

Iqaluktutiaq Voices: Local Perspectives about the Importance of Muskoxen, Contemporary and Traditional Use and Practices

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ABSTRACT. Understanding human-wildlife relationships and interactions is crucial to implementing policies and practices related to wildlife and public health that are locally relevant and adapted to local communities and needs. With the goal of informing a community-based participatory muskox health surveillance system in the community of Iqaluktutiaq (Cambridge Bay) on Victoria Island, Nunavut, Canada, we explored the importance of muskoxen for community residents, their relevance for local food security, and the relationships and interactions between *Iqaluktutiamiut* and muskoxen. We investigated these themes through individual interviews of 30 community members identified as muskox experts by local organizations. Results were finalized and refined with 26 interviewees in feedback sessions. For Iqaluktutiaq residents, muskoxen have nutritional, economic, sociocultural, and environmental importance. The decline of muskoxen documented locally has a multidimensional impact on the community, with negative effects on all the domains explored, from food security to the integrity of the cultural system. Descriptions of subsistence and commercial harvesting and butchering practices are an asset for the successful implementation of participatory muskox health surveillance activities (e.g., hunter-based sampling), as well as for interpretation of derived data (e.g., local knowledge on muskox diseases). Knowledge of specific harvesting practices that might increase exposure to zoonotic agents is also relevant for designing targeted strategies to mitigate public health risks. This research underlines how careful examination of the human-wildlife context through local perspectives can benefit wildlife health surveillance, public health, and wildlife co-management outcomes.

Key words: co-management; food security; hunting; Inuit knowledge; traditional and local knowledge; participatory research; public health; risk communication; risk perception; wildlife health surveillance; *Ovibos moschatus*; Cambridge Bay

RÉSUMÉ. Comprendre les relations et interactions entre les humains et la faune est essentiel à la mise en œuvre de politiques et de pratiques liées à la faune et à la santé publique pertinentes du point de vue local et adaptées aux communautés et aux besoins de l'endroit. Dans le but d'informer un système communautaire participatif de surveillance de la santé des bœufs musqués dans la communauté canadienne d'Iqaluktutiaq (Cambridge Bay) sur l'île Victoria, au Nunavut, nous avons étudié l'importance du bœuf musqué pour les résidents de la région, leur importance en matière de sécurité alimentaire locale, ainsi que les relations et les interactions entre les *Iqaluktutiamiut* et le bœuf musqué. Nous avons étudié ces thèmes au moyen d'entrevues individuelles auprès de 30 membres de la communauté considérés comme des experts du bœuf musqué par des organisations locales. Les résultats ont été finalisés et affinés dans le cas de 26 interviewés ayant participé à des séances de commentaires. Pour les résidents d'Iqaluktutiaq, les bœufs musqués revêtent une importance nutritionnelle, économique, socioculturelle et environnementale. Le déclin du bœuf musqué, documenté localement, a des incidences multidimensionnelles sur la communauté, dont des effets négatifs sur tous les domaines explorés, allant de la sécurité alimentaire à l'intégrité du système culturel. La description de la chasse de subsistance et des pratiques commerciales d'abattage et de dépeçage est un atout pour la mise en œuvre réussie d'activités participatives de surveillance de la santé des bœufs musqués (comme l'échantillonnage en fonction des chasseurs) et pour l'interprétation des données dérivées (comme les connaissances locales sur les maladies des bœufs musqués). La connaissance des pratiques d'abattage susceptibles d'accroître l'exposition aux agents zoonotiques est également pertinente à la formulation de stratégies ciblées visant à atténuer les risques pour la santé publique. Cette recherche fait ressortir à quel point l'examen approfondi du contexte des relations entre les humains et la faune grâce aux perspectives locales peut profiter à la surveillance de la santé de la faune, à la santé publique et à la gestion de la faune.

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Mots clés : cogestion; sécurité alimentaire; chasse; connaissances inuites; connaissances traditionnelles et locales; recherche participative; santé publique; communication des risques; perception des risques; surveillance de la santé de la faune; *Ovibos moschatus*; Cambridge Bay

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INTRODUCTION

In the Arctic, the health and sustainability of wildlife populations directly influence the nutritional and social health of individuals and communities and contribute to the health and resilience of local social-ecological systems. Wildlife species, as a source of traditional or “country” foods, play an important role in promoting both food security and the health of northern people (Kuhnlein et al., 2001, 2009; McGrath-Hanna et al., 2003; Berner and Furgal, 2005; CINE, 2005; Myers et al., 2005; Loring and Gerlach, 2009) in an area particularly vulnerable to food insecurity (Meakin and Kurvits, 2009; ICC, 2012). One assessment for Nunavut, Canada’s northernmost territory, with about 37 400 inhabitants (Nunavut Bureau of Statistics, 2017), suggests that 68.8% of households are food insecure, and this rate is expected to increase as the population continues to grow (Rosol et al., 2011). The income-in-kind or replacement value from country foods and the collateral cash economy associated with traditional food harvesting (e.g., selling of pelts and associated manufactured products) are significant, although difficult to capture analytically (Myers et al., 2005). For instance, it has been estimated that the replacement value of caribou meat harvested each year from the Qamanirjuaq herd alone was \$15.1 million (BQCMB, 2013). Finally, and equally importantly, wildlife-harvesting activities are intrinsically connected to Indigenous social and cultural identity (Myers et al., 2005), and they contribute to shaping local knowledge systems (Berkes et al., 2000; Usher, 2000).

The alterations that northern ecosystems are facing under the pressure of rapid environmental and socio-economic changes are an increasing concern for the negative impact they may have on wildlife populations (Meakin and Kurvits, 2009). For instance, shifts in the geographic distribution of species (McCarty, 2001; Parmesan, 2006; Post et al., 2009; Kashivakura, 2013; Kutz et al., 2013a), altered host-parasite interactions (Harvell et al., 2002; Kutz et al., 2005; Altizer et al., 2013; Gallana et al., 2013), and “mismatch” between the availability of resources and the physiological needs of wildlife species can pose a threat to the health, sustainability, and resilience of Arctic wildlife (Parmesan, 2006; Post et al., 2009). In addition, as demonstrated in other contexts where Indigenous minorities have been moved into permanent settlements, life in centralized communities can contribute to the increased localization of harvesting pressure on wildlife populations and consequently to the depletion of local resources (Hitchcock,

1995; Leeuwenberg and Robinson, 2000). This pressure, when combined with modernized hunting practices and technologies and decreased diversity in country food consumption, may threaten the viability of local populations of free-ranging wildlife. Finally, sustainability of wildlife and safety of wildlife for human consumption are becoming increasing concerns in the Arctic because of the emergence of new pathogens, including zoonoses. For example, Kutz et al. (2015) documented unusual muskox mortalities associated with the emergence of the zoonotic bacterium *Erysipelothrix rhusiopathiae*, which has been newly isolated in muskoxen and apparently is new in the Arctic. All these phenomena warrant special attention because they can modify the resilience of Arctic socio-ecological systems.

In these rapidly evolving contexts, wildlife health surveillance is crucial to allow the timely implementation of strategies for wildlife conservation, sustainability, and population viability, as well as for the protection of human health (Kutz et al., 2013b; Stephen and Duncan, 2017). The critical first step towards delivering improved outcomes for both people and wildlife is understanding the local human-wildlife relationships, including how wildlife is culturally and economically valued, what type of interactions exist between people and wildlife populations, and what outcomes (both positive and negative) result from these interactions (Decker et al., 2012). In addition, in communities that largely depend on the harvesting of wild game for subsistence, it is valuable to understand the local practices for harvesting, preparation, and consumption of wildlife meat, as well as people’s perceptions of its safety for humans, when delivering information on wildlife diseases. Communicators can thus better frame messaging on wildlife health and diseases so that resource users do not exaggerate or underestimate the threats to their health (Decker et al., 2010; Stephen and Duncan, 2017).

In this study, we explored the multifaceted interactions between people and wildlife, with specific reference to the residents of Iqaluktuiaq (Nunavut, Canada) and to muskoxen (*Ovibos moschatus*). This research is part of a broader project focused on gathering traditional and local knowledge to inform a community-based participatory muskox health surveillance system in Iqaluktuiaq. Our present work, including methods and findings, serves as a model to better explore the complex human-wildlife interface in other settings characterized by traditional food systems and contributes to efforts to promote improved socio-ecological resilience of rural northern communities.

METHODS

Study Area

We conducted our study in the community of Iqaluktutiaq (Cambridge Bay), located in the southeastern part of Victoria Island in the Kitikmeot Region of Nunavut (Fig. 1). The community grew around a trading post that was settled in 1921 by the Hudson's Bay Company. Starting in the 1950s, more and more Inuit started to live year-round in the community, which grew rapidly with the increase in municipal services (Municipality of Cambridge Bay, 2017). Currently, the population of Iqaluktutiaq is approximately 1600 people, the majority of whom are Inuit (Statistics Canada, 2016). Although life in the community is rapidly changing with influences from southern Canada, unemployment remains high, and the harvest of free-ranging wildlife is essential to the subsistence economy. In Iqaluktutiaq, as in most Arctic communities, gardening and agriculture are limited, so any fresh food other than country food has to be flown in (Myers et al., 2005; Loring and Gerlach, 2009; Meakin and Kurvits, 2009).

Another important year-round resident of the Iqaluktutiaq area is the muskox (*Ovibos moschatus*). An Ice-Age survivor that was considered almost extinct on the Arctic mainland at the beginning of the 20th century, the muskox was finally protected in Canada in 1917 (Lent, 1999). With the implementation of active management (hunting bans), muskox numbers increased, especially on Banks and Victoria Islands in the Canadian Arctic archipelago, and since the 1960s, muskoxen have recolonized their historical range (Dumond, 2006; Gunn and Patterson, 2012) (Fig. 1). Recently, however, local and scientific knowledge show a decline in muskox numbers in the Iqaluktutiaq area (Leclerc, 2015; Tomaselli et al., 2018) and increasing evidence, including disease emergence and mortality outbreaks, that the health status of muskoxen has deteriorated (Kutz et al., 2013a, 2015, 2017; Tomaselli et al., 2016, 2018). These combined events raise concern regarding current and future sustainability and resilience of muskoxen in the study area.

Interview Process and Data Analyses

From July to September 2014, we performed 30 individual semi-structured interviews in the community of Iqaluktutiaq. We recruited participants that were identified as “muskox experts” by the Kitikmeot Inuit Association (KIA) and the local Ekaluktutiak Hunters and Trappers Organization (EHTO) (purposive sampling; Davis and Wagner, 2003). We also asked participants to identify additional community experts to include in our study (snowball technique; Green and Thorogood, 2014). We adopted the principles of grounded theory and defined the sample size by the thematic saturation approach: that is, we stopped recruiting participants when no new information or themes emerged from the narratives of new interviewees

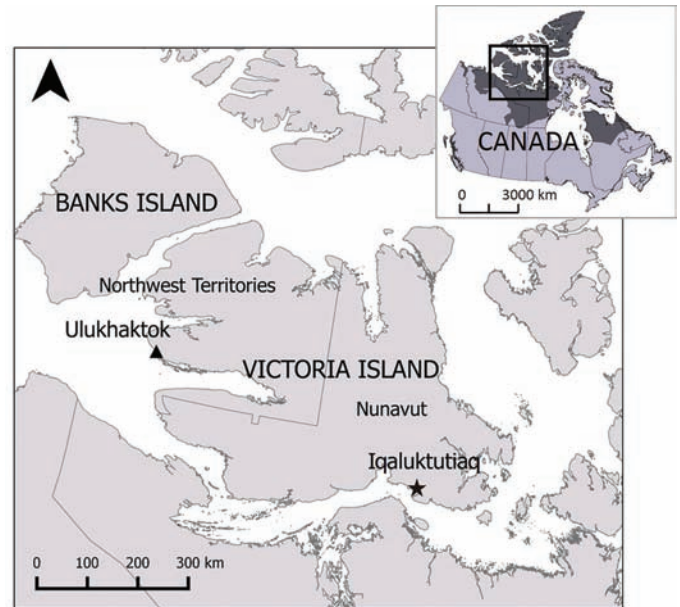


FIG. 1. Map of Victoria Island showing the communities of Iqaluktutiaq, Nunavut (study area), and Ulukhaktok, Northwest Territories. The current known distribution of muskoxen in Canada is shown in dark grey on the smaller map at top right, using information from Kutz et al. (2017). Map generated in QGIS 2.8.9.

(Watling and Lingard, 2012; Green and Thorogood, 2014). Participation was voluntary, with written informed consent, and interviewees could withdraw at any time during the study. Anonymity was assured by assigning each participant a pseudonym and following a standard protocol for data and identity management. A monetary compensation, the amount set by the KIA, was issued after the interviews. The length of the interviews varied among participants, with an average of approximately two hours.

The questions explored participants' perspectives on the importance of muskoxen, the relative importance of muskoxen as country food, muskox harvesting and butchering practices, including meat storage, and preparation and consumption methods (see online Appendix S1). Finally, we explored participants' concerns regarding the local muskox population. Open-ended questions were used in the interview process to avoid constraining interviewee responses to predetermined categories and to allow for more open dialogue and emergence of themes (Huntington, 2000). Participatory proportional piling techniques (Chambers, 1994; Mariner and Paskin, 2000) were implemented to further explore the relative importance of different country foods in the diet of participants. Proportional piling exercises use a fixed quantity of counters as a unit of measure to help participants identify proportions (Mariner and Paskin, 2000). Here we used a fixed mass (0.5 kg) of beans that were measured using a measuring cup with a percentage scale to allow rapid identification of proportions (Tomaselli et al., 2018; Appendix B). We began by asking questions about the relative annual proportion of country food and store-bought food consumed and how these proportions have changed

over time. Then, we explored the relative importance of muskoxen as food, measured against the total amount and variety of country foods consumed, and inquired whether and how proportions have changed over time. Descriptive statistics were used to analyze and report quantitative data originating from the proportional piling exercises.

During the interviews, field notes were taken and the entire interview was audio-recorded to allow thorough thematic content analysis (Green and Thorogood, 2014; Braun and Clarke, 2006). Audio records were analyzed by coding the data in themes using both deductive and inductive approaches. Key information for each theme was transcribed to allow for comparison among interviewees and emergence of patterns within the data (Green and Thorogood, 2014). Once the information was interpreted and summarized, we verified the findings by presenting the results to participants through individual or group community feedback sessions held in May 2016 (Johnson, 1997; Green and Thorogood, 2014). Participants had the opportunity to comment on the aggregate data presented in order to corroborate, further refine, and expand on or clarify results. A local interpreter and translator suggested by the KIA was present during interviews and feedback sessions with two Elders whose first language was Inuinnaqtun and who were not fluent in English. The remaining participants did not require or request the presence of the interpreter.

RESULTS AND DISCUSSION

The participants included 28 year-round community residents, of whom 23 were Inuit (nine Elders and 14 adults) and five non-Inuit, and two summer residents (commercial float plane pilots). For the community of Iqaluktuiaq, “Elder” refers to an Inuk of age 60 or older who has earned respect as an Elder from this community. Participants ranged from 30 to 84 years of age, with an average age of 53 years. Interviewees were predominately male, with only five females among the 30 participants. Finally, 26 of the 30 interviewees participated in feedback sessions and all agreed with the results we present here.

Importance of Muskoxen

All 30 participants considered muskoxen to be important at both the individual and community levels. Four major themes emerged from participant narratives: nutritional, sociocultural, economic, and environmental importance. Subthemes identified in each of these domains provide a deeper understanding of participants’ values and attitudes toward muskoxen.

Nutritional Importance: Muskoxen are considered to have been particularly important historically as a source of food, and they remain so today. Sharing meat with the immediate and extended family network and community members is a practice deeply connected to Inuit culture and tradition: “my family loves the muskox meat, it is

good for people to eat muskox meat and share it with others, especially with Elders ... My parents ate lots of muskoxen ... Elders like that a lot, muskox was important to them” (Elder, Interviewee 9). Muskoxen were historically considered a reliable food resource to harvest, possibly because of their sedentary nature, especially when other country foods were scarce. As one Elder (Interviewee 5) explained, “muskoxen have always been our meat, an important source of food that we used to share with families. Muskoxen were always there also when other foods were scarce, but now muskoxen are scarce.” Even though, at the time of our study, muskoxen were less abundant in the Iqaluktuiaq area than they used to be (see Tomaselli et al., 2018), the harvesters we interviewed continued to consider them a reliable source of country foods. Muskoxen are particularly important to offset the local scarcity of caribou, a situation occurring during our study. As an Inuk harvester eloquently explained, “The importance of muskox [as a source of food] fluctuates along with the abundance of caribou. When caribou are plenty we don’t get as many muskox, and we do not rely on muskox at that time, [but] we tend to get more muskox when the caribou are not plentiful...this [transition from caribou to muskoxen in Iqaluktuiaq] started in the last couple of years ... Even this summer we are having [a] hard time getting caribou, so I know a lot of people would be harvesting muskox this fall, just to have the meat” (Interviewee 13).

Finally, participants stressed that muskoxen are bigger and heavier than caribou and provide more meat per hunt effort: this further emphasizes the critical value of muskoxen for local food security. “There is a lot of meat in them [muskoxen]...They are bigger than caribou, [you can get] a lot of meat out of them...and you can give them out to old people too...or when somebody has no skidoos we share it [muskox meat]” (Elder, Interviewee 26) and then, “the meat you buy at the store here is pretty expensive. So, there is value in getting a muskox because the meat will last longer than a caribou...you know when people don’t have an income, they might be able to buy bullets and gas to go and harvest a muskox and when they come back it will last a long time” (Inuk harvester, Interviewee 11).

Sociocultural Importance: The sociocultural importance theme that emerged from participants’ narratives had three subthemes: traditional use, community identity, and psychophysical well-being.

The muskox is an important part of Inuit culture, contributing to the traditional subsistence economy by providing food, tools, clothing, and shelter, as well as to social life by inspiring art and games. For example, historically, horns were useful for making hunting tools like the *kakivak* (fishing spear); bones were used to make scraping tools to soften caribou hides before sewing them; ribs were useful as drilling tools and to make sled runners and even bone arrows. Bones were also used to make games for children, and horns were carved to create art. The durable and highly insulating muskox hides were useful for bedding, and both skins and hides were used to make

kamiit (boots) and parkas, while the warm *qiviut* (muskox inner wool) was used inside *kamiit* and mitts because of its insulating properties. One Elder (Interviewee 3) explained, “I still use the skin for my bedding, like a foam. If you live in an igloo or in a tent you like to put it [the muskox hide] on the ground: you put the skin down and the fur up. Other people like to use it for the *kamik* ... and there are some bones of the muskox that my grandfather I have seen to make scraping tools [with], so we could soften the skin of caribou before mom sewed some [skins] together.” According to participants, muskox hides are still commonly used for bedding, especially in campsites, but other traditional uses are less common now.

The muskox is considered to be a unique, iconic animal; an integral part of the landscape; and connected to Inuit culture and identity: “muskox means identity, where we come from!” (Inuk woman, Interviewee 13). Reflecting on Iqaluktutiaq identity, some participants recalled that the traditional community games held every spring in Iqaluktutiaq are called *umingmak* frolics (muskox games). Additionally, the annual muskox commercial harvest, although suspended in 2012, was also considered to have helped shape community identity: “muskox is part of our community identity! We used to do our annual muskox harvest here on the island ... I think that the community identity kind of grew with the commercial harvest” (Inuk hunter, Interviewee 11).

Muskoxen are also valued for their aesthetic value: “personally I will never get tired to see muskoxen. They look so nice and they have a so nice temperament” (non-Inuk resident, Interviewee 12). For the Inuit that we worked with, the connection with muskoxen also has a deep spiritual meaning, a meaning so strong that it could influence the well-being of a person. In summer 2014, when we conducted the interviews, it was evident to community members that the local muskox population was in decline (Tomaselli et al., 2018). In this context, an Elder (Interviewee 3) said, “I miss their presence out there because I love watching them...I hope to see them before winter comes again. When you don’t see muskoxen it is kind of lonely. It is lonely when you don’t see part of your animals that roam close by your community.”

Economic Importance: Many economic opportunities are associated with muskoxen. Community revenue and business development are two subthemes that emerged in participant narratives about the economic importance of muskoxen.

Muskox commercial harvesting and outfitted hunting activities were consistently highlighted as creating important employment opportunities for the community. Interviewees explained that the annual harvest provided a number of jobs for local hunters, Elders, and women who were employed in either harvesting or processing activities: “for the community, muskox is important because, when they had the muskox harvest, hunters, haulers, and abattoir workers were employed, and I say ‘had’ because they haven’t had the muskox harvest for about two or three

years now” (Inuk hunter, Interviewee 11). The muskox commercial harvest was suspended in 2012 because of local declines of muskoxen. Participants also highlighted the economic importance of the outfitted muskox sport hunts as these are still organized and provide a regular source of revenue to local Inuit harvesters employed as guides. One Elder (Interviewee 16) said, “it [the muskox] is important for the community, especially for the sport hunters. It makes a little bit of income for people in town, so it keeps up the [local] hunters to be able to get gas and the other stuff they need to go out on the land.” The selling of carved muskox horns is another economic activity contributing to the local cash economy. As another Elder (Interviewee 3) explained, “an artist can make art out of the [muskox] horns, and it is good for them to make their own money if they need to buy things for their tables, to pay for their power, telephone [and bills].” Finally, the *qiviut*, harvested from the muskox hides to be sold commercially and used for knitting fine garments, is a source of revenue for the local Hunters and Trappers Organization.

Participants indicated that all these economic activities increase the revenue of community members and provide opportunities for entrepreneurship. One interviewee even emphasized that the economic potential of muskoxen has not been fully realized. He suggested that muskoxen could be a key for the future economic development of the community through ecotourism activities and local processing of *qiviut*: “they [muskoxen] could be even more valuable. I think people should be looking at tourism for muskox...There is not really anything [for economic development] except for sport hunters, but nothing for people who would like just to see them; and the wool could be used more than [it is] used now” (Inuk hunter, Interviewee 14). This last concept, although expressed at the time of the interviews by only one participant, was embraced by the other interviewees during the feedback sessions.

Environmental Importance: Although less represented in participant narratives, perhaps because it is considered an obvious value, the environmental importance of muskoxen nonetheless emerged as a separate theme in the narratives of three Inuit participants. The long-lasting ecological role of the muskox was discussed by one participant who recognized the historical importance of this Ice-Age survivor in the northern ecosystem. Finally, another interviewee identified the contribution of muskoxen to local biodiversity and pointed out the difference between the mainland and island subspecies. The uniqueness of the island muskoxen is also believed to contribute to the identity of the island community of Iqaluktutiaq: “I have heard [of], and I have seen myself, muskox from farther south, from the Bathurst Inlet area [on the mainland], that have longer legs than the muskox out on the island. So, when I talk about identity, that’s what I mean: the different species!” (Inuk hunter, Interviewee 13).

At the time of the interviews, participants reported a substantial decline of muskoxen in the Iqaluktutiaq area (Leclerc, 2015; ECCC, 2017; Tomaselli et al., 2018).

Participants provided valuable insights into the impact of the local muskox decline on both the community and individuals and this is clearly expressed in many of the quotes (online Appendix S2). Community residents consider reduced numbers of muskoxen to have negative economic consequences, significant implications for food security, and negative effects on the social and cultural system. Furthermore, the absence of muskoxen is considered a barrier to the connection and flow of knowledge among generations, especially between Elders and youth. An Inuk hunter (Interviewee 15) emphasized this concept by saying, “I have learned from Elders that muskox[en] are important, and I am the next [generation] after the Elders...It is important that younger generations try to keep the tradition, but muskox herds are dwindling.”

Muskoxen in the Traditional and Contemporary Food System

We explored the relative importance of muskoxen in the context of the traditional food system with the 28 year-round residents (23 Inuit and five non-Inuit), but we excluded the two summer residents. Results for Inuit and non-Inuit community residents are reported separately. Online Appendix S3 summarizes the average consumption of country foods and store-bought foods in the annual diet of participants. Because participants included in this study were mainly active hunters, we don't think that the data on country food consumption reflect the community as a whole. However, we do believe that these data are an approximation for the dietary behavior of hunters within the community.

Inuit: No differences between age groups (Elders vs. adult Inuit) were found with respect to the relative proportions of country foods, so these data are reported combined.

Inuit participants ate three to 10 types of wild game, of which eight were the most common, and Elders reported never eating fewer than six types of country foods. The three most consistently consumed country foods were fish, caribou, and muskoxen. The annual median relative proportions of the different types of country foods are reported in Figure 2.

Caribou represented 30% and fish 25% of the annual country food intake, while muskoxen accounted for only 10%. However, the amount of muskox consumed for subsistence depended on the local availability and accessibility of caribou. Caribou are generally preferred over muskoxen for several reasons, including personal preference, but also because they are easier to butcher, transport, and process than muskoxen: “the muskox is different than the caribou. It is more tougher, more heavier...it is more needy [more effort is required to butcher the carcass and transport meat packages] than caribou” (Interviewee 15). However, if caribou are not locally available or accessible, the amount of caribou that hunters would harvest is replaced by muskox (online Appendix S4). This form of prey switching helps stabilize the country

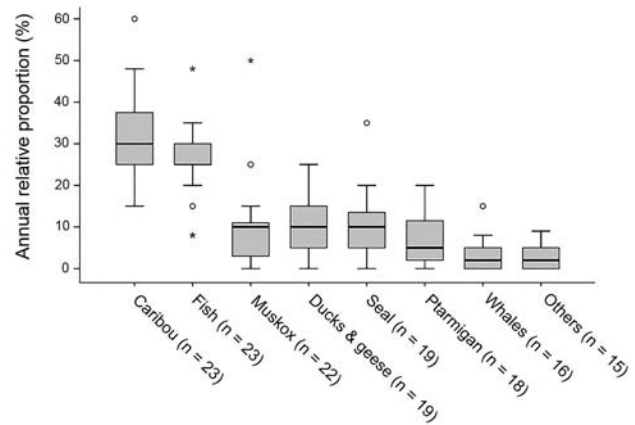


FIG. 2. Box plots show the relative proportions of country foods consumed annually by 23 Inuit interviewed in Iqaluklutiaq in summer 2014, with median values (heavy horizontal lines), first and third quartiles (lower and upper limits of box), and ranges of data (vertical lines), as well as points outside the ranges: outliers (empty circles) and extreme values (asterisks). On the horizontal axis, the parenthesis after each species shows the number of participants who reported consuming it. “Others” include hares, polar and grizzly bears, Arctic foxes, and moose.

food supply system and contributes positively to food security when muskoxen are available. This situation was described historically in the Iqaluklutiaq area when caribou were farther away from the community: “in the past, we were eating more muskox [instead of] caribou. Maybe half [of what is caribou now was replaced by muskox] in the 60s and 70s” (Interviewee 25). The diet switch from caribou to muskox was described as happening again at the time of our study. “We are in a point that in the last three years, two years we are not getting as much caribou, so we know that we need to get one or two muskox[en] [instead]... Just today one of my friends told me that he got a muskox and he never got a muskox before, just because they are not getting the caribou” (Interviewee 13). This concept was well illustrated by Interviewee 23, who has been switching his diet from muskoxen to caribou when the last one became available close to Iqaluklutiaq (from 2000 to 2010); progressively, since 2010, he had transitioned back to muskoxen because caribou became scarce again (Fig. 3; online Appendix S4). However, in contrast to the past, when muskoxen were increasing in number in the Iqaluklutiaq area, at the time of our study both caribou and muskoxen were declining (Leclerc, 2015; ECCC, 2017; Tomaselli et al., 2018). In this particular situation, the described caribou-muskox diet switch is likely to be ineffective to stabilize the traditional subsistence food system since neither species is predictably available (Fig. 3). In addition, the possible increased hunting pressure on declining muskoxen, as a consequence of the absence of caribou, might also negatively influence muskox future sustainability and resilience, further exacerbating food insecurity.

Both availability and accessibility of caribou and muskoxen were factors negatively impacting the traditional food system and harvesting practices. Interviewees explained that when animals were less accessible because

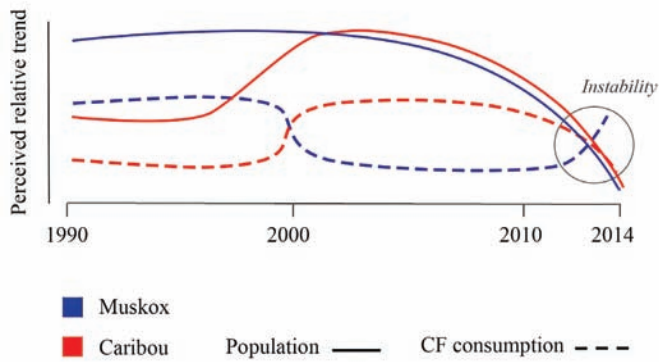


FIG. 3. Country food (CF) choices of Interviewee 23 from 1990 to 2014 (dotted lines) in relation to the perceived population trends of muskoxen and caribou (solid lines). This graphic representation of the narrative and proportional piling exercise of Interviewee 23 exemplifies the muskox-caribou prey switch mechanism.

they were farther away from the community, hunters might be discouraged from practicing subsistence harvesting because the costs associated with those activities would increase, meaning that more gas and more time are required for a successful hunt and harvest: “I really cut down the number of muskox I hunt per year now, because we have to go really far away to hunt muskox and I just lost the interest in hunting them: hauling them back for 45 or 50 miles can be pretty tough...I just have a quad; I don’t have a skidoo” (Interviewee 15).

Finally, interviewees explained that the country food compensatory mechanism of muskoxen when caribou are fewer in number or not available is common in other communities. For instance, “in Ulukhaktok, [people’s diet] already shifted [from caribou to muskoxen] in the last 20 years...because the caribou were gone from the area... We were sending a lot of caribou meat to Ulukhaktok in the last 15 years” (Interviewee 13). From this quote it is clear that there are several intra- and inter-community strategies (e.g., caribou-muskox diet switch and social sharing network of country foods among communities, respectively) that can contribute to the stability of the traditional food supply system. Any barrier to the sustainable implementation of these adaptive solutions can consequently have a negative effect on northern food security.

Non-Inuit: Four of the five non-Inuit year-round residents interviewed were originally from southern Canada but had moved to live long-term or permanently in Iqaluktuiaq; the fifth had always been a Nunavut resident. Three of the non-Inuit participants were also active hunters.

Responses from non-Inuit residents were similar to what we found for Inuit. Among non-Inuit residents, the number of country food types consumed varied from two to 10 different types. Fish, caribou, and muskox were the three most important country foods, and the annual country food intake of non-Inuit interviewees was represented by 50% (interquartile range, IQR: 1–25) fish, 25% (IQR: 30–70) caribou, and 15% (IQR: 15–30) muskox.

Local availability of wildlife clearly influenced the dietary behavior of our non-Inuit participants. Voluntary reduction of harvest was done because of declining caribou and muskox populations, and this reduction influenced both the overall amount of country foods consumed and the relative proportions of the different types of wild game harvested.

Harvesting Practices

All participants interviewed had been harvesting muskoxen through the subsistence harvest, outfitted sport hunts, or the commercial harvest (Table 1). At the time of the interviews, 24 participants were still actively involved in subsistence muskox harvesting, sport hunts, or both, but not in the muskox commercial harvest (suspended since 2012). A brief description of the different types of harvest and associated practices based on participants’ narratives is provided below.

Subsistence Harvest: Muskox subsistence harvesting had been practiced by 25 of the participants interviewed (22 Inuit and three year-round residents). Among these, 21 were still involved in subsistence harvesting at the time of our interviews. About 90% hunted one to two muskoxen per year, 5% hunted more than two muskoxen per year, and the remaining 5% harvested only one muskox every two years. Additionally, 90% of the hunters preferred to harvest sub-adult animals (2–3 years old) for subsistence purposes, with no strong preference between females and males. The remaining 10% were equally divided in preferring to harvest adult cows or juveniles (yearlings or calves), with calves especially preferred by Elders (online Appendix S5: Interviewee 26). We found that the favorite hunting season varied with respect to the hunters’ personal preferences and was influenced by environmental conditions (e.g., cold in the winter vs. mosquitos in the summer); the vehicle preferred or available for traveling on the land (e.g., four-wheeler vs. snowmobile); preference for harvesting a muskox in excellent body condition (fall) or with a thick hide with lots of *qiviut* (end of winter – beginning of spring) (online Appendix S5: Interviewee 12).

One Elder shared his knowledge about traditional hunting management practices that he learned from his father: “Every time I see five animals in one herd, I don’t shoot it. When they are really lots, maybe 10 or 15, then I get one...when I was young my dad told me: ‘you can’t shoot a muskox when there are only just [a] few [animals] in one [herd]. You never know what might be happening...and when the young ones [calves] are coming out, March, April, May, you can’t shoot them, never do that. They are important! To keep the little ones is important!’” Three other Elders shared another traditional hunting management practice: when they were young, their families used to hunt no more than one muskox per season and shared the harvested meat with the families living close by (online Appendix S5: Interviewee 3). In the feedback sessions, those four Elders added that they were also taught not to hunt pregnant cows.

Muskoxen hunted for subsistence were butchered in the field, regardless of the hunting season, and transported back to the community in segments identified as more easily transported “meat packages” (see Binford, 1978). One Inuk participant described sometimes hauling the full carcass back to town, especially in extremely cold weather conditions, so that the butchering could be performed closer to home (online Appendix S5: Interviewee 27). However, during the feedback sessions, the practice of transporting whole animals was considered to be poor carcass handling, both from a food safety perspective and with respect to culturally appropriate Inuit harvest practices.

The field slaughter activities for subsistence hunted muskoxen were described as consisting of first removing the head and the lower legs from the carcass, then skinning, next removing gut and internal organs, and finally quartering the animal. The quartered carcass and the rib cage were always brought back to town, and often the head and hide as well. However, participants described sometimes leaving the hide, the head, or both in the field to minimize the weight to haul back, especially in the summer when using four-wheelers (quads) for travel (online Appendix S5: Interviewees 23 and 15). Similarly, feet and hooves were generally left behind, and the gastrointestinal tract was never brought back except on very rare occasions when selected parts (i.e., reticulum, stomach, and intestine) were to be consumed, a practice reported by only three participants. Most (80%) of the subsistence harvesters interviewed reported leaving the lungs at the kill site but saving the heart for consumption. Finally, half of the interviewed hunters reported also keeping the liver and kidneys; the latter were especially valued when surrounded by fat (online Appendix S5, see Interviewee 14). A few participants reported saving the abdominal fat found on the greater omentum or surrounding the abdominal organs when the muskox was particularly fat (online Appendix S5: Interviewees 25 and 26). When the internal organs were kept, their use differed depending on the type of organ and the hunter’s preferences and needs. Although organs were important both for personal consumption and for dog food, muskox hearts and livers were more often used for human consumption, while lungs and kidneys were typically fed to dogs (online Appendix S5). Similarly, muskox feet and hooves, when kept, were used either for personal consumption (considered delicacies by Elders) or as dog food (online Appendix S5: Interviewees 3 and 23). Additional information regarding the use and consumption of muskox organs is provided below.

Throughout our study, we documented traditional butchering practices in as much detail as possible. This information increased our knowledge and understanding about the interactions between study participants and muskoxen and is also useful for public health (i.e., risk of pathogen exposure) and management considerations, as discussed below.

One young Inuk hunter (Interviewee 8) explained a traditional butchering practice as follows: “I have been

always told ‘If you catch an animal that has a calf in it, either caribou or muskox, [you] cut [the womb and take] the calf out of the animal and leave it [the calf] on the land.’ It didn’t happen to me with muskox, but [with] caribou yes, it has [happened].” The practice of extracting fetuses from the womb of harvested pregnant cows (muskoxen or caribou) was further confirmed during the feedback sessions by other participants, including Elders, and was explained to be associated with spiritual values. However, when we presented these findings during the feedback sessions to four of the oldest Elders interviewed, they unanimously commented that hunters should not harvest a pregnant cow in the first place: “If a cow is expecting a calf, you don’t shoot it. But if younger hunters do that, they should learn not to do it!” (Interviewee 9). This comment stimulated further discussion about the importance of teaching traditional hunting practices to younger Inuit hunters, including how to recognize which animals to harvest and not to harvest, how to butcher them correctly, and the proper use of different parts of the carcass.

Finally, two Elders who grew up in the Bathurst Inlet area on the mainland shared knowledge that revealed cultural taboos in practice when they were young. These taboos prevented children from participating in the butchering activities and from seeing any internal organs with identified lesions or abnormalities. Such abnormalities were typically fed to dogs, or if the carcass was too badly affected, it was buried on the land. One Elder (Interviewee 4) explained: “When I was growing up, I heard about disease in the heart...but [as] children we were not allowed to see the interior parts of an animal, and if the animals had a disease, we were not allowed to see the body and the lesions.” Although this practice might not be generalized to other areas or even to certain families, it is important to document it as this helps us to further understand the local context.

Outfitted Sport Hunts: Twelve interviewees were involved in the outfitted sport hunts: 10 were Inuit hunters employed as guides, and two were summer residents involved in the logistics of the muskox outfitting activities conducted in the summer. Participants explained that sport hunts in Iqaluktutiaq happened at fixed times of the year during spring (March–April), summer (August), and fall (October–November), though these times were subject to change depending on regulations. Animals typically selected by sport hunters were mature bulls with desirable coat and trophy characteristics (big horns and boss).

Butchering activities for sport-hunted muskoxen were described as being similar to butchering practices for muskoxen harvested for subsistence. The main exception consisted of maintaining the hide mostly intact. Depending on the type of taxidermy display preferred by the sport hunter, the muskox hide could be fully intact including the hooves (full body mount) or discontinued at the shoulder level (shoulder mount). It was explained that the horns were cut from the skull and the skull was generally left in the field unless the hunter requested a European skull mount.

In this case, the full skull including the jaw was collected; however, this was reported to be a very rare occurrence. The internal organs were left in the field, often together with the rib cage, but the legs and selected meat cuts (i.e., backstraps and tenderloins) were brought back to camp or town. It was further explained that the sport hunters would typically save a few meat cuts, while the rest was shared with community members. However, participants also reported that muskox adult bulls were not particularly desirable as country food because their meat had a strong flavor and harder texture than the meat of the sub-adult animals normally harvested for subsistence purposes. An eloquent description of the butchering activities for sport hunts is provided by Interviewee 19 (online Appendix S5).

One discussion theme that emerged during the feedback sessions, triggered by the fact that the rib cages of sport-hunted animals are often left in the field, relates to the importance of ensuring that the meat of sport-hunted muskoxen is not wasted but is fully harvested and shared with community members. Other themes that emerged from analysis of participants' narratives were the importance of Elders' delivering specific training on proper harvesting practices to Inuit guides and subsistence harvesters (especially younger hunters) to ensure that the carcasses are fully and properly harvested and used and that the meat (even the less desirable meat from muskox bulls) is fully consumed.

Commercial Harvest: Of the 15 interviewees (year-round residents) who had been involved in the commercial harvest, 12 were employed in harvesting, processing the carcass, or both, and the remaining three, in the logistics associated with the harvesting and processing activities (Table 1).

Participants explained that the community of Iqalukutiaq has been harvesting muskoxen for commercial purposes since the 1980s. Initially, the activity was organized as a territorial harvest with a portable abattoir, and the meat was marketed in the territory. Subsequently, to meet the Canadian Food Inspection Agency (CFIA) requirements and standards for export outside the territory and even outside Canada, the abattoir was moved to town, and muskoxen were harvested in an area around the community so that the carcasses could be butchered inside the inspected facilities. The federally inspected harvest was conducted once per year in winter, between February and March, and all muskoxen present in the herds were harvested as long as they were inside the allowed hunting area to comply with CFIA regulations. Participants explained that the hunting area was within the radius of a maximum one-hour snowmobile ride from town so that the carcasses could be inspected at the abattoir prior to freezing. During the feedback sessions, three of the oldest Elders were concerned that female and male muskoxen of all age classes were harvested for commercial reasons; they considered this an inappropriate harvesting practice that was not aligned with Inuit tradition and "way of doing things." The last commercial muskox harvest took place in

TABLE 1. Numbers of Inuit and non-Inuit muskox hunters from Iqalukutiaq (Victoria Island, Nunavut) interviewed in summer 2014 who participated in each type of muskox harvesting activity.

| Types of muskox harvest | Study participants involved (<i>n</i>) | | |
|----------------------------------|------------------------------------------|-----------|-------|
| | Inuit | Non-Inuit | Total |
| Only subsistence | 8 | 1 | 9 |
| Only sport | 0 | 2 | 2 |
| Only commercial | 1 | 2 | 3 |
| Subsistence + sport | 4 | 0 | 4 |
| Subsistence + commercial | 4 | 2 | 6 |
| Subsistence + sport + commercial | 6 | 0 | 6 |
| Total | 23 | 7 | 30 |

February–March 2012. After that, commercial harvesting was suspended because of the decline in muskox numbers in the permitted hunting area.

Food Practices Related to Muskoxen

Questions about food practices were asked only to the 27 year-round residents who consumed muskoxen.

Storage Techniques and Practices: Interviewees stated that meat storage mostly depends on the season in which muskoxen are harvested. When the harvest occurs during the cold months of the year (late October to April), the meat, either quartered or cut in smaller portions, is stored in personal freezers or left outside, protected in shacks adjacent to the house in meat boxes or even cardboard boxes. By May, when the ambient air temperatures start to increase, the meat stored outside is then transferred into personal commercial freezers. When harvesting activities occur in summer, the meat is processed in smaller portions and mostly stored in freezers, but it can also be preserved dried as *umingmak mipku* (muskox dry meat).

Elders shared their knowledge regarding traditional ways to store muskox meat, which was typically preserved as *umingmak mipku* in the summer and frozen in the winter months. In early fall, when the ground was not yet covered in snow, the meat was often left on the land and protected in a food cache built with rocks. Later the next spring or early in the summer, when the snow and ice started to melt, the meat was recovered. This system allowed the meat to be preserved for longer periods of time and minimized the transport costs of food resources (online Appendix S5: Interviewee 3).

Although mostly preserved frozen during the winter months, the cached meat underwent the process of aging and fermentation. Caching, therefore, required refined technical expertise to avoid meat spoilage. During the feedback sessions, participants explained that, although less common today than in the past, caching is still practiced. Interviewees described different techniques (e.g., in the permafrost, on the ground, spreading the stomach content on the meat) and different names for caching meat, which further highlights the complexity of this highly specialized traditional preservation technology developed in a subsistence society based on hunting.

TABLE 2. Muskox parts consumed by year-round residents from Iqaluktutiaq (Victoria Island, Nunavut) (n = 27). For each part, the number of interviewees who consumed it, and how they consumed it, is indicated.

| Muskox part | No. of interviewees | Food preparation |
|-----------------------------|---------------------|-----------------------------|
| Meat | 27 | Cooked, frozen, dried, aged |
| Heart | 19 | Cooked, frozen, raw |
| Tongue | 17 | Cooked, raw |
| Liver | 11 | Cooked, frozen, raw, aged |
| Kidney | 10 | Cooked, raw |
| Bone marrow | 10 | Cooked, frozen, raw |
| Eye balls | 7 | Cooked, raw |
| Feet (ligament and tendons) | 7 | Cooked |
| Ears | 5 | Cooked |
| Hooves | 5 | Cooked, aged |
| Abdominal fat | 4 | Frozen, raw, dried |
| Nose and lips | 4 | Cooked |
| Brain | 3 | Cooked, raw |
| Lung | 2 | Cooked, frozen, raw |
| Stomach | 1 | Raw, aged |
| Selected part intestine | 1 | Cooked, raw, aged |
| Reticulum | 1 | Cooked |

Muskox Consumption and Preparation: A list of the different muskox cuts and organs consumed by the study participants and the ways that they are eaten is provided in Table 2. A major finding was that, in contrast to caribou consumption, not all muskox parts were regularly consumed because of personal preferences and also because of lack of familiarity with eating certain parts. For example, a young Inuk hunter (Interviewee 8) said, “I have never tried the muskox head before...I have never tried the tongue. Curious though, caribou tongue is always really good. I eat the caribou head, the brain, the tongue, the meat of the jaw, but I have never tried muskox head before. I have never been taught how to eat it, so I have never taught myself to cook it before because I have never seen it done”. This theme emerged among adult Inuit harvesters, but was reiterated also by one Elder (Interviewee 24) who said, “Caribou you eat it all, but not the muskox...the head I eat only in caribou, the eyes only in caribou, and the brain in caribou and the seal, the bone marrow only in caribou, I have never tried it in muskox...I don’t know why. Nobody told me, I guess.”

Traditional cultural taboos related to muskox butchering and consumption also emerged from participant narratives. Two Elders interviewed explained that they were not allowed as females to eat muskox internal organs: “We were taught to eat the outside part of the muskox [the meat], but not the internal organs; those were fed to the dogs...especially the girls were not allowed to eat the inside part of the muskox; but we know in other parts of the *nuna* [land] other people were used to eat the internal parts, [like] in Gjoa Haven” (Elder, Interviewee 5). A similar cultural taboo was described by an Inuk hunter (Interviewee 14) originally from Resolute Bay, who explained that for his family still living in Resolute Bay, muskox is a food “that men eat and not a food that women eat.” He associated this behavior with the traditional consumption of fermented muskox meat.

Traditional and cultural taboos associated with muskox consumption and butchering might have local significance but need not be practiced in the same way in other regions, communities, or even families.

Participants Concerns about Muskoxen

Finally, all participants were asked if they had any concerns regarding muskoxen in the Iqaluktutiaq area, and the 28 participants who hunted or consumed muskoxen were also asked if they had specific concerns about butchering, handling, or eating muskoxen. General concerns emerging from participants’ narratives pertain to local observations of muskox and caribou decline, as well as to deterioration of both muskox and caribou health (summarized in Tomaselli et al., 2018). However, the majority of the interviewees didn’t express any concern regarding butchering, handling or eating muskoxen, with the exception of two Elders and two Inuit hunters. The Elders explained that they were afraid to eat muskox meat because they were aware of recent observations of dead muskoxen on the land. They also explained that they felt the responsibility as Elders to be prepared to teach the next generation of Inuit about how to cope with changes in the health of muskoxen. One Elder (Interviewee 4) explained, “now muskox is still food but we need to watch the meat. We need to prepare the meat because we hear stories about muskox dying and it is very scary to use the part of the muskox...we are concerned for the animals, we are concerned for our next generation. We need to prepare [ourselves] on how to prepare the next generation [for] these changes.”

One of the two Inuit harvesters (Interviewee 7) expressed a general concern about the safety of muskox meat, stating that “we preferred the meat [of muskoxen], but now we heard that some muskox are having some kind of worms like ...they are not too healthy now for eating.” This interviewee was clearly referring to the muskox lungworm, *Umingmakstrongylus pallikuukens*, which was described in recent years in the Iqaluktutiaq area (Kutz et al., 2013a). Although this lungworm is not a human health concern, this quote represents how the lack or misinterpretation of information can influence the perception of risk, consequently modifying or conditioning dietary behaviors. Finally, the other Inuk harvester (Interviewee 19) expressed concerns about handling muskoxen with signs of disease, stressing the importance of personal protection to avoid or minimize the risk of infection.

SUMMARY AND CONCLUSIONS

Muskoxen have multidimensional importance for Iqaluktutiaq residents. They contribute significantly to local food security in different ways. For example, muskoxen provide more meat per hunt effort in comparison to caribou, and they serve as an important “replacement food resource” to mitigate the food insecurity arising from the

unavailability or inaccessibility of caribou. Through our work, we found that the county food security system of Iqaluktuq may currently be under stress because of the concurrent decline of both caribou and muskoxen and the consequent unavailability of both species for successful harvesting. This situation may not only exacerbate food insecurity and lead to unhealthy food choices (i.e., increased consumption of lower quality market food), but also have a negative impact on the local economy and the social and cultural aspects of Arctic community life and well-being. It becomes urgent, therefore, to understand muskox population health and the drivers of muskox decline. This understanding will enable sound management aimed at the future sustainability of muskoxen, directly improving community food security and helping to maintain sociocultural identity, as well as sustaining opportunities for the local economy.

Through this work, we gained a better understanding of opportunities to develop a participatory surveillance program and the logistical challenges involved. Knowing which types of animals are harvested, when they are harvested, and what organs are valuable for consumption is relevant for developing and implementing a successful hunter-based surveillance program and for the a priori evaluation of possible sampling heterogeneity and biases. In addition, understanding hunters' behavior and interactions with muskox carcasses (e.g., butchering practices, meat consumption) is essential to the correct interpretation of local knowledge on muskox health and diseases gathered through participatory methods as part of an active surveillance program (see Tomaselli et al., 2018). For example, this research highlighted that lungs are minimally inspected, since they are generally discarded and not consumed; therefore, we can expect to have minimal observations of lesions localized in the lungs. Ultimately the aim of a muskox health surveillance program will be to enable informed management actions that promote both muskox conservation and public health protection. The information about the local context that is summarized here can serve to improve co-management strategies for muskoxen and disease prevention for humans.

We see our work as a first step toward understanding community concerns and collaboratively identifying solution strategies that align with Inuit culture, practices, and beliefs. This process has a direct value for improving co-management efforts and outcomes. For instance, we documented current practices that are in conflict with the Inuit traditional "way of doing things" that was meant to preserve wildlife resources. Elders identified the need to create formal teaching opportunities to pass on traditional harvesting practices to younger generations and less experienced hunters, so as to avoid harvesting the wrong animals (e.g., pregnant cows or leaders of the herds, both caribou and muskoxen), poor butchering (e.g., full carcass butchered in the community), or inappropriate use of carcasses (e.g., selection of certain meat cuts and wastage of others). They also reinforced the importance of teaching

traditional and contemporary methods of preparing and consuming muskox meat so as to promote the consumption of country foods. We documented that the traditional knowledge of muskoxen is rapidly evolving in Iqaluktuq and its maintenance is threatened by the absence of the animals in the area, among other factors. In this context, it is a priority to preserve traditional knowledge on muskoxen and facilitate the knowledge exchange among generations, particularly between Elders and youth. To achieve this goal, we recommend continued participatory engagement of Iqaluktuq residents so as to promote a platform for knowledge exchange among generations. This exchange will also help a large variety of stakeholders (e.g., community and governmental organizations, health and wildlife professionals, researchers, and NGOs) to better adapt current programs to the local reality and needs and to identify new priorities.

With respect to public health, this study highlights the importance of both understanding the local harvesting context to better assess the risks of human exposure to hazards (zoonotic agents or contaminants) and adequately communicating such risks. For instance, we documented the practice of extracting the fetus from the womb of hunted pregnant caribou or muskox cows. Considering the endemicity of brucellosis in caribou (Forbes, 1991), this practice could increase the risk of exposure to *Brucella* spp. for hunters. Knowledge about such practices will aid in implementing mitigation strategies that are specifically tailored to the local context and thus more likely to be effective.

Risk communication applied to wildlife diseases and food safety is also crucial in the Arctic, where country foods play a critical role in food security and people regularly act as their own food inspectors (Myers et al., 2005). If risk communication is not appropriately implemented, perceived risks could modify people's dietary choices and contribute to the decline of traditional harvesting and country food consumption, which is already a concerning trend in the Arctic (Furgal et al., 2005; Myers et al., 2005; Myers and Furgal, 2006; Stephen and Duncan, 2017). However, even if appropriate messaging is used to communicate risks regarding the safety of wildlife for human consumption, it is still possible to produce undesired adverse effects. For example, some interviewees described muskoxen that became "scary" or "not too healthy" to eat. Participatory risk analysis can assist in the evaluation of risks, as well as the implementation of strategies that avoid or minimize unwanted effects when communicating risks (Grace et al., 2008). Wildlife and public health professionals should work collaboratively with local communities and organizations to develop and implement appropriate risk communication strategies. Most importantly, the effects of the resulting messaging should be carefully evaluated so to avoid generating the undesired adverse effect of discouraging the consumption of country foods (Furgal et al., 2005), which remain the most nutritious and culturally appropriate foods in the Arctic (Myers et al., 2005; ICC,

2012). As one Inuk subsistence harvester we interviewed explained, “You stay full longer with country foods, and you stay energized” (Interviewee 15).

Finally, this study reinforces the importance of community-based participatory research in the Arctic that empowers local people (in our case resource users) in the process of knowledge generation and identification of concerns, priorities, and solution strategies customized to the local reality and needs (Berkes and Jolly, 2001; ITK and NRI, 2006; Huntington, 2011; Brunet et al., 2014). Collaboration, better communication, and knowledge exchange among stakeholders are additional positive outcomes derived from this research. We recommend that local stakeholders build on our findings and further share knowledge and engage with residents of Iqaluktutiaq to fully understand specific aspects of the local context (e.g., community concerns and solutions, traditional butchering and management practices). On the basis of our experience, we encourage wildlife researchers and professionals working in subsistence-oriented systems to engage with local resource users with the aim of understanding the local human-wildlife context. Such engagement can contribute to generating better outcomes for both people and wildlife, and ultimately, to the future resilience of subsistence social-ecological systems.

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APPENDICES

The following appendices are available in a supplementary file to the online version of this article at:

<http://arctic.journalhosting.ucalgary.ca/arctic/index.php/arctic/rt/suppFiles/4697/0>

APPENDIX S1. Interview guide used during the individual interviews with study participants from the community of Iqaluktutiaq (Victoria Island, Nunavut, Canada).

APPENDIX S2. Selected quotes from study participants from the community of Iqaluktutiaq (Victoria Island, Nunavut, Canada) offering conjoint perspectives on the importance of muskoxen and the impact of their decline.

APPENDIX S3. Average consumption of country foods and store-bought foods in the annual diet of study participants from the community of Iqaluktutiaq (Victoria Island, Nunavut, Canada).

APPENDIX S4. Selected quotes from study participants from the community of Iqaluktutiaq (Victoria Island, Nunavut, Canada) representing the muskox-caribou prey switch mechanism.

APPENDIX S5. Selected quotes from study participants from the community of Iqaluktutiaq (Victoria Island, Nunavut, Canada) describing harvesting and butchering activities of muskoxen, as well as historical and contemporary meat storage and consumption habits.

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