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"The Time of the Most Polar Bears": A Co-management Conflict in Nunavut

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ABSTRACT. Since the 1990s, Inuit traditional knowledge (Inuit *Qaujimajatuqangit*) has taken on a substantial role in polar bear management in the Canadian territory of Nunavut through its direct use in quota-setting procedures. A co-management conflict has arisen from an increase of hunting quotas in January 2005 for Inuit living in the Baffin Bay and Western Hudson Bay polar bear population areas. The quotas were based on Inuit observations and their conclusion that these polar bear populations had increased. Scientific information suggests that climate change has concentrated polar bears in areas where humans are more likely to encounter them, but that the populations are in decline as a result of overhunting and climate-change effects on demographic rates. During consultations with wildlife managers and through other interviews in 2005, Inuit indicated their lack of support for quota reductions. Discussions with Inuit reveal two categories of problems that, though couched in the polar bear management issue, involve the co-management system and the integration of Inuit and scientific knowledge more generally. The first relates to direct observations of the environment by both Inuit and scientists and the synthesis of such information. The second relates to Inuit conceptualizations of human-animal relationships and the incorporation of scientific studies and management into that relationship. These problems reveal that differences between Inuit *Qaujimajatuqangit* and scientific knowledge are not fully understood and accounted for within the co-management system and that the system does not effectively integrate Inuit cultural views into management.

Key words: Inuit, polar bears, *Ursus maritimus*, co-management, Inuit *Qaujimajatuqangit*, traditional ecological knowledge, climate change, Baffin Bay, western Hudson Bay

RÉSUMÉ. Depuis les années 1990, les connaissances traditionnelles des Inuits (Inuit *Qaujimajatuqangit*) jouent un grand rôle dans la gestion des ours polaires du territoire canadien du Nunavut et ce, grâce au recours direct aux quotas. Un conflit de co-gestion s'est déclaré en raison de l'augmentation des quotas de chasse en janvier 2005 chez les Inuits vivant dans les régions peuplées d'ours polaires de la baie de Baffin et de l'ouest de la baie d'Hudson. Les quotas avaient été établis en fonction des observations faites par les Inuits et de leur conclusion selon laquelle les populations d'ours polaires étaient à la hausse. Pour leur part, les données scientifiques laissent entendre que le changement climatique a fait en sorte que les ours polaires se concentrent dans des régions où les humains sont plus susceptibles de les rencontrer, mais que les populations connaissent une diminution en raison de la chasse abusive et des effets du changement climatique sur les taux démographiques. Dans le cadre de consultations avec des gestionnaires de la faune et d'entrevues réalisées en 2005, les Inuits ont mentionné qu'ils n'appuyaient pas la réduction des quotas. D'après les discussions entretenues avec les Inuits, les problèmes font partie de deux catégories même si celles-ci relèvent toutes deux de l'enjeu de la gestion des ours polaires, soit le système de co-gestion, ainsi que l'intégration des connaissances des Inuits et des connaissances scientifiques de manière plus générale. Le premier problème a trait aux observations directes de l'environnement réalisées tant par les Inuits que par les scientifiques, ainsi qu'à la synthèse de cette information. Le deuxième problème se rapporte aux conceptualisations des Inuits en matière de relations entre les humains et les animaux ainsi qu'à l'intégration des études scientifiques et de la gestion à cette relation. Ces problèmes révèlent que les différences entre les connaissances inuites (*Qaujimajatuqangit*) et les connaissances scientifiques ne sont pas entièrement comprises et considérées dans le cadre du système de co-gestion, et que le système n'intègre pas efficacement les points de vue culturels des Inuits à la gestion.

Mots clés : Inuit, ours polaires, *Ursus maritimus*, co-gestion, Inuit *Qaujimajatuqangit*, connaissances écologiques traditionnelles, changement climatique, baie de Baffin, ouest de la baie d'Hudson

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INTRODUCTION

There have been more polar bears these days. There were some by these houses, and also by cabins. We always need a "watch person" while berry picking. We always hear polar bears are decreasing, but that's not true. We like berry picking and walking in summer, but we need rifles to protect ourselves. If you are going to talk about the past,

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> there were fewer then than there are today. This is the time of the most polar bears.
>
> (Clyde River community consultation participant, Dowsley and Taylor, 2006a:71)

Indigenous or traditional knowledge has become an integral part of wildlife management in northern Canada. It has provided historical and ecological information on several different species (Ferguson et al., 1998; Huntington et al., 1999; Gilchrist et al., 2005), served as a red flag to draw attention to changes in particular species (Mallory et al., 2003) and proven useful in population monitoring for some harvested species (Moller et al., 2004). However, traditional knowledge, or Inuit *Qaujimajatuqangit* (IQ) in Nunavut, is not merely observations of the environment; it is a paradigm for viewing the world and the place of humans in it (Wenzel, 1991, 2004; Usher, 2000). This knowledge is not restricted to traditional knowledge in the meaning of "old knowledge passed down from previous generations"; it also includes knowledge acquired by the current generation. Usher (2000) describes four categories of such knowledge, which he calls traditional ecological knowledge (TEK): 1) Knowledge about the environment, 2) Knowledge of the use of the environment, 3) Environmental values, and 4) The knowledge system itself. The first two categories of knowledge have been used, as in the examples mentioned above, to improve wildlife management. This paper explores the ways in which all four categories of knowledge influence how Inuit approach the Nunavut co-management system for polar bears (*Ursus maritimus*).

Co-management systems have been the subject of much recent academic inquiry (Nadasdy, 2003; Moller et al., 2004; Natcher et al., 2005; White, 2006). Carlsson and Berkes (2005) stress that these systems should be viewed not as static entities, but rather as iterative processes that function as a space for discussion and problem solving. With this in mind, particular attention will be paid here to Inuit understandings of human–polar bear interactions, since indigenous perspectives are often poorly understood and therefore have been undervalued in co-management situations (Nadasdy, 2003; Natcher et al., 2005).

In January 2005, the Nunavut hunting quotas for two polar bear populations, Baffin Bay and Western Hudson Bay (see Fig. 1), were increased on the basis of Inuit *Qaujimajatuqangit*. Scientific survey and harvest data suggest that these populations are in decline (Stirling et al., 1999; Aars et al., 2006; Dowsley and Taylor, 2006a, b; Stirling and Parkinson, 2006). However, Inuit support for a decrease in quotas is mixed. In order to better understand this conflict in the co-management system, Inuit observations and interpretations are explored here using information gathered through interviews conducted in 2005 and the minutes of meetings between the Government of Nunavut (GN) and Inuit communities in the Western Hudson Bay and Baffin Bay polar bear population areas in November and December 2005 (Dowsley and Taylor, 2006a, b).

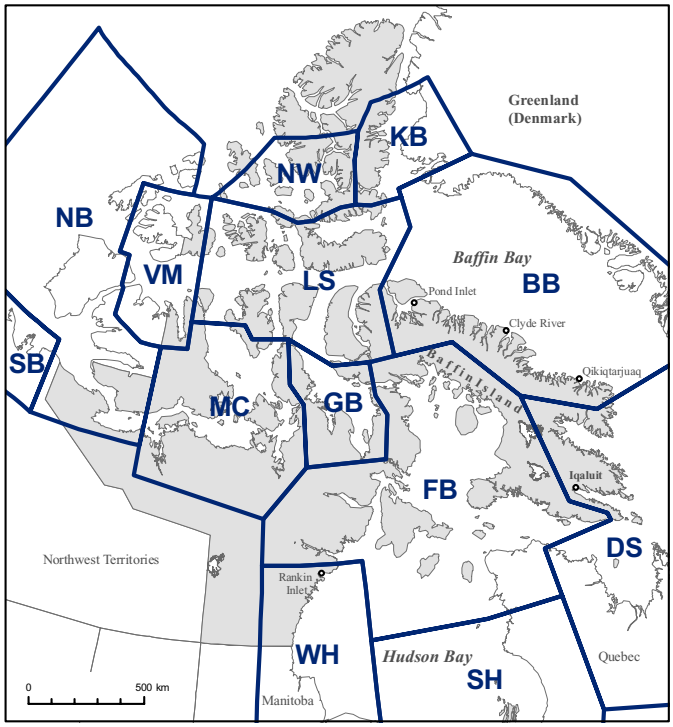

FIG. 1. Map of Nunavut (shaded area), showing the location of the study communities of Pond Inlet, Clyde River, Qikiqtarjuaq, and Rankin Inlet. Heavy lines represent the boundaries of the polar bear population areas of Canada, including the Western Hudson Bay (WH) and Baffin Bay (BB) populations. (Courtesy Jay McConnell, Dept. of Environment, Government of Nunavut.)

POLAR BEAR MANAGEMENT IN NUNAVUT

In 1973, Canada signed the International Agreement on the Conservation of Polar Bears and their Habitat (Lentfer, 1974). Within Canada, polar bears fall under the jurisdiction of the provinces and territories in which they range, including the Northwest Territories, from which the territory of Nunavut was created in 1999. In the Inuit-majority territory of Nunavut, the government has adopted Inuit *Qaujimajatuqangit* as a guiding philosophy (GN, 2004; Wenzel, 2004).

The Nunavut Land Claim Agreement mandates a co-management system to conserve polar bears and other wildlife for future generations, while allowing Inuit to harvest these species at sustainable rates (NTI, 2000). A quota system is in place to control hunting of polar bears, and various other regulations protect reproductive females and cubs. Adult females unaccompanied by cubs can be taken in a ratio of 1 female per 2 males harvested. GN Department of Environment biologists intend to survey each of Nunavut's 13 polar bear populations on a 15-year rotation. This inventory has two main components: first, to delineate the population (Taylor et al., 2001a) and second, to determine demographic parameters sufficient to assess population status and sustainable harvest levels (Taylor et al., 2002, 2005).

The scientific information is then used to develop total allowable harvest (TAH) recommendations, which are sent to the government's co-management partner, the Nunavut

Wildlife Management Board (NWMB), for an initial decision regarding the TAH levels. The Minister of Environment may accept or reject the NWMB's first decision. If the Board's first decision is rejected, the NWMB provides its final decision to the Minister, who may accept, reject or modify that decision (NTI, 2000: Article 5, Part 3). The TAH for a polar bear population area is then given to the appropriate regional wildlife organization for allocation among the hunters and trappers' organizations of the affected communities, who then allocate tags (licences) to hunters.

The community organizations, the Minister of Environment, and the regional wildlife organization also sign a memorandum of understanding (MOU) on how the polar bear population will be managed for the following 15-year interval until the next survey. This document includes information on how the quota was set, other government regulations, and local hunting rules. Memoranda of understanding are not legally binding on any of the signatories, but are formally accepted as a final decision by the NWMB.

In 2005, Inuit *Qaujimajatuqangit* was directly incorporated into memoranda of understanding on polar bear management for Western Hudson Bay, Baffin Bay, and several other populations. The TAH for the first seven years of the 15-year survey cycle was set using a conservative harvest rate based on the calculations of the biologists, as outlined above. Harvesting at the conservative harvest rate is expected to allow population growth. For the next seven years, or until the next population survey is completed, the guided harvest rate, based on IQ perceptions of trends, will be used to set the TAH. The guided harvest rate is determined as "the number of bears that can be taken without reducing the population below the target number" and must be in agreement with the conservation principles of the Nunavut Land Claim Agreement (GN, 2005a:1.1). The target number of a population is based on previous estimates of population size. Harvest levels are supposed to maintain the population, or in the case of a reduced population, are supposed to allow for population growth back to the target number.

In 2004, IQ from the Baffin Bay and Western Hudson Bay polar bear population areas indicated an increase in polar bear sightings that was believed to have been caused by population growth, and the NWMB identified an increase for the TAH. Both of the populations had last been surveyed more than seven years previously, so the guided harvest rate was used. The Minister of the Environment accepted the increase in January 2005, raising the combined quota for the three Baffin Bay communities from 64 to 105 bears per year and that for the five western Hudson Bay communities from 47 to 56 bears per year (GN, 2005a, b). These increases were based on IQ rather than scientific estimates of population size. Nunavut was criticized by the Canadian Polar Bear Technical Committee and by the Polar Bear Specialist Group of the IUCN/SSC for raising quotas on the basis of traditional knowledge without supporting scientific evidence (PBTC, 2005; Aars et al., 2006). Despite the criticism, in 2005 and 2006, Nunavut decided not to reduce the quotas, because of lack of community support (PBTC, 2006).

According to the MOU, if "new research indicates that the population has declined below 90% of the target number for any reason, a moratorium on harvesting will be implemented until the population is projected to have recovered, or until a new population estimate shows that it has recovered to its target number" (GN, 2005a: 5.7.1). The Baffin Bay target number is 2074, based on the last mark-recapture survey conducted from 1994 to 1997 (GN, 2005b; Taylor et al., 2005). Harvest data from Nunavut and western Greenland, which also harvests from the Baffin Bay population, were used in population projections with the computer population-modeling program RISKMAN (Taylor et al., 2001b), and these projections suggest that the population had fallen to about 1550 polar bears (a decline of 25%) by the time of the 2005 consultations (Dowsley and Taylor, 2006a).

The target number for the Western Hudson Bay population was set at 1400 in 2005 using IQ (GN, 2005a). This was an increase from 1997 scientific population estimates and from the previous target number of 1200 animals (Lunn et al., 1997). The population estimate was raised in the 2005 agreement because community consultations revealed that Inuit harvesters felt there were more bears than the surveys indicated, and they estimated nine more bears could be harvested per year. If their information is correct, a population of 1400 animals is needed to support such a harvest level. Thus, 1400 was set as the new population target, and quotas were set on the assumption that this was indeed the population size. Since then, Canadian Wildlife Service (CWS) data for the Western Hudson Bay population have given an estimate of 977 ± 108 bears (Aars et al., 2006), a decline of 18.5% from the 1997 estimate of 1200 and 32% less than the target number of 1400.

According to the scientific calculations, both populations had dropped below 90% of the target numbers by 2006. The GN was therefore in a position to impose a hunting moratorium in both Baffin Bay and Western Hudson Bay. However, given the cultural value of bear hunting, safety concerns raised by community residents, and the political climate in Nunavut, the GN was reluctant to act without the support of the community hunters and trappers' organizations.

SCIENTIFIC RESEARCH

Research conducted by the CWS in Hudson Bay has shown that spring breakup of ice now occurs significantly earlier than it did 30 years ago (Stirling et al., 2004). This change forces polar bears onto the land earlier in the year, reduces their critical spring seal-hunting season, and prolongs their summer fast (Stirling et al., 1999). As a result, the condition of adult female polar bears in the Western Hudson Bay population has declined significantly (Stirling et al., 1999). The resulting decrease in population productivity renders recent population projections and the

quotas based on them inaccurate, since they were developed using estimates of higher productivity than is now the case (Stirling and Parkinson, 2006).

Stirling and Parkinson (2006) report a significant trend towards earlier breakup of ice in Baffin Bay, on the order of 6–7 days per decade since 1979. The effects of changing ice conditions in Baffin Bay on polar bears have not been scientifically studied, but Stirling and Parkinson (2006) hypothesize that climate change–induced stress, similar to that observed in the Western Hudson Bay population, could be affecting the Baffin Bay population.

What is known with more certainty is that the Baffin Bay population faces the problem of overhunting. Nunavut shares this polar bear population with Greenland. A Greenland harvest report containing data from 1993 to 2004 and published in 2005 showed an increase in the harvest levels (Born and Sonne, 2006). According to RISKMAN projections, by the end of 2005 the combined hunting pressure from Nunavut and Greenland had reduced the Baffin Bay population to the point that Greenland and Nunavut were each harvesting above the sustainable yield independently (Dowsley and Taylor, 2006a). Greenland initiated a quota system in January 2006, and discussions between Greenland and Canada on the Baffin Bay harvest are ongoing (Lønstrup, 2006).

In order to achieve consensus for management actions in Nunavut, both Inuit and scientists must agree on what is happening to the polar bear populations and why. The lack of Inuit support for quota reductions in Baffin Bay and western Hudson Bay indicates that Inuit perceptions of the situation differ from the scientific understandings.

METHODS

In order to examine Inuit understandings of the management issues in Baffin Bay and Western Hudson Bay, the first author collected data using two methods. The first method was through interviews conducted during the spring of 2005 in the three Baffin Bay communities of Nunavut, Pond Inlet, Clyde River, and Qikiqtarjuaq (see Fig. 1) (Dowsley, 2005, 2007). Unfortunately similar data are not yet available for Western Hudson Bay. In each Baffin Bay community, 15 to 17 community members were interviewed using a semi-directed approach (Ferguson and Messier, 1997; Huntington, 1998; Fox, 2002). The participants were mainly senior (over age 40) and retired hunters recommended by Inuit organizations, GN personnel, and earlier participants in the study. Other participants were eight female elders and five experienced hunters under the age of 40 (the youngest was 28). A total of 48 interviews were completed. Participants were asked three sets of questions. The first set concerned changes in the population size, behaviour, and health of polar bears. The second set was on changes observed in the sea ice environment and possible relationships between such changes and polar bears. The last set involved questions about the management system. The number of respondents who discussed each topic varied because they were asked to discuss changes rather than answer individual questions.

We analyzed the responses using both qualitative and quantitative methods. As part of the quantitative analysis, responses were categorized by community and gender of respondents. Fisher's exact test (2-sided) (SPSS, 2001) was used to look for differences within the categories using an observed level of significance less than 0.100. The information gathered from these interviews is available both as a report from the Government of Nunavut (Dowsley, 2005), and, in a more condensed version, as a journal article (Dowsley, 2007). We summarize the information here to allow for a discussion of its interaction with the Nunavut co-management system.

The second method was to analyze minutes recorded at co-management consultations held between GN representatives, Inuit organizations, and community hunters and trappers' organizations (HTOs) in both the Baffin Bay and Western Hudson Bay communities in November and December 2005 (the minutes are contained in reports of the meetings, Dowsley and Taylor, 2006a, b). These meetings focused on an explanation of the scientific concerns regarding hunting levels and climate change. Four meetings were held in the Baffin Bay communities, one with each HTO and one general meeting for the community-at-large in Clyde River. As part of the Baffin Bay meetings, the first author presented the interview report (Dowsley, 2005) and solicited comments. In the Western Hudson Bay polar bear population area, one meeting was held in Rankin Inlet (see Fig. 1), which involved HTO representatives from the five hunting communities. Canadian Wildlife Service data were presented to the western Hudson Bay communities with an explanation of the scientific perspective. We qualitatively analyzed the minutes of all five consultations to gain an understanding of IQ relating to the polar bear management situation.

The following section first uses interview data from Baffin Bay to explore IQ from Usher's first two categories (knowledge about the environment and knowledge about the use of the environment). The interview data are compared to scientific data and to the hypothesis put forward by Stirling and Parkinson (2006) that climate change is affecting Baffin Bay and Western Hudson Bay polar bears in a similar way. Then data from both the interviews and the consultations are used to examine IQ from Usher's other two, more abstract categories (environmental values and the knowledge system itself).

RESULTS AND DISCUSSION

Climate Change and the Sea Ice

The sea ice is a key habitat component for polar bears because it serves as a platform for hunting and is critical habitat for prey species. Changes in ice conditions, including the amount and quality of landfast ice and the timing

of breakup and freeze-up, were reported during the Baffin Bay Inuit knowledge study (Dowsley, 2005). No significant differences were found between communities or between male and female respondents for these topics.

The main change in ice reported was a decrease in the amount of landfast ice (Dowsley, 2005, 2007). A total of 16 of the 21 survey participants reported that the floe edge has receded in the past 10 to 15 years. More participants chose to discuss icebergs, with 27 of 33 stating that the number of icebergs grounding near their community has decreased. Several participants linked the two observations, for example:

> The floe edge is closer to the land and there are hardly any icebergs. That's why the floe edge is close by. The ice-bergs keep the ice from going anywhere. They are like plugs.
> (Qikiqtarjuaq survey participant, Dowsley, 2005:16)

Finley et al. (1983) also report that grounded icebergs, which drift down from the north along the west coast of Baffin Bay, are important for maintaining the landfast ice of northeastern Baffin Island.

Scientific studies from both western Hudson Bay and Baffin Bay report the date of spring breakup is now significantly earlier than it was approximately 30 years ago (Gagnon and Gough, 2005; Stirling and Parkinson, 2006). Stirling and Parkinson (2006) report that breakup in Baffin Bay is occurring between two and three weeks earlier than it did in the early 1980s. In the community interviews, the timing of spring breakup in Baffin Bay was reported by 12 of 13 people to be earlier now than 10 to 15 years ago (Dowsley, 2005, 2007). Four of the respondents specified that breakup was two weeks earlier from 2000 to 2005 than it had been 10–15 years previously. The others did not specify a time.

A change in the timing of fall freeze-up has not been as apparent to either Inuit or scientists. Scientific studies in western Hudson Bay report a non-significant trend for time of freeze-up from 1975 to 2000 (Stirling et al., 1999). However, Gagnon and Gough (2005) found statistically significant trends towards later freeze-up in the northern and northeastern regions of Hudson Bay. Data are not available for Baffin Bay. Only eight people chose to discuss freeze-up in the Baffin Bay interviews when asked to discuss changes in the sea ice. Six of the eight reported that freeze-up was later than during the early 1990s (Dowsley, 2005, 2007). The low number of responses about freeze-up suggests that it is more variable, or that changes in freeze-up are more difficult to judge than changes in other aspects of the sea ice. This result does not refute Stirling and Parkinson's (2006) hypothesis that the two areas are experiencing similar changes.

Changes in Polar Bears

In the interviews, Inuit reported numerous changes in polar bears over the past 10–15 years, mainly involving human-bear interactions and the condition of bears (Dowsley, 2005, 2007). There was more variability between the Baffin Bay communities on this topic than there was on the climate-related observations. There were significant differences ($p < 0.10$) between communities for four topics concerning polar bear population size and human-bear encounters and two topics involving the reason for increased damage caused by bears. No significant differences between male and female respondents were found.

Polar Bear Population

During the Inuit knowledge survey in the Baffin Bay area, Inuit knowledge varied significantly between communities on whether there was any change in the population of polar bears ($p = 0.010$) (Dowsley, 2005, 2007). In the northern community of Pond Inlet, all 14 respondents indicated a population increase. In the central community of Clyde River, 16 of 17 respondents reported an increase. In the most southern community of Qikiqtarjuaq, 9 of 15 reported an increase. The other six respondents in Qikiqtarjuaq reported either that they did not know, or that no change was observed. No respondent in any of the communities reported a decrease in the bear population.

Interview participants were asked if there were changes in the number of bears coming around town over the last 10–15 years. Again, there was a significant difference in responses between communities ($p = 0.021$). In Pond Inlet, all eight respondents stated that the number of bears coming into the community had increased. In Clyde River, 15 of 16 respondents gave the same response, while one person indicated no change. In Qikiqtarjuaq, three of six respondents stated that there was an increase, while the other three indicated no change.

The differences in community responses to questions regarding polar bear population levels and changes in the number of bears coming to the community indicate a north-south gradient along the eastern coast of Baffin Island. Two biogeographic features may explain this gradient. First, there is a weak differentiation between sub-groups of bears in northern and southern Baffin Bay, which is due to currents and movements of the pack ice (Taylor et al., 2001a; Dunlap and Tang, 2006). The split between the northern and southern areas occurs in the Home Bay area, just south of Clyde River and north of Qikiqtarjuaq. Second, the Lancaster Sound polar bear population, which borders on the Baffin Bay population in the vicinity of Pond Inlet, is a productive population and may contribute immigrant bears to the Pond Inlet hunting area or to the north Baffin Bay group in general (Taylor and Lee, 1995; Taylor et al., 2008). Thus, it is possible that changes that affect the northern part of Baffin Bay might not be as obvious to observers in the southern areas. This could explain the difference between observations made in Qikiqtarjuaq and those from the two more northern communities.

Condition of Polar Bears

The condition of polar bears varies throughout the year, depending on available food resources. In Western Hudson Bay, progressively earlier spring breakup of ice over the past 25 years has resulted in significantly poorer condition of both male and female polar bears when they come on shore (Stirling et al., 1999; Stirling and Parkinson, 2006). Early spring breakup was also associated with increased human-polar bear encounters in Churchill, Manitoba (Stirling et al., 1999). Stirling and Parkinson (2006) hypothesize that polar bears are increasingly coming around humans because of food stress in both Western Hudson Bay and Baffin Bay. If this is correct, then the condition of these polar bears is expected to be poorer than that of bears encountered on the land or ice far from communities.

During the interviews in the Baffin Bay communities, 11 of 24 respondents felt that polar bears are skinnier now than 15 years ago, and there was no significant difference between categories of respondents (Dowsley, 2005). The remaining 13 respondents indicated that there was no trend. When asked specifically to compare bears that come to the community versus other bears, 5 of 10 participants reported that "town bears" are skinny; four participants reported there was no pattern; and one said they were fat.

These data suggest that the polar bears Inuit are encountering around human habitation in Baffin Bay are not obviously in poorer condition than other polar bears. This does not necessarily refute the hypothesis put forward by Stirling and Parkinson. The weight loss they discuss for bears in Western Hudson Bay is based on a large sample size and is not necessarily of the magnitude that would be noticed by an observer or hunter encountering many fewer bears across a long time period. Annual and interannual fluctuation in condition may mask the trends in weight loss observed through scientific analysis in Western Hudson Bay and hypothesized to exist in Baffin Bay.

Property Damage by Bears

When Baffin Bay Inuit were asked about the amount of property damage caused by polar bears, 27 of 29 respondents said polar bears are causing more damage now than 15 years ago (Dowsley, 2005). The other two respondents indicated no obvious change. There was no significant difference between categories of respondents. Destruction of meat caches was reported in Pond Inlet and Clyde River, while damage to cabins and tents was mentioned in all three communities.

Respondents were asked what had caused the bears to be more destructive. For this question, there was a significant difference between communities regarding the interpretation of the bears' behaviour as being related to bear population size ($p = 0.092$). Six of seven Pond Inlet respondents stated that the increase in the polar bear population was the reason for increased damage, while respondents in the other communities did not feel as strongly about this explanation (given by 5 of 13 in Clyde River and 2 of 6 in Qikiqtarjuaq). There was also a significant difference between communities regarding humans as the cause of increased bear damage ($p = 0.043$). In Qikiqtarjuaq, four of six respondents stated that the cause of increased bear damage was that there are more people now and more human objects around for bears to get into. In Clyde River, four of 13 respondents agreed, while the other nine said this was not the reason. All Pond Inlet respondents (7 of 7) stated that the cause of increased damage was not that there are more people or more human objects on the land.

Some of the disagreement between Inuit and scientists regarding the polar bear population size may also result from a time lag for IQ between making sufficient observations and then synthesizing that information into an understanding of cause and effect. Omura (2005) discusses the timely formation of Inuit knowledge when he points out that while science focuses on the strategy (the big picture), Inuit focus on the tactics (or particulars of events) and try to avoid generalizations. When this different approach is combined with the lower precision (compared to scientific studies) of observations of trends within naturally fluctuating systems, it is expected that the result will be fewer strong conclusions.

This is not to say that no Inuit have connected changes in the sea ice with the changes they have observed in polar bears. In the Inuit knowledge survey, 12 people discussed possible links between polar bears and climate change (Dowsley, 2005, 2007). Three did not think there was a link, and four respondents were uncertain. Five respondents felt climate change could be contributing to what they had observed about polar bears, for example:

> The bears are more hungry. There is a problem with the ice. The rough ice makes it hard for them to find seals, but there is the same number of seals.
>
> (Qikiqtarjuaq survey participant, Dowsley, 2005:11)

In summary, Inuit observations of the sea ice environment in Baffin Bay are fairly consistent with each other and with scientific information on Baffin Bay and do not clearly refute Stirling and Parkinson's (2006) hypothesis that climate change is affecting both the sea ice and polar bears similarly in western Hudson Bay and Baffin Bay. There was more variability between interview participants regarding the polar bear population, the bears' behaviour and condition, and the meaning of the observations, making it difficult to assess how climate change is affecting polar bears on the basis of IQ from Usher's categories 1 and 2.

Discussion of IQ

The collection and interpretation of IQ (and TEK more generally) involves several cautions. The first is the individual nature of traditional knowledge. The second is that Inuit focus on particulars rather than generalizations, as

noted above. Finally, TEK is almost always derived from local-level observations and may not always translate well into discussions of wildlife populations at the larger geographic scale.

TEK in general is not a single unified body of knowledge, catalogued and accepted by everyone in a community as truth. There is much variation in life experience, analysis of observations, and ability to integrate various pieces of information among Inuit, just as there is among other people.

The Baffin Bay consultations provided an example of the problems that arise from the individual nature of IQ pertaining to observations of the environment (Dowsley and Taylor, 2006a). It involved the claim by some Inuit participants that a loss of sea ice due to climate change would not affect polar bears' hunting success or population distribution, as they are perfectly capable of hunting in the open water. Thus, the argument concluded, scientists' belief that bears are being concentrated on land was incorrect. While it has been reported that polar bears hunt in open water (Furnell and Oolooyuk, 1980; Smith and Sjare, 1990), these reports note that polar bears bring their prey out of the water to feed. Similarly, other Inuit reported the use of a feeding platform during the consultations in Clyde River and Pond Inlet. For example:

> In 1969 we used to go by ship to Alexandra and Grise Fiords, when my father worked for the RCMP. When we were in the middle of the ocean, going by boat, we used to see polar bears in the water where there was no ice. And when they caught seals they would take them to the ice to feed themselves in summer.
>
> (Pond Inlet consultation participant, Dowsley and Taylor, 2006a:42).

This example demonstrates the importance of vigilance in collecting and verifying traditional knowledge, as discussed by Ferguson and Messier (1997) and Fox (2002). It also illustrates the usefulness of viewing co-management as an iterative process of sharing knowledge among all participants.

The individual nature of IQ should also be recognized and accommodated by the Nunavut co-management system more generally. The transformation of individual observations and conclusions by Inuit politicians into an "official" group opinion occurred often during the 2005 consultations and allowed these elected officials to demonstrate a unified front to wildlife managers and add weight to their concerns (Dowsley and Taylor, 2006a, b). In such a transformation, however, the textured nature of the original reports can be lost. For example, although the majority of Baffin Bay interview participants reported the polar bear population had increased, there was a significant difference ($p = 0.01$) between the proportion of people who reported more bears in Qikiqtarjuaq and the proportion in Clyde River and Pond Inlet (Dowsley, 2005, 2007). Biogeographic differences between northern and southern Baffin Bay may be affecting bears differently in the two areas.

Once a group opinion has been expressed, furthermore, it may also be difficult to modify. Inuit generally try to avoid contradicting other people because other people's words are assumed to be true (Ferguson and Messier, 1997; Fox, 2002). Therefore, people may try to add their own knowledge to a discussion without openly contradicting the observations and conclusions of someone else. For example, although 16 of 17 interview participants in Clyde River reported an increase in polar bears during the interview study (Dowsley, 2005, 2007), an elder reported an opposing view during the co-management consultations:

> I think that there's a decrease in polar bears, but I don't want everyone to believe that because Inuit Knowledge says there is an increase. Sometimes we hardly see them anywhere. From Inuit Knowledge I know if we don't see a polar bear it's because they are moving around a lot. Inuit Knowledge is saying more polar bears are being seen.
>
> (Clyde River consultation participant, Dowsley and Taylor, 2006a:56)

Closely related to the individual nature of IQ is the fact that Inuit tend to be cautious about overgeneralizing or simplifying their knowledge and prefer to admit ignorance rather than speculating on topics (Gilchrist et al., 2005; Dowsley, 2007). Often they share information as anecdotes of individual events rather than drawing generalizations as scientists do (Omura, 2005). The difference between their approach and the scientific one needs to be recognized in order to hold more effective discussions between people using the different knowledge systems.

Finally, TEK is almost always formed from a local geographic focus. Traditional knowledge of wildlife can be useful at the population level as a source of information on population trends, which can be ascertained, for example, from the body condition of harvested animals (Lyver and Gunn, 2004) or from movement patterns in migratory species such as caribou (Kendrick et al., 2005). However, TEK (as well as scientific information) has at times proven less reliable in discussions of animal population size or distributions. In several studies, when asked about possible declines in wildlife populations, Inuit reported that the species had declined in the local area, but that this represented a shift in distribution rather than a decline in population (McDonald et al., 1997; Johannes et al., 2000; Gilchrist et al., 2005). Further scientific studies indicated in some instances that there had been a change in distribution (Johannes et al., 2000), while in others a decline in population was concluded (Hammill et al., 2004; Gilchrist et al., 2005). Problems in data collection and synthesis, or the geographic or time scale of the observations, may explain the incorrect conclusions that were initially offered by either scientific researchers or Inuit observers (Johannes et al., 2000; Gilchrist et al., 2005).

The disagreement in western Hudson Bay over the population of polar bears may provide an example of incomplete data collection and synthesis among Inuit

observers, or of scientific data collection that is too narrowly confined in geographic area. The scientific studies by the CWS in western Hudson Bay indicate a significant decline in the body fat of female bears in the fall (Stirling et al., 1999), as well as a population decline. A representative from the land-claim organization Nunavut Tunngavik Inc. summarized Inuit views of the situation as follows:

> The elders don't know the exact population, but they say the population is stable…We will tell you when we are concerned. We'll tell you when there is a problem.
> (Dowsley and Taylor, 2006b:44).

One possibility for the disagreement between the CWS data and Inuit experience is that IQ has not yet noticed a decline in bear condition or population in Western Hudson Bay. The amount of body fat on polar bears varies throughout the year, with bears at their lowest weight in early spring (Stirling et al., 1999). Inuit in western Hudson Bay harvest polar bears throughout the year, with a male-to-female ratio of 2:1, and may not yet have made sufficient observations of the condition of bears in any one season to notice a decrease in the amount of fat on females in the fall. Another possibility for the disagreement is that the geographic areas observed by CWS and Inuit differ. CWS studies are conducted in the southern portion of the Western Hudson Bay polar bear population area, while the Inuit communities are located farther north. Both of these hypotheses could be further investigated.

In discussions about possible population declines of other species (Johannes et al., 2000; Gilchrist et al., 2005), Inuit recognized that local harvesting rates were quite high, or local disturbance of animals had caused the animals to leave. In the case of thick-billed murres (*Uria lomvia*) in western Greenland, most of the Inuit hunters interviewed did not consider the lack of alternative habitat for the species outside the local area, or the cumulative effects of harvesting or disturbance of the birds by many settlements, including their own (Gilchrist et al., 2005). Instead, most interview participants concluded that the declines were caused by local disturbance or non-local overharvesting. Gilchrist and colleagues explained these conclusions as a lack of knowledge of the regional movements of the species and an ignorance of harvest levels relative to productivity. An underlying reason for this apparently narrow geographic focus in the synthesis of harvest and movement data comes from IQ categories 3 and 4 (discussed further below) and relates to the Inuit view of animals as sentient beings.

If these cautions are noted, the arguments over the Baffin Bay and Western Hudson Bay polar bear populations relating to Usher's TEK categories 1 and 2 are relatively easy for non-Inuit to understand and can be discussed by scientists and managers. These arguments work within the scientific paradigm and can be addressed either within the present co-management system (for example, through further research and education) or with slight modifications to that system. If they were the only arguments used, one would expect that a solution could soon be reached. These arguments do not, however, fully explain the reluctance of the Inuit to take immediate action regarding the scientific evidence that the Western Hudson Bay and Baffin Bay polar bear populations are declining. The participants in the consultations and interviews frequently offered another type of argument, either directly or indirectly, as to why they did not want to lower quotas. This argument has to do with a cultural view of animals that differs greatly from that of Euro-Canadians.

Environmental Values and the Knowledge System

Inuit *Qaujimajatuqangit* from Usher's categories 3 and 4 was also used to discuss the polar bear situation in western Hudson Bay and Baffin Bay and to argue against quota reductions or against the structure of the management system itself. These arguments reveal an underlying conflict in the co-management system: that it has not effectively incorporated Inuit cultural traditions. Inuit participants made several statements against the co-management system itself during the community consultations:

> As Inuit, we have rights. You're just here telling us things. We have rights and a voice. We can do something about that. The elders know [about the polar bears]. Even though I'm young, I believe them, I don't believe you.
> (Clyde River community consultation participant, Dowsley and Taylor, 2006a:67)

> Ever since we abided by the government, we have been following things we don't like. They impose it on the settlements. We used to follow our own thoughts and we were conservation minded. If we work together we won't be over-killing wildlife.
> (Western Hudson Bay consultation participant, Dowsley and Taylor, 2006b:52)

These statements reflect a strong interest in participating in wildlife management, but in a culturally appropriate way. Omura (2005) and Fienup-Riordan (1999) point out the desire among Inuit and Yup'ik Eskimos to maintain their own perspective rather than following non-indigenous ways. This desire, manifested in many aspects of life and interactions with non-Inuit, serves to strengthen aboriginal identities in the face of much outside influence in their lives (Omura, 2005).

For Inuit, hunting plays a key role in cultural identity (Condon et al., 1995) and is essential to developing and maintaining human-animal relations and also human-human relationships (Stairs and Wenzel, 1992; Nuttall, 2000). Directly from the relationship between hunter and prey (as food provider) comes the necessity to share that food with other people in order to fulfill one's relationship obligations to the hunted species and to other humans who also share food. In this way, hunting ties people to each other as well as to animals. Furthermore, the IQ principles of Nunavut stress that animals and land are not owned and

therefore people must show respect for them and avoid disputes over them (Wenzel, 2004).

For northern hunters, animal-human relationships are most obviously expressed through hunting, and in order to be successful hunters, humans must have a proper attitude towards animals (Fienup-Riordan, 1990; Stairs and Wenzel, 1992). One key aspect of this relationship, not generally shared by Euro-Canadian ideology, is that all animals are understood to be sentient (Wenzel, 1991; Fienup-Riordan, 1999; Zavaleta, 1999; Natcher et al., 2005). Inuit *Qaujimajatuqangit* principles include several references to proper behaviour in relation to animals, which includes recognizing that one's actions have consequences and that one should harvest without malice and avoid unnecessary harm (Wenzel, 2004). Two related themes arising from this cultural construct appeared in the interviews and consultations: the recognition of polar bears as sentient and deserving of respect, and the incorporation of new information into traditional understandings of the relationship between humans and polar bears.

Polar bear hunting holds a special importance to Inuit (Wenzel, 1983; Sandell and Sandell, 1996). This was expressed at the Clyde River community consultation:

> We have many problems and there are many youths who want to catch their first polar bear. There are many people. Sometimes there are people in their 50s who never caught a polar bear. It's very important to get your first bear. It brings you up in your life.
>
> (Clyde River community consultation participant, Dowsley and Taylor, 2006a:70)

Inuit traditions dictate that one should show proper respect to polar bears in thought, word, and deed in order to avoid a negative response from bears (Wenzel, 1983; Sandell and Sandell, 1996). These negative responses may be anything from avoidance of the disrespectful hunter to an attack on one's person or property (Wenzel, 1983; M. Dowsley, unpubl. data). The importance of proper communication between humans and polar bears is illustrated in a case of hunting near Clyde River reported by Wenzel (2004), in which the Inuk hunter emphasized the importance of watching the bear for signs of how to proceed with the interaction and reported his understanding that a successful hunt was the result of acting on the information communicated by the bear.

Some Inuit consider the human–polar bear relationship to be threatened by the very existence of the quota system. Wenzel (2005) discusses how the Inuit in the Clyde River area saw the establishment of quotas as bragging about hunting ability by predicting the number of bears that would be harvested and as acting outside the human-bear relationship by limiting the harvest to fewer bears than might present themselves. Fighting over hunting tags, which can result from a quota system, was also seen as inappropriate. Such behaviour is predicted to cause polar bears to leave the area and go to a place where there are respectful hunters. This belief was apparent during the Baffin Bay consultations when the high rate of harvest on the Greenland side of the bay was discussed with the HTO of Qikiqtarjuaq (Dowsley and Taylor, 2006a). One HTO board member there stated:

> A few years back when I was also doing a survey [in Greenland] I asked what kind of animals they had. Greenland seemed to respect polar bears more because it is not for money and they even cut up the hide and share it to make clothes. They are not hunting for money but for food and clothes.
>
> (Qikiqtarjuaq consultation participant, Dowsley and Taylor, 2006a:34)

The implication of this statement is that Greenland is able to harvest more polar bears because Greenlanders (Kalalliit) have been more respectful by sharing and by not fighting over money or tags, and thus the polar bears have moved there from Nunavut. The scientific reports that concluded a drop in quota was necessary because there were fewer bears for Nunavut hunters could be interpreted as supporting this understanding. This view also explains some of the reluctance of Baffin Bay Nunavummiut to judge Greenland's recent large harvests negatively as overharvesting. Instead, they turn the concern inward to encourage consideration of the things Nunavummiut are doing wrong in their relationship with polar bears.

Suggestions for improving the relationship between humans and polar bears were also offered during the Baffin Bay interviews and consultations. Some Inuit consider current management rules to be damaging to good human–polar bear relations, and a removal of quotas was seen as potentially restorative:

> It's not right for animals to be chased away with a rifle [when there is no available hunting tag]. It must be recognized that this is wrong. We should try going back to Inuit knowledge for 4 or 5 years and see the effect.
>
> (Pond Inlet consultation participant, Dowsley and Taylor, 2006a:42).

The second, and closely related, theme from IQ categories 3 and 4 is the incorporation of new knowledge into traditional views of human-animal relationships. Among northern aboriginal groups, the traditional view of wildlife as sentient means that the animals may disappear and reappear according to their own way (Fienup-Riordan, 1999). This view was expressed in this study, specifically for polar bears and caribou (Dowsley, 2005; Dowsley and Taylor, 2006a). Traditionally, hunting was thought to influence the population only by the manner in which it was carried out. Disrespectful hunting would drive animals away, while respectful hunting could draw animals towards humans (Fienup-Riordan, 1999). Given this cultural belief, the scientific perspective that the level of hunting influences population size is a difficult concept.

Northern aboriginal groups are now in the process of expanding their views of human-wildlife relationships to include this understanding of hunting levels (Zavaleta, 1999). Many interpretations of the relationship between hunting and wildlife populations have been offered in this and other studies. For example, Gilchrist et al. (2005) found that only two of ten expert thick-billed murre hunters in Upernavik, Greenland, cited overhunting as the cause of decline in the murre population. Other hunters cited shifts in distribution. Further scientific studies showed overhunting to be the leading cause of the decline. A similar process of partial integration of the concept of overhunting was observed in Nunavut concerning polar bear populations. During the Baffin Bay interviews, four of 16 interview participants stated that they liked the quota system the way it is (Dowsley, 2005). Some hunters recognized the connection of hunting to population size:

> I like the idea of the quota. If we don't have a quota and there are more hunters we'll have fewer polar bears. The population will go down.
>
> (Pond Inlet survey participant, Dowsley, 2005:19).

Other participants made remarks throughout the interviews that illustrate a more complex integration of the quota system into traditional views. For example, an elderly woman in Qikiqtarjuaq, when asked why a polar bear might attack a particular person, discussed wildlife regulations as if breaking them would upset bears:

> I don't really know [why a bear might attack someone]. Maybe it is that we are not supposed to say bad things about polar bears. When a man's property is damaged he might get mad. We are told polar bears have minds like humans. The man might threaten to kill that polar bear. The polar bear also knows there are seasons when humans can't kill polar bears and if a man kills one out of season the polar bears might get mad.
>
> (Qikiqtarjuaq survey participant, M. Dowsley, unpubl. data).

(Note that regulations regarding hunting seasons have been rescinded because the quota system and a 2:1 male-to-female harvest ratio adequately protect the populations.)

CONCLUSIONS

Science and traditional knowledge are not diametrically opposed, either generally or in the case of understanding polar bears. There are many areas of overlap, particularly with regard to Usher's categories 1 and 2 of traditional knowledge. In evaluating population size or distribution of species, coarse change is noted in traditional ecological knowledge, but finer changes are not, or seem not to be, as easily detected (Gilchrist et al., 2005). This distinction may explain a lack of agreement between scientific observations of declining polar bear condition in Western Hudson Bay and the observations of harvesters. In the discussions of polar bears and climate change, there was much variability in IQ around the synthesis of information provided by observations. This variability suggests that IQ knowledge holders have not yet had sufficient time to make observations or connect the environmental changes to changes in polar bears. Continued monitoring, using both large-scale scientific studies and smaller-scale local observations, will likely result in a consensus over time if communication and cooperation between the two sets of observers are maintained or improved.

Developing co-management as an iterative process is also necessary to address the issues regarding IQ from the more abstract categories 3 and 4. Communication has helped scientists to incorporate IQ into their research, and Inuit are also recognizing the role of science. For example, the land-claim organization Nunavut Tunngavik Inc. acknowledged the benefits of science in this comment on climate change:

> While it is unusual for Inuit to predict years ahead into the future, scientific knowledge can help to anticipate change and prevent being so suddenly faced with it…Thought must be given to future challenges and opportunities.
>
> (NTI, 2005:4)

Incorporation of science into Inuit understandings of the relationship between wildlife populations and hunting was highly variable among individuals in this study. Views of this relationship ranged from the understanding espoused by Euro-Canadians to a combination of traditional Inuit and Euro-Canadian views. A dialogue between Inuit, scientists, and managers on cultural understandings of polar bears must be encouraged because this is a very complex and individual aspect of management that can affect levels of the governance system well above the individual hunter. Co-management has the conservation of wildlife populations as the tangible management goal, but it also has the social goal of developing a governance system that builds trust and allows for problem solving among participants (Natcher et al., 2005). If group cohesion does not develop among co-management participants, effective management may fail to occur (Ostrom, 1992; Natcher et al., 2005).

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REFERENCES

AARS, J., LUNN, N.J., and DEROCHER, A.E. 2006. Polar bears. Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Seattle, Washington, 20–24 June 2005. Occasional Paper of the IUCN Species Survival Commission No. 32. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources. 189 p.

BORN, E.W., and SONNE, C. 2006. Research on polar bears in Greenland 2001–2005. In: Aars, J., Derocher, A.E., and Lunn, N.J., eds. Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Seattle, Washington, 20–24 June 2005. Occasional Paper of the IUCN Species Survival Commission No. 32. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources. 135–143.

CARLSSON, L., and BERKES, F. 2005. Co-management: Concepts and methodological implications. Journal of Environmental Management 75:65–76.

CONDON, R.G., COLLINGS, P., and WENZEL, G. 1995. The best part of life: Subsistence hunting, ethnicity, and economic adaptation among young adult Inuit males. Arctic 48(1):31–46.

DOWSLEY, M. 2005. Inuit knowledge regarding climate change and the Baffin Bay polar bear population. Final Wildlife Report 1. Department of Environment, Government of Nunavut, PO Box 1000, Station 1300, Iqaluit, Nunavut X0A 0H0. 43 p.

———. 2007. Inuit perspectives on polar bears (*Ursus maritimus*) and climate change in Baffin Bay, Nunavut, Canada. Research and Practice in Social Science 2(2):53–74.

DOWSLEY, M., and TAYLOR, M.K. 2006a. Community consultations with Qikiqtarjuaq, Clyde River and Pond Inlet on management concerns for the Baffin Bay (BB) polar bear population: A summary of Inuit knowledge and community consultations. Final Wildlife Report 2. Department of Environment, Government of Nunavut, PO Box 1000, Station 1300, Iqaluit, Nunavut X0A 0H0. 83 p.

———. 2006b. Management consultations for the Western Hudson Bay (WH) polar bear population (01–02 December 2005). Final Wildlife Report 3. Department of Environment, Government of Nunavut, PO Box 1000, Station 1300, Iqaluit, Nunavut X0A 0H0. 55 p.

DUNLAP, E., and TANG, C.C.L. 2006. Modelling the mean circulation of Baffin Bay. Atmosphere-Ocean 44(1):99–110.

FERGUSON, M.A.D., and MESSIER, F. 1997. Collection and analysis of traditional ecological knowledge about a population of Arctic tundra caribou. Arctic 50(1):17–28.

FERGUSON, M.A.D., WILLIAMSON, R.G., and MESSIER, F. 1998. Inuit knowledge of long-term changes in a population of Arctic tundra caribou. Arctic 51(3):201–219.

FIENUP-RIORDAN, A. 1990. Eskimo essays: Yup'ik lives and how we see them. New Brunswick, New Jersey: Rutgers University Press.

———. 1999. *Yaqulget qaillun pilartat* (what the birds do): Yup'ik Eskimo understanding of geese and those who study them. Arctic 52(1):1–22.

FINLEY, K.J., MILLER, G.W., DAVIS, R.A., and KOSKI, W.R. 1983. A distinctive large breeding population of ringed seals (*Phoca hispida*) inhabiting the Baffin Bay pack ice. Arctic 36(2):162–173.

FOX, S. 2002. These things are really happening: Inuit perspectives on the evidence and impacts of climate change in Nunavut. In: Krupnik, I., and Jolly, D., eds. The Earth is faster now: Indigenous observations of Arctic environmental change. Fairbanks, Alaska: Arctic Research Consortium of the United States. 12–53.

FURNELL, D.J., and OOLOOYUK, D. 1980. Polar bear predation on ringed seals in ice-free water. Canadian Field-Naturalist 94(1):88–89.

GAGNON, A.S., and GOUGH, W.A. 2005. Trends in the dates of ice freeze-up and breakup over Hudson Bay, Canada. Arctic 58(4):370–382.

GILCHRIST, G., MALLORY, M., and MERKEL, F. 2005. Can local ecological knowledge contribute to wildlife management? Case studies of migratory birds. Ecology and Society 10(1):20. http://www.ecologyandsociety.org/vol10/iss1/art20/.

GN (GOVERNMENT OF NUNAVUT). 2004. *Pinasuaqtavut* 2004–2009: Our commitment to building Nunavut's future. http://www.gov.nu.ca/english/pinasuaqtavut/.

———. 2005a. Polar bear management memorandum of understanding between Arviat HTO, Baker Lake HTO, Aqigiq HTO (Chesterfield Inlet), Aqiggiaq HTO (Rankin Inlet), Issatik HTO (Whale Cove), Kivalliq Wildlife Board and the Department of Environment for the management of the "Western Hudson" polar bear population. Department of Environment, Government of Nunavut, PO Box 1000, Station 1300, Iqaluit, Nunavut X0A 0H0.

———. 2005b. Polar bear management memorandum of understanding between Nativak HTO (Qikiqtarjuaq), Namautaq HTO (Clyde River), Mittimatalik HTO (Pond Inlet), Qikiqtaaluk Wildlife Board and the Department of Environment for the management of the "Baffin Bay" polar bear population. Department of Environment, Government of Nunavut, PO Box 1000, Station 1300, Iqaluit, Nunavut X0A 0H0.

HAMMILL, M.O., LESAGE, V., GOSSELIN, J.-F., BOURDAGES, H., de MARCH, B.G.E., and KINGSLEY, M.C.S. 2004. Evidence for a decline in northern Quebec (Nunavik) belugas. Arctic 57(2):183–195.

HUNTINGTON, H.P. 1998. Observations on the utility of the semi-directive interview for documenting traditional ecological knowledge. Arctic 51(3):237–242.

HUNTINGTON, H.P., and THE COMMUNITIES OF BUCKLAND, ELIM, KOYUK, POINT LAY, and SHAKTOOLIK. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the eastern Chukchi and northern Bering seas, Alaska. Arctic 52(1):49–61.

JOHANNES, R.E., FREEMAN, M.M.R., and HAMILTON, R.J. 2000. Ignore fishers' knowledge and miss the boat. Fish and Fisheries 1:257–271.

KENDRICK, A., LYVER, P.O'B., and ŁUTSËL K'É DENE FIRST NATION. 2005. Denésǫłiné (Chipewyan) knowledge of barren-ground caribou (*Rangifer tarandus groenlandicus*) movements. Arctic 58(2):175–191.

LENTFER, J. 1974. Agreement on the conservation of polar bears. Polar Record 17(108):327–330.

LØNSTRUP, L. 2006. Polar bear management in Greenland. In: Derocher, A.E., and Lunn, N.J., eds. Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Seattle, Washington, 20–24 June 2005. Occasional Paper of the IUCN Species Survival Commission No. 32. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources. 133–134.

LUNN, N.J., STIRLING, I., ANDRIASHEK, D., and KOLENOSKY, G.B. 1997. Re-estimating the size of the polar bear population in western Hudson Bay. Arctic 50(3):234–240.

LYVER, P.O'B., and GUNN, A. 2004. Calibration of hunters' impressions with female caribou body condition indices to predict probability of pregnancy. Arctic 57(3):233–241.

MALLORY, M.L., GILCHRIST, H.G., FONTAINE, A.J., and AKEAROK, J.A. 2003. Local ecological knowledge of ivory gull declines in Arctic Canada. Arctic 56(3):293–298.

McDONALD, M., ARRAGUTAINAQ, L., and NOVALINGA, Z. 1997. Voices from the Bay: Traditional ecological knowledge of Inuit and Cree in the Hudson Bay bioregion. Ottawa and Sanikiluaq: Canadian Arctic Resources Committee and Environment Committee of Municipality of Sanikiluaq.

MOLLER, H., BERKES, F., LYVER, P.O'B., and KISLALIOGLU, M. 2004. Combining science and traditional ecological knowledge: Monitoring populations for co-management. Ecology and Society 9(3): 2. http://www.ecologyandsociety.org/vol9/iss3/art2.

NADASDY, P. 2003. Reevaluating the co-management success story. Arctic 56(4):367–380.

NATCHER, D.C., DAVIS, S., and HICKEY, C.G. 2005. Co-management: Managing relationships, not resources. Human Organization 64(3):240–250.

NTI (NUNAVUT TUNNGAVIK INCORPORATED). 2000. Nunavut Land Claims Agreement. Iqaluit: Department of Communications.

———. 2005. What if winter doesn't come? Inuit perspectives on climate change adaptation challenges in Nunavut. Summary Workshop Report, 15–17 March 2005, Iqaluit, Nunavut. 9 p.

NUTTALL, M. 2000. Becoming a hunter in Greenland. Études/Inuit/Studies 24(2):33–45.

OMURA, K. 2005. Science against modern science: The socio-political construction of otherness in Inuit TEK (traditional ecological knowledge). In: Kishigami, N., and Savelle, J.M., eds. Indigenous use and management of marine resources. Senri Ethnological Studies 67. Osaka, Japan: National Museum of Ethnology. 323–344.

OSTROM, E. 1992. Community and the endogenous solution of Commons problems. Journal of Theoretical Politics 4(3): 343–351.

PBTC (POLAR BEAR TECHNICAL COMMITTEE). 2005. Minutes of the 2005 Meeting of the Canadian Federal-Provincial-Territorial Polar Bear Technical Committee. Meeting held in Edmonton, Alberta, on 7–9 February 2005. Available from Environment Canada, Wildlife Research Division, 5320 122 Street, Edmonton, Alberta T6H 3S5.

———. 2006. Minutes of the 2006 Meeting of the Canadian Federal-Provincial-Territorial Polar Bear Technical Committee, 6–8 February 2006, St John's, Newfoundland. Available from Environment Canada, Wildlife Research Division, 5320 122 Street, Edmonton, Alberta T6H 3S5.

SANDELL, H., and SANDELL, B. 1996. Polar bear hunting and hunters in Ittoqqortoormiit/Scoresbysund, NE Greenland. Arctic Anthropology 33(2):77–93.

SMITH, T.G., and SJARE, B. 1990. Predation of belugas and narwhals by polar bears in nearshore areas of the Canadian High Arctic. Arctic 43(2):99–102.

SPSS (STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES). 2001. SPSS for Windows, Rel. 11.0.1. Chicago, Illinois: SPSS Incorporated.

STAIRS, A., and WENZEL, G.W. 1992. "I am I and the environment": Inuit hunting, community and identity. Journal of Indigenous Studies 3(1):1–12.

STIRLING, I., and PARKINSON, C.L. 2006. Possible effects of climate warming on selected populations of polar bears (*Ursus maritimus*) in the Canadian Arctic. Arctic 59(3):261–275.

STIRLING, I., LUNN, N.J., and IACOZZA, J. 1999. Long-term trends in the population ecology of polar bears in western Hudson Bay in relation to climate change. Arctic 52(3): 294–306.

STIRLING, I., LUNN, N.J., IACOZZA, J., ELLIOTT, C., and OBBARD, M. 2004. Polar bear distribution and abundance on the southwestern Hudson Bay coast during open water season, in relation to population trends and annual ice patterns. Arctic 57(1):15–26.

TAYLOR, M., and LEE, J. 1995. Distribution and abundance of Canadian polar bear populations: A management perspective. Arctic 48(2):147–154.

TAYLOR, M.K., AKEEAGUK, S., ANDRIASHEK, D., BARBOUR, W., BORN, E.W., CALVERT, W., CLUFF, H.D., FERGUSON, S., LAAKE, J., ROSING-ASVID, A., STIRLING, I., and MESSIER, F. 2001a. Delineating Canadian and Greenland polar bear (*Ursus maritimus*) populations by cluster analysis of movements. Canadian Journal of Zoology 79:690–709.

TAYLOR, M.K., OBBARD, M., POND, B., KUC, M., and ABRAHAM, D. 2001b. RISKMAN: Stochastic and deterministic population modeling RISK MANagement decision tool for harvested and unharvested populations. Iqaluit: Government of Nunavut.

TAYLOR, M.K., LAAKE, J., CLUFF, H.D., RAMSAY, M., and MESSIER, F. 2002. Managing the risk from hunting for the Viscount Melville Sound polar bear population. Ursus 13: 185–202.

TAYLOR, M.K., LAAKE, J., McLOUGHLIN, P.D., BORN, E.W., CLUFF, H.D., FERGUSON, S.H., ROSING-ASVID, A., SCHWEINSBURG, R., and MESSIER, F. 2005. Demography and viability of a hunted population of polar bears. Arctic 58(2):203–214.

TAYLOR, M.K., LAAKE, J., McLOUGHLIN, P.D., CLUFF, H.D., and MESSIER, F. 2008. Mark-recapture and stochastic population models for polar bears of the High Arctic. Arctic 61(2):143–152.

USHER, P.J. 2000. Traditional ecological knowledge in environmental assessment and management. Arctic 53(2):183–193.

WENZEL, G. 1983. Inuit and polar bears: Cultural observations from a hunt near Resolute Bay, N.W.T. Arctic 36(1):90–94.

———. 1991. Animal rights, human rights: Ecology, economy and ideology in the Canadian Arctic. Toronto: University of Toronto Press.

———. 2004. From TEK to IQ: Inuit *Qaujimajatuqangit* and Inuit cultural ecology. Arctic Anthropology 41(2):238 – 250.

———. 2005. Nunavut Inuit and polar bear: The cultural politics of the sport hunt. In: Kishigami, N., and Savelle, J.M., eds. Indigenous use and management of marine resources. Senri Ethnological Studies 67. Osaka, Japan: National Museum of Ethnology. 363 – 388.

WHITE, G. 2006. Cultures in collision: Traditional knowledge and Euro-Canadian governance processes in northern land-claim boards. Arctic (59)4:401 – 414.

ZAVALETA, E. 1999. The emergence of waterfowl conservation among Yup'ik hunters in the Yukon-Kuskokwim Delta, Alaska. Human Ecology 27(2):231 – 266.