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Weaving Together Knowledge Through Collaborative Archaeological Research in the Shúhtagot'ine Cultural Landscape

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We describe collaborative archaeological research on caribou hunting sites in the homeland of the Shúhtagot'ine in the central Mackenzie Mountains of Canada's Northwest Territories. Shúhtagot'ine

Elders and cultural resource managers are working together to investigate important cultural places that are at risk of destruction from climate-driven landscape changes. We use 3 case studies to illustrate how knowledge production in the context of long-term, place-based research has led to key insights about ancestral caribou hunting sites, including perennial alpine ice patches and wood hunting structures, and how that knowledge is being

mobilized to help conserve important values in the Shúhtagot'ine cultural landscape. Archaeological research promotes the sustainability of Indigenous cultural landscapes through the preservation of cultural heritage, via the recall of “landscape memories,” and by unlocking archives of ancient biological material. The process of knowledge coproduction is mutually beneficial for all participants, especially when Indigenous Elders and youth are brought together in fieldwork settings.

Keywords: archaeology; knowledge coproduction; northern mountain caribou; alpine ice patches; caribou fences; cultural landscape; Shúhtagot'ine.

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Introduction

The mountain regions of Canada's North are Indigenous cultural landscapes that are central to the identity and cultural sustainability of Indigenous communities. The archaeological traces of past human activities are a vital component of Indigenous cultural landscapes (Lozny 2008; Lepofsky et al 2017; Östlund and Norstedt 2021), but many archaeological sites in northern Canada—an area warming at a pace 3 times the global average (Bush and Lemmen 2019)—are under increasing pressure from rapid environmental change. In this article, we describe our collaborative archaeological research on ancestral caribou (*Rangifer tarandus*) hunting sites in the homeland of the Shúhtagot'ine in the central Mackenzie Mountains of Canada's Northwest Territories (NWT), where Shúhtagot'ine Elders and cultural resource managers are working together to investigate important cultural places that are at risk of destruction from climate-driven environmental change. We present 3 case studies to illustrate the knowledge that our team has cocreated through this work and discuss how this knowledge and the knowledge coproduction process promotes the wellbeing of the Shúhtagot'ine and their homeland.

Norström et al (2020: 183) have recently defined knowledge coproduction as: “Iterative and collaborative

processes involving diverse types of expertise, knowledge and actors to produce context-specific knowledge and pathways toward a sustainable future.” They encourage the use of research methodologies that embrace multiple ways of knowing and are inclusive of information shared by research participants with diverse backgrounds. Knowledge coproduction should be a collaborative process with opportunities for frequent interactions among participants, be sensitive to the social and ecological contexts of the research, and chart a clear path to the practical impacts of the knowledge coproduction process.

We believe that cocreating archaeological knowledge with Indigenous Elders provides opportunities to view ancestral sites within landscapes of meaning and to integrate archaeological information with traditional ecological knowledge, leading to new insights into the relationships among people, the land, and animals, and how these relationships structure the archaeological record. The process of knowledge coproduction expands networks for the mobilization of knowledge and contributes to the sustainability of Indigenous cultural landscapes—dynamic landscapes that people sustain through ongoing engagement with the land—by creating opportunities for the renewal of the knowledge embedded in ancestral cultural places (Prosper 2012).

Background

Setting: the Shúhtagot'ine cultural landscape

The setting for this paper is the homeland of the Shúhtagot'ine (Mountain Dene in earlier anthropological literature), who up until the 1950s lived a mobile way of life in the central Mackenzie Mountains (Gillespie 1981). The Shúhtagot'ine cultural landscape centers on Begádeé, currently known as the Keele River on official maps, which is one of the main drainages flowing out of the mountains to Deho, or the Mackenzie River (Figure 1). Shúhtagot'ine land use patterns revolved largely around the pursuit of big game, including caribou, Dall sheep (*Ovis dalli*), and moose (*Alces alces*), requiring a highly mobile way of life. Well-worn walking and dog-sled trails form the framework of the cultural landscape, and named places along these routes hold abundant cultural knowledge about the landscape, its resources, and Shúhtagot'ine history (Andrews, MacKay, Andrew, et al 2012; Andrew 2018).

Today, many Shúhtagot'ine people live in the community of Tulita, located on the Mackenzie River, and travel into the mountains to hunt. Their homeland lies within the Tulita District of the Sahtu Settlement Area (SSA), created by the Sahtu Dene and Metis Comprehensive Land Claim Agreement signed in 1993. Comanagement agencies such as the Sahtu Land and Water Board and Sahtu Renewable Resources Board manage land use and renewable resources in the SSA. The Sahtu Land Use Plan, which came into effect in 2013, uses zoning and conformity requirements to determine “what land use activities are appropriate, where, and under what conditions” in the SSA (Sahtu Land Use Planning Board 2013: 9).

Collaborative archaeology projects in the Shúhtagot'ine cultural landscape

Collectively, the authors of this paper have collaborated on archaeology projects in the Shúhtagot'ine cultural landscape on an annual basis since 2005. This work falls under 2 major projects: The NWT Ice Patch Study (NWTIPS) and the Shúhtagot'ine Cultural Landscape Project (SCLP). We conducted annual field campaigns to monitor alpine ice patches in the intervening years between these 2 projects (2011–2018).

The NWT Ice Patch Study: The NWTIPS was an International Polar Year (IPY) project funded by the government of Canada between 2006 and 2010. Designed to address the key themes of climate change impacts and adaptation, and the health and wellbeing of northern Canadians, Canada's IPY program enabled multidisciplinary research on the archaeology and paleoecology of alpine ice patches in the Shúhtagot'ine homeland (Andrews and MacKay 2012).

Alpine ice patches are well-preserved archives of the long relationship among perennial ice, caribou, and precontact Shúhtagot'ine hunters (Figure 2). Caribou use ice patches on hot days to cool down and avoid insects, making ice patches predictable places for human hunters to find caribou in the summer months (Ion and Kershaw 1989). Climate change is accelerating the seasonal melt of once-persistent alpine ice patches, revealing well-preserved hunting weapons, as well as biological materials, including the bones of caribou and other animals, and massive quantities of caribou dung

accumulated in the ice over hundreds or thousands of years (Andrews, MacKay, and Andrew 2012; MacKay et al 2019). The largest ice patches in the NWTIPS area have persisted for more than 5000 years. The primary objective of the NWTIPS was to locate alpine ice patch sites in the mountainous areas of the Tulita District and collect and conserve the fragile organic artifacts that melted out of the ice before they decayed and were lost.

As described in Andrews, MacKay, Andrew, et al (2012), the NWTIPS created opportunities for knowledge coproduction in 3 main ways: The direct involvement of a Shúhtagot'ine Elder (coauthor Leon Andrew) in all of the project's field campaigns; science camps in 2007 and 2008 that brought together Shúhtagot'ine Elders and youth at O'Grady Lake in the NWTIPS area; and map-based traditional knowledge studies of the Shúhtagot'ine cultural landscape conducted in the community of Tulita in 2007 and 2008.

The Shúhtagot'ine Cultural Landscape Project: The SCLP, which started in 2019 and is ongoing, is supported by the Canadian Mountain Network (CMN), Canada's first formal research organization dedicated to work that supports the resilience and health of mountain peoples and places. The CMN places high value on research methodologies that engage both Indigenous and Western ways of knowing to advance understandings of mountain systems.

The goals of the SCLP are to promote the conservation of cultural landscape values in the Shúhtagot'ine homeland through the restoration of Indigenous geographical place names and archaeological research on specialized caribou hunting sites at risk of impact from climate change-driven processes. The archaeology component of the SCLP continues the long-term monitoring of rapidly melting alpine ice patches, but its particular focus is on historic wood caribou fences, which are communally operated hunting structures used by ancestral Shúhtagot'ine hunters to channel groups of caribou toward kill zones, where they could be easily snared or shot with arrows or musket balls (Figure 3). Consisting of numerous dry, decaying timbers, these culturally and scientifically significant structures are at increasing risk of destruction from forest fires as climate change leads to greater incidence and severity of forest fires in Canada's boreal forests. To mitigate the potential loss of these sites, we are using unmanned aerial vehicles (UAVs) to create high-resolution digital maps and orthophotos of the fences and their landscape settings; dendrochronology methods to establish time frames for their use; and archaeology and traditional knowledge research to understand how the fences were used to facilitate caribou hunting (van der Sluijs et al 2020; Beckhusen et al 2022).

The SCLP creates opportunities for knowledge coproduction through the direct involvement of a Shúhtagot'ine Elder (coauthor Leon Andrew) and an Indigenous student in the project's field campaigns, and through in-person and virtual community meetings and presentations in Tulita.

Case studies of knowledge coproduction

In this section, we describe 3 case studies that highlight key insights gained through knowledge coproduction between

FIGURE 1 Map showing the Tulita District and places discussed in the text. The Dene trails shown on the map were documented during the Dene Mapping Project, in which Dene hunters recorded the traditional trails that they had used throughout their lifetimes (Asch et al 1986). (Map by Julie Buysse, GNWT)

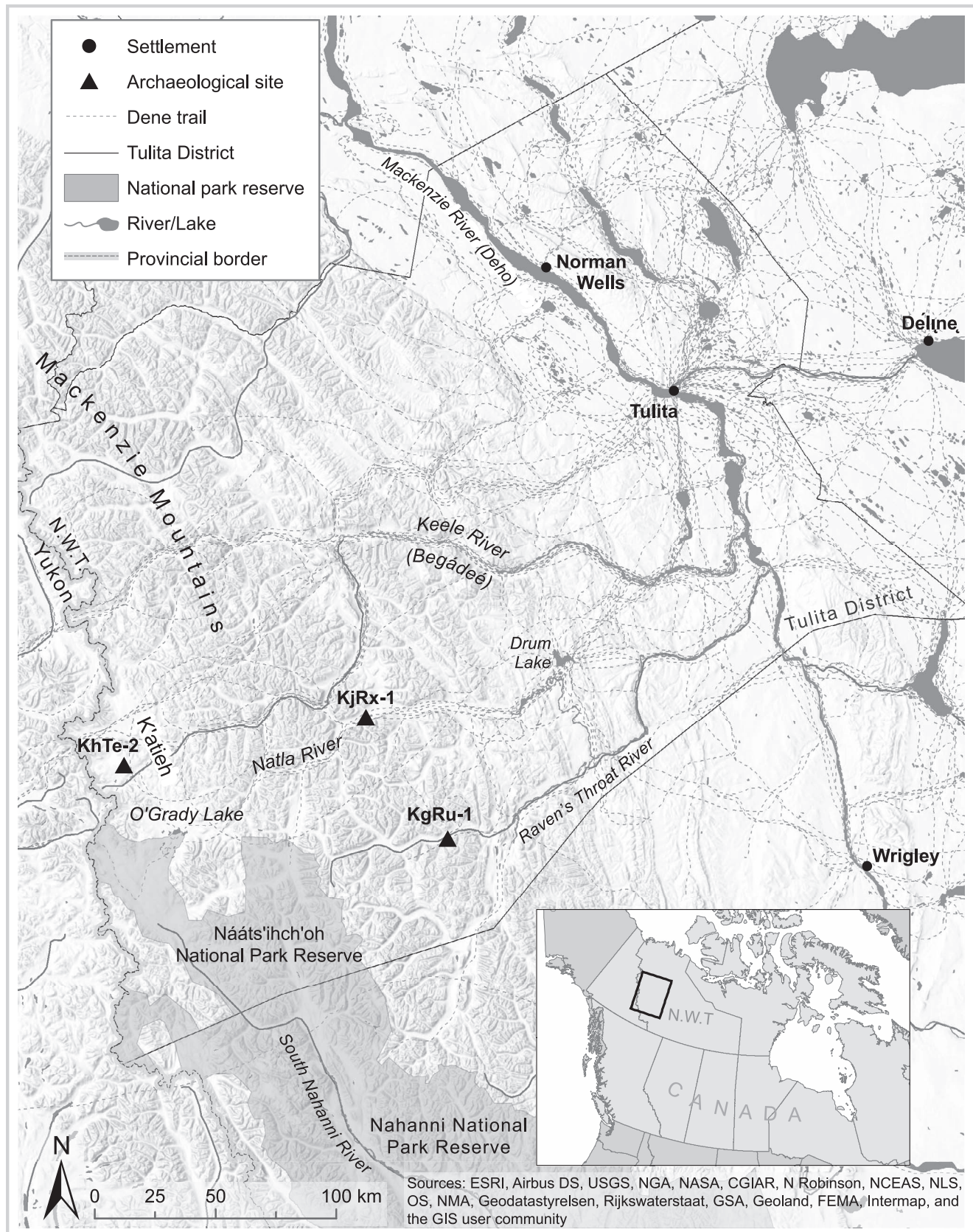


FIGURE 2 Perennial alpine ice patch KhTe-2 in the summer of 2009. The ice patch is approximately 250 m long and is ringed with a black band of caribou dung that has melted out of the ice. Well-worn caribou trails lead to the patch from multiple directions. (Photo by Thomas D. Andrews)



FIGURE 3 A section of caribou fence KjRx-1. Heavy timbers were laid end-to-end to create a barrier to channel caribou into a corral. The main fence at KjRx-1 is approximately 800 m long. (Photo by Thomas D. Andrews)



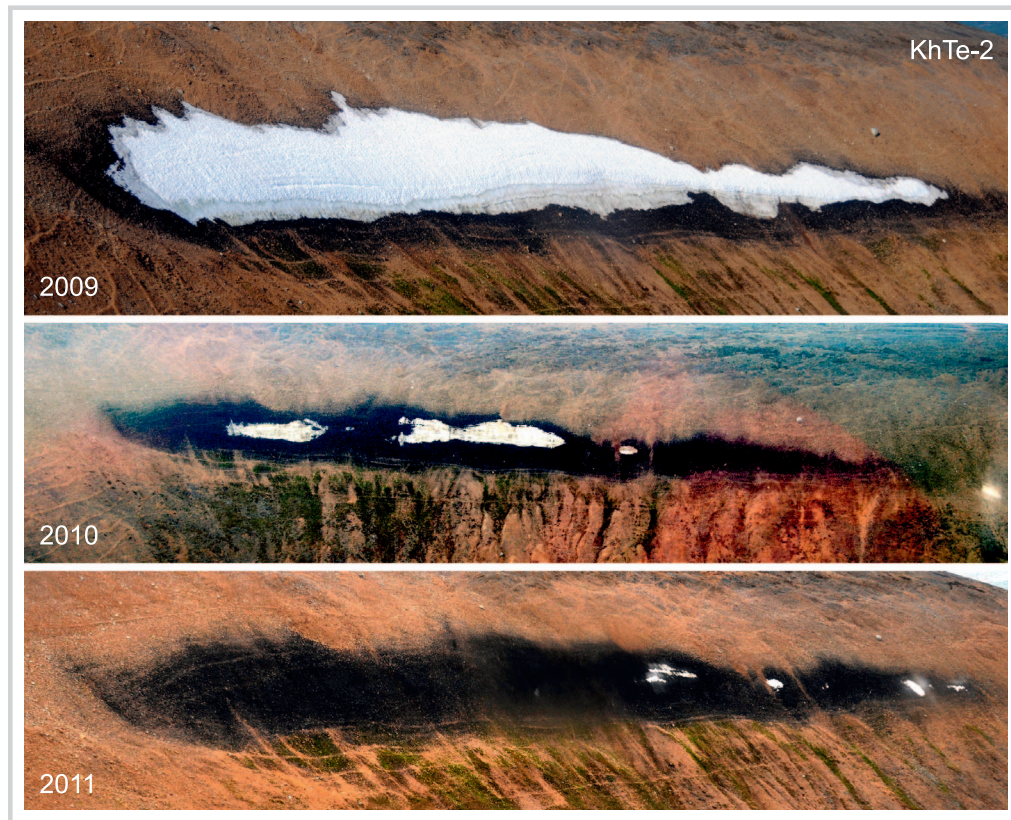
archaeologists and Shúhtagot'ine Elders through the NWTIPS and the SCLP.

Melting alpine ice patches and *Shúhta ʔepé* (northern mountain caribou)

Most of the perennial ice patches with evidence of long-term use by caribou and human hunters in the NWTIPS study area are in an area that the Shúhtagot'ine call K'atieh, or “willow flats.” The K'atieh area is located adjacent to the continental divide and consists of sweeping alpine plateaus covered with alpine shrub, lichen, and wet sedge tundra; wetlands are common throughout the area. Perennial ice patches with evidence of use by caribou and precontact hunters are found on the north-facing slopes of rounded mountains that rise gently from the surrounding plateau. Shúhtagot'ine traditional knowledge recognizes K'atieh as a key place for caribou, which travel here in the spring to calve. They spend much of the summer feeding on the abundant shrubs, lichen, and other forage available in the area before migrating back to their winter ranges. Shúhtagot'ine oral tradition and traditional trail information (see Figure 1) identify K'atieh as an important traditional land use area (Andrews, MacKay, Andrew, et al 2012). This knowledge of K'atieh as a place where caribou and people came together in the summer played a vital role in determining where to look for ice patches used by ancestral Shúhtagot'ine hunters in the large alpine landscape of the Tulita District.

Our field observations of alpine ice patches in K'atieh builds on earlier work in the area by Ion and Kershaw (1989) that established the importance of late-lying snow or ice patches as summer caribou habitat. The search for artifacts required us to walk transects through the thick, wet deposits of caribou dung surrounding ice patches—accumulated by many generations of caribou and now melting out of the ice. From the air, we observed networks of deep-cut caribou trails leading into ice patches and often saw small groups of

FIGURE 4 The rapid decline of permanent ice at KhTe-2 between 2009 and 2011. In 2011, only a thick carpet of caribou dung remained by late August. (Photos by Thomas D. Andrews)



caribou resting on the ice, even in mid- to late August, when most of our annual field campaigns took place. Overall, the NWTIPS identified nearly 30 ice patches with evidence of long-term, recurring use by caribou in K'atieh and adjacent areas (Andrews, MacKay, and Andrew 2012).

The most important observation of our annual field campaigns was just how rapidly alpine ice patches are melting because of climate change. Andrews and MacKay (2012) documented the complete loss of a once-persistent ice patch called KhTe-2 between 2009 and 2011 (Figure 4). Radiocarbon dating of caribou dung recovered from an ice core extracted from KhTe-2 showed that the oldest areas of the ice patch had persisted for almost 3000 years. Ice patches form through the accumulation of winter snow that is deposited on the leeward slopes of north-facing mountains. Snow still accumulates at KhTe-2 and persists into the summer, but our field observations, as well as examination of satellite imagery, indicate that without its permanent ice core, KhTe-2 is snow-free by early to mid-August in most years. Field observations during the SCLP field campaign in 2019 indicated catastrophic melt of other ice patches in K'atieh.

The NWTIPS created space for multiple ways of knowing in a context that enabled regular and long-term interaction among the field team, consisting of a Shúhtagot'ine Elder and 2 archaeologists. While this team came together to tackle a cultural resource management challenge, Shúhtagot'ine traditional knowledge of K'atieh as a special place for caribou, coupled with long-term observations of ice patches as summer caribou habitat and their accelerating melting in the face of climate change, also led to concern that this trend

would cause negative impacts to caribou (Andrews and MacKay 2012). Cocreating this knowledge facilitated its mobilization by traditional knowledge holders into other regional discussions. For example, the NWT Species at Risk Committee added northern mountain caribou to the NWT List of Species at Risk as a species of special concern in 2021. One of the reasons provided by the committee for this assessment is: "Northern mountain caribou are vulnerable to the effects of climate change, particularly the already noticeable decline in ice patches in the Mackenzie and Selwyn Mountains. These areas, used to escape insects and cool down in the summer, are considered critical habitat components" (Species at Risk Committee 2020: 3). This listing requires the development of a management plan to create objectives and approaches to mitigate potential threats to northern mountain caribou.

Caribou fences and mineral licks

As part of the SCLP, we continue to work at 2 fence sites that we believe were used primarily to harvest caribou during their annual spring and fall migrations: KgRx-1 and KgRu-1. These fences are physical manifestations of Shúhtagot'ine traditional ecological knowledge obtained through countless observations and interactions with animals and shared over many generations (see Smith 2013). This includes landscape-scale knowledge to determine the most productive places to invest in the construction of hunting structures, as well as knowledge about how to take advantage of local topography to build effective traps (Lemke 2021).

Our archaeological work at these sites has focused on creating high-resolution maps and aerial photos of the fences and collecting samples for dendrochronological dating. While this detailed site work is necessary to create robust records of the fences and their landscape contexts, and to develop a temporal framework for the construction and operation of the fences, understanding why a fence was built where it was within the wider landscape requires a broader perspective on where the trails of hunters and caribou were most likely to intersect. Creating opportunities for traditional knowledge holders and archaeologists to walk these sites together proved invaluable for understanding this broader context. The archaeologists on the team learned that KjRx-1, for example, is located along an important Shúhtagot'ine traditional trail close to the location where it traverses a mountain pass called *İts'édée ʔotai* (moose antler pass or summit). Shúhtagot'ine traditional knowledge indicates that this pass is also part of a *níqneþ'ene* (migration route) for caribou during their annual migrations.

A key finding of the NWTIPS traditional knowledge interviews was the importance of mineral licks in Shúhtagot'ine land use (Andrews, MacKay, Andrew, et al 2012). Several Shúhtagot'ine geographical place names make direct reference to these features. Like ice patches, mineral licks are predictable places for hunters to encounter caribou (and other ungulates) at certain times of the year. Previous archaeological research along Begádeé (Keele River) demonstrated that some hunting structures were built near mineral licks. In the 1980s, Shúhtagot'ine Elders showed archaeologists a historic wood sheep fence on a mountain above Begádeé and described how hunters chased sheep from the mineral lick into the fence, which was set with snares (Pokotylo and Hanks 1985). The Shúhtagot'ine place name for this mountain is *Pietl'aʔnejo*, which means “chase animal into cliff pocket.”

Our field observations at KjRx-1 and KgRu-1 indicate that hunters may also have built these fences to target mineral lick locations. KjRx-1 is located on a high, flat terrace. The main fence at this site runs for 800 m along the terrace and then plunges down the steep bank to a corral structure on the valley floor (van der Sluijs et al 2020). A biologist who visited the site with our field team identified mineral deposits in the sediment along the edge of the terrace, with numerous caribou and sheep tracks leading toward them. KgRu-1 is a complex fence structure located at a large U-shaped bend in the Raven's Throat River. UAV data collected in 2021 show numerous well-worn game trails radiating from this landform in many directions. Patches of exposed sediment found across the landform and covered in caribou and sheep tracks seem to be places that animals targeted to ingest minerals. These data strengthen evidence of the apparent association between historic hunting structures and mineral licks in the Shúhtagot'ine cultural landscape.

Collaborative research with Shúhtagot'ine Elders, who shared their knowledge of animal behavior and habitat, brought the association between mineral licks and hunting structures into focus. The Sahtu Land Use Plan provides a mechanism to mobilize this information. Conformity Requirement #9 (Sensitive Species and Features) states that land use activities “must not take place within 1000 m of any known mineral lick, unless the activity cannot feasibly meet this requirement, and it can be demonstrated that

alternative mitigation measures will protect the lick” (Sahtu Land Use Planning Board 2013: 42). This does not apply to traditional harvesting activities.

Keeping hunting sites clean

An archaeological conundrum common to both the NWTIPS and the SCLP is the apparent absence of butchered caribou bones in the vicinity of ice patches and fence sites. Given the long history of human hunting at alpine ice patches, and the use of fences to amass and kill large numbers of caribou, the archaeologists involved in these projects expected to find butchering areas at these sites with extensive deposits of caribou bones. As noted in Andrews, MacKay, and Andrew (2012), many caribou bones were recovered from ice patch sites, but none showed signs of human butchering and were interpreted as natural death assemblages.

An important cultural principle for Shúhtagot'ine hunters is to keep hunting sites clean (Andrews, MacKay, Andrew, et al 2012; Andrew 2018). As Leon Andrew (2018: 103) pointed out: “The Shúhtagot'ine have great respect for ʔepé [caribou] and we take good care of them. . .In the old days, ʔepé fences and snaring sites were kept clean, and only hunters were allowed to walk over the area. Salt licks are special places to the Shúhtagot'ine. We would never butcher a ʔepé on a salt lick and instead would drag the carcass away to dress it out.” In the 1980s, Shúhtagot'ine Elders similarly informed archaeologists that sheep killed at a sheep fence were taken down the mountain whole because the scent of blood on the sheep trails would prevent sheep from returning to the fence (Pokotylo and Hanks 1985). Out of deep respect for caribou, Shúhtagot'ine hunters disposed of their bones by placing them neatly in tree branches; they were never left unattended (Andrew 2018).

Working together to understand ancestral hunting sites brought to light how Shúhtagot'ine cultural practices to maintain hunting sites and show respect for the animals they hunted structured the archaeological record of these sites.

Discussion

The 3 case studies presented above show how collaborative research methodologies that weave together different ways of knowing have led to a deeper understanding of archaeological caribou hunting sites in the Shúhtagot'ine cultural landscape. How can archaeological research promote the wellbeing of the Shúhtagot'ine and their homeland today? One way is through the conservation of cultural heritage to ensure that it is available for the education and enjoyment of future generations. The Government of the Northwest Territories' (2014) Land Use and Sustainability Framework highlights the importance of considering the sustainability of land-based cultural values when making land-use decisions in the NWT. Conservation actions in the Shúhtagot'ine cultural landscape include collecting and preserving artifacts, biological material, and contextual information from alpine ice patches that are rapidly degrading due to anthropogenic climate change; creating robust digital records of fence sites that are at increasing risk of destruction from forest fires; and generating detailed site information for the cultural resource managers charged with ensuring that development activities do not disturb archaeological sites.

FIGURE 5 A Sahtu student holds a stone tool that she found associated with a sheep fence site on the mountain known to the Shúhtagot'ine as Pietl'ar'nejo during the 2021 field campaign for the Shúhtagot'ine Cultural Landscape Project.



Archaeological research can also evoke the “landscape memories” held within cultural landscapes. The conceptual framework that Lindholm and Ekblom (2019: 3) developed for biocultural heritage—a concept closely related to the idea of a cultural landscape—categorizes archaeological sites as landscape memories, which they define as “tangible materialized human practice and semi-intangible ways of organizing landscapes.” Landscape memories are 1 of 3 “memory reservoirs,” which also include “ecosystem memories” and intangible “place-based memories” such as place names. Lindholm and Ekblom (2019) encouraged practitioners to explore these memory reservoirs—and the linkages between them—in order to mobilize the knowledge that they hold toward contemporary landscape management. The case studies presented above wove landscape memories and place-based memories together to identify places where humans and caribou have come together over many generations. Unlocking these memories through collaborative archaeological research at fence sites has led us to recognize previously unrecorded mineral lick areas that can now be managed more effectively through available land management mechanisms. Evoking the memory of the long relationship between caribou, humans, and perennial ice in K'at'ieh has brought attention to the contemporary implications of the rapid decline of alpine ice patches.

In a related way, archaeological sites are also archives of biological information that scientists can use to create long-term perspectives and baseline reference points for the abundance and health of species and environmental conditions, which can be used to inform future conservation efforts (Hambrecht et al 2020; Crumley 2021). For example, scientists have used ancient deoxyribonucleic acid (DNA) from caribou bones found at alpine ice patches to track the genetic diversity of caribou through time (Letts et al 2012) and analyzed the contents of caribou dung from ice patches to create a long-term perspective on caribou diet (Galloway et al 2012; Polling et al 2021). With the help of long-dead but well-preserved archaeological timbers from KjRx-1, Beckhusen et al (2022) created a millennia-long tree ring chronology, providing a long-term record of local environmental variability that can form a baseline for tracking the impacts of anthropogenic climate change in the Shúhtagot'ine cultural landscape.

Perhaps the most important pathway to sustainable Indigenous cultural landscapes and cultural wellbeing is through ongoing engagement with the cultural landscape. Indigenous cultural landscapes are not frozen in time as cultural artifacts, but instead exist as dynamic, living landscapes in which intangible cultural meanings and knowledge embedded in place are renewed through activities on the land (Andrews and Buggey 2008; Prosper 2012). Both the NWTIPS and the SCLP have provided opportunities for Indigenous Elders and youth to transfer knowledge about the Shúhtagot'ine cultural landscape in on-the-land settings (Figure 5). A highlight of the NWTIPS science camps was visiting an alpine ice patch with Shúhtagot'ine Elders and youth, where the Elders described how they would hunt caribou on the ice patch. The need to hunt caribou from above an ice patch explained why ice patches containing hunting artifacts are almost always found on mountains with rounded tops (Andrews, MacKay, Andrew, et al 2012). The SCLP has also led to the renewal of community memories of special hunting places. As an Elder noted in an SCLP community meeting, this information is important for the young people to learn because making a living in the mountains relies on knowing the places where you can find animals. In turn, archaeologists involved in these projects have learned how to conduct research in the Shúhtagot'ine cultural landscape in a respectful way. This includes practices such as leaving offerings when collecting artifacts or samples from the land and “paying the water,” an offering made to request good weather and safe travel from the spiritual entities that inhabit the landscape. Referring back to Norström et al's (2020) definition of knowledge coproduction, they emphasized that the goal of coproduction processes is not just the generation of knowledge, but also to develop capacity and build networks that can work toward sustainability.

Conclusion

We believe that the case studies presented in this article highlight the value of long-term collaborative archaeological research in the Shúhtagot'ine cultural landscape. Advancing research methodologies that embrace multiple ways of knowing, are sensitive to the local socio-ecological setting, and build momentum toward the mobilization of knowledge in current land management and future sustainability will be critical for conserving Indigenous cultural heritage at risk of destruction from climate change in Canada's North.

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REFERENCES

- Andrew L.** 2018. Harvesting in Dene Territory: The connection of ʔepé (caribou) to the culture and identity of the Shúhtagot'ine. In: Parlee BL, Caine, KJ, editors. *When the Caribou Do Not Come: Indigenous Knowledge and Adaptive Management in the Western Arctic*. Vancouver, Canada: UBC Press, pp 101–106.
- Andrews TD, Buggey S.** 2008. Authenticity in Aboriginal cultural landscapes. *APT Bulletin* 39:63–71.
- Andrews TD, MacKay G.** 2012. The archaeology and paleoecology of alpine ice patches: A global perspective. *Arctic* 65(suppl 1):iii–vi.

- Andrews TD, MacKay G, Andrew L.** 2012. Archaeological investigations of alpine ice patches in the Selwyn Mountains, Northwest Territories. *Arctic* 65(suppl 1):1–21.
- Andrews TD, MacKay G, Andrew L, Stephenson W, Barker A, Alix C, Shúhtagot'ine Elders of Tullita.** 2012. Alpine ice patches and Shúhtagot'ine land use in the Mackenzie and Selwyn Mountains, Northwest Territories, Canada. *Arctic* 65(suppl 1):22–42.
- Asch M, Andrews TD, Smith S.** 1986. The Dene Mapping Project on land use and occupancy: An introduction. In Spaulding P, editor. *Anthropology in Praxis*. Calgary, Canada: University of Calgary Press, pp 36–43.
- Beckhusen G, Stuart G, Andrew L, MacKay G, Andrews T, Laroque C.** 2022. Creating a millennial-long chronology in northern Canada: Dendroarchaeological dating of the Moose Horn Pass Caribou Fence (KjRx-1), Mackenzie Mountains, NT. *Forests* 13(2):221.
- Bush E, Lemmen DS, editors.** 2019. *Canada's Changing Climate Report*. Ottawa, Canada: Government of Canada.
- Crumley CL.** 2021. Historical ecology: A robust bridge between archaeology and ecology. *Sustainability* 13:8210.
- Galloway JM, Adamczewski J, Schock DM, Andrews TD, MacKay G., Bowyer VE, Meulendyk T, Moorman BJ, Kutz S.** 2012. Diet and habitat of mountain woodland caribou inferred from dung preserved in 5000-year-old alpine ice in the Selwyn Mountains, Northwest Territories, Canada. *Arctic* 65(suppl 1):59–79.
- Gillespie BC.** 1981. Mountain Indians. In: Helm J, editor. *Handbook of North American Indians: Vol 6 Subarctic*. Washington, DC: Smithsonian Institution, pp 326–337.
- GNWT [Government of the Northwest Territories].** 2014. *Northern Lands Northern Leadership: The GNWT Land Use and Sustainability Framework*. Yellowknife, Canada: GNWT.
- Hambrecht G, Anderung C, Brewington S, Dugmore A, Edvardsson R, Feeley F, Gibbons K, Harrison R, Hicks M, Jackson R, et al.** 2020. Archaeological sites as distributed long-term observing networks of the past (DONOP). *Quaternary International* 549:218–226.
- Ion PG, Kershaw GP.** 1989. The selection of snowpatches as relief habitat by woodland caribou (*Rangifer tarandus caribou*), Macmillan Pass, Selwyn/Mackenzie Mountains, N.W.T., Canada. *Arctic and Alpine Research* 21:203–211.
- Lemke A.** 2021. Literal niche construction: Built environments of hunter-gatherers and hunting architecture. *Journal of Anthropological Archaeology* 62:101276.
- Lepofsky D, Armstrong CG, Greening S, Jackley J, Carpenter J, Guernsey B, Matthews D, Turner NJ.** 2017. Historical ecology of cultural keystone places of the Northwest Coast. *American Anthropologist* 119(3):448–463.
- Letts B, Fulton TL, Stiller M, Andrews TD, MacKay G, Popko R, Shapiro B.** 2012. Ancient DNA reveals genetic continuity in mountain woodland caribou of the Mackenzie and Selwyn Mountains, Northwest Territories, Canada. *Arctic* 65(suppl 1):80–94.
- Lindholm K-J, Ekblom A.** 2019. A framework for exploring and managing biocultural heritage. *Anthropocene* 25:100195.
- Lozny LR.** 2008. Place, historical ecology and cultural landscape: New directions for applied archaeology. In: Lozny LR, editor. *Landscapes Under Pressure: Theory and Practice of Cultural Heritage Research and Preservation*. New York, NY: Springer, pp 15–25.
- MacKay G, Andrew L, Smethurst N, Andrews TD.** 2019. Rapid loss of perennial alpine ice patches, Selwyn and Mackenzie Mountains, NWT. In: Parrott L, Robinson Z, Hik D, editors. *The Alpine Club of Canada's State of the Mountains Report*. Vol 2. Canmore, Canada: The Alpine Club of Canada, pp 26–28.
- Norström AV, Cvitanovic C, Löf MF, West S, Wyborn C, Balvanera P, Bednarek AT, Bennett EM, Biggs R, de Bremond A, et al.** 2020. Principles for knowledge co-production in sustainability research. *Nature Sustainability* 3:182–190.
- Östlund L, Norstedt G.** 2021. Preservation of the cultural legacy of the Indigenous Sami in northern forest reserves—Present shortcomings and future possibilities. *Forest Ecology and Management* 502:119726.
- Pokotylo, DS, Hanks CC.** 1985. *Mountain Dene Ethnoarchaeology: Preliminary Perspectives, Permit 83-531*. Unpublished report on file at the Prince of Wales Northern Heritage Centre. Yellowknife, Canada. Available from corresponding author of this article.
- Polling M, ter Schure ATM, van Geel B, van Bokhoven T, Boessenkool S, MacKay G, Langeveld BW, Ariza M, van der Plicht H, Protopotopov AV, et al.** 2021. Multiproxy analysis of permafrost preserved faeces provides an unprecedented insight into the diets and habitats of extinct and extant megafauna. *Quaternary Science Reviews* 267:107084.
- Prosper L.** 2012. Aboriginal perspectives on renewing and revitalizing cultural meaning in place. Unpublished paper presented at the 15th Annual US/ICOMOS International Scientific Symposium: *Confluence of Cultures, World Heritage in the Americas*. San Antonio, TX, 30 May–1 June. Available from corresponding author of this paper.
- Sahtu Land Use Planning Board.** 2013. *Sahtu Land Use Plan*. Fort Good Hope, Canada: Sahtu Land Use Planning Board.
- Smith B.** 2013. Modifying landscapes and mass kills: Human niche construction and communal ungulate harvests. *Quaternary International* 297:8–12.
- Species at Risk Committee.** 2020. *Status Report for Northern Mountain Caribou (Woodland Caribou [Northern Mountain Population]) (Rangifer tarandus caribou) in the Northwest Territories*. Yellowknife, Canada: Species at Risk Committee.
- van der Sluijs J, MacKay G, Andrew L, Smethurst N, Andrews TD.** 2020. Archaeological documentation of wood caribou fences using unmanned aerial vehicle and very high resolution satellite imagery in the Mackenzie Mountains, Northwest Territories. *Journal of Unmanned Vehicle Systems* 8:186–206.