Moving forward together: Weaving Indigenous and Western sciences with practices and peoples in aquatic research in Inuit Nunangat

by

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Abstract

Climate change and development are causing rapid and profound changes in aquatic ecosystems across Inuit Nunangat, the homelands of Inuit in what is now known as Canada. Shared concerns regarding ecological integrity and fundamental knowledge gaps are increasingly drawing Inuit communities and researchers together in partnerships that center Indigenous voices to understand local change. In this thesis, I reviewed the practices of weaving Indigenous and Western sciences in coastal and marine research and monitoring, where an exploration of decision points that shape co-developed projects highlighted a diversity of possible research pathways. Additionally, I collaborated with the community of Kinngait, Nunavut to document Indigenous knowledge of environmental and biodiversity change in marine and lacustrine ecosystems through a questionnaire. This valuable record may inform community decision-making and planning, and will serve future generations. This thesis provides insights to facilitate continued efforts towards meaningful relationships between Inuit and researchers in environmental discourses.

Acknowledgements

There are countless people and places that have shaped my journey and brought me here, and to whom I owe my thanks. First, I am deeply grateful to my co-supervisors Dr. Karen Dunmall and Dr. Vivian Nguyen, and to my unofficial third supervisor, Dr. Steven Alexander. Thank you for your guidance and mentorship, your unwavering support, and your trust in me. I look forward to continuing to learn from you and with you in coming years. I am also grateful to my committee members Dr. Nathan Young and Dr. Joseph Bennett for your helpful input.

I am humbled to have been able to work with the Aiviq Hunters and Trappers Association in Kinngait, Nunavut, and community technicians Ooloosie Manning, Sheojuk Peter, and Pudloo Qiatsuq. A heartfelt thank you for your guidance, your support, your willingness to share your knowledge, and for your enthusiasm and interest in understanding environmental change in your community. I also extend my gratitude to the knowledge holders who contributed to this study. I hope to one day meet and spend time with you all in person to share laughter, stories, and tea.

As a settler, I am honoured to have been able to spend time living, working, and exploring many spaces in what is now called Canada. Thank you to the Indigenous Peoples who care for and occupy lands on which my families and I have been guests, and to the non-human teachers in these places. I am grateful to have completed this study and the degree that led me here in the unceded traditional territory of the Algonquin Anishinaabe Peoples in Ottawa, Ontario. My time spent in Winnipeg, Manitoba in Treaty No. 1 Territory in the traditional lands of the Anishinaabe, Ininew, Oji-Cree, Dene, and

Dakota, and the homeland of the Métis Nation was influential in my pursuit of this degree. Thank you to the Assiniboine Park Zoo Conservation and Research Department for reigniting my longstanding interest in Arctic ecosystems and for your encouragement.

Finally, thank you to my loved ones. I am immensely grateful to my parents Suzanne and Peter for your unconditional love and support. My siblings Alex and Jessica, whose parallel passions in aquatic restoration and nature interpretation greatly enrich my own work. My Nana, for your profound respect for the worldviews, wisdom, and rights of Indigenous Peoples everywhere. My Grandpa, who feels strongly that something must be done about climate change. My friends, especially Alison Conrad and Rachel Thiessen, for believing in me and challenging me. My colleagues, especially Adam Perkovic, for your optimism and for walking alongside me.

I recognize that I am only at the start of this path. As we continuously learn from each other, may we all tread more lightly, speak more gently, and treat Mother Earth with respect, reverence, and reciprocity.

Thesis Format and Contributions

This thesis is comprised of a general introduction (Chapter 1) and discussion (Chapter 4), and two co-authored manuscripts (Chapter 2 and 3) that are in preparation for submission to peer-reviewed journals. The repetition of definitions and details is at times necessary so that chapters can stand alone. All co-authors have provided guidance and critical input on drafts and near final versions of these manuscripts. To reflect the collaborative nature of the research chapters in this thesis, I use the pronoun 'we' throughout Chapter 2 and 3. Co-authorship contribution details are as follows:

Chapter 2. Weaving Indigenous and Western sciences: Decision points guiding aquatic research and monitoring in Inuit Nunangat Drake AK, Nguyen VM, Dunmall KM, and Alexander SM.

This chapter was conceptualized by Drake and Alexander and guided by Alexander, with continuous input from Nguyen and Dunmall. Drake conducted analyses and wrote the original and subsequent drafts, and all co-authors contributed to editing and revisions.

Chapter 3. Community experiences and perceptions of aquatic environmental and biodiversity change in ᑭᙵᒪᐃᑦ, ᓄᓇᕗᑦ (Kinngait, Nunavut) Drake AK, Aiviq Hunters and Trappers Association, Manning O, Peter S, Qiatsuq P, Christie LR, Nguyen VM, Alexander SM, and Dunmall KM.

This chapter was conceptualized by Drake, Dunmall, and Nguyen. This study would not have been possible without the consent, guidance, and support of the Aiviq Hunters and

Trappers Association (AHTA) in Kinngait, Nunavut, the insights and on-the-ground ‘field’ work by community technicians (Manning, Peter, and Qiatsuq), and the participation of 39 knowledge holders (acknowledged in manuscript). Drake, Christie, Dunmall, Nguyen, and Alexander contributed to the initial draft of the relevant questionnaire and assisted with research ethics processes, and Drake, Christie, Manning, Peter, Qiatsuq, and the AHTA further co-developed the questionnaire and verified results. Drake conducted analyses and wrote the original and subsequent drafts, and Dunmall and Nguyen contributed to study design, editing, and revisions.

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Chapter 1. General Introduction

In the research chapters of this thesis, I review the practices of weaving Indigenous and Western sciences in coastal and marine research and monitoring in Inuit Nunangat, the homelands of Inuit in what is now known as Canada (Chapter 2). In addition, I document Indigenous knowledge of environmental and biodiversity change in marine and lacustrine ecosystems with the community of Kinngait, Nunavut (Chapter 3). To provide the necessary background, in this introductory chapter, I begin by sharing my positionality because the context from which I approach this research shapes my worldviews, interpretations, and biases (Section 1.1). Following this, I characterize Inuit Nunangat (Section 1.2), discuss Arctic environmental change and the need for collaboration (Section 1.3), and highlight characteristics of partnerships between Indigenous communities and researchers (Section 1.4). I then define Indigenous and Western sciences (Section 1.5) and the weaving of these sciences (Section 1.6), before describing the objectives of my research chapters in detail (Section 1.7).

It is important to place this thesis in the context of the COVID-19 pandemic that brought this country to a standstill in March 2020. The pandemic directly affected this research by preventing in-person communication, connections, and trips on the land with the people of Kinngait, Nunavut (Chapter 3), but its impacts reverberate far beyond this into all areas of life for many.

1.1 Positionality

I am a white settler born on the traditional lands of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit in what is now known as Mississauga, Ontario. For almost a decade, I have lived in the traditional and unceded territory of the Algonquin Anishinaabe Peoples in what is now known as Ottawa, Ontario. I echo Dr. Colin Sutherland (Littlechild and Sutherland, 2021) in acknowledging that my journey here is connected to the trials and tribulations of many peoples. My families, from the Netherlands, Finland, and the United Kingdom, settled on the same lands on which I was eventually born, in Halton Hills and Toronto, Ontario. Other members of my families settled in Treaty No. 1 Territory in the traditional lands of the Anishinaabe, Ininew, Oji-Cree, Dene, and Dakota, and the homeland of the Métis Nation in Winnipeg, Manitoba, and in Treaty No. 4 Territory, in the lands of the Cree, Ojibwe, Saulteaux, Dakota, Nakota, Lakota, and homeland of the Métis Nation in Webb, Saskatchewan, thereby contributing to a period of displacement. My mother's family emigrated from the Netherlands in 1952 after the Second World War, one of many Dutch families who arrived at Pier 21 in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People in Halifax, Nova Scotia. I owe and extend my profound gratitude to the Indigenous Peoples who care for and occupy lands on which my families and I have been uninvited guests, and to the non-human beings who have taught me, inspired me, and brought me peace in the spaces where I have lived, worked, and explored. I recognize that gratitude alone will not suffice, and I resolve to continue to listen to and be guided by Indigenous Peoples, sciences, and priorities, to actively work to dismantle settler colonialism in the many spaces it permeates, and to reflect upon my thoughts and actions to unravel my complicity in its perpetuation. Looking forward, and leading with humility and reflexivity, I would like to deepen my understanding of Inuit, First Nations, and Métis realities and lands across northern and Arctic regions. I sincerely hope that this thesis contributes in some way to a future defined by Inuit self-determination[1], and recognize that there is infinitely more unlearning and learning ahead of me.

1.2 Inuit Nunangat

The majority of Inuit (Inuktut[2]: 'the people') in what is now known as Canada (approximately 65,000 people) reside in 51 communities across Inuit Nunangat (Inuit homelands, which include land, water, and ice), which encompasses the Territory of Nunavut, the Inuvialuit Settlement Region (northern Northwest Territories and Yukon Territory), Nunavik (northern Québec), and Nunatsiavut (northern Labrador) (ITK, 2018). Inuit Nunangat comprises approximately one third of Canada's landmass and half of its coastline (ITK, 2018), and has been recognized as a distinct geographic, cultural, and political region through the recent endorsement of the *Inuit Nunangat Policy* (Government of Canada, 2022). For millennia, Inuit have relied upon coastal and marine ecosystems that support wildlife (fishes, cetaceans, pinnipeds, birds), which are important sources of country food, skins, and furs. Many communities also rely heavily on freshwater rivers and lakes for fish harvest. The land is inseparable from all aspects of daily life, including food sharing, cultural practices, community celebrations and seasonal activities, and the mixed economy (Ljubicic et al., 2021). Time on the land is therefore

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[1] Self-determination is the expression of sovereignty; the right to self-government and autonomy in the pursuit of economic, social, and cultural development (United Nations, 2007; Borrows and Rotman, 2018).
[2] Inuktut refers to Inuit language, and includes all dialects used across Inuit Nunangat.

vital for the physical, emotional, mental, and spiritual health of individuals and communities, and is central to Inuit identity and culture (Parlee and Furgal, 2012; Durkalec et al., 2015; Watt-Cloutier, 2015; Karetak et al., 2017). In recent years, altered species availability and accessibility as well as unpredictable environmental conditions have rendered harvesting increasingly difficult and dangerous (Berkes and Jolly, 2001; Ford et al., 2013; Hansen et al., 2013), and disrupted relationships between Inuit and the land (Watt-Cloutier, 2015; Karetak et al., 2017). Understanding local changes can inform community decision-making in relation to species and habitat conservation and management, and support Inuit in fostering further resilience and adaptive capacity to environmental changes (Riedlinger and Berkes, 2001; Flynn et al., 2018; Ford et al., 2021).

1.3 Arctic environmental change and the need for collaboration

A perpetually expanding body of Arctic climate change literature offers familiar and bleak reports of rising water temperatures, greater loss of multi-year ice, longer ice-free seasons, decreasing snow cover, and increases in humidity and precipitation, among other changes (e.g., Stroeve et al., 2012; AMAP, 2017; Box et al., 2019; Overland et al., 2019). These shifts, which are associated with warming occurring nearly three times faster than the global average in Arctic regions (IPCC, 2022), are fundamentally altering aquatic species distribution, seasonal range, phenology, and interactions (e.g., Wassmann et al., 2011; Huntington et al., 2020). The effects of climate change both enable and are exacerbated by stressors including shipping, microplastics, contaminants, hydrocarbon development, mining, tourism, and commercial fisheries (Arctic Council, 2009; AMAP, 2018). The rapidity, extent, complexity, and cumulative impacts of change create a dire need for insights into aquatic ecology, yet render data compilation very challenging (McNicholl et al., 2021). As a result, there lacks a comprehensive baseline of biodiversity, habitat use, and ecosystem structure, processes, and variability across most of the Arctic region (Dey et al., 2018; Niemi et al., 2019).

In light of these significant knowledge gaps and the acute manifestations of climate change experienced by Inuit, environmental researchers and northern communities are increasingly collaborating for mutual learning. Common objectives to discern and understand changes in ecosystems and in the abundance and distribution of organisms, as well as recognition of the interconnectedness of living and physical entities, form the basis of these partnerships (Ban et al., 2018; Wong et al., 2020). Community-researcher collaborations generally center around the knowledge documentation or data collection phase of the research process, where community participation is often heightened through reliance on local expertise (Dale and Armitage, 2011; Turreira-García et al., 2018; Thompson et al., 2020). A wide variety of methods and approaches are used to compile and document Indigenous scientific knowledge regarding aquatic environmental change, including interviews, participatory mapping, focus groups, workshops, and participant and field observations (Alexander et al., 2019; Thompson et al., 2020; Alexander et al., 2021; Drake et al., in press). Western scientific data is frequently collected alongside Indigenous scientific knowledge, and can involve an equally diverse array of methods, such as mapping, telemetry, sea ice measurements, tissue sampling, or natural history observations (Alexander et al., 2019; Thompson et al., 2020; Alexander et al., 2021; Drake et al., in press). While understanding the methods used in knowledge documentation and data collection is important for assessing environmental change, so too are the background and fundamental characteristics of strong community-researcher partnerships.

1.4 Community-researcher partnerships

Over the past five decades, collaborative approaches have evolved towards respectful partnerships that can remove logistical and financial constraints, increase result relevancy, and enable a clearer grasp of implications on Indigenous communities (Danielsen et al., 2005; Gearheard and Shirley, 2007; Pearce et al., 2009; Tondu et al., 2014; Martinez-Levasseur et al., 2016; Carter et al., 2019; Pedersen et al., 2020). These approaches can also strengthen outcome ownership through knowledge sharing and co-production during the research process (Reed, 2008; Castleden et al., 2017a; Wilson et al., 2018; Chapman and Schott, 2020), while enhancing existing capacity and offering local employment opportunities (Pearce et al., 2009; Dale and Armitage, 2011; Wilson et al., 2018; Thompson et al., 2020). In recent years, the importance of authentic community participation throughout all research phases (i.e., research design, knowledge interpretation and verification, project evaluation and dissemination) has been highlighted to ensure that participation does not lend itself to tokenism or misrepresent research practices (Loseto et al., 2020; Mosurska and Ford, 2020; Wong et al., 2020; Drake et al., in press). Yet, in many cases, studies referencing community inclusion and participation have not demonstrated community involvement beyond contractual tasks (David-Chavez and Gavin, 2018; Drake et al., in press).

There remains a need for reconciliation in environmental research and monitoring (McGregor, 2018; Wong et al., 2020), where research is often undertaken by those with little understanding of Inuit realities (Kaiser et al., 2019), and an extractive and appropriative legacy of research on or with Indigenous Peoples lingers (Simpson, 2004; Hayward et al., 2021; Yua et al., 2022). These legacies are present in governance structures (Tester and Irniq, 2008), in the often inadequate incorporation of community interests in objectives, and in the frequent failure to return results to communities (Gearheard and Shirley, 2007; Wong et al., 2017; Hayward et al., 2021). Many Inuit, non-Inuit, and institutions have contributed to efforts to address these issues, with guidance offered in the Inuit Circumpolar Council *Ethical and Equitable Engagement Synthesis Report* (ICC, 2021) and in the Inuit Tapiriit Kanatami *National Inuit Strategy on Research* (NISR) (ITK, 2018). The importance of transparency in reporting is often emphasized, and researchers are urged to "specifically report on the ways in which ethical research principles are operationalized and…discuss unforeseen challenges" (Morton Ninomiya and Pollock, 2017, p. 35; Wheeler et al., 2020). Recently, Yua et al. (2022) noted that the COVID-19 pandemic has highlighted equity gaps, and has offered an opportunity to re-evaluate ways to support community means and ability (i.e., capacity) to engage in research, which is a critical step towards more ethical partnerships.

1.5 Indigenous and Western sciences

On a national level, several organizations call attention to the importance of Indigenous sciences (defined below) in research processes and decision-making. For example, *Canada's Arctic and Northern Policy Framework* discusses Indigenous leadership in developing and implementing knowledge-creation agendas for the conservation and sustainable use of ecosystems and species as one of its core objectives (CIRNAC, 2019). In addition, recent federal mandates for Fisheries and Oceans Canada and Environment and Climate Change Canada call for heightened research that is grounded in Indigenous sciences, and greater inclusion of Indigenous sciences in planning and policies (Government of Canada, 2021a, b). The *United Nations Declaration on the Rights of Indigenous Peoples Act*, containing responsibilities congruent with its international framework, seeks to support the contribution of Indigenous practices and knowledges to sustainable development and management, and the exercise of the right to self-determination by Indigenous Peoples (Department of Justice Canada, 2021). These calls to action illuminate important objectives that require extensive transformations and efforts at all levels of government, industry, and academia.

In this thesis, I consider Indigenous sciences[3] to be ever-evolving, highly contextual systems of thought, action, and orientation developed through close interaction with other living beings and the environment, and applied through biological, physical, cultural, and spiritual means (adapted from Berkes, 2018 and ICC, 2021). This includes insights acquired through direct, long-term experiences, and multigenerational observation, lessons, and skills. Other nuanced terms are often utilized similarly, including Traditional Ecological Knowledge (TEK), local knowledge, and Inuit Qaujimajatuqangit (IQ)[4]. These sciences are developed through time on the land hunting,

[3] Indigenous sciences is pluralized to reflect the heterogeneity of Indigenous cultures (McGregor, 2004).
[4] IQ are "Inuit ways of knowing, ways of being, and worldview – past, present and future" (Canadian Polar Commission, 2003, p. 6; Karetak et al., 2017). IQ follows ethical principles, including four *maligarjuat* (literally, "big things that must be followed"): 1) working for the common good, 2) living in respectful

fishing, gathering, or travelling (Karetak et al., 2017). I use 'sciences' in alignment with influential Indigenous thinkers and teachers, among them: Yup'ik scholar Dr. Angayuqaq Oscar Kawagley (see Kawagley, 1990, and Kawagley et al., 1998), Tewa scholar Dr. Gregory Cajete (see Cajete, 2000), Anishinaabe scholar Melanie Goodchild (see Goodchild, 2021), and Maya Ch'orti' and Zapotec scholar Dr. Jessica Hernandez (see Hernandez, 2022). In 1998, Kawagley et al. wrote that "science has a plurality of origins and a plurality of practices …[w]e contend that knowledge embedded in [a Yupiaq] worldview is scientific in nature" (p. 134). These authors go on to caution of the potential harm associated with the failure to consider Indigenous science a 'true science', explaining that "a narrow view of science not only diminishes the legitimacy of knowledge derived through generations of naturalistic observation and insight, it simultaneously devalues those cultures which traditionally rely heavily on naturalistic observation and insight" (p. 134). Also of note, while the word 'science' originates in Western society, coming from Old French and originally derived from the Latin *scientia*, it simply means *what is known*, *knowledge*, or *experience*. Hence, despite its association with Western science, the meaning of the term should not lend itself to sole use by Western societies.

While I use the term Indigenous sciences throughout this thesis, I have also chosen to use the term Indigenous knowledges in my research chapters. Drawing from the work of Dr. Nicholas Reo, a citizen of the Sault Ste. Marie Tribe of Chippewa Indians, I consider Indigenous knowledges to be the ways in which Indigenous sciences

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relationships with every person and thing that one encounters, 3) maintaining harmony and balance, and 4) planning and preparing for the future (Karetak et al., 2017, p. 3).

are manifested through a specific understanding of species, populations, habitats, and geography (see Reo, 2011). This distinction between sciences and knowledges was made to clarify and signal that as a settler, I was and will always be removed from the process of experiencing and creating Indigenous sciences[5]. In Chapter 2, I use Indigenous knowledges (plural), while in Chapter 3, I use Indigenous knowledge (singular) because the knowledge belongs to a single community (Kinngait, Nunavut).

Western science has historically been and continues to be a low-context system that excludes relational connections and often involves scientists separating themselves from nature or the object of study (Cajete, 2000; Nakashima and Roué, 2002). This body of knowledge favours objectivity and reductionist methods, and is anchored in Greek philosophy and the Renaissance (Mazzocchi, 2006). Western science also includes knowledge appropriated from many cultures that was modified to conform to Eurocentric values, worldviews, metaphysics, and epistemologies (Aikenhead and Ogawa, 2007). It is important to recognize, however, that Western science is not homogenous, and there are equally numerous fields, disciplines, and approaches that embrace uncertainty and complexity. For example, Western science can encompass opportunities for collaboration through community science, or Bayesian methods. Moreover, many Indigenous scholars are redefining Western science in spaces that bring together Indigenous and Western sciences[6]. Both Western science and Indigenous sciences are based on extensive, repeated experience and observation (Laidler, 2006; Gorelick, 2014), and use classifying,

[5] I recognize the inherent limitations of language, and that it can shape one's understanding differently. As articulated by Anishinaabe scholar Dr. Deborah McGregor, "every term is going to limit [Indigenous ways of knowing] in some way" (McGregor, 2008, p. 145).
[6] For example, Red River Métis/Michif scholar Dr. Max Liboiron discusses 'dominant science' in place of 'Western science' (see Liboiron, 2021).

inferring, questioning, observing, interpreting, predicting, monitoring, problem solving, and adapting (Johnson et al., 2016).

1.6 Weaving sciences

Throughout this thesis, I use the term ‘weaving sciences’ to refer to a dynamic, co-evolving process that maintains the integrity of each science while enabling the reciprocal exchange of understanding for mutual learning (Rathwell et al., 2015; Henri et al., 2021). This term was chosen to move beyond a narrative of integrating, incorporating, or combining Indigenous and Western sciences, which can connote the assimilation of Indigenous sciences into a Western scientific paradigm (Reid et al., 2021). ‘Weaving’ shares similarities with terms used by other authors, including ‘braiding’ (e.g., Kimmerer, 2013a; Hopkins et al., 2019) or ‘bridging’ (e.g., Aikenhead and Michell, 2011; Rathwell et al., 2015; Mantyka-Pringle et al., 2017; Alexander et al., 2019, 2021). I favour ‘weaving’ as it alludes to the numerous possible ways to bring these sciences together at broad levels, such as between institutions or organizations (i.e., weaving large pieces of fabric), or at finer levels, such as through personal relationships (i.e., weaving individual threads). ‘Weaving’ has been used by several authors in recent years (e.g., Johnson et al., 2016; Tengö et al., 2017; Popp et al., 2020; Henri et al., 2021).

Weaving can allow for the amplification of the strengths of Indigenous sciences and Western science because they are often considered temporally and spatially complementary (Riedlinger and Berkes, 2001; Moller et al., 2004; Laidler, 2006; Gagnon and Berteaux, 2009; Rathwell et al., 2015). Indigenous sciences tend to focus on qualitative measures, occur at local-to-regional scales, and enable longer historical baselines and an understanding of environmental variability, while Western science usually focuses on quantitative measures, is conducted on local-to-global scales, and may be limited by small sample sizes, discrete field seasons, or technological capacities (Moller et al., 2004; Berkes, 2018; Ban et al., 2018; Wheeler and Root-Bernstein, 2020). When woven together, Indigenous and Western science observations can increase confidence and the depth of knowledge generated (Huntington et al., 2004; Gearheard et al., 2009). These collaborative efforts can strengthen conservation and co-management by enabling a richer understanding of ecosystem shifts, and community context and impacts (e.g., cultural, political, socioeconomic) (Ban et al., 2018; AMAP, 2018; Alexander et al., 2019; Wheeler et al., 2020; ICC, 2021; Ford et al., 2021). Mi'kmaw Elder Dr. Albert Marshall refers to this "gift of multiple perspective[s]" as *Etuaptmumk* (Mi'kmaw for 'Two-Eyed Seeing'), which is "learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways and knowing, and to us[e] both these eyes together, for the benefit of all" (Bartlett et al., 2012, p. 335). While I did not specifically intend to enact and explore a Two-Eyed Seeing approach in this thesis, this understanding has undoubtedly influenced this undertaking.

1.7 Objectives

My overarching objective is to provide insights to facilitate continued efforts to build meaningful relationships between Inuit and settler peoples in environmental research. This thesis builds upon and is informed by the efforts of many Inuit, First

Nations, and Métis individuals, communities, and organizations, and of colleagues in this field.

This thesis is composed of two research chapters undertaken with the guidance and support of my co-authors (Chapter 2 and 3), and a general discussion describing important considerations and areas for further reflection (Chapter 4). The research chapters, while complementary, are independent projects and manuscripts. In Chapter 2, I seek to elucidate the operationalization of weaving through a systematic realist review. This type of review combines systematic and realist review characteristics to synthesize the state of knowledge in a subject area and examine why, how, for whom, and in what context certain approaches function. I explore the practices of weaving in aquatic research and monitoring across Inuit Nunangat, and identify points in a research or monitoring project where significant decisions are made that contribute to weaving ('decision points'). I then present example case studies to walk readers through possible applications of these decision points. In Chapter 3, I work in partnership with the community of Kinngait, Nunavut to document experiences and perceptions of environmental and biodiversity change in marine, coastal, and lacustrine ecosystems, and associated changes in harvesting practices. Under the guidance of the Aiviq Hunters and Trappers Association, and through collaborations with community technicians and other knowledge holders, I create a record to address ecological knowledge gaps, establish a baseline of change for future generations, and inform community decision-making in the context of continuous change. In its totality, this thesis describes an endeavour to weave Indigenous and Western sciences with practices and peoples to holistically understand aquatic environmental change.

Chapter 2. Weaving Indigenous and Western sciences: Decision points guiding aquatic research and monitoring in Inuit Nunangat

2.1 Abstract

There is a compelling need to draw upon multiple ways of knowing to understand and address complex environmental problems. Indigenous and Western sciences, when brought together, offer holism that can strengthen research and monitoring efforts and outcomes, yet the practices and processes of weaving these sciences are not well understood. As settlers, we sought to elucidate the operationalization of weaving through a systematic realist review of coastal and marine research and monitoring studies that use methods for compiling and documenting Indigenous knowledges and methods for collecting data from across Inuit Nunangat (Inuit homelands in the place now called Canada; n = 25 case studies). We identified and explored three decision points that shape projects co-developed by researchers and Inuit communities: research objectives, method bundles (the totality of methods used in a case study), and method sequencing (the order of application of Indigenous and Western sciences). Five categories of objectives emerged from the case studies reviewed; these were addressed through 24 different method bundles, and a multitude of repeating method combinations that are components of more complex bundles. We found that Indigenous and Western sciences can be applied in at least five sequences. Example case studies drawn from the review are presented to walk readers through a few possible applications of these decision points. We highlight the diversity of research pathways available to researchers and Inuit Nunangat communities, and emphasize that weaving sciences does not need to be an intricate

undertaking. This chapter provides practical details to foster and facilitate meaningful cross-cultural processes, partnerships, and conversations.

2.2 Introduction

There is a compelling need to draw upon multiple ways of knowing to understand and address complex environmental problems (Riedlinger and Berkes, 2001; McGregor, 2013; Johnson et al., 2016; Wong et al., 2020; Reid et al., 2021). Indigenous and Western sciences, when brought together through a process of weaving[7] sciences (Table 2-1), offers holism that can strengthen environmental conservation in research, monitoring, management, and governance spaces (Tengö et al., 2014; Mistry and Berardi, 2016; Ban et al., 2018; Wilson et al., 2018; Wheeler and Root-Bernstein, 2020; Buxton et al., 2021). The recent expansion of weaving literature and embodiment in federal frameworks, mandates, and laws reflects its relevancy in the place now called Canada (e.g., CIRNAC, 2019; Department of Justice, 2021; Government of Canada, 2021a, b). Weaving Indigenous and Western sciences can enable the amplification of the strengths of both sciences, which are considered to be temporally and spatially complementary (Moller et al., 2004; Laidler, 2006; Gagnon and Berteaux, 2009; Rathwell et al., 2015). Moreover, the process of weaving sciences is conducive to partnerships between researchers and communities that are grounded in respect and trust, and enable knowledge sharing and co-production (Bartlett et al., 2012; Chapman and Schott, 2020; Carter et al., 2019; Pedersen et al., 2020; Yua et al., 2022).

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[7] 'Weaving' has been used by several authors in recent years (e.g., Johnson et al., 2016; Tengö et al., 2017; Popp et al., 2020; Henri et al., 2021). Other terms with slight variations in meaning include *braiding* or *bridging* sciences.

There is a long tradition of co-existence models that do not subsume Indigenous sciences into Western science, and can be used to guide relationships between Indigenous Peoples and settlers on environmental issues (Ransom and Ettenger, 2001; McGregor, 2008; Reid et al., 2021). Indigenous models include Tekani teyothata'tye kaswenta (Two-Row Wampum), which emphasizes the equal validity of Indigenous and Western sciences and their necessary distinction (Ransom and Ettenger, 2001; Hill and Coleman, 2019; Goodchild, 2021); Naagan ge bezhig emkwaan or Gidonaaganinaa (Dish with One Spoon or Our Dish), which asserts the importance of sharing the land peacefully (Jacobs and Lytwyn, 2020); and Etuaptmumk (Two-Eyed Seeing), which calls for the use of the strengths of multiple perspectives (Bartlett et al., 2012). In 2012, McGrath introduced the Qaggiq Model based upon a Qaggiq iglu, a communal iglu that serves as a gathering place for restoring relations, affirming community, and at times for reconciliation (McGrath, 2012). This conceptual space enables dialogue among Indigenous Peoples about shared values, where "qablunaat[8] can listen, experience and observe…so that they understand more clearly what they need to support" (McGrath, 2012, p. 252). This model emphasizes accountability in interactions with Inuit and Inuit knowledge[9].

Weaving is prominent in environmental sciences as both researchers and Indigenous communities recognize the interconnectedness of all living beings, and share a common priority to conserve ecological integrity in the context of continuous climate change (Kimmerer, 2013a, b; Ban et al., 2018; Wong et al., 2020). For Inuit across Inuit

[8] Qablunaat or Qallunaat are used refer to non-Inuit. Varied spellings are used depending on the local or regional dialect (Tester and Irniq, 2008).
[9] See Ljubicic et al. (2021) for a recent application of this model in a caribou and land camp project with the community of Uqšuqtuuq (Gjoa Haven, Nunavut).

Nunangat (Inuit homelands in the place now called Canada)[10], threats to aquatic species (e.g., marine mammals, fishes) and habitats, combined with significant knowledge gaps (see Dey et al., 2018; Niemi et al., 2019), have resulted in heightened research and monitoring efforts. Recent systematic reviews capture the body of research on weaving in relation to aquatic ecosystems, with Castleden et al. (2017a) contextualizing integrative Indigenous and Western approaches to advance water research and management, and Alexander et al. (2019; 2021) examining methods used in studies bridging sciences in marine and freshwater research, monitoring, and management across Canada. Indigenous participation and the role of communities in environmental monitoring have also been investigated extensively (e.g., Danielsen et al., 2009; Kouril et al., 2016; David-Chavez and Gavin, 2018; Thompson et al., 2020). While these reviews help characterize the weaving landscape in which researchers and communities engage, they do not detail the process of weaving Indigenous and Western sciences and corresponding methods (Table 2-1). The lack of clarity into the operationalization of weaving in research and monitoring with Indigenous communities (McGregor, 2008; Mosurska and Ford, 2020; Buxton et al., 2021; Drake et al., in press) renders it necessary for many researchers to "interpret for themselves what this means and how to do it in practice" (Pedersen et al., 2020, p. 326).

To help address this issue, we conduct a systematic realist review of marine and coastal research and monitoring in Inuit Nunangat. Specifically, we seek to identify and explore key decision points (i.e., points in a research or monitoring project at which significant decisions are made that contribute to weaving) that shape projects co-

[10] Inuit Nunangat (ᐃᓄᐃᑦ ᓄᓇᖓᑦ; includes lands, waters, and ice) is a distinct geographic, cultural, and political region encompassing the Inuvialuit Settlement Region (Northwest Territories and Yukon Territory), Territory of Nunavut, Nunavik (Northern Québec), and Nunatsiavut (Northern Labrador).

implemented by researchers and Inuit communities. We then present example case studies drawn from the review to illustrate the application of these decision points together. Although weaving can occur throughout all project phases (initiation, research design, gathering, analyzing, and interpreting data, and applying and disseminating findings), we focus on the knowledge documentation/data collection phase[11] as there may be greater opportunity for weaving through heightened Indigenous participation in field endeavours that rely upon local expertise (Dale and Armitage, 2011). By elucidating various methods for compiling and documenting Indigenous knowledges and methods for collecting data, and different applications of Indigenous sciences and Western science to address case study research objectives, we draw attention to the diversity of research pathways available. This can help guide future aquatic research or monitoring endeavours and contribute practical details to the growing scholarship aimed at fostering mutually beneficial processes and partnerships with Indigenous communities.

The authors are settlers committed to ongoing work to critically examine our own positions and to decolonize[12] our minds (sensu Trisos et al., 2021). This research is informed by our environmental and social science backgrounds within academia and government, and is shaped by our collective experiences conducting research with Indigenous communities. This chapter builds upon the efforts of many Indigenous Peoples, communities, and organizations, and of colleagues in this field.

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[11] As we do not consider Indigenous knowledges to be 'data' or 'information', we have chosen to differentiate knowledge documentation and data collection processes associated with Indigenous sciences and Western science, respectively.

[12] Individuals including Unangax̂ scholar Dr. Eve Tuck and Dr. K. Wayne Yang (see Tuck and Yang, 2012) and Red River Métis/Michif scholar Dr. Max Liboiron (see Liboiron, 2021) use a definition of decolonization that refers to the repatriation of Indigenous lands to Indigenous Peoples and communities.

Table 2-1 Key terminology.

Term	Definition
Indigenous sciences[ab]	Ever-evolving, highly contextual systems of thought, action, and orientation developed through close interaction with other living beings and the environment, and applied through biological, physical, cultural, and spiritual means. This includes insights acquired through direct, long-term experiences, and multigenerational observation, lessons, and skills (adapted from Berkes, 2018 and ICC, 2021). Like Western science, Indigenous sciences are based on extensive, repeated experience and observation (Laidler, 2006; Gorelick, 2014), and use classifying, inferring, questioning, observing, interpreting, predicting, monitoring, problem solving, and adapting (Johnson et al., 2016).
Indigenous knowledges[a]	The ways in which Indigenous sciences are manifested through a specific understanding of species, populations, habitats, and geography (see Reo, 2011). While language is inherently limiting (McGregor, 2008), we differentiate sciences and knowledges to clarify and signal that as settlers, we were removed from the process of experiencing and creating Indigenous sciences.
Methods for compiling and documenting Indigenous knowledges	The methods employed by Indigenous and/or Western scientists in research or monitoring to compile and document Indigenous knowledges. These methods can be carried out through oral, written, observational, experiential, or other means individually or in groups. These methods can also include the compilation of knowledge from secondary sources. Methods for compiling and documenting Indigenous knowledges used in the relevant case studies are found in Table 2-3.
Western science	A low-context system that excludes relational connections and often involves scientists separating themselves from nature or the object of study (Cajete, 2000; Nakashima and Roué, 2002). This evolving body of knowledge favours objectivity and reductionist methods, is anchored in Greek philosophy and the Renaissance (Mazzocchi, 2006), and includes knowledge appropriated from many cultures that was modified to conform to Eurocentric values, worldviews, metaphysics, and epistemologies (Aikenhead and Ogawa, 2007). Western science is not homogenous, and there are many disciplines and approaches that embrace uncertainty and complexity. For example, Western science can encompass opportunities for collaboration through community science or Bayesian methods. Many Indigenous scholars are redefining Western science in spaces that weave together Indigenous and Western sciences[c].
Western data	The outputs of Western science.
Methods for collecting data	The methods employed by Indigenous and/or Western scientists in research or monitoring to collect data. These methods can be carried out in the field or laboratory. These methods can also include the compilation of data from secondary sources. Methods for collecting data used in the relevant case studies are found in Table 2-4.
Weaving sciences	Weaving Indigenous and Western sciences refers to a process that maintains the integrity of each science while enabling the reciprocal exchange of understanding for mutual learning (Rathwell et al., 2015). In this chapter, we consider the inclusion of both Indigenous sciences and Western science to be 'weaving', in alignment with Alexander et al. (2019; 2021).

a. We pluralized Indigenous sciences and knowledges to reflect the heterogeneity of Indigenous cultures (McGregor, 2004).
b. We use 'sciences' in alignment with influential Indigenous thinkers and teachers, among them: Yup'ik scholar Dr. Angayuqaq Oscar Kawagley (see Kawagley, 1990, and Kawagley et al., 1998), Tewa scholar Dr. Gregory Cajete (see Cajete, 2000), Anishinaabe scholar Melanie Goodchild (see Goodchild, 2021) and Maya Ch'orti' and Zapotec scholar Dr. Jessica Hernandez (see Hernandez, 2022).
c. For example, Red River Métis/Michif scholar Dr. Max Liboiron discusses 'dominant science' in place of 'Western science' (see Liboiron, 2021).

2.3 Methods

2.3.1 Approach

We conducted a systematic realist review to identify aquatic research and monitoring studies that weave Indigenous and Western sciences, and to examine the practices, processes, and contexts of use. Frequently used within the social sciences (Petrasek MacDonald et al., 2013), this type of review combines both systematic and realist review characteristics. A systematic review provides a rigorous and replicable methodological approach to synthesize the state of knowledge in a subject area (Shamseer et al., 2015), and a realist review examines why, how, for whom, and in what context certain approaches function (Pawson et al., 2005; Berrang-Ford et al., 2015).

2.3.2 Case study selection

The case studies included in this review were drawn from a systematic map of published studies where the weaving of Indigenous and Western sciences was discussed and/or inferred in coastal and marine research, monitoring, management, or decision-making across Canada (Alexander et al., 2019). This database was chosen because our intent was to examine weaving in coastal and marine ecosystems across Inuit Nunangat, and this systematic map identified the appropriate set of case studies. The systematic map used adhered to Collaboration for Environmental Evidence guidelines (CEE, 2018) and Reporting Standards for Systematic Evidence Syntheses (ROSES) (Haddaway et al., 2017), wherein records were compiled from several databases, duplicates were removed, and a title and abstract screening and full text screening were conducted. This resulted in 71 case studies included in the original systematic map (Alexander et al., 2019). For the purpose and scope of this realist review, we screened the case studies to include only those that had been previously coded by Alexander et al. (2019) as ‘research and monitoring’ in any of the four regions of Inuit Nunangat (Figure 2-1 and Table 2-2). We did not include ‘management and decision-making’ case studies because weaving in collaborative research and monitoring occurs in considerably different settings and contexts than weaving in management and decision-making. This yielded a final set of 25 case studies. See Appendix A.1 for the relevant dataset from Alexander et al. (2019).

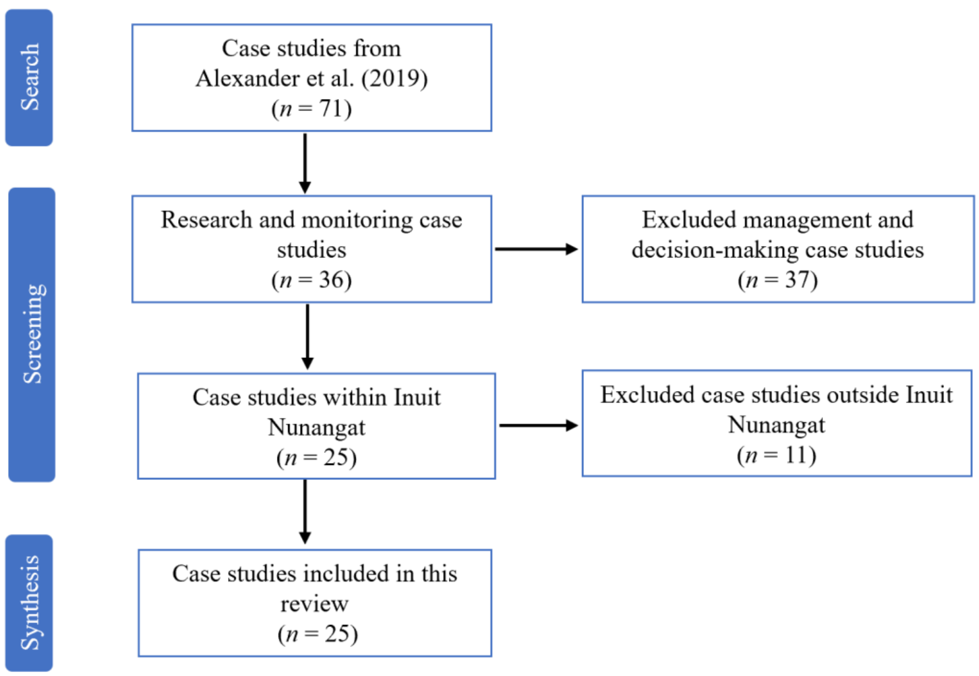

Figure 2-1 Flow chart of screening process, modified from ROSES Flow Diagram for Systematic Maps. Version 1.0.

Table 2-2 Criteria for case study inclusion.

Inclusion criteria	Alexander et al. (2019)	Additional inclusion criteria
Population	Coastal or marine habitat, ecosystems, or species (including coastal birds, diadromous fish, and polar bears)	NA
Study design	Report empirical results (qualitative or quantitative), and where bridging practices and/or methods are discussed or inferred Case studies can include environmental or ecological research and monitoring (classified simply as 'research and monitoring') or co-management and decision-making (classified as 'management and decision-making')	Research and monitoring case studies
Geographical scope	Canada's three coastal and marine regions (Atlantic, Pacific, and Arctic)	Inuit Nunangat (Inuvialuit Settlement Region, Nunavut, Nunavik, Nunatsiavut)
Language	English	NA

2.3.3 Thematic analysis

We conducted a thematic analysis using the qualitative analysis software NVivo 12, which allowed for the identification, analysis, organization, description, and reporting of themes (Braun and Clarke, 2006; Nowell et al., 2017). This analysis was chosen as it is highly flexible and can provide a detailed account of data (Braun and Clarke, 2006).

The lead author reviewed each case study thoroughly, focusing on case study objectives and details of the process of weaving Indigenous and Western sciences. We were interested in research objectives because they guide the methods chosen to compile and document Indigenous knowledges and to collect data, and how they are applied. We began with three thematic codes to organize these components of interest: research objectives, methods for compiling and documenting Indigenous knowledges, and methods for collecting data. The lead author further inductively coded the texts using sub-themes to categorize and extract detailed information by asking guiding questions (e.g., what specific objectives were found in case studies focused on species ecology? What methods were used to compile Indigenous knowledges and collect data, and were Indigenous and Western sciences used concurrently or sequentially? Did the findings or questions arising from one science inform the other science?). In this process, three sub-themes emerged: research objectives (containing more detail than in the initial thematic code), method bundles (the totality of methods for compiling and documenting Indigenous knowledges and for collecting data used together in a case study), and method sequencing (sequence in which methods were used in each case study), all of which are further described in the Results section. In order to identify method bundles, methods described for each case study were sorted by key characteristics (i.e., remote or in-person interactions, individual or group settings, how knowledges were shared, how data were acquired) to rectify cases where the same term was used to refer to different science methods, or dissimilar terms were used to refer to the same method (Table 2-3 and 2-4).

Table 2-3 Methods for compiling and documenting Indigenous knowledges, examples in the case studies reviewed, and definitions for these methods.

Method	Includes	Definition
Verbal knowledge sharing	Structured, semi-structured, and unstructured interviews	Verbal interchanges with participants, intended to elicit views on defined topics. Interviews primarily involve learning through conversations and listening (Shackleton et al., 2021). Structured interviews follow a predetermined list of questions and are led by the researcher, while semi-structured interviews have guiding questions but are flexible. Unstructured interviews follow themes rather than set questions, and are often led by the informant (Longhurst, 2016; Shackleton et al., 2021).
	Oral histories	Lived experience and Elders' stories, including events earlier than living memory (Berkes, 2018). The participant decides what is important to share (Shackleton et al., 2021).
	Telephone conversations, informal discussions	Opportunities for these discussions can arise unexpectedly. The informal and causal nature of these interactions can build trust and enhance participant willingness to share information (Shackleton et al., 2021).
Written knowledge sharing	Surveys, questionnaires	Sometimes used interchangeably or together (i.e., questionnaire survey). This research acquires information about a population by administering a standardized questionnaire or survey to a sample of individuals (McLafferty, 2016). Information gathered is often at the household level (e.g., demographics, ecosystem service use, livelihood activities, stressors) or individual level (e.g., related to perceptions, values, sense of place). Surveys and questionnaires are structured, and can provide quantitative and qualitative data (the latter through open-ended questions). While information is documented in a written format, surveys and questionnaires can be delivered verbally[a] (Shackleton et al., 2021).
Guided group interactions	Meetings	Occur between community members, Hunters and Trappers Organizations, researchers, government representatives, wildlife officers, management committee members, or other entities. Community members or researchers may guide these interactions. Advance preparation, clear objectives, and working towards the implementation of ideas developed during the meeting are important components (Huntington et al., 2002).
	Focus groups	Semi-structured sessions moderated by a facilitator, with guideline questions or stimuli (e.g., photos). Knowledge compilation is focused on selected topics (Carey and Asbury, 2016). Focus groups can bring participants together to generate new ideas or consensus about the interpretation of local phenomena (Shackleton et al., 2021). This method usually results in rich, detailed data, often through storytelling (Carey and Asbury, 2016). Often involve a smaller group of participants than workshops.

	Workshops	Semi-structured sessions moderated by a facilitator. Workshops can bring Indigenous and Western scientists together to discuss different perspectives, offer insights, and jointly develop research and management priorities (Huntington, 2000). Often involve a larger group of participants than focus groups.
Spatial mapping	Participatory mapping, map biographies	Practical spatial processes to understand place-based perspectives and information on ecological systems (Rathwell et al., 2015). Mapping is completed by the community to record resources and important places in relation to one another (De Vos et al., 2021).
Participant observations	Observations of community members	Researchers immerse themselves in community life and spend time being, living, or working with people (thus becoming 'participants' in the community). Fieldnotes or video notes are used for data collection (Laurier, 2016; De Vos et al., 2021).
Document review[b]	Compilation of knowledge from secondary sources	A process of reviewing documents that can serve several purposes: provide contextual data, identify questions to be asked in research, provide supplementary data, allow for a comparison of change over time, and be used to verify findings from other sources (Bowen, 2009).

Another method (technology field trials) was used only once by Gearheard et al. (2010) and thus was not included in this table.

a. Surveys and questionnaires can be administered verbally through interviews. In these cases, both verbal and written knowledge sharing were selected.

b. Document reviews draw upon secondary data that have been previously gathered or published, which can take many forms. This category within a case study signifies that a single or several methods used in other categories were gathered through a document review process, or a document review was conducted in addition to the other methods.

Table 2-4 Methods for collecting data and examples in the case studies reviewed.

Method	Includes
Biotic field work[a]	Wildlife monitoring, field surveys, satellite tracking. This includes fish sampling, plankton concentration (through tows), invertebrate sampling, and vegetation type.
Abiotic field work[a]	Water sampling (temperature, salinity, dissolved oxygen and other compounds, total suspended solids, organochlorine content, chlorophyll a), ice sampling and measurements (ice cores, measurements of thickness, growth, and melting).
Tissue analysis[a]	Field and/or laboratory work. Includes biological sampling and analyses (parasite examinations, stomach content analysis, blubber thickness, physiological indices), and chemical analyses (serology, histopathology, genetic analysis, analyses of stable isotopes, trace elements, persistent organic pollutants).
Observational methods	Surveys (aerial, land/shore-based surveys, boat), or photographic methods (photos, satellite imagery obtained through remote sensing).
Maps and mapping	The use of existing maps, the use of geographic and wildlife data to derive maps, or the creation of digital maps produced using community output.
Document review[b]	Compilation of raw or secondary data, a review of literature or other documents. This process of reviewing documents can serve several purposes: provide contextual data, identify questions to be asked in research, provide supplementary data, allow for a comparison of change over time, and be used to verify findings from other sources (Bowen, 2009).

Another method (developing technical equipment) was used only once by Gearheard et al. (2010) and thus was not included in this table.

a. We have included processing (e.g., in a laboratory) because we consider it to be part of the data collection phase.

b. Document reviews draw upon secondary data that have been previously gathered or published, which can take many forms. This category within a case study signifies that a single or several methods used in other categories were gathered through a document review process, or a document review was conducted in addition to the other methods.

2.4 Results

In this section, we identify and explore what we term *decision points*, which can guide the process of weaving Indigenous and Western sciences in coastal and marine research or monitoring in Inuit Nunangat. We focus on weaving occurring during the knowledge documentation/data collection phase. Lastly, we highlight these decision points using three example case studies to illustrate the diversity of research pathways.

2.4.1 Identifying decision points

Through thematic analysis, we identified three main sub-themes, which we consider to be decision points that shape collaborative research or monitoring for researchers and Indigenous communities: research objectives, method bundles, and method sequencing. See Figure 2-2 for a summary and Table 2-5 for definitions of these decision points.

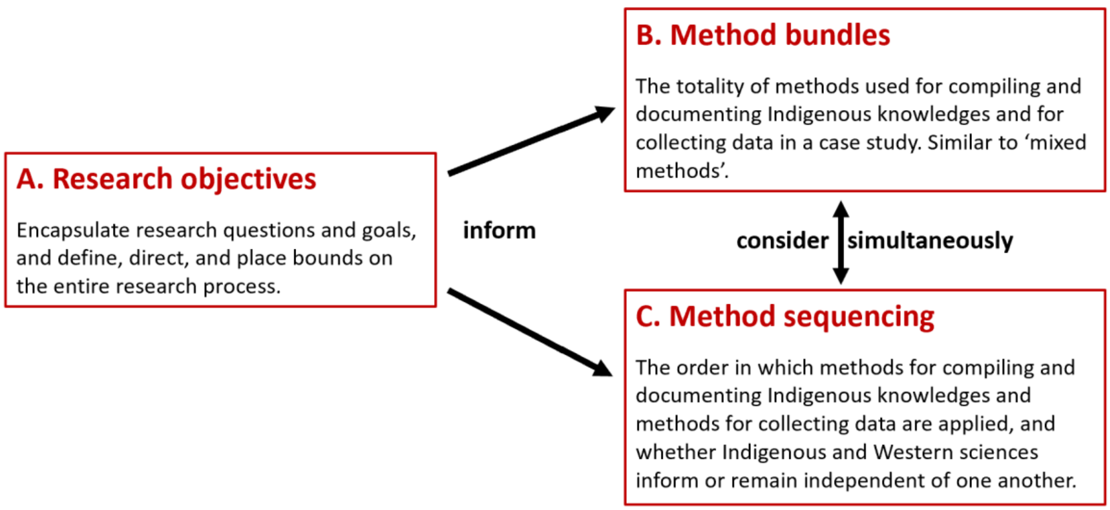

Figure 2-2 Decision points to consider in research or monitoring conducted with Indigenous communities.

Table 2-5 Definitions of decision points in research or monitoring conducted with Indigenous communities.

Decision point	Definition
A. Research objectives	Research objectives encapsulate research questions and goals, and define, direct, and place bounds on the entire research process. They inform the methods used and how they are applied (decision points B and C). These objectives must be co-defined with Indigenous partners, and include topics relevant to the interests of community members (David-Chavez and Gavin, 2018; Chapman and Schott, 2020; ICC, 2021).
B. Method bundles[a]	Method bundles refer to the totality of methods used for compiling and documenting Indigenous knowledges and for collecting data in a case study. This decision point must be considered simultaneously with decision point C (method sequencing) as in practice they occur in parallel. These bundles are akin to ‘mixed methods’, which combine qualitative and quantitative forms of research (Creswell and Creswell, 2018).
C. Method sequencing	Method sequencing refers to the order in which methods for compiling and documenting Indigenous knowledges and methods for collecting data are applied in a case study (e.g., concurrent, sequential). There can be varied levels of complexity in sequence structure. Sequencing illuminates whether Indigenous and Western sciences inform or remain independent of one other.

a. The term ‘bundle’ arose from the author team’s awareness of and respect for the four sacred medicines (tobacco, sweetgrass, sage, cedar) for First Nations in the areas in which they live and work, which are dried and often bundled. This term has also been used by Rathwell et al. (2015), who suggested that a ‘bundled approach’ to methods can support the bridging of knowledge systems.

2.4.2 Exploring decision points

2.4.2.1 Research objectives

Research objectives are crucial since they inform and influence decisions made in subsequent research phases, including the knowledge documentation/data collection phase.

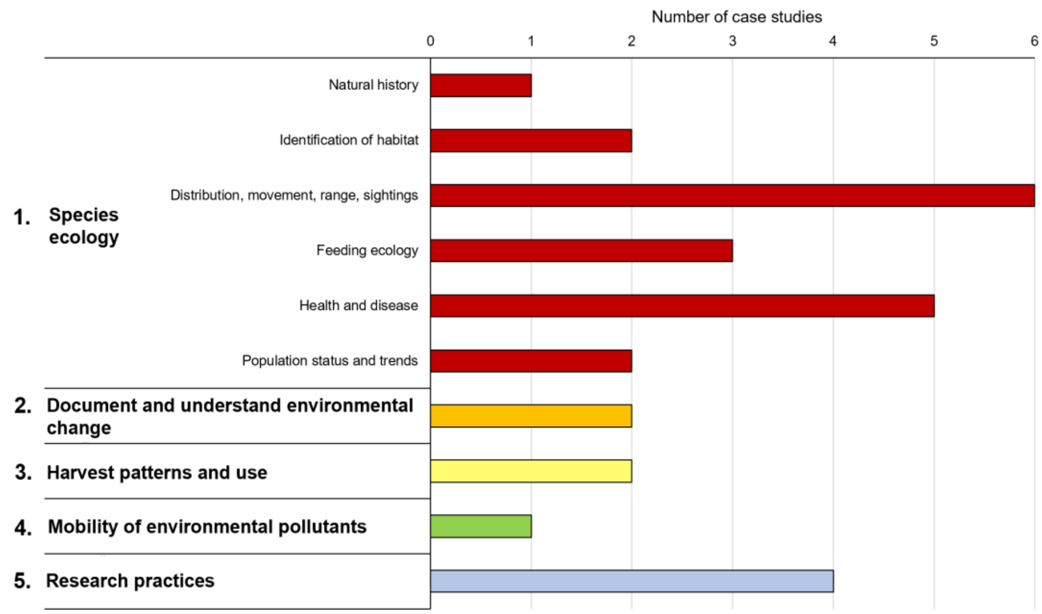

Figure 2-3 Research objective categories emerging from analysis of case studies, and the number of case studies within each category.

Five research objectives categories were identified based on objectives articulated in the case studies reviewed (Figure 2-3). The most extensive category (Category 1: species ecology) contained 16 case studies in six subcategories, while Category 2 (document and understand environmental change), Category 3 (harvest patterns and use), and Category 4 (mobility of environmental pollutants) contained much fewer case studies (n = 2, n = 2, and n = 1, respectively). Category 5 (research practices) case studies (n = 4) were dissimilar to other categories as an analytical lens was used to discuss research or monitoring practices. See Appendix A.2 for the case studies in which each research objective was found.

2.4.2.2 Method bundles

Research objectives can be addressed through method bundles composed of various methods for compiling and documenting Indigenous knowledges, and methods for collecting data. We examine the level of complexity of method bundles and the methods comprising those bundles within case studies (Table 2-6)[13]. We also provide insight into repeating method combinations (i.e., methods used together in two or more case studies) that are components of more complex bundles (Appendix A.3).

[13] Note that this table could also be presented and organized by the complexity of methods for compiling and documenting Indigenous knowledges. We chose to present the method bundles by complexity of methods for collecting data as the maximum number of methods used for either science in any case study was five methods for collecting data.

Table 2-6 Methods used in case studies reviewed and their level of complexity (first number is the number of methods for collecting data, second number is the number of methods for compiling and documenting Indigenous knowledges).

Complexity	Methods for collecting data						Methods for compiling and documenting Indigenous knowledges						Relevant case studies
	Biotic field work	Abiotic field work	Tissue analysis	Observational methods	Maps and mapping	Document review	Verbal knowledge sharing	Written knowledge sharing	Guided group interactions	Spatial mapping	Participant observations	Document review	
5-2	✓	✓	✓	✓		✓		✓				✓	Paulic et al., 2014
4-2	✓		✓	✓		✓	✓	✓					Loseto et al., 2018
3-4				✓	✓	✓	✓		✓	✓	✓		Fox, 2004
3-3	✓			✓		✓	✓		✓			✓	York et al., 2016
3-2			✓	✓		✓	✓					✓	Finley, 2001
2-4	✓					✓	✓	✓		✓	✓		Usher, 2002
2-3	✓		✓				✓	✓		✓			Mallory et al., 2006
2-2	✓		✓				✓		✓				Pellerin and Grondin, 1998
2-2					✓	✓	✓			✓			Kowalchuk, 2010
2-1	✓		✓				✓						Iverson et al., 2016
2-1	✓		✓						✓				Dunmall and Reist, 2018
2-1	✓			✓			✓						Westdal et al., 2010
2-1				✓		✓	✓						Higdon and Ferguson, 2011
2-1				✓		✓						✓	Wheeler et al., 2012
1-3				✓			✓		✓			✓	Meier et al., 2006
1-3						✓	✓	✓	✓				Ostertag et al., 2018
1-2	✓						✓	✓					Brewster et al., 2016
1-2		✓							✓	✓			Huntington et al., 2011
1-2			✓				✓			✓			Gélinas, 2016; Henri et al., 2018
1-2				✓			✓			✓			Mallory et al., 2003
1-2						✓	✓			✓			Ferguson et al., 2012
1-1		✓					✓						Carmack and Macdonald, 2008
1-1					✓				✓				Gearheard et al., 2010
1-1						✓						✓	Higdon, 2010

The bundling of methods in case studies ranged from very complex bundles that combined several methods for collecting data with several methods for compiling and documenting Indigenous knowledges, to the use of a single method on each side (Table 2-6)[14]. The most complex bundle included five methods for collecting data with two methods for compiling and documenting Indigenous knowledges (i.e., a 5-2 bundle). Therefore, there was a maximum of five methods for collecting data used in any individual case study. There was a similarly complex 4-2 bundle present in another case study. The presence of a 3-4 bundle that included three methods for collecting data with four methods for compiling and documenting Indigenous knowledges showed that there were at most four methods for compiling and documenting Indigenous knowledges used in any individual case study. There were also 3-3 bundles, as well as 3-2, 2-4, 2-3, 2-2, and 2-1 combinations. The least complex method bundles included one method for collecting data combined with several methods for compiling and documenting Indigenous knowledges (e.g., 1-3, 1-2 bundles), and the use of one method on each side (i.e., 1-1 bundle). The possibilities for number of methods used for collecting data in a study were comparable to the number of methods used for compiling and documenting Indigenous knowledges, with there being five, four, three, two, and one method used for collecting data in a given study, and four, three, two, and one method used for compiling and documenting Indigenous knowledges. Interestingly, every case study had a unique

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[14] It is important to recognize the variation in the use and applications of methods comprising method bundles beyond what is shown here. For example, see Table 2-3 and 2-4 for variation present within each method for compiling and documenting Indigenous knowledges and method for collecting data.

set of methods used, with the exception of Gélinas (2016) and Henri et al. (2018), whose bundles were identical. In total, 24 different method bundles appeared in case studies.

It is equally important to consider the methods that compose these bundles (Table 2-6), and the repeated method combinations (i.e., methods are used together in two or more case studies) that contribute to more complex bundles (see Appendix A.3). *Verbal knowledge sharing* was the most common method for compiling and documenting Indigenous knowledges (i.e., appeared in 19/25 or 76% of case studies) (Table 2-6). This method was always bundled with at least one method for collecting data, and was used with all six methods for collecting data (*biotic field work*, *abiotic field work*, *tissue analysis*, *observational methods*, *maps and mapping*, *document review*) individually or in various combinations. Additionally, in 13 case studies, *verbal knowledge sharing* was bundled with at least one other method for compiling and documenting Indigenous knowledges (Table 2-6); however, it was only used repeatedly as a component bundle with four methods for compiling and documenting Indigenous knowledges: *written knowledge sharing*, *guided group interactions*, *spatial mapping*, and *document review* (Appendix A.3). *Guided group interactions* and *spatial mapping* similarly individually appeared in bundles of different complexities with all methods for collecting data in various combinations, while *written knowledge sharing* and *document review* individually appeared with all methods for collecting data apart from *maps and mapping* (Table 2-6). Interestingly, these methods for compiling and documenting Indigenous knowledges (*guided group interactions*, *spatial mapping*, *written knowledge sharing*, *document review*) were only used with *verbal knowledge sharing* to form core components of more complex bundles (Appendix A.3). The least common method for compiling and documenting Indigenous knowledges found in bundles was *participant observations* (*n* = 2).

Document reviews (*n* = 12), *biotic field work* (*n* = 10), *observational methods* (*n* = 10), and *tissue analysis* (*n* = 9) were commonly used methods for collecting data within bundles (Table 2-6). *Document review* was most often used repeatedly as a component of bundles of increasing complexity when bundled individually with *biotic field work*, *observational methods*, and with *maps and mapping*, a less common method of collecting data (Appendix A.3). Likewise, *biotic field work* and *tissue analysis* were used together to contribute to larger bundles. In contrast, *abiotic field work* was used infrequently (*n* = 3), and was not a core method contributing to complex bundling.

2.4.2.3 Method sequencing

When seeking to address research objectives, the sequencing of methods should be considered at the same time as method bundles. Five method sequences were uncovered in the case studies reviewed (Table 2-7, Appendix A.4 for the case studies in which each sequence was used). For some sequences (Sequence 2, 3, and 4), case study details enabled insight into the ways in which one science informed or did not inform the other science.

Table 2-7 Indigenous sciences (IS) and Western science (WS) method sequences and descriptions found in the case studies reviewed.

Sequence	**Diagram**	**Description**		**# of uses**[a]
1		Interactions between IS and WS are cyclical, and the sciences build off each other		2
2	IS → WS	IS followed by WS (sequential)	IS informed WS	3
			IS did not inform WS	1
3	WS → IS	WS followed by IS (sequential)	WS informed IS	4
			WS did not inform IS	1
			WS verified using IS	2
4	IS | WS	IS and WS conducted concurrently	For a more complete understanding	4
			To compare sciences	2
			To support the other science[b]	1
			One science shaped the other[c]	1
5		Document reviews for IS and WS		5

a. This column totals 26 rather than 25 case studies because one case study (Fox, 2004) used Indigenous and Western sciences for two purposes: to form a more complete understanding, and to compare sciences (Sequence 4).
b. In this case study (Henri et al., 2018), Indigenous science supported Western science.
c. In this case study (Mallory et al., 2006), Indigenous science shaped Western science.

Sequence 1 (n = 2) is a cycle that can begin with either Indigenous or Western science, and is characterized by one science informing the other science in a continuous manner. This sequence is used in Carmack and Macdonald (2008), where the accounts of Elder Jimmy Jacobson (Indigenous science) led researchers to conduct surveys (Western science) to explore hypotheses formed from Jimmy's stories. Their findings spurred further conversations (Indigenous science) and additional oceanographic research (Western science). Sequence 2 (n = 4) consists of Indigenous sciences followed by

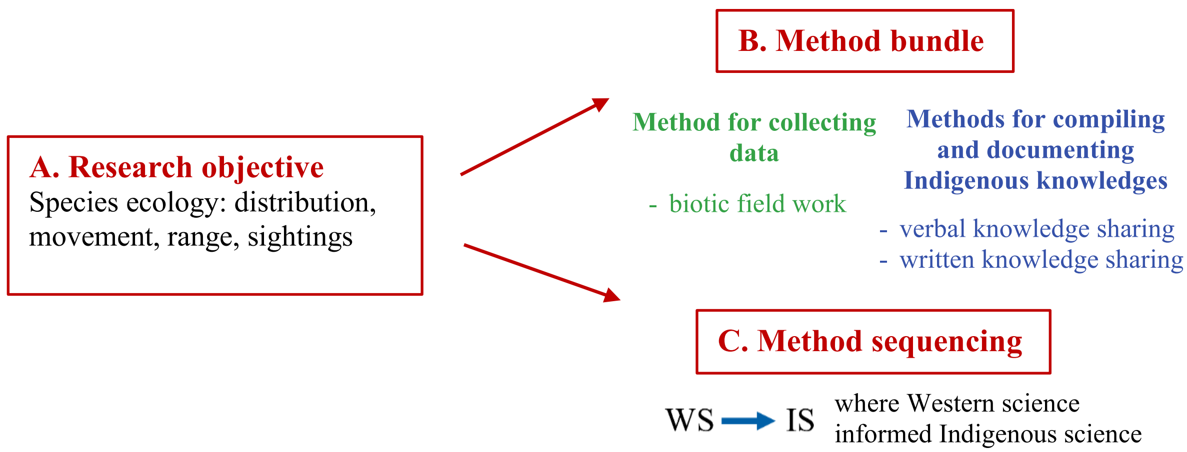
Western science, while Sequence 3 ($n = 7$) begins with Western science followed by Indigenous sciences. Both sequences contain case studies in which the first science informed the second, and those where the sciences remained independent of each other. Sequence 3 included an additional process, where Indigenous science was used to verify Western science. Sequence 4 ($n = 8$) is the most common sequence, and is defined by the concurrent use of Indigenous and Western sciences for the following purposes: for a more complete understanding, to compare sciences, to support the other science, and to shape the other science. Characteristics of 'shaping the other science' are similar to Sequences 2 and 3, but this case study (Mallory et al., 2006) was classified in this category as the methods were not conducted sequentially. Also note that these purposes are not mutually exclusive. For example, Fox (2004) wove sciences through concurrent and independent use of both Indigenous and Western science methods to compare sciences, and for a greater understanding of environmental change. Sequence 5 ($n = 5$) is characterized by a document review process that uses raw or secondary data.

2.4.2.4 Example pathways

The use of different research objectives, method bundles, and method sequencing shape countless research pathways for weaving Indigenous and Western sciences in research or monitoring. Here, we present three examples from the case studies reviewed to walk readers through possible applications of decision points. These case studies were chosen because they are illustrative of varied pathways and were published in recent years. They focus on fishes, a marine mammal (beluga whale), and environmental change, all of which are critical to the wellbeing of Inuit in Inuit Nunangat.

Example 1. **Brewster et al. (2016)**

Traditional Ecological Knowledge (TEK) at Shingle Point, YT: Observations on Changes in the Environment and Fish Populations



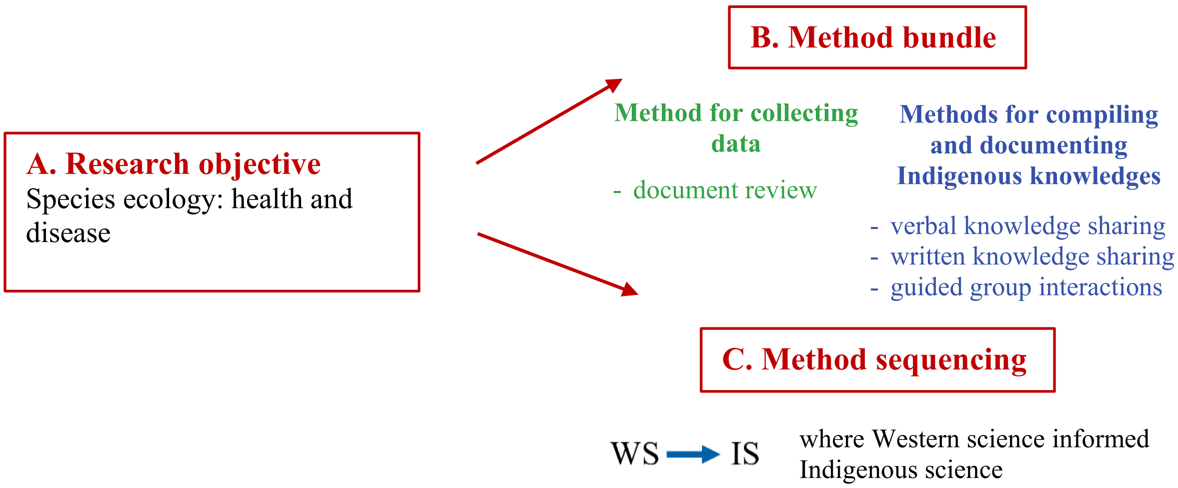
A. The objective (Category 1 – *Species ecology*; Figure 2-3) was to understand environmental changes and determine baseline information for Beaufort Sea fishes (specifically their distribution range), in order to sustain fish populations and habitats within a changing Arctic.

B. The method bundle consisted of one method for collecting data (*biotic field work*) and two methods for compiling and documenting Indigenous knowledges (*written knowledge sharing, verbal knowledge sharing*). The *biotic field work* consisted of a Fisheries and Oceans Canada fish monitoring program in which fishes were collected and inventoried by researchers and local harvesters. Questionnaires and interviews (*written and verbal knowledge sharing*) gathering knowledge on fish population changes, environmental changes, and concerns were created with the Aklavik (Akłarvik) Hunters and Trappers Committee and conducted with Shingle Point harvesters.

C. This case study used Sequence 3 (Table 2-7). The fish monitoring program informed the questionnaires and interviews. Monitoring had been occurring at Shingle Point since 2010, and the sixteen most commonly captured fish species were the focus of the questionnaires and interviews conducted in 2015.

<u>Example 2.</u> Ostertag et al. (2018)

"That's how we know they're healthy": the inclusion of traditional ecological knowledge in beluga health monitoring in the Inuvialuit Settlement Region



A. The objective (Category 1 – *Species ecology*; Figure 2-3) was to develop local indicators of beluga health that bridged Traditional Ecological Knowledge about beluga condition, illness, and disease with western science through knowledge co-production to support holistic monitoring in the Inuvialuit Settlement Region.

B. The method bundle consisted of one method for collecting data (*document review*), and three methods for compiling and documenting Indigenous knowledges (*guided group interactions, written knowledge sharing*, *verbal knowledge sharing*). The *document review* consisted of a review of findings and observations from published studies on an indicator approach and beluga monitoring efforts. Public meetings (*guided group interactions*) were held in Paulatuk (Paulatuuq), Tuktoyaktuk (Tuktuuyaqtuuq), and Inuvik (Inuuvik) to refine research directions, and record observations about harvested whales. Semi-structured questionnaires (*written knowledge sharing*) were conducted at neighbouring islands and whaling camps about harvested whales, and semi-structured interviews (*verbal knowledge sharing*) were developed and administered in Paulatuk, Tuktoyaktuk, and Inuvik to record observations about beluga health. Focus groups (*guided group interactions*) were used to validate findings and create beluga indicators.

C. This case study used Sequence 3 (Table 2-7). An understanding of an indicator approach and beluga monitoring efforts garnered through a document review informed this project and public meetings (undertaken in 2013, 2014, and 2017). The outcomes (i.e., lists of observations) of early public meetings in 2013 were then used to generate questionnaires (delivered in 2014 and 2015) and interview questions (administered in 2014). Focus groups in 2014 were used to validate the knowledge gathered through these methods of compiling and documenting Indigenous knowledges.

<u>Example 3.</u> Fox (2004)

When the Weather is *Uggianaqtuq:* Linking Inuit and Scientific Observations of Recent Environmental Change in Nunavut, Canada

A. Research objective
Document and understand environmental change

B. Method bundle

Methods for collecting data

- observational methods
- maps and mapping
- document review

Methods for compiling and documenting Indigenous knowledges

- verbal knowledge sharing
- guided group interactions
- spatial mapping
- participant observations

C. Method sequencing

IS | WS — where Indigenous and Western sciences were conducted concurrently for a complete understanding and for comparison purposes

A. The objective (Category 2 – *Document and understand environmental change*; Figure 2-3) was to document Inuit observations and knowledge of climate and environmental processes and changes, and to examine how these observations intersect (or do not intersect) with scientific observations.

B. The method bundle consisted of three methods for collecting data (*observational methods*, *maps and mapping, document review*), with four methods for compiling and documenting Indigenous knowledges (*verbal knowledge sharing*, *guided group interactions*, *spatial mapping*, *participant observations*) undertaken in Baker Lake (Qamani'tuaq) and Clyde River (Kangiktugaapik). The methods for collecting data included air photos and photographs (*observational methods*), maps (*maps and mapping*), and the consultation of secondary sources and scientific literature, as well as raw weather station data (*document review*). Semi-directed and unstructured interviews (*verbal knowledge sharing*) were conducted with Inuit hunters and elders, and focus groups (*guided group interactions*) were held in each community. Participatory mapping (*spatial mapping*) was undertaken during interviews and focus groups. *Participant observations* encompassed the author's role as an active member of community life, including participating in travel and harvesting.

C. This case study used Sequence 4 (Table 2-7). The interviews were conducted in 2000 and 2001, and focus groups were held in 2001. Participatory mapping took place during interviews and focus groups in 2001, with secondary topographic maps providing a base layer, and sources such as air photos and photographs being used to facilitate discussions. Weather station data from 1960 to 2000 were collected and analyzed to link Inuit observations of environmental change to scientific data. While Indigenous and Western sciences were not inter-reliant, they together allowed for greater overall detail.

2.5 Discussion

Through the identification and exploration of three key decision points in case studies in Inuit Nunangat, this review draws attention to important decisions that shape aquatic research and monitoring projects undertaken in partnership between researchers and Indigenous communities. These decision points guide the many research pathways available when weaving Indigenous and Western sciences. We identified five categories of *research objectives* that can be addressed through method bundles composed of various numbers and combinations of methods for compiling and documenting Indigenous knowledges (e.g., interviews, questionnaires, focus groups) and methods for collecting data (e.g., wildlife monitoring, biological tissue analysis, mapping). Twenty-four *method bundles* of varying complexities were identified in the case studies reviewed; these are only a subset of additional possible method bundles in research and monitoring literature. Lastly, Indigenous and Western sciences can be applied in at least five *method sequences*. Different applications of these decision points create an array of options that can be undertaken in research and monitoring, which can facilitate weaving for researchers, and in turn lead to greater efforts to weave Indigenous and Western sciences. However, we emphasize that weaving does not need to be an overly complex endeavour (i.e., there are many smaller and simpler method bundles). We encourage researchers and community partners to consider these possibilities as opportunities to explore research pathways together.

In this context, it is critical to consider benefits and limitations of combining specific methods for compiling and documenting Indigenous knowledges and methods for collecting data in research or monitoring. The use of complementary methods can create synergisms that enhance the breadth, depth, and local relevancy of knowledge generated (Rathwell et al., 2015) and enable insights into "multiple dimensions of complex…problems and their solutions" (Shackleton et al., 2021, p. 109), such as community implications of environmental change. In the case studies reviewed, the prevalence of *verbal knowledge sharing* in bundles can be attributed to parallels between this method and the transmission of Indigenous teachings and cultures through oral tradition. The inherent flexibility of this method also creates the potential to gather detailed knowledge on a variety of topics. The similar versatility of *guided group interactions, spatial mapping*, *written knowledge sharing*, and *document review* render these methods well-positioned to complement knowledge gained through verbal means as they can enhance specificity when discussing locations and phenomena. The regular use of these methods, however, may be at the expense of other methods, such as participant observations, which require spending a significant amount of time in a community. For methods for collecting data, *document reviews* were important components of larger bundles and complemented field and laboratory data. While this method is useful due to the vast amount of data readily accessible in secondary sources, document reviews often involve minimal levels of community collaboration. The common uses of *biotic field work*, *tissue analysis*, and *observational methods* (e.g., aerial surveys, photographs) may reflect efforts to fill significant Arctic ecological knowledge gaps, and the importance of various species (e.g., marine mammals, fishes) to Inuit research partners. These methods, which often require more intensive levels of community participation, can strengthen weaving through knowledge exchange within and between researcher and community groups. Recognizing the varied capacities of methods to contribute to weaving

Indigenous and Western sciences can lead to further exploration of method characteristics that bolster complementarity.

The patterns that emerged within the differing applications of Indigenous and Western sciences investigated through method sequencing are a salient consideration, with both sciences being used sequentially to inform the other science, and used concurrently to broaden the knowledges/data obtained in the case studies reviewed. A clear gap became evident when comparing Sequence 2 (i.e., Indigenous sciences applied prior to Western science) and Sequence 3 (i.e., Western science applied prior to Indigenous sciences), where case studies emerged in which Indigenous sciences played a supporting role or were used to verify Western science, yet the contrary was not found. The absence of weaving case studies in which Western science was used to support Indigenous sciences is part of a pervasive issue of Indigenous sciences solely being accepted, and thus reported, if they concur with Western data (e.g., Kimmerer, 2013b; Wheeler and Root-Bernstein, 2020; Wheeler et al., 2020; Kadykalo et al., 2021; Reid et al., 2021)[15]. This is in large part due to the "continued colonial sentiment throughout governing bodies [that] prevents their full and equitable inclusion…" (Reid et al., 2021, p. 11; Yua et al., 2022). We strongly encourage the heightening of efforts to apply Western science as a means of supporting Indigenous sciences to ensure that Indigenous sciences occupies the full extent of roles in research or monitoring (i.e., informing,

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[15] There has been much work done in which Indigenous sciences are described, compiled, documented, or explored without including any Western science components; however, here, I am referring only to case studies that weave together Indigenous and Western sciences.

supporting, allowing for research comparisons). As there are many ways that methods can be applied within sequences, a closer look at these possibilities may be fruitful.

Additionally, this review may contribute to dismantling path dependency in northern research by highlighting the plethora of research pathways available. Path dependency occurs when previous actions affect decisions, which shape a path that is then stabilized through positive feedback (Röhring and Gailing, 2010). Resulting dependencies render it difficult to depart from this path, and potentially sub-optimal options establish themselves permanently (Röhring and Gailing, 2010). This phenomenon is often discussed in science policy and climate change action and adaptation research (e.g., Aghion et al., 2014; Barnett et al., 2015), and occurs through the repeated use of the same methods in projects or programs with communities. The intensive use of a few key methods in this chapter (e.g., *verbal knowledge sharing,* such as interviews) points to the occurrence of path dependency among the case studies. The use of the same methods in a community over time, especially among similar demographic groups (e.g., male Elders and hunters, see Hitomi and Loring, 2018), can place a disproportionate burden on community members, and potentially amplify limitations and biases associated with these methods (David-Chavez and Gavin, 2018). Moreover, any duplicative efforts can evoke or worsen existing research and engagement fatigue in Arctic regions that are heavily researched for climate change impacts (Ford et al., 2016; ICC, 2021). By describing decision points within case studies, we aim to equip researchers and Indigenous communities with a variety of alternate research practices and approaches that can be adopted to curb some of these effects, and hope that continued research will add to this knowledge base.

While the considerations discussed above must be accounted for, we emphasize that weaving Indigenous and Western sciences is not solely a technical matter, it is also relational (McGregor et al., 2018; Held, 2019; Goodchild, 2021; Littlechild et al., in preparation). Upholding ethical standards and conducting research ‘in a good way’, meaning that the process is as or more important than results, and that relationship-building and accountability are central (Wilson, 2008; Ball and Janyst, 2008; AHA Centre, 2018), should be at the heart of these forms of research. For instance, we noticed fragmented reporting of ethical and relational components including licensing, permitting, consent, confidentiality, community-researcher relationships, and verification and dissemination of findings with community members. The limited transparency in the abovementioned practices may contribute to challenges in ensuring respectful weaving. Good practices in community engagement in research and monitoring have recently been shared by the Inuit Tapiriit Kanatami *National Inuit Strategy on Research* (ITK, 2018) and the Inuit Circumpolar Council *Ethical and Equitable Engagement Synthesis Report* (ICC, 2021). Indigenous data sovereignty and governance in alignment with OCAP® principles of ownership, control, access, and possession (FNIGC, 2019) must also be prioritized. At the time this thesis was written, Littlechild et al. (in preparation) explored the degree to which research and monitoring case studies reviewed in this chapter, and others, foster an ‘Ethical Space’ of engagement that invites co-creation, re-centers relationality, and both respects the integrity of and elevates Indigenous systems. We encourage researchers to reflect upon their own imperative to create an Ethical Space with Indigenous persons and communities, and to undertake and report methods with authenticity so that we can continue to learn from each other regarding respectful processes.

2.6 Conclusion

Weaving Indigenous and Western sciences can strengthen aquatic research and monitoring by enabling holistic insights into ecological processes and social implications of change. At the same time, weaving can help redefine the relationships between settlers and Indigenous Peoples in the place now called Canada if meaningful and mutually respectful relationships are nurtured. The lack of clarity into the operationalization of weaving sciences poses a significant challenge in this context. In this systematic realist review of coastal and marine case studies from Inuit Nunangat, we provided practical insights by identifying and describing three decision points (research objectives, method bundles, method sequencing) that shape research and monitoring projects. We elucidated the applications of these decision points in 25 case studies reviewed, which together create a rich diversity of research pathways that can expand the range of knowledge documentation and data collection options available for researchers and Inuit communities. However, we emphasize that this knowledge gap requires both technical and relational considerations, and thus necessitates researcher reflection and guidance by Indigenous Peoples in relation to methods to compile and document Indigenous knowledges. It is our hope that these insights contribute to ongoing cross-cultural and intersectional processes, partnerships, and conversations.

2.7 Acknowledgements

In this chapter, the authors discuss only some of the knowledge of Inuit across Inuit Nunangat. We are grateful to every individual who participated or contributed to each case study in this review. Nakurmiik (South Qikiqtaaluk). Qujannamiik (North Qikiqtaaluk). Quyanainni (Inuvialuktun). Quana (Inuinnaqtun). Qujanaqqutit (Nattilingmiutut). Ma'na (Paallirmiutut). And in the many more dialects not written here, we express our thanks. We acknowledge that this research was completed in the unceded, traditional territory of Algonquin Anishinaabe Peoples in Ottawa, Ontario, and in Treaty No. 1 Territory in the traditional lands of the Anishinaabe, Ininew, Oji-Cree, Dene, and Dakota, and the homeland of the Métis Nation in Winnipeg, Manitoba. Funding was provided by Fisheries and Oceans Canada (Results Fund).

Chapter 3. Community experiences and perceptions of aquatic environmental and biodiversity change in ᑭᓐᖓᐃᑦ, ᓄᓇᕗᑦ (Kinngait, Nunavut)

3.1 Abstract

Climate change and increasing development are shaping the Arctic in unprecedented ways that are intimately known to Inuit. Through a partnership between a research team and the Aiviq Hunters and Trappers Association in Kinngait, Nunavut, we compiled and documented Indigenous knowledge of environmental and biodiversity change in coastal, marine, and lacustrine ecosystems near this community. Remote collaborations with community technicians enabled the co-development and delivery of a questionnaire to 39 knowledge holders. Questionnaire results were variable, with environmental parameters such as turbidity, erosion, and swells/waves being characterized by a lack of change. Responses showed that wind may be changing and water is likely warming, while nearly all participants reported diminishing sea and lake ice area, thinner ice, earlier ice breakup, and later formation. These changes are altering the timing of harvesting, and rendering travel more dangerous and difficult. Overall, species diversity and relative abundance of marine mammals, fishes, and invertebrates were reported not be changing; however, ringed seal and beluga whale may be declining, salmon are appearing more frequently, and mussels are rapidly proliferating. This research serves as a record and baseline of change for future generations, and may be used by the community to inform decision-making and planning. At the same time, this study contributes to filling fundamental Arctic ecological knowledge gaps. While

undertaken to directly benefit Kinngarmiut, this study contributes to centering Indigenous experiences and voices in environmental research, and is part of a transition in how research is conducted within Inuit Nunangat (Inuit homelands in the place now called Canada).

3.2 Introduction

Inuit resilience and adaptation to environmental change across Inuit Nunangat, the homelands of Inuit in the place now called Canada[16], are being challenged by Arctic warming occurring nearly three times faster than the global average (Watt-Cloutier, 2015; Ford et al., 2021; IPCC, 2022). Profound disruptions in aquatic ecosystems are affecting species distribution, seasonal range, phenology, and interactions (Wassmann et al., 2011; AMAP, 2017; Huntington et al., 2020). Temperature and ice-related changes are enabling increased shipping and the expansion of industrial activities, including the exploration and exploitation of oil and gas, minerals, fisheries, and tourism (Arctic Council, 2009; AMAP, 2018; Dawson et al., 2020). This multiplicity of threats creates a need for increased information to assess change occurring at local scales to guide community decision-making and planning (Flynn et al., 2018; Ford et al., 2021). In recent years, collaborations between Indigenous and Western scientists have grown, enabling more complete insight into shifting ecosystems and cultural relationships between Inuit and

[16] Inuit Nunangat (ᐃᓄᐃᑦ ᓄᓇᖓᑦ; includes lands, waters, and ice) is a distinct geographic, cultural, and political region encompassing the Inuvialuit Settlement Region (Northwest Territories and Yukon Territory), Territory of Nunavut, Nunavik (Northern Québec), and Nunatsiavut (Northern Labrador).

their land, or *nuna* in Inuktut[17]. Documenting environmental and biodiversity shifts in partnership with local Indigenous communities is essential to fill prominent knowledge gaps, quantify the magnitude and direction of change, and identify critical species and habitats for assessment and conservation priority.

Inuit have relied upon aquatic environments for their physical and spiritual wellbeing for millennia, gaining an intimate understanding of other living beings and habitats through direct, long-term experiences, and extensive and multigenerational observations (Laidler, 2006; ICC, 2021). We refer to this ever-evolving, highly contextual system of thought, action, and orientation developed through close interactions with the land (Gorelick, 2014; Berkes, 2018) as Indigenous sciences, in alignment with several influential Indigenous thinkers and teachers (see Kawagley, 1990, 1998; Cajete, 2000; Goodchild, 2021; Hernandez, 2022). Indigenous sciences can extend over considerable spatial scales (i.e., many hundreds of square kilometres) through travel and sustenance harvesting. The value-centric term Inuit Qaujimajatuqangit (IQ) is used similarly and defined by Elders as "Inuit ways of knowing, ways of being, and worldview – past, present and future" (Canadian Polar Commission, 2003, p. 6; Karetak et al., 2017). In this chapter, we primarily refer to Indigenous knowledge[18], which we consider to be the ways in which Indigenous sciences are manifested through a specific understanding of species, populations, habitats, and geography (see Reo, 2011). We

[17] Inuktut refers to Inuit language, and includes all dialects used across Inuit Nunangat. We use Inuktut when referring generally to the Inuit language, and Inuktitut for references to the community of Kinngait, Nunavut.

[18] The term 'knowledge' is used in its singular form because we are referring to the knowledge of a single community.

chose to differentiate Indigenous science and knowledge to clarify and signal that myself and settler co-authors were removed from the process of experiencing and creating Indigenous science and do not have access to Inuit ways of knowing and being or worldviews[19].

In the territory of Nunavut, the Land Claims Agreement allocates the implementation of resource management and environmental monitoring decisions to community Hunters and Trappers Associations (HTAs) or Organizations (HTOs) (INAC, 1993; Lokken et al., 2019), who often partner with southern researchers to address common research questions and priorities. This process and the role of local organizations facilitates community influence over the project (e.g., species or ecosystem of focus, breadth of study, level of community participation); nonetheless, researchers should adhere, at minimum, to ethical protocols and good practices for community research, which have been conferred by Inuit Tapiriit Kanatami (ITK) in the *National Inuit Strategy on Research* (ITK, 2018), and by the Inuit Circumpolar Council in the *Ethical and Equitable Engagement Synthesis Report* (ICC, 2021). Many researchers working with communities are seeking to center and amplify Indigenous Peoples and their experiences within ecological narratives to capacitate mutual learning and holistically address complex problems.

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[19] We recognize the limitations of language, and that it can shape one's understanding differently. As articulated by Anishinaabe scholar Dr. Deborah McGregor, "every term is going to limit [Indigenous ways of knowing] in some way" (McGregor, 2008, p. 145).

This study examines changes in species and habitats near the community of ᑭᓐᖓᐃᑦ (Kinngait)[20] (64°13'N, 76°32'W; population: 1441, 93% Inuit (Statistics Canada, 2017)). This hamlet is located in the Qikiqtaaluk Region of Nunavut on a small island off the southwestern tip of Baffin Island (Foxe Peninsula). Situated on the northern shore of the Hudson Strait, Kinngait has another name: *Sikusilaaq*, meaning 'where there is no ice' for the strong Hudson Strait currents that prevent extensive ice formation and result in open water year-round (Henshaw, 2006; Laidler and Elee, 2008). This phenomenon is unique in Nunavut (Kelley and Ljubicic, 2012). The proximity of the floe edge, and the dynamic sea ice and open water environment near Kinngait are defining characteristics of local conditions and seasonal processes, and shape community harvesting practices (Laidler et al., 2010). The species supported by these ecosystems may be at an elevated risk due to the increasingly intensive use of the Hudson Strait as a shipping corridor, and the associated array of possible adverse effects (e.g., underwater noise, water pollution) (Kelley and Ljubicic, 2012). As this community is geographically positioned to be impacted by a multitude of climate and anthropogenic changes, it is critical to understand the aquatic ecosystems that support the wellbeing of Kinngarmiut (people of Kinngait).

In partnership with the community of Kinngait, Nunavut, our aim was to compile and document perceptions, observations, and experiences of environmental and biodiversity change in marine, coastal, and lacustrine ecosystems as well as associated

[20] We use Inuktitut names in syllabic or Roman orthography (South Baffin dialect) to recognize the relationship of Inuit to the land. Indigenous names are records of linguistic heritage and land use history, and can indicate locations of significant events, ecologically important areas, landscape features, and refer to potential dangers (Henshaw, 2006; Wong et al., 2020). 'Kinngait' is Inuktitut for 'where the hills are' in reference to a mountain on the island that is part of the Kinngait Mountain range.

changes in harvesting practices. We use the community's understanding and definitions of these ecosystems, with 'marine' encompassing the area beyond the low tide line where there is open water, and 'coastal' encompassing the area from the shoreline out to the low tide line. Under the guidance of the Aiviq Hunters and Trappers Association (AHTA) in Kinngait, we investigated marine and lacustrine environments because they are interconnected, and the community relies upon both for harvesting. By collaborating with the AHTA, community technicians, and other knowledge holders, we created a written record to retain this knowledge for future generations, and to serve as a baseline for the community in the context of continuous change. This will aid Kinngarmiut in preparing for a future shaped by climate change and increased development (e.g., shipping, potential commercial fisheries). On a broader scale, this study also responds to the need for research that considers social and cultural implications of changes for individual communities (Wheeler et al., 2020; Worden et al., 2020; Ford et al., 2021).

Authors AD, LC, VN, SA, and KD are settlers and live in southern Canada. This research is informed by their environmental and social science backgrounds within academia and government, and is shaped by their collective experiences conducting research with Indigenous communities across Inuit Nunangat. This chapter builds upon the efforts of many Indigenous Peoples, communities, and organizations, and of their colleagues in this field. These authors are committed to ongoing work to identify and unlearn the colonial perspectives that shape their worldviews. Through reflexivity, humility, and listening, as well as continuous communication and efforts to foster relationships with the community of Kinngait, the aforementioned authors endeavoured to approach and conduct this research 'in a good way'[21] and are delighted to share authorship with the Aiviq Hunters and Trappers Association, OM, SP, and PQ.

3.3 Methods

3.3.1 Methodology

This research was conducted following a community-based participatory approach methodology, which studies a phenomenon with the full engagement of those affected by it, and involves collaborative efforts to develop a research plan, gather data, and conduct analysis (Breitbart, 2016). This approach commits to applying findings in a manner that benefits the community in tangible ways. This is similar to and often overlaps with participatory action research, which emphasizes the involvement of community members in research design and process (Banks et al., 2013). Both of these participatory approaches enhance community capacity and require continuous dialogue between researchers and community members (Breitbart, 2016). Participatory research often uses mixed methods, which apply the strengths of both qualitative and quantitative approaches to obtain a greater degree of detail than the independent use of either method (Creswell and Creswell, 2018). The mixed method approach used in this chapter draws upon text and statistical analyses.

[21] Conducting research 'in a good way' means that the process is as or more important than results, and that relationships and accountability are central (Wilson, 2008; Ball and Janyst, 2008; AHA Centre, 2018).

3.3.2 Project initiation

Community interest in an Indigenous knowledge study with the Aiviq Hunters and Trappers Association[22] in Kinngait, Nunavut, was garnered during the implementation of a coastal monitoring program by the AHTA and Fisheries and Oceans Canada (DFO) in 2020 (details found in Chapter 4 of this thesis). The AHTA expressed interest in documenting Indigenous knowledge about nearby coastal, marine, and lake ecosystems in order to understand environmental conditions and biodiversity change over time and in geographic areas beyond coastal monitoring sampling sites. Our original intent prior to the onset of the COVID-19 pandemic was to conduct in-person interviews and workshops in Kinngait to compile and document this knowledge. When travel restrictions were introduced, video or telephone interviews were considered but were not deemed feasible due to difficulties including language barriers, bandwidth, and technological capacity.

In December 2020, DFO team members held an audio teleconference with the AHTA to create a project plan. The central focus was aquatic ecosystems, with discussion of priority questions for the community, including: changing species abundance and diversity, altered habitat features and the timing of these changes, and the impacts of changes on harvesting. The DFO team introduced the possibility of conducting a questionnaire[23] that could be remotely co-developed with community

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[22] Members of the AHTA are elected by the community, and the AHTA has the authority to speak on behalf of the community on subjects pertaining to local resource management.

[23] We define 'questionnaire' as follows: 'A questionnaire acquires information about a population by administering a standardized questionnaire to a sample of individuals (McLafferty, 2016). Information gathered is often at the household level (e.g., demographics, ecosystem service use, livelihood activities, stressors) or individual level (e.g., related to perceptions, values, sense of place). Questionnaires are

technicians to adapt to COVID-19 travel restrictions, and the AHTA decided on this option. This work was conducted under a scientific research license (0101221N-M) from the Nunavut Research Institute, and we received ethics clearance (project ID #115098) from the Carleton University Research Ethics Board.

3.3.3 Questionnaire co-development and content

The research team, which consisted of individuals from both the federal government and academia, first created a draft questionnaire derived from the interests expressed by the AHTA in the December 2020 teleconference. This questionnaire focused on environmental and biodiversity changes associated with marine, coastal, and lacustrine ecosystems surrounding Kinngait as observed or experienced in the lifetime of participants. Insight into biodiversity at different trophic levels was sought, with biodiversity changes centering on marine mammals, fishes, invertebrates, and plants. This draft included environmental, biological, and harvest-related questions addressed through closed ended (e.g., checkboxes) and open-ended questions, the latter which enabled qualitative data compilation for contextual insight. The questionnaire was organized by ecosystem, and structured such that sections were related, but could stand alone if challenges were encountered during questionnaire delivery. The options 'not sure' and 'prefer not to answer' were included to allow for a range of responses (McLafferty,

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structured, and can provide quantitative and qualitative data (the latter through open-ended questions). While information is documented in a written format, questionnaires can be delivered verbally (Shackleton et al., 2021), which removes some rigidity and can allow for more flexible conversations' (adapted from Chapter 2 of this thesis).

2016). This draft was created through meetings between team members, where discussions were held when difficulties arose.

The first draft of the questionnaire was then altered and revised with community technicians to ensure alignment with community objectives, and to enable optimal accessibility for knowledge holder participants. The AHTA selected three community technicians; Ooloosie Manning, Sheojuk Peter, and Pudloo Qiatsuq (Figure 3-1; co-authors on this chapter), to further co-develop the questionnaire with AD and LC. Over the course of seven days throughout January 2021, we held audio teleconferences to discuss, review, and revise the questionnaire. These teleconferences consisted of informal conversations focused on content (i.e., whether they thought the community might be interested or have knowledge related to various topics) and structure (i.e., whether they thought certain options made sense in terms of the responses we might receive). Questions were also re-worded for clarity and ease of understanding. At the end of questionnaire co-development, AD and LC reviewed the questions with community technicians to ensure that we shared the same understanding of the intent of each question. Furthermore, we asked and encouraged the technicians to record as many details and as much information as possible for each question during delivery. The technicians were compensated for time spent co-developing the questionnaire. A revised questionnaire was provided to the AHTA for final approval (Table 3-1, see Appendix B.1 and B.2 for questionnaire), and opportunities for community questions and comments arose during an AHTA meeting in March 2021. See Christie et al. (submitted) for additional details regarding the co-development process.

Figure 3-1 Questionnaire co-development in January 2021 with Sheojuk Peter (left), Ooloosie Manning (centre) and Pudloo Qiatsuq (right). Photo by Sheojuk Peter.

Table 3-1 Summarized questionnaire topics.

Topic		Details
Participant demographic information		Gender Age Number of years in community
Changes in ecosystems	**Ocean**	Water temperature Wind Swells Ice characteristics (area, thickness, quality, timing of breakup and formation) Numbers and kinds of species of marine fishes, mammals, and invertebrates
	Coast	Water temperature Wind Swells Erosion Numbers and kinds of species of marine fishes, mammals, and invertebrates Kinds of plants
	Lake	Water temperature Wind Waves Water clarity Ice characteristics (area, thickness, quality, timing of breakup and formation) Numbers and kinds of species of fishes and invertebrates
Harvest information		Harvesting practices (hunting and/or fishing), locations, timing, number of years Most harvested species, and changes in their abundance, timing, and locations Condition of marine mammals, and marine and lacustrine fishes
Community concerns		Concerns about the ocean, coast, and lake
Feedback and future research		Questionnaire effectiveness and length Missing topics and future research interests

Note that each section in the questionnaire contained an open-ended question enabling participants to include additional comments.

3.3.4 Participants and questionnaire delivery

The community technicians created a list of potential questionnaire participants, 39 of whom were then selected by the AHTA. Research participants were active or past users of local lakes, marine areas, and travel routes for fishing and/or hunting, and recognized holders of ecological knowledge associated with these areas. Both Elders and non-Elders[24] participated, as the AHTA wished to include participants with a range of experience levels. All 39 questionnaires were delivered from March 10 – 25, 2021 by the community technicians following a radio announcement and efforts by the technicians to spread word around the community about the questionnaire. The technicians were compensated for each questionnaire administered. Participants signed a consent form written in Inuktitut or English that informed them about the project, the intended use of information, and their rights in the study. We offered the opportunity to be identified by name, by age and experience (Elder/non-Elder), or to remain anonymous.

Each questionnaire took approximately 30 minutes for community technicians to complete with bilingual (English/Inuktitut) respondents or non-Elders, and 45 minutes to complete with unilingual Inuktitut speakers or Elders. The questionnaires were delivered by the community technicians in the participants' language of choice (Inuktitut or English), with the technicians interpreting or providing explanations as needed. For some questions, terms used in the questionnaire differed from those used in this chapter. The terms *kinds of species* and *numbers of species* in the questionnaire are referred to as *species diversity* and *relative abundance*, respectively, in this chapter. The term *water clarity* in the questionnaire is referred to as *turbidity* here. The use of clear language and minimal technical terms in the questionnaire were important for community understanding and ease of translation between English and Inuktitut. All questionnaire

[24] The AHTA in Kinngait informed our team that individuals greater than 54 years were considered to be Elders, and individuals 54 years and younger were considered to be non-Elders.

delivery sessions were held in the homes of participant knowledge holders. Each participant received compensation based upon rates pre-determined by the AHTA.

3.3.5 Analysis, knowledge verification, and reporting

The questionnaires were digitized and analyzed using Excel. Descriptive statistics were generated to summarize changes reported, with results distinguished by Elders and non-Elders due to interest expressed by the AHTA in including participants with varying years of experience. Preliminary results were shared with the community through a newsletter provided in English and Inuktitut in October 2021 (Appendix B.3 and B.4).

Knowledge verification was undertaken in March 2022 through audio teleconferences with community technicians. AD and LC held two audio teleconferences with community technicians in which AD reviewed the questionnaire results with the technicians to verify that they aligned with the responses they recall receiving during questionnaire delivery, and to receive feedback on the entire collaborative research process. The next week, AD, LC, and KD met with the AHTA via video teleconference to share questionnaire results and ask about their preferences for content within a final summary report (currently in preparation). During this teleconference, the AHTA gave their consent to include copies of the questionnaire in this thesis and future published manuscripts, and expressed interest in co-authorship. Later in 2022, results may be shared through a presentation or in a workshop in Kinngait. All original questionnaires will be returned to the AHTA at the conclusion of this project, with copies securely held at the DFO Freshwater Institute in Winnipeg, Manitoba.

3.3.6 Limitations

Limitations and biases in this study should be acknowledged. Participants may have been reluctant to share sensitive information; however, these occurrences may have been lessened through strong support from the AHTA, questionnaire delivery by community members, and shared concern regarding environmental change. In addition, responses could have been affected by recall bias, resulting in a lack of specific information provided by participants (e.g., year or location of observations), or by question order bias, which could have caused participants to react differently based on the order in which questions appeared (Tourangeau et al., 2000). Efforts were made to limit these biases by ensuring that general questions were asked before specific ones, and by asking about similar topics using different wording and a variety of question types. Questionnaire delivery by technicians rather than self-delivery greatly curbed these effects. Moreover, initial teleconferences with community technicians to discuss the intent of questions helped ensure consistency in questionnaire delivery and participant interpretations.

Responses may also have been influenced by community technician connections to participants, and the degree of opportunity for iterative interaction between technician and participant (Brook and McLachlan, 2005). Questionnaire design and the remote delivery of questionnaires contributed to our inability to distinguish factual and inferential information (Usher, 2000). In cases where questions were unanswered, it was unclear whether participants did not know or did not wish to answer. To curb these occurrences, technicians were encouraged to differentiate between the two. When more than one answer was selected, technicians were asked to provide a short explanation.

Furthermore, as the questionnaires were delivered in English, Inuktitut, or a mixture of both, miscommunications may have occurred in translation and transcription. However, the language options lessened the possibility of altered intended ideas, as knowledge is embedded in language, and “ideas are best understood relative to the language that shapes them and gives them meaning” (Dale and Armitage, 2011, p. 445).

Finally, as the lead author and DFO research team we were unable to be present during questionnaire delivery, the nuances and the context of responses were not available. However, meetings held with technicians to verify the knowledge compiled and its interpretation helped limit these effects. The information gathered through questionnaires encompasses only a portion of the knowledge held about environmental and biodiversity changes in Kinngait. Non-random sampling is commonly used when seeking expert knowledge but prevents us from knowing whether our results may be generalized to the community level (Drescher et al., 2013; Creswell and Creswell, 2018). As research participants were experienced and recognized knowledge holders or leaders within the community, and our sample size was reasonable, we have a greater degree of confidence that questionnaire results may represent community knowledge.

3.4 Results

In this section, we present questionnaire results including participant demographic information, experiences and perceptions of change in environmental parameters (i.e., habitats) and biological parameters (i.e., species), and other community concerns. Accounts of changes in harvesting practices are embedded within environmental and biological parameter sections.

3.4.1 Demographics

The community technicians administered 39 questionnaires to a similar number of Elders (54%, $n = 21$) and non-Elders (46%, $n = 18$) (Figure 3-2). Approximately 40% of participants identified as female ($n = 16$), and 60% as male ($n = 23$). Male Elders were the most common participant of all categories, followed closely by male non-Elders, female Elders, and female non-Elders. Participant ages ranged from 27 to 83 years, with an average age of 54 ± 17 years.

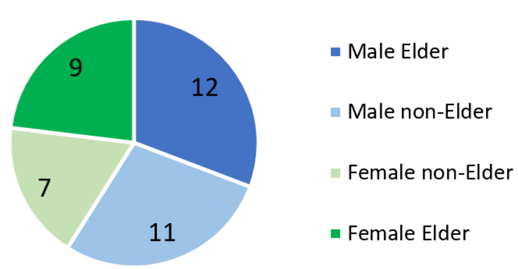


Figure 3-2 Participant age and gender, where Elders were greater than 54 years old, and non-Elders were 54 years old and younger.

The majority of participants both hunted and fished in marine, coastal, and lacustrine ecosystems. The average years of harvest experience was approximately 42 ±

20 years, but ranged from 15 to 83 years. Most participants (77%) had less than 59 years of harvest experience. A few participants had 75 to 83 years of experience (13%), and fewer had 60 to 74 years of experience (5%).

3.4.2 Changes in environmental parameters

In this section, we describe reported changes in environmental parameters, and the direction of these changes. These parameters include: water temperature, turbidity, erosion, swells and waves, wind, and sea and lake ice (Table 3-2 and 3-3). For each environmental parameter, we present summarized results and participant voices[25], and distinguish responses by Elders/non-Elders and by ecosystem (Figure 3-3 and 3-4).

[25] 'P' refers to 'participant' and is used alongside a number in this section and hereafter to recognize the contributions of different knowledge holders while maintaining anonymity. Note that identifying numbers for participants (e.g., P54) exceed 39 because the questionnaires were pre-numbered, and some were not distributed.

Table 3-2 Summary of changes reported in water temperature, water clarity, erosion, swells and waves, and wind. See Figure 3-3 for figures associated with these results.

Parameter	Summarized results	Participant voices
Water temperature	More than twice as many Elders than non-Elders reported an increase in water temperature in the ocean, coast, and lakes beginning as early as 40 or 50 years ago, or as recently as the past five years. A few individuals (mainly non-Elders; *n* ≈ 4)* reported relatively recent declines in water temperature in all ecosystems (i.e., over approximately the past 15 years). Some participants (*n* ≈ 7; Elders and non-Elders) reported that there was no change in water temperature in all ecosystems.	*“Water temperature getting warmer each year”* (P34) *“Water temperature is causing different ice freeze up on the coastline each year”* (P54) *“Freeze up in the coastal line. Change in temperature in the ocean is causing this in the coast”* (P55) In lakes: *“Water temperature rise makes so much change”* (P54) *“Snow conditions also changed over time, also cause temperature change”* (P55)
Turbidity	Most participants (Elders and non-Elders; *n* = 14 each) reported that there was no change in turbidity in lakes. A few participants reported an increase in turbidity beginning 60 to six years ago, and very few reported a decrease in turbidity.	Increasing turbidity: *“Last spring around break-up it was very murky - shallow areas very murky. In the deep it was clear. Around the river was murky”* (P10)
Erosion	Almost the same number of Elders reported an increase (*n* = 7) and no change (*n* = 9) in erosion on the coast. This increase in erosion began 40 to four years ago. A few Elders also reported a decrease in erosion starting 30 years ago. Most non-Elders (*n* = 12) reported that there was no change in erosion on the coast.	No comments were provided.
Swells and waves	Almost the same number of Elders reported an increase (*n* = 8) and no change (*n* = 11) in swells in the ocean. On the coast, more Elders (*n* = 11) reported an increase in swells. These increases began as early as 40 years ago. In comparison, most non-Elders reported that there was no change in swells in the ocean or on the coast (*n* = 10 each). In lakes, most Elders and non-Elders reported that there was no change in waves (*n* = 14 each).	No comments were provided.
Wind	Elder and non-Elder responses were very similar in regard to wind across all three ecosystems. In the ocean and coast, almost the same number of participants (Elders and non-Elders) reported an increase and no change in wind (*n* ≈ 9 across groups and ecosystems). Increases in wind in the ocean and coast were reported to have begun as early as 60 and 30 years ago, respectively, and may be most prominent in the fall. Most participants (Elders and non-Elders) reported that there was no change in wind in lakes; however, a few participants reported increases in wind. Several participants indicated that winds are coming from the same directions more often (primarily easterly, and possibly southeasterly).	Increasing wind intensity in the ocean/coast: *“More windy in summer into fall seasons”* (P2) *“Winds are increasing in the fall”* (P9) *“The wind seems to be picking up”* (P17) *“When wind is strong than I know it is cold in the ocean”* (P54) Wind direction changes: *“Wind direction changed”* (P55) *“Now the winds are easterly, when it used to usually be northwestern”* (P10) *“Winds are coming more from the same direction…east winds”* (P20) *“Wind direction seems to be coming from the same two directions now”* (P54) *“If the wind comes from southeast and east, it contributes to the thickness of the ice while forming”* (P53) Wind temperature changes: *“The wind temperature is different”* (P20) *“It is not that windy from warm temperature when it’s time for freeze-up”* (P36)

*Note that *n* ≈ X refers to the average number of participants between Elder or non-Elder groups, or across ecosystems (or both, depending on context).

Table 3-3 Summary of changes reported in sea and lake ice, including ice area, thickness, quality, and the timing of ice breakup and formation. See Figure 3-4 for figures associated with these results.

Parameter	Summarized results	Participant voices
Ice	**Sea ice** Nearly all participants (Elders and non-Elders) reported a decrease in sea ice area and thickness, as well as earlier spring breakup, and later fall formation. Ice that used to remain until July now breaks up in June, and sometimes as early as April or May. Some participants noticed that there is no flooded water when the ice melts anymore**. Ice formation (freeze-up) that used to occur in early November is now often observed in December. Participants reported poorer ice quality, the danger this poses, and the need to take alternate travel routes. Ice is also becoming less sturdy, especially near areas with strong currents. These changes were reported to have begun occurring up to 60 years ago. **See Laidler and Elee (2008) for descriptions of sea ice formation and melting processes in Kinngait and their associated Inuktitut terminologies.	Thickness and area: "*More open water and thinning of the ice*" (P37) "*Less of old ice packs*" (P41) *"Less ice formation, now it is like half of what it used to be. Thickness is poorer, as it is thinning and we cannot go out fishing as we would then until June/July"* (P36) *"If the wind comes from southeast and east, it contributes to the thickness of the ice while forming"* (P53) Quality: *"The quality is poorer and dangerous for us"* (P10) *"More dangerous ice conditions, must be aware of your surroundings"* (P41) *"Due to warming temperature…ice conditions seem to be not too good"* (P17) Timing of ice breakup and formation: *"Takes longer to freeze in the fall and earlier break-up"* (P2) *"Freeze-up used to be in early November now it's in December. Break-up used to be in July now it's June sometimes May"* (P10) *"Last year (2020) we didn't have much of a spring because the ice was gone very fast"* (P35) *"Due to warming temperature, ice break-up is sooner"* (P17) *"Warming water causing the formation of ice later"* (P33) *"Ice barely ever froze and very late"* (P13) *"Freezing later, melting earlier…We need to take not regular route due to earlier melting"* (P10) Changing characteristics of ice breakup: *"Less ice around coast in winter. Less floodwater when melting - just break up"* (P54, P55) Changes on the coast: *"Coastal line seems to be changing in freeze up. Water temperature is causing different ice freeze up each year"* (P54) *"The ice pack on some of the coastline, especially where there are strong currents is less sturdy"* (P41) *"Floe edge is getting closer over time"* (P2)
	Lake ice For lake ice, responses were very similar to sea ice, with most participants (Elders and non-Elders) reporting a decrease in ice area and thickness, earlier spring breakup, and later fall formation. The only different report between the ocean and lake was ice area. In lakes, almost the same number of participants reported a decrease and no change in ice area. A few participants noted that ice quality is highly dependent upon the snow present on the ice, and that the fishing season is becoming shorter due to changes in ice. These changes were reported to have begun as early as 60 years ago.	Thickness and area: *"Sometimes thicker ice"* (P9) *"In the winter, it is always thinner"* (P42) *"The lakes are thinner…each year decreasing"* (P60) *"Lakes used to and could be 7-8 ft thick 5-6 years ago. The past couple years it's been 4-5 ft thick"* (P10) Quality: *"Depends on how much snow there is on the ice"* (P36) *"Less snow on lakes now, so this is causing different ice formation and conditions. Snow conditions also changed over time, also cause temperature change"* (P55) Timing of ice breakup and formation: *"I could see that our ice is breaking sooner than usual. And forming later than usual"* (P13) *"Ice melts faster now"* (P35) *"Because weather is warming up - ice breaks up easy"* (P17) *"Thinner ice, later freeze-up, earlier melting, we like to fish longer but we can't"* (P10) *"Fishing is shorter now because in the springtime everything is melted"* (P35) *"Takes longer to go fishing in early winter due to lake freeze-ups in the fall"* (P2)

Note that *n* ≈ X refers to the average number of participants between Elder or non-Elder groups, or across ecosystems (or both, depending on context).

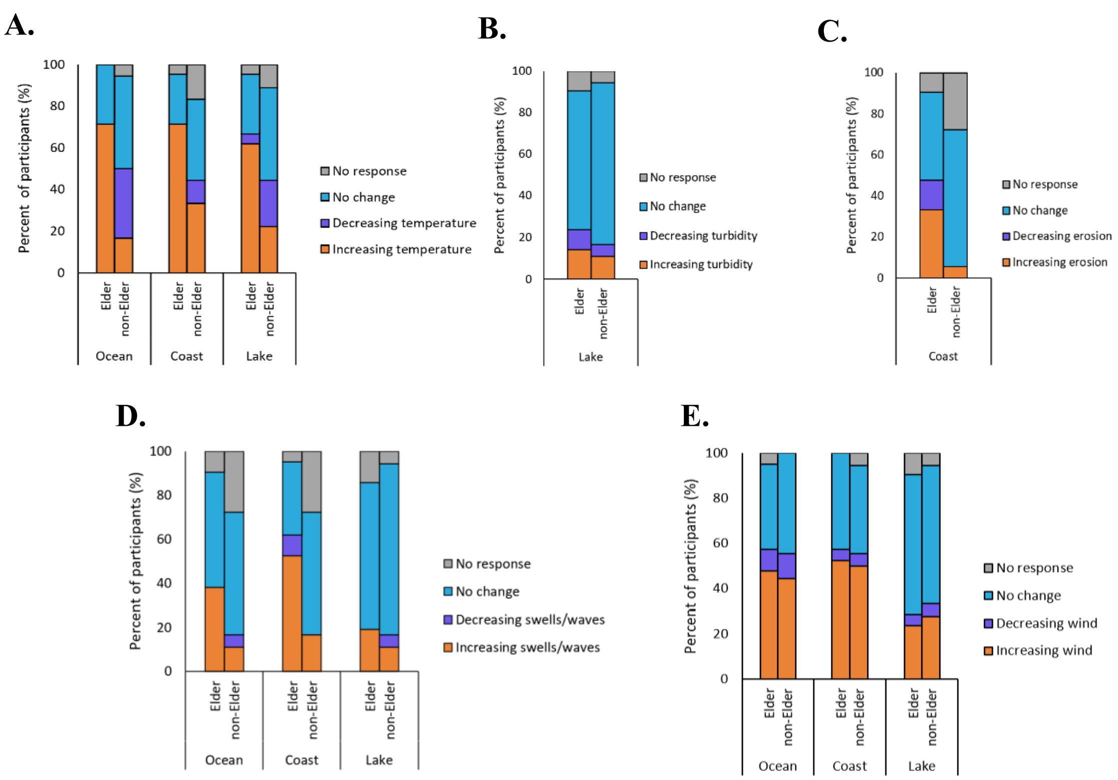


Figure 3-3 Percent (%) of participants who reported changes in: A) water temperature, B) turbidity, C) erosion, D) swells and waves, and E) wind, in the ocean, coast, and lakes. Figure results are presented by Elders and non-Elders (i.e., percentages are out of 21 and 18 participants, respectively).

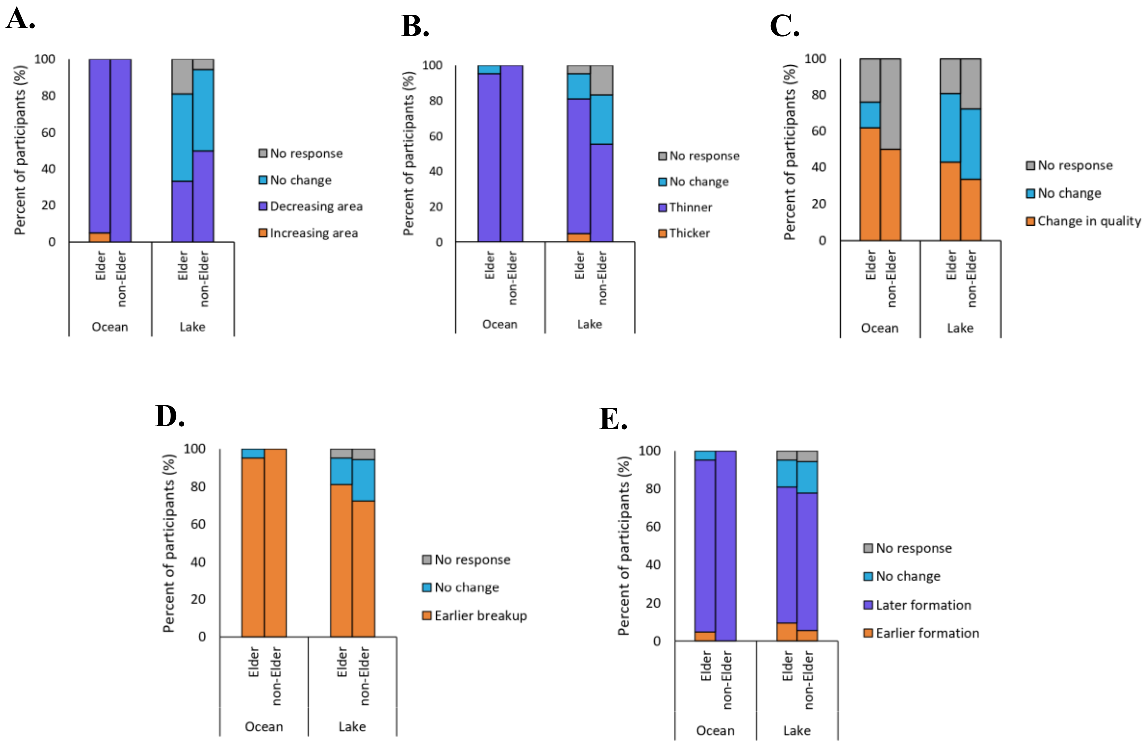


Figure 3-4 Percent (%) of participants who reported the following changes in sea and lake ice: A) area, B) thickness, C) quality, D) timing of spring breakup, and E) timing of fall formation. Figure results are presented by Elders and non-Elders (i.e., percentages are out of 21 and 18 participants, respectively).

3.4.3 Changes in biological parameters

In this section, we describe reported changes in biological parameters, and the direction of these changes. These parameters include: species diversity and relative abundance of marine mammals (Table 3-4), marine and lacustrine fishes (Table 3-5), and marine and lacustrine invertebrates and coastal plants (Table 3-6). For each biological parameter, we present summarized results and participant voices, and distinguish responses by Elders/non-Elders and by ecosystem (Figure 3-5). We then discuss knowledge related to community harvests including species harvested, and changes in species condition and timing of harvests.

3.4.3.1 Biological parameters: species diversity and relative abundance

Table 3-4 Summary of changes reported in species diversity and relative abundance of marine mammals. See Figure 3-5 for figures associated with these results.

<table>
<tr><th colspan="2">Parameter</th><th>Summarized results</th><th>Participant voices</th></tr>
<tr><td rowspan="2">
Marine mammals</td><td>**Species diversity**</td><td>Most participants (Elders and non-Elders) reported that there was no change in marine mammal species diversity in the coast or ocean (*n* ≈ 10). Some participants reported the appearance or disappearance (*n* ≈ 3 each) of species, beginning as early as 60 years ago and 40 years ago, respectively.</td><td rowspan="2"><u>Seals (all species)</u>
“Less seals appear in some areas. We hear of people not harvesting seals at all for some days now. There used to be bountiful seals” (P54)
“There are less seals hunted nowadays. There used to be lots around here” (P55)
“The (ringed seal) skins are not so good quality anymore, it seems like there are less seals too” (P54)
“Ice formation is less now, and I think numbers are ok but breathing holes are less and seals in open water more, ice coverage is less now, that is why there are less holes” (P36)

<u>Ringed seal</u>
“Much less ringed seal for the past few years” (P15)
“If the winds were strong then there are more ringed seals. Note this winter not alot of breathing holes” (P36)
“I have noticed there are less ringed seals because of increasing polar bears. Polar bears eat seal pups. Even in the spring the seals on the ice sunbathe. Temperature rise they sunbathe in warmer temperature. Older ringed seals sunbathe early in the year now” (P18)
Hunts for ringed seal “all year long depends on weather” (P36)

<u>Bearded seal</u>
“Bearded seals are not as many seems like…[they] are not seen on a piece of ice anymore” (P55)
“More bearded seals” (P18)

<u>Harbour seal</u>
“Fewer kinds of mammals - mainly harbour seals [that there are fewer of]” (P2)

<u>Harp seal</u>
“Harp seals not on coast” (Q31)
“I hunt for harp seals - but in a couple years I have not caught one” (P9)
“Have not seen harp seals any more (P31)

<u>Beluga whale</u>
“Less beluga pods come in, in spring, numbers are less than 20 years ago” (P55)
“Less belugas around that migrate, maybe affected by the Mary River mine. Not sure but what I think” (P55)
For timing in the winter, “beluga whale come early” (P36)

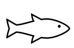
<u>Bowhead whale</u>
“Bowhead whales were not seen often” (P55)

<u>Walrus</u>
“Some walrus can get hungry and can eat seal. Kinngait usually have walrus around the island most year-round” (P20)</td></tr>
<tr><td>**Relative abundance**</td><td>A similar number of Elders and non-Elders reported decreasing abundance of marine mammals, and no change in the abundance of marine mammals in the ocean and coast. However, it was clear that most Elders (*n* = 12) noticed decreases in marine mammal abundance in the ocean.

Several participants specifically indicated that there is less ringed seal, bearded seal, harbour seal, and harp seal, and thus fewer harvesting opportunities. The impact of lessened ice formation on seals was discussed. There were observations of fewer breathing holes, and seals spotted more frequently in open water. There were also reports of fewer beluga whale migrating, and earlier migrations during the winter, as well as infrequent sightings of bowhead whale. Participants mentioned differences in the taste and texture of walrus and ringed seal. These changes may have begun as early as 60 years ago, and as recently as over the past few years.</td></tr>
</table>

Note that *n* ≈ X refers to the average number of participants between Elder or non-Elder groups, or across ecosystems (or both, depending on context).

Table 3-5 Summary of changes reported in species diversity and relative abundance of marine and lacustrine fishes. See Figure 3-5 for figures associated with these results.

Parameter		Summarized results	Participant voices
 **Fishes**	**Species diversity**	A similar number of participants (Elders and non-Elders) reported that there was no change in fish species in the ocean, coast, or lakes (*n* ≈ 13 across groups and ecosystems). A few participants who described an increase in diversity spoke about the occasional appearance of salmon in recent years. A new species of fish with 'lumps' was also reported. Cods and sculpins were commonly observed.	Marine fishes: *For new species, wrote: "Heard of salmon around here never seen it though"* (P54) *"At times I heard of salmon caught not so often though"* (P18) *"No change in codfish"* (P16) *"We may get codfish around, I just don't see anybody fishing them"* (P3) *"Three different kinds of sculpins [on the coast]"* (P55) Lacustrine fishes: *"I've seen puffer fish couple times now in the freshwater lakes last 10 years. I don't know if this is new or what"* (P3) *"They are new some kind of fish and has lumps"* (P5)
	Relative abundance	Most participants reported that there was no change in the relative abundance of marine or lacustrine fishes (n ≈ 13 across groups and ecosystems). Some participants (more Elders: n ≈ 7, than non-Elders: n ≈ 3) discussed increases in relative abundance beginning as early as 60 years ago in the ocean, and 50 years ago in the coast and lakes. Participants mentioned abnormalities or differences in skin characteristics, seasonal changes in parasite numbers, changes in taste and texture (based on what the fish consume and their location), and an increase in average fish size.	Marine fishes: *"Some years differ in terms of marine fishes numbers, but increasing now"* (P20) *"Looks like a lot more Arctic char these days"* (P42) *Differing abundance of Arctic char, "depends on month"* (P36) *"Less trout"* (P31) *"No change in codfish"* (P16) *"Less sculpins, and rarely seen in these areas now"* (P54) *"Less sculpins in the coast"* (P55) *Marine fishes numbers "differ with snow/winter weather"* (P20) *"People nowadays catch less fish in the spring/summer"* (P18) Lacustrine fishes: *"A lot more fish in winter up at the Fish Lakes"* (P42)

Anadromous Arctic char may be accounted for in both ocean and lake ecosystems.
Note that *n* ≈ X refers to the average number of participants between Elder or non-Elder groups, or across ecosystems (or both, depending on context).

Table 3-6 Summary of changes reported in species diversity and relative abundance of marine and lacustrine invertebrates, and coastal plants. See Figure 3-5 for figures associated with these results.

Parameter		Summarized results	Participant voices
Invertebrates	**Species diversity**	In the ocean and coast, a similar number of participants reported increases (n ≈ 7) and no change (n ≈ 9) in invertebrate species diversity. This diversity was reported to have begun increasing between 20 and four years ago. Most participants (n ≈ 14) reported that there was no change in invertebrate diversity in lakes. A few Elders reported decreases in invertebrate diversity in all three ecosystems beginning as early as 50 years ago. The main invertebrates discussed were mussels and clams.	Marine invertebrates: *"Starting to see more mussels around"* (P33) *"Just more mussels and this type is new to this area"* (P16) *"Some kind of worms in the sea"* (P5) *"Shrimp"* (P31) Lacustrine invertebrates: *"Know of some lakes with clams"* (P20)
	Relative abundance	Most participants (Elders and non-Elders) reported that the relative abundance of invertebrate species did not change across ecosystems (n ≈ 13). However, there were many reports of increasing relative abundance of mussels, which are also being observed in new areas. The increases in relative abundance began as early as 20 years ago in the ocean and coast, and as recently as six years ago in lakes. A few participants (n ≈ 2) reported decreasing relative abundance of invertebrates (possibly clams) in the ocean and coast up to 30 years ago.	Marine invertebrates: *"In some areas we used to collect clams, now we get less"* (P55) *"From alot of people clam digging there seems to be less bigger ones around. Mussels are growing in numbers and growing bigger"* (P36) *"Seems to have more mussels where there used to be almost nothing around this area"* (P3) *"Mussels are around now, there used to be nothing around Kinngait"* (P9) *"Mussels have increased in numbers in some areas"* (P60) *"I have noticed more mussels around coastal areas"* (P41) *"Harvests clams twice a season, and there are two extra months to harvest them. Harvests mussels three times a season. They are spreading"* (P36) *"Harvest clams and mussels twice a season. Mussels located in different areas now"* (P51) *"Less jellyfish"* (P31) *"Invertebrate numbers and size are increasing"* (P36) Lacustrine invertebrates: *For mussels, "rivers expanding locations"* (P16)
Plants	**Species diversity**	Most participants (Elders and non-Elders) reported that plant species diversity on the coast did not change, although several Elders reported a decrease in diversity (n = 3) beginning up to 26 years ago.	Decreasing plant diversity and/or abundance: *"Less seaweed. Seaweed seems to be lighter in colour now from increasing water temperature"* (P31) *"There are not much seaweeds in the shore anymore"* (P5) Increasing plant diversity and/or abundance: *"New kinds of seaweed. Changing in 40 years"* (P4) *"More seaweeds. More seaweeds from more winds, summer and fall can get lots of waves and swells and this causes more seaweeds to be washed up"* (P10) *"Those botanicals are good as a broth"* (P20)

Note that *n* ≈ X refers to the average number of participants between Elder or non-Elder groups, or across ecosystems (or both, depending on context).

A. Marine mammals

B. Fishes

C. Invertebrates

D. Plants

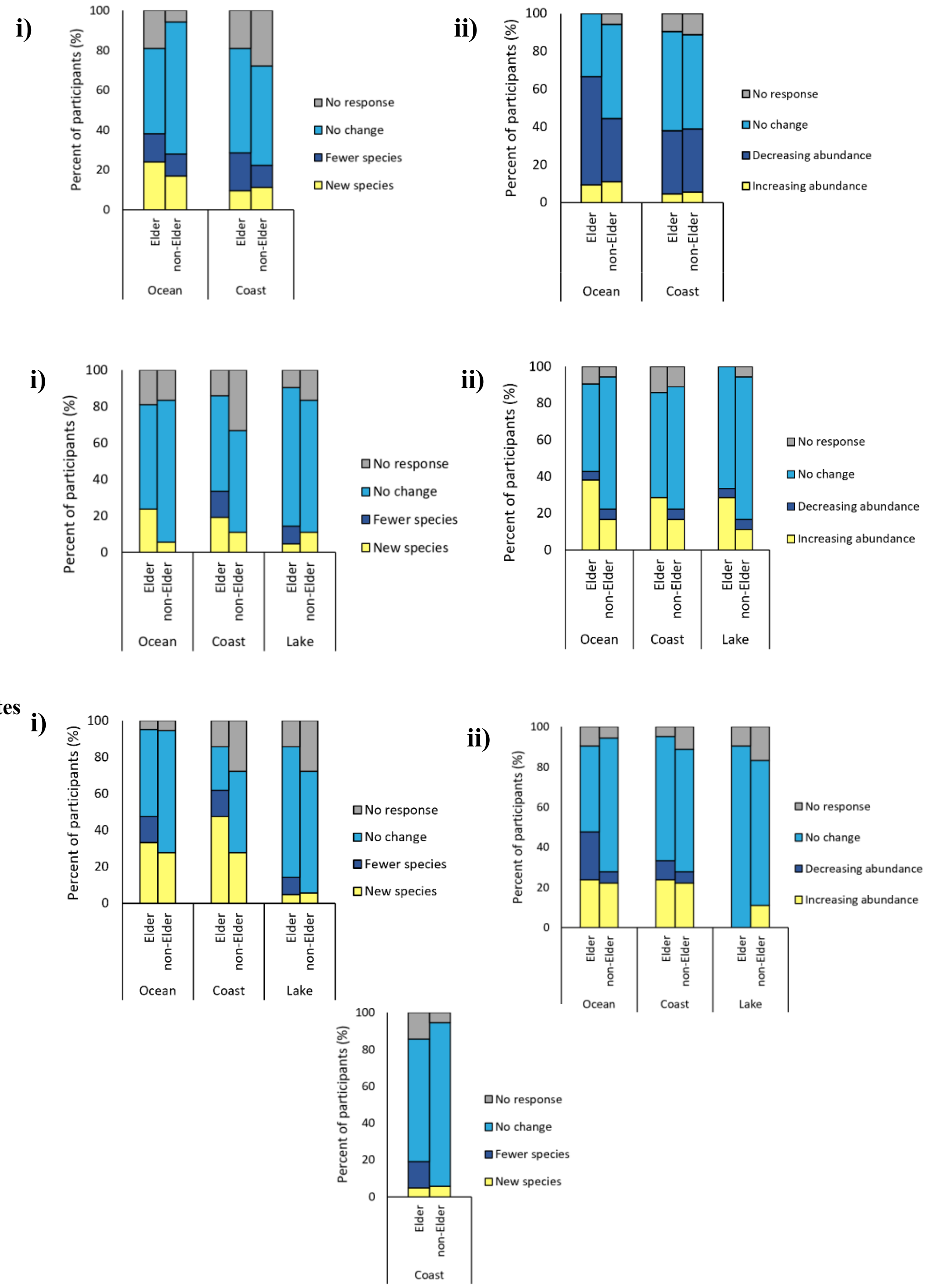


Figure 3-5 Percent (%) of participants who reported changes in the species diversity (i) and relative abundance (ii) of: A) marine mammals, B) marine and lacustrine fishes, C) marine and lacustrine invertebrates, and D) marine plants (only species diversity). Figure results are presented by Elders and non-Elders (i.e., percentages are out of 21 and 18 participants, respectively).

3.4.3.2 Species harvested, species condition, and timing of harvests

The most reported species harvested were Arctic char (*Salvelinus alpinus*), followed by clams, mussels, beluga whale (*Delphinapterus leucas*), and seal (most commonly ringed seal; *Pusa hispida*) (Figure 3-6). Landlocked char, unidentified landlocked/freshwater fishes, and fishes referred to as *ivitaaru*, *kakirraq*, and *nutilliit* in Inuktitut were also harvested. When asked about the physical condition of these species, participants most readily reported changes in scars, parasites, size, and indications of disease; these changes were observed to a similar degree between marine mammals and fishes (Figure 3-7).

Details regarding marine mammal condition were shared, with one participant indicating that marine mammal taste differs depending on diet, and that “if a walrus eat[s] seal they taste and smell different, usually they just eat clams” (P20). One participant mentioned that the texture of ringed seal is different (P55), while another shared that they had “seen parasites on two seals about three years ago” (P53). For fish, participants shared that in some years there are “more parasites [for] Arctic char” and “some years [where] some lakes or fish have parasites and become clean again, you can tell from the gills…[it] seems like every year there are more parasites when it becomes fall time” (P36). One participant suggested that in lakes, there are “different areas, different parasites” (P55). Additionally, one participant noted that “when fish go down the river, some smell dirty on the skin” (P20). For lacustrine fishes specifically, participants shared that “diet differs in areas…the skin smells and meat is good” (P20), that in “a certain lake, fish has different taste” (P55), and that “certain fishing lakes have different texture now…[there is a] soft or different texture in eating the meat” (P54). Fish size was also reported to be increasing, with one participant noting that “one fishing lake has less smaller fish” (P55). The same trend was reported among marine fishes, which are “bigger than 10 years ago” (P36).

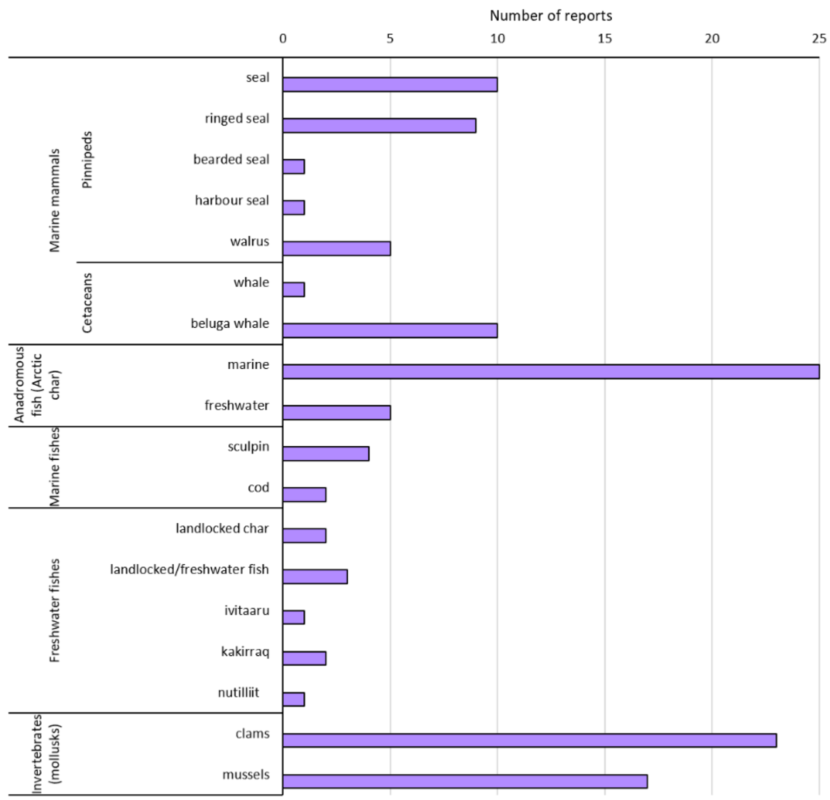


Figure 3-6 Harvested species reported in the questionnaire. Note that landlocked char are non-anadromous Arctic char (*Salvelinus alpinus*).

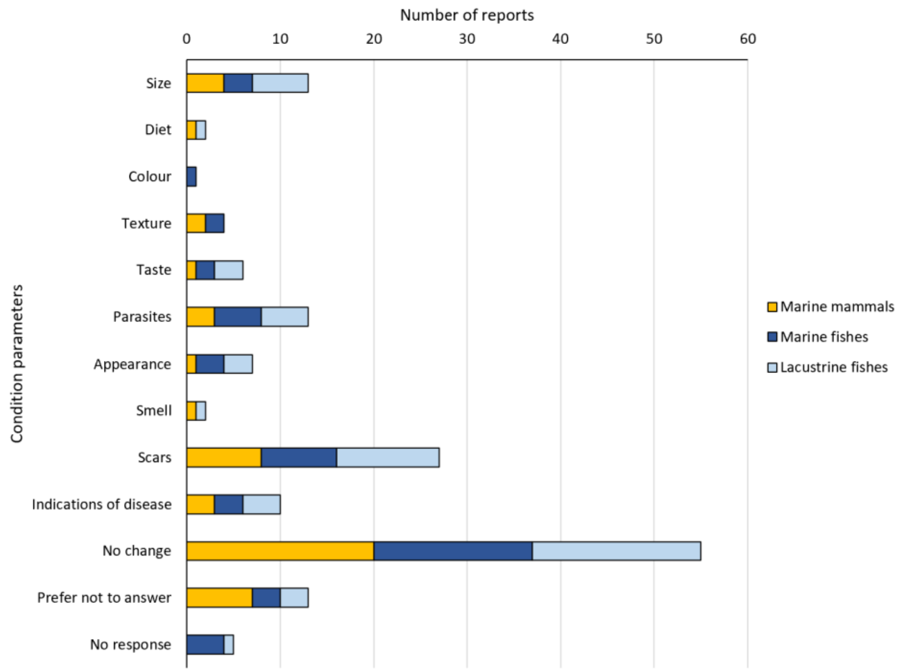


Figure 3-7 Number of reports of changes in the condition of marine mammals, marine fishes, and lacustrine fishes. Note that anadromous Arctic char may be accounted for in both marine and lacustrine fish reports.

Changes in the timing of harvesting differed across the four seasons (summer, fall, winter, spring)[26] (Figure 3-8). In the winter, one third of participants reported a later start to harvesting, while in the spring, a similar number of participants reported an earlier start to harvesting and no change in timing. Some participants expressed that "winter [is] com[ing] in later and spring weather com[ing] earlier" (P33, 34), with "ice break[ing] sooner" (P6). One participant shared: "I have been hunting all my life and teaching my kids how to hunt but sometimes hard when early breakups with snow machine" (P42). In the summer and fall, participants primarily noted no change. Many participants

[26] Community technicians informed AD and LC that Kinngait generally considers there to be four seasons (compared to six defined by some communities): winter (December, January, February, March), spring (April, May, June), summer (July, August), and fall (September, October, November).

highlighted the effect of weather on their ability to harvest, and that they go out at "every chance" (P58, 59); however, they "never know how the weather will be, each day is always different" (P15).

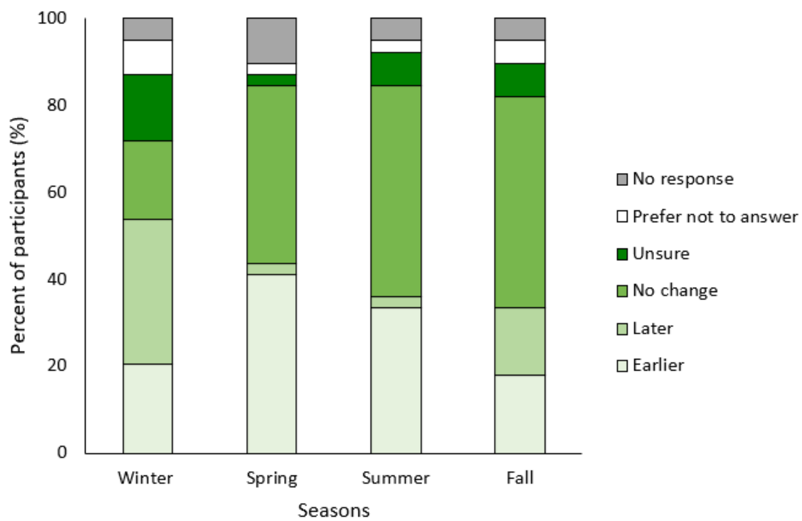


Figure 3-8 Percent of participants (%) who reported changes in the timing of harvesting in the winter, spring, summer, and fall.

3.4.4 Other community concerns

Many participants expressed concern regarding occurrences of "lower tides now than before" (P20, 31) resulting in a "dry coast in the summer" (P36). There was also concern about freshwater bodies, with participants sharing that "I heard of fish not making it up river some years due to not enough rain" (P54), and that "some fish have rot and died…fish also suffer when there is less river flowing also caused by community gravel control" (P55). This has resulted in lakes drying up over time (P5, 17, 32, and others) and becoming "thinner [for] 5 years [now]" (P41), although one participant noted that "no fishing lakes I know of dried up though" (P16). One participant attributed this to climate change (P5), and another shared that this phenomenon has been occurring "all my life" (P20). One participant raised concerns related to the impacts of shipping, sharing: "I am afraid Mary River iron mine ship will have a route near Kinngait, that it will change migration routes or marine mammals and leave such a difference over the years" (P18). Future research interests were also garnered in the questionnaires, and can be found in Appendix B.5.

3.5 Discussion

3.5.1 Results overview: changes in environmental and biological parameters

There was substantial variation in experiences and perceptions of environmental change among questionnaire participants. Many environmental parameters were characterized by a lack of change (turbidity, erosion, swells/waves), whereas responses were divided for wind. Although there were no specific wind direction questions, several individuals discussed this topic, with one participant indicating that "it's one of the critical questions" (P3). Wind direction, as well as wind speed and temperature, can influence the ability of harvesters to go out on the land, species behaviour and distribution, and ice processes (i.e., by facilitating ice formation/deterioration or leading to ice instability or break-off), among other effects (Laidler et al., 2010; Hansen et al., 2013; Chila, 2021). Increasing water temperatures were reported by many Elders, and more Elders than non-Elders; however, others also reported that there was no change in temperature. In contrast, for sea and lake ice, participants consistently reported diminishing ice area, thinner ice, earlier spring breakup, and later fall formation (by three to four months). These findings echo those of a previous sea ice study in Kinngait (Laidler et al., 2010), and reports from across the circumpolar Arctic (Knopp et al., 2022).

Across ecosystems, a greater number of participants reported increases in water temperature, swells/waves, and wind in the ocean and coast compared to lakes. These differences may be due to the geography of exposed and comparably flat ocean and coastal areas over which the wind carries and contributes to swells. This process could help explain some reports of coastal erosion, although this phenomenon has not yet been widely observed in Kinngait. In the future, increased permafrost thaw is likely to cause increases in erosion, which will in turn render water more turbid through sediment release. This process has already been observed to be a growing problem in Arctic communities (Fritz et al., 2017; Worden et al., 2020; Knopp et al., 2022). Similarly, decreasing water levels, and the drying and draining of rivers and lakes reported by participants is a widespread issue in many locations across the circumpolar Arctic (Knopp et al., 2022).

Similar to environmental parameters, there was much variability within participant responses for biological parameters. Species diversity and relative abundance of marine mammals, fishes, invertebrates, and plants were characterized by most participants as not having changed, with the exception of marine mammal relative abundance reported by many as being in decline. Diminishing marine mammal relative abundance was discussed more readily by Elders than non-Elders. Written accounts from the questionnaire (participant voices) yield insight into species in decline, including ringed seal (*Pusa hispida*) and beluga whale (*Delphinapterus leucas*). Lowered ringed seal abundance and condition have been reported in other (Western science-based) biological studies and linked to diminishing sea ice (Harwood et al., 2012; Ferguson et al., 2017). Trends in beluga abundance are less clear for the Eastern Hudson Bay population, with which many belugas harvested by Kinngarmiut are likely associated (Hammill et al., 2017). Reported changes in the taste and texture of some mammals may point to altered diet and/or habitat to adapt to environmental shifts. Unfortunately, this questionnaire did not enable us to determine whether the presence (or abundance) of some marine mammal species can be attributed to the year-round sea ice and open water features associated with strong Hudson Strait currents.

Open-ended questionnaire responses (participant voices) provide more information regarding possible changes in fish diversity and relative abundance, despite the majority of participants citing a lack of change in this parameter. The few reports of increasing species diversity and relative abundance seem to be associated with recent observations of Atlantic salmon (*Salmo salar*), whose distribution is shifting northwards with warming water temperatures (Bilous and Dunmall, 2020; Dunmall et al., 2021). Pink salmon (*Oncorhynchus gorbuscha*) could also begin to be observed in coming years, as it has already been sighted near various communities in Nunavut and Nunavik (McNicholl et al., 2021). The Nunavut Coastal Resource Inventory (NCRI)[27] offers insights into other species discussed in the questionnaire, including cods (*Gadidae*; possibly Atlantic cod,

[27] The Nunavut Coastal Resource Inventory is a Government of Nunavut initiative by the Fisheries and Sealing Division within the Department of Environment (at the time), undertaken annually in different communities since 2007. The NCRI is intended to document the presence, distribution, and characteristics of coastal resources to facilitate their assessment for economic development, coastal management, and conservation. In 2017, nine interviews were conducted on one occasion in Kinngait (Government of Nunavut, 2018), where three interviewees were also participants in this study.

Greenland cod, or polar cod) and sculpins (*Cottidae*; possibly shorthorn sculpin and other sculpin species); however, some lacustrine fishes remain unidentified ('landlocked/freshwater' fishes, or with names known in Inuktitut). Changes in the physical condition of fish, such as skin abnormalities, parasites, and changes in taste and texture reported are a growing concern for community members.

For invertebrate species diversity and relative abundance, participant voices reveal many reports and much community interest in the recent proliferation of mussels, and their distribution into new areas. Based on NCRI findings, these may be blue mussel (*Mytilus edulis*), which were found to have a wide thermal window indicating that populations are highly adapted to Arctic conditions (Thyrring et al., 2019). Habitat heterogeneity and climate change-induced temperature changes may be allowing leading-edge mussels to inhabit new areas that may have previously been lethal. Some participants also reported a decreasing abundance of clams (possibly truncate softshell clam *Mya truncata*, see NCRI) that could be associated with the increase in mussels; however, this may only be occurring in certain areas.

Changes in environmental and biological parameters detailed above are altering harvesting practices. Kinngarmiut are now harvesting some marine mammal species earlier than in previous years, such as beluga whale, which were reported to be migrating earlier. The lessened availability of other mammals such as ringed seal, which are hunted year-round, also render harvesting more challenging. Additionally, fishing is occurring earlier in the spring and summer and later in the winter due to earlier ice breakup and delayed formation, thereby shortening the fishing season.

The unpredictability of weather was emphasized in questionnaire responses, as were the increasingly dangerous conditions for travel and accessing harvesting locations, especially near Hudson Strait currents. These observations echo other studies in Kinngait (see Laidler and Elee, 2008 and Laidler et al., 2010). These conditions have led to greater reliance on alternate routes that follow shoreline contours and areas with thicker ice, which are usually longer and over difficult terrain (Laidler et al., 2010). Environmental and biological changes will continue to challenge harvesting and will require further adaptations by harvesters and community members who rely on key species and habitats. Therefore, additional insight into these changes, and the reverberating impacts on Kinngarmiut, must be explored in order to inform the implementation of both ecological and social adaptive measures.

3.5.2 Future research directions

3.5.2.1 Demographics

Participant representation among gender groups and age categories (Elders and non-Elders) was balanced, yet very few participants had a lifetime of experience (i.e., 75 to 83 years). Future research could be further enriched through greater involvement of Elders with cumulative experience (i.e., those of advanced age), who are recognized and relied upon for their firsthand experiences of change over longer time periods. For several environmental and biological parameters discussed below, disparities in Elder and non-Elder responses can likely be attributed to differing years and experiences on the land. Furthermore, while youth were not involved in this study, there is a growing focus on youth engagement to support the acquisition of land-based knowledge and skills within and beyond Inuit Nunangat, with importance placed on learning from Elders (e.g., Reich et al., 2017; Gérin-Lajoie et al., 2018; Ljubicic et al., 2021; Sadowsky et al., 2022). The participation of youth could prove to be a meaningful path forward should the AHTA be interested and supported in this work.

3.5.2.2 Environmental and biological parameters

The degree to which changes are noticed and how they affect the community is directly linked to local experiences, and is a function of who is using and experiencing these environments, as well as how (e.g., hunting or fishing), where (e.g., location of harvesting sites), and when (e.g., season, year) they are being used or experienced (Laidler et al., 2010). The baseline created in this study could be enriched by insights into differences in experiences and perceptions of change within Elder and non-Elder groups, the factors that contribute to these differences, notable periods of fluctuation that occurred within the broad baselines in this study, and specific locations where changes are prominent. The use of participatory mapping during questionnaire delivery would be helpful in identifying local harvesting sites, migration routes, boat trajectories, and areas where species have been observed. This method is commonly used during interviews (see Chapter 2), which shares similarities with the delivery of questionnaires in this study, to provide specific local context to complement knowledge shared orally (e.g., Fox, 2004; Henri et al., 2018; Martinez-Levasseur et al., 2021). Such flexible approaches could also enable an understanding of species diversity or relative abundance metrics for species that were not discussed during questionnaires (e.g., polar bears, birds)[28]. Future inquiry focused on the impact of these reported environmental and biological changes on Kinngarmiut is also paramount. Community sustenance, livelihoods, and wellbeing (e.g., physical, emotional, spiritual) will continue to be affected by diminishing species condition, abundance, and accessibility. The lessened availability and poorer health of culturally and nutritionally important species, such as ringed seal and Arctic char, may have a disproportionate negative impact on community members (e.g., Rosol et al., 2016; Chila, 2021). These impacts are not limited to harvesters and their families, with others affected through food sharing networks and cultural activities (e.g., making clothing from skins and furs). Furthermore, the economic impacts of high costs associated with gas and equipment, which are exacerbated by the need to take lengthy alternate routes, and the need for different modes of transportation (i.e., the use of boats instead of snowmobiles in the winter due to lack of ice) will also need to be explored. The complexity and multitude of environmental and biological shifts precludes us from discussing all possible impacts of these changes to this community. Continued monitoring will be essential in understanding and facilitating community adaptation to current, expected, and unknown impacts of changes, and will enable trends to be distinguished from underlying variability (Huntington et al., 2004; Salomon et al., 2007).

[28] Species not discussed are an interesting point of reflection that should also be further explored.

3.5.3 Applications

The lack of documentation of Indigenous knowledge is a key limitation to its use in decision-making (Breton-Honeyman et al., 2016). Therefore, a record of environmental and biological changes and community implications will be helpful to the Aiviq HTA and community leaders (e.g., the Hamlet Council) in informing local co-management decisions (e.g., hunting and fishing quotas) or conservation plans, and may also inform planning regarding economic opportunities. These could include ecotourism, or the development of a sustainable, community-led commercial fisheries (e.g., for Arctic char) or shellfish harvesting (e.g., for mussels) that does not jeopardize sustenance harvests (Schott et al., 2020). Questionnaire results can also be used towards the mitigation or prevention of impacts of shipping activities, which are increasing in intensity and frequency with diminishing ice extent and longer ice-free seasons. Kinngarmiut are concerned about the "potential for ships sinking, dumping, noise, and travel through important wildlife areas" (Kelley and Ljubicic, 2012, p. 31). The location of Kinngait on the Hudson Strait places this community on an important shipping route, as the Hudson Strait connects shipping networks in the Labrador Sea with the port of Churchill, Manitoba, and is an alternate Northwest Passage route[29] (Kelley and Ljubicic, 2012). In Kinngait and in many other Nunavut communities, there is heightening concern and urgency regarding shipping impacts associated with Baffinland Iron Mines Corporation's proposed expansion of the Mary River iron ore mine on northern Baffin

[29] The Hudson Strait is the seventh alternate Northwest Passage route, from the Labrador Sea, through the Hudson Strait to Foxe Basin, to Fury and Hecla Strait, and through to the Bering Strait and Bering Sea (Headland, 2010).

Island. Kinngait would be impacted by the development of the Steensby Inlet port, an all-season deep-water port and ship loading facility, and the expected increase in shipping traffic.

In a report on the state of Canada's Arctic oceans, Niemi et al. (2019) stated that "[t]he ongoing collective efforts of scientists and Indigenous peoples have yet to produce holistic knowledge adequate for management of ecosystem-level changes in the Canadian Arctic region" (p. 6). Results from studies such as these may enhance this knowledge base and enable ecosystem management that is undertaken in full conversation with and directly benefits Indigenous communities. For example, with community consent, results may contribute to the identification of Ecologically and Biologically Significant Areas (EBSAs) or the establishment and/or co-management of Marine Protected Areas (MPAs) by Fisheries and Oceans Canada. They may also extend into decisions and policies made by regional and territorial organizations (e.g., Qikiqtani Inuit Association, Nunavut Wildlife Management Board, Government of Nunavut), and other federal organizations (e.g., Environment and Climate Change Canada, Parks Canada, Crown-Indigenous Relations and Northern Affairs Canada).

3.5.4 Importance

The baselines of change reported in this study may address 'patchy' and 'intermittent' baseline (and Western scientific) knowledge of Arctic marine environments (Niemi et al., 2019, p. 6) and freshwater environments (Knopp et al., 2022), as well as fundamental knowledge gaps for several Arctic species (Dey et al., 2018). This study yielded insights into historical ecological conditions that may have been otherwise unattainable (Government of Nunavut, 2018), with experiences and perceptions from community members dating back over 60 years to 1961. The local relevance of this compiled knowledge to Kinngarmiut renders it highly useful to community decision-making and planning surrounding species conservation. This research also provides preliminary insights that may lead to the identification of rare or threatened species, unique habitats, or ecological hotspots. As the year-round presence of both sea ice and open water due to strong Hudson Strait currents may provide habitat for species requiring both features, further research will elucidate whether there may be higher local biodiversity near Kinngait than near coastal communities surrounded by ice year-round.

Furthermore, this research responds to calls for and efforts towards community-researcher partnerships and community-led approaches in research and monitoring that prioritize local interests and support Inuit self-determination[30] (e.g., Tondu et al., 2014; ITK, 2018; Carter et al., 2019; Wong et al., 2020; Held, 2020; Ljubicic et al., 2021; ICC, 2021). Through guidance from the AHTA and collaborations with technicians, local priorities were embedded within this study. Co-development teleconferences and questionnaire delivery by community technicians in response to COVID-19 travel restrictions enabled technicians to enhance existing skillsets, which may also facilitate their engagement in future research and monitoring opportunities (Kouril et al., 2016; Yua et al., 2022). This questionnaire and its results belong to the community of Kinngait, and can thus be used in the manners the Aiviq HTA wishes. While imperfect, these

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[30] Self-determination is the expression of sovereignty; the right to self-government and autonomy in the pursuit of economic, social, and cultural development (United Nations, 2007; Borrows and Rotman, 2018).

methodological decisions bring us closer to ITK's *National Inuit Strategy on Research* priority areas for research with Inuit, including: advancing Inuit governance in research, enhancing the ethical conduct of research, aligning funding with Inuit research priorities, ensuring Inuit access, ownership, and control over data and information, and building capacity for Inuit Nunangat research (ITK, 2018). We emphasize that community ownership, control, access, and possession of knowledge (see OCAP® principles, FNIGC, 2019) must be a central priority in community-led research, yet we also recognize the need for Inuit-guided safeguards and structures to ensure that these principles are upheld, and to protect and limit the sharing of Indigenous knowledge to applications chosen by individual communities.

> "I bet it's going to be helpful for you guys to know about the changes that's going on out there. This is interesting to learn about how people are…[and a]bout the fish and land. We'll learn too from them"
>
> - Sheojuk Peter, community technician and co-author, January 28, 2021

This study was directly intended to document the knowledge of Kinngarmiut, which is critically important in its own right. Through questionnaire results, and meetings with the AHTA, it became very clear that the questionnaire will serve as a valuable record of their knowledge for younger generations, and that "[f]or future of our descendants this will be useful" (P17). Several AHTA Board members shared that this baseline will enable comparisons in coming years. Moreover, there is community interest in further research on the topics of environmental and biodiversity change, with participants sharing: "[t]here is too much we don't know about the ocean" (P43), "I have too much to tell and not enough time" (P20), and "keep surveying, keep surveying, keep surveying" (P1). In March 2022, co-author and community technician O. Manning informed AD and LC that she still receives questions about the questionnaire, one year after it was delivered. Based on discussions with community technicians and with the AHTA throughout the project, this study was enabled by the strong interests of community technicians in learning from knowledge holders (see quote above), and in mutual learning between the research team and the Aiviq HTA, as iterated by an AHTA Board member : "…in the future we want more meetings because I think we can learn from each other, from your side and our side, so we want to thank you for having a meeting with us" (pers. comm., March 8, 2022).

3.6 Conclusion

While Inuit have historically adapted to changes in their environment and species distribution, climate change and increased development are shaping the Arctic in unprecedented ways. Through a partnership between a research team and the Aiviq HTA in Kinngait, Nunavut, this study compiled and documented Indigenous knowledge of coastal, marine, and lacustrine environmental and biodiversity change using a questionnaire. This questionnaire was co-developed with community technicians and delivered remotely due to the COVID-19 pandemic. As this process was completed under the guidance of the AHTA, this study reflects community priorities and interests, and results will serve as a baseline of change for current and future generations. These results may be used by the community to inform local and regional decision-making and planning, and on a broader scale, contribute to filling prominent Arctic ecological knowledge gaps. While undertaken to directly benefit Kinngarmiut, this study also contributes to centering Indigenous voices and experiences of change in environmental research, and is part of a transition in how research is conducted within Inuit Nunangat.

3.7 Acknowledgements

We gratefully acknowledge the guidance and support of the Aiviq Hunters and Trappers Association in Kinngait, Nunavut, and the assistance and knowledge shared by community technicians Ooloosie Manning, Sheojuk Peter, and Pudloo Qiatsuq. We thank Annie Suvega and Mialisa Nuna at the AHTA, the knowledge holders who shared their time and experience through questionnaires: Kavavaok Pootoogook, Etusaju Kingwatsiak, Taqialuk Nuna, Atsiaq Alassuaq, Kovianaktuk Pudlat, Stephen Faichney, Eleesusie Parr, Sarah Oshutsiaq, Elisapee Samayualie Pudlat, and thirty participants who chose to remain anonymous. We also thank Dr. Jacqueline Chapman for providing input during the creation of the initial questionnaire, Darcy McNicholl for contributing to the Arctic Coast program, and Adam Perkovic for assisting during questionnaire co-development. This research was completed from the unceded, traditional territory of Algonquin Anishinaabe Peoples in Ottawa, Ontario, and Treaty No. 1 Territory in the traditional lands of the Anishinaabe, Ininew, Oji-Cree, Dene, and Dakota, and the homeland of the Métis Nation in Winnipeg, Manitoba. This project was funded by Fisheries and Oceans Canada (Results Fund).

Chapter 4. General Discussion

4.1 Summary

This thesis flows into an ever developing and transforming discourse centering Indigenous Peoples, communities, and ways of knowing to holistically address environmental issues in marine and freshwater ecosystems. Specifically, I draw upon and come into conversation with a body of research that recognizes that bringing together Indigenous and Western sciences, and applying their differences as strengths, can enhance ecological conservation "for the benefit of all" (Bartlett et al., 2012, p. 335). My research responds to the still unrealized potential of weaving together Indigenous and Western sciences to enhance our collective understanding of Arctic ecosystem processes (Huntington et al., 2004; Johnson et al., 2016). Insights from both research chapters make important contributions to facilitating meaningful partnerships, and to filling prevalent Arctic aquatic ecology knowledge gaps (e.g., Dey et al., 2018; Niemi et al., 2019).

In Chapter 2, under the guidance and with the support of my co-authors, I led a process to elucidate the practices of weaving Indigenous and Western sciences through a systematic realist review of coastal and marine research and monitoring across Inuit Nunangat. I identified and explored three decision points that shape projects co-developed by researchers and Inuit communities (research objectives, method bundles, method sequencing). I drew upon example case studies from this review to walk readers through a few possible applications of these decision points. In doing so, I highlighted the diversity of research pathways available to researchers and Indigenous communities, and demonstrated that weaving does not need to be a complicated endeavour. However, I emphasize that the operationalization of weaving has both technical and relational facets, and thus necessitates researcher reflections and guidance by Indigenous Peoples. This chapter contributes to ongoing cross-cultural and intersectional processes and partnerships.

In Chapter 3, through a partnership with the Aiviq Hunters and Trappers Association in Kinngait, Nunavut, I compiled and documented Indigenous knowledge of environmental and biodiversity change in coastal, marine, and lacustrine ecosystems near this community. Remote teleconferences with community technicians enabled the co-development and delivery of a questionnaire to recognized knowledge holders. Questionnaire results revealed variable responses regarding environmental parameters; turbidity, erosion, and swells/waves may not have greatly changed, water temperature and wind may be changing, and sea and lake ice are near-unanimously diminishing. While most biological parameters were reported not to be changing, participants cited declines in the abundance of marine mammals (especially ringed seal and beluga whale), the appearance of a fish species (salmon), and the rapid proliferation of an invertebrate (mussels). Many participants shared that shifts in the environment and in the availability and accessibility of species are altering the timing of harvesting, and rendering travel more difficult and dangerous. As articulated by the AHTA, this research will serve as a community record and baseline of change for future generations. Results may be used by the community to inform local and regional decision-making and planning regarding conservation or economic opportunities, and on a broader scale, contributes to filling prominent Arctic ecological knowledge gaps. This study centers Indigenous experiences of change in environmental research, and is part of a transition in how research is conducted in Inuit Nunangat.

4.2 Thesis story and title

The title chosen for this thesis *Moving forward together: Weaving Indigenous and Western sciences with practices and peoples in aquatic research in Inuit Nunangat* represents key parts of the story I convey.

'Moving forward' speaks to the need for change in so-called Canada that is guided by Indigenous Peoples. Many Inuit individuals, communities, and organizations have contributed to defining and characterizing a meaningful path forward in Arctic research. This timely thesis is written in awareness of and enacts some of these calls to action and good practices. It is now universally understood that 'moving forward' also entails decolonization (see Smith, 1999; Tuck and Yang, 2012; Held, 2019; Liboiron, 2021; Goodchild, 2021) and reconciliation (see TRC, 2015; McGregor, 2018; Wong et al., 2020). While I do not speak directly about how this thesis contributes to decolonization and reconciliation, it serves as a small contribution to this pathway. Further reflection and conversations are required to understand links between my thesis and these topics.

'Together' speaks to the importance of partnerships in addressing complex challenges (i.e., climate change, development) through shared conservation and research objectives. By consolidating and presenting key methods and considerations in researcher-community partnerships in Chapter 2, I support other researchers in pursuing collaborative projects. In this chapter, I emphasize that weaving is not solely a technical endeavour, but also a relational one (in other words, I feel that it's not just 'let's figure out how to do it better', it's 'let's figure out how to be better when we do it'). Chapter 3 puts this concept and key methods introduced in the previous chapter into action, and allows for the direct application of Inuit-offered guidelines and good practices through the guidance of the AHTA. In doing so, we (the DFO research team and community of Kinngait) were able to 'move forward, together', despite the onset of the COVID-19 pandemic and associated travel restrictions. Thus, this chapter also serves as a key example of a 'successful'[31] remote collaboration with a northern community that will contribute to forthcoming literature discussing pandemic research adaptations (see Christie et al., submitted for additional details regarding remote questionnaire co-development).

'Weaving Indigenous and Western sciences' describes both the processes and outcomes of respectful research partnerships, and involves applying the strengths of different ways of knowing. Chapter 2 reviews weaving undertaken in previous research to guide future weaving endeavours. Chapter 3 involves elements of weaving, in which the Western ways of knowing brought forth by myself and the DFO research team meet Indigenous ways of knowing, and I have sought to summarize, present, and amplify the latter. This chapter serves as an example of a study in which Indigenous scientific knowledge stands alone with the same, or more, integrity and rigour as Western science, which is still uncommon due to the pervasive issue of Indigenous sciences being reported

[31] I recognize that 'success' is subjective.

solely if results align with Western data (Kimmerer, 2013b; Mistry and Berardi, 2016; Wheeler and Root-Bernstein, 2020; Wheeler et al., 2020; Reid et al., 2021).

As I touched on above, this thesis focuses largely on the ‘practices’ that enable researchers and Indigenous communities to weave sciences in partnership, with Chapter 2 deconstructing the application of different methods (i.e., which methods are woven, and how they are woven). The acknowledgement that we (the research community) need to weave sciences, yet most people do not know how, has only recently begun to be discussed in literature. In Chapter 3, I intentionally included a detailed account of the practices that led to and enabled the partnership between the DFO team and the AHTA and technicians in Kinngait. Reporting these practices is critical to transparency and ethical research, and I consider these steps (e.g., initiation, co-development, knowledge verification) to be as important as the research outcomes, in alignment with the work of many influential Indigenous and non-Indigenous scholars. This chapter may influence the research approaches of others as they seek to work in partnership with communities on similar projects, and help to normalize and encourage more detailed reporting practices.

An underlying theme is the importance of collaborating ‘with peoples’, as neither chapter would be possible without the strong interest of Indigenous community partners. In Chapter 3, interactions with community technicians and the AHTA were characterized by mutual learning and openness. Part of these partnerships also involves ensuring there is benefit for community partners, an understanding of their priorities (both research and otherwise), and support provided to facilitate collaborative work. These considerations were embedded into reporting practices (discussed above), and thus center people in research and monitoring narratives. This chapter is part of an important shift in placing relationships before research priorities.

Lastly, as discussed earlier in this thesis, I focus on 'aquatic research' because coastal and marine environments are inextricably linked to the ways of knowing and being of Inuit communities across Inuit Nunangat. The rapid change in these ecosystems, which are vitally important to community wellbeing, render this a priority research area now and in the future. Both chapters contribute to informing further Arctic aquatic research and monitoring, with Chapter 3 offering specific insight into marine and lacustrine environmental and biological changes as well as their implications for the community of Kinngait, Nunavut.

4.3 Chapter 3-specific directions

As this research chapter is part of a larger joint initiative between the Fisheries and Oceans Canada team and the community of Kinngait, situating this study in a broader context can be helpful. A community-led coastal monitoring program (briefly mentioned in Chapter 3) assessing baseline environmental conditions in the ocean (in winter and summer months) and in lakes (only in winter months) has been in place since late 2019. A team of researchers with DFO has worked closely with a team of community field technicians under the guidance of the AHTA for this program, which consists of: water temperature and salinity data collection, ice and snow thickness measurements, the use of time-lapse cameras to assess ice conditions, benthic cameras to record the benthic environment, ponar grabs to identify substrate types and benthic invertebrates, and plankton tows for water column species identification. Fish sampling to understand diet is also a key component of this program.

In the future, the DFO research team intends to weave together the outcomes of the Indigenous knowledge questionnaire and the coastal monitoring program with the community of Kinngait. Insights from both programs can improve understanding of community structure and population parameters within each trophic group, our grasp of trophic processes, and can help contextualize indicators of ecosystem integrity and environmental variation (Ehrman et al., in press). While the Indigenous knowledge study provided preliminary insights into species distribution and habitat use, connectivities within and between environmental and biological phenomena, and pointed to potential causes of these phenomena, these areas can be further explored when woven with coastal monitoring data. In the future, it will be necessary to disentangle the relative roles of species in maintaining ecosystem integrity, and their ability to adapt to change (Ban et al., 2018; Niemi et al., 2019). When bringing these projects together, it will be important to consider that Indigenous knowledge often deems environmental parameters to be in a more dire state than suggested by Western science (e.g., Mantyka-Pringle et al., 2017; Abu et al., 2020). This can be attributed to the ability of Indigenous knowledge to capture any departure from a past known state (i.e., the relative nature of change), whereas Western science relies upon objective thresholds of concern (Mantyka-Pringle et al., 2017; Reid et al., 2021). These differences can be informative, as they can enable early detection of ecological change, and a more complete understanding of complex systems (Berkes, 2018).

4.4 Application misalignment

The Inuit Tapiriit Kanatami *National Inuit Strategy on Research* "envisions research being utilized as a building block for strong public policies, programs, and initiatives that support optimal outcomes for Inuit" (ITK, 2018, p. 3). Yet, there remains a misalignment between the high value placed on Indigenous sciences and their comparably infrequent usage in wildlife conservation and management (Henri et al., 2020; Kadykalo et al., 2021). Wheeler et al. (2020) similarly identified that collaboration and co-production often leads to research results; however, "these often did not translate to an impact on or involvement in decision-making" (p. 549). While there are several contributing factors (e.g., knowledge exchange and mobilization difficulties, see Nguyen et al., 2017), positioning communities as leaders in the research process can help rectify this misalignment, and can be an expression of Indigenous governance (Pecl et al., 2017; Morton Ninomiya and Pollock, 2017; Wilson et al., 2018). This self-governance can extend into co-management, policy-making, and decision-making structures that support learning and are grounded in and embed Indigenous knowledges (Rathwell et al., 2015; Wheeler et al., 2020; Alexander et al., 2021). Such change can enhance the applicability of and community support for outputs derived directly from research, and limit the potential for decontextualization or compartmentalization of Indigenous sciences (Ford et al., 2010; Grimwood et al., 2012; Wong et al., 2017; Henri et al., 2020). We emphasize that this process begins at the community level, which can lead to highly relevant social-ecological insights that can be used to strengthen community mitigation and adaptation efforts.

4.5 Ongoing and critical considerations

Many authors (e.g., Fox, 2004; Pearce et al., 2009; Huntington et al., 2011; Castleden et al., 2012; Tondu et al., 2014; Carter et al., 2019; Ferrazzi et al., 2019; Pedersen et al., 2020; Chapman and Schott, 2020; Held, 2020; Wilson et al., 2020; Ljubicic et al., 2021) and institutions (e.g., ACUNS, 2003; ITK and NRI, 2006; NAHO, 2011; ITK, 2018; CIHR et al., 2018; ICC, 2021) have contributed to ongoing conversations regarding good practices in community engagement in northern regions. However, there is no consistent system or structure to hold researchers accountable to Indigenous communities, resulting in "the onus [being] placed on researchers to understand and put principles into practice in their intended ways, and for Indigenous communities to know and assert their rights, as well as invest their own time in holding researchers and academic institutions accountable" (Morton Ninomiya and Pollock, 2017, p. 32). I identify several 'next step' areas for continued reflection in Indigenous community engagement, many of which are considered articulations of Indigenous methodologies (Wilson, 2008; Grimwood et al., 2012). As I am a settler, these sections are written and limited by my own (growing) understanding of these concepts.

4.5.1 Relational accountability and Ethical Space

A recurrent theme in my thesis has been relationship-building when research and monitoring are conducted within Inuit homelands. This is particularly important as "it cannot be taken for granted that researchers or research institutions know how to be relational or support relational approaches" (Morton Ninomiya and Pollock, 2017, p. 35). Wilson (2008) explains that relational accountability "means that the methodology needs to be based in a community context (be relational) and has to demonstrate respect, reciprocity and responsibility (be accountable as it is put into action)" (p. 99)[32]. Latulippe (2015) explains that relational accountability first requires "reflexive self-study", which includes "reflection on self-location, purpose, and sources of knowledge" (p. 6). Relational accountability holds researchers responsible to participants and their communities throughout the research process (Latulippe, 2015; Reich et al., 2017; McGregor et al., 2018; Held, 2019, 2020), which includes choice of research topic, data collection and analysis methods, and the presentation of findings (Wilson, 2008). The return of research results to communities, and the accessibility of these findings (e.g., through plain language, visual graphics) are a critically important extension of this accountability at later stages of a research process (Grimwood et al., 2012; Reich et al., 2017; Morton Ninomiya and Pollock, 2017).

Relational accountability in research can contribute to creating an Ethical Space[33] of engagement (Held, 2019; Goodchild, 2021), which was first described by Willie Ermine as a "place between [contrasting] worldviews" which "opens up the possibility for configuring new models of research and knowledge production that [are] mutually developed through negotiation and respect in cross-cultural interaction" (Ermine, 2000, p. v). Littlechild et al. (in preparation) consider an Ethical Space to be one of dynamism that centers Indigenous systems, invites co-creation, and is characterized by discomfort and

[32] Wilson (2008) echoes the four Rs of working in Indigenous contexts (respect, relevance, reciprocity, and responsibility) introduced by Kirkness and Barnhardt (1991), to which Restoule (2008) added a fifth principle (relationships).

[33] This term is capitalized to distinguish Ethical Space as a concept with specific meaning rather than as an adjective describing a space that is ethical, in alignment with Littlechild and Sutherland (2021) and Littlechild et al. (in preparation).

reflexivity. This concept is present in Inuit-specific contexts, with Tester and Irniq (2008) explaining that "IQ [Inuit Qaujimajatuqangit], by definition, should be identified as a space, a context within which respectful dialogue, discussion, questioning, and listening can take place" (p. 58). Moreover, as described in Chapter 2, McGrath (2012) introduced the *Qaggiq* Model based upon a *Qaggiq iglu*, a communal *iglu* and gathering place. This conceptual space enables dialogue among Indigenous Peoples, where non-Indigenous researchers "can listen, experience and observe…so that they understand more clearly what they need to support" (p. 252), and to whom they are accountable. McGrath (2012) also emphasizes that "Inuk[tut] epistemology is fundamentally relational…therefore knowledge is renewed upon *the renewal and support of relationships*" (emphasis in original, p. 119). These concepts can help orient researchers and research projects, and are continuously being explored and built upon (e.g., Ljubicic et al., 2021; Littlechild et al., in preparation).

4.5.2 Participant representation

As briefly discussed in Chapter 2 and 3, it is critical to consider which participant voices are represented in research (Hitomi and Loring, 2018; Mosurska and Ford, 2020), as knowledge can differentially affect certain groups (Agrawal, 1995), as well as who benefits from research partnerships (Sadowsky et al., 2022). In northern research, there is disproportionate representation of male Elders who are typically hunters, fishers, or trappers, while women and youth are frequently underrepresented (Hitomi and Loring, 2018). Yet, women hold a wealth of knowledge relating specifically to species health and condition gained through practices such as processing and preparing country food, or harvesting berries and medicines (Ohmagari and Berkes, 1997). Comparatively, there has been much focus on youth engagement, often with Elders, to support the acquisition of land-based knowledge and skills (Gérin-Lajoie et al., 2018; Ljubicic et al., 2021; Sadowsky et al., 2022). These processes of learning and transforming experiences into knowledge are vital to the continuous evolution of Indigenous knowledge systems and indeed, to Inuit culture and identity (Simpson, 2004). Relevant and enjoyable activities (e.g., land camps) that empower and recognize the capabilities of youth, but retain an awareness of community contexts (i.e., of supports that may or may not be available), can help enhance scientific literacy and strengthen relationships with researchers (Reich et al., 2017; Gérin-Lajoie et al., 2018; Wong et al., 2020; Pedersen et al., 2020; Ljubicic et al., 2021; Sadowsky et al., 2022). This is one way that Indigenous sciences can extend beyond utilitarian discourses to reinforce Indigenous cultural systems (Battiste, 2000).

At the same time, addressing the underrepresentation of community groups is complex, as it is paramount to respect a community's right to identify their knowledge holders, representatives, and leaders (Hitomi and Loring, 2018). Referencing Kuokkanen (2012), Hitomi and Loring (2018) caution that "proactively seeking the inclusion of women and youth in these studies, [may] touch on tensions between…interference and self-determination" (p. 840). Guta et al. (2013) also raise the important point that while many participants are grateful to have been involved in projects that build capacity through community participation, they may feel misled if they were unaware of this intent. This could be resolved by clear communication about community learning objectives at the project onset, and efforts to shape research programs accordingly. Moreover, researchers should recall that not all community members may have an interest in or ability to access or participate in research endeavours (David-Chavez and Gavin, 2018). The considerable time commitment and effort often required for community engagement in collaborative ventures render it necessary for researchers to remain aware of demands placed on community members to avoid evoking research fatigue (Loucks et al., 2017).

4.5.3 Data sovereignty

The Inuit Circumpolar Council (ICC) *Ethical and Equitable Engagement Synthesis Report* (2021) states that:

> "Sharing our knowledge in decision making processes is important, but others must recognize that this knowledge collectively belongs to us, is ours to demonstrate, apply, assess, and interpret, and that we must be able to determine how our knowledge is compiled, validated, used, understood, and stored" (p. 18).

Upholding Indigenous data (or knowledge) sovereignty, defined as "managing information in a way that is consistent with the laws, practices and customs of the nation-state in which it is located" (Snipp, 2016, p. 39) is a growing concern due to the greater recognition of Indigenous sciences in strengthening decision-making (FNIGC, 2019; ICC, 2021). This enhanced role of Indigenous sciences can lead to appropriation and misuse of knowledge that may further marginalize knowledge holders (Brook and McLachlan, 2005; Kimmerer, 2013b; ICC, 2021). While organizations provide suggested protocols and guidelines, there lacks standards and agreements that hold researchers accountable when engaging with Indigenous sciences (ITK, 2018), and the ICC writes that "there are serious concerns about continuing to share our knowledge until the proper guidelines and protocols can be developed and agreed upon. These guidelines must address the misconceptions about, and misconduct in, engagement with our knowledge" (2021, p. 18). Accordingly, this topic is highly relevant to both research chapters in this thesis.

Guidelines have been provided by the Nunavut Research Institute and Inuit Tapiriit Kanatami through a joint report discussing concerns surrounding the generalization, decontextualization, and inaccessibility (i.e., storage location) of Inuit sciences (NRI and ITK, 2006). In their 2018 *National Inuit Strategy on Research*, Inuit Tapiriit Kanatami highlighted the efforts by other countries (New Zealand, Australia, United States) to create Indigenous data sovereignty networks, while it appears that development of such protocols is much slower in Canada (ITK, 2018). Other guidelines include the OCAP® principles of ownership, control, access, and possession (FNIGC, 2019) developed in 1998, and Chapter 9 of the *Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans* emphasizing consent regarding access to and use of information (CIHR et al., 2018). The recent Inuit Circumpolar Council *Ethical and Equitable Engagement Synthesis Report* goes further by illuminating the strong link between security and longevity of Indigenous sciences and Indigenous self-determination and self-governance (ICC, 2021). This context highlights the critical importance and urgent need for structures and protocols to ensure the sovereignty of Indigenous sciences.

I recognize that Indigenous sovereignty over uses of knowledges is heavily influenced by power differentials, and the inherent issue that Indigenous Peoples are infrequently seen as experts of themselves (Wheeler et al., 2020; Hayward et al., 2021; Yua et al., 2022; Hernandez, 2022). Chapman and Schott (2020) explain that "unequal power dynamics often force TK holders to make difficult decisions regarding the sharing of their knowledge as they decide whether or not they are willing to risk having their knowledge misused and appropriated by the dominant actors, or be left out of the process [altogether]" (p. 932). Research can also entrench positions of power (Nadasdy, 1999; Brook and McLachlan, 2005; Latulippe, 2015; McGregor et al., 2018; Wheeler et al., 2020; Yua et al., 2022). This can occur when researchers seek to fill knowledge gaps through the weaving of sciences; this process must not transform or subsume Indigenous sciences into Western science (Abu et al., 2020). Disregard for asymmetries can strongly impact research findings and cause lasting harm to Indigenous communities if scientific knowledge is translated, decontextualized, or manipulated to conform to Western discourses (McDowell et al., 2016). A shift in power (i.e., who holds knowledge, who decides what knowledge is 'valid') in research and monitoring is essential to address these complex difficulties (Wong et al., 2020; Thompson et al., 2020; Hayward et al., 2021).

4.6 Final reflection

In collaborative contexts that amplify Indigenous voices, there are possibilities for the conservation and renewal of reciprocity and relationships between Indigenous and settler peoples and their environments (Kimmerer, 2013a; Tang and Gavin, 2016; Fox et al., 2017; Castleden et al., 2017b; McGregor et al., 2018; Greenwood and Lindsay, 2019). There is, however, a need to draw upon Indigenous methods and ways of knowing in a manner that extends beyond the compilation and documentation of Indigenous sciences to prevent further loss and degradation of sciences in Indigenous communities (Tang and Gavin, 2016) and to allow for community healing (Drawson et al., 2017). Mi'kmaq scholar Battiste (2000), and Yup'ik scholar Kawagley (1990) have identified that weaving Indigenous and Western sciences, and examining the worldviews, ontologies, epistemologies, axiologies, and methodologies that underpin these knowledge systems (see Reid et al., 2021) can be a pathway towards self-determination in spaces in which reciprocal and ethical community engagement is undertaken. When a bridge is built that brings together different sciences, practices, and peoples, "the landscape is inevitably altered - on each side of the bridge…" (McGrath, 2012, p. 103). In *Research is Ceremony* (2008), Opaskwayak Cree scholar Dr. Shawn Wilson echoes this truth by quoting a friend who said, "If research doesn't change you as a person, then you aren't doing it right" (p. 83). Although I cannot truly know if I did this 'right', I do know that I am changed, and will continue to be changed by the places and peoples I encounter next.

Appendices

Appendix A (associated with Chapter 2)

A.1 Case studies dataset from Alexander et al. (2019)
Please use the hyperlink to access this Excel file.

A.2 Case studies associated with research objectives

Table A.2 Research objectives and corresponding case studies, where some case studies repeat across research objective categories.

Research objective		Case studies
Species ecology	Natural history	Finley, 2001
	Identification of habitat	Wheeler et al., 2012 Paulic et al., 2014
	Distribution, movement, range, sightings	Westdal et al., 2010 Kowalchuk, 2010 Higdon and Ferguson, 2011 Brewster et al., 2016 Gélinas, 2016 Loseto et al., 2018
	Feeding ecology	Ferguson et al., 2012 Gélinas, 2016 Loseto et al., 2018
	Health and disease	Pellerin and Grondin, 1998 Iverson et al., 2016 Henri et al., 2018 Loseto et al., 2018 Ostertag et al., 2018
	Population status and trends	Mallory et al., 2003 York et al., 2016
Document and understand environmental change		Fox, 2004 Meier et al., 2006
Harvest patterns and use		Usher, 2002 Higdon, 2010
Mobility of environmental pollutants		Carmack and Macdonald, 2008
Research practices		Mallory et al., 2006 Gearheard et al., 2010 Huntington et al., 2011 Dunmall and Reist, 2018

A.3 Component method bundles (appear in two or more case studies)

Please use the hyperlink to access this Excel file.

A.4 Case studies associated with method sequences

Table A.4 Indigenous science (IS) and Western science (WS) method sequences and the case studies in which they appear.

Sequence	Description		Case studies
1	Interactions between IS and WS are cyclical, and the sciences build off each other		Carmack and Macdonald, 2008 Gearheard et al., 2010
2	IS followed by WS (sequential)	IS informed WS	Huntington et al., 2011 Iverson et al., 2016 Dunmall and Reist, 2018
		IS did not inform WS	Mallory et al., 2003
3	WS followed by IS (sequential)	WS informed IS	Ferguson et al., 2012 Gélinas, 2016 Brewster et al., 2016 Ostertag et al., 2018
		WS did not inform IS	Pellerin and Grondin, 1998
		WS verified using IS	Wheeler et al., 2012 York et al., 2016
4	IS and WS conducted concurrently	For a more complete understanding	Fox, 2004[a] Meier et al., 2006 Westdal et al., 2010 Higdon and Ferguson, 2011
		To compare sciences	Fox, 2004[a] Kowalchuk, 2010
		To support the other science[b]	Henri et al., 2018
		One science shaped the other[c]	Mallory et al., 2006
5	Document reviews for IS and WS		Finley, 2001 Usher, 2002 Higdon, 2010 Paulic et al., 2014 Loseto et al., 2018

[a] This author used Indigenous and Western sciences separately to form a more complete understanding, and for comparison purposes

Appendix B (associated with Chapter 3)

B.1 Questionnaire (English)

Questionnaire #

Kinngait Coastal Biodiversity Questionnaire:
Arctic Coast Local Knowledge Component

Introduction

Climate change is altering habitats, fish distributions, and ecosystems in the Canadian Arctic. The goal of this research is to document biodiversity and environmental conditions of coastal ecosystems in the Hudson Bay Complex and understand how those have changed over time. Our objective is to collaborate with the community to document local knowledge regarding biodiversity and environmental conditions near Kinngait and build upon ongoing community-led research. This knowledge will provide a broader understanding of the coastal ecosystem and will help to monitor rapid coastal change in order to assist the communities in preparing for the future.

The questions below categorize the environment into three sections - lakes, coast (the shoreline out to low tide), and the ocean (beyond the low tide line, open water).

When answering this questionnaire, we want you to think about areas that are near your community.

Section 1: Information about respondent

1) What is your gender?

☐ Male ☐ Female ☐ Other_____________ ☐ Prefer not to answer

2) What is your age? ____________________ years

3) How long have you lived in Kinngait? ____________ years

4) What is your current employment status?

☐ Full time ☐ Part time ☐ Seasonal (you may not work in the winter)

☐ Retired ☐ Unemployed ☐ Student ☐ Prefer not to answer

1

Section 2: Changes to the ocean

5) Have you noticed changes in the ocean? This is the area beyond low tide where there is open water. ☐ Yes ☐ No ☐ Not sure ☐ Prefer not to answer

6) What changes have you noticed in the ocean in your lifetime? If there was a change, approximately how many years ago did you notice this change?

Water temperature	☐ Increasing ☐ Decreasing ☐ No change	____ years
Wind	☐ Increasing ☐ Decreasing ☐ No change	____ years
Swells	☐ Increasing ☐ Decreasing ☐ No change	____ years
<u>Sea ice</u>: Area covered by ice Thickness Quality Timing of ice break up in spring Timing of ice formation in fall	 ☐ No change ☐ More ice ☐ Less ice ☐ No change ☐ Thicker ☐ Thinner ☐ No change ☐ Change ☐ ________ ☐ No change ☐ Earlier ☐ Later ☐ No change ☐ Earlier ☐ Later	____ years
<u>Marine fishes</u>: Numbers Types	 ☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of fish ☐ Fewer kinds of fish	 ____ years ____ years
<u>Marine mammals</u>: Numbers Types of marine mammals	 ☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of mammals ☐ Fewer kinds of mammals	 ____ years ____ years
<u>Invertebrates</u>: Numbers Types (e.g., clams, crabs)	 ☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of invertebrates ☐ Fewer kinds of invertebrates	 ____ years ____ years
Other changes you have noticed in the ocean, or additional comments:		

Section 3: Changes to the coast

7) Have you noticed changes to the coast? This is the area from the shore to the low tide zone. ☐ Yes ☐ No ☐ Not sure ☐ Prefer not to answer

8) What changes have you noticed to the coast in your lifetime? If there was a change, approximately how many years ago did you notice this change?

Water Temperature	☐ Increasing ☐ Decreasing ☐ No change	____ years
Wind	☐ Increasing ☐ Decreasing ☐ No change	____ years
Swells	☐ Increasing ☐ Decreasing ☐ No change	____ years
Erosion	☐ Increasing ☐ Decreasing ☐ No change	____ years
Marine fishes: Numbers Types	☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of fish ☐ Fewer kinds of fish	____ years ____ years
Marine mammals: Numbers Types	☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of marine mammals ☐ Fewer kinds of marine mammals	____ years ____ years
Invertebrates: Numbers Types	☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of invertebrates ☐ Fewer kinds of invertebrates	____ years ____ years
Types of plants (e.g., seaweed)	☐ No change ☐ New kinds of plants ☐ Fewer kinds of plants	____ years
Other changes you have noticed to the coast, or additional comments:		

Section 4: Changes to lakes

9) Have you noticed changes in lakes?

☐ Yes ☐ No ☐ Not sure ☐ Prefer not to answer

10) What changes have you noticed in lakes in your lifetime? If there was a change, approximately how many years ago did you notice this change?

Water Temperature	☐ Increasing ☐ Decreasing ☐ No change	____ years
Wind	☐ Increasing ☐ Decreasing ☐ No change	____ years
Waves	☐ Increasing ☐ Decreasing ☐ No change	____ years
Water clarity	☐ More clear ☐ Less clear ☐ No change	____ years
Lake ice: Area covered by ice Thickness Quality Timing of break up in spring Timing of formation in fall	 ☐ No change ☐ More ice ☐ Less ice ☐ No change ☐ Thicker ☐ Thinner ☐ No change ☐ Change ☐ ___________ ☐ No change ☐ Earlier ☐ Later ☐ No change ☐ Earlier ☐ Later	____ years
Freshwater fishes: Numbers Types	 ☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of fish ☐ Fewer kinds of fish	____ years ____ years
Invertebrates: Numbers Types	 ☐ No change ☐ Increasing ☐ Decreasing ☐ No change ☐ New kinds of invertebrates ☐ Fewer kinds of invertebrates	____ years ____ years
Other changes you have noticed to lakes or additional comments:		

Section 5: Animals

Hunting and Fishing

11) Do you go fishing, hunting for marine mammals, or both?
☐ Hunting ☐ Fishing ☐ Both ☐ Neither ☐ Prefer not to answer

12) Please select ALL the areas that you hunt for marine mammals and / or fish:
☐ Ocean ☐ Coast ☐ Lake ☐ River ☐ Prefer not to answer

13) How many years have you been hunting and / or fishing? ________ years
☐ N/A ☐ Prefer not to answer

14) If you do not currently hunt or fish, have you been hunting or fishing in the past?
☐ Yes ☐ No ☐ Prefer not to answer

15) If you do not go hunting or fishing yourself, does a member of your household go hunting or fishing? ☐ Yes ☐ No ☐ Prefer not to answer

16) How often do you go out on the land to hunt and / or fish?

Winter	☐ Daily	☐ Weekly	☐ Monthly	☐ Once a season	☐ Never	☐ Prefer not to answer
Spring	☐ Daily	☐ Weekly	☐ Monthly	☐ Once a season	☐ Never	☐ Prefer not to answer
Summer	☐ Daily	☐ Weekly	☐ Monthly	☐ Once a season	☐ Never	☐ Prefer not to answer
Fall	☐ Daily	☐ Weekly	☐ Monthly	☐ Once a season	☐ Never	☐ Prefer not to answer

17) Has the timing of when you hunt and / or fish changed?

Winter	☐ Earlier	☐ Later	☐ No change	☐ Not sure	☐ Prefer not to answer
Spring	☐ Earlier	☐ Later	☐ No change	☐ Not sure	☐ Prefer not to answer
Summer	☐ Earlier	☐ Later	☐ No change	☐ Not sure	☐ Prefer not to answer
Fall	☐ Earlier	☐ Later	☐ No change	☐ Not sure	☐ Prefer not to answer

Additional comments about hunting and fishing:

Specific Animal Questions

18) We would like to ask you questions related to the animals that you hunt and / or fish for:

Animal (please write on line)	How **often** do you go out to hunt or fish for this animal?	During which **season(s)** do you go out to hunt or fish for this animal?	Have you noticed changes in the **number** of this animal?	Have you noticed changes in **when** you see or catch them?	Have you noticed changes to **where** you see, or catch them?
Most frequently harvested **marine mammal**: ____________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No
Second most frequently harvested **marine mammal**: ____________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No

Most frequently harvested **marine fish**: ______________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No
Second most frequently harvested **marine fish**: ______________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No
Most frequently harvested **freshwater fish**: ______________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No
Second most frequently harvested **freshwater fish**: ______________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No
Most frequently harvested **invertebrate**: ______________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No
Second most frequently harvested **invertebrate**: ______________	☐ Daily ☐ Weekly ☐ Monthly ☐ Once a season	☐ Spring ☐ Summer ☐ Winter ☐ Fall	☐ More ☐ Less ☐ No change	☐ Earlier ☐ Later ☐ No change	☐ Yes ☐ No

Additional comments about specific animals questions:

19) What changes have you noticed to the condition of marine mammals, marine fishes, and freshwater fishes?

Marine mammals	☐ Size ☐ Diet ☐ Meat quality ☐ Colour ☐ Texture ☐ Taste ☐ Parasites ☐ Appearance ☐ Smell ☐ Scars ☐ Indications of disease (tumours, lesions) ☐ Other ______________ ☐ No change ☐ Prefer not to answer
Marine fishes	☐ Size ☐ Diet ☐ Meat quality ☐ Colour ☐ Texture ☐ Taste ☐ Parasites ☐ Appearance ☐ Smell ☐ Scars ☐ Indications of disease (tumours, lesions) ☐ Other ______________ ☐ No change ☐ Prefer not to answer
Freshwater fishes	☐ Size ☐ Diet ☐ Meat quality ☐ Colour ☐ Texture ☐ Taste ☐ Parasites ☐ Appearance ☐ Smell ☐ Scars ☐ Indications of disease (tumours, lesions) ☐ Other ______________ ☐ No change ☐ Prefer not to answer
Please describe changes in condition in detail:	

Section 6: General Community Concerns

20) Please answer the following questions thinking about the animals and environment around your community, and how you feel.

The questions are divided into three sections – ocean (beyond the low tide line), coast (the shoreline out to low tide), and lakes.

	Do you have concerns about this area?	If yes, what are you concerned about when thinking about these areas?
Ocean	☐ Yes ☐ No ☐ Unsure ☐ Prefer not to answer	
Coast	☐ Yes ☐ No ☐ Unsure ☐ Prefer not to answer	
Lakes	☐ Yes ☐ No ☐ Unsure ☐ Prefer not to answer	

Section 7: Questionnaire and Research Feedback

21) Do you think this questionnaire was effective in gathering information about the coast/ocean/lake in Kinngait?

☐ Yes ☐ No ☐ Somewhat ☐ Prefer not to answer

22) What do you think about the length of this questionnaire?

☐ Too long ☐ Too short ☐ Good length ☐ Prefer not to answer

23) Is there anything that you feel we are missing or should remove from this questionnaire? Please describe/explain.

24) What are your top 3 interests for future research?

1.

2.

3.

25) Any other comments or suggestions:

ᓇᑯᕐᒦᒃ Nakurmiik! (Thank you!)

B.2 Questionnaire (Inuktitut)

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ᑭᙵᐃᑦ ᓯᒡᔭᖓᓂᑦ ᐆᒪᓂᖃᐅᖅᑐᐃᑦ ᒦᖕᓄᑦ ᐊᐱᖅᑯᑏᑦ:
ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᓯᒡᔭᖕᒋᓐᓂᑦ ᖃᐅᔨᒪᓂᕐᒨᖓᔪᖅ

ᑐᑭᓯᑎᑦᑎᓂᖅ

ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓ ᐊᓯᐊᙳᖅᑎᑕᔪᖅ ᐃᓂᒋᔭᐅᖃᑦᑕᖅᑐᓂᒃ, ᐃᖃᓗᐃᑦ ᓇᒧᙵᐅᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᓄᑦ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ. ᑐᕌᖓᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑎᑎᕋᐅᓯᕆᓂᐊᕐᓗᒋᑦ ᐆᒪᓂᖃᐅᖅᑐᓂᒃ ᐊᒻᒪᓗ ᐊᕙᑎᐅᑉ ᖃᓄᐃᓐᓂᖓᓄᑦ ᓯᒡᔭᒥᑦ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᓄᑦ ᑕᓯᐅᔭᕐᔪᐊᕐᒥᑦ ᐊᒻᒪᓗ ᑐᑭᓯᐊᓗᒋᑦ ᖃᓄᖅ ᐊᓯᐊᙳᖅᓯᒪᓕᕐᒪᖔᑕ. ᐱᔾᔪᑎᒋᔭᐆᑦ ᐱᓕᕆᖃᑎᒋᓗᒋᑦ ᓄᓇᓕᖕᒥᐅᑕᐃᑦ ᑎᑎᕋᐅᓯᕆᓂᐊᕐᓗᒋᑦ ᖃᐅᔨᒪᓂᕆᔭᖏᑦ ᐆᒪᓂᖃᖃᑎᒌᒃᑐᐃᑦ ᒦᖕᓄᑦ ᐊᒻᒪᓗ ᐊᕙᑎᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ ᑭᙵᐃᑦ ᖃᓂᑕᖓᓂᑦ ᐊᒻᒪᓗ ᐱᕚᓪᓕᐊᓂᖃᕐᓗᑕ ᓄᓇᓕᖕᒥᑦ ᐊᐅᓚᑕᐅᔪᒥᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ. ᖃᐅᔨᒪᓂᕆᔭᐅᔪᖅ ᑐᑭᓯᐊᒃᑲᓐᓂᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᓯᒡᔭᒥᑦ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᓂᒃ ᐊᒻᒪᓗ ᐃᑲᔪᕐᓗᓂ ᖃᐅᔨᓴᖅᑕᐅᓂᖓ ᐱᐊᓪᓚᔪᒥᒃ ᓯᒡᔭᒥᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐃᑲᔪᕈᓐᓇᕐᓂᐊᕐᓗᒋᑦ ᓄᓇᓖᑦ ᐸᕐᓇᒃᐸᓪᓕᐊᓂᕐᒧᑦ ᓯᕗᓂᒃᓴᒥᑦ.

ᐊᐱᖅᑯᑏᑦ ᐃᓂᓕᐅᖅᑕᐅᓯᒪᔪᑦ ᐊᕙᑎᒧᑦ ᐱᖓᓱᐃᖓᓕᖅᑯᒥᑦ - ᑕᓰᑦ, ᓯᒡᔭ (ᓯᒡᔭᖓ ᑎᓐᓂᕐᒧᑦ), ᐊᒻᒪᓗ ᑕᕆᐅᖅ (ᐅᖓᑖᓅᖅᑐᖅ ᑎᓐᓂᐅᑉ, ᐃᒪᑦᑕᐃᓐᓇᕐᒧᑦ).

ᑭᐅᕙᓪᓕᐊᑎᓪᓗᑎᑦ ᐊᐱᖅᓲᑎᓂᒃ, ᐃᓱᒪᒋᔭᐅᖁᔭᕗᑦ ᐃᓂᐅᔪᑦ ᓄᓇᓕᒃᐱᑦ ᖃᓂᑕᖓᓃᑦᑐᑦ.

ᐃᓚᒋᔭᐅᔪᖅ 1 ᑐᑭᓯᐅᒪᔾᔪᑏᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᑭᐅᒪᔪᒥᒃ

1) ᐊᖑᑕᐅᕕᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐊᕐᓇᐅᕕᑦ

☐ ᐊᖑᑎ ☐ ᐊᕐᓇᖅ ☐ ᐊᓯᐊ ____________________ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

2) ᖃᑦᓯᓂᒃ ᐅᑭᐊᖃᖅᐱᑦ ____________________ ᐅᑭᐅᑦ

3) ᖃᓄᖅ ᐊᑯᓂᐅᑎᒋᔪᖅ ᑭᖓᕐᒥᐅᑕᐅᓕᖅᐱᑦ? ________________ᐅᑭᐅᑦ

4) ᒫᓐᓇ ᐱᓕᕆᕕᑦ?

☐ ᐃᖅᑲᓇᐃᔮᖃᐃᓐᓇᖅᑐᖅ ☐ ᐃᓚᐃᓐᓇᖓᑐᑦ ☐ ᐅᑭᐅᑉ ᐃᓚᖓᑐᑦ (ᐅᑭᐅᒃᑯᑦ ᐱᓕᕆᖃᑎᑕᙱᑦᑐᒃᓴᐅᔪᑎᑦ)

☐ ᐃᖅᑲᓇᐃᔮᒥᑦ ᓄᖅᑲᖓᓕᖅᑐᖅ ☐ ᐃᖅᑲᓇᐃᔭᙱᑦᑐᖅ ☐ ᐃᓕᓐᓂᐊᖅᑎ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

ᐃᓚᒋᔭᐅᔪᖅ 2: ᐊᓯᐊᙳᕐᓃᑦ ᑕᑯᐅᕐᒧᑦ

5) ᖃᐅᔨᓯᒪᕚᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ ᑕᑯᐅᕐᒥᑦ? ᐃᓂᐅᔪᒥᑦ ᑎᓂᓐᓂᐅᑉ ᐅᖓᑖᓂᑦ ᐃᒪᓐᓇᕐᒥᑦ.

☐ ᐋ ☐ ᐋᒃᑲ ☐ ᖃᐅᔨᒪᙱᑦᑐᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

6) ᐃᓅᓯᕐᓂᑦ ᓲᓇᓂᒃ ᐊᓯᐊᙳᖅᑐᓂᒃ ᐅᔾᔨᕈᓱᒃᓯᒪᕚᑦ ᑕᑯᐅᕐᒥᑦ? ᐊᓯᐊᙳᖅᓯᒪᔪᖃᖅᐸᑦ, ᖃᑉᓯᓄᑦ ᐅᑭᐅᖑᓕᖅᐸᑦ ᐅᔾᔨᓇᔭᐃᑦ ᐊᓯᐊᙳᖅᑐᖅ?

ᐃᒪᐅᑉ ᐆᓇᕐᓂᖓ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	________ ᐅᑭᐅᑦ
ᐊᓄᕆ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	________ᐅᑭᐅᑦ
ᐃᒪᖅᕿᖅᑐᓂᖅᓴᐃᑦ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	________ᐅᑭᐅᑦ
<u>ᑕᑯᐅᕐᒥᑦ ᓯᑯ:</u> ᐃᓂᐅᔪᖅ ᓯᑯᖃᖅᑐᖅ ᐃᑉᔪᓂᖓ ᖃᓄᐃᓐᓂᖓ ᖃᖓᒃᑯᑦ ᓯᑯ ᓯᕐᑯᑉᑎᖃᑦᑕᕐᓂᖓ ᐅᐱᕐᖔᒃᑯᑦ ᖃᖓᒃᑯᑦ ᓯᑯᕙᓪᓚᐊᖃᑦᑕᕐᓂᖓ ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓯᑯᖃᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᓯᑯᖃᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐃᑉᔪᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᓵᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐊᓯᐊᙳᕐᓂᖃᖅᑐᖅ ☐ ________ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ ᐱᓇᓵᕐᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ ᐱᓇᓵᕐᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ	________ ᐅᑭᐅᑦ
<u>ᑕᑯᐅᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ:</u> ᖃᑉᓯᐅᓂᖏᑦ ᖃᓄᐃᑦᑑᓂᖏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ᐃᖃᓗᐃᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᔾᔩᙱᑦᑐᑦ ᐃᖃᓗᐃᑦ	________ᐅᑭᐅᑦ ________ᐅᑭᐅᑦ

ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ: ᖃᑉᓯᐅᓂᖏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ	________ᐅᑭᐅᑦ
ᖃᓄᐃᑦᑑᓂᖏᑦ ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ᓂᕐᔪᑏᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᔾᔩᙱᑦᑐᑦ ᓂᕐᔪᑏᑦ	________ᐅᑭᐅᑦ
ᑭᙳᕋᓗᐃᑦ: ᖃᑉᓯᐅᓂᖏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ	________ᐅᑭᐅᑦ
ᖃᓄᐃᑦᑑᓂᖏᑦ (ᓲᕐᓗ, ᐊᒻᒨᒪᔪᐃᑦ, ᑯᕌᑉ ᐊᒥᓲᓂᒃ ᓂᐅᓛᑦ)	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᔾᔩᙱᑦᑐᑦ	________ᐅᑭᐅᑦ
ᐊᓯᖏᑦ ᐊᓯᐊᙳᖅᑐᑦ ᐅᔾᔨᕆᓯᒪᔭᑎᑦ ᑕᕆᐅᕐᒥ, ᐅᕝᕙᓘᓐᓃᑦ ᐊᓯᖏᑦ ᐅᖃᐅᓯᕆᔪᒪᔭᑎᑦ:		

ᐃᓚᒋᔭᐅᔪᖅ 3: ᐊᓯᐊᙳᕐᓂᖏᑦ ᓯᓪᔭᐅᑉ

7) ᐅᑉᐱᓇᓯᒪᕚᐅᒃ ᐊᓯᐊᙳᕐᓂᖓ ᓯᓪᔭᐅᑉ? ᐃᓂᐅᔪᑦ ᑎᓂᓐᓂᕐᒥᑦ ᐱᒋᐊᖅᑐᓂ.

☐ ᐄ ☐ ᐋᒃᑲ ☐ ᖃᐅᔨᒪᙱᑦᑐᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

8) ᐃᓅᓯᕐᓂᑦ ᓯᓇᓂᒃ ᐊᓯᐊᙳᖅᑐᓂᒃ ᐅᑉᐱᕈᓱᒃᓯᒪᕕᑦ ᓯᓪᔭᒥᑦ? ᐊᓯᐊᙳᖅᓯᒪᔪᖃᖅᐸᑦ, ᖃᑉᓯᓄᑦ ᐅᑭᐅᙳᓕᖅᐸᑦ ᐅᑉᐱᓕᔭᐃᑦ ᐊᓯᐊᙳᖅᑐᖅ?

ᐃᒪᐅᑉ ᐆᓇᕐᓂᖓ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	________ᐅᑭᐅᑦ
ᐊᓄᕆ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	________ᐅᑭᐅᑦ
ᐃᒪᖅᑯᖅᑐᓂᖅᓴᐃᑦ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	________ᐅᑭᐅᑦ
ᓱᕋᒃᐸᓪᓚᐊᔪᖅ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ	_______ ᐅᑭᐅᑦ

<u>ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ:</u> ᖃᑉᓯᐅᓂᖏᑦ ᖃᓄᐃᑦᑑᓂᖏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᒃᓱᐅᖏᑦᑐᑦ ᐃᖃᓗᐃᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᒃᓱᕈᙱᑦᑐᑦ ᐃᖃᓗᐃᑦ	________ᐅᑭᐅᑦ ________ᐅᑭᐅᑦ
<u>ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ:</u> ᖃᑉᓯᐅᓂᖏᑦ ᖃᓄᐃᑦᑑᓂᖏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᒃᓱᐅᖏᑦᑐᑦ ᓂᕐᔪᑏᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᒃᓱᕈᙱᑦᑐᑦ ᓂᕐᔪᑏᑦ	________ᐅᑭᐅᑦ ________ᐅᑭᐅᑦ
<u>ᑭᖑᕋᓗᐃᑦ:</u> ᖃᑉᓯᐅᓂᖏᑦ ᖃᓄᐃᑦᑑᓂᖏᑦ	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᒃᓱᐅᖏᑦᑐᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᒃᓱᕈᙱᑦᑐᑦ	________ᐅᑭᐅᑦ ________ᐅᑭᐅᑦ
ᖃᓄᐃᑦᑑᓂᖏᑦ ᐱᕈᖅᑐᐃᑦ (ᓲᕐᓗ, ᕿᖅᑯᐊᑦ)	☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᒃᓱᐅᖏᑦᑐᑦ ᐱᕈᖅᑐᐃᑦ ☐ ᐊᒥᓲᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᒃᓱᕈᙱᑦᑐᑦ ᐱᕈᖅᑐᐃᑦ	________ᐅᑭᐅᑦ
ᐊᓯᖏᑦ ᐊᓯᐊᙳᖅᑐᑦ ᐅᔾᔨᕆᓯᒪᔭᑎᑦ ᓯᓪᔭᒥᑦ, ᐅᕝᕙᓘᓐᓃᑦ ᐊᓯᖏᑦ ᐅᖃᐅᓯᕆᔪᒪᔭᑎᑦ:		

ᐃᓚᒋᔭᐅᔪᖅ 4: ᐊᓯᐊᙳᕐᓂᖏᑦ ᑕᓰᑦ

9) ᐅᔾᔨᕆᓯᒪᕙᐅᒃ ᐊᓯᐊᙳᖅᑐᓂᒃ ᑕᓯᕐᓂᑦ?

☐ ᐄ ☐ ᐋᒃᑲ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

10) ᐃᓅᓯᕐᓂᑦ ᓯᓇᓂᒃ ᐊᓯᐊᙳᖅᑐᓂᒃ ᐅᔾᔨᕈᓯᒃᓯᒪᕙᑦ ᑕᓯᕐᓂᑦ? ᐊᓯᐊᙳᖅᓯᒪᔪᖃᖅᐸᑦ, ᖃᑉᓯᓄᑦ ᐅᑭᐅᖑᓕᖅᐸᑦ ᐅᔾᔨᓇᔭᐃᑦ ᐊᓯᐊᙳᖅᑐᖅ?

ᐃᒪᐅᑉ ᐆᓇᕐᓂᖓ	☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᙱᓐᓂᖅᓴᐅᓕᖅᑐᖅ	_________ ᐅᑭᐅᑦ

	☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ	
ᐊᓄᕆ	☐ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ	________ᐅᑭᐅᑦ
ᑕᒡᔮᕋᐃᑦ	☐ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ	________ᐅᑭᐅᑦ
ᐃᒪᐅᑉ ᑲᑭᐊᖅᓂᖓ	☐ ᑲᑭᐊᖅᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᑲᑭᐊᖏᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᓐᖏᑦᑐᖅ	________ᐅᑭᐅᑦ
ᑕᓯᕐᒥᑦ ᓯᑯ: ᐃᓂᐅᔪᖅ ᓯᑯᖃᖅᑐᖅ ᐃᑉᔪᓂᖓ ᖃᓄᐃᓐᓂᖓ ᖃᖓᒃᑯᑦ ᓯᑯ ᓯᕐᑯᑉᑎᖃᑦᑕᕐᓂᖓ ᐅᐱᕐᖔᒃᑯᑦ ᖃᖓᒃᑯᑦ ᓯᑯᕙᓪᓚᐊᖃᑦᑕᕐᓂᖓ ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᓯᑯᖃᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᓯᑯᖃᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᐃᑉᔪᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᓵᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᐊᓯᐊᓐᖑᕐᓂᖃᖅᑐᖅ ☐ ______________________ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ ᐱᓇᓵᕐᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᐱᓇᓵᕐᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ	________ᐅᑭᐅᑦ
ᑕᓯᕐᓂᑦ ᐃᖃᓗᐃᑦ: ᖃᐸᓯᐅᓂᖏᑦ ᖃᓄᐃᑦᑑᓂᖏᑦ	☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ᐃᖃᓗᐃᑦ ☐ ᐊᒥᓲᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᔾᔩᓐᖏᑦᑐᑦ ᐃᖃᓗᐃᑦ	________ᐅᑭᐅᑦ ________ᐅᑭᐅᑦ
ᑭᖑᕋᓗᐃᑦ: ᖃᐸᓯᐅᓂᖏᑦ ᖃᓄᐃᑦᑑᓂᖏᑦ	☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᐆᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐆᓇᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᓐᖑᓐᖏᑦᑐᖅ ☐ ᓄᑖᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ☐ ᐊᒥᓲᓐᖏᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᐊᔾᔩᓐᖏᑦᑐᑦ	________ᐅᑭᐅᑦ ________ᐅᑭᐅᑦ

ᐊᓯᖏᑦ ᐊᓯᐊᓐᖑᖅᑐᑦ ᐅᔾᔨᕆᓯᒪᔭᑎᑦ ᑕᓯᕐᓂᑦ, ᐅᕝᕙᓘᓐᓃᑦ ᐊᓯᖏᑦ ᐅᖃᐅᓯᕆᔪᒪᔭᑎᑦ:

ᐃᓚᒋᔭᐅᔪᖅ 5: ᓂᕐᔪᑏᑦ

ᒪᖃᐃᓐᓂᖅ ᐊᒻᒪᓗ ᐃᖃᓗᒃᓯᐅᕐᓂᖅ

11) ᐃᖃᓪᓚᖃᑦᑕᖅᐱᑦ, ᑕᑭᐅᕐᒥᐅᑕᓂᒃ ᓂᕐᔪᑎᓂᒃ ᒪᖃᐃᖃᑦᑕᖅᐱᑦ, ᐅᕝᕙᓘᓐᓃᑦ ᑕᒪᐃᓐᓂᑦ?
☐ ᒪᖃᐃᖃᑦᑕᖅᑐᖓ ☐ ᐃᖃᓪᓚᖃᑦᑕᖅᑐᖓ ☐ ᑕᒪᐃᓐᓂᑦ ☐ ᓇᓕᑐᐃᓐᓇᖏᐅᖏᑦᑐᖅ
☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

12) ᓂᕈᐊᕐᓗᒋᑦ ᑕᒪᕐᒥᓗᒃᑖᖅ ᒪᖃᐃᕝᕕᖃᑦᑕᖅᑕᑎᑦ ᑕᑭᐅᕐᒥᐅᑕᖏᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓪᓚᕐᓗᑎᑦ:
☐ ᑕᑭᐅᕐᒥᑦ ☐ ᓯᓪᔭᒥᑦ ☐ ᑕᓯᕐᒥᑦ ☐ ᑰᖕᒥᑦ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

13) ᖃᑉᓯᓂᒃ ᐅᑭᐅᓂᑦ ᒪᖃᐃᖃᑦᑕᖅᓯᒪᓕᖅᐱᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓪᓚᖃᑦᑕᖅᓯᒪᓕᖅᐱᑦ? ______ ᐅᑭᐅᑦ
☐ ᐱᑕᖃᙱᑦᑐᖅ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

14) ᒫᓐᓇᐅᔪᖅ ᒪᖃᐃᖃᑦᑕᙱᒃᑯᕕᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓪᓚᖃᑦᑕᙱᒃᑯᕕᑦ, ᒪᖃᐃᑉᐸᓚᐅᖅᐱᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓗᒃᓯᐅᖅᐸᓚᐅᖅᐱᑦ?
☐ ᐄ ☐ ᐋᒃᑲ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

15) ᒪᖃᐃᖃᑦᑕᙱᒃᑯᕕᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓪᓚᖃᑦᑕᙱᒃᑯᕕᑦ, ᐃᓪᓗᒥᐅᖃᑎᒋᔭᐃᑦ ᒪᖃᐃᖃᑦᑕᖅᐸ ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓪᓚᖃᑦᑕᖅᐸ? ☐ ᐄ ☐ ᐋᒃᑲ ☐ ᑭᐅᔪᒪᙱᑐᙵ

16) ᖃᑉᓰᖅᑕᕐᓗᑎᑦ ᒪᖃᐃᖃᑦᑕᖅᐱᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᐃᖃᓪᓚᕐᓗᑎᑦ?

ᐅᑭᐅᒃᑯᑦ	☐ ᖃᐅᑕᒫᒃᑯᑦ ☐ ᐱᓇᓱᐊᕈᓯᑕᒪᒃᑰᑦ ☐ ᑕᖅᑭᑕᒫᒃᑯᑦ ☐ ᐊᑕᐅᓲᕐᓗᒍ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ☐ ᐱᖃᑦᑕᙱᑦᑐᖓ ☐ ᑭᐅᔪᒪᙱᑐᙵ
ᐅᐱᕐᖔᒃᑯ	☐ ᖃᐅᑕᒫᒃᑯᑦ ☐ ᐱᓇᓱᐊᕈᓯᑕᒪᒃᑰᑦ ☐ ᑕᖅᑭᑕᒫᒃᑯᑦ ☐ ᐊᑕᐅᓲᕐᓗᒍ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ☐ ᐱᖃᑦᑕᙱᑦᑐᖓ ☐ ᑭᐅᔪᒪᙱᑐᙵ
ᐊᐅᔭᒃᑯᑦ	☐ ᖃᐅᑕᒫᒃᑯᑦ ☐ ᐱᓇᓱᐊᕈᓯᑕᒪᒃᑰᑦ ☐ ᑕᖅᑭᑕᒫᒃᑯᑦ ☐ ᐊᑕᐅᓲᕐᓗᒍ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ☐ ᐱᖃᑦᑕᙱᑦᑐᖓ ☐ ᑭᐅᔪᒪᙱᑐᙵ
ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ ᖃᐅᑕᒫᒃᑯᑦ ☐ ᐱᓇᓱᐊᕈᓯᑕᒪᒃᑰᑦ ☐ ᑕᖅᑭᑕᒫᒃᑯᑦ ☐ ᐊᑕᐅᓲᕐᓗᒍ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ☐ ᐱᖃᑦᑕᙱᑦᑐᖓ ☐ ᑭᐅᔪᒪᙱᑐᙵ

17) ᖃᖓᒃᑯᑦ ᒪᖃᐃᖃᑦᑕᕐᓂᕆᔭᐃᑦ ᐊᒻᒪᓗ/ᐅᖕᒐᓘᓐᓃᑦ ᐃᖃᓪᓚᐊᖃᑦᑕᕐᓂᕆᔭᐃᑦ ᐊᓯᐊᙳᖅᐸ?

ᐅᑭᐅᒃᑯᑦ	☐ ᐱᓪᓚᓂᖅᓴᐅᖃᑦᑕᓚᖅᑐᖅ ☐ ᑭᖑᕙᓯᓐᓂᖅᓴᐅᓚᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ
ᐅᐱᕐᖔᒃᑯ	☐ ᐱᓪᓚᓂᖅᓴᐅᖃᑦᑕᓚᖅᑐᖅ ☐ ᑭᖑᕙᓯᓐᓂᖅᓴᐅᓚᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ
ᐊᐅᔭᒃᑯᑦ	☐ ᐱᓪᓚᓂᖅᓴᐅᖃᑦᑕᓚᖅᑐᖅ ☐ ᑭᖑᕙᓯᓐᓂᖅᓴᐅᓚᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ
ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ ᐱᓪᓚᓂᖅᓴᐅᖃᑦᑕᓚᖅᑐᖅ ☐ ᑭᖑᕙᓯᓐᓂᖅᓴᐅᓚᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

ᐅᖃᐅᓯᐅᒃᑲᓂᖅᑐᑦ ᒪᖃᐃᓐᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐃᖃᓗᒃᓯᐅᕐᓂᕐᒧᑦ:

ᐱᔾᔪᑎᖃᖅᑐᑦ ᓂᕐᔪᑎᓂᒃ ᐊᐱᖅᑯᑏᑦ

18) ᐊᐱᕆᔪᒪᔭᕌᑎᒋᑦ ᓂᕐᔪᑏᑦ ᒪᖃᐃᖃᑦᑕᖅᑕᐱᑦ ᐅᖕᒐᓘᓐᓃᑦ ᐃᖃᓗᒃᓯᐅᖃᑦᑕᖅᑕᕙᑦ ᒥᒃᓵᓄᑦ:

ᓂᕐᔪᑏᑦ (ᑎᑎᕋᕐᓗᑎᑦ)	**ᖃᑉᔾᖅᑕᕐᓗᑎᑦ** ᒪᖃᐃᖃᑦᑕᖅᐱᑦ ᐅᖕᒐᓘᓐᓃᑦ ᐃᖃᓪᓚᐊᖃᑦᑕᖅᐱᑦ ᑖᑉᓯᒧᙵ ᓂᕐᔪᑎᒧᑦ?	ᐅᑭᐅᑉ **ᐃᓚᖓᓂᑦ(ᖏᓐᓂᑦ)** ᓂᕐᔪᑎᒧᑦ ᒪᖃᐃᖃᑦᑕᖅᐱᑦ ᐃᖃᓪᓚᐊᖅᓱᑎᓪᓗᓐᓃᑦ?	ᐅᔾᔨᕆᔭᒃᓯᒪᕙᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ **ᖃᑉᓯᐅᓂᖏᓐᓄᑦ** ᓂᕐᔪᑎᐅᑉ?	ᐅᔾᔨᕆᔭᒃᓯᒪᕙᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ **ᑕᑯᔭᕋᖕᒪᕙᑦ** ᐅᖕᒐᓘᓐᓃᑦ ᓂᕐᔪᑎᑕᓇᔭᕋᖕᒪᖕᓂ?	ᐅᔾᔨᕆᔭᒃᓯᒪᕙᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ **ᓇᓂ** ᑕᑯᔭᕋᖕᒪᒃᑎᒃ, ᐅᖕᒐᓘᓐᓃᑦ ᓂᕐᔪᑎᑕᓇᔭᕋᖕᒪᒃᑎᒃ?

ᒪᖃᐃᑕᐅᒐᔪᓛᑦ **ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ:** ______________ ᑐᓪᓕᕆᔭᐅᔪᑦ ᒪᖃᐃᑕᐅᒐᔪᓛᑦ **ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ:** ______________	☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ ☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ	☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ ☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ ᐱᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᐄ ☐ ᐋᒃᑲ
ᐃᖃᓗᒃᓯᐅᖅᑕᐅᒐᔪᓛᖅ **ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ:** ______________ ᑐᓪᓕᕆᔭᐅᔪᖅ ᐃᖃᓗᒃᓯᐅᖅᑕᐅᒐᔪᓛᖅ **ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ:** ______________	☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ ☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ	☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ ☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᐄ ☐ ᐋᒃᑲ

ᐃᖃᓗᒃᓯᐅᖅᑕᐅᒐᔪᖢᖅ **ᑕᓯᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ:** _______________ ᑐᓪᓕᑎᔭᐅᔪᖅ ᐃᖃᓗᒃᓯᐅᖅᑕᐅᒐᔪᖢᖅ **ᑕᓯᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ:** _______________	☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ ☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ	☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ ☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᐄ ☐ ᐋᒃᑲ
ᐱᓯᐅᒐᔪᖢᖑᔪᑦ **ᑭᖑᕐᓚᐃᑦ ᓲᕐᓗ ᐊᒻᒨᒪᔪᐃᑦ:** _______________ ᑐᓪᓕᕆᔭᐅᔪᖅ ᐱᓯᐅᒐᔪᖢᖑᔪᖅ **ᑭᖑᕐᓚᐃᑦ ᓲᕐᓗ ᐊᒻᒨᒪᔪᐃᑦ:** ____________________	☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ ☐ ᖃᐅᑕᒫᑦ ☐ᐱᓇᓱᐊᕈᓯᑕᒫᑦ ☐ ᑕᖅᕿᑕᒫᑦ ☐ᐊᑕᐅᓰᖅᓱᒍ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ	☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ ☐ ᐅᐱᕐᖔᒃᑯᑦ ☐ ᐊᐅᔭᒃᑯᑦ ☐ ᐅᑭᐅᒃᑯᑦ ☐ ᐅᑭᐊᒃᓵᒃᑯᑦ	☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐊᒥᓱᐃᖅᑕᕐᓂᖅᓴᐅᔪᖅ ☐ᐱᓗᐊᖕᒋᓐᓂᖅᓴᐅᔪᖅ ☐ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ ☐ᐱᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᖅ ☐ᑭᖑᕙᓯᖕᓂᖅᓴᐅᓕᖅᑐᖅ ☐ ᐊᓯᐊᖑᙱᑦᑐᖅ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᐄ ☐ ᐋᒃᑲ

ᐊᐱᖅᓲᑎ #

ᐅᖃᐅᓯᐅᖃᓐᓂᖅᑐᑦ ᓂᕐᔪᑏᑦ ᒥᒃᓵᓄᑦ ᐊᐱᖅᑯᑎᓄᑦ:

19) ᓱᓇᓂᒃ ᐊᓯᐊᙳᖅᑐᓂᒃ ᐅᔾᔨᕈᓱᒃᓯᒪᕙᑦ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ ᑕᑯᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ, ᐃᖃᓗᐃᑦ, ᐊᒻᒪ ᑕᓯᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᖕᓄᑦ?

ᑕᑯᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ	☐ ᐊᖏᑎᒋᓂᖓ ☐ ᓂᕆᔭᖏᑦ ☐ ᓂᕿᖓᑕ ᖃᓄᐃᓐᓂᖓ ☐ ᑲᓚᖓ ☐ ᓂᕿᖓ ☐ ᑎᐱᖓ ☐ ᖁᐱᕈᐃᑦ ☐ ᑕᐅᑦᑐᖓ ☐ ᓇᐃᒪᓐᓇᕐᓂᖓ ☐ ᕿᓕᕈᖄᕐᓂᖓ ☐ ᐋᓐᓂᐊᓖᑦ (ᐱᕈᖅᑐᓖᑦ, ᑭᓪᓚᓖᑦ) ☐ ᐊᓯᖓ ________________ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᑭᐅᔾᒪᙱᑦᑐᖓ
ᑕᑯᕐᒥᑕᐃᑦ ᐃᖃᓗᐃᑦ	☐ ᐊᖏᑎᒋᓂᖓ ☐ ᓂᕆᔭᖏᑦ ☐ ᓂᕿᖓᑕ ᖃᓄᐃᓐᓂᖓ ☐ ᑲᓚᖓ ☐ ᓂᕿᖓ ☐ ᑎᐱᖓ ☐ ᖁᐱᕈᐃᑦ ☐ ᑕᐅᑦᑐᖓ ☐ ᓇᐃᒪᓐᓇᕐᓂᖓ ☐ ᕿᓕᕈᖄᕐᓂᖓ ☐ ᐋᓐᓂᐊᓖᑦ (ᐱᕈᖅᑐᓖᑦ, ᑭᓪᓚᓖᑦ) ☐ ᐊᓯᖓ ________________ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᑭᐅᔾᒪᙱᑦᑐᖓ
ᑕᓯᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ	☐ ᐊᖏᑎᒋᓂᖓ ☐ ᓂᕆᔭᖏᑦ ☐ ᓂᕿᖓᑕ ᖃᓄᐃᓐᓂᖓ ☐ ᑲᓚᖓ ☐ ᓂᕿᖓ ☐ ᑎᐱᖓ ☐ ᖁᐱᕈᐃᑦ ☐ ᑕᐅᑦᑐᖓ ☐ ᓇᐃᒪᓐᓇᕐᓂᖓ ☐ ᕿᓕᕈᖄᕐᓂᖓ ☐ ᐋᓐᓂᐊᓖᑦ (ᐱᕈᖅᑐᓖᑦ, ᑭᓪᓚᓖᑦ) ☐ ᐊᓯᖓ ________________ ☐ ᐊᓯᐊᙳᙱᑦᑐᖅ ☐ ᑭᐅᔾᒪᙱᑦᑐᖓ
ᐅᖃᐅᓯᑎᓗᒋᑦ ᓇᓗᓇᐃᔭᖅᓯᒪᔪᒃᑯᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ:	

ᐃᓚᒋᔭᐅᔪᖅ 6: ᓄᓇᓕᖕᒥᐅᓄᑦ ᐃᓱᒫᓘᑎᒋᔭᐅᔪᑦ

20) ᑭᐅᓗᒋᑦ ᐊᐱᖅᑯᑎᑦ ᐃᓱᒪᒋᓗᒋᑦ ᓂᕐᔪᑏᑦ ᐊᒻᒪ ᐊᕙᑎᒋᔭᖅᐱᑦ ᓄᓇᓕᒃᐱᑦ, ᐊᒻᒪ ᖃᓄᖅ ᐃᒃᐱᒋᓂᕆᔭᑎᑦ.

ᐊᐱᖅᑯᑏᑦ ᐊᕕᒃᑐᖅᓯᒪᔪᑦ ᐱᖓᓱᐃᓕᖓᐸᓗᑎᒃ - ᑕᕆᐅᖅ (ᐅᖓᑖᓃᖅᑐᖅ ᑎᓂᓐᓂᐅᑉ), ᓯᓯ (ᑎᑭᓪᓗᒍ ᑎᓂᓐᓂᕐᒧᑦ), ᐊᒻᒪ ᑕᓲᑦ.

	ᐃᓱᒫᓘᑎᖃᖅᐱᑦ ᐃᓂᐅᔪᒧᑦ?	ᐄᖑᒃ<ᑦ, ᓱᓇᒥᒃ ᐃᓱᒫᓘᑎᖃᖅᐱᑦ ᐃᓱᒪᒋᐸᓗᒋᑦ ᑖᑉᑯᐊ ᐃᓂᐅᔪᑦ?
ᑕᕆᐅᖅ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ	
ᓯᓚ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ	
ᑕᓲᑦ	☐ ᐄ ☐ ᐋᒃᑲ ☐ ᓇᓗᔪᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ	

ᐃᓚᒋᔭᐅᔪᖅ 7: ᐊᐱᖅᑯᐦᑎᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑐᓴᕐᕕᐅᔪᑦ

21) ᐊᐱᖅᓱᐃᓂᖅ ᐋᑐᑎᖃᕋᓱᒋᕕᐅᒃ ᑲᑎᖅᓱᐃᓂᕐᒧᑦ ᑐᑭᓱᐅᒪᔾᔪᑎᓂᒃ ᓯᓚᔭᐅᐸ/ᑕᕆᐅᐸ/ᑕᓲᑦ ᒥᒃᓵᓄᑦ ᑭᖕᒐᕐᓂᑦ?

☐ ᐄ ☐ ᐋᒃᑲ ☐ ᐃᓚᖕᒐᒍᑦ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

22) ᖃᓄᖅ ᐃᓱᒪᒋᕕᒃ ᑕᑭᑎᒋᓂᖓᔪᖓ ᐊᐱᖅᓱᐃᓂᐅᐸ?

☐ ᑕᑭᓗᐊᖅᑐᖅ ☐ ᓇᐃᓗᐊᖅᑐᖅ ☐ ᓈᒻᒪᒃᑐᖅ ᑕᑭᓂᖓ ☐ ᑭᐅᔪᒪᙱᑦᑐᖓ

23) ᓲᓇᑐᐃᓐᓇᒥᒃ ᐊᐱᕆᙱᑕᑉᑎᖕᓂᒃ ᐱᑕᖃᙱᑦᑐᕆᔭᖃᖅᐱᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐲᖅᑕᐅᔪᕆᐊᖃᕋᓱᒋᕙᐅᒃ
ᐊᐱᖅᓲᑎᒥᑦ?
ᐅᖃᐅᓯᕆᓗᒍ.

24) ᓲᓇᐅᕙᑦ ᐱᖓᓱᐃᑦ ᖁᑦᑎᓛᕆᔭᑎᑦ ᐱᔪᒪᓂᕆᔭᑎᑦ ᓱᕗᓂᒃᓯᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ?

1.

2.

3.

25) ᓲᓇᑐᐃᓐᓇᓂᒃ ᐅᖃᐅᓯᒃᓴᖃᖅᐱᑦ ᐅᕝᕙᓘᓐᓃᑦ ᖃᓄᐃᓕᐅᕐᑯᔭᕐᓂᑦ:

ᓇᑯᕐᒦᒃ Nakurmiik! (Thank you!)

B.3 Newsletter for Kinngait with preliminary results from Fall 2021 (English)

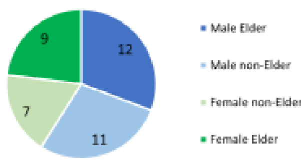
ARCTIC COAST—KINNGAIT

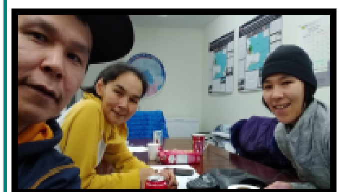
INDIGENOUS KNOWLEDGE QUESTIONNAIRE UPDATE

Background

In response to community interest, an Indigenous knowledge questionnaire was co-developed with the HTA and community technicians from January to March 2021. Using these questionnaires, we documented knowledge of biodiversity and environmental change in the ocean, coast, and lakes near Kinngait.

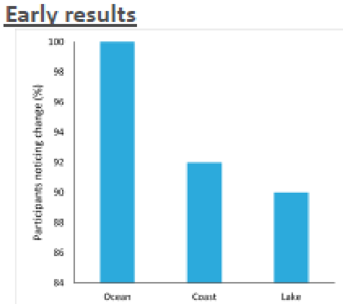
Questionnaires were administered to **39 knowledge holders** in March 2021. Responses came from a similar number of male and female Elders and non-Elders.





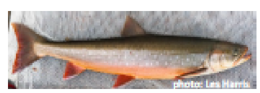
Community technicians Sheojuk Peter (left), Ooloosie Manning (centre), and Pudloo Qiatsuq (right), who co-developed and administered the questionnaire.

Early results



All participants said there were changes in the ocean. Some participants did not notice changes in the coast (8%) or lake (10%).

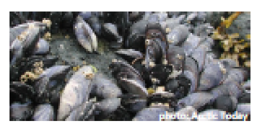
- The most common animals participants discussed were: Arctic char, beluga whales, seals (especially ringed seals), clams, and mussels:



Possible changes in timing of fishing Arctic char

Beluga whale may be stable or fewer in number

Seals may be fewer in number



More mussels in new locations

Questionnaire participants indicated:

- Sea ice and lake ice are changing (less ice, thinner, poorer quality, earlier spring breakup, later fall formation)
- Water temperature is increasing
- Wind intensity may be increasing

Next steps

1. Continue to receive input from the HTA about priority research questions and data analyses.
2. Expand on early results presented here.
3. Verify the results and our interpretation through knowledge sharing.
4. Receive input from the community and HTA on future research questions that could be addressed in Kinngait.

Nakurmiik, thank you to the Aiviq HTA, community technicians, and survey participants. Funding was provided by the DFO Results Fund.

Fisheries and Oceans Canada Pêches et Océans Canada

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B.4 Newsletter for Kinngait with preliminary results from Fall 2021 (Inuktitut)

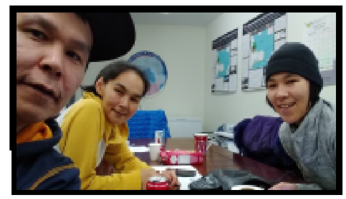
ᐅᑭᐅᖅᑕᖅᑐᒥ ᓯᒃᓯᐸᓯᒃ –ᑭᙵᐃᑦ

ᓄᓇᖃᖅᑳᖅᓯᒪᔪᑦ ᖃᐅᔨᒪᔾᑦ ᐊᐱᖅᓲᑎᓄᑦ ᓄᑖᙳᖅᑎᑕᐅᓯᒪᔪᑦ

OCTOBER 2021

ᖃᓄᐃᓐᓂᕆᔭᐅᔪᑦ

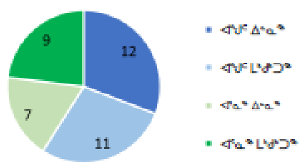
ᑭᐅᓗᒋᑦ ᓄᓇᓕᒧᑦ ᐱᔪᒪᔪᓄᑦ, ᓄᓇᖃᖅᑲᖅᓯᒪᔪᓂᑦ ᖃᐅᔨᒪᔾᑦ ᑲᒪᒋᔭᐅᓚᐅᖅᑐᑦ ᐃᑲᔪᖅᑎᒋᔭᐅᔪᑦ–ᓴᖅᑭᑎᑦᑎᓪᓗᑎᒃ ᐊᖑᓇᓱᒃᑎᓪᓗ ᐊᒻᒪᓗ ᓄᓇᓕᒥ ᓴᓇᔾᑦ ᔭᓄᐊᕆᒥ ᒪᔾᒧᑦ 2021. ᑖᒃᑯᓂᖓ ᐊᐱᖅᓲᑎᖕᓂᒃ ᐊᑐᖅᑐᑎᒃ, ᑎᑎᕋᖅᓯᒪᔪᒧᑦ ᖃᐅᔨᒪᔾᓂᑦ ᐆᒪᔪᑦ ᓇᔪᕕᖕᒋᑦ ᐊᒻᒪᓗ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᐊᓯᙳᖅᐸᓪᓕᐊᓂᖓ ᑕᕆᐅᒥ, ᓯᒃᓯᐸᓯᒥ, ᐊᒻᒪᓗ ᑕᓯᓂ ᑭᙵᐃᑦ ᖃᓂᒋᔮᖕᓂ.



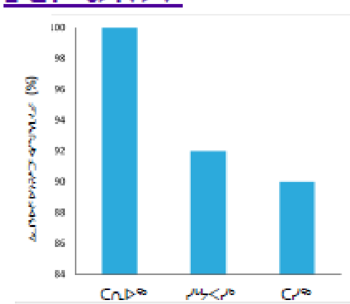
ᓄᓇᓕᒥ ᓴᓇᔾᑦ ᓯᐅᔪᒃ ᐱᑕ (ᓴᐅᒥᒃ) ᐅᓘᓯ ᒫᓂᖕ (ᕿᑎᐊᓂ), ᐊᒻᒪᓗ ᐳᓪᓗ ᕿᐊᑦᓯᖅ (ᑕᓕᖅᐱᒃ), ᐃᑲᔪᖅᑎᒋᔭᐅᔪᑦ–ᓴᖅᑭᑎᑦᑎᓪᓗᑎᒃ ᐊᒻᒪᓗ ᑲᒪᓪᓗᒋᑦ ᐊᐱᖅᓲᑎᐅᔪᓂᑦ.

ᐊᐱᖅᓲᑎᑦ ᐊᐅᓚᑕᐅᓚᐅᖅᑐᑦ 39 ᖃᐅᔨᒪᔨᓄᑦ ᒪᔾ 2021–ᒥ.

ᑭᐅᔪᑦ ᑕᐃᒃᑯᓇᑲᓴᓂᑦ ᐊᒥᓲᓂᖏᑦ ᐊᖑᑎᑦ ᐊᒻᒪᓗ ᐊᕐᓇᐃᑦ ᐃᓄᓇᐃᑦ ᐊᒻᒪᓗ ᒪᒃᑯᓂᖅᓴᐃᑦ.

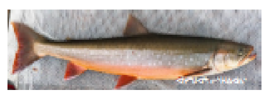


ᒫᓐᓇᕈᖅ ᖃᐅᔨᔭᐅᔪᑦ



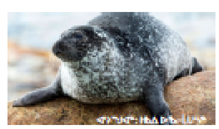
ᐃᓚᒋᔭᐅᓗᒃᑖᖅᑐᑦ ᐅᖃᖅᓯᒪᔪᑦ ᐊᓯᙳᖅᓯᒪᓂᖓᓄᑦ ᑕᕆᐅᒥ. ᐃᓚᖏᑦ ᐃᓚᒋᔭᐅᔪᑦ ᐅᒃᐱᕈᓱᒻᒪᖏᑦᑐᑦ ᐊᓯᙳᖅᓯᒪᔪᓂᒃ ᓯᒃᓯᐸᓯᒥ (8%) ᐅᑲᓪᓘᓂᑦ (10%).

ᐅᖃᐅᓯᕆᓚᐅᖅᓯᒪᔪᑦ ᓂᕆᔪᓂᑦ ᐃᓚᒋᔭᐅᔪᓂᑦ ᐅᖃᐅᓯᐅᔪᑦ: ᐃᖃᓗᒃᐲᑦ, ᕿᓚᓗᒐᐃᑦ, ᓇᑦᑏᑦ (ᐱᓗᐊᖅᑐᒋᑦ ᓇᑦᑏᑦ), ᐊᒡᒌᒪᔪᑦ ᐊᒻᒪᓗ ᐅᕖᓗᐃᑦ:

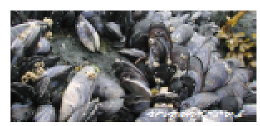


ᑕᐃᒪᐅᑐᐃᓐᓇᓇᐊᖅᑐᑦ
ᐊᓯᙳᖅᑐᑦ ᖃᓄᑎᒃᑯᑦ ᐃᖃᓗᐊᓗᓂ

ᕿᓚᓗᒐᐃᑦ
ᓱᖏᑐᐃᓐᓇᓇᐊᖅᑐᑦ
ᐅᑲᓪᓘᓂᑦ ᐊᒥᓲᖏᓐᓂᖅᓴᐅᓗᑎᒃ



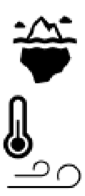
ᓇᑦᑏᑦ
ᐊᒥᓲᖏᓐᓂᖅᓴᐅᑐᐃᓐᓇᓇᐊᖅᑐᑦ



ᐊᒥᓲᓂᖅᓴᐅᔪᖅ
ᐅᕖᓗᐃᑦ ᓇᔪᖅᑳᑦ ᐊᓯᖏᓐᓂ

ᐊᐱᖅᓲᑎᓄᑦ ᐃᓚᒋᔭᐅᔪᑦ ᐅᖃᐅᓯᖃᖅᑐᑦ:

- ᑕᕆᐅᖅ ᓯᑯᖓ ᐊᒻᒪᓗ ᑕᓯᐅᑉ ᓯᑯᖓ ᐊᓯᙳᖅᐸᓪᓕᐊᔪᑦ (ᓯᑯᖃᙱᓐᓂᖅᓴᐅᔪᖅ, ᓃᓐᓂᖅᓴᖅ, ᖃᓄᐃᓐᓂᖓ ᐊᑲᐅᙱᓐᓂᖅᓯᒪᔪᑦ, ᐊᐅᑦᑎᖅᐸᓪᓕᐊᓂᖅᓴᐅᓯᖅ ᐅᐱᓐᖑᕐᕕᖕᒍᑦ, ᐊᑯᓂᐅᓂᖅᓴᖅ ᐅᑭᐊᖅᓴᖕᒍᑦ ᓯᑯᓕᓪᓕᐊᓂᖓ)
- ᐃᒪᐅᑉ ᓂᒡᓕᓇᕐᓂᖓ ᓂᒡᓕᓇᖅᓯᒃᑲᓂᕈᐃᓇᖅᑐᖅ
- ᐊᓄᓂ ᓴᙱᓕᕐᓕᕈᑎᓕᐊᕆᐊᓖᑦ ᐊᓂᕆᐊᒃᑲᓐᓂᖅᓯᒪᔪᑦ



ᓇᑯᕐᒦ, ᖁᔭᓕᕗᑦ ᐊᐃᐃᖅ ᐊᖑᓇᓱᒃᑎᒃᑯᓐᓄᑦ, ᓄᓇᓕᒥ ᓴᓇᔾᑦ, ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑎᓄᑦ ᐃᓚᒋᔭᐅᔪᑦ. ᑮᓇᐅᔭᑦ ᐃᑲᔫᓯᐊᑦ ᑐᓂᔭᐅᓯᒪᔪᑦ ᐃᖃᓗᓕᕆᔨᒃᑯᑦ

ᖃᓄᐃᓕᖓᓕᕐᓂᐊᕐᓂᖅ

1. ᑲᔪᓯᓂᖅ ᐅᖃᐅᖅᓯᐃᔭᐅᖃᑦᑕᕐᓗᑕ ᐊᖑᓇᓱᒃᑎᓂᑦ ᓯᕗᓪᓕᐅᑎᑕᐅᔭᕆᐊᖃᖅᑐᓄᑦ ᐱᖅᑯᑎᖃᖅᑐᓄᑦ ᓱᓇᒃᑯᑖᓂᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐊᐱᖅᓲᑎᓂᒃ ᐊᒻᒪᓗ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ.
2. ᐱᒋᐊᖃᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᒫᓐᓇᕈᖅ ᖃᐅᔨᓴᐅᓯᒪᔪᓄᑦ ᑖᒃᑯᓂ ᑲᒪᒋᔭᐅᓚᐅᖅᑐᓂᑦ.
3. ᓇᓗᓇᐃᔭᐃᓗᒋᑦ ᖃᐅᔨᓴᐅᓯᒪᔪᓄᑦ ᐊᒻᒪᓗ ᖃᓄᖅ ᐅᖃᐅᓯᕆᔭᐅᔾᑦ ᖃᐅᔨᒪᔨᒋᔭᐅᔪᒃᑯᑦ ᑎᑎᕋᖅᓯᒪᔪᑦ ᐅᖃᖃᑎᒌᖕᓂᕐᒧᑦ.
4. ᐅᖃᐅᓯᐃᔭᐅᔪᓂᒃ ᑐᓴᕐᓗᑕ ᓄᓇᓕᒥᑦ ᐊᒻᒪᓗ ᐊᖑᓇᓱᒃᑎᓂᑦ ᓯᕗᓂᒥ ᓱᓇᒃᑯᑖᓂᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐊᐱᖅᓲᑎᓂᒃ ᐅᖃᐅᓯᕆᔭᐅᔪᓐᓇᖅᑐᑦ ᑭᙵᓂ.

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B.5 Future research interests identified in the questionnaire

Table B.7 Future research interest areas.

Research interest area	Details provided
Terrestrial environments	- Fjords - Plants - Lichens - Caribou - Wolves
Climate change*	- Weather - Wind - Ocean temperature - Snow
Ice	- Ice thickness - Ice conditions - Icebergs
Ocean	- Ocean currents - Ocean warming
Fish	- Freshwater and marine fish - Arctic char - Salmon - Fish quality
Marine mammals	- Walrus - Seals (ringed and bearded seal specifically) - Orcas - Polar bears (population growth, and effect on other marine mammals) - Marine mammal quality
Birds	- Migratory birds
Invertebrates	- Lobsters - Crabs
Other	- Parasites - Water pollution levels - Evaluating the possibility of a local fisheries - Polar bear tourism opportunities - Construction of a bridge to Baffin Island**

*Climate change components may also appear in other sections.
**As Kinngait is situated on an island, the community depends heavily on sea ice to travel to Baffin Island.

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