



Social-Ecological Determinants of Access to Fish and Well-Being in Four Gwich'in Communities in Canada's Northwest Territories

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Published online: 27 March 2020
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Abstract

River systems globally are experiencing social-ecological changes that often impact Indigenous fishing practices, including climate change and resource developments. We explore the relationship between access to fish and well-being, and the determinants of access to fish amidst changing social-ecological conditions through interviews with 29 individuals across four Gwich'in First Nation communities in Canada's Northwest Territories. Our interviews show that socioeconomic and environmental barriers are making it harder to access fish and that this has negative implications for well-being. Despite these barriers, access to fish continues to make positive, diverse contributions to well-being in Gwich'in communities through socioeconomic factors such as sharing networks and adaptive practices that are often part of ecological monitoring and land-based education and facilitate access to fish. Increasing our understanding of the relationship between access to fish and well-being, and determinants of access to fish, can contribute to land-based programs, land-use planning, and decision-making in Gwich'in territory and other river systems.

Keywords Well-being indicators · Determinants of access · Fishing livelihoods · Social-ecological change · Climate change · Traditional knowledge · Knowledge transmission · Gwich'in · Northwest Territories · Canadian subarctic

Introduction

River systems around the world are being altered by industrial development and climate change (Baird *et al.* 2015; Holmes *et al.* 2013; Kelly *et al.* 2010; Prowse *et al.* 2009; RAISG 2012; Yang *et al.* 2002). The impacts of these changes are significant, because rivers play critical roles in the global water budget, and support diverse human and ecological communities (Gummer *et al.* 2006; Klubnikin *et al.* 2000; Silvano and Valbo-Jørgensen 2008). Some of these impacts include degraded water quality and damaged or destroyed animal

habitat, fishing areas, cultural sites, and community infrastructure (Baird *et al.* 2015; Loo 2007; Michell *et al.* 2018; Sandlos and Keeling 2016; Yakovleva 2011). These changes can negatively affect fishing and hunting livelihoods for many local and Indigenous peoples (Ford and Pearce 2010; Middleton *et al.* 2009).

For the Gwich'in First Nation in Canada's Northwest Territories, fishing practices are an important component of livelihoods (GRRB and Gwich'in Elders 2001; Gwich'in Land Use Planning Board 2018; Gwich'in Renewable Resources Board 2008), and contribute to a complex social-ecological system, based on reciprocal interactions among traditional foods, cultural practices, and the environment (Alexie 2015; Andre 2006; Berkes and Folke 1998; Gwich'in Land Use Planning Board 2018; Parlee *et al.* 2005). Many Gwich'in community members grew up spending summers and autumns at fish camps, harvesting, preparing, consuming, and storing traditional foods (Alexie 2015; Andre 2006; Slobodin 1962; Wishart 2014). Although Gwich'in land use practices have changed through time (Parlee 2006; Parlee *et al.* 2018; Turner *et al.* 2018; Wray and Parlee 2013), the Mackenzie River system continues to support a large subsistence harvest of fish (Gwich'in Renewable Resources Board 2009; Wishart 2014). However, ongoing environmental changes including

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s10745-020-00131-x>) contains supplementary material, which is available to authorized users.

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increased air temperatures, more frequent natural disturbances, hydrological changes, shifts in vegetation, and development projects such as oil and gas exploration and highway construction (Gill *et al.* 2014b; Gwich'in Land Use Planning Board 2018; Holmes *et al.* 2013; Lantz *et al.* 2010; Parlee *et al.* 2018; Scott 2011; Segal *et al.* 2016; Stantec Consulting Ltd. 2014; Vincent *et al.* 2015) are raising concerns about the impacts of environmental changes on traditional foods (Greenland and Walker-Larsen 2001; Parlee *et al.* 2018; Turner *et al.* 2018). Concurrent changes to Gwich'in cultural, spiritual, educational, political, and economic systems over the last 200 years have also altered local livelihoods and access to traditional foods (Alexie 2015; Andre 2006; Gwich'in Land Use Planning Board 2018; Kuhnlein *et al.* 2009).

Traditional foods like fish are strongly linked with physical health and well-being in Indigenous communities (Gwich'in Renewable Resources Board 2009; Kuhnlein *et al.* 2009; Receveur *et al.* 1997; Schuster *et al.* 2011; Turner 2006a; Wein *et al.* 1991). Cultural activities associated with traditional foods connect Indigenous people with the land, maintain social networks, facilitate knowledge transmission, and influence physical health and well-being (Alexie 2015; Guerin *et al.* 2011; Kuhnlein *et al.* 2009; Lambden *et al.* 2007; Parlee and Furgal 2012; Petrusek MacDonald *et al.* 2015; Schultz *et al.* 2018; Schuster *et al.* 2011; Wishart 2014). Well-being can generally be considered as “quality of life,” and is conceptualized differently between Indigenous communities: *Dene ch'anié* or “the Dene way of life” in Lutsel K'e, Northwest Territories (Parlee 2006), but *miyupimaatisiü* or “being alive well” in some Cree communities (Adelson 1998; Parlee and Furgal 2012). While we are not aware of a Gwich'in-specific well-being definition, we drew on Indigenous conceptualizations (First Nations Health Authority 2018; Parlee and O'Neil 2007; Petrusek MacDonald *et al.* 2015; Reading *et al.* 2007; Robertson and Ljubicic 2019; Sangha *et al.* 2015; Schultz *et al.* 2018) to define well-being as: “balance between the emotional, mental, spiritual, and physical dimensions of the person in connection to [their] family, community, and environment” (Parlee and Furgal 2012: 7).

Well-being frameworks describe the cultural factors that influence health, and can be used to clarify how well-being is understood and measured (Kent 2014). Across the circumpolar north, recent literature has emphasized the link between environmental and human health, and the negative consequences of environmental change on well-being (Cunsolo Willox *et al.* 2015; Parlee and Furgal 2012; Petrusek MacDonald *et al.* 2015; Robertson and Ljubicic 2019). Many Indigenous well-being frameworks highlight the importance of spending time on the land, animate and inanimate parts of the environment, and social, cultural, and economic factors including: the

importance of community, health of the mind, body, and spirit, knowledge sharing, and culture and language (Mignone and O'Neil 2005; Panelli and Tipa 2007; Reading *et al.* 2007; Royal Commission on Aboriginal Peoples 1996; Turner 2006a). To understand the effects and interactions of both environmental and socioeconomic processes on well-being in Indigenous communities, additional case studies are required (Parlee and Furgal 2012). In this research project, we explore how socioeconomic and environmental factors influence fishing livelihoods and well-being in four Gwich'in communities in Canada's Northwest Territories.

Specifically, we use the concept of access to explore the relationship between Gwich'in fishing practices and the well-being indicators described in the Assembly of First Nations Wholistic Policy and Planning Model (Reading *et al.* 2007). Following Ribot and Peluso (2003), we define access as “the ability to derive benefits from things,” in this case, to gain well-being benefits from harvesting, preparing, consuming, and distributing fish. While fishing practices themselves are tied to well-being, in many communities this relationship is mediated by mechanisms that determine whether people can or cannot access the land (Gilani *et al.* 2018). Mechanisms of access are unique to communities and periods of time, but often relate to technology, capital, markets, labour, knowledge, authority, identity, and social relations (Ribot and Peluso 2003). In social-ecological systems, environmental factors also directly or indirectly impact access. Environmental factors like weather or ice conditions can impact access by determining whether or not people can physically travel to harvesting areas. Other factors, like fish abundance or quality, can impact access to fish by altering resource *availability* (Bennett *et al.* 2018). We consider availability of fish to be a prerequisite for access, as changes in availability ultimately impact peoples' ability to get fish. Detailed analysis of the determinants (i.e., mechanisms) of access is needed to build a more complete understanding of the ways that traditional foods impact Indigenous well-being. Understanding these drivers could also shed light on the impacts of social-ecological change on access to fish and well-being, and ways to manage these impacts.

We conducted this research project with members of the Gwich'in First Nation to examine the relationship between access to fish and well-being, and socioeconomic and environmental determinants of access to fish amidst social-ecological changes. We worked with Gwich'in community members to: 1) examine relationships between access to fish and well-being; 2) document observations of environmental change; and 3) explore factors preventing or helping people get fish (determinants of access to fish). Ultimately, we hope that this research provides insights into the impacts of social-ecological conditions on

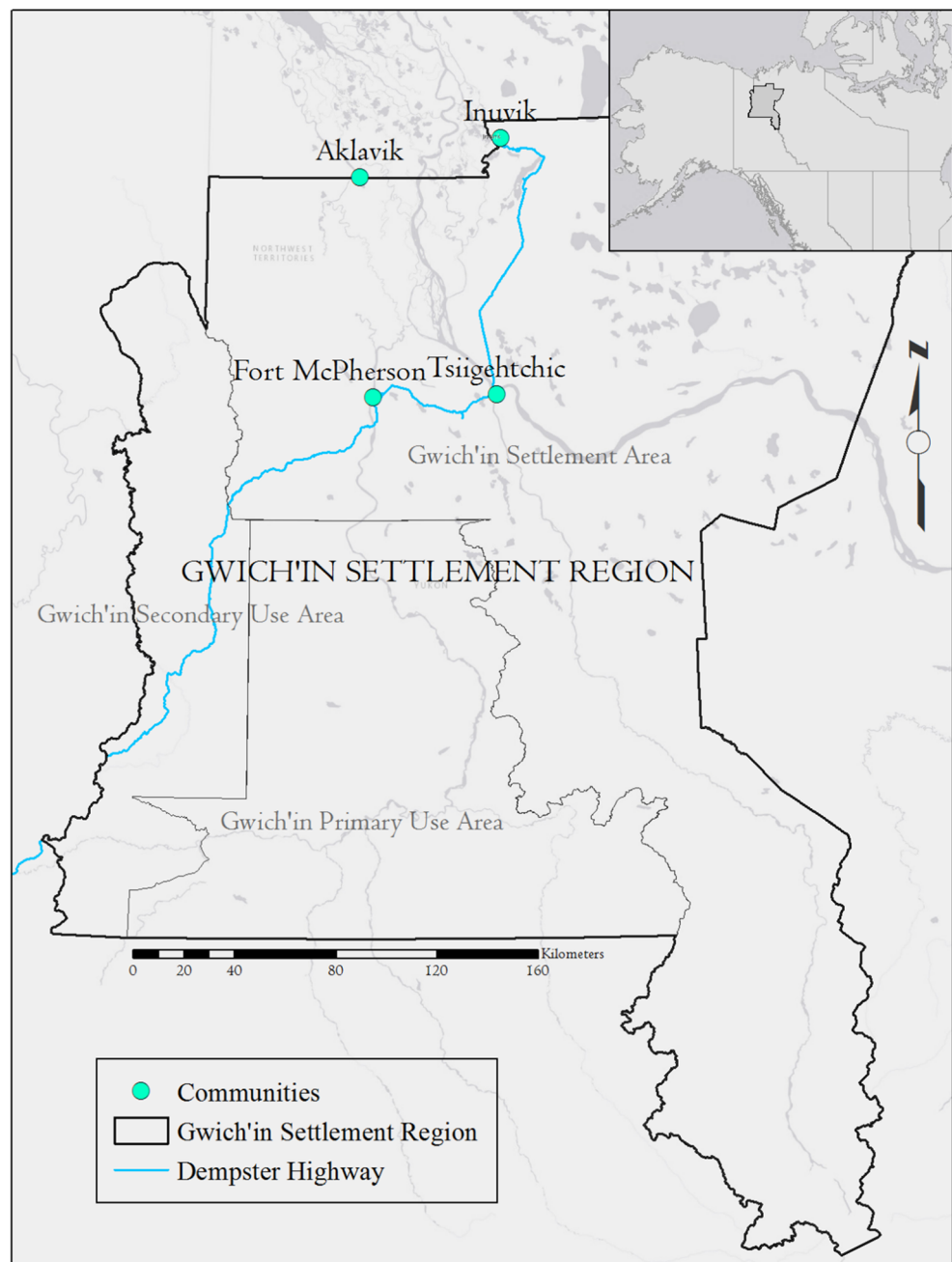
Gwich'in fishing livelihoods and well-being that can help inform local and regional decisions about land use and traditional foods.

Study Area

The four Gwich'in communities involved in this study are in the Gwich'in Settlement Area (GSA) (Fig. 1), which was delineated in 1992 through the Gwich'in Comprehensive Land Claim Agreement (Gwich'in Land Use Planning Board 2018). The GSA is in the Northwest Territories and part of the larger Gwich'in Settlement Region that also includes areas of

overlapping land use in Yukon Territory (the Primary and Secondary Use Areas) (Gwich'in Land Use Planning Board 2018). Gwich'in territory has a subarctic climate, with average daily temperatures ranging between -26°C in January to 14°C in August (Environment Canada 2018). There are approximately 3400 Gwich'in residents throughout the GSA: the Ehdit'at Gwich'in of Aklavik, the Teet'it Gwich'in of Teet'it Zheh/Fort McPherson, the Nihtat Gwich'in in Inuvik, and the Gwichya Gwich'in in Tsiigehtchic (Gwich'in Land Use Planning Board 2018). There are also other Gwich'in communities in Yukon Territory and Alaska (Gwich'in Council International 2015).

Fig. 1 Map of the Gwich'in Settlement Region, showing the Gwich'in Settlement Area, Primary Use Area, Secondary Use Area, and communities of Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic



Traditionally, the Gwich'in way of life was based on subsistence harvesting, involving extensive travel on the land and water to hunt, trap, fish, and gather food and medicines (Asch and Tychon 1993; GRRB and Gwich'in Elders 2001; Gwich'in Land Use Planning Board 2018; Slobodin 1962). The modern economy is a mix of subsistence harvesting and wage labour (Alexie 2015; Andre 2006; Gwich'in Land Use Planning Board 2018; Parlee *et al.* 2005). The Gwich'in continue to travel throughout their territory, and ties to the land and water and harvesting activities including fishing remain critical to cultural identity (Alexie 2015; Andrews *et al.* 2016; Gill *et al.* 2014a; Parlee *et al.* 2005). Gwich'in fishers have used different methods over time, including nets, hooks, and fish traps (Andre 1994; GRRB and Gwich'in Elders 2001; Wishart 2014). Today, most fish are harvested with nets in open water through the summer and fall, and under ice in early winter (Wishart 2014). Fish harvested in significant quantity for consumption in Gwich'in communities include: *luk dagaii* (broad whitefish, *Coregonus nasus*), *sruh* (coney, *Stenodus leucichthyes*), *dalts'an* (crookedback, *Coregonus clupeaformis*), *chehluk* (loche, *Lota lota*), and *dhik'ii* (Dolly Varden char or *Salvelinus malma*) (Greenland and Walker-Larsen 2001; Gwich'in Renewable Resources Board n.d.; Thompson and Millar 2007; Wishart 2014).

Methods

This research was guided by principles articulated in several Indigenous methodologies, including: centralizing local values and priorities, valuing and cultivating relationships, and recognizing the critical nature of the land for community members and research (Absolon 2011; Edosdi 2008; Kovach 2009; Smith 1999). Our work emerged from previous collaborations between the University of Victoria (UVic), the Gwich'in Renewable Resources Board (GRRB), and the Gwich'in Tribal Council Department of Cultural Heritage (DCH) (Gill *et al.* 2014a; Parlee and Maloney 2017; Turner *et al.* 2018). UVic researchers took the lead conceptualizing the research project, and the GRRB and DCH provided key guidance regarding project objectives, interview questions, and logistics. To ensure that the questions explored in this project were consistent with the concerns and priorities of Gwich'in fishers, we conducted six pilot interviews in 2016. Our research focus emerged from our analysis of these interviews, which highlighted the relationship between fishing and well-being, and widespread observations of barriers to accessing fish. To explore determinants of access to fish, and the relationship between access and well-being, we utilized interviews and thematic coding analysis, while prioritizing local youth engagement and knowledge sharing activities.

Interviews

We interviewed 29 Gwich'in community members between July and September, 2017. Interviews lasted about one hour. Most participants were interviewed individually, but six participants were interviewed in groups of two. Participants were recruited with the help of Renewable Resource Council (RRC) Coordinators and word of mouth in each community, as well as the DCH in Fort McPherson, and the Ehdiitat Gwich'in band office in Aklavik. To include a variety of perspectives, we interviewed 17 individuals who fished regularly, and 12 individuals who did not fish or fished irregularly. Most participants were interviewed in communities (25 total: six in Aklavik, eight in Fort McPherson, five in Inuvik, and six in Tsiigehtchic), and four were interviewed at fish camps. Of the 29 interviewees, 16 were women and 13 were men. Although we did not ask for participant ages, we estimate that they ranged from 30 to 80 years old.

We used a semi-structured interview format to allow for open-ended discussions. Conversations were guided by pre-determined questions, but participants often steered the discussion. This flexibility and fluidity is important within many Indigenous methodologies (Brayboy and Deyhle 2000; Kovach 2009). Interview questions focused on participants' personal fishing history, access to fish, and observations of environmental change (Appendix S1). Although well-being was central to our research question, we did not refer to this topic explicitly during interviews, but allowed it to emerge where and when it was relevant. Interviews were recorded with a digital audio recorder (Zoom Handy Recorder H2) and/or video camera (Nikon D7000 camera) and transcribed. Each participant was offered a copy of their interview transcript to review for accuracy and to keep for their records. The majority of participants requested copies, which were delivered during community visits in February, 2018. Most of our participants wanted their names to be published alongside their quotes, but some participants chose not to have their name published, and are referred to as "anonymous" in the results section.

Thematic Coding Analysis

To analyze interviews, we coded them for themes using NVivo software (Version 10). In a first round of coding, the text of each interview was systematically reviewed to identify various themes, including environmental change, factors influencing access to fish, family, place names, animals, land-use activities, and well-being. In subsequent rounds of coding, themes were refined, and organized into three topics relevant to our research: 1) well-being, 2) environmental change, and 3) determinants of access to fish.

To identify aspects of well-being that are related to accessing fish, we coded the sections of each interview where

participants discussed positive or negative influences of fishing practices (or lack of/ altered fishing practices) on any of 22 well-being indicators from the Assembly of First Nations Wholistic Policy and Planning Model (Reading *et al.* 2007). These indicators included community, eight aspects of health, and 13 social determinants of health (Reading *et al.* 2007). We coded for these indicators based on a wide array of general criteria (Table 1, a full list provided in Appendix S2). While some criteria were loosely pre-determined, the majority emerged throughout the coding process.

To track participant observations of environmental change, we coded changes that participants had observed or were concerned about occurring in the future. To organize participant observations about determinants of access to fish, we coded portions of each interview that mentioned factors that impede or enhance the ability of Gwich'in individuals to harvest, prepare, consume, and distribute fish. This coding focused on socioeconomic barriers and facilitators of access and environmental barriers that directly affect access to fish (i.e., changing ice conditions) or that indirectly affect access through

reductions in the availability of fish (i.e., catching fewer fish). Environmental factors facilitating access were not coded because while participants made it clear that a healthy environment is critical in facilitating access to fish, they typically did not discuss this in enough detail to be coded. To assess if fishing effort was stable or changing, we coded instances where participants described changes in access to fish through time. To further explore the relationship between access to fish and well-being, we used NVivo to identify the sections of each interview where themes of socioeconomic and environmental determinants of access overlapped with well-being themes.

Knowledge Sharing and Youth Involvement

During this research project, we maintained regular contact with partner organizations and visited Gwich'in territory a total of five times for periods of two weeks to two months. We visited the region for initial scoping interviews, for the main interviews and fish camp visits, to deliver newsletters and transcripts, to touch base with participants and partner

Table 1 Well-being indicators from the Assembly of First Nations Wholistic Policy and Planning Model that were discussed in interviews. The table highlights summarized criteria used to code for the positive impacts of access to fish and negative impacts of reduced or altered access

to fish on well-being indicators discussed during interviews. The “number of participants who discussed” columns display the number of participants who identified the indicators as being positively influenced by access to fish, and negatively influenced by reduced or altered access to fish

Well-being indicator	Summarized criteria used to code for each indicator		Number of participants who discussed	
	Positive	Negative	Positive	Negative
Life-long learning	Learning/teaching on the land throughout life, importance of elders	Fewer people learning on the land and having fishing knowledge	29	17
Community	Helping each other get on the land and get fish	Harder to go on or gather on the land	29	7
Lands and resources	Importance of travelling, harvesting on the land	Fewer people going on the land	28	26
Environmental stewardship	Teaching and acting on land use values	Disrespecting the land	27	8
Employment & economic development	Contributions of fish to the local economy	Monetary challenges to accessing fish	27	5
Physical health	Health benefits of eating fish and land use	Health concerns from eating fish or land use	26	17
Economic health	Fish contributing to vibrant economy	Challenges in selling fish and land use	26	4
Languages, heritage, and culture	Importance of fish and land use to Gwich'in culture	Fewer connections between land, fish, and Gwich'in culture	25	13
Social health	Working together to get fish, get on the land, and understand fish	Challenges in bringing people on the land	25	4
Housing	Living or growing up on the land	Less access to bush camps	18	3
Self determination	Getting on the land no matter what	Fewer opportunities to “just go fish”	18	2
Cultural health	Importance of fish and land use for Gwich'in identity and values	Fewer connections between land, fish, and Gwich'in culture	16	6
Environmental health	Enacting values about respecting the land	Concerns about human impacts on the land	14	19
Urban and rural	Balance between time in town and on the land	Factors keeping people in town more	13	8
Health care	Healthy habits related to fish and land use	None discussed in interviews	9	—
Emotional health	Good feelings associated with fish and land use	Emergencies keeping people off the land	6	1
Mental health	Mental health benefits of time spent at fish camps	Emergencies keeping people off the land	6	1
Social services	Organizations helping people get on the land	None discussed in interviews	6	—
Spiritual health	Spiritual benefits of fish and land use	None discussed in interviews	2	—

organizations, to help organize a high school visit in Fort McPherson, to attend RRC or GRRB meetings, and to hold community meetings to discuss results. Throughout data collection in August 2017, we visited three established fish camps near Fort McPherson and one near Aklavik (Fig. 2). These visits brought together researchers, youth, and land users to discuss this research project, and provided a land-based context to this work that increased experiential understandings of fishing in Gwich'in territory. These trips also provided the opportunity to briefly employ six young adults (two from Fort McPherson and four from Aklavik). These youth participants received training in digital SLR cameras and audio recorders and were given the opportunity to photo and video-document fish camp activities and assist with interviews. Fish camps also provided youth with opportunities to spend time on the land with elders and helped facilitate knowledge sharing between generations, the importance of which has been well documented in the region (Aporta *et al.* 2014; Bennett and Lantz 2014; Gill *et al.* 2014a; Turner *et al.* 2018).

Results

“It is Gwich'in:” the importance of access to fish for well-being.

Throughout our interviews it became clear that accessing fish is deeply tied to the well-being of Gwich'in community members. Participant responses indicated that access to fish influences 19 of the 22 well-being indicators that we examined from the Assembly of First Nations framework (Reading *et al.* 2007; Table 1). Participants noted instances where sustained access positively influenced indicators and cases where limited or altered access negatively influenced indicators (Table 1).

The majority of indicators that were positively influenced by access to fish were mentioned by over half of the participants (Table 1). For instance, participants frequently cited physical health benefits of accessing fish. When discussing physical health, participants overwhelmingly described fish as nutritious and healthy: “... boy fish is good for you, you know. The best stuff in the world” (Tom Wright, Inuvik). Another prominent criterion used to code for the “physical health” indicator was “not being able to live” without fish. This was often elicited when participants discussed the possibility of not being able to access fish: life without it “would mean death” (Dwayne Semple, Aklavik), “a disaster” (Abraham Stewart, Fort McPherson), or as one anonymous participant described: “I think we’ll starve [if we couldn’t get fish]. We’ll go hungry for sure for a few days out of a month.”

Participants also often described the positive influence of access to fish on life-long learning. The criteria for coding the “life-long learning” indicator regularly related to knowledge transmission, including learning or teaching land-based skills (Table 1). Abraham Stewart (Fort McPherson) described the importance of knowledge transmission to him: “I’m so honoured that I’ve been able to learn from them [old timers]. We need to continue that [teaching] tradition.” Participants described many reasons that it is important to continue the knowledge sharing tradition through continued land use, for instance: it helps people to “get common sense” (Anonymous participant), to learn to “value your traditional way” (Anonymous participant), and to be prepared for the future:

It’s good for young people to learn [land-based skills], you don’t know what’s going to come in the future, maybe famine or something like that. They have to fend for themselves when they get older so

Fig. 2 Photos from fish camp visits in Gwich'in territory: A) Aerial view of a camp near Aklavik (Photo: Kiyo Campbell), B) Abraham Stewart (Fort McPherson interview participant/fish camp owner) checking his net on the Peel River (Photo – 2017 Peel fish camp participant), C) William Tyrrell (Aklavik youth participant) cutting a fish to make dry fish (Photo: Tracey Proverbs), D) Fish drying for consumption at Mary Effie Snowshoe’s fish camp on the Peel River (Photo: Tracey Proverbs)



it's good for them to learn when they're young
(Walter Vittrekwa, Fort McPherson).

Another concept that was often described in interviews was the role of accessing fish in building and maintaining community. The “community” indicator was coded using various criteria, including community members helping each other get on the land and teaching or learning land use practices and values (Table 1). These coding criteria demonstrate that some criteria, such as those related to teaching or learning, were used to simultaneously code for multiple indicators (i.e., community, life-long learning). In this way, one interview section often touched on many aspects of well-being. Interview participants documented different ways that accessing fish builds community, including fish camps being gathering spaces, programs that teach fishing skills, and the frequently described Gwich'in value of sharing traditional food: “It's the Gwich'in way, if you have enough, you should be sharing. . . because long ago that's what they did, and I think those are the things that need to be carried on” (Margaret Gordon, Inuvik).

Conversely, participants also made it clear that reduced or altered access to fish can negatively influence well-being. Most interview participants described changes in their fishing practices through time, with 28 of 29 describing decreased access, and 23 describing altered access. Participants mentioned negative impacts to 16 well-being indicators (Table 1). Unlike indicators that were positively influenced by access to fish, the majority of well-being indicators that were negatively influenced by reduced or altered access were discussed by under half of the participants (Table 1). Some of the most frequently discussed impacts of reduced access to fish on well-being included negative influences to physical health, relationships with the land, and knowledge transmission. Some of the criteria used to code for negative influences on physical health included risk of injury from novel river conditions (e.g., low water levels) as well as health impacts associated with decreased access to traditional foods and the land:

Those days, people ate a lot of fish and ate a lot of berries off the land. Everything was off the land. And we never heard of cancer. Nobody was sick. Even old people would be out there on the land. And we never heard of anybody being sick. But now, nobody's out on the Peel [River] fishing, and a lot of people are sick.
(Mary Effie Snowshoe, Fort McPherson)

Similarly, the criteria used to code for negative impacts to the “lands and resources” and “life-long learning” indicators often related to fewer people utilizing and learning harvesting skills (Table 1). For instance, Abraham Stewart (Fort McPherson) described what can happen to the land when people stop learning how to use and take care of fishing areas:

People need to continue using the places they fish . . . we used to live just around the bend . . . and nobody has lived there for years, and now it's all grown [in with] willows. If people don't use it, it's going to spoil . . . people need to continue doing what our elders did . . . [They said] go on the trails at least once a year. Otherwise it's all going to grow in . . . We can't find the trails anymore.

Ultimately, our interviews illustrated that access to fish significantly affects well-being through intricate connections with multiple aspects of socio-cultural traditions in Gwich'in communities. The fact that access to fish can both positively and negatively influence well-being was illustrated through the many connections between access to fish and well-being indicators that our participants described, and also through more general participant observations. For instance, fishing is so enmeshed with Gwich'in identity that not having access to it would be “like killing part of our spirit” (Elizabeth Vittrekwa, Fort McPherson). Summed up by one anonymous participant, “It [fishing] is Gwich'in.”

“If I can't get fish, I'm not going to be too happy about it:” determinants of access to fish.

Our interview participants reported that both socioeconomic and environmental processes influence access to fish for Gwich'in community members. By increasing or decreasing access to fish, these drivers are linked to the positive and negative influences on well-being that our participants outlined. Participants' observations of decreased access were linked to 13 environmental barriers (Table 3), and 16 socioeconomic barriers (Table 4). However, interviewees also discussed 16 socioeconomic determinants that facilitated access to fish (Table 4).

Access Barriers

Some of the barriers participants mentioned that negatively influenced well-being resulted from the wide variety of observations of environmental change and concerns about future change that were discussed (Table 2). For instance, participants discussed environmental changes that resulted in indirect barriers to accessing fish through decreased availability of fish (i.e., shifts in abundance and distribution). While participants generally expressed their gratitude that local fish were healthy and abundant, many reported catching some fish that they would not eat due to health concerns, including fish with soft flesh or marks. Participants also generally described plentiful fish populations, but some participants noted smaller catches in recent years:

The first two weeks in July. There was hardly anything. . . Usually we have only one [net], and there's enough fish. But we had four [nets] in. And sometimes [we]

Table 2 Environmental changes and concerns observed by interview participants

Environmental change theme	Environmental change sub-theme	Number of participants who discussed
River & lake	River morphology (changes to sand bars, cut banks, erosion)	24
	Water levels* (increased or decreased)	23
	Water quality (sediments in water, orange stuff in water)	19
	Eddies and current* (changes in eddies or current)	11
	Ice dynamics (changes to freeze up/break up, overflow)	11
	Water temperature (warmer or colder)	10
Climate and weather *	Air temperature (warmer or colder)	20
	Climate & seasonal change (climate change, seasonal shift)	17
	Storm and wind (wind, blizzards, thunder storms)	10
	Precipitation (rain, snow)	7
Fish health*	Soft fish (soft flesh)	13
	Amount of fish (increased or decreased amount)	12
	Internal physical issues (concerns about liver, eggs, disease)	11
	External physical issues (scratches, spots, pus, scabs)	10
	Fish migration* (change in pattern)	8
	Spawning* (change in pattern)	5
Landscape change	Permafrost thaw, landslides	13
Anthropogenic development	Transportation (ferries, roads)	10
	Oil, gas & mining development (oil and gas, mining, seismic)	7
	Other anthropogenic development (dams, sewage lake)	6
	Garbage & pollution	5
Vegetation	Vegetation growth, forest health	7

* These themes were asked about explicitly in interview questions

only got four or five fish . . . we experienced this twice now [in 2016 and 2017]. (Anonymous participant)

Participants also shared numerous observations of environmental changes that directly affected access to fish (Table 3). Changes to river morphology (e.g., increased sand bars) and lower water levels were two of the most frequently described environmental changes that created barriers to accessing fish (Table 3). One anonymous participant described how lower water levels in the past few years have made it harder to access fishing locations: “There’s some places we used to go and now we hit sand bars. You know it never used to be there, so you never think it’s going to be until you hit it. The river is changed.” David Thompson (Fort McPherson) elaborated on this, describing how low water levels also endanger physical health: “I was in an accident last summer. I’ve got a fast boat, and I went over a shallow spot and my friend flew right over. He got hurt.”

Many environmental observations shared in interviews revealed unprecedented disruptions to a cycle of land use synchronized to the seasons, which Dwayne Semple (Aklavik) described as “just like clockwork” until recently. Many participants described this shift with a sense of uncertainty about the future. One anonymous participant worried about whether or not the

animals, land, and water in Gwich’in territory will remain healthy:

You don’t know . . . when fish are going to turn bad . . . we go to Yellowknife and around there and we see a lot of people. I know a lot of people from way back there. And now they can’t even fish around their community. The fish is . . . full of that mercury.

Socioeconomic determinants like cultural change, limited fishing knowledge, and high cost were some of the most frequently described barriers to accessing fish (Table 4). These barriers were often described together, indicating that there are multiple overlapping factors that can make it harder to access fish:

A lot of people weren’t raised up [on the land]. If they were shown how to do things I think a lot of people would do it. It’s just they don’t know how to prepare [fish] or cut it up . . . and when it comes down to it, it’s money again. It costs too much to do things . . . there’s a lot of people that are willing to try but, they don’t have the equipment to do it. (Anonymous participant)

Table 3 Environmental determinants acting as barriers to accessing fish mentioned by participants. The “indirect or direct impact” column describes whether each determinant indirectly impacts access to fish through a decline in the availability of fish, or directly impacts access to fish by impacting peoples’ ability to travel to fishing locations or harvest fish

Environmental determinant	Indirect or direct impact	Description of the barrier	No. of participants who discussed
Fish health*	Indirect	Declines in the availability of healthy fish (fewer fish, or fish people don’t want to eat)	22
River morphology change*	Direct	Increase in sand bars, erosion (harder to travel)	20
Water levels*	Direct	Lower or higher water levels, increased fluctuation (harder to set nets or travel)	18
Water quality	Direct	Muddy water (damages nets), orange substance in water (people don’t want to fish)	13
Anthropogenic development	Direct & Indirect	Direct – pollution concerns (people don’t want to fish), concerns about sediment at ferry landings (people can’t access areas) Indirect - one observation of a blocked creek from seismic lines (may impact fish populations)	12
Weather conditions*	Direct	Storms and challenging weather (harder to travel)	11
Air temperature	Direct	Too warm for some people to go on the land, earlier ice break up (dangerous conditions, harder to travel), permafrost thaw releasing more sediments (harder to travel)	10
Eddies change*	Direct	Eddies harder/impossible to fish in because of increase in sediments or other changes	7
Water temperature	Direct	Water is too warm to fish, some think that it makes the fish too soft	6
Vegetation change	Direct	Increased growth (harder to travel), more plants are falling in the river due to erosion (harder to fish in eddies and to travel)	5
Ice dynamics	Direct	Changes in freeze up and break up patterns (harder to travel and fish under ice)	5
Permafrost thaw	Direct	Permafrost thaw releasing sediments (harder to set nets and to travel)	3
Wildlife	Direct	Bears in the area can make it hard to get on the land	3

* These themes were asked about explicitly in interview questions

Cultural change and limited fishing knowledge were cited by participants as barriers to accessing fish, illustrating the negative impacts of declining traditional land use and knowledge transmission on well-being. For example, Archie Norbert (Tsiigehtchic) discussed how cultural change alters aspects of well-being like traditional land use:

It’s not like the old days. The old days everybody was raised on fishing in the fall and all summer. Hunting in the fall. Moose, caribou, whatever. So you know, we were raised that [way], but nowadays we’re not. Now it’s [formal] education. And, we’re losing our language, we’re losing the old traditional ways.

Access Facilitators

While all participants described barriers that make it challenging to get on the land, they also emphasized that they can still access fish: “No, no, no. It doesn’t matter what it costs me, I’ll

still try to make it out there [to my fish camp]” (Mary Effie Snowshoe, Fort McPherson). Multiple factors help individuals get fish, including family and sharing networks, among other socioeconomic facilitators (Table 4). Jamie Benoit-Cardinal (Tsiigehtchic) described how factors such as family, sharing, and having a place to fish ensure continued access while positively influencing well-being by building relationships with the land and community and enhancing land-based learning:

My mother-in-law goes out fishing on her holiday, her camp is set up down the river and she does fish, so that’s an opportunity for us to go down and, you know, share the knowledge with us. So that’s really good.

The socioeconomic determinants that our participants discussed reflect both traditional and contemporary factors. Traditional determinants, related to sharing and learning from elders, are important for enhancing multiple aspects of well-

Table 4 Socioeconomic determinants acting as facilitators and barriers to accessing fish that were mentioned by participants. Facilitators are factors that increase access to fish, and barriers are factors which impede access to fish

Socioeconomic determinant	Facilitators		Barriers	
	Description of the facilitator	No. of participants who discussed	Description of the barrier	No. of participants who discussed
Fishing knowledge*	Having the knowledge to harvest or prepare fish	29	Lacking knowledge to harvest or prepare fish	18
Access through others*	Being taken on the land, taught about fish, or given fish by others	28	—	—
Equipment*	Owning or borrowing necessary fishing equipment	26	Not owning or being able to borrow fishing equipment	18
Place to fish on the land*	Having your own place to fish, or using someone else's	29	Not having a place to fish on the land	13
Monetary wealth/cost*	Having enough money to pay for fishing activities	12	Not having enough money to pay for fishing activities	22
Cultural change	Fewer dogs (described as positive because may contribute to more fish)	1	Culture shifting away from eating fish and being on the land	19
Time to get on the land*	Having enough time to go fishing	14	Being too busy to go fishing	13
Organizations*	Organizations like RRCs helping people get on the land	20	—	—
People to fish with	Having other people to fish with	12	Not having anyone to go fishing with	5
Regulations and licensing*	Allowing people to sell fish	11	Certain regulations make it harder to get on the land/sell fish	5
Fish storage	Having somewhere to store your fish for the winter	8	Not having anywhere to store your fish in winter	2
Health	—	—	Health problems preventing people from going on land	10
Like fish/working with fish	Enjoy working with fish	3	Dislike working with fish	6
Open access	Everyone in Gwich'in communities is encouraged to fish	8	—	—
Older age	—	—	Older age can make it harder to fish	6
Necessity	Needed fish to survive in the past	1	Not fishing as much because it's not necessary any more	4
Self-motivation	Nothing will stop people from fishing or getting fish	3	—	—
Technology	Generators help preserve fish	2	Newer technology keeping people in town	2
Fear	—	—	Afraid to fish	2
Personal tragedy	—	—	Family emergencies keeping people in town	2

*These themes were asked about explicitly in interview questions

being. One anonymous participant reiterated the importance of values that ensure that everyone gets fish and that enhance well-being by building community and maintaining traditions:

We all help one another to do our traditional living out on the land. If somebody's successful out on the land, we can ask them if we could help them and work with them . . . whatever they get . . . they bring it into town and they just share it with everybody. We all share our values together, our food.

While embracing traditional ways of getting fish, participants also discussed more contemporary access facilitators, such as modern equipment and selling or buying fish. While selling fish was widely acknowledged as a recent practice that was not part of the traditional Gwich'in economy, it was generally accepted:

There's nothing wrong with that [selling fish] because it's their way of getting income and helping out . . . and people are willing to pay for it. We have a hard time getting a fish, so I know I have to go and buy a fish and you know, I don't mind that. It's helping out and they're helping me too. (Anonymous participant)

Another interesting dimension of our conversations about the determinants of access to fish related to current efforts that may increase the ability for community members to access fish in the future. For example, several participants mentioned ongoing efforts to monitor fish populations in the face of environmental changes, and generally expressed their pleasure that Gwich'in community members and organizations were involved in monitoring: "We're doing this [community-based whitefish monitoring] study, which is really good, really important" (Alice Vittrekwa, Fort McPherson).

Overall, interview responses showed that the drivers of access to fish include a suite of socioeconomic and environmental determinants that can make it harder or easier to access fish, which in turn positively or negatively influences the well-being of community members. Despite detailed observations of barriers that make it harder to access fish, several socioeconomic facilitators maintain access and positively impact well-being for Gwich'in individuals.

Discussion

The Importance of Fish

Fishing practices are a central element of the Gwich'in social-ecological system. Our interviews showed that access to fish is a significant component contributing to the quality of life of Gwich'in community members and that reduced or altered

access to fish can have negative impacts on well-being. By positively influencing numerous facets of well-being, including health, connections with the land, and knowledge transmission, access to fish plays a significant role in maintaining balance for Gwich'in individuals, communities, and the environment. Participants stressed the positive influence of fish on physical health (Bersamin *et al.* 2007; Blanchet *et al.* 2000; Kuhnlein *et al.* 2009), but more frequently cited aspects of well-being connected with Gwich'in cultural traditions: travelling and harvesting on sacred lands and waters (Alexie 2015; Andre 2006; Slobodin 1962), learning and teaching between generations (Andre 2006), and building and maintaining community through resource sharing (Parlee *et al.* 2005; Wray and Parlee 2013). By providing an important food source while promoting these cultural traditions the benefits of access to fish include, but also transcend, nutrition to incorporate broader benefits. These findings align with past research highlighting the importance of traditional food systems for well-being as well as food security (Collings *et al.* 2016; Lambden *et al.* 2007; Searles 2002).

Barriers to Accessing Fish

The responses of our interviewees highlighted that environmental change is creating barriers to accessing fish that negatively influence well-being, as has been described in other regions (Cunsolo Willox *et al.* 2015; Parlee and Furgal 2012; Petrasek MacDonald *et al.* 2015; Tobias and Richmond 2014). Changes discussed included processes related to anthropogenic development and climate change (Cameron and Lantz 2016; Gill *et al.* 2014a; Segal *et al.* 2016) that can directly affect fish health (Roe 2003; Walker and Simmons 2018), but can also make it harder for community members to access harvesting areas (Guyot *et al.* 2006; Lawrence 2009). Participants described many environmental changes and concerns as barriers that indirectly impacted access to fish via declines in fish availability, as well as directly through barriers such as lower water levels that made it harder for Gwich'in community members to access fishing areas. In addition to observations of current environmental changes, our participants described concerns about further changes in environmental conditions that elicited a sense of uncertainty about the future, which may intensify negative effects on well-being by impacting mental and emotional health (Cunsolo Willox 2018; Cunsolo Willox *et al.* 2015; Hayes *et al.* 2018).

Our analysis also showed that social, cultural, and economic factors can result in barriers to accessing fish. Cultural changes that make it difficult to access fish were frequently described, such as eroded knowledge of fishing practices including setting nets, preparing fish, and choosing camp locations. Many participants discussed these barriers in relation to changes stemming from colonial policies, including residential schools and lifestyle changes associated with the

introduction of the wage economy and permanent settlements. Interviewees also indicated that, by affecting livelihoods, diet, and cultural traditions central to Gwich'in identity, reduced access to fish negatively influences well-being (Alexie 2015; Andre 2006; Slobodin 1962), echoing research in other Indigenous communities (Biddle and Swee 2012; Kuhnlein and Receveur 1996; Turner 2006b). Overall, this combination of social and ecological changes creates barriers to accessing fish that culminate in fewer people out on the land and negative effects on well-being.

Cultural Institutions that Sustain Gwich'in Fishing Practices

Despite reduced access, fishing remains integral in Gwich'in communities. Our analysis suggests that multiple social, economic, and cultural processes related to sharing networks and adaptive practices contribute to sustaining access to fish in the face of social-ecological stressors. Sustained access fosters many of the well-being benefits linked to accessing fish, of which the most prominent facilitators discussed in our interviews related to sharing networks, such as gifting fish, learning with a mentor, borrowing equipment, or utilizing a relative's fish camp. Participants often described benefits of these facilitators for aspects of well-being like physical health, heritage, and culture. Local food sharing networks, without imposition by external elements, can be described as self-organizing processes (Biggs *et al.* 2015), which are important in resilient land use activities (Abel *et al.* 2006; Berkes and Turner 2006; Biggs *et al.* 2015) and have been shown to contribute to well-being across Indigenous communities in North America (Baggio *et al.* 2016; Collings *et al.* 2016; Natcher 2009). Additionally, the use of both traditional and modern fishing practices in Gwich'in communities represents adaptation that also contributes to sustained access to fish. Participants frequently discussed traditional land use values and fishing practices such as sharing, while also incorporating modern facilitators like newer equipment. This response to change likely plays a role in the evolution of fishing practices and the continued ability to access fish.

Gwich'in communities are also engaged in co-management and education programs that encompass sharing networks and adaptations that are likely to strengthen fishing systems. These efforts include fish monitoring programs such as the Rat River Char Monitoring program and a recently started community-based whitefish monitoring program (Armitage *et al.* 2011; Harwood *et al.* 2009; Hovel *et al.* *in press*), as well as land-based education like the new *Ganahghoot' onatan* – Teetl'it Land Based Learning Project and past land-based science camps (*Ganah Khoonatan* - Teetl'it Land Based Learning Project 2018; Kritsch and Andre 1997), both of which foster sharing networks and adaptation by disseminating scientific and traditional knowledge

about fish populations and traditional and modern land-use practices (Armitage *et al.* 2011; Berkes *et al.* 2009). The pace of ongoing social and environmental change (Kokelj *et al.* 2015; St. Pierre *et al.* 2018) underscores the importance of existing programs to monitor fish and facilitate intentional, intergenerational knowledge transfer.

Our results suggest that social, economic, and cultural factors facilitate access to fish and bolster aspects of Gwich'in well-being. Sustained access to fish in spite of increased barriers can be described as resilience, “the natural, human capacity to navigate life well” (HeavyRunner and Marshall 2003), “to be ready” or “to never give up” (Inuvialuit elders in Rawluk 2012: 69), or “to be strong” (Gwich'in elders in Rawluk 2012: 69). While ongoing social-ecological changes in Gwich'in territory have the potential to push the factors enabling Gwich'in fishing practices outside of their typical ranges of variation, the combination of positive feedbacks between access to fish and well-being, and a diversity of processes that sustain access indicate that Gwich'in fishing livelihoods will continue to be strong.

The Importance of Understanding Access to Traditional Foods and Well-Being

Examination of the relationship between access to fish and well-being and the socioeconomic and environmental determinants that drive access to fish offers insights that could guide programs to strengthen connections with the land and promote well-being. Several programs in Gwich'in territory are working to overcome barriers to accessing fish, by promoting learning through others, providing a camp and necessary land use equipment through land-based education (*Ganah Khoonatan* - Teetl'it Land Based Learning Project 2018), and addressing concerns about fish health through ongoing fish monitoring programs (Armitage *et al.* 2011; Hovel *et al.* *in press*). Our participants highlighted connections between access to fish and well-being, indicating that these programs enhance land use alongside a wide array of other factors important for wellness. The continued evaluation of determinants of access to traditional foods will contribute to these efforts if new barriers or facilitators arise, and ongoing examination of determinants of access to traditional foods could guide programming and contribute to well-being in other regions.

Future land use decisions must consider the role of access to traditional foods in enhancing well-being in Indigenous communities (Parlee *et al.* 2005; Sangha *et al.* 2015; Tobias and Richmond 2014). Some planning processes are working to incorporate local well-being indicators into decision making (Gilani *et al.* 2018; Marine Plan Partnership for the North Pacific Coast 2017; Rubus EcoScience Alliance 2007), but many land use decisions prioritize resource developments that limit access to traditional foods (Baird *et al.* 2015; LaDuke

2005; Parlee *et al.* 2018). The Gwich'in continue to collaborate with neighbouring groups to limit development in the upper Peel Watershed that could cause barriers to accessing traditional foods like fish and caribou (Parlee *et al.* 2018; Stantec Consulting 2019; Staples *et al.* 2013). Our research indicates that, because access to fish is intertwined with well-being for Gwich'in community members, changes in access caused by resource development have consequences that extend beyond the need for alternative food sources, and include severe impacts to identity and cultural traditions.

Similar to northern Canada, river systems globally are experiencing changes related to environmental pollution, dams, and industrial activities such as oil and gas developments (McCreary and Milligan 2014; Molle *et al.* 2009; Walker and Simmons 2018), which can affect access to traditional foods like fish (Finley-Brook and Thomas 2010; Roe 2003; Sarkkula *et al.* 2009; Yakovleva 2011). Our study suggests that local consultation and engagement can identify social-ecological factors that influence the ability of people to access fish or other traditional foods for the well-being benefits this provides. While there are broad similarities between Gwich'in territory and other watersheds experiencing change, regional or local analysis is critical to understanding relevant determinants of access to traditional foods, and how they relate to well-being. As our research in Gwich'in communities suggests, insights into the influence of access to traditional foods on well-being can contribute to decision making related to land use planning to enhance multiple aspects of well-being by conserving areas that provide access to traditional foods and guiding the focus or creation of land-based programs that seek to overcome common barriers to accessing traditional foods.

Conclusion

Our research and analysis show that access to fish makes a vital contribution to well-being in Gwich'in communities despite often detrimental ongoing social-ecological changes. Even with declines and alterations in access to fish resulting from socioeconomic and environmental barriers, all our participants continue to value, utilize, and/or share fishing practices in ways that foster Gwich'in culture, identity, and well-being. Access to fish is sustained through a variety of social, cultural, and economic factors related to social networks and adaptive practices that are embodied in ecological monitoring and land-based education. These processes are likely to sustain access to Gwich'in fishing livelihoods in the face of future changes by facilitating knowledge transmission about fishing practices and fish health. Illustrating socioeconomic and environmental drivers of access to fish as well as the relationship between access to fish and well-being builds on understandings of well-being relevant for Indigenous communities, with

the potential to guide programming efforts and inform land use decision making in Gwich'in territory and other global river systems.

Acknowledgements The authors gratefully thank all of the interview participants and youth assistants involved with this project, including Lorraine Francis, Walter Vittrekwa, Elizabeth Vittrekwa, David Thompson, Abe Stewart, Ernest Vittrekwa, Alice Vittrekwa, Bernice Francis, Mary Effie Snowshoe, Dwayne Semple, Richard Ross, Robert Buckle, James McDonald, Wally Tyrrell, John Jerome, Tom Wright, Margaret Gordon, Archie Norbert, Winnie Blake, Frederick Blake, Billie Veryl Inglangasuk, Jamie Benoit-Cardinal, Karen Benoit, William Tyrrell, Justin Elanik, Arlyn Charlie, Rayna Vittrekwa, and all anonymous participants and assistants. Mahsi' choo as well to the communities of Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic for their warmth and generosity. Thank you to the local organizations and community members who were essential to planning this project, helping with logistics, and assisting with participant selection. We would also like to thank Emma Hodgson and Rachel Hovel for their collaboration, as well as all past and present members of the Arctic Landscape Ecology Lab at UVic - especially those who assisted with this project in the field and lab: Kiyoo Campbell, Chanda Turner, Zander Chila, Maliya Cassels, and Nina Moffat.

Compliance with Ethical Standards

Ethics Approval Ethics approval for the research was obtained from the University of Victoria Human Research Ethics Board, and the project was approved by the Gwich'in Tribal Council Department of Cultural Heritage through a formal Research Agreement.

Conflict of Interest The authors declare that they have no conflict of interest in relation to the funding for the research.

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