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Denésǫliné (Chipewyan) Knowledge of Barren-Ground Caribou (*Rangifer tarandus groenlandicus*) Movements

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ABSTRACT. Semi-directed interviews relating to the traditional knowledge (TK) of barren-ground caribou (*Rangifer tarandus groenlandicus*) movements were conducted with elders and hunters from the Denésǫliné (Chipewyan) community of Łutsël K'é, Northwest Territories, Canada. The objective was to document Denésǫliné knowledge of past and present caribou migration patterns and record their explanations for perceived changes in movements. Elders recognized expected and unusual levels of variation in caribou movements. Local narratives show that Denésǫliné communities have a fundamental awareness of caribou migration cycles. Most elders thought fire frequency and intensity had increased over their lifetimes and that caribou numbers and distribution had been affected. The majority of Łutsël K'é elders thought mining development was affecting caribou movements in some way. Elders believe that disturbance around traditional migration corridors and water crossings and disturbance of "vanguard" animals might be forcing caribou to use less optimal routes and influencing where they overwinter. Elders also believe that a lack of respect for caribou will cause the animals to deviate from their "traditional" migration routes and become unavailable to the people for a period of time. Wildlife management practices may need to further accommodate aboriginal perspectives in the future.

Key words: caribou, migration, Dene, Łutsël K'é, traditional knowledge, aboriginal hunting, Northwest Territories, Denésǫliné, Chipewyan

RÉSUMÉ. Des entrevues semi-dirigées relatives au savoir traditionnel (ST) sur les déplacements du caribou des toundras (*Rangifer tarandus groenlandicus*) ont été faites auprès d'aînés et de chasseurs de la communauté denésǫliné (chippewyan) de Łutsël K'é, dans les Territoires du Nord-Ouest au Canada. L'objectif était de documenter le savoir denésǫliné concernant les habitudes migratoires passées et présentes du caribou, et de consigner les explications sur les changements perçus dans les déplacements. Les aînés ont reconnu des niveaux de variation anticipés et inusités dans la migration du caribou. Des récits locaux révèlent que les communautés denésǫliné possèdent une connaissance fondamentale des cycles de migration du caribou. La plupart des aînés étaient d'avis que la fréquence et l'intensité des feux de forêt avaient augmenté au cours de leur vie et que cela avait eu un impact sur le nombre et la distribution des caribous. La majorité des aînés de Łutsël K'é pensaient que l'exploitation minière affectait les déplacements du caribou, d'une manière ou d'une autre. Ils estimaient que les perturbations près des corridors de migration et des traversées de cours d'eau traditionnelles, ainsi qu'une perturbation subie par les animaux formant «l'avant-garde» de la harde, pourraient forcer les bêtes à suivre un trajet moins optimal et avoir une incidence sur leur site d'hivernage. Les aînés croyaient en outre qu'un manque de respect envers le caribou amènerait la harde à s'écarter de ses routes de migration «traditionnelles», la rendant inaccessible aux Autochtones pour une certaine durée. À l'avenir, il faudrait sans doute que les pratiques de gestion de la faune tiennent davantage compte du point de vue des Autochtones.

Mots clés: caribou, migration, Déné, Łutsël K'é, savoir traditionnel, chasse autochtone, Territoires du Nord-Ouest, Denésǫliné, Chippewyan

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INTRODUCTION

Societies with access to their traditional lands and resources maintain a deep understanding of and relationship with their local environment and its natural processes. This traditional knowledge (TK) represents a living, dynamic, knowledge system that uses historic and contemporary information to inform current thinking. Traditional knowledge and narrative are important in the lives of Dene—commonly differentiated by the Denésǫliné (Chipewyan), Tłicho (Dogrib), Gwich'in, and Slavey language groups—in Canada's Northwest Territories. The term "Denésǫliné" is used in this text to refer to the Dene peoples historically known as Chipewyan peoples. The name "Chipewyan"

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('pointed skins'), still in common usage, was originally a semi-derogatory term thought to refer to the "pointed" style of Chipewyan dress or hide preparation in the early fur trade era, or both (Smith, 1981).

As hunter-gatherers, the Dene have a rich and diverse knowledge of the natural environment and wildlife populations on which they continue to rely. This knowledge is expressed in their holistic beliefs and in their oral accounts, especially those associated with the ecology, movements, and harvest of barren-ground caribou (*Rangifer tarandus groenlandicus*. As the most abundant large mammal in the North American Subarctic and Arctic zones, the caribou is of special significance in the traditional economy of the indigenous people of these environments (Berkes, 1998). The abundance and migration patterns of caribou provided the basis for a successful long-standing dependency on the herds by the Dene people.

Because of their almost continual interaction with the animals and wealth of experience on the land, the Dene people can recognize natural changes in caribou numbers or migratory movements. This ability places them in a favourable position for determining whether changes are related to natural variation or human activities (Stevenson, 1996). Other wildlife species besides caribou (e.g., prairie bison, *Bison bison bison*) similarly move across extensive landscapes, and as with caribou, there is evidence that local observations of these species contain insights that apply at regional and even global scales. Examples are insights of traditional knowledge into glacial events and climate change (Cruikshank, 2001), mass movement of caribou populations (Ferguson et al., 1998), and isostatic rebound (Spink, 1969).

The objective of our research was to document Denésǫliné knowledge relating to past and present caribou movements. Denésǫliné TK can provide detail of temporal and spatial changes in both local and regional settings. In contrast to local knowledge, TK not only represents many generations of cumulative, culturally transmitted knowledge about particular environments (Berkes, 1999:8), but is also seated in a way of life. In addition, it can expand our understanding of the differences between natural variation and unexpected changes in the behaviour or ecology of caribou. In recent years, an expansion of effort to document TK in ways that are meaningful and relevant to aboriginal communities (Nakashima, 1991; Johnson, 1992; Inglis, 1993; AFN and NAFA, 1995; Tobias, 2000) has included studies of the TK about caribou (Ferguson et al., 1998; Thorpe and Kadlun, 2000; Legat et al., 2001).

To avoid marginalizing the belief systems that lie at the core of traditional knowledge and practice, this study engaged in community-based research efforts controlled and directed by the people of Łutsël K'é. We outline Łutsël K'é elders' and hunters' knowledge of expected variations in caribou movement, as opposed to variations beyond their experience. Spatial and temporal changes in caribou movements observed by the elders and hunters were recorded. We also documented elders' perceptions of how fire, development (mine infrastructure), and some current wildlife management practices (e.g., fire control and satellite collars) could affect caribou. The importance of Denésǫliné beliefs to the relationship between elders and caribou is also discussed.

HISTORICAL BACKGROUND

Before European contact, the Denésǫliné were the most numerous and widely distributed of the Northern Athapaskan groups. They occupied boreal forest-tundra areas in a wide arc stretching from near Hudson Bay north of the Seal River (in present-day northern Manitoba) to the mouth of the Coppermine River north of the Arctic Circle in the northwest (Smith, 1981). In historical times, this area extended westward between Lake Athabasca and Great Slave Lake (Gillespie, 1976). By the 19th century, Denésǫliné occupation of the south and central Barren Lands had shrunk (Smith and Burch, 1979) as the people died from European diseases such as small pox, tuberculosis, influenza, and measles. However, increasing participation in the fur trade also affected Denésǫliné land-use and occupancy patterns, as did the adoption of European technologies (such as the metal ice chisel, which made mid-winter fishing with nets possible) and dog teams as the main form of transportation in the late 19th century (Smith, 1981). There is also evidence that the historical land use and occupancy patterns of the Denésǫliné people exhibited expansion, shrinkage, and shifts that paralleled variation in the ranges and movements of the barren-ground caribou herds they relied upon. These shifts are well documented in the oral accounts of Tłicho, Denésǫliné, and Inuit elders, by early explorers (Rae, 1850; Pike, 1917; Back, 1970), and by anthropologists (Gillespie, 1976; Smith, 1981; Helm, 2000). Łutsël K'é is a member of the Treaty 8 Akaitcho Territory Government (ATG). Figure 1 depicts the Akaitcho territory as defined by the ATG.

Most (currently about two million) of the barren-ground caribou in North America live in seven large herds that migrate seasonally from the tundra to the taiga. In order, from Alaska to Quebec, these are the Western Arctic, Porcupine, Bluenose, Bathurst, Beverly, Qamanirjuaq, and George River herds. Other barren-ground caribou live in smaller herds that spend the entire year on the tundra (Wager Bay and Lorillard herds). In spring, barren-ground caribou cows head toward traditional calving grounds, to which they show a high degree of fidelity; as a result, most herds are named for their calving grounds.

The distribution of Denésǫliné bands and hunting groups was historically linked to the peoples' ability to anticipate the dispersal and movements of barren-ground caribou. Caribou movements were tracked by communication networks of families and bands, each highly mobile within its own geographical locality, linked to each other across a broad front (Smith, 1978). In late summer, the front would advance north out onto the barrens, and in winter the

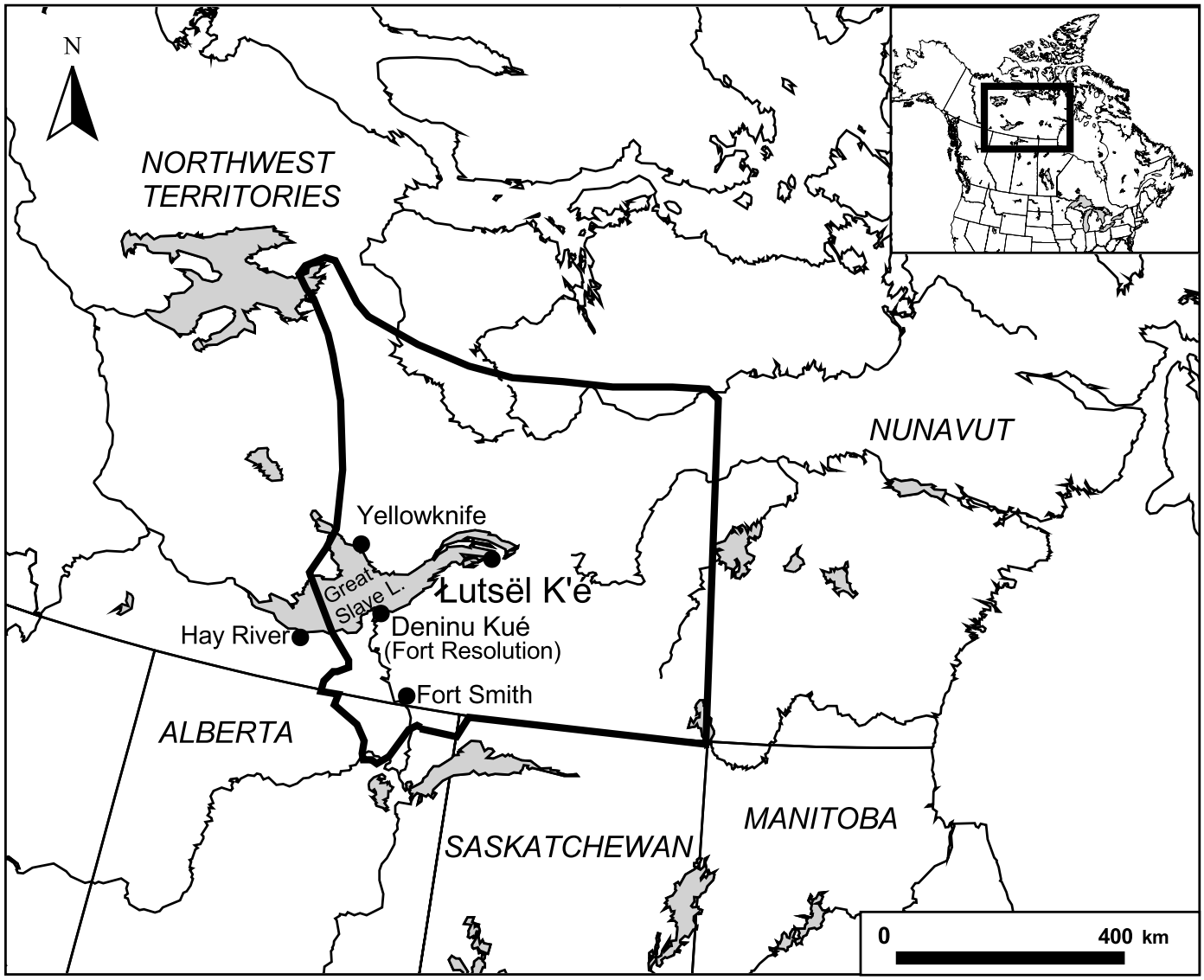

FIG. 1. Akaitcho territory. (Akaitcho boundary from Akaitcho Territory Government, 2003).

people would withdraw into the taiga country and come together in larger camps to share information (Smith, 1978). Figure 2 shows some of the campsites where people would gather in larger groups to intercept caribou during fall migrations and to meet caribou at fall water crossings (e.g., ʔedacho tłazi, Kaché) or winter feeding grounds (e.g., Nanula Tué). Using this system, the people could expect to remain reasonably well informed about the whereabouts of caribou at any particular time. Essentially, this network of communication served as a "reconnaissance system," informed by experience and collectively held, multi-generational knowledge of caribou movement patterns. Denésǫliné hunters' knowledge of the migration routes and key water crossings that caribou used to access wintering grounds allowed them to focus their hunting efforts and position themselves on the caribou range. Therefore, the ability of groups to intercept caribou depended on the hunters' knowledge of migration routes, the strategies they used, and the efficiency of communication networks between hunting groups (Smith, 1978). Hunters from Denésǫliné communities reminisce about the way people in numerous, scattered camps helped each other by sharing information about caribou distribution and movements (Fig. 2). Observations of "unexpected" versus "normal" variations in movement through these areas would have been noted and potentially linked with environmental conditions, such as early or late occurrence of winter freeze-up or spring breakup.

The Denésǫliné people moved over great geographical distances in order to match the widely varying migratory movements of barren-ground caribou populations. Prior to contact with Europeans, people moved in and out of the barrens regularly, virtually as far north as the calving grounds of the Beverly herd and almost as far north as the mouth of the Coppermine River (Gillespie, 1976; Smith, 1981). Archaeologists surmise that with major population shifts of caribou every one to two human generations (30–50 years), "emigration" or starvation events did occur

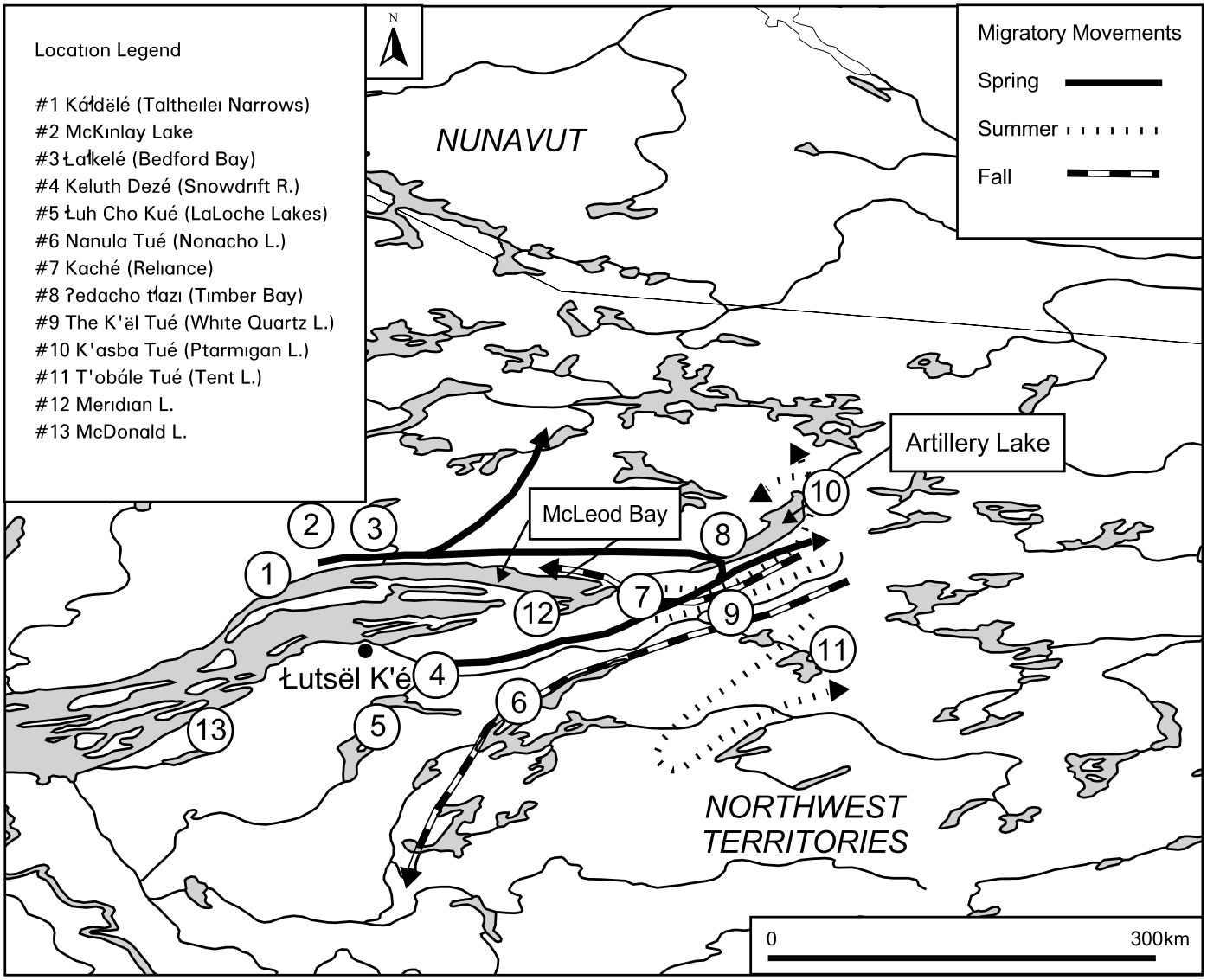

FIG. 2. Network of selected hunting camps and barren-ground caribou migratory movements described by Łutsël K'é elders.

among caribou-dependent peoples (Speiss, 1979). However, starvation is not as prevalent a part of Denésǫliné cultural narratives, as it is in those of other cultures. Although elders' knowledge of metaphysical human-caribou relations and caribou ecology is no longer absolutely necessary for survival, community members recognize its role in cultural identity, spiritual well-being, and the management of caribou as still relevant and important.

METHODS

The study was conducted in the Denésǫliné community of Łutsël K'é (62˚24' N, 110˚48' W), located in the East Arm of Great Slave Lake, Northwest Territories, Canada (Fig. 1). The reference area for this paper includes the land areas where elders hunted through the course of their lifetimes and the areas described in elders' accounts of their ancestral land use. Descriptions of land use in this paper do not claim to represent the full extent of present-day or historical Denésǫliné land use. In this research, we did not inquire about all aspects of the Łutsël K'é Dene First Nation's current and past land use, nor did we set out to map them comprehensively. Land rights are currently under discussion within the Akaitcho Treaty negotiation process.

We used individual elder and hunter interviews, group workshops, and participant observation during the two years that we (the individual authors) lived in Łutsël K'é (2000–01). We interviewed 39 elders (27 men and 12 women) and 39 active hunters (38 men and 1 woman) from the community, using a semi-directed approach. From this group, 24 elders were interviewed at least twice (at least once by each researcher). Active hunters were interviewed about their recent observations of caribou body condition, but the majority of the material in this paper is derived from interviews with elders. Only elders were interviewed about their cumulative knowledge of caribou movements,

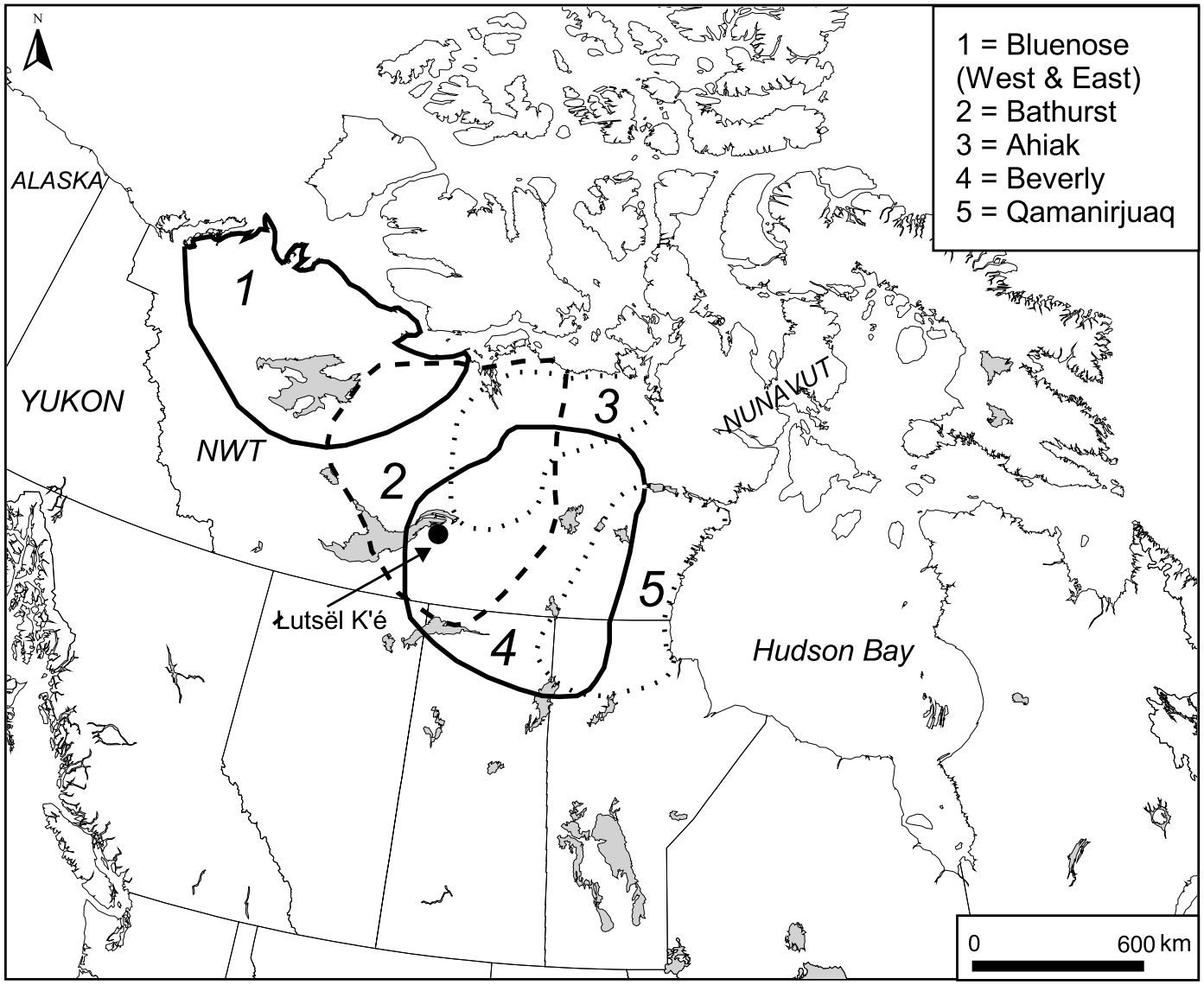

FIG. 3. Overlapping ranges of selected barren-ground caribou herds in the Łutsël K'é traditional land use area. The Bluenose herd is included because individuals from this herd have occasionally been observed within the Łutsël K'é hunting area.

indicators of caribou body condition, and the possible effects of development on caribou movements and condition. All interviews employed local facilitators fluent in both English and Denésǫliné. While this paper is informed specifically by the individual interviews and workshops described above, each author also spent extensive time learning about community perspectives from other community-based projects.

RESULTS

Łutsël K'é Elders' Knowledge of Caribou Migration Patterns

Łutsël K'é elders described geographic and temporal variation in the migration patterns of barren-ground caribou. However, the breadth of knowledge needed by elders to even begin to distinguish patterns in caribou movements is overwhelming. The Łutsël K'é area is only a small portion of the vast, overlapping ranges of the Bathurst, Beverly, Qamanirjuaq, and Ahiak herds (Fig. 3). While Figure 3 shows the range of these herds as conventionally understood by biologists, recent satellite collar data show movements well beyond the ranges depicted. For instance, some of the satellite-collared animals from the Ahiak herd, which calves well north of Baker Lake in Nunavut, have wintered south of Łutsël K'é and in Saskatchewan in the last few years (Gunn et al., 2002). Bathurst and Beverly animals have wintered together south of Łutsël K'é, and satellite-collared Bluenose animals have been noted in the wintering areas of the Bathurst herd in recent years (Gunn et al., 2002). We should add that it would likely take many years to fully understand elders' knowledge of movement patterns. Most elders are hesitant to acknowledge they have a comprehensive knowledge of migratory move-

ments, probably because it sounds presumptuous and violates their sense of humility about presuming to "know" caribou.

Accounts from Łutsël K'é hunters suggest that range overlap may not be an insurmountable problem when attempting to identify animals from particular herds. Well over half the hunters (23 of 39, or 59%) stated that they could recognize caribou from particular herds by an aspect of morphology, or by the direction the animals are coming from (or traveling toward) at particular places and times of the year. For example, hunters report it is possible to distinguish between Bathurst and Beverly caribou migrating north through the Reliance area (see Fig. 2) in April. According to the elders and hunters, identification of the caribou relies to some extent on where the caribou have over-wintered.

Some hunters say that they cannot differentiate between Beverly and Bathurst animals. The recognition that animals from one herd are in better or worse condition than animals from another herd may change from year to year or from season to season. Morphological characteristics used by hunters to identify caribou from different herds (Bathurst vs. Beverly caribou) include pelage and antler coloration, the size and shape of animals, and body condition. Quite often a number of these characteristics were used in conjunction with location or the direction the animals were traveling at the time of interception by hunters. Beverly caribou were generally described as shorter, stockier animals than Bathurst caribou, with a paler (whitish) pelage on their heads and along their flanks.

> You can tell which herd animals may belong to based on their hide colour, size, and body shape, and the direction the cows are migrating to. (James Marlowe, 2001)

Some Łutsël K'é elders have noted in recent years that the fetuses of caribou cows harvested during the winter and spring months are less developed than previously. They have found it is not possible to make the same clothing and equipment from unborn calf hides, since the fetuses are relatively hairless and small compared to those of past years.

Very few of the Łutsël K'é elders interviewed said that they had noticed changes in the abundance of caribou in their traditional area over the years. However, virtually all the elders interviewed spoke of geographic and temporal changes in caribou migration patterns.

> Caribou have a large range and do not migrate using the same routes year after year. They go where the food is….In some years they [travel] different routes to go south. (Joe Desjarlais, 2000)

> The caribou don't migrate through this area [Łutsël K'é] anymore. Some people say the caribou don't migrate towards us now. Some also say the caribou have decreased in numbers, but I still think there is plenty of caribou. If people don't see caribou for a while, the caribou will come looking for the people. To this day the caribou are still like this. The problem is now the mines interfere with their migration and stop the caribou coming to the people. Another problem is all the land that has been burnt around Łutsël K'é and this also keeps the caribou away. In the past when there were forest fires the land would burn just to a certain point, but now the fires burn out of control. In the past there were not that many areas that were burnt, so the caribou were everywhere. Now there are many large burn areas and the caribou stay away. They do not migrate through those areas because there is nothing to feed on (Madeleine Drybones, 2000).

Elders recognize that there is always interannual variation in caribou movements. The winter and spring of 2000–01, the years when the interviews occurred, was the first time caribou had concentrated around Łutsël K'é since 1997. The elders consider these cycles of caribou wintering around—or moving through a particular area in some years, but not in others—to be "standard migratory behaviour." They discuss the range of routes and wintering areas caribou may use from year to year. It is clear that migratory routes, wintering areas, and fall and spring staging areas (areas where large aggregations of animals come together before splitting into smaller groups) are always somewhat variable. In contrast, when caribou swam relatively large distances instead of crossing water bodies at a narrows, elders considered it an unusual movement. Elders have also mentioned that before the 1950s, caribou used to wash ashore regularly in the Reliance area after drowning in the Lockhart River, but this is rarely seen anymore.

> Caribou still migrate using the same routes. There has been no change. In the past caribou migrated from here all the way up to the barrens. They don't move through this area [Łutsël K'é] anymore, not like they used to. (Joe Michel, 2000)

This quotation is a clear example of the challenges of interpreting statements properly. Initially it seems that this elder is contradicting himself by saying that caribou still use the same migration routes, but do not migrate through the Łutsël K'é area as they used to. The elder could be aware that although the caribou had not migrated through Łutsël K'é recently, or in the same numbers as before, they were still using a recognized alternative migration route. It is also possible that the time spans between these shifts in migratory routes were not long enough for the elder to consider them a "change." Elders may have a wider view, perceiving multiyear patterns rather than just year-to-year variations.

Evidence from community mapping interviews shows that Łutsël K'é people have "backup areas" (places where caribou are likely to be if they are not in the area where they

were expected to appear) and "backup strategies," which include resorting to harvesting other foods, like fish, moose, or muskox. Burch (1977) has discussed the use of muskox as a "backup" by the Denésǫliné when caribou and fish were unavailable.

> There are no caribou some years so [people] stay [at Meridian Lake]. If it's a bad year for caribou, then they could get moose there. (Pierre Catholique, 2001)

Łutsël K'é hunters and elders discussed the variability of winter movements and the strategies they used to decide when and where to move hunting camps when caribou did not migrate through or winter in certain areas as expected. There is a general recognition with respect to large bodies of water (like McLeod Bay and Artillery Lake, see Fig. 2) that if caribou that normally were seen in the area in a certain season were not on one side of a lake, they would almost certainly be found on the "other side." Elders explained that if caribou did not winter in the relatively accessible (to people) areas recognized for their "good" hunting, then it was worth the effort to travel to areas that were less easily accessed, but highly dependable for the presence of caribou. Perceptions of accessibility are dependent on the areas where family groups were living on the land. Elders also speak of spans of time (many years in length) when caribou stayed north of the tree line throughout the winter. Such a period occurred during the height of the white fox trapping era in the barrenlands.

There were times when caribou did not winter in the Łutsël K'é area for a number of years. People coped in various ways:

> During the fifties and sixties, people used to stay around [McKinlay Lake because] there were no caribou on the south side. They went north. I remember they hauled some meat from [McKinlay Lake] with a single engine plane. They used to haul meat from [McKinlay Lake] to Snowdrift [Łutsël K'é]. They did that a few times and then in the seventies, the same thing: there were no caribou on this side [at Łutsël K'é]. In the seventies, there were lots over…on the north shore [of McLeod Bay], and people used to go across. I was trapping at McKinlay Lake, not only me, there were some people that went hunting in the fall time, December; they went across by dog team…. Most of the time there were caribou at McKinlay Lake. There used to be no caribou around Łutsël K'é. (Ernest Boucher, 2001)

Role of Oral Narratives in Describing Variation in Caribou Movements

In many instances when caribou are difficult to locate, narrative and legend may be used to explain the phenomenon. Much of the content of these stories reveals the human-environment relationship that exists between the Denésǫliné people and wildlife. In parallel Subarctic and Arctic cultures, observations that certain animal populations occasionally "disappear underground or underwater" are possibly an illustration of the expected variable and fluctuating nature of the movements of wide-ranging northern wildlife populations. Animals may disappear for a length of time from a given region, but they are not gone in an absolute sense: rather, they may be temporarily using another area of their range. Denésǫliné elders narrated these accounts to provide explanations for the disappearance of caribou or changes in their movements:

> All of a sudden the caribou (*ʔetthen*) were gone, and the people were starving. There were no caribou tracks to be found. However, a small bird called a whiskey-jack (*jize*) was flying around and saw something encircling the caribou. The whiskey-jack saw that the raven (*datsa*) had the caribou surrounded by the stomach fat (*ʔechayu*). The raven had used the stomach fat to net the caribou. The raven just sat there eating pemmican [a mixture of ground dry meat and fat] and keeping guard. All around the raven were lots of caribou moving. The raven was chasing other animals away from the caribou to keep them for himself. While the raven was doing this, the *jize* broke through the fence and freed the caribou, and that is how the caribou were found again. (Mary Rose Enzoe, 2000)

> When you skin out the head of the caribou you will find writing on its forehead. No one can actually read this writing. However, in the past some elderly women would say it meant "wherever the people are, that is where the caribou will go." The caribou would always eventually migrate towards the people. That is what they said was written there. (Madeleine Catholique, 2000)

Reasons Postulated by Elders for Changes in Migration Routes

Elders suggested a variety of natural, anthropomorphic, and ideological reasons for caribou to alter their migration routes. Reasons were related to fire effects, mining development (contamination and disturbance issues, winter roads), current caribou management practices (use of satellite collars), and cultural beliefs (respect for caribou).

Effects of Fire on Caribou Movements: Łutsël K'é elders were asked to comment on their impressions of fire in the winter caribou range. When asked directly for comment on whether or not burn rates had changed during their lifetimes, almost all elders stated that the frequency and intensity of fires had increased in recent times.

> Forest fires are more severe now than in the past. In the past there were so many caribou, but now there are not as many because of the forest fires. Forest fires also kill a lot of the wildlife like insects, birds, and small furbearing animals. A lot of things have gone. There were not as many forest fires in the past. (Maurice Lockhart, 2000)

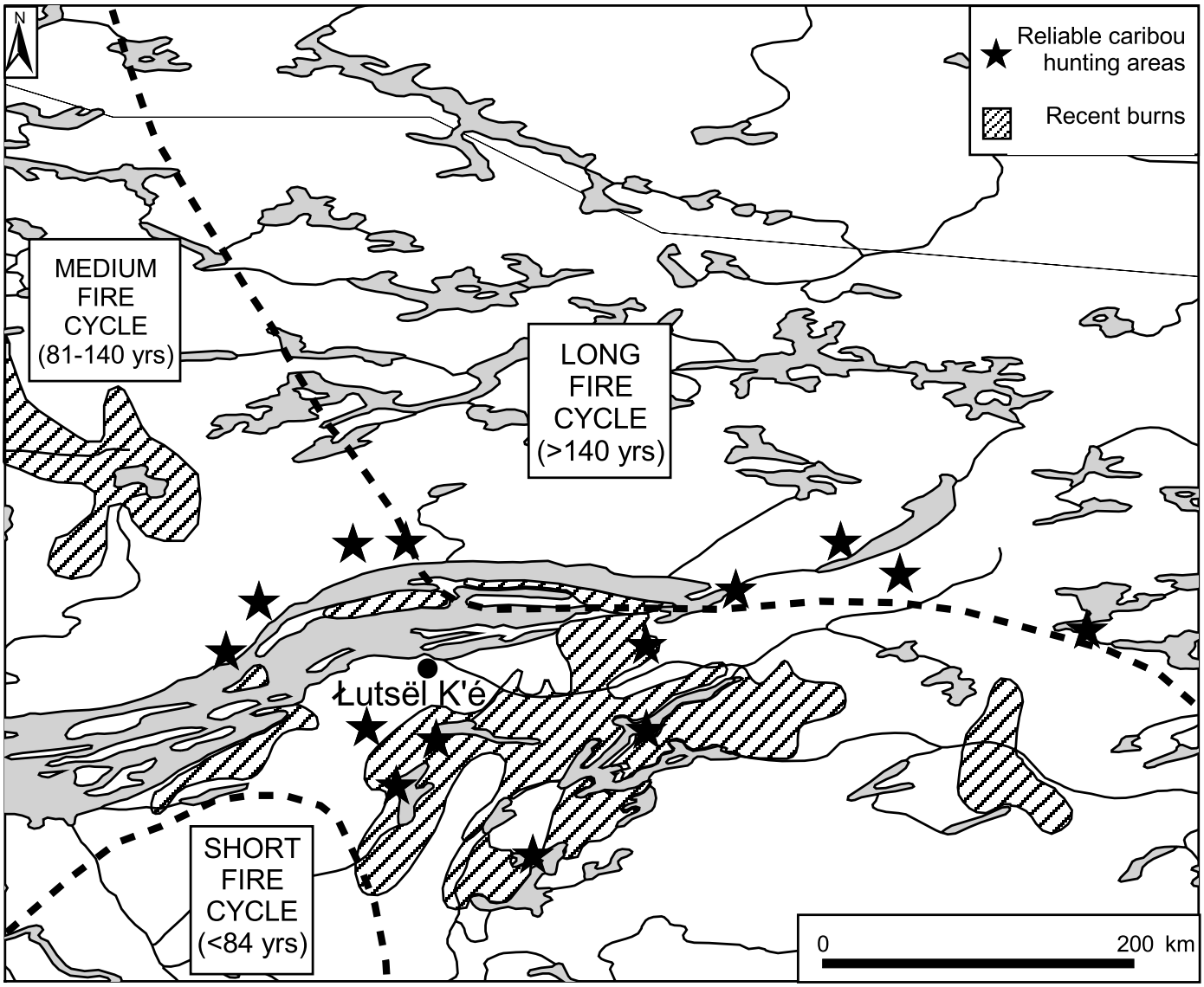

FIG. 4. Fire cycles and the effects of recent fires on selected reliable caribou-hunting areas in the Łutsël K'é area. (Adapted from BQCMB, 1994; CWFIS, 2003)

The few elders that did not indicate that the frequency and intensity of fires had increased during their lifetimes said that the number of fires fluctuated annually, and it was difficult for them to determine whether the trend in fire frequency was increasing or decreasing. Elders have noted that the recovery rate of forest around Łutsël K'é and Nanula Tué (Nonacho Lake) (Fig. 2) is slower than in the Deninu Kué or Fort Smith areas (Fig. 1). Elders felt that current firefighting policy does not properly account for this variability in forest recovery rate (Fig. 4).

Just over half of the 29 elders involved in one set of interviews (15, or 52%) reported that caribou would move straight through a burnt region without stopping to feed, while almost a quarter of elders (24%) thought that caribou would alter their migration route to avoid burns. The remaining elders either believed caribou were capable of both behavioral responses to burnt areas or did not comment on this aspect. Elders (24%) believe that the size and the number of burnt areas caribou have to negotiate each winter and spring can determine the body condition status of those particular animals.

A mapping exercise was carried out during a round of interviews in which elders identified areas where they had been consistently successful at intercepting the caribou migration, e.g., ʔedacho (Artillery Lake), Kaché (Reliance), Nanula Tué (Nonacho Lake), McDonald Lake, Łuh Cho Kué (LaLoche Lakes), and Hok'os Tué (Meridian Lake) (Fig. 2). Elders reported when and how caribou negotiate around or through burns of a variety of sizes and ages, and in some cases, gave the length of time that elapsed before caribou returned to "good hunting areas" that had experienced fire events (Fig. 4). Elders explained that, depending on how large a burn was and where it was located relative to migration routes and feeding areas, caribou would travel through burns or avoid burn areas altogether. The discussion was unavoidably complicated, however, by the effects of flooding from the Talston River hydroelectric project in the caribou wintering grounds

south of Łutsël K'é. Caribou and human movements naturally influenced by fluctuating ice conditions and winter forage are now also affected by flooding events in the Nonacho Lake area south of Łutsël K'é. This area (Rocher River, Talston River, Nonacho Lake) was recognized as "caribou country" in Hudson Bay records predating the establishment of Canadian government agencies in this part of the North (Bone et al., 1973).

Many of the Łutsël K'é elders voiced their concern about the detrimental short-term (< 50 years) impacts where fire has destroyed winter caribou forage, thus reducing the forest's ability to support caribou, especially around communities. As a result, fire has reduced the availability of caribou to some communities (e.g., Black Lake, Saskatchewan; Tadoule Lake, Lac Brochet, Manitoba). The need to develop a fire management plan taking into account the "values-at-risk" of caribou-hunting communities was a high priority of the Beverly-Qamanirjuaq Caribou Management Board for many years. Elders often focused on the politics of fire policy and firefighting methods that they did not believe met their needs. Their concerns included the loss of property (cabins), trapline areas, and particular plants and trees used for medicines and crafts. In general, elders indicated that they had observed an increase in the number of fires from the late 1950s to the 1970s.

Mining Developments: Mining and other industrial activities, such as petroleum exploration and extraction, hydroelectric development, and tourism are increasing in the Arctic and Subarctic, along with the associated infrastructures (Walker et al., 1987; Wolfe et al., 2000), especially in the Northwest Territories of Canada. The expansion of industry in the Northwest Territories can be attributed largely to recent discoveries of mineral deposits (e.g., diamonds) and recent advances in technology. The impact of these developments on wildlife populations (such as caribou) is debated among industry, scientific, and aboriginal representatives. Łutsël K'é elders concentrated their discussion of industrial development on the effects of mining activities.

The majority of elders expressed concern about the impact of mining activities on the environment, the wildlife, and their lifestyle. The primary concern for elders was the effect of blowing particulate matter (e.g., kimberlite, granite, and schist dust) from the mines that was entering waterways and covering vegetation. Many elders postulated detrimental flow-on effects through the food web to fish, waterfowl, caribou, and subsequently the people themselves. Half of the elders made reference to potential contamination issues. The direct effect of mining activities on caribou migration routes, caribou welfare (e.g., damage to limbs when caribou cross road berms), and habituation of caribou to human activity were also suggested as potential impacts.

Infrastructure Avoidance by Caribou: Many elders suggested that mine infrastructure could be affecting caribou migration patterns (i.e., routes used and time taken to reach the tree line).

> The mines are on the caribou migration route. For me the way the caribou migrate is different. It takes longer for the caribou to migrate to the tree line now that the mines are there. It was not like that before. The caribou used to come to the bush very quickly. It is taking longer for them to come to the trees. (Jim Fatte, 2000)

Transport corridors servicing the mines within the Bathurst caribou range are of special concern to the Łutsël K'é community (Fig. 5). Construction of a permanent road is being considered: it would run between the Lupin Mine and Bathurst Inlet on the coast of the Arctic Ocean, near the Bathurst caribou calving area. Already a 500 km road is constructed each winter (beginning on about 10 December) between Yellowknife, Ekati, and Echo Bay's Lupin Mine operation. There are measures in place to control the speed of the traffic on the road and to provide caribou crossings, and drivers are advised to give wildlife the right-of-way. A member of the Łutsël K'é community has a seat on a combined government-industry-community committee that makes recommendations on road operations, and there are continued efforts to mitigate the "barrier effect" that the road presents to migrating caribou. Collision risk, disturbance of traditional migration routes and annual distribution by heavy traffic densities, the visual barrier of an elevated road, and the easy access to the caribou herds that the winter road networks provide to hunters are potential effects that are of concern to elders.

> Not too long ago [approximately 1997] two big herds used to come around Łutsël K'é, and people came from all over to hunt the caribou. In the years following, the herd began coming towards us, but then turned away. Now that there are mines with roads and high snow drifts on the sides, the caribou won't cross and their migration route is disrupted. The old people said if you pile up snow into drifts, the caribou would not cross them. They just move alongside of it. This is what is happening with the winter roads. They don't teach kids about this anymore. The white man does not know this. The way the caribou migrate has been disrupted. The roads bisect the migration routes and disrupt the natural behaviour of the caribou. (Liza Enzoe, 2000)

The possible effects of human activity on caribou migration are recognized in Denésǫliné taboos. The Denésǫliné were mindful of these taboos when they first began constructing log-cabin villages in the 1930s. For example, many Łutsël K'é elders lived at a site known as ʔedacho tłazi (Timber Bay, Artillery Lake), located slightly inland from a major caribou water crossing (ʔedacho). Elders recall that they were told never to pitch tents or build cabins too close to these water crossings. They also recall a time when someone disregarded this taboo, and recount how the caribou changed their migration pattern through the Artillery Lake region.

Another traditional practice was to allow the first group of animals that arrived at a water crossing like ʔedacho to

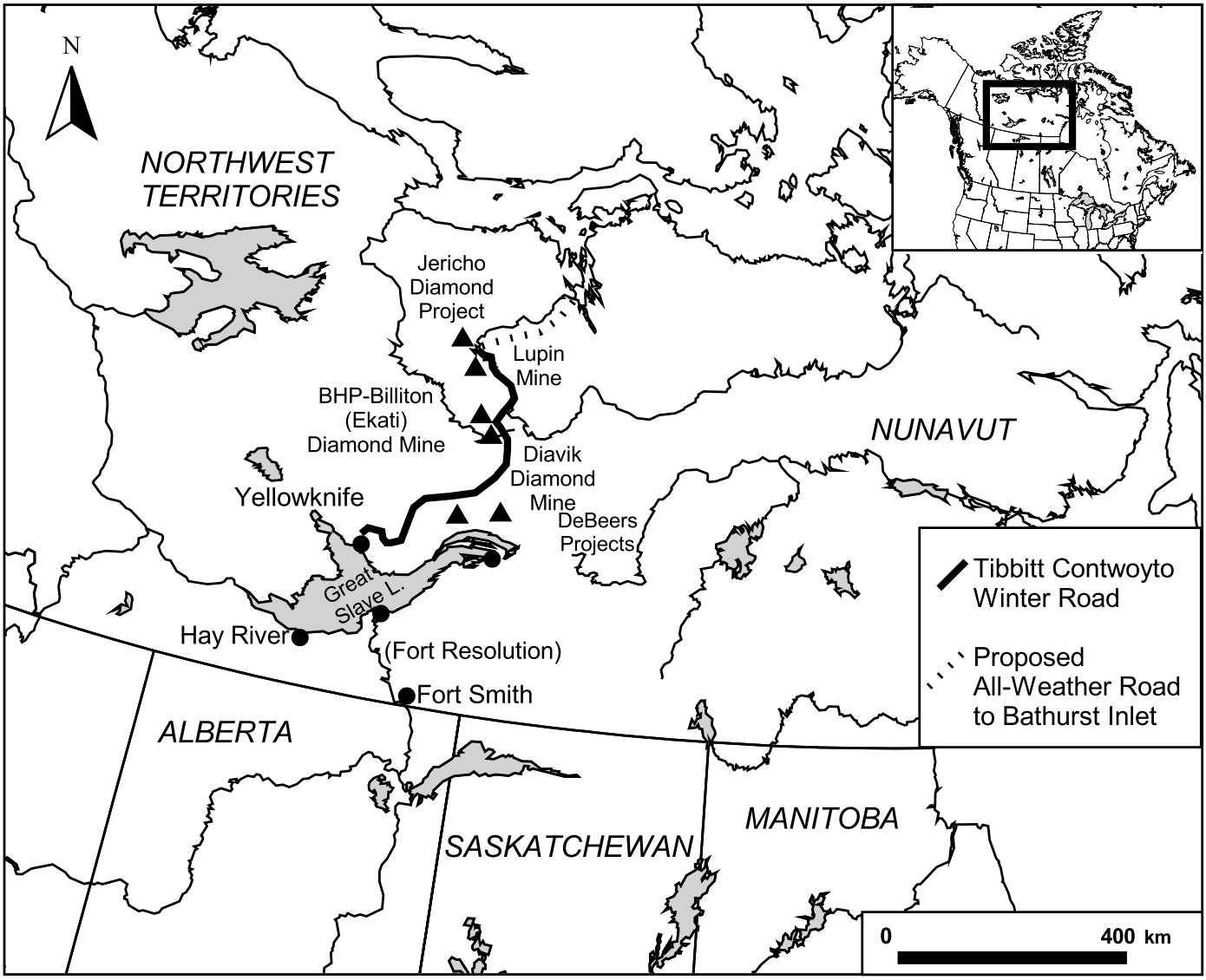

FIG. 5. Selected mines and roads on the barren-ground caribou ranges.

pass undisturbed, ensuring that vanguard animals were not killed. Caribou speared at water crossings were dragged away from crossing sites before they were butchered.

Potentially, the greatest impact on caribou of transportation corridors is the facilitation of hunter access. Łutsël K'é elders recognize that the ease of hunter access to caribou herds along transport corridors could directly affect caribou numbers by increasing harvest opportunities. They also acknowledge the potential for greater disturbance, especially if the proposed all-weather road from the Lupin mine site north to Bathurst Inlet bisects the Bathurst calving grounds.

Location of Mine Sites with Respect to Caribou Movements: Many elders specifically mentioned the location of current mine sites on migration routes as a problem. Corridors are regularly used by caribou to pass through areas of "rough" terrain, while crossing points are usually located at constrictions in many of the lakes. In many instances, the locations of these corridors and crossing points are common knowledge to local aboriginal people. The regularity with which caribou use these routes means it is highly likely that aboriginal elders or hunters will notice changes in the frequency and numbers of caribou using these traditional corridors and crossings. Monitoring would require the elder(s) to observe the caribou movements once the mine became operational. A change in caribou numbers could be attributed to an absolute decline/increase in the population or to a temporal or spatial shift in migration routes.

> By observing the mines I've seen that they are not good for the caribou. In the past, the caribou used to migrate and stop in the Dathi Kué (Walmsley Lake) area. Very few caribou move through that area now. People also do not go up into that area now. You go to the mines to observe the caribou. I've been up to the mines three times and have observed the caribou there. You just see a few caribou here and there. For me the mines have changed the way

> caribou behave, although I am not all that sure how much they have changed. I know the main caribou migration trails are still there. In the past you could see caribou trails all along the landscape, even in the summer. You could see their tracks everywhere. Now you do not see them that much. Just some of the main migration routes remain. These are the only tracks you see. In the past you could see where the caribou have played when they've stopped, but now you do not see these signs of caribou playing. You only see the migration trails. After they put the mines up in the barrens the caribou have changed for me. The meat, however, still tastes the same. The way I hunt, I know how far the caribou are from my house. These days the caribou are much farther away than they used to be. In the past it was not like that. (Noel Drybones, 2000)

Elders suggest that mining activity could have the effect of deflecting caribou from these migration routes. Caribou use these corridors and crossing points to minimize the time and energy expended on migrating to wintering grounds. Some elders stated that animals are "driven" to move quickly at certain times of year or at certain stages of migration and are therefore more prone to injury at certain sites. Animals forced onto rough ground to bypass mines may also be more prone to injury, especially if disturbed by mining or predator activity. When elders talked about the effects of waste rock piles on caribou (injuries and deflection of movements), they often compared them to an area known as the "very rocky area" (near Healey Lake, north of Artillery Lake) that is virtually impassable. Elders have noticed that caribou avoid this area.

Just over a third of elders stated, citing observations at mine sites and reports from hunters, that the number of caribou with leg injuries has increased. The elders have suggested that the caribou might have sustained these injuries while negotiating road berms and waste rock dumps (50 m high) after being disturbed by mining activities (e.g., trucks and blasting).

> I think the mines are not good for the caribou. This fall [2000] the [Denésǫliné guides at the] hunting lodges saw more caribou limping and caribou with sore legs. The mine roads have huge boulders on the side of them. Even though the roads are constructed through the caribou's migration [routes], the caribou knows it has been through there before and must migrate through. The boulders are the reasons why caribou have injured legs. When people make roads, they should fix the sides of the roads properly. The mine people said they would watch out for the animals out there, but they're not doing their job properly. (Joe Desjarlais, 2000)

Culturally Appropriate Respect for Caribou: An especially important belief of the Denésǫliné is that their relationship with caribou must be based on respect. Almost all of the Łutsël K'é elders and hunters in discussions have emphasized the importance of respect and have postulated lack of respect as a reason for changes in caribou behaviour or migration. It was often stated that it was important for the people to respect caribou so that they will continue to return to communities. Failure to do so would cause the caribou to deviate from their usual migration routes and become unavailable to hunters for a number of years.

People show respect to caribou by (i) using as much of the animal as possible; (ii) removing the tip from the caribou heart; (iii) sharing meat with community members; (iv) not beating or poking the caribou with a stick; (v) not chasing caribou down with snow machines and running them to exhaustion; (vi) women not being involved in the hunting process while menstruating; (vii) women not stepping over the caribou's blood or the hunters' equipment; (viii) treating the meat and animal products with respect once they are inside the home (i.e., not having blood on the floor or letting meat go bad), and (ix) not leaving animal remains (e.g., bones) lying around outside. The failure of caribou to winter around Łutsël K'é between 1997 and 2000 was attributed by elders to a number of respect-related violations.

> The caribou don't migrate through this area anymore, not like they used to. The people have no respect for the caribou. The women go out and shoot and skin caribou and don't watch out for the caribou blood and the way they skin it. Nowadays, when meat is brought into the home, people do not watch out for blood being spilt on the floor. They don't wipe it up and step right over it. Another reason why caribou don't come round anymore is that people have no respect for them, and they chase them on skidoos. Some hunters from outside the area were hunting around here a few years ago and left a lot of dead caribou around the community and on Stark Lake. I was very sad. Many of the bodies were left to decompose slowly. (Joe Michel, 2000)

Elders commonly used the story of "hitting caribou with a stick" as an explanation for the failure of caribou to appear around Łutsël K'é. The belief that if you disrespect caribou in this way they will not return to your area for three to seven years is widely held by many Dene people. Wastage of meat is considered to be a marked show of disrespect to the caribou. This form of violation was also considered by some elders to be one of the main reasons for caribou to alter their migration routes and over-wintering areas. Denésǫliné people believe failure to treat animal remains correctly causes offence to the remaining population of that species, and these animals can make themselves unavailable in the future. The elders understood that the other animals in the population could sense inappropriate treatment intuitively. The animals did not need to witness the act or observe the results of the disrespectful behaviour. Correct treatment and proper disposal of animal remains (e.g., caribou bones) are appropriate ways to show respect. The prescribed treatment means (i) not

leaving caribou carcasses lying all over the lakes in winter and spring, but rather taking them up onto the shore and disposing of them in the trees; (ii) covering the remains with the skin or snow or both, and (iii) burying or burning leftover bones from around homes, campsites, and points where dogs are tied. In the past, bone fragments were disposed of in lakes:

> After the people crushed up the bones to make lard and grease, they would throw all the remaining bone fragments into a small lake. In the past the people would leave no trace of passing. People mainly used caribou for everything. Now if you go out on the land, you don't see any evidence of where the old people stayed. You don't see piles of hair where the women shaved the hides or piles of old bones. You see old sites that are very clean. It's hard to find evidence of the old camping sites now. (Madeleine Drybones, 2000)

The use of satellite tracking collars by scientists of the Northwest Territories' Department of Resources, Wildlife, and Economic Development (RWED) to monitor the migratory movements of Bathurst caribou cows is considered by many elders to be interfering with the caribou. Over three-quarters (24 of 30, or 80%) of the elders involved in one set of interviews disagreed with the practice, while almost one-fifth (17%) of the elders did not mind collars being used on caribou, and 3% did not hold any particular position. Age-related differences in attitudes were detected. The average age of Łutsël K'é elders that disagreed with the practice (71 years, SD = 7.3, n = 26) was higher ($t = 6.02$, $df = 27$, $p < 0.0005$) than that of elders that agreed with or did not mind radio/satellite collaring (62 years, SD = 1.2, n = 6) (The remainder did not answer this question).

The satellite collaring issue is complex. While the majority of Łutsël K'é elders oppose the use of collars, the community as a whole supports the collaring program. Some of the reasons elders had for opposing this management practice were (i) the large weight and size of the collars; (ii) hair loss caused by rubbing of the collar, which could increase the animal's susceptibility to frostbite during winter; (iii) interference of the collar with the animal's feeding; (iv) irritation and potential strangulation if the collar slips down the animal's neck and; (v) the collars' tendency to ice up. Elders believe these problems could cause the animals to suffer and lose condition. In an effort to address these concerns, biologists have made satellite collars smaller and lighter (with the development of smaller batteries) and programmed them to drop off after a certain time, so that caribou do not have to be recaptured for removal of the collars. In the Bathurst herd collaring program, only adult cows are fitted with satellite collars, helicopter pursuit times are limited to one minute to avoid stressing the animals excessively, and "vanguard" cows are not collared to avoid influencing herd migratory behaviour (A. Gunn, pers. comm. 2001).

DISCUSSION

Defining Variations in Caribou Movements

Denésǫliné elders appear to recognize differences between short-term fluctuations and long-term shifts in caribou movements. They have observed what seem to be three different kinds of variation in caribou movements: "expected" variation (movements seen regularly in an individual's lifetime); "unusual" variation (changes seen once in a generation or less); and "unprecedented" variation, which is ominous or dangerous change, never witnessed before or recounted by an individual's predecessors. It is important to determine the scale of the variation to understand how elders perceive the change in caribou movements. Denésǫliné elder Joe Michel reported that caribou were still using the "same" migration routes, although they did not migrate through the Łutsël K'é area as they used too. This could be an example of "expected" variation in caribou movements, especially since the caribou returned to the Łutsël K'é area, for the first time in three years, just two months after the interview took place. The early arrival of caribou cows in spring in the Łutsël K'é area (measured from the level of development of the caribou fetus), as well as the lack of regularity in washing ashore of drowned caribou at Reliance, could indicate "unusual" or "unprecedented" temporal and spatial variation in caribou movements. Knowledge of "backup areas" to harvest caribou may have been a Denésǫliné response to expected changes in caribou movements. The use of "backup strategies," or the changing of food species entirely, may have been a response to an unusual or unprecedented change in caribou migration routes.

The ability of Denésǫliné hunting groups to intercept herds each year may have been affected by the character of the migration as it passed through their region. The chances of hunters' intercepting a herd would have been greatly reduced if the animals passed by in a thin, highly concentrated "stream." As a result, there are documented instances of hunters missing huge migrations by a few miles, and oral accounts of Dene people going hungry in the Great Slave Lake area when neighboring camps and settlements had plenty of caribou in their areas (Pike, 1917; Maurice Lockhart, pers. comm. 2001).

Denésǫliné people have historically exhibited wide-ranging movements, and this pattern has implications for the spatial and temporal scope of their traditional knowledge. Spatially, traditional knowledge is often perceived to be highly "localized." It is generally assumed that all traditional knowledge develops over a long time span in one localized area. Łutsël K'é elders' knowledge of caribou movements illustrates that traditional knowledge may encompass a much larger geographical area than was first assumed. It is possible that some aspects of traditional knowledge operate over both a long time span and a large area. It is important to account for the ecological context from which a particular traditional knowledge base is

derived. Denésǫliné people, according to Burch (1991), may have had the most wide-ranging movements of any people on the planet. This is not surprising, given that the barren-ground caribou upon which they were highly dependent also have one of the most wide-ranging terrestrial migrations of any wildlife species.

Interpreting Traditional Knowledge Narratives

Translating cultural understandings of migratory concepts is an involved process. For instance, when saying that animals "disappear underground" (as described earlier), people may be portraying emigration episodes that may or may not be regular fluctuations in population numbers. It is important to distinguish this kind of movement from (seasonal) "migration" (Ferguson et al., 1998).

The Denésǫliné have a fundamental understanding of variations in migratory movements. The local stories of caribou that "go underground or underwater" may be a metaphorical reminder of this appearance and disappearance of caribou populations, reflecting the culture's attempt to explain a complex natural phenomenon. In all of the discussions pertaining to respect, no elder or hunter stated that caribou would stay away indefinitely because of human actions; the strong ties with humans meant the caribou would always return to use traditional travel routes and wintering grounds:

> The old timers say if the caribou don't see people for a long time, they will become lonely for humans. Caribou eventually will migrate towards where the people are. (Pierre Catholique, 2000)

(For this elder, "a long time" means anywhere from three to seven years.)

Elders would also state that this feeling was reciprocal, and they too would become lonely for the caribou after a long term of absence. The intense nature of this relationship may reflect just how dependent Denésǫliné were on the caribou and their continued return. Elders' comments about changing caribou migratory behaviours are often entwined with comments about their own beliefs. An elder who says that caribou are no longer at a certain place may explain that this is so because people are no longer at that location. Understanding the circumstances that lead an elder to tell one story or another is as important as deriving meaning from the story itself. If such stories are read using lines of rationalization that do not make sense in Denésǫliné culture, or without the context in which they were told, meaning will be lost. In addition to serving as critiques of contemporary management actions (for example, collaring caribou to learn about movement patterns), narratives may also depict concepts of population dynamics in metaphoric language. There is a large literature on the significance of animal-human transformation stories in indigenous cultures (Cruikshank, 1998; Bringhurst, 2000), and these narratives may play a role in describing ecological concepts.

An important aspect highlighted by narratives is that although TK can be relatively strong at identifying a problem or change, it is not reasonable to expect a story to outline the exact mechanisms that drive ecological or natural systems. This is not the "language" or the logic that stories employ. Stories act as reminders that life and circumstances change through time. Stories also serve as tools for problem solving in contemporary situations (Cruikshank, 1998).

Use of Denésǫliné Traditional Knowledge in Fire Management

Fire is generally accepted to be a natural part of the taiga (boreal forest) ecosystem. Łutsël K'é elders reported that fire events have increased in frequency and intensity during their lifetimes. Winter movements and distribution of caribou are unpredictable, which makes it hard to gauge the direct influence of fire events. Fire has been one of the largest topics of discussion for the Beverly-Qamanirjuaq Caribou Management Board (Kendrick, 2000). Existing data suggest that the incidence of forest fires has increased across Canada in the last 50 years (Wotton and Flannigan, 1993). However, not all regions have kept statistics on all fire incidents; some record only those fires that were actively suppressed by fire crews. It is only recently that fires (especially in remote areas) have been tracked by satellite. Therefore, it is unknown whether there has been an increasing trend in fire incidents, especially in more remote areas and at smaller spatial scales, where conventional tracking and monitoring of fires is difficult. The Beverly-Qamanirjuaq fire cycling maps support Łutsël K'é elders' observations that it takes longer for an area to recover from fire in the Nonacho Lake area than it does in the Fort Resolution or Fort Smith area (Fig. 2).

Denésǫliné people historically travelled through areas varying greatly in fire cycle length. Warburton Pike (1917) reported the effect of fires on caribou migration routes in the 1870s in the Great Slave Lake area. After a large fire in the Deninu Kué (Fort Resolution) area, caribou stopped using the Rocher River/Deninu Kué region as a wintering area:

> … great stretches of the country have been burnt, and so rendered incapable of growing the lichen so dearly beloved by these animals. The same thing applies to Fort Resolution, where, within the last decade, the southern shore of the Great Slave Lake has been burnt and one of the best ranges totally destroyed. (Pike 1917: 50)

Pike's report is reminiscent of elders' accounts of the effect of fires in the same area about 60 years ago (in the 1930s and 1940s). Caribou are only now starting to winter in that area again. The impact of fire on the Denésǫliné way of life may be greater now that the people have become increasingly stationary in communities. In the past, camps were relocated in response to variations in caribou movements resulting from burns. The establish-

ment of permanent, year-round settlements in the Northwest Territories means that the people now have to travel large distances to hunt if the forest around communities is burnt. This effect could be felt over a large part of a person's life, or the time it takes for the forest to recover enough to support overwintering caribou.

Łutsël K'é hunters and elders have reported changes in caribou distribution and numbers in response to fire. Elders recognize that caribou respond differently to burns of various sizes and ages. They also observed that caribou movements in response to burns could differ depending on the season. For instance, during spring migration, caribou cows may move straight through smaller burns because of their drive to reach calving grounds. In contrast, caribou in winter become increasingly stationary because they require areas that will provide them with stable feed. As a result, it has been observed that caribou attempt to avoid burn areas during winter months.

Denésǫliné Knowledge of Mining Impacts

In the past, involvement of, and consultation with, aboriginal organizations about mining development in the Northwest Territories were limited, if not absent. Progress in land-claim agreements and the emergence of the diamond industry in the Northwest Territories over the last two decades have made the mining sector more accountable to local aboriginal communities. Under legally binding agreements (e.g., Government of Canada et al., 1997, 2000), mining companies like BHP-Billiton and Diavik are required to provide opportunities for aboriginal organizations to express their concerns and to give traditional knowledge full consideration in developing environmental monitoring programs related to the mines. Much of this information is recorded through community working groups, site visits by elders and aboriginal representatives, and independent environmental monitoring agencies and boards.

Denésǫliné elders have the potential to predict impacts from the mines through their traditional knowledge of caribou migratory behaviour. Elders know that disturbance near traditional corridors or water crossings causes caribou to deviate from these crucial points. If caribou are forced to use less optimal routes, the increase in their energy expenditure could begin to affect the survival of some animals (e.g., calves). Similar outcomes may occur if vanguard animals are disturbed.

The role of barriers as a means of altering caribou movement is clearly understood by the Denésǫliné people. Therefore, elevated roads and increasing traffic densities through the caribou range are of special concern to elders. The increased risk of collision was also proposed as a problem, especially if recreational traffic on winter roads remains uncontrolled. In an attempt to mitigate the effect of mine-pit access roads to the BHP-Billiton and Diavik sites, berm heights have been minimized (< 3 m in height along 90% of the length), and caribou crossings have been constructed at sites where caribou trails bisect the roads. However, these measures do not apply to the 500 km winter road that bisects the Bathurst caribou herd's spring migration route. To minimize collisions, driver training at the mine includes wildlife awareness. Fencing of the entire mine site was suggested by some elders as a means of keeping caribou clear of hazards and reducing habituation. A trial attempt to deflect caribou movements away from a mine site by using streamers tied to wires had only limited success. If an all-weather road is constructed through the caribou range, easier access to herds could become an issue. Elders realize there is potential for increased harvest and disturbance from hunters and sightseers, as access would be difficult to control.

Cultural Beliefs and Wildlife Management

In Arctic and Subarctic cultures, people believe there is an obligation on both humans and animals to support and complement each other. Harvested animals are perceived as providing a "gift of life" and thus should be treated accordingly. It is perceived that a lack of respect will result in chastisement and reduced hunting success because animals can respond by becoming unavailable to the hunters. Therefore, through a series of protocols, rituals, and practices specific to each aboriginal group, a certain level of respect is maintained at all times.

For Łutsël K'é elders, the traditional belief that humans should not "play" or "interfere" with wildlife is still very relevant. Cultural beliefs and community concerns regarding the use of modern technologies in wildlife management are issues biologists must now account for when working in the North. Placing radio or satellite collars on caribou is a scientific technique that is perceived by many Dene elders to be an act of disrespect and interference with the animals. Some elders consider the caribou tagging programs of the 1960s to be responsible for a change in caribou migratory behaviour.

In 1992, scientists applied for permission from the Beverly-Qamanirjuaq Caribou Management Board to radio-collar a sample of Beverly caribou. However, because of the opposition to the use of satellite collars by elders in some of the representative communities, the Board did not recommend approval of the request. Further requests by NWT government scientists to place satellite collars on Beverly animals have been denied. There are signs, however, that communities are more accepting of satellite collars now than they were 10 years ago.

We found younger Łutsël K'é elders and hunters more accepting of the technique than older elders. Hunters use the Bathurst caribou herd satellite collar data to determine the location of caribou for hunting. The benefit of using these data is that hunters can locate herds more easily, saving the time, effort, and travel costs that would otherwise have been spent finding the herds.

The percentage of aboriginal users that disagreed with the use of radio/satellite collars was higher in our study

than in the research conducted by Klein et al. (1999). Their survey showed that 60% of the traditional users of the Beverly and Qamanirjuaq herds and 38% of Western Arctic herd users found the practice unacceptable. The differences are most likely because of cultural and age-class sampling variation between studies. However, it is also important to consider that the politics in the Canadian and Alaskan situations are different. Canadian traditional users may be freer to talk about their discontent because they know they can influence research practices, whereas Alaskan traditional users may not take a stand on this issue since they do not have the same legally recognized political authority. Moreover, our survey includes impressions mostly from elders, rather than a broad sample of adult aboriginal users.

Respect for wildlife and the environment is central to the beliefs of aboriginal hunter-gatherer cultures. This belief largely arises from the holistic perception that humans have an intimate kindred relationship with the natural world, and that all animate and inanimate forms are involved in a social network. For many aboriginal groups, there is no conceptual separation between humans and the environment. "Objectivism" is rather a principle that seems to dominate the ecological philosophy of Eurocentric cultures originating to a large degree in the philosophy of Rene Descartes and Francis Bacon. Cartesian dualism, dividing "mind" and "body," led to a major shift in scientific thinking in the 17th century. The resultant focus on positivist and reductionist thought is premised on a split between "subject" and "object" (Berkes, 1999). As Livingston (1981) phrases it, the subject-object split also emphasizes a "one-sided divorce" between people and nature. This divide between human beings and "the environment" obviously has an ancient history in the Western world, predating the advent of modern science. The divide can be traced back as far as ancient Greece (Glacken, 1967). Further understanding the cross-cultural differences this divide creates may be crucial if traditional and scientific knowledge systems are to be used in cooperation for wildlife management. Monitoring programs that recognize these differences may facilitate broader learning about barren-ground caribou dynamics.

Ecological studies usually collect data of few variables and within specific geographical areas for short periods. Therefore, there are large problems generalizing to broader spatial and temporal scales (Ferguson et al., 1998). Not only is it difficult to generalize to broader scales, but in the North, regional variations are becoming accentuated. For instance, the year-to-year variability in the timing of freeze and thaw events in one region is not necessarily applicable to the situation in a neighboring region (Brydges, 2000).

Beyond such differences in variability, monitoring programs attempt to address differences in regional approaches to monitoring in order to bridge interjurisdictional fragmentation. This is especially crucial for the monitoring of overlapping barren-ground caribou herds. Monitoring programs must address the delay between the collection of data and the feeding of this information back to management organizations and policymakers who can act on the results. Most (80%) of current ecological monitoring programs last less than three years and are so dependent on the scale at which the monitoring was done that the information collected does not scale up very well in time or in space (Vaughan, 2000). There are tensions inherent in developing standards or protocols that allow monitoring data to be compared across regions, and this is especially crucial where caribou are concerned. How will monitoring programs in the North address these challenges, and what kind of monitoring efforts will include the traditional knowledge of aboriginal caribou-hunting communities?

CONCLUSIONS

Community-Based Monitoring in the North

> …the informed network of communication which is a dynamic part of contemporary community life provides a system by which wildlife condition, numbers, distribution, etc. can be monitored with unequal efficiency. (Nakashima, 1991:339)

Aboriginal communities dependent for their survival on wildlife species have always had to monitor the animals' movements in one form or another and adapt to any changes they observed as a result. This paper has explained some of the knowledge of changing caribou movements held by Łutsël K'é elders and hunters. Through accumulated experience of past movements, elders in Łutsël K'é described how it is possible to project potential variations in caribou movements from the animals' point of arrival or timing of arrival in a given area. In addition, Dene hunters project winter hunting patterns from caribou behaviour at bifurcation points: for example, which direction they deflect to at a particular crossing (Parlee et al., 2005). Elders were aware that caribou were more or less likely to use certain water crossings in a given year, or were able to gauge where caribou were most likely to be wintering after freeze-up, on the basis of their presence or absence in certain areas.

Rangifer (caribou and reindeer) continue to be the most important terrestrial subsistence resource for northern aboriginal peoples. Traditional caribou-hunting communities in the Canadian North are bound in their relationship to caribou to many other circumpolar cultures, including at least 26 aboriginal cultural groups in Eurasia and North America (UNEP, 2001). There are ongoing efforts to form coalitions between and among these groups to protect *Rangifer* populations from encroaching industrial development, as well as to use the traditional knowledge of northern communities to monitor and act on changes that aboriginal peoples are seeing in *Rangifer* populations (Kofinas et al., 2000). Many aboriginal communities perpetuate links between their communities and their

institutions, and ultimately the bonds between people and the resources they depend upon. Moreover, aboriginal caribou-hunting communities voice the importance of community-designed and implemented research projects and ecological monitoring programs to document the changes that local people are seeing on the barren-ground caribou ranges.

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