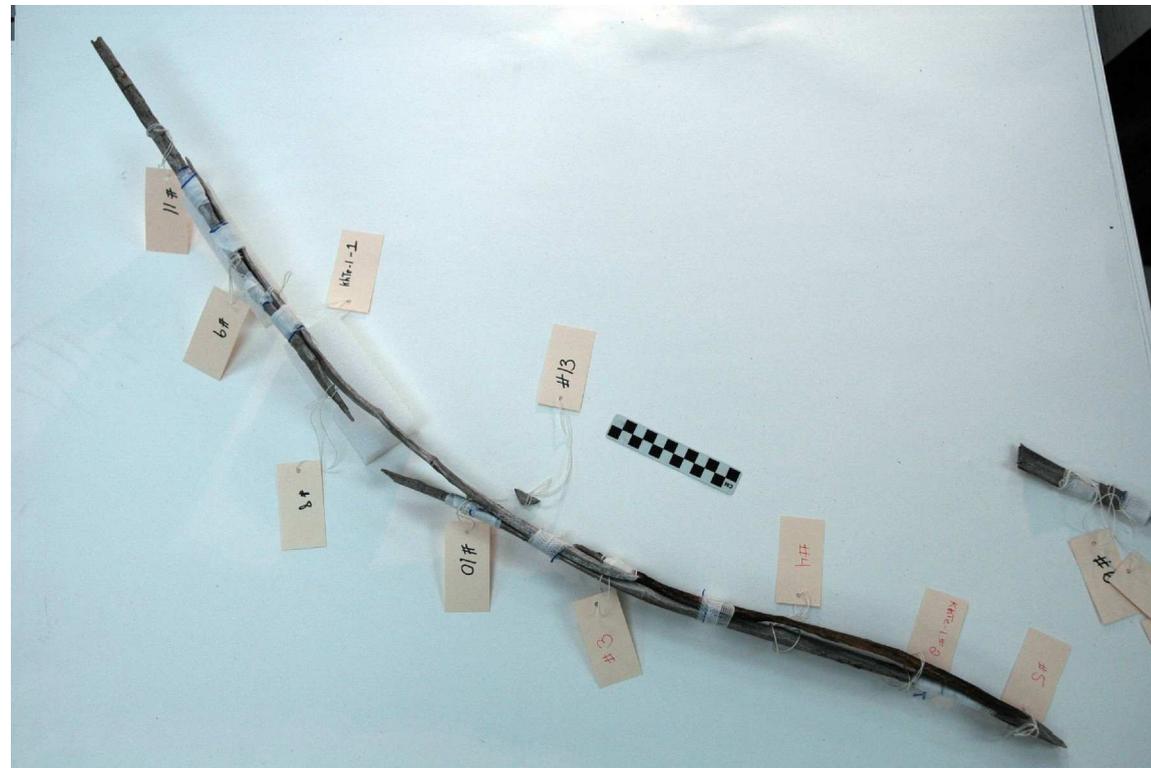


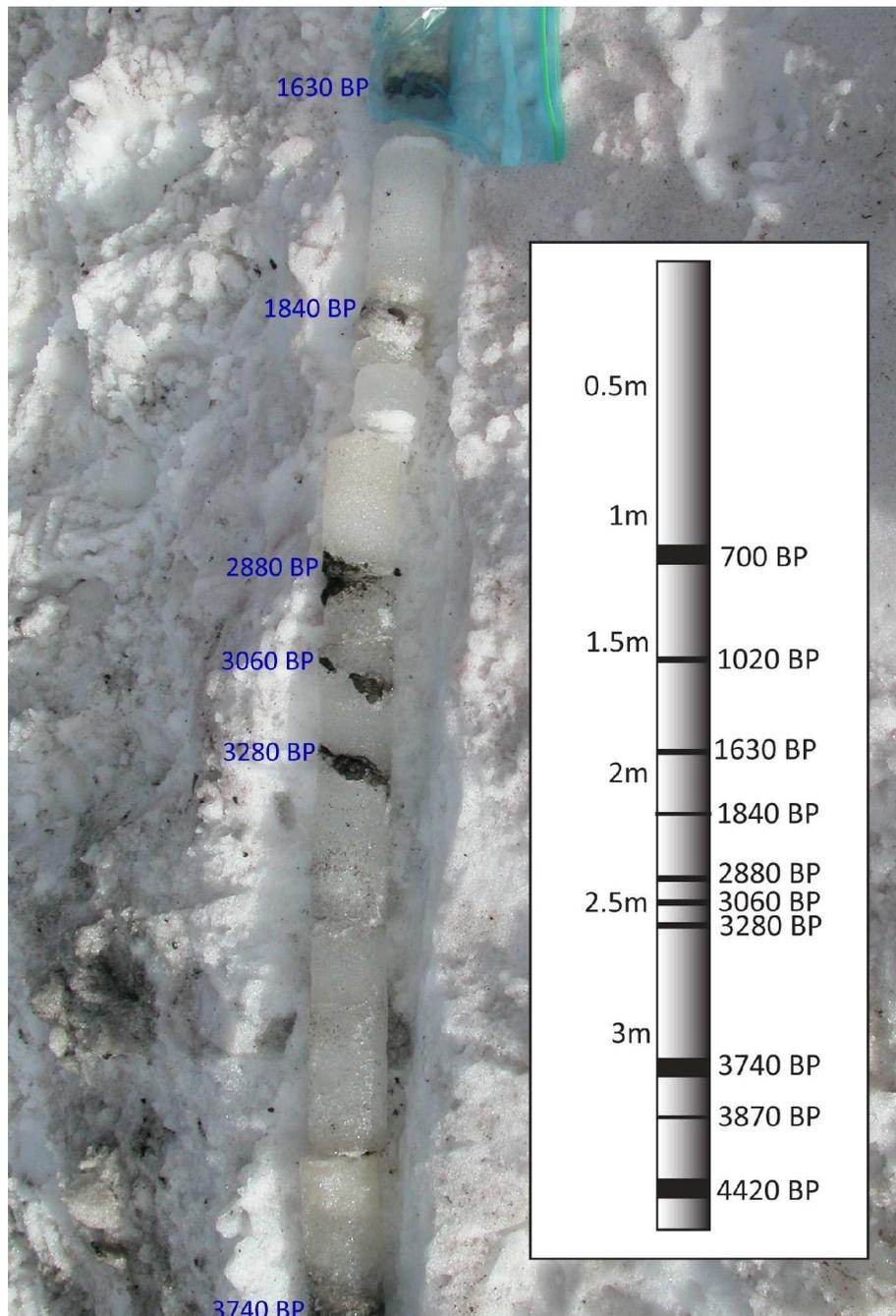
Jennifer Galloway, an expert in identifying fossil pollen grains, examined a series of dung samples from ice cores to reconstruct what past environments were like.

In order to tell how old a wooden artifact is we must remove a sample and send it to a radiocarbon dating facility. We try to lessen the visual impact of taking the sample and here have chosen to drill into the end of an arrow shaft. The drill shavings are sufficient material for a radiocarbon date.

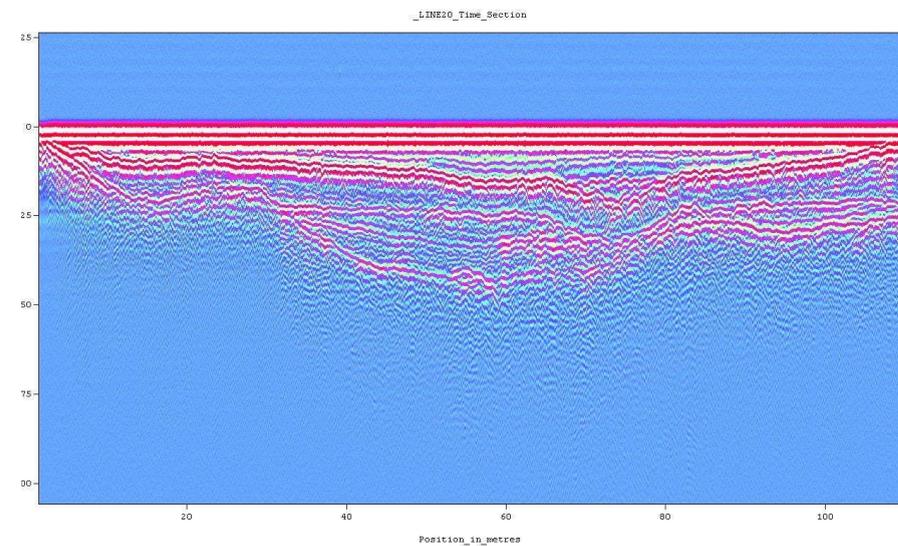


Sometimes artifacts are found in many pieces. This photograph shows a willow bow being reconstructed from 13 separate pieces.





Ice cores tell us about the past and by studying them we can learn much about changes in environmental conditions over time. The illustration demonstrates the age of the various dung bands in years 'BP' or 'before the present'.



A ground-penetrating radar plot of ice patch site KfTe-1, showing the internal banded structure. The thick bands on top are last year's snow.



Artifact conservation is a critical part of the process. Fragile organic artifacts are retrieved from the dung wet and need to be slowly dried over a long period of time. Here, PWNHC conservator, Rose Scott inspects an arrow point.

Shuhtaot'ine traditional knowledge

The Shuhtaot'ine, or Mountain Dene, have hunted, fished and trapped in the mountains bridging the Yukon and Northwest Territories for thousands of years. Moose, caribou, and mountain sheep, as well as fish and small game, provided them with food throughout their long history of living in the mountains. Oral tradition and archaeological evidence suggest that the Shuhtaot'ine have lived in the mountains for more than 5000 years. Today, in the Northwest Territories, the Shuhtaot'ine live principally in the community of Tulita.

Sometimes travelling on foot with pack dogs, or by dog team in winter, or mooseskin boat in summer, the Shuhtaot'ine hauled furs, meat and supplies between their mountain home and the trading posts in the Yukon and Northwest Territories. Shuhtaot'ine oral tradition is rich with stories of individuals who walked great distances.

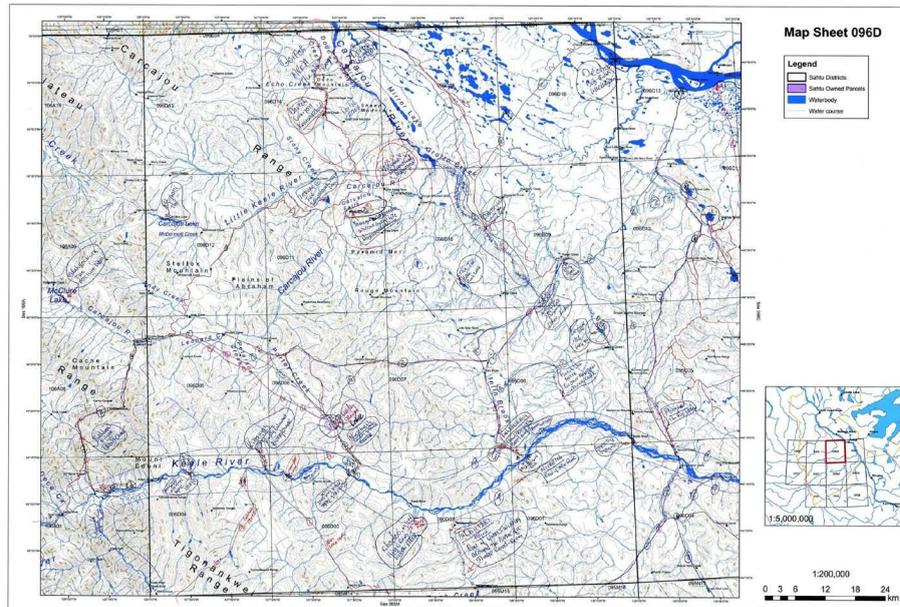
The Shuhtaot'ine are perhaps best known for using the mooseskin boat. These large boats were made from raw moose skins stretched over wooden frames and could be propelled by oars or a sail. Inspiration for the boat may have come from the Hudson Bay Company's sturdy, wooden York boats.

As part of the NWT Ice Patch Study, elders and community leaders recorded traditional trails, place-names, hunting practices and other traditional activities that helped explain how ice patches were used. This information was critical in helping to find productive ice patches and to help explain what we found at them.

The photographs in this section are from the NWT Archives and were taken by Norman Simmons, a biologist who worked with the Shuhtaot'ine in the 1960s and 70s.



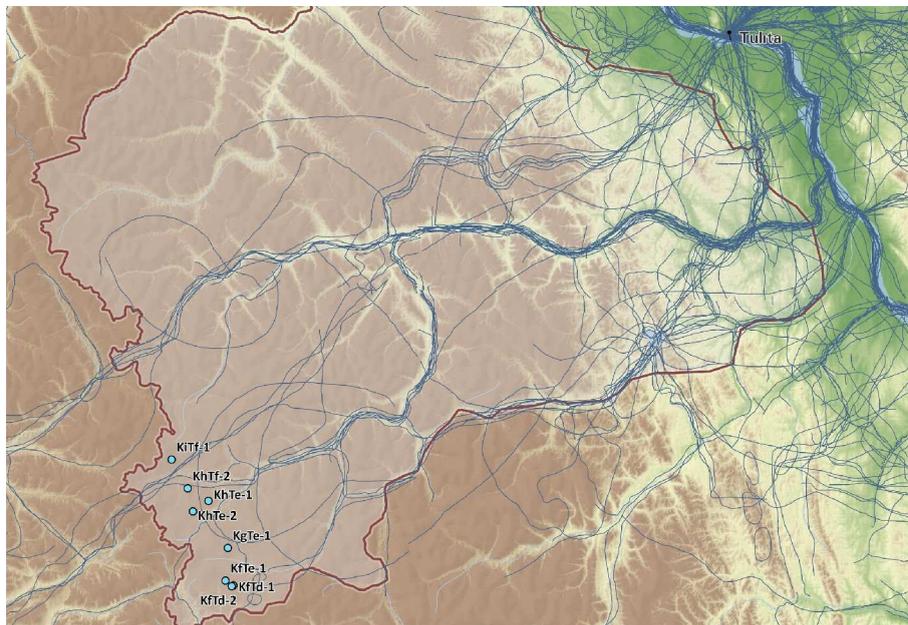
George Pellissey butchering a young caribou near Sterile Lake in 1967. Note the ice patch in the background. (N-2007-002-004)



Working with Shuht'ine elders, Leon Andrew undertook an ice patch traditional knowledge study that included recording land use and place names on maps.



Caribou hunters from Tulita travel up the Moosehorn River towards its headwaters in 1969. (N-2007-002-058)



Shuht'ine traditional trails demonstrate how important the mountains were. The ice patch area could be reached by a variety of routes.



George Pellissey hauling out a net full of lake trout at Drum Lake, 1967. (N-2007-002-017)



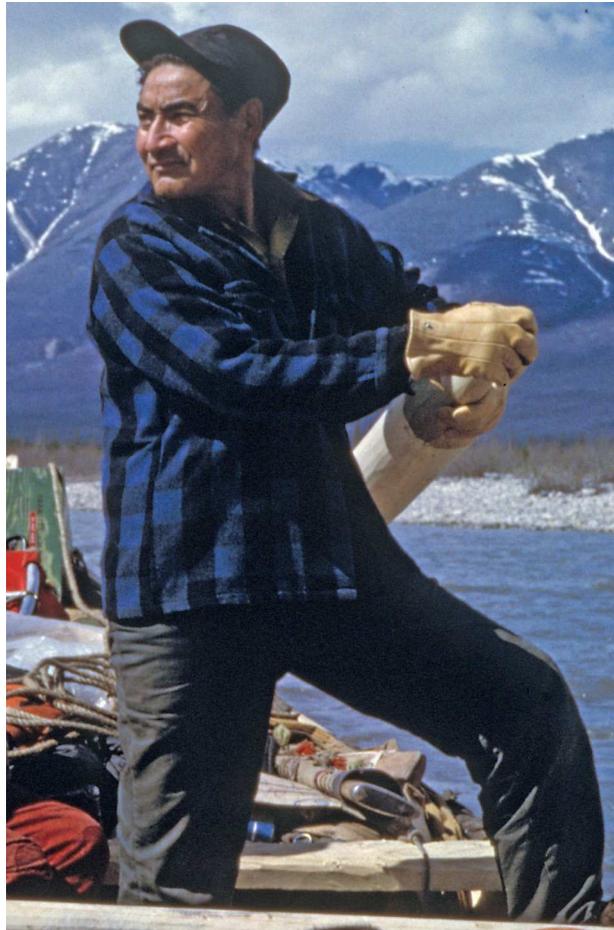
Madeleine Karkagie making moose dry meat, 17 May 1968. (N-2007-002-034)



Gabe Etchinelle just south of Caribou Flats by the Keele River, travelling by dog team, 14 March 1971. Note the snowshoe trail beside the dog team. (N-2007-002-075)



Gabe Horesay's winter camp at Tate Lake, 9 March 1967. (N-2007-002-001)



Gabe Etchinelle at the steering oar of a mooseskin boat, Keele River, 1968. (N-2007-002-048)



Gabe Etchinelle making a caribou skin drum, Keele River, 1968. (N-2007-002-029)



Gabe Etchinelle netting a pair of newly made snowshoes, Caribou Flats, 1971. (N-2007-002-076)

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Caribou hunters taking a tea break on the Moosehorn River near Drum Lake, March 1969. (N-2002-002-021)



Dogs rest while hunters take a tea break, March 1969. (N-2007-002-060)



George Pellissey and Gabe Etchinelle navigating shallow water on the Keele River, 11 August 1967. (N-2007-002-010)



Vivian Pellissey at a winter camp at Drum Lake, 15 March, 1968. (N-2007-002-018)



Madeleine Karkagie uses moose sinew to double stitch the hides to ensure the seams are waterproof, 25 May 1968. (N-2007-002-039)



Jonas McCauley, Gabe Etchinelle, and George Pellissey attaching moose hides to the gunwales, Keele River, 1968. (N-2007-002-042)



A moose skin boat tied to shore at Fort Norman, Mackenzie River, about 1922. (N-1979-004-022)



The finished boat on the Keele River, 29 May 1968. (N-2002-002-049)

What have we found?

The beauty of ice patch archaeology is that hunting weapons lost long ago by precontact hunters ended up in a natural deep-freeze. Artifacts melting out of ice patches in the Mackenzie Mountains are often perfectly preserved – even 2500 years after they were lost. As the illustrations and photographs in this section of the book show, the wood, sinew, feather and stone parts of artifacts are emerging from the ice on an annual basis. These spellbinding artifacts are shedding light on the history and design of the hunting technologies used by precontact hunters in alpine regions of the subarctic.

Three types of precontact hunting technology are represented in ice patch collections from the Mackenzie Mountains. Dart throwing systems – often referred to as ‘atlatl’ or spear-throwing technology – are the oldest hunting weapons in the ice patch collections. Hunters used a throwing stick to launch a long, stone-tipped dart at their prey. The examples from the Mackenzie Mountains date to about 2400 years ago. Bow-and-arrow technology found on the ice patches is consistently younger than dart throwing technology. We have found pieces of four arrows and a bow. This technology ranges in age from 850 to 270 years ago. Unexpectedly, we have also found snaring technology on an ice patch in the Mackenzie Mountains. This snare radiocarbon dated to nearly 1000 years old, and is very similar to ground squirrel snares used by the Shuhtaot’ine today.

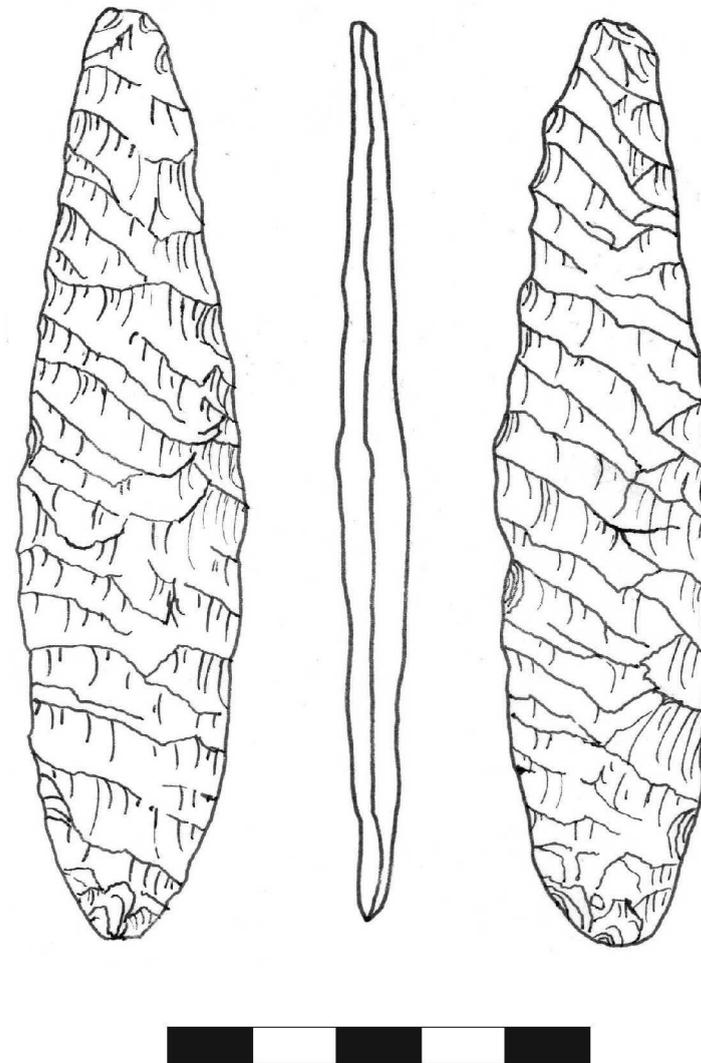
As artifacts continue to be exposed in the coming years, we will monitor the melting ice patches on an annual basis. Some patches have already completely melted, underscoring the urgency of a monitoring program.



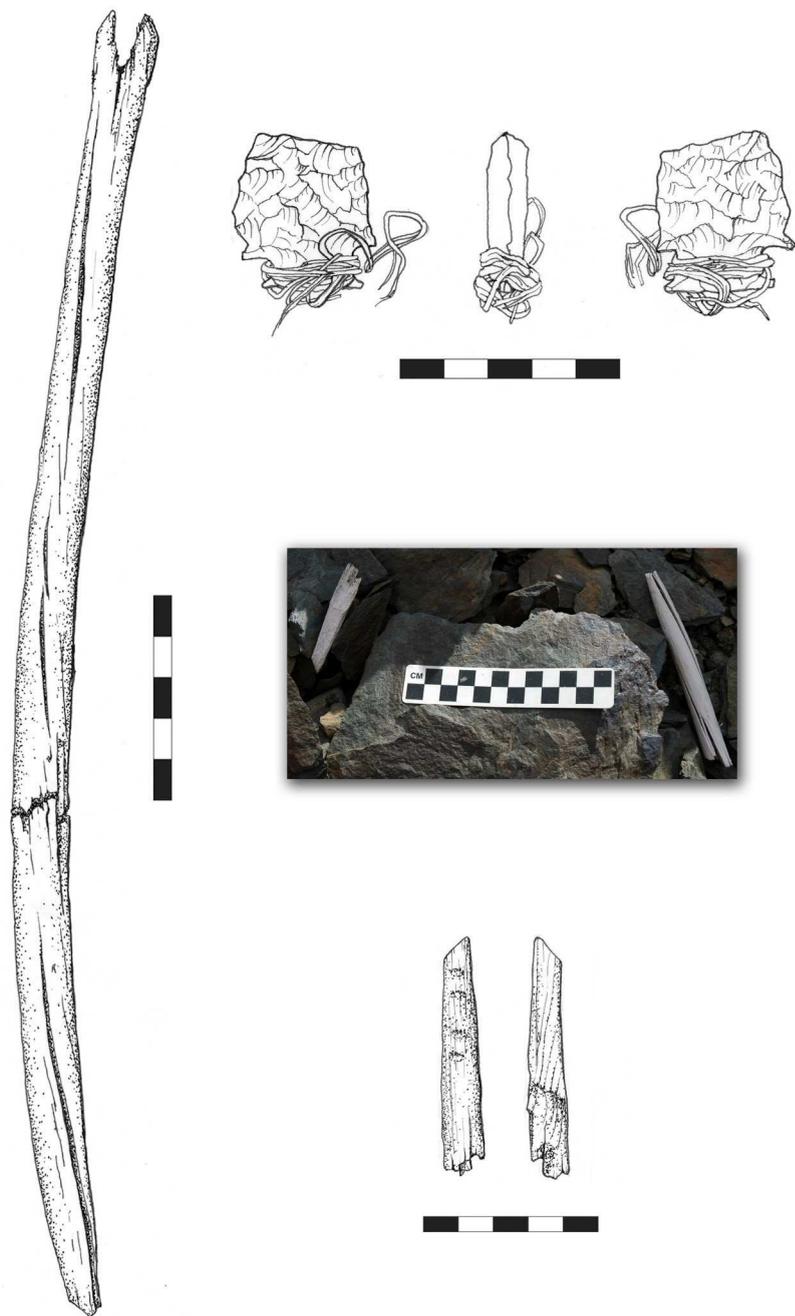
A birch arrow and stone arrowhead found at one of the ice patches in 2007. The wooden arrow shaft was found in four pieces with stone point laying nearby. This arrow dates to 270 years ago.



Sometimes we find just the stone portion of a tool suggesting that the wooden parts have already decomposed. This beautiful, large stone tool is likely a knife.



Technical drawings, like this one by artist Rae Braden, help bring out the manufacturing details of the tool which helps us better understand how it was made. Here, we can see the skillful lateral, oblique flakes removed by the tool-maker, creating a serrated edge.



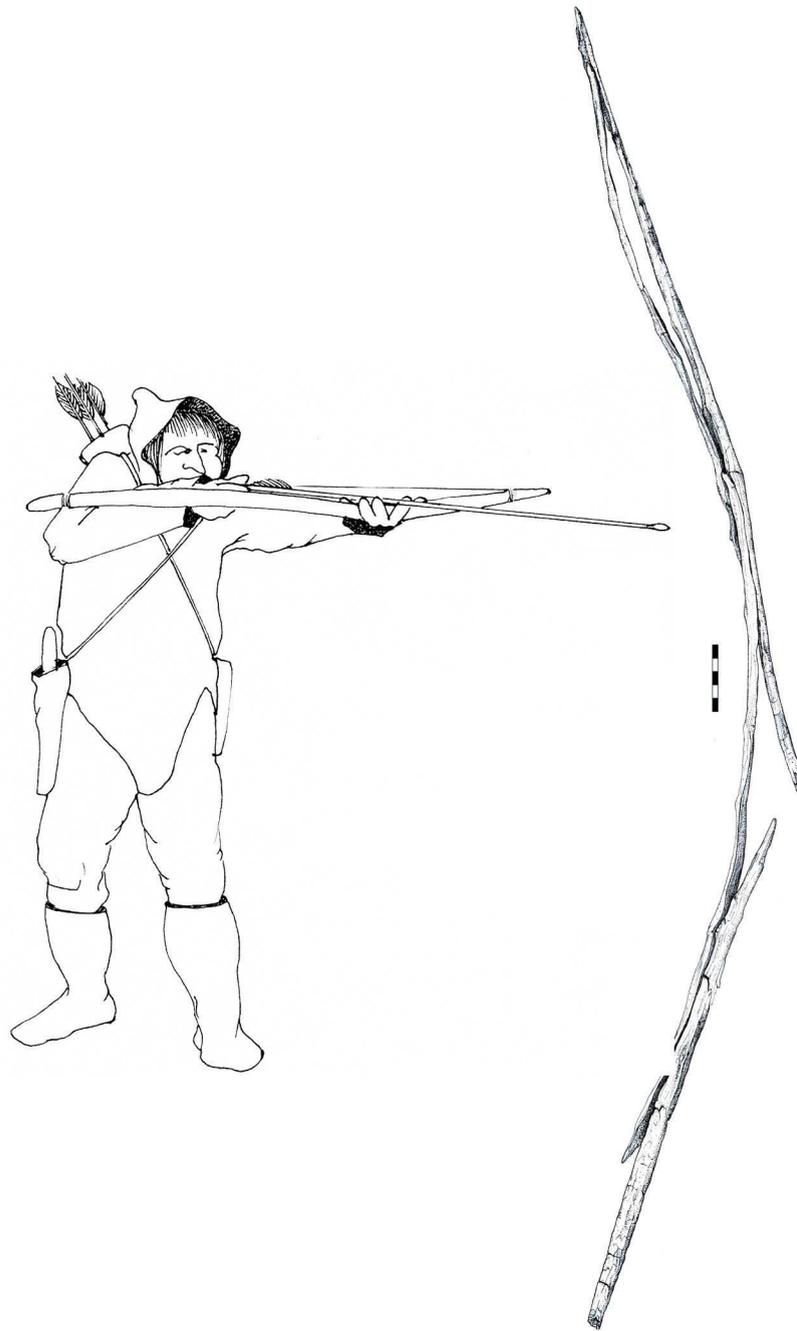
A wooden dart foreshaft with its corner-notched chipped stone projectile point, still wrapped with sinew. The small wood fragment in the lower right is a piece of the shaft and is made from birch. Both date to 2310 years ago.



Made from Saskatoon berry, the wood of this dart foreshaft is very hard. Significantly, reference to the use of this specific wood is still told in oral stories related to Yamozhah, an important Dene culture hero.



An exciting find: a broken stone dart point with the sinew still attached. The dart was probably thrown with a spear-thrower or atl-atl.



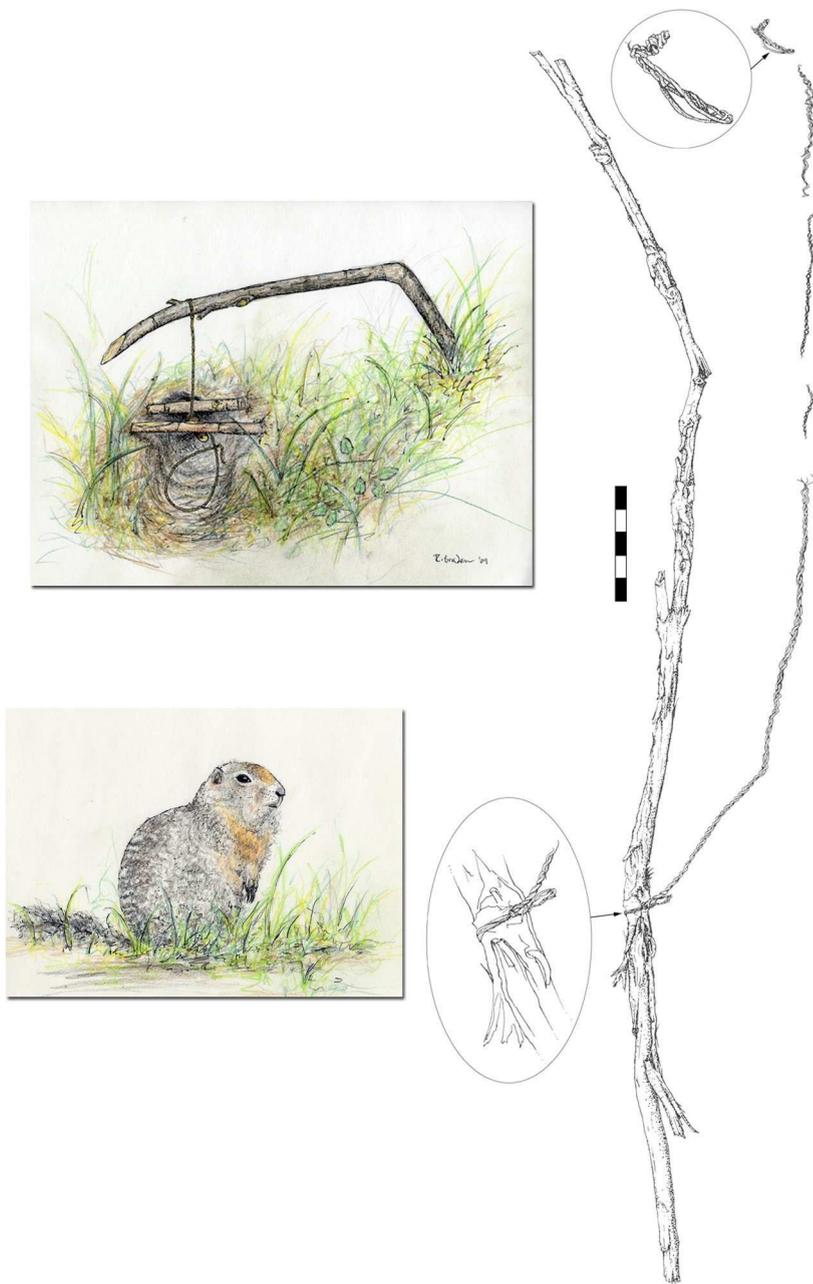
Artists' illustrations showing the assembled bow and how Shuhtaot'ine elders said they were used. Skillful hunters needed to get very close to a caribou to be effective. Another photo of the bow can be found on page 14.



Found in 14 pieces (one small fragment was sacrificed for radiocarbon dating) the bow was like a jig-saw puzzle that needed re-assembly. Claire Alix worked for a day fitting it back together in 2008.



The bow was found on a terrace above the ice patch, illustrating the importance for searching a wide area around the patches. The bow is made from willow and is 340 years old.



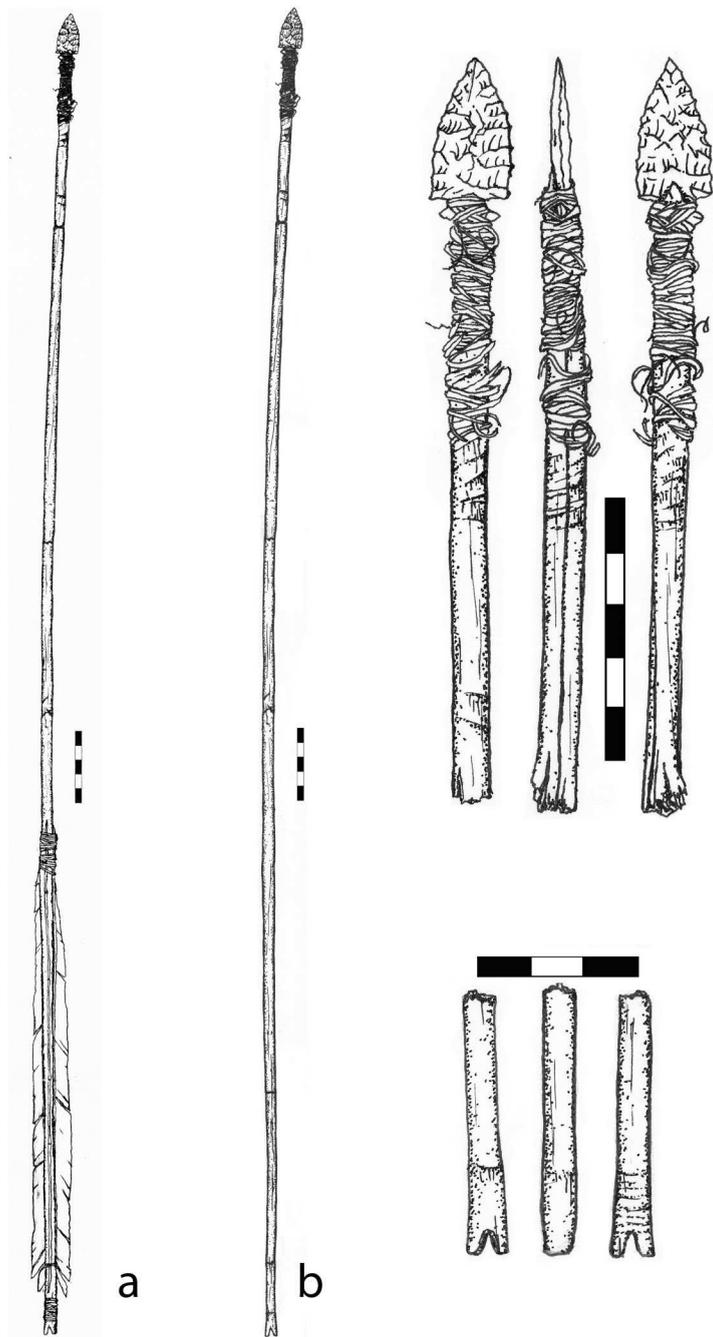
A simple, yet elegant tool: The cord for this ground squirrel snare is made from two twisted strands of sinew. A radiocarbon date on the willow branch showed it was 970 years old.



Still wet with meltwater, the snare cord is visible against the partially frozen dung.



A remarkable find at a caribou hunting site! A simple but effective tool, snares have been used for thousands of years.



This arrow consists of 6 pieces that have been re-assembled in the lab. We also recovered the three feathers used to fletch it. The illustrations 'a' and 'b', above are artist's reconstructions of what the arrow looks like with, and without, its fletching.



These feathers, found beside the wood arrow fragments, were used to fletch the arrow and are probably from a large bird, perhaps an eagle, owl or goose.



Finding pieces of the the arrow in two different years underscores the importance of continuing to monitor the ice patches as new things can be found where ice patches continue to melt. The arrow is made from birch and is 340 years old.

Science camps

In the main International Polar Years of 2007 and 2008, we held science camps for high school students from the community of Tulita. We based the camps at O’Grady Lake, a traditional gathering place of the Shuhtaot’ine located close to many of our key ice patch sites. Providing a forum for Aboriginal elders, youth and scientists to share knowledge of the cultural and environmental history of the Mackenzie and Selwyn Mountains, the science camp curriculum incorporated both traditional knowledge and ice patch science in a unique learning opportunity.

The photos in this section illustrate the many learning opportunities offered by the science camps. Working alongside the elders of their community, the students learned to make and set ground squirrel snares, predict the behaviour of game animals, and butcher and make dry meat from caribou and moose. The students practiced using models of precontact hunting technologies, and experimented with manufacturing the types of tools used to hunt caribou on ice patches in the past. Listening to stories shared by their elders, the students also learned the rich oral traditions of life in the mountains.

Each camp also included a helicopter trip up to one of the ice patches, where the students helped to search for artifacts and gained hands-on experience in ice patch science, learning about ice patch formation, caribou biology and ice patch archaeology. The discussions between the elders, students and scientists during these site visits led to many insights into how people hunted on the ice patches in the past.



Ricky Andrew holding the beautiful knife described on page 23.



Tulita elder David Yelle



Dion Lennie shows his homemade atl-atl.



Throwing darts with spear throwers, one of the main hunting tools used to kill caribou millennia ago, was a popular activity in Science Camp 2007.



Maurice Mendo works at making a walking stick. He told us that in the old days, people would often use sticks when walking in the mountains as it helped them remain safely on the trail.



Leon Andrew and John Hotti help Tracey, Kyle, and Dion prepare to use spear-throwers.



Elder David Yelle helps Dion Lennie with his project.



David Yelle, John Hotti, J.B. Etchinelle, Tracey Campbell, Ricky Andrew, Dion Lennie, and Kyle Yakelaya pose with an artifact recovered from one of the ice patches.

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Tom Andrews describes ice patch archaeology to the science camp students and elders.



Here the students help to extract a core from an ice patch.



Elders and staff help search for artifacts in the dung band below an ice patch, while students help extract an ice core.



Brian Moorman explains the structure of ice with an ice core recently taken from one of the patches.



Tulita elder Maurice Mendo splitting a feather quill in order to make a ground squirrel snare.



Maurice Mendo displaying the results of his snare set.



An eagle feather quill used in a ground squirrel snare set.



Kyle Yakelaya with a ground squirrel he caught in a snare.



Elders Ricky Andrew and Frank Yelle studying a 1000 year-old ground squirrel snare recovered from one of the ice patches.



Vanessa Kenny-Andrew splits an eagle feather quill to make a snare.



Working in groups allows elders to share stories about life in the mountains.



Vanessa Kenny-Andrew and Maurice Mendo share a laugh while working on their projects.



Brian Moorman teaches the students how to use a GPS receiver.



Students and researchers share the table in the cook shack.



Shannon Andrew and Tracey Campbell try their hand at throwing a dart, while Glen MacKay offers assistance.



Practicing with spear-throwers or atlatls helped us understand how difficult they are to use.



Elders taught the students how traditional bows were made and used.



Atlatls can be thrown with great force and distance and were an effective caribou hunting weapon. They were used by many ancient cultures around the world.



John B. Etchinelle, John Hotti, and Ricky Andrew with a cow moose head.

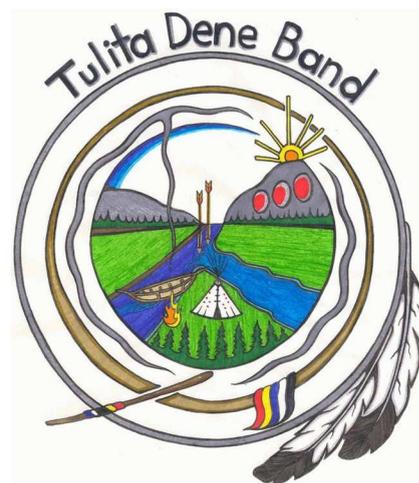
Canada's commitment to the International Polar Year research program was significant and provided much of the funding to support the activities represented in this book. We are grateful for their support.



The Prince of Wales Northern Heritage Centre, part of the Department of Education, Culture and Employment, Government of the Northwest Territories, provided continuing financial and logistic support and much encouragement throughout the course of this project. We are grateful to our colleagues at the PWNHC for their help in the field and at home.



The Tulita Dene Band has supported the project from the beginning and provided logistical and financial support throughout. Many elders, students and other residents from the community have participated in the project and we hope that they have gotten as much from our collaboration as we have. We are grateful to our partners and look forward to working with them in the future.



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A project of this scale needs support and assistance from a great number of organizations and individuals. We are very grateful for the support we have received and we extend our appreciation to:

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Consultation: Greg Hare (Senior Projects Archaeologist, Yukon Territorial Government)

Logistical Support (Sahtu): Keith Hickling, Alasdair Veitch, Jason Salter, Tulita District Land Corporation, Norman Wells Land Corporation

Helicopters: Guy Thibault and Daryl Ressler (pilots); Canadian & Sahtu Helicopters

Accommodation: Ram Head Outfitters, Gana River Outfitters, Mackenzie Valley Inn (Norman Wells), Heritage Hotel (Norman Wells)

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