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PRACTICE BRIDGE

An update on Inuit perceptions of their changing environment, Qikiqtaaluk (Baffin Island, Nunavut)

Julie Sansoulet¹, Michèle Therrien^{1,2}, Joseph Delgove³, Guilhem Pouxviel⁴, Julie Desriac⁵, Noé Sardet⁶, and Jean-Paul Vanderlinden⁷

The Inuit of Qikiqtaaluk (Baffin Island) have developed a deep respect for their natural environment and are able to report not only changes in weather, ice, and natural resources but also changes in their communities as a result of climate change. The objective of this study was to shed light on how the impacts of climate change are currently perceived in the communities of Kanngiqtuqaapik, Pangniqtuuq, and Qikiqtarjuaq. In order to construct a shared knowledge base, we conducted qualitative video interviews and participated in a hunting camp with multigenerational and multigender Inuit hunters and fishers. First, Inuit continue to see the world in which they cohabit with other living things, particularly animals, as a world that they cannot control on their own—a world they must adapt to, passing learning from one generation to the next. Second, they report that changes in the ice have been among the major and most important transformations to have occurred in recent decades. Observations made by these local populations also indicate changes in hunted species, with fewer caribou and narwhal, more birds, insects, and fish, including from more southerly regions, and an uncertainty about polar bear populations. Seal hunting remains stable, and this meat is still the most popular and healthy food, physically and psychologically. Third, sociological and economic changes (e.g., lifestyle change, monetary economies, quotas), in addition to environmental changes (e.g., climate change, species change), have had a significant impact on food harvesting activities as well as food consumption in the region. A final perspective concerns the needs of the Qikiqtaaluk communities to further develop collaboration with scientists. This need for partnership is not only perceived as a scientific necessity but also recognized by Inuit as essential to their communities, with some local leaders ready to work toward a fruitful collaboration.

Keywords: Arctic, Inuit, Fishing, Hunting, Climate

Introduction

Because of their deep knowledge of the land, weather conditions, and the terrestrial and marine animals that provide them with food, clothing, and shelter (Wenzel, 2013), Inuit people are able to thrive in a demanding climate. Canadian Inuit have been forced to adapt to changes in their environment, whether natural or imposed by Euro-Canadian settling, affecting every aspect of their daily lives. Today, climate change affects not only social, economic, and environmental conditions in the Arctic but also cultural conditions by impacting the local system of knowledge often associated with hunting and fishing practices for the people of the Arctic (Gearheard et al., 2010; Fawcett et al., 2018). In Qikiqtaaluk,

environmental management is carried out using a design system that involves both scientific studies along with Inuit Qaujimagatuqangit, representing Inuit knowledge (Wenzel, 2009; Gearheard et al., 2013).

Inuit have a deep respect for their land and a close relationship to their environment (Therrien, 2007). They have been reporting changes in the predictability of the weather since the 1990s (Weatherhead et al., 2010), with a general feeling of insecurity (Dowsley et al., 2010). Across much of the Arctic, they have noticed that the sea ice is retreating, thinning, or both. This loss of ice poses a significant challenge to Inuit communities in Qikiqtaaluk who use the sea ice for hunting and travel (Gearheard et al., 2006; Meir et al., 2006). They also report on the impact of

¹ Takuvik Joint International Laboratory, Université Laval (Canada)-CNRS (France), Québec, Canada

² INALCO, Institut National des Langues et Civilisations Orientales, Paris, France

³ Université Paris-Saclay, Saint-Aubin, France

⁴ AgroParisTech, Paris, France

⁵ Sorbonne Université, Paris, France

⁶ Parafilms, Montréal, Canada

⁷ CEARC, Cultures, Environments, Arctic, Representations, Climate—Université de Versailles Saint-Quentin-en-Yvelines, Université Paris-Saclay, Guyancourt, France

* Corresponding author:

Email: julie.sansoulet@takuvik.ulaval.ca

the climate as it relates to changes in the quality and quantity of the species hunted (Rosol et al., 2016). Inuit have been shown to suffer disproportionately from food insecurity compared to the rest of Canada (Huet et al., 2012). Market foods, although largely inaccessible to Inuit during the first half of the 20th century, now constitute over 70%–80% of their entire diet (Sharma, 2010). Yet, most Inuit adults (74%–80%, depending on the region) prefer to eat a mixture of store-bought and traditional foods (Egeland, 2010). Recently, the ability to hunt and fish traditional food has not only been challenged by the difficulties of climate change but has also been influenced by other factors such as community relocation, a market-based economy, the introduction of quotas, and all the hunting and fishing costs associated with new technologies (Therrien, 2012).

In light of these significant impacts and in order to construct a substantive knowledge base, questions have been raised to better understand how Inuit hunters and fishers in Qikiqtaaluk perceive their changing environment. How have Inuit hunters' stories and beliefs adapted with climate change? Are their practices and eating habits changing? What would Inuit hunters need to have a more effective collaboration with scientists?

Since the mid-1980s, communities on Qikiqtaaluk have participated in four studies on food, diet, and or nutrition, including (1) the 1988 Qikiqtarjuaq Study (Kinloch and Kuhnlein, 1988); (2) the 1998 to 1999 McGill University Centre for Indigenous Nutrition and Environment (CINE) study (WHO and CINE, 2003); (3) the 2007 to 2008 Inuit Health Survey (IHS; Saudny et al., 2012); and (4) the Nunavut Wildlife Harvest Study (Priest and Usher, 2004). Although many of these studies only report on Inuit perceptions of climate change, most of them focus primarily on western Qikiqtaaluk (Gearheard et al., 2010; Weatherhead et al., 2010); there is not much literature on the eastern parts of the region. A few studies in the past have reported local changes observed on Qikiqtaaluk, simultaneously considering cultural context, weather conditions, sea-ice stability, species migrations, and the challenges faced by Inuit hunters in altering centuries-old practices in order to obtain traditional food. While these studies were valuable, they were carried out with the objective to document a specific issue (e.g., ice cover, Meir et al., 2006; Laidler et al., 2010; or polar bears, Dowsley et al., 2010), whereas the present study examines an extensive and changing repertory of marine and land resources throughout three communities of Qikiqtaaluk. In the northern Territory of Nunavut, wildlife management needs to be carried out using a local management system involving both scientific studies and Inuit knowledge. Thus, this research proves a database of Inuit perspectives to inform future collaborations.

To gauge local perception of climate change impact on hunting and fishing, we conducted qualitative interviews and participated in a hunting camp along with multigenerational Inuit hunters and fishers in Nunavut. The main objective of the study was to understand how the impacts of climate change are perceived locally in the Arctic, in the communities of Kanngiqtuqaapik,

Pangniqtuuq, and Qikiqtarjuaq and then to understand (1) the sociocultural context and Inuit observation system; (2) Inuit perceptions of climate change, including weather, impacts on the ice, and invasive/disappearing species; and (3) changes in hunting practices, fishing practices, and eating habits. A final perspective was addressed regarding the needs of the communities to develop more robust, complementary scientific and Inuit sharing of knowledge.

Methodology

Green Edge project and inclusion of human and social studies

Along with other studies, this research is part of an ongoing scientific effort led by the Takuvik International joint laboratory (UMI 3376; CNRS-France, Université Laval-Canada), which is aimed at understanding the dynamics of the phytoplankton spring bloom phenomenon and its likely role in the Arctic Ocean of tomorrow, including human populations (<http://www.greenedgeproject.info/>). All of these investigations fall under the scope of the Green Edge project. Green Edge includes leading-edge expertise in all aspects of the project, which fall primarily in the field of life sciences. In this context, several different work packages of the Green Edge project, focusing on different aspects of the ongoing changes taking place in Arctic marine environments, have been established. This study focuses on the seventh and final work package, which seeks to gain a better understanding of local knowledge of the environment and harvested food by fostering connections with local communities.

The Baffin Island research sites

Kanngiqtuqaapik (Clyde River), Pangniqtuuq (Pangnirtung), and Qikiqtarjuaq (Broughton Island) are all medium-sized towns in the Qikiqtaaluk Region (**Figure 1**), located on the eastern coast of Baffin Island—Qikiqtaaluk (respectively, 70°28'05" N, 68°35'40" W; 66°08'49" N, 65°41'47" W; and 67°33'29" N, 64°01'29" W). They have approximately 1,053, 1,481, and 598 Inuit residents (Statistics Canada, 2007), the majority of whom speak the Iglulingmiut dialect. The locations of these communities in parallel with the hunting, fishing, and harvesting activities suggest that local knowledge of the timing of the ice melt and the interannual variability in the abundance of plankton, fish, and marine mammal life as the ecosystem matures over spring and summer is extensive. Here, hunting of ringed seal, polar bear, Arctic char, caribou, and narwhal dominates the traditional resource sector (Wenzel, 2009, 2013). In Qikiqtarjuaq, the economy is still essentially centered on traditional hunting and fishing practices. At Kanngiqtuqaapik, the economy can be characterized as mixed, with traditional subsistence activities, including hunting, fishing, trapping, and gathering, all coinciding with wage-based economic activities. In Pangniqtuuq, turbot fishing is central to the community's economy. After a long period of waiting, a recently constructed harbor funded by the federal government in 2013 has allowed the community to expand its existing fishing activities (Government of Nunavut, 2010). Although

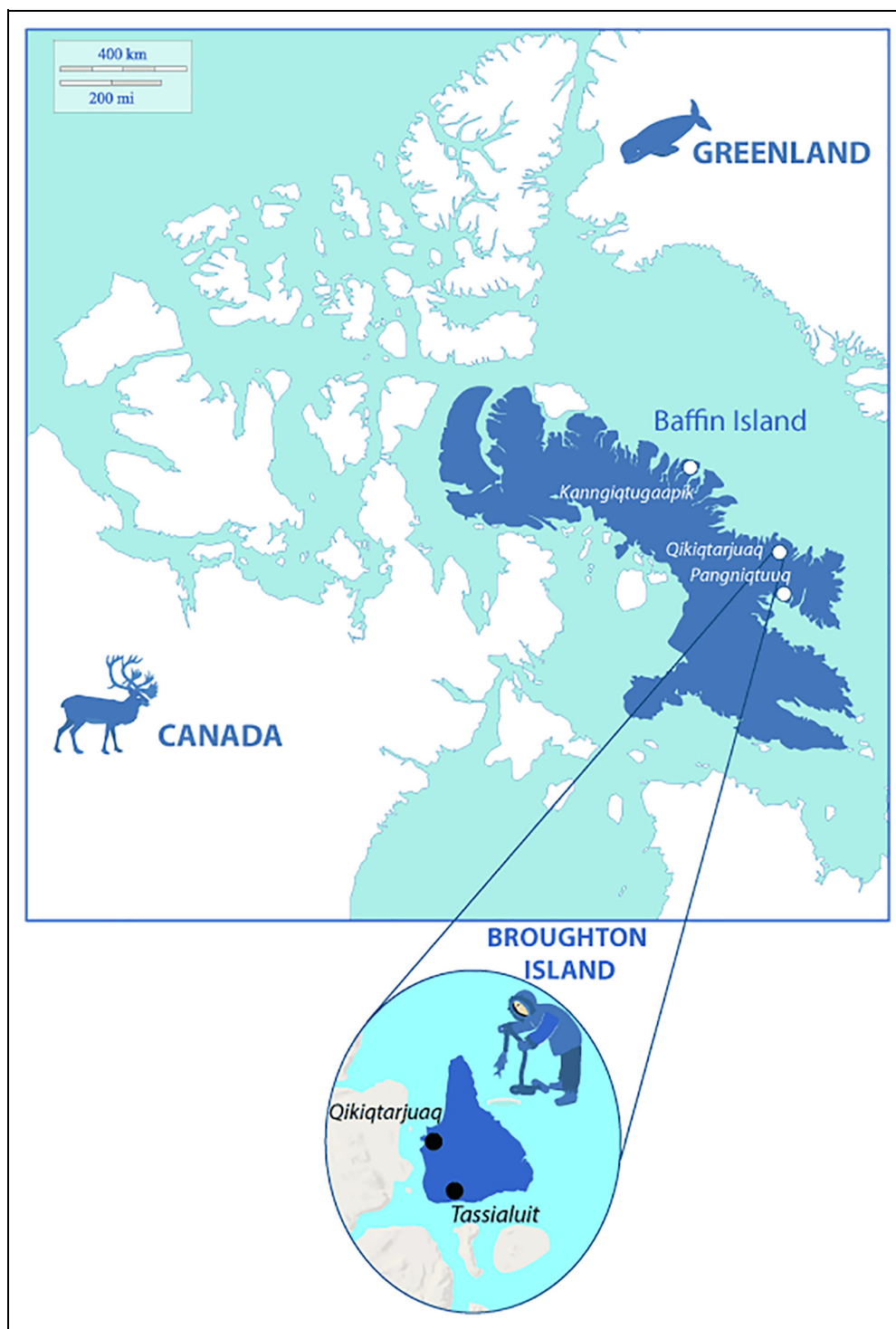


Figure 1. Map showing the three studied communities, Kanngiqtugaapik, Pangniqtuuq, and Qikiqtarjuaq, located on Baffin Island. The hunting camp is also shown in Tassialuit, 1:30 a.m. south from Qikiqtarjuaq by snowmobile. DOI: <https://doi.org/10.1525/elementa.025.f1>

Qikiqtarjuaq does not benefit from the decentralized Government of Nunavut offices, which stimulates the economies of many other communities like Pangniqtuuq, the fishing industry is developing a presence here, in addition to an ongoing seal fishery (Government of Nunavut, 2016). As with many indigenous territories in Canada, all three communities have a growing youth population with 39% of Kanngiqtugaapik's population under 25 years of

age compared to 51% for Pangniqtuuq and Qikiqtarjuaq (Statistics Canada, 2017). In the 2006 census, 72% of Pangniqtuuq and Kanngiqtugaapik residents reported having hunted over the past year.

Relationship building

An essential pre-fieldwork task involved initiating community contact and building trust between the research team

and the communities. Beginning in December 2015, contact with the communities was established through discussions with the Nunavut Research Institute, local researchers with experience working in communities, the regional land claims body, and local associations including Nunavut Tunngavik Incorporated and the Nunavut Wildlife Management Board, as well as community liaison officers. The hamlet Council Senior Administrative officers and mayors were enlisted to help inform the community about the proposed project. After an initial written interaction, two preliminary community visits were arranged to meet the regional, local, and hamlet officials and representatives from territorial government departments, local federal government offices (e.g., Parks Canada), schools (local schools but also Nunavut Arctic College in Iqaluit), local radio stations, and Pangniqtuuq fisheries along with hunters and trappers' organizations (HTO). Conducting all of the necessary background work required more than 2 years. Scientific research licenses were issued by the Nunavut Research Institute on November 24, 2016, for Qikiqtarjuaq (# 023417 N-M) and on April 18, 2017, for Pangniqtuuq and Kanngiqtugaapik (#0100116R-M). Ethical approval was given on May 23, 2016, by the Ethics Committee of *Université Laval* (#2016- 129/23-05-2016).

Face-to-face interview process

Face-to-face interviews with Inuit hunters and fishers were conducted. In order to recruit participants, several events were organized. The first was a presentation of the project in May 2016 during a public gathering with the elders along with HTO. The second took place in May 2016 in Qikiqtarjuaq and in May 2017 in Pangniqtuuq and Kanngiqtugaapik, where the Mayor or HTO liaison officers made a radio call to invite the hunters and fishers to participate in the project, using a script provided by the research team. Finally, through informal discussions and word of mouth, the project became more public.

The research team collected qualitative data through semi-structured interviews from May 7 to 26, 2016, in Qikiqtarjuaq and from May 1 to May 16, 2017, in Kanngiqtugaapik and Pangniqtuuq. In the past, semi-structured interviews had proven useful for other researchers working in the Canadian Arctic (Dowsley, 2007; Pennesi et al., 2012). The participants consisted of Inuit male hunters/fishers (seven in Pangniqtuuq, eight in Clyde River, seven in Qikiqtarjuaq) and one female Inuit health project coordinator from Pangniqtuuq interviewed in Ottawa, for a total of 23 interviews. The desired number of initial participants for each community was reached (approximately 10), and the project did not experience any attrition. Participants were between the ages of 20 and 86. In order to have the same numbers of interviewed persons in each category, a decision was made to classify the different generations into young adults (under 40 years of age), adults (from 40 to 60 years of age), and elders (over 60 years of age). This multigenerational sample allowed a more complete evaluation of Inuit perspectives on climate change through the eyes of the different generations.

A local Inuktitut translator was hired for three interviews conducted with elders. Interviews were all filmed by the research team using a camera (Canon 7D) and a lapel microphone placed on the participants. Prior to the interviews, the subjects were briefed on the details of the study and given assurances about ethical principles, such as anonymity and confidentiality, through a consent form they agreed to sign. This process was in accordance with the requirements of the research license and ethical guidelines set forth by the *Université Laval*. The interviews were conducted either at a location suggested by Inuit participant or at local schools in a spacious and well-lit room provided, so that the hunters felt comfortable in a familiar environment. Those who appear in video interviews in supplementary information (Video S1 and S2) gave their consent to appear on the screen.

A 4-day hunting camp

The team also participated in a land-based activity. Two scientists from the research team and a videographer joined a 4-day multigenerational/gender nomadic hunting camp on sea ice with 13 Inuit. The videographer continuously recorded everything that was said and done during the camp. The hunting camp took place in Tassialuit (**Figure 1**), a usual hunting ground where Qikiqtarjuaq families and friends go on weekends. This particular spot, located 1.5 h from Qikiqtarjuaq by snowmobile, comprises several hunting cabins in order for the hunters and their family to find shelter and rest. From May 27 to 30, 2016, a hunting team was put together, which included Inuit participants:

- Three elders: one man and two women
- Two hunters and their wives (Adults)
- A pastor and his wife (Adults)
- Two female students (Young Adults, 15 and 16 years old)
- Two male children (3 and 5 years old)

Data gathering, analysis, and visualization

Interview discussions and hunting camp questions mainly covered topics related to the impact of the changing climate, such as changes in hunting education, the organization of the hunt (when do you hunt, how, what and where?), the distribution and consumption of the hunt, the introduction or disappearance of certain animals, the role of women and elders, ice safety, and changes observed in the climate and ecosystems. All interviews were transcribed verbatim afterward, thus avoiding bias and keeping a permanent record of what was and was not said. Transcriptions were in English except for three that were in Inuktitut. In the latter situation, we hired a local translator, and data were transcribed in English. Also useful was taking "field notes" during and immediately after each interview to note any observations, reflections, and ideas about the interview, as this approach can assist the data analysis process. A qualitative analysis of the interviews was conducted twice using the NVivo software (NVivo for Mac—Version 11). Two research evaluators then analyzed

the data, which made it possible to verify agreements between the evaluators.

A system of thematic coding of the qualitative data was particularly useful in attempting to determine the range of experiences, perceptions, information, and attitudes within the study population. The technique consisted of classifying and categorizing text data segments into a set of nodes, theme, and subtheme categories. The interpretations were based on observed empirical data. We chose thematic analysis because it allows considerable flexibility in interpreting the data and allows to approach large data sets more easily by sorting them into broad themes. To ensure that the theory was based solely on observed evidence, the approach required that researchers suspended any pre-existing theoretical expectations before data analysis. After the analyses, nodes were organized in a hierarchical structure with themes and subthemes. As the written analysis was conducted according to the qualitative analysis, the current structure of the results is very influenced by the thematic and subthematic coding. We used noteworthy quotations from the transcript in order to highlight major themes within findings. This approach incorporated Inuit perspective directly into our study, as we used their words through quotes extracted from the aforementioned conducted interviews not simply as a complement but rather as a central part of the final and written analysis.

Visual representations were created using Adobe Premiere Pro and Illustrator software to inform our qualitative data (Sansoulet et al., 2019). We first chose to visualize data using word clouds and maps (data not shown), but we found more pertinent to present here a more design-oriented infographic (**Figure 2**) that represents the inventory of the different current species in Qikiqtaaluk region, as well as the new and unusual ones. This inventory was discussed in detail with the participants. Next, infographics and a 13-min documentary called “Inuit Belief” were produced and published on an educational website entitled AOA—Arctic Ocean Arctique, accessible at <http://aoa.education/>. The 13 videos were translated in Inuktitut: <https://vimeo.com/showcase/6726889>. This website is intended for students 11–16 years of age. The platform contains vignettes (web documentaries), each one associated with interactive educational modules (photos, infographics, interactive activities, teaching files). Our partners from Qikiqtarjuaq hamlet were included in the process from beginning to end, and they presented with great enthusiasm this final work locally (especially films and videos). We would like to suggest that, even though this work was conducted with Inuit participants, views of the histories and cultures of Inuit societies from a Western perspective can sometimes lead to a misrepresentation of existing realities: We tried to avoid/minimize this effect by showing and validating our texts and multimedia supports and by having our texts reread to the involved communities.

Results and discussion

Framing change

In this section, we present the cultural, socioeconomic contexts and systems of observation in which this study

was conducted, in order to fully understand the situation in which climate change is perceived in the Arctic.

Complementary beliefs and value systems

Inuit develop tools and techniques to hunt seals, whales, walrus, polar bears, and other arctic wildlife, allowing them to benefit from a healthy and nutrient-rich diet (**Figure 2**). Everything necessary for the traditional Inuit way of life—clothing, tools, shelters, food—is provided by the land they live on and the sea. This characteristic of their way of life leads them to place a high value on respect for the land and for relationship to their environment and its inhabitants.

We believe in life, we have to balance everything for us to be in tune with our environment and Mother Nature. (Inuit adult from Pangniqtuuq)

Therrien (2007) describes this interaction with nature and the concept of Inuit “nuna”: a shared territory, for every human and animal, which has been used for centuries by both. Animals are then considered not only as a means of subsistence but also as a part of their daily life, as members of their community with whom they can interact and communicate.

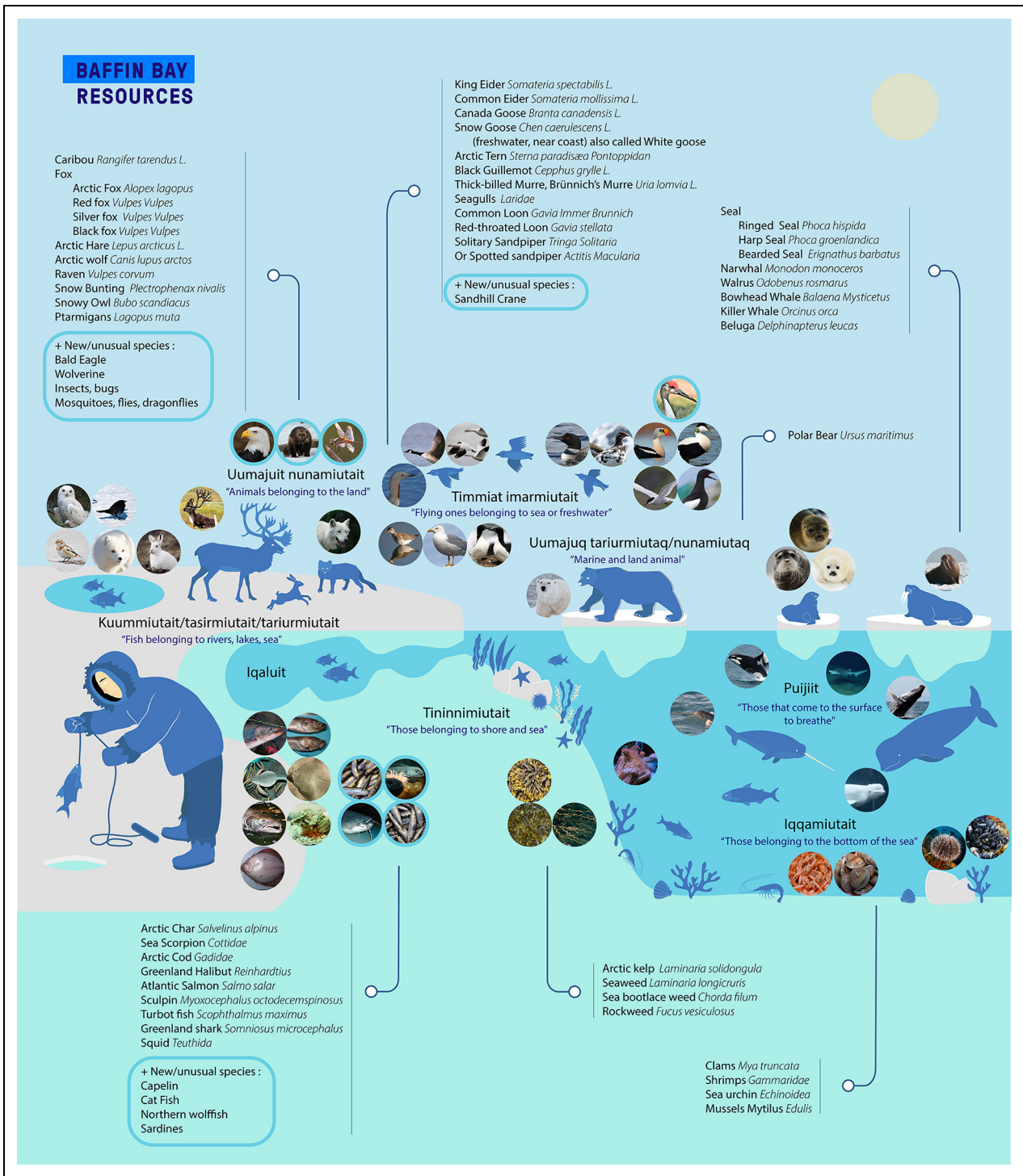
Polar bears seem to be learning from Inuit too. We're learning from them and they're learning from us. For that, polar bears are incredible species . . . [They're] just like community members, they know you, they will recognize you. (Inuit elder from Kanniqqtugaapik)

There is a profound appreciation for the land and for the animals that have sacrificed themselves for the survival of Inuit in many of the traditional stories and teachings that have been passed down from generation to generation. While they respect each animal, Inuit tend to have a particular attachment to the seal, which is considered special (Video S1).

If I buy food from store, it is different taste, it is not gone last very long, if I eat seal it is going to last a very long time. If I go around during winter time, I am not going to be cold faster, because there is blood in the seal meat. Before I go out I want to eat seal meat, because I am going to survive more, I will be warmer. (Inuit adult from Pangniqtuuq)

This relationship to the seal has been documented in all three communities studied and has been observed in the region, where seals are the main traditional means of subsistence. In addition, seal hunting rituals and their consumption contribute to a sense of well-being for the individual or/and the community.

Back then whenever they lived in family camps, they live a nomadic lifestyle, going by seasons, where the animals were available to them and upon catching a seal and this is evident through the circumpolar



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Figure 2. Infographic illustrating marine, air, and land resources in Kanngiqtugaapik, Pangniqtuuq, and Qikiqtarjuaq. This drawing is adapted from Rapinski et al. (2018). DOI: <https://doi.org/10.1525/elementa.025.f2>

Inuit Arctic regions, where a man caught a seal. To give thanks for the catch they placed some snow into the mouth and allowed it to melt on its own and then transferred it to the mouth of the seal. This way they released the spirit, and gave thanks to the gift, and then they were able to enjoy it with their family and the camps where they were situated. (Female Inuit Health Project Coordinator born in Pangniqtuuq)

Honoring animals in this way is a cornerstone of Inuit shamanism (Therrien, 2012). Shamanism, which is defined by the belief that not only living beings but also objects and places each have a particular spiritual essence, plays an essential role in Inuit belief system based on the idea that there are similar souls or essences despite physical differences (Descola, 2013). When Christianity was adopted in the early 20th century, Inuit came to be more discreet about these traditional beliefs (Laugrand, 2017). Despite the advent of Christianity, Inuit continue to see

the world through this lens, a world where they cohabit with other living beings, a world that they cannot control alone but rather try to decipher the wills.

We don't know. We're not controlling the world, we can't control it and it's kind strange. We can't control the world and what the world wants. (Inuit Young Adult from Pangniqtuuq)

This acceptance of the world is one of the main reasons why Inuit have survived and adapted so well to the inhospitable environment (Therrien, 2012), that is, the Canadian Arctic. While many if not all Inuit agree that changes such as warming and melting ice are occurring, they also view these changes as an inevitability to which they must adapt.

Because of their ability and responsibility to pass on knowledge, the elders are highly regarded by other community members.

[When I see something new], I usually go to the elders, elders first. If they don't know, go on the radio, whoever knows this thing, you can call me. But yes, first thing I ask the elders, they know more than us. (Inuit adult from Kanngiqtugaapik)

The main teachings are not just taught by the elders but also by the parents and extended families involved in hunting and fishing activities (uncle, aunt . . .). All believe in the need to prepare the youth to learn to survive on their own.

Same things with my parents, grandparents or others hunters. They teach you all these things so you can survive in this environment. It is not like you can pick up a form and call for help. When you go out you go out, in your own, unless you overdue, then they put up a search party. (Inuit adult from Kanngiqtugaapik)

Stories and legends are passed on from generation to generation, teaching the new generation to learn how to survive in the Arctic. Traditional Inuit education makes learning a part of daily life through observation and practical application. This transmission of environmental knowledge and land skills happens through practical activities out in the field or on the hunt (Pearce et al., 2011).

As a young man, you learn these skills from an adult, either your parents or another hunter you go with. At that time, it didn't feel like they were teaching you but you learn. You learn by watching and doing what you are told. You learn best that way. (Inuit adult from Kanngiqtugaapik)

The problem faced by some communities lies in changes to this traditional way of learning and transmitting local knowledge to young people, as it has been replaced by a formal Western education. However, traditional education is becoming increasingly integrated into the schooling system, particularly through specific programs.

We teach kids, there is program once a year. It's called "Ataata on the land" which means you take a student out, teaching how to hunt, teaching how to travel, to navigate, using snow drifts, the names of the land, how to skin, how to prepare meat for the community or for the family [. . .], and survival in summer in the fjords when the wind picks up. (Inuit adult from Kanngiqtugaapik)

A challenging relationship with the South

Notwithstanding the visit and settlement of a few explorers and whalers in the Canadian Arctic, the colonial history of Inuit begins with the arrival of the fur traders in the 20th century but also involves the missionaries and administrators whose activities in the region helped to colonize Inuit groups (Therrien, 2012). In the early 1900s, the church (primarily Anglican and Catholic) not only took responsibility for conducting religious services but also contributed to health and education services (Oosten, 2005). In the 1950s, the role of education shifted in part from the church to the state as government began showing an interest in the Arctic region because of its strategic location in the context of the Cold War (Video S2).

There were a few families there, I do not know, maybe 5 to 10 families. They were moved from Padloping Island to Qikiqtarjuaq. They didn't have a school there, that's why they did a major clean-up for the last few years. They damaged all buildings, totally clean it up. Yes. [. . .] People were fighting, they were resistant against the move, but it was the federal government decision, they forced people to move to Qikiqtarjuaq. It was forty years ago. They cut all the communities down. So many people died. [. . .] And at the same time, right after, we were forced to go to school. And it was covered up. But government just shot all the dogs and forced people to move in. [. . .] Even today, government is still denying, they say that they never did something wrong. (Inuit adult from Qikiqtarjuaq)

The above statement refers to the forced migration endured by the families of Padloping Island who were moved to Qikiqtarjuaq because of the installation of a radar station, built during the Cold War to act as a Distant Early Warning Line (Josselin, 2017) to enhance their surveillance and hold control of the North. Inuit were forcibly removed from their homes and taken to residential schools, usually hundreds of miles away from their communities. Children were cut off from their families and usually only returned during the summer months, if at all, and were no longer allowed to speak their language or participate in cultural activities (LHF, 2010). The reparations offered by the government can never fully repair the many decades of displacement of entire communities that have affected the relationship of the displaced with their lands, communities, and even their families.

[...] After, they were willing to give compensation, they're willing to give money to go back home but some of the children did not want to go, . . . , they wanted to stay up there. Some of them came with their parents, but few of them, instead of . . . So, we have another problem: their parents, back home, but their children did not want to leave. (Inuit adult from Qikiqtarjuaq)

Observing change

Changing weather patterns

Inuit people do not see their climate as extreme but rather as “demanding” (Therrien, 2007). We have seen that over the centuries and due to their culture of adaptation, they have learned to adapt and survive in the Arctic. However, Inuit of today have been reporting changes in weather predictability over the past 30 years. Persistent changes in the data indicate a clear shift when compared to previous decades (Weatherhead et al., 2010). The impacts of this change in predictability could be significant for Inuit people in terms of health, harvesting activities, and ecosystem changes.

The ice is changing; the flatness and the bumps are different than when I used to hunt. The ice is melting faster than it used to be, back then in 1970s. (. . .) Floe ice does not seem to come early anymore, because of the wind. (. . .) Faster melting and slower freezing. (Inuit elder from Kanngiqtuqaapik)

Inuit from all three communities are reporting changes on the ice as one of the major and most widespread changes to have occurred in recent decades (Video S1). The nature and stability of the ice is changing, along with the frequency and rapidity of the freezing of the ice, which is now also occurring later in the year according to locals.

It is almost five months summer now. We use to have only four months per year summer. (. . .) It changed. The weather is warmer. (Inuit elder from Qikiqtarjuaq)

Our observations of the impacts of climate change on the sea ice do indeed correlate with those of Meier et al. (2006) who found similar changes in ice stability based on Inuit testimonies they collected. Their observations suggest that not only is there less ice cover, but the ice has become “softer” and less stable. These findings are consistent with what respondents told us about the changes that they have observed.

Back then, if we were in Arctic if it was a winter it would be -60 but at these days it seems to be going -40 and that environment seems to be changing [...] It's definitely getting warmer. And when someone is trying to build one [an igloo] they're having a hard time finding the right type [of snow]. You know texture of the snow is different now. The

snow is softer now. (Inuit adult from Kanngiqtuqaapik)

Arctic warming and glacier melting have been documented by the scientific community for quite some time now. While Inuit do not use the same tools to measure climate change, they have reported significant and accurate changes in temperature since the 1990s (Weatherhead et al., 2010). These changes in temperature have been confirmed by our respondents in the three communities studied. They recall seeing many more glaciers when they were younger, or they see the changes based on what they have heard from elders.

Nowadays, our glaciers seem to be melting even further than we thought. Back then they weren't that much cracks or any other things that could make it more sensitive. (Inuit elder from Kanngiqtuqaapik)

According to our respondents, the character of the wind is also directly linked to how quickly the ice and the snow are melting. Nevertheless, opinions differ greatly on the changes observed in wind patterns over the past few decades. In Kanngiqtuqaapik, for instance, some adults do not consider that there has ever been any change in the wind, whereas the elders consider that, in fact, the wind is effectively and rapidly changing.

The wind is changing; back then, when the weather permitted it would be very nice all week day long. Nowadays it seems to be a wind that pass every three or four days. Back then, it used to be one week long. Nowadays there is more wind than it used to be. (Inuit elder from Kanngiqtuqaapik)

Impacts on safety on the ice

People says weather is changing faster. Sometimes it is harder to go out hunting by skidoos because people have accident, they do not survive because the ice is thinner and thinner. Some people got lost, they go down, the ice is too thin, they don't survive some people survive some other lose everything. There are more accidents than before. (Inuit adult from Pangniqtuuq)

Nowadays it's very sensitive to cross the glaciers or just to drive close to it. It's getting dangerous now. It's very important not to drive too close to ice glaciers. But if it's on the ice like the floe edge ice, it'll be alright unless it's springtime. (Inuit elder from Kanngiqtuqaapik)

The melting of the ice and the change in the stability of the land and the sea ice poses a real problem for hunters who are being forced to alter their usual routes in order to avoid the most “sensitive” areas caused by new cracks in the ice. Such travel route changes can lengthen the duration of the hunt and the distance traveled by hunters in order to reach an area of interest for hunting. Similarly, another

important and often overlooked consequence of the changing icescape is that uncertainty increases, which contributes to a general feeling of danger or lack of safety. This uncertainty therefore has a real impact on the psychological state of hunters and their families (Dowsley et al., 2010). Monitoring for cracks, strong winds, or ice breakup over entire seasons allows the residents to determine the safety of the sea ice for hunting and transport (Gearheard et al., 2006), but as such changes become more frequent, adapting to them is becoming increasingly difficult for hunters. Furthermore, the communities rely on the experience and knowledge of the elders and of the adults who have been hunting all their lives, and are still able to go hunting. As uncertainty and dangerous conditions on the ice increase, however, people become less active on the ice, including young people. Younger generations are thus losing important learning experiences from the hunt.

Changing animal resources

The observations made by Inuit from the three communities studied indicate a significant change in the types of species hunted (Video S1). Indeed, in the three communities, the disappearance of the caribou and the narwhal has been acknowledged. In Kanngiqtugaapik and Pangniqtuuq, some birds, like the Canada goose, the Arctic tern, and the snowy owl, are less visible than before. In Qikiqtarjuaq and Kanngiqtugaapik, seals, although still a main source of food, have become sparser and difficult to catch. A suspected reason for this behavior is phenological mismatch:

We know that by March the seal pups are born to their moms between the sea ice and the snow so with climate change and the sea ice melting sooner than in the past, our diet is at peril. (Inuit adult from Pangniqtuuq)

In contrast, some animals have become more present over the last decade. Many bird species, like cranes, geese (white goose, snow goose), seagulls in the winter, and some unidentified species of birds described as “westerners’ birds” by an Inuit adult, have been sighted in the region. Fish, such as sardines, Atlantic salmon, capelins, more Arctic charrs, and even a catfish (in Pangniqtuuq), were also spotted.

In 2016, in an article focusing on Nunavut, the Inuvialuit Settlement Region and Nunatsiavut, Rosol et al. (2016) discussed the impact of climate change on the evolution of species hunted by all 36 communities. Qikiqtaaluk communities participating in this earlier research reported population declines of 60% for caribou, almost 70% for fish, almost 20% for seal, almost no difference in the bird/fowl abundance, and 15% for whales in the year preceding the current study.

According to several Inuit interviewed, the warming has also had an impact on the animals and could be the reason for their migration.

[Birds are] probably changing their routes because it's getting too warm, they're going to the cold climate. (Inuit adult from Pangniqtuuq)

The declining presence of caribou led the residents of Pangniqtuuq (defined as “the place of many caribou bulls”) to try finding alternative species to eat, like ptarmigan.

Everybody tries to catch it [ptarmigan] and we never stop to catch it, everybody wants cause it's good cause we're not supposed to catch caribou and we make soup out of the ptarmigan. It's almost same taste of caribou, the rabbits too, almost same taste of caribou meat. Because they're eating the same thing. (Inuit elder from Pangniqtuuq)

When he says, “we’re not supposed to catch caribou,” he is referring to the implementation of quotas by the government, which regulate the number of caribous each community can hunt in a given year. Both these quotas and the caribou migration lead to a significant decrease in caribou consumption.

In 2007, Dowsley (2007) raised the possibility that the effects of climate change on Qikiqtaaluk ice may force polar bears to stay on land for longer periods, resulting in poorer health due to a longer period of fasting in the summer and a shorter hunting season in the spring. Observations by Inuit from Pangniqtuuq and Kanngiqtugaapik suggest that the effects of climate change on the ice and on polar bears are now being observed in the Qikiqtaaluk region, even though the findings are still mixed.

Hunting, fishing practices, and eating habits

Hunting, fishing practices: Usual versus new practices

Inuit ancestors quickly realized the need to use every resource available to them in order to survive in the Canadian Arctic. Animals constitute the majority of these resources to varying degrees depending on season, location, animal behavior, and Inuit preferences and habits (Therrien, 2012).

My grandfather remembers that, when he was young, he was with dog teams instead of snowmobiles or any other engines whatsoever. (. . .) And there were no radios or whatsoever. (Inuit elder from Kanngiqtugaapik)

The changes observed in hunting practices can also be linked to the relocation experience endured by Inuit. As a result of the history described above, they changed their hunting equipment from sled dogs to snowmobiles. Previously, hunters camped in the spring “with a dog team (around 12 dogs), needing about three seals to feed the dogs for a 1-week hunt” (Inuit adult from Qikiqtarjuaq). They used to build igloos or sleep in the shacks in winter and in tents during the summer. Today, they use snowmobiles in the spring, fall, and winter and boats during the summer (Therrien, 2012). The consistency of the ice combined with the increasing weather uncertainty has made the building of igloos more of an opportunity than a habit.

If we go caribou hunting there's cabins or either in the tent or if I have an elder that can make an igloo in the snow. (Inuit adult from Pangniqtuuq)

The arrival of new technologies in response to climate change has changed the way Inuit hunt, through changes in the nature of their equipment and the scope of their hunting territory. The integration of modern technology such as the radio, the smartphone, the GPS, and the snowmobile has had a tremendous impact on the traditional Inuit way of life and the way they hunt and travel on the ice (Video S1). Using powerful rifles and gas-powered vehicles, Inuit can now hunt and travel in vastly different ways than their ancestors ever could. This adaptation can be seen as positive, as it increases the ability to travel and secure a greater amount of game. It comes, however, at both a financial and cultural cost (Wright, 2014).

Inuit ideas around sharing and minimizing waste are also threatened by these changes. Indeed, even if Inuit people keep the concept of sharing at the center of their way of life, they need to work and make money to pay for store-bought food and equipment to hunt.

Ten years ago, when we were hunting [caribou], we never sold them, us, and we would just give to the people that don't go hunting (. . .) but nowadays people are selling them through Facebook, and for the money, for the gas, for ammunition or for the supplies that hunter that needs. (Inuit elder from Pangniqtuuq)

Given the vital importance of animals for the very survival of Inuit in such a demanding environment, they have learned to use every single part of their catch to survive, even through some very hard times, such as periods of starvation. They “use everything from their catch, from the meat to the skin, the eyes, brain, heart, fat, tusks, and sometimes even the liver” (Inuit Young Adult from Qikiqtarjuaq). Turning the skins of animals into clothing such as kamiit (boots) or atigi (vests) is still a staple of their activities (Therrien, 2007). Nevertheless, our observations are consistent with the people who describe a decreasing number of full-time hunters along with an increase in the female workforce. These changes have led to the replacement of traditional clothing with expensive fabric clothing, even though the latter does not possess the same thermal and aesthetic properties (Therrien, 2012).

We can observe a clear preference for natural traditional food, yet store-bought food remains popular and is one of the main causes of Inuit food insecurity, given food cost, access to perishable foods, processed food, high fat, and glucose food. This food insecurity is particularly the case in Nunavut, where 68.8% of adults experience a high level of food insecurity compared to a national Canadian average of 9.2% (Huet et al., 2012).

As an Inuit elder from Kanngiqtugaapik explained, this cause of food insecurity is attributable to the arrival of supermarkets, such as Northern (which is owned by the North West Company), as “it was easier,” in the

sense that he had to provide less physical effort to access food.

If I'm working, I'll buy more stuff at Northern. If I'm not working, I get more from outside. Because sometimes I work seven days a week, 11 hours a day. But spring and summer, 24-hour day light, after working hour, I'm gone. I only got few hours to rest, come back, cut my seal, go to bed and in the morning, go to work. (Inuit elder from Kanngiqtugaapik)

The dependency on work and money described earlier may be directly related to the high cost of a diet that is increasingly based on store-bought food. The need for money to buy fuel and the use of store-bought food can drive communities into a positive regulatory feedback cycle that will make them even more dependent on store-bought food. According to Ford et al. (2012), these socioeconomic–cultural factors are primary determinants of food security, as this second part of our study appears to confirm. Ford et al. (2010) highlight the fact that the significant changes in climate being observed in Nunavut, as we described in the first part of this study, are not directly affecting food security. We believe, however, that this socioeconomical effect is reinforced by the impacts of climate change on the possibility of going out on the ice, along with the diminishing populations of animals. At least these changing sociological (e.g., lifestyle changes, monetary economies) and environmental conditions (e.g., climate change, species decline) should have combined impacts on the consumption of traditional food (Duhaime et al., 2002).

Benefits and changes in eating habits

The longtime abundance of certain species, such as the seal, caribou, and Arctic char, has meant throughout history that Inuit included them in their daily diet. In support of this habit, they found many different ways to prepare their animals. Whether boiled, cooked, dried, fried, frozen, raw, or smoked, Inuit know when and how to cook each of their animals.

We can eat them raw. It's so good when they're frozen. And you cook them, boil them, fry them, dry them, smoke them [. . .] You try to make it the same way. And to make it last longer, you freeze it. (Inuit adult from Pangniqtuuq)

Certain techniques have been inherited from passed-on knowledge and experience, such as “igunak,” which consists of catching an animal, most often a walrus, in the summer, slicing it into steaks and putting it underground, so that it ferments in autumn and freezes in winter. In the summer, the meat is dug up for consumption and is considered valuable, rich, and tasty. In Pangniqtuuq, this method of preparing the meat is considered a delicacy and is very valuable, despite being less prepared than before. In the three communities studied, Inuit preferred traditional food, and if it was not already

the case, they often wanted to be able to eat more seal, caribou, or ptarmigan every day (**Figure 2**).

Oh, yes [country food is important]. If I cook spaghetti or pork chops or something and if I have caribou meat, my sons will ask, can we have caribou instead? They want some more caribou all the time, they like caribou more. (Inuit elder from Kanngiqtuqaapik)

The benefits of eating traditional food are not only good for “your stomach, your muscle and your body,” as described by an Inuit elder from Kanngiqtuqaapik, the role of the seal meat also plays an important factor for the psychological state and overall health of Inuit “that shouldn’t be put aside.”

In fact, the seal even appears to help maintain the physical, mental, and spiritual well-being of the individual; the social fabric of the community; and the confidence in Native power relations, and structures, to maintain self-determination (Borré, 1994). The impact on communities resulting from the depletion of seal numbers and traditional food may be devastating in the sense that it would have a profound impact on the socio-economic and individual status of Inuit.

Inuit have not observed much change in the quality of the meat, except for the polar bear and the seal. Inuit from Pangniqtuuq and Kanngiqtuqaapik have agreed that there has certainly been a change in the polar bear meat.

There has been lots of changes from 60 years ago when they were able to eat polar bear meat raw, frozen, now 60 years later you can't eat it raw because of all the toxins it has within itself so it has to be cooked for hours and hours before they could enjoy it at a dinner table or at a community feast. (Inuit adult from Pangniqtuuq)

If that polar bear (. . .) is very skinny, you don't have to eat it raw, you just cook it and cook it. But if it's very fat, and very healthy you can eat it frozen without even cooking it. But once it's very skinny, and no fat at all, you would dehydrate and get sick, and you wouldn't be getting up probably for two days, three days, approximately. (Inuit elder from Kanngiqtuqaapik)

Moreover, the changes observed in the meat of some animals—such as “all the toxins” present in the polar bears as discussed above—can have direct consequences on the overall health of Inuit. In fact, Inuit have reported a direct link between viruses and disease in parallel with the decrease in animal consumption and the increase in local store-bought food products within communities. Specific techniques have long been used to identify sick animals before catching them, such as walruses, which often carry diseases. Nevertheless, the sick species of animals can easily be identified visually through their physical appearance (skin rashes, skinny appearance

. . .) or by testing the meat at the conservation office or health center.

A collaborative work

Inuit insights are particularly crucial for scientists in the Arctic, where climate change creates an urgent need to understand local dynamics, but the need for collaborative and reciprocal work is observed on both sides.

It is important to collaborate any way possible, regardless of who we are—organization, group or school, scientists. We need to work together and collect much information, as much as possible for our next generation. This way, we can build up Qaujimajatuqangit (Inuit traditional knowledge). (Inuit adult from Pangniqtuuq)

This production of knowledge can lead to a better understanding of the current changes happening in the Canadian Arctic and more specifically in Qikiqtaaluk communities while trying to clarify misunderstandings between local inhabitants and scientists by considering the historical, economic, and social context of the region in the work. An approach that links local knowledge with scientific methods is a promising path to pursue, one that could yield unexpected positive results.

Like I said in my QYA board director, that's what we're always studying, our ocean, our ocean creatures, are they behaving, are they not behaving, the way they used to behave, we're observing. Your research could be really useful for us. (Inuit adult from Pangniqtuuq)

This study supports the conclusion of a number of research studies on the need for collaboration between Inuit and the scientific community in the South (Gearheard et al., 2010; Pennesi et al., 2012) and advocates bringing these sources of knowledge together to better examine climate change in the Arctic. This study identified the need for strong leadership as one of the most important elements of this collaboration (Video S2).

I think it depends a lot on leadership. But the people are so deeply wounded that they don't know how to properly negotiate, and make things even worse. In this situation, we really need mediators and you have to understand both sides. If you don't have that, it can get out of balance and it could be misunderstanding. . . . But today, some play leaders have really. . . I mean. . . did something to bring some kind of reconciliation or understanding. For myself, I am willing to bring the gap together. I think that is very important. (Inuit adult from Qikiqtarjuaq)

Having leaders who are able to understand both Inuit and scientific perspectives, with mediators who speak both languages, would improve communication and interactions between these two parties. This path forward

could be a way of bridging the gap between different perspectives and lead to a profound restructuring of the Canadian Arctic in future decades.

Conclusion

In the context of the Green Edge project, aimed at understanding the spring phytoplankton bloom that supports the Arctic marine ecosystem, scientists were interested in elaborating a documentary perspective, one that fostered stronger connections with local Inuit communities in order to gain insights into current local knowledge about environment and food harvested from the larger ecosystem. We found that conducting qualitative video interviews and participating in a hunting camp with multigenerational and multigender Inuit hunters and fishers from Nunavut allowed knowledge development that provided valuable insight into how the impacts of climate change are perceived locally in the Arctic communities of Kanngiqtugaapik, Pangniqtuuq, and Qikiqtarjuaq. To this day, Inuit people of these communities continue to see the world as one that they cohabit with other living beings, particularly animals; a world that they cannot control on their own; and a world in which they have to adapt to survive, where learning is transmitted from generation to generation. Several decades of displacement of entire communities have affected their perspective and their relationship with their land. With respect to Inuit perceptions on climate change, including weather, climate impacts on the ice, and invasive/disappearing species, Inuit report the change in the ice as the main and most widespread change to have occurred in the last decades, with adaptation to this change being increasingly difficult and unsafe for hunters. Inuit observations also indicate change in the populations of hunted (and associated) species, with less caribou and narwhals, more birds (bald eagles, wolverines), insects (bugs, dragonflies), and fish (capelin, catfish, northern wolffish, sardines), and an uncertain view of the state of the polar bear. Seal hunting, which remains stable, provides meat that is considered the most popular and the healthiest food from many perspectives. However, sociological and economic changes (e.g., lifestyle changes, monetary economies, quotas), in addition to environmental changes (e.g., climate change, species change), have all had significant impacts on traditional food harvesting and consumption practices in these communities. Developing a collaborative effort and sharing of knowledge between scientists and local Inuit is seen not only as a scientific necessity but also as an adaptive and beneficial pathway forward, recognized among Inuit themselves, with some local leaders from these communities prepared to help build this bridge.

Data Accessibility Statement

Part of the data set has been made accessible at: Sansoulet, J, Pangrazi, JJ, Sardet, N, Mirshak, S, Fayad, G, Bourgain, P, Babin, M. 2019. Green Edge Outreach Project: a large-scale public and educational initiative. *Polar Rec* 1–8. DOI: <http://dx.doi.org/10.1017/S0032247419000123>.

Supplemental material

The supplemental files for this article can be found as follows:

- Video S1. 13 min documentary—Inuit Belief. “Hunting and fishing practices in a context of climate change”: This video is part of the educational website Arctic Ocean Arctique (<http://aoa.education/>). Production: UMI Takuvik (MP4) (<https://www.youtube.com/watch?v=ALJJaJ1LRAQ>)
- Video S2. Qikiqtarjuaq pastor witness about scientific collaboration with communities. This testimony was taken in cabin during the multi-generational and gender hunting camp that took place in Tassialuit in May 2016.

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The authors have declared that no competing interests exist.

Author contributions

- Contributed to conception and design: JS, MT, GP.
- Contributed to acquisition of data: JS, MT, GP.
- Contributed to analysis and interpretation of data: JS, MT, JD, GP, JD, NS.
- Drafted and/or revised the article: JS, JD, GP, JD, NS, JPV.

- Approved the submitted version for publication: JS, MT, JD, GP, JD, NS, JPV.

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