

Inuit perspectives of polar bear research: lessons for community-based collaborations

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ABSTRACT. Research partnerships with northern communities hold promise for capacity and resilience against environmental changes. Given their historical ecological and cultural relationship with and, thus, ongoing concern for polar bears, Inuit communities are keen to participate in monitoring programmes. In spite of this, northern communities continue to meet polar bear research and collaborations with some resistance. Here, we summarise and report interviews with Nunavummiut from four communities on Inuit experiences with polar bears and research perspectives. Research interactions reveal ongoing cultural, socio-ecological and ethical barriers to polar bear research projects. Research licenses and standardised ethics procedures do not always guarantee collaborations. Adaptable research methods, mutual understanding and open dialogue are essential to form strong research partnerships with northern communities.

Introduction

Community-based collaborations between (either governmental or non-governmental) researchers, decision-makers and communities can build local community support for adaptive policies (Berkes and others 2007; Ford and others 2010). In Canada, rapid environmental changes are affecting Arctic ecosystems and these compel northern communities to participate in research (Gearhead and Shirley 2007; Pearce and others 2009; Ford and others 2010; Armitage and others 2011). Unfortunately, some research projects inadequately involve community members and/or fail to address community interests and concerns (Provencher and others 2013). Ongoing barriers to establishing meaningful collaborations include a historical lack of trust (Kendrick 2000), 'fly in, fly out' research practices (Gearhead and Shirley 2007) and colonial histories that have not served the interests of northern communities (Tester and Irniq 2008). Subjects that have high political interest are especially challenging for forming and maintaining strong bonds between researchers and northern communities. Disputes between Inuit and scientific communities over the responses of

polar bears to climatic change exemplify this concern (Dyck and others 2007; Clark and others 2008; Dowsley and Wenzel 2008; Dyck and others 2008; Stirling and others 2008; Vongraven and Peacock 2011). A lack of data on population dynamics for some subpopulations (Obbard and others 2010; Peacock and others 2011), varying degrees of local support for monitoring methods (Dowsley 2009; Tyrell 2009) and harvest management decisions that seemingly victimise northern communities (Clark and others 2013) might further polarise views. It is important to ameliorate the lack of local support for monitoring programmes because management decisions that incorporate the best available scientific and community-based information continue to hold promise for effective polar bear conservation (Peacock and others 2011; Dowsley and others 2013; Tyrell and Clark 2014). It is critical that all researchers form strong relationships with Inuit communities to ensure support for management decisions founded on scientific and community-based information.

It is necessary to engage communities throughout all levels of research – from research proposals to

disseminating results – to support community ownership of research outputs (Buytaert and others 2014). Research engagement can also allow local priorities to be integrated into decision-making and sustain long-term collaborations (Pearce and others 2009; Grimwood and others 2012; Brunet and others 2014a). Accordingly, researchers have encouraged a shift from ‘participatory’ to more active ‘partnership’ roles of northern communities in collaborative research (Gearhead and Shirley 2007; Brunet and others 2014a; Tondou and others 2014). In Nunavut, community consultations and participation are mandatory (for example, through permits; INAC 1993). Community members consult as well as actively shape research throughout all stages of the process. For research involving traditional ecological knowledge (TEK) – historical observations, experiences and values in relation to environmental processes that are passed on from one generation to the next – on territorial, institutional and local levels usually require ethics protocols. Northern community members usually review ethical procedures and require evidence of local consultations a priori (INAC 1993; Inuit Tapiriit Kanatami and Nunavut Research Institute 2007; Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada 2010). From a practical standpoint, local experience and knowledge benefits fieldwork safety and travel in remote and unpredictable environmental conditions. But, to encourage support for research outcomes, it is essential to go beyond the minimum requirements for community participation in any research programme.

Including Inuit collaborators in scientific monitoring programmes can gain local support for wide-ranging management applications, going far beyond those offered by scientific methods alone (for example, Garnett and others 2009; Huntington and others 2004; Moller and others 2004; Phillipson and others 2012; Buytaert and others 2014). This can involve the encouragement of public understanding (Reed and McIlveen 2006), intergenerational transfer of knowledge (Garnett and others 2009) and innovative ways to gather new information (Phillipson and others 2012). However, how to integrate TEK and science in a mutually complementary manner that does not compromise the integrity of either source of knowledge remains an ongoing challenge to resolve. Scientific methods emphasise cause-and-effect relationships and objective, quantitative procedures (Moller and others 2004) that separate researcher and/or observer perspectives from their conclusions (Huntington and others 2004). In contrast, TEK holders see themselves as part of the inter-related phenomena under study, with long-term observation and continuous integration of new data (Berkes and others 2007; Houde 2007), despite lack of quantification. TEK literature continues to separate indigenous and scientific knowledge in a paradoxical way; scientific and indigenous knowledge have been used to validate one another (Agrawal 1995). Still, keeping

these lenses of viewing reality separate may undermine overlaps between both types of knowledge and this should be recognised (Agrawal 1995). Both science and TEK emphasise repeatability, analyses and prediction gleaned through empirical observations, albeit in differing ways (Huntington 2000).

Including TEK in monitoring programmes allows TEK holders to continue to use their skills and benefit from employment (Pearce and others 2009) while documenting and safeguarding knowledge for future generations. Few studies highlight the key elements and procedures necessary to establish research relationships with northern communities within specific and political research contexts (but see Pearce and others 2009; Huntington and others 2011; Grimwood and others 2012; and Tondou and others 2014). It is possible to cultivate collaborative support for northern research by drawing from examples on how to develop meaningful relationships with non-academic (for example, indigenous and public) communities and stakeholders (for example, Rowe and Frewer 2000; Mercer and others 2008; Phillipson and others 2012) in non-Arctic contexts. Documenting TEK can also engage and build relationships with northern local communities while allowing researchers to identify unanticipated community perspectives, contexts and other types of knowledge that communities can share, including unique ways that community participation can take place.

For polar bear researchers (for example, individuals that either live in the north and are employed by government agencies, or live in the south and are academics), building relationships with Inuit can promote an understanding and appreciation of nonconventional methods of knowledge formation. Efforts to develop strong partnerships with Inuit communities are underway in ecotourism development (for example, Dowsley 2009), climate change mitigation and adaptation (for example, Ford and others 2010; Pearce and others 2010) and natural resource management (for example, Grimwood and Doubleday 2013), including wildlife (for example, Freeman and Wenzel 2006; Kowalchuk and Kuhn 2012). Partnerships in the form of co-management can also reveal persisting political and cultural barriers that may stagnate collaborative efforts on the part of communities and decision-makers alike.

In Nunavut, where most of Canada’s polar bears are managed, the ultimate responsibility for polar bear management rests with the Minister of Environment of the Government of Nunavut. However, the Nunavut Land Claims Agreement (INAC 1993) sets out a co-management system for wildlife management and, thus, the Minister’s responsibilities are subject to the terms as laid out in the land claims agreement. Accordingly, the Minister shares authority to make decisions with the Nunavut Wildlife Management Board, which is an institution of public government and the primary designated Inuit organisation for management that regulates access to wildlife within the Nunavut Settlement Area (INAC

1993). This shared co-management system approach intends to guarantee that the best available Inuit TEK (Inuit *qaujimaqatugangit*) and science are used to make decisions. Moreover, any decision has to take Inuit values, beliefs and views into account, aside conservation issues. The land claims agreement also asserts that Inuit are involved in all aspects of wildlife management including research, monitoring and harvest management (INAC 1993; Obbard and others 2010). However, despite these efforts to incorporate Inuit perspectives, dissatisfaction with both scientific research methods (Tyrrell 2006) and management (Kotierk 2010) are ongoing.

Driven by the common goal of better understanding polar bear ecology and the desire for community members to voice their concerns, we report and summarise Inuit experiences with polar bear research and management in scientific contexts. We report on interviews with 23 hunters and 33 elders (48 men and eight women) in four Nunavut communities that range in their experience with polar bear research. While quotations include Inuit TEK of polar bears, these themes have been expanded on elsewhere (Wong and Murphy 2016). We highlight persisting challenges with polar bear research and emphasise research practices that can improve support for research and monitoring efforts, ensure better collaborations with Inuit communities and, ultimately, garner more complementary biological and environmental data.

Methods

Collaborations with the Gjoa Haven Hunters and Trackers Organisation (HTO) began in 2008 during an independent project integrating polar bear TEK in a non-invasive survey (Wong and others 2011; Van Coeverden de Groot and others 2013). This fieldwork allowed participating researchers to witness first-hand the different relationships, experiences, and levels of enthusiasm and engagement that Inuit hunters and elders have with polar bears and polar bear fieldwork. Camping on the land was often associated with unpredictable, physically and mentally challenging environments. This provided unique opportunities to develop interpersonal and adaptable research skills. This also provided context for subsequent interviews.

Interviews in Gjoa Haven began in 2011 for Inuit experience with polar bears to devise new Inuit-based methods of monitoring. Building on this, visitations and data collection in Arctic Bay, Kimmirut and Arviat HTOs began in 2014 based on their ongoing harvest-based monitoring programme with the Government of Nunavut. Interviews with these additional communities expanded on Inuit relationships with polar bears and recommendations for polar bear research and monitoring, which became the focus of this work.

Face-to-face meetings with HTOs occurred in each community, except in Arviat, where these discussions occurred over telephone to discuss research objectives, recruitment and wages. HTOs prescribed and led all recruitment procedures (radio announcements, flyers and/or

recommendations by other community members), which varied in effectiveness among communities. HTOs also recruited interpreters except in Arviat, where the Hamlet recommended an interpreter. We recruited interview participants through a combination of key informant and snowball sampling methods (Marshall 1996). HTOs and local interpreters initially recommended interview participants. We also made radio announcements for interview locations and times to allow all community members to participate and, thus, cover a broad range in perspectives (Marshall 1996). In Kimmirut, participants were recruited through HTO recommendation only. In all communities, initial interview participants also recommended additional, experienced community members until we recruited a maximum of 20 participants from each community (based on budget constraints).

As participants were compensated financially and wages differed between elders and hunters, we divided participants into the categories according to Wong and Murphy (2016). Participants were categorised as 'elders' (60 years old or older and recognised for his/her experience on the land among other community members) and 'hunters' (less than 60 years old and usually less experienced than elders). To provide context to their responses, we also grouped participants according to experience: active hunters, who have hunted and continue to when the opportunity presents itself (for example, upon receiving a tag); non-active hunters, who have hunted but no longer do so; and less experienced hunters, who have assisted community members with hunts and would hunt upon receiving a tag. To protect confidentiality, we coded participant names according to their home community (Gjoa Haven [GH], Arctic Bay [AB], Kimmirut [K] and Arviat [AR]) and order that they were interviewed. One Kugaaruk hunter was interviewed in Gjoa Haven (KU1).

For consistency, the first author conducted all interviews and initial analyses. Interviews were semi-structured, with open-ended questions using a guideline and plain language to ensure a mutual understanding (Huntington 2000) and facilitate translation. Interviews began with directive icebreaker questions (for example, name, age, birthplace) followed by discussions on polar bear hunting, population dynamics, monitoring and management. As most initial participants steered interviews toward their own views of polar bear population ecology research, subsequent interviews included an opportunity for participants to describe what they felt the 'best way to research and survey polar bears' would be. We generalised questions to ensure conversations were not encouraged in a leading way. We posed follow-up questions as a response to encourage participants to produce their own understanding and thoughts, and clarify information that was being discussed (Huntington 1998).

The first author recorded and manually transcribed interviews using an audio recorder. She recorded non-verbal cues and verbal styles, informally shared relevant information and personal reflections in a journal. We

analysed interviews following conventional content analysis, where categories, themes and coding names were allowed to emerge from the data without any pre-existing theory (Hsieh and Shannon 2005). We identified unique perspectives and reported the quotations and participant information that we felt best described common themes and categories. In 2015, a second trip was made to Arctic Bay, Arviat and Kimmirut communities to discuss initial results, perspectives at a broader community level and desirable research applications. This visit was also necessary to confirm interpretations of interviews and findings.

Outside of interviews, the first author spent time exchanging cultural views and stories, familiarising herself around town and participating in community activities (when invited) with community members and students. These interactions were exceptionally important in cultivating trust, transparency and comfort in sharing research perspectives and understanding community priorities. Spending more personal time prior to data collection through multiple visitations might have further strengthened participant understanding and engagement (Pearce and others 2009; Huntington and others 2011; Grimwood and others 2012; Tondu and others 2014).

Results

From May 2011 to April 2014 over four visits, we conducted individual interviews with 23 hunters and 33 elders (48 men and eight women) comprising 32 active, 14 non-active and nine less experienced hunters. In February 2015, we interviewed one additional active hunter. Three participants from Gjoa Haven (GH2, GH5, and GH9) and KU1 were or had previously served as HTO board members. One participant in Arctic Bay (AB1) was an HTO board member. Four participants in Kimmirut (K1, K2, K5 and K6) were HTO board members, including a previous regional wildlife organisation board member. One regional wildlife organisation (AR3) and HTO (AR20) board member were interviewed in Arviat. Interviews occurred on the land (for Gjoa Haven hunters and KU1) and at participant homes, hotels and HTO offices. Appointed interpreters translated 27 interviews. One Arctic Bay hunter translated an elder's interview before her interview. One Arviat hunter translated six interviews following her interview, as the local interpreter was unavailable due to illness. While questions initially focused on experiences with and perspectives on polar bear population dynamics, monitoring and research practices, participants raised concerns that pointed to cultural, ecological and ethical considerations in research that they felt needed to be shared with researchers. In Arviat, most community members were familiar with polar bear management regulations and research methods, and interview data became saturated; no new themes emerged with additional interviews (Hsieh and Shannon 2005).

Cultural factors affecting participant responses to research questions

Several cultural considerations could influence participant responses and involvement in TEK research, which extend beyond polar bear knowledge. The interpreter in Arviat cautioned that modest participants respond with short answers and it is frowned upon to 'boast' about experience and/or knowledge. This ethic might be so respected that participants provide vague responses or do not answer questions directly. Arctic Bay and Kimmirut participants also touched upon some of these themes:

...[Polar bears] should not be bothered ... don't make fun of them or you know, traditionally we were told 'no don't talk about animals in a negative way' ... and never say that you're a great hunter too. Because if you say 'oh I can get a bear' the bear will teach you a lesson ... so they told us 'no don't brag about polar bears, that you're able to hunt them' ... even questions about hunting bears is kind of very touchy too, for elders especially. I could tell that they don't want to answer ... because they're afraid ... because it's not something that Inuit talk about, just bragging about it, [you know] it's ... vital ... important subject, animals. Any animal. Not to talk about them, not to bother them ... leave them be, you know. (AB15)

The interpreter in Arviat also advised that Inuit were taught to 'do as elders say', thus, some interview topics were never questioned or doubted among community members; some knowledge and experience was a 'matter of fact'. Participants also emphasised the importance of oral tradition.

...Those elders here ... in Nunavut there're [a] lot of uh, they know everything like they have a lot of knowledge about life, or look after their family and so, they know everything ... the elders ... like from young to ... middle age. Taught them how to be alive ... but they don't write it down because they have their knowledge in their head ... rules ... in their head because we didn't have any—or Inuit didn't have any paper or pencil so [they] have [it] in their head ... so that's ... the Inuit culture ... we carry on ... I carry, and now I told to my young family, my family, so they started to know ... so they'll be know Inuit knowledge ... like we don't educate by writing down ... by looking at [it], by listening and by doing it, we learn. (AR9)

The interpreter in Arviat indicated chores at camp were often distributed among family members, so while some individuals did not have practical experience, they were familiar with technical skills through observation. Relevant to this, all participants indicated they learned how to hunt by observing and/or camping with other (older) family members.

By the age of ten he started going with his dad to go hunting ... he wasn't really taught how to hunt ... he was watching his dad ... but now he realised that he was being taught how to hunt ... but he didn't know that he was being taught ... just by watching his father hunting

... just looking at him, seeing him and he learned how to hunt. (AB1)

Inuit knowledge is thus shared through experience as a 'way of life'. Researchers should become aware of and open to unanticipated responses and potentially sensitive topics. Communities also stressed the importance of gathering knowledge through experience. Camping trips with community members can expand dialogue and encourage accurate interpretations of interview discussions while establishing interpersonal relationships.

Inuit observations of polar bear ecology

All participants reported having more bear encounters in recent years than in the past. Some participants indicated that the bears they have encountered are healthy.

...Last year he said that there's more bears that are more fat ... they rarely see unhealthy bears ... the only time they would see one is when it's pretty old ... it won't hunt—hunt as much ... and it's skinny. (AB9)

Others indicated the opposite.

Since they're getting hungry, the polar bears ... they seems to be declining in fatness. So they're skinnier one ... lack of uh, food ... the year before one that he caught seems skinnier than the one that he caught last year ... due to lack of food. (K7)

Some participants attributed interactions with bears to cyclical changes in polar bear distribution.

Back then there used to hardly be any bears ... 1920s, the father-in-law said they used to go miles and miles by dog team, or by walking to go hunt polar bears ... but after 1980s, to now there's a lot of bears ... 1920s, his father-in-law was saying that there were a lot of bears back then ... few years later they were all gone ... and now they're all back ... I think it goes like that, back and forth. (AB12)

Our elders, they say, they migrate, into other area ... for years, and then they come back ... that's what we're experiencing now ... back in early 80s, and mid 90s, there were hardly any bears ... there's too many polar bears now. (AR16)

Some participants linked these changes to food availability.

They go where there's more food, you know ... they always look around, they can—they walk around everywhere for—look for food ... so, if there's more seals down there they'll be right there. (AB6)

And nowadays we tend to see bears close by Kimmirut ... he doesn't really know why but he thinks it's uh because they go—they follow their food ... the more hunters catch around the community ... or just outside the community, the more [bears tend to come] where the hunters hunt. (K1)

Despite climate change effects, many participants indicated bears are able to learn from and/or adapt to changing environments.

He said he don't really know about if [melting ice] affect the polar bears but he said the um polar bears could stay in the water ... they could go on the land. And like, before they go on the ice they eat um, grass or from the land and they stay on the ice ... before they go on the ice and lay—laid down or rest or something they eat grass so they don't have to get hungry right away. (GH3)

... Bears can catch seals even—even if the—if the ice is really thin ... they're great hunters those bears ... they're really smart ... they know how to survive ... even if it was just in the water floating, seal go by him and just grab it and eat it. (KU1)

All participants felt bears are more aggressive toward humans now than in the past.

Bears are really knowledgeable ... they know now they won't be caught ... they're like humans ... way of thinking that nobody's gonna take them [to eat] ... and that's why they're smart as—they're more aggressive and there's [potentially] more of them now ... the polar bears know that they won't be shot at ... now, but back then they used to be afraid ... knowing that they'll be shot. (AB5)

Arviat participants were particularly concerned with declining health in bears attracted to and feeding at local dumps.

In the early 70s, '65 to 70s, there has been increased in seeing bears around. And yes we see more if it, they're not healthy ... because they eat a lot at the dumps ... before the 70s, it was much cleaner, you know, the tundra was much cleaner, the town was cleaner but these days we have dumps ... in most communities. And that's what they go for, so most—most bears, when they're hun-hungry enough they'll go looking for food at the dump ... and it's getting more and more frequent because of the dumps that they go looking for food. (AR4)

Arviat residents face heightened safety concerns (Stirling and Parkinson 2006; Kotierk 2010; Peacock and others 2011), and being able to identify and respond to aggressive bears is an ongoing priority. This was evidenced through participants sharing knowledge of aggressive bears even when the topic was not addressed directly.

... A group of three or more? The lead bear, if he doesn't attack right away, the rest won't ... and if you're approached that close? You don't move ... you don't make quick movement[s], you don't move, you just sit still, because you're watching the lead bear ... you don't provoke it ... you don't even make any noise. Like even coughing. (AR6)

... An elder always go through the radio ... worried about young people, 'Don't walk away so far' or something like that. There's always somebody encourage or like, announce it on the radio ... 'Keep an eye, keep—keep look[ing] around, when—when it's dark' ... there's always somebody saying something about the polar bears, what to do and what not to do. (AR14)

Interestingly, participants across all communities indicated females and younger bears are more likely to enter communities versus males and adults, respectively.

... The big adult male, they're kind of—they got confidence, when they're walking ... they kind of just kind of move around. Slowly. Young one—young ones are very curious. They move around and [you know], they look around, they go into c-camps, and you know, they're the one[s] that follow the people more ... 'cause they're young, they don't know, they don't have experience. Whereas the big males, they know not to bother the camps, so they don't. They kinda cool. (AB15)

... They're gonna bring their cubs right to the dump ... they're gonna show their cubs where they can find their—their free meal? And the cubs grew, and, even though they're not with their moms anymore they—they're gonna remember and they're gonna come back to the site, or to different places and they're gonna find whatever scent they ... smell? (AR1)

Documenting observations of polar bear ecology offered elders and hunters a chance to voice their personal observations and perspectives, regardless of agreement with scientific views. Community members can offer a more nuanced understanding of population dynamics than science alone. Polar bears are not isolated objects of study; they also react to human interventions.

Inuit perspectives on management practices and recommendations

Even though hunting regulations were implemented recently, participants stressed that, historically, polar bears were harvested responsibly, sustainably and respectfully. When learning how to hunt, young hunters are taught ethical responsibilities in addition to basic hunting techniques.

We always get enough food for the year we don't try to finish all the bears we just get enough. [When we get] what we need ... we say stop or [even] any animal ... when we go out we check the tracks for fresh tracks, if we see them sometimes when there's bears with cub—young cubs we just don't bother them we just go after one single bear ... when we have enough food for the family we'll always stop ... we been controlling our animals ... ever since long time ago ... so we could control it for our—the bears ... 'cause we don't grow food ... up here, that's one of our main diet ... even without tags. (KU1)

... Bears are not just a game ... and they're not for pets. (K5)

... The older people, they know ... how to handle them and [because] our parents used to tell us not, to kill too many animal because what you need, just kill what you need. No more than [that]. So that's what's, our rule is ... Inuit. (AR9)

Some informants felt scientific and management practices (for example, quotas and male-biased harvests) have increased bear abundance.

But ever since I started growing up in Kugaaruk there's way more bears than when I used to be a small or young ... today there's a lot more bears now 'cause the hunters don't kill the mom with uh females with little cubs anymore. (KU1)

The government specifically tells each community [how] many bears to hunt ... and not enough tags are coming into the community and that's why the population is growing. (AB9)

Some participants expressed concern over male-biased harvests and felt males are important in maintaining populations.

... There's a by-law now and like they have to go for only males and he asked that person how come like if you catch all the males and there's no more males ... how they gonna make cubs ... he said he don't believe that there's only one male and there's lots of females they gonna make lots of cubs 'cause they always make cubs only once a year ... same time. (GH3)

Informants were aware of mark-recapture methods (ear tags, tattoos, collars and tranquilisation) used to monitor polar bears. Most participants have collected scientific samples or are aware of harvest-based sampling.

... They gave us an example of how they counted polar bears and they used uh, beans. They had a whole bunch of beans and then white beans of some sort and then they—they opened that and then they coloured ... so many beans and then they thrown them back in there, they shook it and then they grabbed a handful ... and then there's a couple of beans, that they grabbed and then—and then the rest are not coloured so they determine the population in each area that way sort of ... so, yeah that's exactly how they do it. With the tattoo ... so instead of just colouring the bean, they tattoo the bears. (GH2)

Informants were also concerned with loud aerial surveys that negatively affect bears, which are sensitive to noise and depend on sound to hunt.

... Polar bears are hunters. They need their ears to hunt seals. 'Cause they're under the sea ... I mean the ice. They need the ears for sure and they are ask when they're working, in an environment that's really loud, they're asked to use ear protections ... so they won't damage their ears. Helicopters tend to damage ears ... and the polar bears are more skinny 'cause they're not successful in their hunt ... skidoos more safer than the helicopter. (AB12)

Participants also felt tranquilisation continues to affect polar bear meat for consumption.

You can tell, if the bear is healthy, or not ... if you catch a—one with the tattoo ... on the lip ... even cooking it you can tell that it's unhealthy sometimes ... the water—they're boiling in ... it's a little whitish. (AB11)

Due to ongoing concerns, participants provided broad and specific recommendations for monitoring and research methods. Some informants preferred non-invasive versus

invasive studies, reminding researchers to treat bears with respect.

He said it's better if you don't put them to sleep and looking at the footprints instead to study. (GH7)

I think the way we're doing now it's—I think it's better to count bears and ... 'cause we're on the ground ... we don't put them to sleep or anything we just see them and let them leave ... we can always tell whether there's more bears or less bears as—as a—'cause we keep going out rather than hunting bear only we—we go out on the sea ice all the time. (KU1)

Participants recommended all surveys take into account bear movements, seasons and ice conditions, as surveys using transects and random sampling regimes (Buckland and others 2001) incur a sampling bias (for example, individuals in difficult-to-access areas).

Sometimes there are surveys being done on polar bears but they don't catch all of them, or they don't see all of them ... it's kind of impossible. He has been on the helicopter too when they're surveying ... it's—you can't [nit-pick] any bear, like ... sometimes they'll miss ... when they're following the tracks by helicopter, if they're zigzagging or going everywhere, uh, they tend to get air sick ... following the tracks. (K6)

Community members also emphasised the importance of spending time making observations in the field and including local knowledge could help interpret scientific findings. Participants continue to support and in some cases prefer harvest-based sample collection.

For his opinion, he'd rather have a polar bear killed ... get the meat sample and the fat sample and send that down ... to be analysed, why the polar bears are getting sick ... [he] doesn't want anyone coming up here, so they won't be scared off ... so they can be healthy. (AB1)

He prefer not to have them surveyed ... he prefer uh when the hunter catches on ... uh the fat, the meat, the penis, the heart and all that be sent down instead of them coming up here ... and survey and research them ... they use helicopters to tranquilise the bears ... and the tranquiliser, medication I think, is still in the body and he doesn't want that. (AB12)

Unfortunately, many community members are not aware of why researchers are interested in polar bear samples or how samples could be used to monitor polar bears.

Few times we did on our sporting hunting uh with the polar bear and there was a scientist came along to, to survey and ... test out the polar bears and stuff like that ... I didn't really learn it ... they were on their own doing stuff. (AB2)

They don't report back ... if they're given samples ... and they don't tell them why they're collecting, [what] they want those samples for ... the only way that you can get those is 'cause the hunters are giving those to the GN (Government of Nunavut) ... he feels it would be nice if the GN or whoever they sent the samples to are—if they can get feedback on those ...

they must know as to—if you receive the samples, where it might have come in from ... and they would know accurately a—if they're given feedback of how old, and ... was that bear healthy or unhealthy. (K1)

The differentiation between academic versus government researchers was not clear in these discussions, and several participants discussed research in the context of academic and government research interchangeably. Management and research practices should consider long-term ethical and ecological impacts on local communities and polar bear populations, which will differ across the north. Explaining how scientific surveys are designed, their limitations and the inferences that are made from sampling data to community members could resolve some criticisms against these surveys. Some academic and government researchers already make these efforts, suggesting other factors that limit access to or understanding of scientific information and materials (for example, communication) might be at play. These implications are not always immediately evident through initial community consultations or scientific literature.

All participants felt including Inuit hunters and TEK can enrich polar bear research with historic, holistic and contextual insight to improve projects and achieve common research goals. Participants were especially supportive of efforts that allow elders to share their stories, experiences and perspectives.

... All the hunters are usually out, along these leads ... they always have a story to tell, if they see a bear ... how many bears they saw, they're reliable information ... so that information were used to determine—let's [say] caribous were caught in this area, how many. Like the same with the polar bear, ask the hunters if they saw anything, if they found a bear here ... other hunter does found a polar bear here, we can determine if it's the same bear if they're close together ... so we could tell by what day the hunter saw that, what day the other hunter saw that ... they could tell 'yeah that's a different bear' ... so that way we could tell, and the seasons too, are different. Like right now, they're in the den ... summertime we know most of them are around the coast. (AB15)

Indeed, community members are able to provide specific recommendations in research design and encourage the inclusion of hunters and elders, suggesting communities could inform—and recognise value in—collaborative research.

Discussion

Lessons learned from community-based interactions

In this study, few community priorities were discussed during initial HTO meetings. Community-wide concerns only became evident after subsequent interactions and multiple visitations with community members, where time was spent to allow community members to understand research objectives and resulting outputs. Participant recruitment was especially challenging in Arctic Bay

due to previous misrepresentation of visitors' intents and was only successful after broadcasting a live radio show, where respected community members were able to phone in and ask questions about research objectives and also show support for this work. Similarly, local support and encouragement by other community members facilitated participant recruitment in all communities.

Through their own enthusiasm in and understanding of research objectives, interpreters were especially important in affecting the willingness of community members to participate in this work when approached. Interpreters also provided a contextual background for interviews through their own personal observations and experiences, such as identifying knowledgeable community members and instances where participants might have held back responses. While research experience varied among the interpreters, each interpreter influenced the research process in some way. The Arctic Bay interpreter had no previous experience with research participation, yet introduced this research to participants without the researcher's intervention and also shared her support for TEK work outside of interviews. Interpreters in Gjoa Haven and Kimmirut were more reserved – displaying little evidence of their own research perspectives – and interactions were largely research-oriented, creating a more 'formal' atmosphere for interviews. The Arviat interpreter was a recognised translator and asked to review the interview guideline prior to interviews so that she could anticipate how participants would respond to some questions and guide participants toward research themes of interest. AR10, who translated six interviews in Arviat, had no previous experience with translations and in some cases responded to interview questions directly without the participant's response (as her own responses), suggesting her focus was on the 'true' answer to particular questions versus unique participant perspectives. In this manner, research participants not only shape the research and knowledge-gathering process but also influence how community-based research is perceived and received by the community. Research practices that are culturally acceptable and effectively meet community priorities differ from community to community, and following ethical guidelines and permitting processes does not necessarily guarantee local support (INAC 1993; Inuit Tapiriit Kanatami and Nunavut Research Institute 2007; Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada 2010). Spending as much time with community members as early as is feasible in the research process can allow researchers and communities to overcome any cultural barriers and establish the capacity to mutually understand and appreciate scientific and community-based applications. Unfortunately, funding agencies do not always provide room in budgets for initial community interactions, relationship-building opportunities and meetings for research validation and completion.

Overlaps between polar bear TEK with science and other TEK studies

Though polar bear TEK has been documented in Arviat (Arviat Hunters and Trappers 2011; Kotierk 2012), Gjoa Haven (Keith 2005) and Kimmirut (Kotierk 2010), no known TEK studies in Arctic Bay have been published and individual views and perspectives are not necessarily generalisable across communities and Inuit as a whole. Building on polar bear TEK literature, this study serves to voice detailed Inuit perspectives from different Nunavut communities and regions. Participants were able to share – and in some cases reiterate – their own views within a research (versus management) context, make specific recommendations on monitoring practices and highlight themes that they felt were important. This work also allowed community participants to ask questions about current polar bear research and scientific methods and how data could be used to inform management, from a research perspective.

Several ecological and scientific views expressed by community members align with previous TEK studies. Participants in this work shared views that are consistent with reports from Pond Inlet, Qikiqtarjuaq and Clyde River (Dowsley 2007; Dowsley and Wenzel 2008) and Pangnirtung and Iqaluit (Kotierk 2010). Across the north, Inuit still report recent increases in polar bear abundance and the ability of polar bears to adapt to rapidly changing environments (Keith 2005; Tyrell 2006; Dowsley 2007; Kotierk 2010; Arviat Hunters and Trappers 2011; Kotierk 2012). Consistent with previous TEK work, community members warn polar bears are dangerous animals (Keith 2005; Kotierk 2010; Kotierk 2012) and some Inuit are concerned about consuming polar bears that have been eating garbage (Arviat Hunters and Trappers 2011). In the past, community members have also reported dissatisfaction with scientific methods (Tyrell 2006) and the level of influence that Inuit have in management (Kotierk 2010). Together these reports suggest Inuit share concerns that are ongoing and wide-ranging across the north, and persist despite efforts to integrate them through research collaborations and co-management (Peacock and others 2011).

Across communities in this study, participants reported increasing bear encounters are an adaptive response to dietary changes, which has been scientifically reported in western Hudson Bay, where bears are seeking alternative food sources around settlements (Stirling and Parkinson 2006; Government of Nunavut 2012; Gormezano and Rockwell 2013b). Though dietary changes have been attributed to sea ice changes limiting access to primary prey (ringed and harp seal; Thiemann and others 2008a), evidence for bears foraging on land-based foods (Dyck and Romberg 2007; Rockwell and Gormezano 2009; Gormezano and Rockwell 2013a) – reported as typical behaviour by most participants here – might also suggest an opportunistic feeding strategy (Thiemann and others 2008a). This suggests that bears pursue readily available

food sources even in the presence of preferred ones (Gormezano and Rockwell 2013b).

Bears foraging for land-based foods have been reported in the literature prior to recent concerns over climate change (Russell 1975; Derocher and others 1993; Gormezano and Rockwell 2013a). Observations of bears consuming garbage are not uncommon (Russell 1975; Lunn and Stirling 1985; Gormezano and Rockwell 2013b) and bears are probably more aggressive at sites where resources are defendable and predictable (Elfström and others 2014), such as garbage dumps and Inuit hunting caches, which might explain aggressive behaviour of bears near communities. Participants also felt bears are no longer afraid of humans because of habituation to scientific surveys and human activities, consistent with other community reports (Keith 2005; Kotierk 2010) and scientific observations (Dyck 2006; Stirling and Parkinson 2006; Andersen and Aars 2008). Habituation to human activities is not unexpected, especially when food is rewarded (Keith 2005).

Participants also reported young males are more likely to enter communities, showing some evidence for a sexual dimorphic life history, where males maximise growth by exploiting high-quality food areas (remote areas avoiding humans) and females prioritise offspring and avoid males (Elfström and others 2014). Participants also reported behavioural adaptations, where mothers teach young how to acquire food near communities; human tolerance transmission from mother to offspring has been reported in other bear species (Kaczensky and others 2006; Madison 2008; Elfström and others 2014). Polar bear characteristics reported by community members could thus reveal early changes in population health and ecology; large solitary males near communities might indicate lack of accessible, high-quality habitats (Elfström and others 2014).

Challenges and considerations for polar bear monitoring and research methods

Across the surveyed communities, several participants criticised invasive mark-recapture methods for their negative effects on polar bears. Loud vehicles (for example, snowmobiles) displacing polar bears from hunting areas have been reported in the literature (Andersen and Aars 2008), which could lead to decreases in body condition and reproduction. Although scientific studies have shown little evidence for mark-recapture and radio collaring effects on indicators of body condition, reproduction and survival in polar bears (Messier 2000; Thiemann and others 2013; Rode and others 2014), the impacts of handling on long-term behaviour and human–bear interactions have not been reported. Participants in this work also reported declining health and body condition and abnormal behaviour attributable to radio collaring, as well as increased aggression toward humans of bears that have been previously handled, thus endangering local communities. Still, some community members feel mark-recapture could provide important data on population

dynamics to inform appropriate harvest regulations, as long as surveys take into account temporal and spatial considerations for representative sampling. Mark-recapture surveys in some regions occur in the spring after den emergence and during mating season to maximise probability of capture (for example, when bears are distributed on sea ice versus coastlines, given the ecoregion polar bear populations inhabit; Thiemann and others 2008b; Vongraven and Peacock 2011; Rode and others 2014) and interpretations of population viability analyses have been discussed within the context of sampling biases due to bear movements and reactions to helicopters (Taylor and others 2006). Complete and extensive geographical sampling using mark-recapture methods and employing appropriate analysis models could more reliably estimate population numbers that are in agreement with local TEK (York and others 2016). Including local communities in monitoring research can shed light on effects of research practices that might not be immediately recognisable through scientific methods.

Beyond polar bears, all Nunavut communities have been participating in wildlife research and co-management for many years, as this is part of the existing co-management system (INAC 1993). Efforts to incorporate TEK and cultural perspectives in decision-making through community representation (HTOs and regional wildlife organisations) and public meetings are, therefore, already in place. However, this study shows some dissatisfaction and disagreement with management decisions by Arviat, Arctic Bay, Kimmirut and Gjoa Haven community members. Such views have also been previously reported in Arviat (Tyrrell 2006) and Kimmirut (Kotierk 2010), as well as in Pangnirtung and Iqaluit (Kotierk 2010). Policies and procedures for local community inclusion in co-management do not necessarily guarantee support at the community member (versus community [HTO] and regional) level.

Co-management barriers and complexities across the north are inherent (White 2006; White 2008). Co-management is based on Western, office-based bureaucracies and institutionalised systems of public governance that operate top–down (Timpson 2006), which differ drastically from traditional Inuit principles of collective collaboration (Wenzel 2004; Houde 2007). These structural characteristics also directly oppose fundamental aspects of Inuit knowledge formation and cosmologies, which are rooted in experiential, spiritual and oral systems that were historically based on physical survival in harsh climates (Wenzel 2004; Timpson 2006; White 2006; Houde 2007) versus formalised (written) agreements. Capacity is also lacking for political bodies (Timpson 2006; White 2006; White 2008). While these issues point to some of the social, cultural and political complexities of co-management that provide context for our interviews, they are broad and beyond the scope of our discussion. A comprehensive, empirical exploration of these issues specific to wildlife co-management contexts is warranted.

From a governmental research standpoint, each polar bear subpopulation is examined and studied every 10 to 15 years (Peacock and others 2011; Vongraven and Peacock 2011) and communities affected by this work are usually involved from the initial planning stages (for example, consultation meetings), through the research as participants, to reporting back to communities as a three to four year process. In some cases, local community perspectives and TEK have been documented to complement scientific studies in Baffin Bay (Dowsley 2005), Davis Strait (Kotierk 2010) and western Hudson Bay (Kotierk 2012) populations. However, unless a community harvests from several populations, a substantial time can pass until polar bear-related research occurs in the same community again. This suggests that some of the research concerns that community members reported here might reflect research practices that are out of date, perhaps due to lack of awareness or understanding of updated research methods in other areas, such as new less invasive aerial (Stapleton and others 2014; Stapleton and others 2016), genetic-based (van Coeverden de Groot and others 2013) and biopsy-dart (Pagano and others 2014; Government of Nunavut unpublished reports) sampling methods that have been developed as a response to community concerns. Accessibility to contemporary scientific data in other regions, whether through scientific literature or reports, is also limited. Regional representatives of Inuit designated organisations (regional wildlife boards), must exchange relevant and updated information with their counterparts from other regions, which must then be distilled to each community HTO. As there are three regions spanning Nunavut – Kitikmeot, Kivalliq and Qikiqtaaluk comprising five, seven and 13 communities, respectively – frequent exchange across this scale is certainly challenging. However, through direct research participation and engagement with researchers, community members could become aware of ongoing research in other regions.

Instances where community member participants do not support any scientific research practice are in some cases associated with misunderstanding of research goals, suggesting there is room for improvement in communicating research objectives and expected outcomes among management, research and local communities. The discrepancy in current awareness of issues during this study could be in part caused by a lack of communication between HTOs and all community members. Despite concerns at the participant level over insufficient reporting, some academic and all government researchers do hold consultation meetings on a frequent basis when conducting polar bear research. The researchers include local community members in the field where possible, and report back to HTOs through translated written reports, oral presentations and discussions with translators present. In all communities, scientific information (prepared by the Government of Nunavut) is available through booklets distinguishing male and female polar bears (to encourage male-biased harvests) and posters explaining scientific

surveys. HTOs are aware and acknowledge these efforts, despite lack of awareness at the community member level. This indicates that even though efforts are in place to distil research processes and data to relevant community organisations, community members – especially elders and individuals that are not active in research and/or management participation – may not necessarily receive nor have access to this information. Research reports should highlight themes that are relevant to community-specific interests and priorities (for example, implications for harvests and human–bear interactions) and how these results can be used in monitoring and management and – most importantly – benefitting Inuit. Inuit knowledge is passed on through word of mouth versus written reports; effort is needed to establish capacity for the diversity of community members (for example, youth, older elders) to learn about scientific information as it relates to the community. This could be made possible by making research findings accessible through presentations at the school, local organisations, community hall, radio announcements, posters, videos and websites including contact information, depending on the community. These efforts will require active HTO involvement as academics and scientists working in the north require skills in communications across cultural settings, for example, consulting, programme management and supervision, hiring, mentorship and financing, to name a few. Extra effort on the part of researchers is necessary to constantly remain engaged with communities and ensure community members are up to date with research projects and the broader contexts that they are a part of, which is difficult with expensive northern travel and limited time available to spend in each community.

In some communities, mass turnover of community (HTO) staff might make it difficult for community members to stay up to date with research processes. HTOs often receive several (research and non-research related) reports at a time and other community priorities might take precedence over reading them. HTOs are not only involved in research activities – they review proposals, technical reviews, economic development plans, land plan use activities, harvesting issues, etc. – a plethora of demanding issues that at times cannot be accommodated. HTO boards are formed (for example, they are elected within the community) on the basis of knowledge experience, and the administrative duties and bureaucracy demanded of them often lie beyond their capacity. These issues are also applicable to often overloaded government and academic (for example, graduate student) research positions that also experience high turnover rates. Combined with the limited financial and timing capacity of most researchers to remain in northern communities to engage community members, these ongoing issues suggest that polar bear research – and research in the north in general – might require community-based research institutions and/or coordinators, where designated, active liaisons bridge gaps in communication and engage communities in research projects. Some of the barriers to communication might be

due to poor interpretation (by researchers and community members) or lack of technical understanding of ideas and scientific information that is inadequately translated into local dialects (Inuktitut) and back to English due to language limitations. Interpreters (for both research conduct and preparation of reports) with a comprehensive understanding of research contexts, data gathering and analysis and applications are thus necessary for this process. These issues touch on another endemic issue that is education and beyond the scope of this discussion.

Concluding remarks for community-based research

Our study shows that discussions on research relationships with and practices conducted by academic and government organisations are not easily distinguishable, suggesting some community members might generalise their research experiences to ‘outsiders’ as a whole. Past views and experiences still shape current community perspectives, and views against academic and/or government research persist, especially when past research practices have ignored or failed to incorporate community concerns. Communities differ in their levels of research engagement and understanding of research objectives. For Inuit, local knowledge and perceptions are shaped by social views making communication critical in setting the stage for community–researcher relations. For researchers, knowledge perceptions are usually research and/or academic focused, and not necessarily relevant to livelihood. Ethical research practices from the outset are critical in setting the stage for all types of forthcoming research activities. How research results will be used should be transparent (Rowe and Frewer 2000). Community and research roles should be clear; research limitations and their impacts on communities are important.

Although all participants follow management regulations, each individual varies in his or her level of familiarity with and support for current management and research practices. Researchers are urged to contact other researchers who have worked in the same communities as well as local Hamlet, Arctic college and relevant community organisations to determine what forms of engagement do and do not work. Two-way lines of communication between researchers and community members should be maintained and accommodating for community members throughout all stages of research (for example, telephone or fax may be preferred over email). It will probably be necessary to report back and check in on multiple occasions. This will require persistence on the part of researchers and communities are likely to engage if research objectives speak to community priorities. Lack of community engagement might suggest research outputs have failed to incorporate community needs. Research questions and efforts to determine how communities could benefit from their participation might need to be re-visited. As with any personal interaction, relationships should be maintained and nurtured even after data gathering is complete.

Strong and transparent relationships between polar bear researchers and Inuit communities are necessary to overcome persisting research (and community) misconceptions. For community members, most types of research have been viewed as inseparable from government agendas through funding and consulting programmes (Bocking 2007) and past histories and power relations have politicised views of scientific research as a whole (Reed and McIlveen 2006). Upon arrival into any community, a researcher should take on the role of a learner, shifting from research driven by expertise and certainty to one with humility and willingness to adapt to changes (Grimwood and others 2012; Brunet and others 2014b). As community participation in research projects will undoubtedly impact research results (and community members through potential to inform management), forming collaborations in research design can guide research toward community priorities so that these priorities are effectively included in subsequent decision-making. In the past, academics have been criticised for prescribing expected research plans and outcomes in a rigid way, leading to condescending views of unfamiliar knowledge practices and unwelcoming interactions with community members (Grimwood and others 2012). Notwithstanding, community members also recognise the need to strengthen communication and relationships in order to achieve a mutual understanding in open collaborations. Ethical research conduct will pave the way for positive conceptions of forthcoming research programmes. In these contexts, the ability to build meaningful relationships is not only critical for successful TEK research, but for sustaining community involvement in research activities and support for research-based policies.

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Conflicts of interest

None.

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