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Tracking Change: Traditional Knowledge and Monitoring of Wildlife Health in Northern Canada

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Traditional Knowledge (TK) is increasingly valued in long-term monitoring of wildlife health, particularly in northern Canada where Chronic Wasting Disease (CWD) may represent a threat to valued caribou and moose populations. This article presents comparative research results (1998–2002 and 2010) about caribou and moose health based on research with Łutsël K'é First Nation, Northwest Territories (Canada). Elders' knowledge, harvester observations, harvest data and consumption data indicate a decline in the availability of barren ground caribou and range shifts of both caribou and moose during the study period. An anomalous sighting of a white tailed deer near the community, coupled with moderate community concerns about CWD would suggest the need for greater monitoring of wildlife health. As resources for scientific monitoring become limited, the article suggests how northern Indigenous communities can use their own knowledge (TK) to monitor changes in arctic ecosystems.

Keywords indigenous, sub-arctic, Northwest Territories, wildlife, monitoring, traditional knowledge, Chronic Wasting Disease, Prion

Introduction

Indigenous peoples of the Northwest Territories, Canada have long histories of dependence on barren ground caribou (*Rangifer tarandus groenlandicus*) and moose (*Alces alces*) (Helm, 2000). Variability in the condition, abundance and distribution of these and other species necessitated the tracking of many kinds of ecological indicators. Traditional Knowledge (TK) generated through such tracking continues to be integral to harvester perceptions of wildlife health as well as their harvest and livelihood decisions (Berkes, Colding, & Folke, 2000; Moller, Berkes, Lyver, & Kislalioglu Berkes, 2004; Parlee, Manseau, & Łutsël K'é Dene First Nation, 2005).

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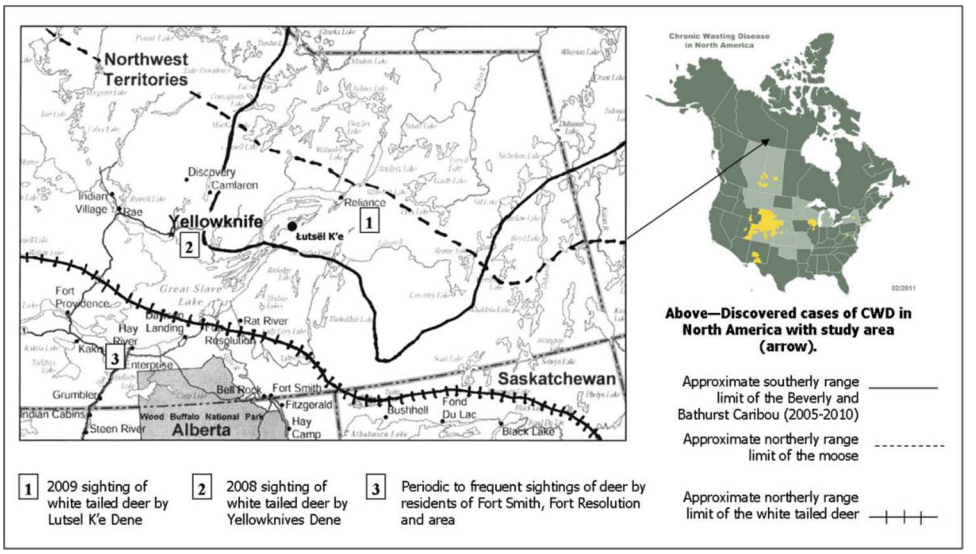

Figure 1. Study areas. The study area and new sightings of white-tailed deer in relation to the previously defined ranges of barren ground caribou, moose, and white-tailed deer populations (color figure available online).

Using Chronic Wasting Disease (CWD) as a case study, this article considers the role of TK in wildlife health monitoring (Figure 1). The article is based on a 12-year period of research with elders and harvesters from Łutsël K'é Dene First Nation. A common set of indicators of caribou and moose health was developed in 1998–2002. These indicators, or "signs," are presented here under the themes of condition, abundance, and distribution. Condition is inclusive of how the animals look and behave. Abundance refers to perceptions of caribou numbers but is also interrelated with distribution. Distribution includes seasonal and inter-seasonal movement patterns and patterns of range use. Harvester and elder observations and interpretations of wildlife health from 1998–2002 are reported here along with new observations and interpretations of wildlife health reported by harvesters interviewed in 2010. In addition, the research in 2010 speaks to the issue of CWD; specifically it presents data on range overlap (between caribou, moose, and potentially infected deer populations from the south), body condition of caribou and moose (which may be symptomatic of CWD), and the degree of harvester concern about CWD.

CWD affects the brain and neural tissue of infected animals (Prusiner, Scott, DeArmond, & Cohen, 1998). It has been found in deer, elk and moose in parts of the United States, Korea and Canada, and is the only prion disease to be detected in ungulates in western Canada. Although not detected in barren-ground caribou to date, testing of herds in Alaska suggests there is the potential for transmission and surveillance has been recommended (Belay et al., 2004; Happ, Huson, Beckmen, & Kennedy, 2007). Testing for the disease is only done through post-mortem tissue analysis, however, late stage signs of infection may be detectable by skilled observation. These signs include changes in body condition (weight loss, poor hide quality) and behavior changes (e.g., lowering of the head, decreased interaction with other animals) (Spraker et al., 1997; Williams, Miller, Kreeger, Kahn, & Thorne, 2002).

Testing for CWD by the government of the Northwest Territories (NWT) has been carried out in recent years—in 2009, there were 104 caribou tested with no positives (Government of the Northwest Territories, 2010). Resources for systematic tracking of the

distribution of white-tailed deer populations have not been available to government biologists to date (Carriere, 2009). In Alberta and the northwestern United States, where CWD is known to be present, testing of tissue samples, culling, and multidisciplinary research is more extensive (Adamowicz et al., 2010; Bishop, 2004; Heberlein & Stedman, 2009; Heberlein & Thomson, 1996; Needham, Vaske, & Manfredo, 2004; Vaske, Needham, Stafford, Green, & Petchenik, 2006). However, then secondary literature review for this article revealed no published studies that have involved Indigenous peoples or focused on the role of TK.

Background

Indigenous peoples in northern Canada have developed systems of wildlife management that are based upon generations of accumulated empirical observation and experience (Berkes, 2008). Knowledge is generated over time with changes in ecological conditions being measured from place to place, season to season and year to year around key indicators. The abundance of animals, timing of migration, length to weight ratios are some indicators commonly used by Indigenous communities that parallel those used in wildlife biology (Moller et al., 2004). This strong connection to lands and resources has led to theories that Indigenous people have a heightened sensitivity to ecological change. As noted by the late Denesoɬiné elder, Morris Lockhart, "Some people who don't care so much won't notice the changes" (Parlee et al., 2005b, p. 173).

Given it is based on oral tradition, much TK has not been documented or published. For barren-ground caribou, however, a relatively large body of TK is available from research in the Northwest Territories, Yukon and Alaska. Harvester observations of caribou condition (e.g., measures of back fat) are useful in predicting population dynamics (Kendrick, Lyver, & Łutsël K'é Dene First Nation, 2005; Lyver & Gunn, 2004; Moller et al., 2004). Elders and hunters throughout the north have good oral histories about caribou distribution dating back to earlier in the century. Oral histories coupled with contemporary observation detail the temporal shifts in range and distribution (Kofinas, 1999; Parlee et al., 2005b; Ruttan, 2012; Thorpe, 1997).

Traditional systems of managing caribou have historically been in conflict with wildlife management institutions established during colonization and northern settlement (Sandlos, 2007). Co-management arrangements have mitigated such conflicts to some extent; however, the relationship between scientists and TK holders remains complex (Kendrick, 2003; Nadasdy, 2003; Berkes, 2009). Although population and harvest are common themes in caribou management decision-making, less consideration has been given to wildlife diseases such as anthrax, bovine tuberculosis, brucellosis, and CWD (McCormack, 1992; Nishi, Shury, & Elkin, 2006; Tessaro, Gates, & Forbes, 1993). Given that CWD is a prion disease, similar to the variant affecting humans (Creutzfeldt-Jakob disease [CJD]), wildlife disease specialists are concerned about the transmission of CWD or variant strains to other wildlife and humans. The consumption of wild meat is often falsely viewed as a causal agent of the transmission to humans. Nonetheless, there are many unknowns about how human health and community well-being might be affected by the spread of diseases like CWD in the region.

The participation of Indigenous harvesters and inclusion of TK is increasingly being used by scientists in many kinds of wildlife health research (Brook et al., 2009; Hoberg et al., 2008; Jack, Brooks, Furgal, & Dobbins, 2010). Biologists especially value observations of body condition, habitat quality, and population change where the data available from Western scientific research is limited (Gunn et al., 2011; Manseau, Parlee, & Ayles,

2005; Moller et al., 2004). Hunters can provide reliable information on population, abundance, structure, and health much more "cheaply" than many scientists (Boyce, Baxter, & Possingham, 2012). However, many communities are mistrustful of outsider efforts to solicit TK (Kendrick, 2000). Some scholars attribute such mistrust to colonial histories of wildlife management that have served the interests of non-Aboriginal people from the south, rather than Indigenous peoples of the north (Sandlos, 2007). Such mistrust may also come from ambiguity in the roles and responsibilities of governments in their relationship with Indigenous peoples. Although the Federal government in Canada has a fiduciary obligation to protect the health and safety of Inuit, First Nations, and Métis peoples, government is also increasingly dependent on Indigenous harvesters for field observations, samples of tissues and for participation in management strategies such as deer culling (Government of Alberta, 2012). Such reliance on harvesters may be increasing given declining government resources for scientific monitoring programs (Boyce et al., 2012; Nishi et al., 2006).

Harvester Engagement in Monitoring Wildlife Disease—Lessons on Risk

The large body of work on contaminants in the arctic and its impact on traditional/country food harvesting patterns provides important context for this work. Studies from Nunavik (northern Quebec), Nunavut and Labrador suggest northern Indigenous peoples may be highly sensitive to information about ecological risks particularly those that pose dangers to traditional food sources (Furgal, Jardine, & Garvin, 2010). In the past, poor scientific communication about the bioaccumulation of contaminants in traditional foods (e.g., PAHs in marine mammal organs and fat) was blamed for detrimentally affecting harvesting and dietary patterns in some communities (Duhamie, Chatbot, Robichaud, & Proulx, 2005; Furgal, Powell, & Myers, 2005; Van Oostdam et al., 1999). Local interpretations of science in northern communities, however, are not straightforward. People respond to risk information differently depending on socioeconomic characteristics and previous experience (Kasperson et al., 1998; Winthrop, 1998; Decker et al., 2012). In the case of contaminants, ". . . northern Aboriginal populations gather, understand, and use information to make personal decisions about food and health differently from Southerners" (Furgal et al., 2005, p. 110). An over emphasis on health's inverse—"disease"—may amplify perceived risks. A trend away from traditional food gathering would compound the decline already documented in traditional practices and diets in many Indigenous communities (Receveur, Boulay, & Kuhnlein, 1997). This may be more than theoretical; communications on CWD in Wisconsin resulted in an 11% decline in license sales (Heberlein & Stedman, 2009). In Alberta, sports hunters were less interested in visiting a site with higher CWD prevalence (Zimmer, Boxall, & Adamowicz, 2011).

While amplification of risk is problematic in some communities, the influence of science may be limited in others due to a greater reliance and trust of TK (Poirier & Brooke, 2000; Wray & Parlee, 2013). Even when actively seeking scientific knowledge, different interests and concerns may motivate or influence interpretation. For example, northerners may seek greater scientific literacy, not because it enables them to better "manage" wildlife, but as a means of managing government. As Jack et al. indicate, "there is value in adopting and utilizing scientific evidence in that it facilitates a community's ability to have open dialogue with government departments where 'science' is the language most commonly spoken and understood" (2010, p. 661). In such cases, TK seems to function as a filter for determining the validity and relevance of information. Such filtering may be the flip-side of the "scientization" process described by Agrawal (1995) and others. Essentially, TK holders, like scientists, are selective in the kinds of scientific information they access and interpret such information according to their own values and interests.

Wildlife Populations in this Study

Łutsël K'é Dene First Nation is located within the overlapping ranges of the Bathurst, Ahiak and Beverly barren-ground caribou herds (*Rangifer tarandus groenlandicus)*. The populations of all three herds have reportedly declined dramatically in the last decade, which is consistent with previous patterns of 40–70 year cycles of variability documented over the last century. Habitat factors are thought to be the main driver behind these cycles (e.g., rain on snow or icing events, forest fire, human disturbance including resource development impacts) with predation and hunting being other issues of concern (Boulanger, Gunn, Adamczewski, & Croft, 2011; Vors & Boyce, 2009). Next to barren ground caribou, moose (*Alces alces*) are among the most common ungulate species in the boreal regions of the NWT. The northwestern moose (*Alces alces andersoni*) is the subspecies most common to the Łutsël K'é Dene First Nation region. They have been the mainstay of Dene populations living at or below the tree-line there for hundreds of years. Density of moose is low but variable (1 to 17 moose per 100 km^2) with density north and west of Łutsël K'é calculated at 2.0–3.5 moose/100 km^2 (Case & Graf, 1992; Cluff, 2005). White-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) were first reported in the NWT in the late 1950s in the Deh Cho regions west of Yellowknife and Fort Smith areas. White-tailed deer are now viewed as common at or below tree line in many areas of the NWT with the most northerly harvest reported in the Sahtu Region (of the Northwest Territories) at Norman Wells (Carriere, 2009; Veitch, 2001). Although deer have historically been limited in distribution within the NWT (Conner, Ebinger, Blanchong, & Cross, 2008), this is predicted to change in coming years due to a variety of factors including climate change. The rising deer population in northern Alberta and Saskatchewan coupled with increasing temperatures (decreased winter severity) and the expansion of resource development—including linear features known to facilitate the dispersal of many faunal and floral species—are the factors that may lead to northerly range expansion (Dawe et al., in press).

The hunting rights of the Dene (including Łutsël K'é Dene harvesters) are protected under treaty and the Canadian Constitution and allow for hunting without the regulatory oversight (and tracking of harvest) of the territorial or federal governments. Some understanding of local dependence on caribou, moose and other species can be drawn from other regions of the Northwest Territories where co-management arrangements have led to comprehensive harvest studies (e.g., Gwich'in Settlement Area and the Sahtú region). The ecological and sociocultural differences between these regions and the study area, however, make comparison difficult. Given these trends, clarification of the value of TK and the role of Indigenous harvesters in monitoring is needed.

Methods

The authors worked collaboratively with Łutsël K'é Dene First Nation through the Chief and Council's Wildlife Lands and Environment Committee (WLEC) to carry out the study (Figure 1). Initial data gathering on themes of wildlife health began during 1998 using methods and protocols for research defined by the local Chief and Council refined and adapted to the particularities of the research questions. CWD was identified by the WLEC and the local elders' committee as a concern in 2009 and led to a funding proposal to the Alberta Prion Research Institute and subsequent research on this theme in 2010. The data presented in this article are from 1998–2002 and 2010.

Study Methods (1998–2002)

TK studies were carried out to learn more about barren ground caribou and moose as well as fish, waterfowl, and water between 1998 and 2002. The lead author, who was employed by the First Nation during this period, was the principal investigator in 1998–2001 and study advisor in 2001–2002. The intent was to define species-specific health indicators (based on TK) and create a baseline against which the results of future studies (including the one done in 2010) could be interpreted. Given that the work from 1998–2002 is largely unpublished, it is included here as part of the results of the article.

Study Methods (2010)

A community researcher (third author) conducted all the interviews over a 1-month period in the summer of 2010 with assistance from a student from the University of Alberta (fourth author). The interviewees included 38 harvesters between the ages of 18 and 75 with the attempt made to have an equal number of participants across all age ranges and from different households in the community. The interviewees were largely men; only three of those interviewed were women. The population of Łutsël K'é is 312 (Government of the Northwest Territories, 2009) given the small size of the community, the intent was to interview all active harvesters. Although the number of active harvesters fluctuates, the WLEC verified that those interviewed accounted for virtually all of the active harvesters in the community during the study period of 2010.

Researchers developed an interview guide with input from the WLEC; the 21 questions in the interview guide were developed around themes previously researched in the community (1998–2002), with the aim of cross comparison with a similar study undertaken in Alberta and with recognition of emergent trends in the region (e.g., barren ground caribou population change) (Nesbitt & Adamczewski, 2009). Questions were organized into four themes: (a) harvest, consumption and sharing of deer and moose meat; (b) perceptions of wildlife health; (c) knowledge/information received about CWD; and (d) willingness to participate in management. The interview guide included questions of an open-ended nature intended to generate descriptive narratives. Questions were also aimed at determining harvest levels and frequency of meat consumption. Others focused on documenting harvesters' perceptions of changes in harvest levels, population, distribution, and condition of animals harvested and sighted in categories that could be comparable with other harvesters and easily summarized for reporting. Scales were used to determine the level of interest in participating in monitoring and management of wildlife health. Quantitative data presented in this paper (in text and figures) correspond with specific questions posed during the interviews. In the case of qualitative data, the quotes are attributed to the individuals who spoke them and gave consent to their names being included in public documents. Where a quote is attributed to a "harvester," that individual preferred to remain anonymous. The article was reviewed by the WLEC with representatives of the Chief and Council, and consent was given for publication.

Results

Perspectives on Wildlife Health

Health/Body Condition. There were numerous indicators of the health of moose and caribou herds; the most common of these was body fat. The thickness and texture of the

hide and coat are other reference points. Internal lesions or discoloration of organs and marrow are also important. "A healthy caribou will possess a firm, creamy white marrow that is rich to the taste. A caribou in poor condition will possess marrow that is red and runny that is watery in taste" (Albert Boucher, 2002). External lesions or sores are other obvious issues of concern, however, these are not a common occurrence (Liza Enzoe, 2001).

Behavioral indicators were similarly defined to be important such as active foraging with recognition that behavior varies by age, sex and season. For example, young caribou are more active and jittery (J. B. Rabesca, 2000). Caribou that are not stressed and are healthy are always eating unlike "traveling caribou" that spend more time moving than eating (August Enzoe, 2001).

Concerns about sickness in caribou are tempered by beliefs and experience that nature takes care of the sicker animals and leaves the healthy ones in the herd for people to harvest (Noel Drybones 2000). When people are seeing a lot of sick animals there is the perception that something is wrong with the balance between the animals with other elements of the ecosystem including predators. Among the biggest perceived threats to caribou and moose health noted by elders are the risks of disturbance from mining activity:

> From my point of view it's [poor condition of caribou] because of the mining industry disturbing the caribou migration route, disturbing the caribou. Twenty-four hours a day there's noise and the smog of dust in the air for miles. Of course caribou eat this smog that lands on the ground. (Harvester, 2001)

These various measures are well explained by elders who wish to pass on their knowledge to younger and active harvesters. The following quote reveals how the late elder Morris Lockhart helped guide hunters in their harvest of caribou.

> Morris Lockhart predicted this caribou would be skinny. He is right - bulls are supposed to be fat this time of the year. This caribou is really skinny you can even see the ribs. The front knee has a bruise on it. The inside looks fine. The liver is good. The marrow is good and white and firm—the caribou is not sick, just very skinny. (Harvester, 2002)

When asked about their level of concern for caribou in 2010, 25 respondents said that they were "very concerned" about the health of the caribou. Another 11 said they were somewhat concerned. However, there were no noted observations of problems in the body condition of caribou in the local area. There were no reported sightings of sick caribou and the caribou were not reported as skinny. The major cause of concern related to caribou abundance or perceived changes in population.

Perspectives on Caribou and Moose Abundance. In 1998–2002, people said they were not seeing as many caribou as in previous years. Most harvesters used extremes in "seeing many caribou" and "seeing no caribou" to talk about the changes in population. A young harvester, recalling the stories of his grandfather, said there were fewer caribou available in the in the 1990s when compared to the 1950s—"there were so many caribou, it would just feel like the ground was moving" (Herman Catholique, 2000). Equally there are stories about the other extreme, as told by the late elder Morris Lockhart: "Some people died here because of the meat shortage . . . it was tough when there was no caribou" (Morris Lockhart, 2000). Drivers of these population ups and downs were variously described.

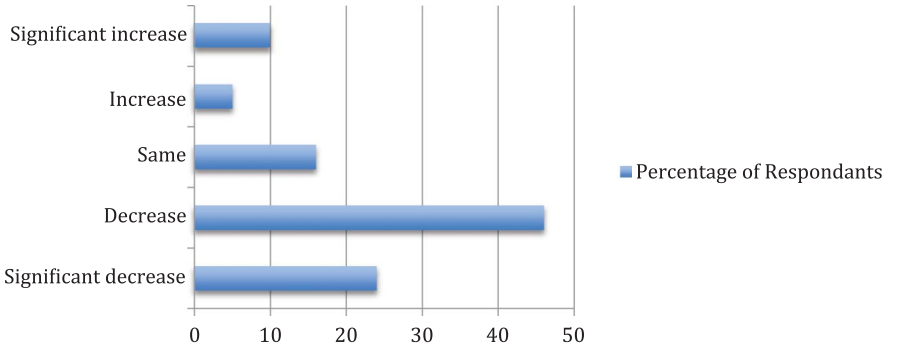

Figure 2. Interpretation of change in caribou abundance from previous years (color figure available online).

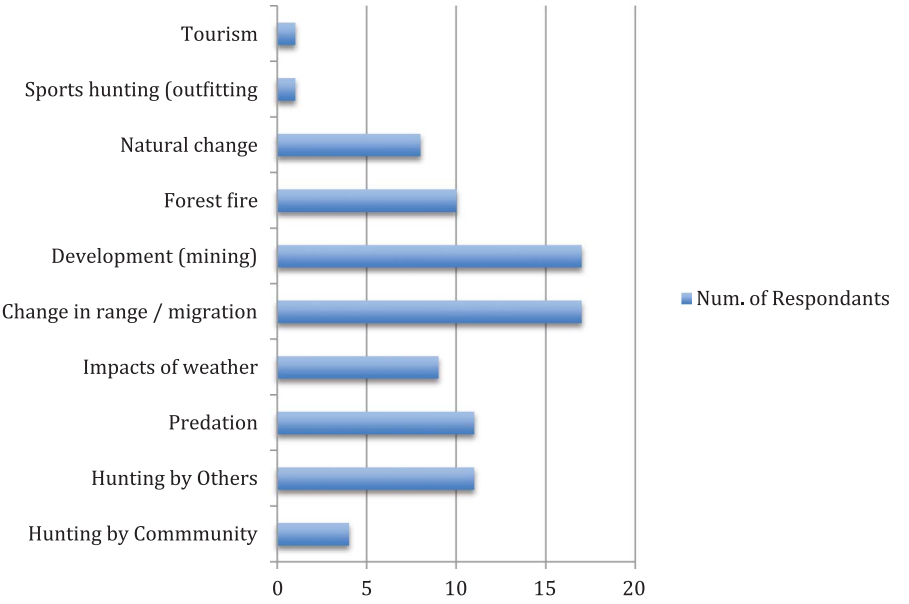

Figure 3. Reported causes of change in the abundance of caribou (color figure available online).

While many see them as natural, climate change related habitat changes, human and industrial disturbance as well as forest fire effects were discussed as influencing the abundance of caribou in the area.

When asked about changes in caribou numbers in 2010, 30 of the 38 interviewees reported a decrease; of these 11 reported a significant decrease (Figure 2). The reasons given behind the decrease were various with mining impacts on habitat and changes in the range being offered as the main explanations for seeing fewer caribou (Figure 3).

Perspectives on Changes in Distribution of Caribou and Moose. According to elders interviewed in 1998–2002, people would begin looking for caribou north of the community (Figure 4), along river trails known as *Tath a Deze, Dez Delgahi Deze, Des Tsël Che Deze,* and *Desnethch'e w*ith the emphasis being on the area between Yellowknife and ʔeda cho Kué (Artillery Lake). Although people traveled east in search of caribou (toward the Thelon

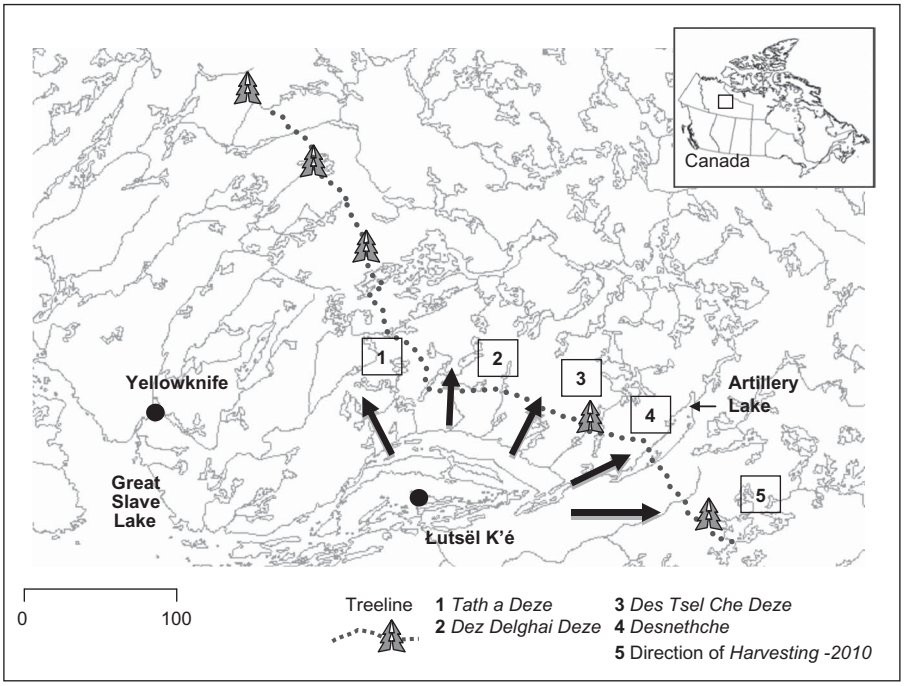

Figure 4. Comparison of direction of caribou harvest (1998–2002 and 2010). The map highlights direction of harvest activity according to trails used from 1998–2002 and 2010. The trails correspond with rivers that flow into Great Slave Lake.

Game Sanctuary) during previous periods, it was not an area well used for caribou hunting in the 1990s. In 2010, however, 17 harvesters observed changes in caribou range. Specific changes included a west–east shift in distribution as well as more scattered use of the range. As noted by Baptiste Catholique, "the caribou are now a long ways east of ʔeda cho Kué (Artillery Lake) compared to the past" (Baptiste Catholique 2010). According to Joseph Catholique, it is not a completely homogenous shift, "caribou now are more scattered, they aren't in one big herd any more—it's because of mining in the migration route—disturbing them" (Joseph Catholique 2010). Consistent with these explanations, development in the caribou range was reported by 17 interviewees as the cause of decline in caribou numbers.

Elders predicted concerns about the impacts of mining on the caribou range in 1998–2002. Although some elders were concerned about the stresses of noise, dust, or the height of haul roads and associated traffic, others described the problem as more cumulative. The late Pierre Catholique, for example stated clearly:

> No matter what you do, caribou will be affected by these mines and roads. The only way to not affect the caribou is to have no mines and roads. If there is a mine, there will be roads. And if you have a road, there will be trucks on it. If they put it through, you can't stop everything for the caribou. But maybe that is what the caribou need. (Pierre Catholique, 2001)

According to Rabesca (2000), previous generations of elders also predicted the loss of the caribou due to increased growth and activity in the caribou range. "You won't see the

caribou— you will only see the path they used to follow. What the elders told us before—it is happening now" (Rabesca, 2000).

Moose populations have also changed in range according to elders during the 1998–2002 period. The late elder Pierre Catholique reflected on his observations as well as oral histories about the ʔeda cho tué area (Artillery Lake) located just over one hundred kilometers northeast of the community. "Around ʔeda cho tué, people lived only off caribou. Now there are lots of moose there too. It never used to be like that" (P. Catholique, 2001). Harvesters in 2010 reported seeing more moose than in earlier years. Such observations, as with caribou, may suggest that the distribution of moose is changing such that they are easier to find or the moose population is increasing.

In 1998–2002, sightings of new or invasive species were documented including sightings of coyotes, robins, warblers, and other birds. Climate was noted as the probable driver behind these changes in range, as well as development further south (northern Alberta and Saskatchewan). In 2010, one respondent reported a sighting of a white-tailed deer in 2009. Harvesters also spoke about deer being commonly sighted further south of this region in the South Slave region by other Dene and Métis harvesters. When asked if there were stories from the elders about deer being in the region in the past, one interviewee (Ernest Boucher) recalled stories of deer being seen just south of the community in the late 1930s and early 1940s.

In 2010, harvesters were asked about their level of concern about moose and caribou health where "health" was assumed to reflect the indicators discussed above. Of the 38 harvesters involved in the interviews, 23 people reported being very concerned (10) or somewhat concerned (13). In the case of caribou the percentage was higher with 32 people reporting being very concerned (22) or somewhat concerned (10). Questions were also asked to determine the degree of awareness of CWD. Although a relatively new issue of wildlife health, it was known to about half of active harvesters (20). The main source of information was the "community" which included other community members, community meetings or community posters.

Caribou Harvest

The caribou harvest reported for fall and spring 2000 was roughly 450 animals. For the fall of 2009, the caribou harvest was averaged to be 110 animals for those interviewed; the majority of these were harvested east and northeast of the community. The 2010 winter/spring caribou harvest amounted to roughly 240 animals and largely took place in the region east, south, and south east of the community, which is the overwintering range of the Bathurst, Ahiak, and Beverly caribou. Based on the assumption that the 2010 data included all active harvesters and is thus comparable to the 2000 dataset, there was a decrease in the reported harvest. Of those interviewed, 29 reported their harvest as lower than previous years; of this group, 15 reported their harvest as "a lot less" than in recent years.

Moose Harvest

The moose harvest reported by the interviewees for the fall and winter of 2010 was roughly 59 animals. Over half of the interviewees reported that this harvest was lower than in previous years. No previous data on moose harvest was available for longer-term comparison.

Consumption and Sharing of Meat

According to the results of the 2010 study, the average consumption of caribou meat (all cuts) was roughly 3.13 meals per person/week. This was down significantly from the range of 4.4–8 meals of caribou meat consumed per week reported in 2000. When asked about the use and sharing of the organ meats and caribou brains, 19 interviewees said they used or shared caribou brains; liver, kidneys, and heart were used or shared by 31 of the 38 interviewees; intestines were used or shared by 31 of the harvesters. Moose consumption was calculated to be roughly 1 meal/week on average. When asked about the use and sharing of organ meat, 29 respondents said they used or shared liver, heart, and kidneys; 36 of the 38 respondents reported using or sharing the head and brains; intestines were used or shared by 33 of those interviewed. Such statistics are best understood in the context of Denesoɬiné traditions of "waste nothing" in which all meat, hide, organ meats, brains, head, bones, bone marrow, and hooves are harvested and used or eaten. Caribou brains, in particular, are a delicacy and necessary ingredient in the tanning of caribou hides.

Discussion

TK can provide a useful baseline of information for tracking changes in the health of moose and caribou in northern Canada. The article comparatively presented data from research in 1998–2002 with data from interviews done in 2010. Some changes in the distribution of both barren ground caribou and moose were noted as well as a new sighting of a white tailed deer. Caribou were observed to be moving further east from the key hunting areas documented in 2000. Moose were observed in 1998–2002 to be expanding their range north east of the community with an increase in the abundance of moose being reported in 2010. Many interviewees reported observing a "decline" or a "significant decline" in caribou numbers in 2010. Such observations of a decline were supported by both the harvest of caribou and caribou meat consumption data. While the declines in harvest and consumption may reflect socioeconomic influences (i.e., increased cost of fuel) or food preferences, the triangulation of this data with observed changes seems indicative of an ecological change.

According to the indicators developed in 1998–2002, there were few changes in the condition of caribou. The usefulness of these observations as scientific data can be gleaned from previous research in this community and elsewhere in northern Canada and Alaska (Kofinas, Russell, & White, 2002; Lyver & Gunn, 2004; Moller et al., 2004). Much research has suggested that harvesters are also attuned to whether the caribou are in good condition (Lyver & Gunn, 2004; Lyver & Łutsël K'é Dene First Nation, 2005). Given that many of the indicators of poor condition used by harvesters are analogous to late stage symptoms of CWD infection (Spraker et al., 1997), active harvester observations may be particularly useful where other kinds of testing are not feasible. There are, however, many possible factors that might lead to an animal being in poor condition, thus a broader perspective and approach is necessary that situates CWD in the context of other kinds of environmental change and is respectful of the sociocultural value of caribou, moose, and other species to northern Indigenous communities.

Implications

Northern Indigenous communities have many ways of making sense of environmental change; systematic observation of changes in population, distribution, and condition of animals has been instrumental to sustaining the livelihoods of northern Indigenous peoples for

thousands of years. This article demonstrates the ways in which Traditional Knowledge can speak to trends in wildlife health over time. In this study, observations and interpretations documented in 1998–2002 formed a baseline for understanding changes a decade later. The long-term research collaboration, including training of local community researchers, was key to the success of the study; in addition to creating conditions of trust between the researchers and harvesters, it enabled researchers to embrace the inter-generational dynamics of knowledge sharing in the community and their long-term view of environmental change.

There are many changes in northern communities of concern to local harvesters. The effects of mineral resource development and climate change are key issues being studied in many regions. The potential effects of diseases such as CWD on wildlife health, human health and the economies of northern communities has been a lesser focus of study.

There are currently no known cases of CWD being transmitted to caribou and moose in the Northwest Territories; nor are there any proven human health links. At the same time, the similarities of this prion disease to bovine spongiform encephalopathy and the variant affecting humans (Creutzfeldt-Jakob disease—CJD) has led wildlife disease specialists to argue for surveillance (Happ et al., 2007). The degree of vigilance currently undertaken may not, however, be sufficient given the degree of dependence of northern Indigenous peoples on caribou and moose as well as the evidence that the range of white-tailed deer may be shifting north (Dawe et al., in press). Unlike in southern Canada and the United States, where hunting by non-Indigenous peoples is predominantly recreational, caribou and moose represent a significant proportion of total dietary proteins in many northern communities; this includes conventional cuts of meat but also many organ meats, neural and related tissues which are hosts of the disease in deer populations.

Research in the United States as well as risk communication theory developed in northern Canada, suggests that caution is needed in research and communication about such diseases lest news of CWD trigger avoidance of traditional foods that have long been protective of health (Furgal et al., 2005). However, there is equal evidence on the benefits of community engagement in environmental monitoring and management for adaptation and resilience. Greater recognition of traditional systems of monitoring can result in useful empirical data for management. Greater recognition of TK and community-based processes of monitoring by outsiders may also contribute to the mending of historic conflicts between governments and northern Indigenous peoples, thereby creating a social space for harvesters to play a more active role in formal systems of wildlife management.

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