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Do Resource Users Learn from Management Disasters? Indigenous Management and Social Learning in James Bay¹

Practice is not always true to belief. Philosophers point out that "ethics bear a normative relation to behavior; they do not describe how people actually behave, but rather set out how people ought to behave" (Callicott 1982). For example, the Koyukon people of Alaska often violate their own rules on limiting harvests when they hunt caribou (Nelson 1982). Anyone who has worked with hunting peoples knows that rules of ethics are sometimes suspended. But one can say that about any culture or any group of people; there is always a gap between the ideal practice and the actual. The story of caribou is important in this regard. Cree elders in Chisasibi readily admit that they once overhunted the caribou. But the events that took place in the community in the mid-1980s indicate that the Cree hunters as a group learned from that experience. The caribou story illustrates how traditional beliefs play out in the real world, and how community-based systems can learn and evolve. It also illustrates the role that traditional stewards and elders play in providing leadership for collective decision-making. It shows why almost all traditional cultures consider elders so important. Elders provide corporate memory for the group, the wisdom to interpret events, and they help enforce the rules and ethical norms of the community.

The main issue here is the development and application of a conservation ethic in a social group. *Conservation ethic*, defined here after Johannes (1994), is the "awareness of one's ability to deplete or otherwise damage natural resources, coupled with a commitment to reduce or eliminate the problem." We will hypothesize that a conservation ethic can develop if a resource is important or limiting, predictable and depletable, and if it is effectively under the control of the social group in question so that the group can reap the benefits of its conservation (Berkes 1989a). We explain each point of the hypothesis in turn.

If a resource is superabundant there is no adaptive advantage in developing a conservation ethic for it, nor a territorial system for its defense. The resource has to be predictable and abundant, and important for the group, if not outright limiting (Dyson-Hudson and Smith 1978; Richardson 1982;

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Nelson 1982; Berkes 1986). If the resource is not depletable, it is perfectly logical (and, one may argue, ecologically adaptive) to kill excess numbers. Under such conditions, "a natural response is not to limit harvests intentionally, but the precise opposite -- take as much as possible, whenever possible, and store the proceeds for later use," as Nelson (1982) points out in his discussion of Alaska caribou hunting.

Finally, there is the question of the control of the resource. Societies do not establish conservation rules and ethics for the benefit of outsiders. The evidence on this question shows that the incursion of outsiders, and the inability of the group to defend an important resource, causes the lifting of rules and conservation ethic (Feit 1986; Berkes 1986). Once open-access conditions are created, perfectly conservation-minded stewards may well become participants themselves in a "tragedy of the commons" rather than to allow the outsiders to take the remaining resource. Such free-for-all depletions of resources seem to have happened in the case of beaver in James Bay in the 1920s, and the overkill of North American bison at the turn of the century (Berkes et al. 1989; Feeny et al. 1990). In some cases, the condition is reversible: if local controls can be re-established, the group can again reap the benefits of its own restraint, and conservation rules and ethics become operative once more (Feit 1986; Berkes 1989b).

The significance of the caribou case is that the *nature* of the resource does *not* lend itself well to the development of a conservation ethic. To be sure, caribou is one of the most important species of the North American subarctic and arctic, just as its close relative, reindeer, is important in Northern Scandinavia and Siberia. But they come in very large numbers when they come, and they are unpredictable. As one Dene Indian saying goes, "no one knows the way of the winds and the caribou" (Munsterhjelm 1953, p. 97). To aboriginal hunters once upon a time, caribou must have seemed superabundant and undepletable. Furthermore, large herds of caribou migrate long distances and are hunted by different groups of people, making local control, and thus local conservation, all but impossible, except in the cases of small herds of woodland caribou. It is relatively easy to envision the conditions under which a conservation ethic can develop for a range of species important for traditional Amerindians, for example, Pacific salmon (Swezey and Heizer 1993; Gottesfeld 1994), black bear and beaver (Nelson 1982), beaver and moose (Feit 1973; 1986); and Canada goose (Berkes 1982). All of them are predictable resources, or at least their harvest areas are predictable from year to year, and they are depletable over a cycle of relatively few years. Not so in the case of caribou.

"No One Knows the Way of the Winds and the Caribou"

As the most abundant large mammal of arctic and subarctic North America, caribou (*Rangifer tarandus*) has a special importance in the traditional economy of the aboriginal peoples of tundra and the lichen-woodland zone. Charles Elton, one of the founders of modern ecology, was interested in caribou population dynamics as an illustration of population cycles in subarctic ecosystems. In his classic 1942 book, Elton used the records of missionaries and fur traders to document the decline of the George River caribou herd of the Quebec-Labrador Peninsula at the turn of the century. When abundant, animals of this herd migrate in large numbers, as do barren-ground caribou, but show physical characteristics intermediate between woodland and barren-ground caribou, considered by some biologists as subspecies. Elton's reconstruction indicated that there was a general population decrease after about 1905. The most westerly of the three subpopulations of the George River herd occupied the James and Hudson Bay coast. This subpopulation had started declining earlier, through

the 1880s and the 1890s. As the population decreased, the range of the George River herd contracted, and the peripheral range was presumably the first to be abandoned. Sources consulted by Elton mentioned one final large kill in 1914 at the crossing of the Caniapiscau River which runs north-south and bisects the Quebec-Labrador Peninsula. By 1916, the herd was so reduced that, for the first time in living memory, the caribou did not migrate across the George River which also runs north-south but is closer to the Atlantic on the Labrador side of the Peninsula.

The George River herd stayed as a small population nestled in the hills of northeastern Labrador, still hunted by the Innu of Labrador. Population surveys as late as the 1950s showed a small herd, perhaps as few as 5,000, and biologists speculated on the reasons for the decline of the herd, citing a variety of possible explanations including extensive fires in Labrador and climate change, but often emphasizing the key role of aboriginal hunters and the repeating rifle which became extensively used in the area at the turn of the century (Banfield and Tener 1958). Then the herd started increasing in the 1960, with a noticeable expansion of range in the 1970s and the 1980s (Figure 1). Piecing together information from aerial surveys, tagging studies with radio collars, observation of tracks, hunters' observations, and kill locations, one could assemble the larger picture of the return of the caribou. The migrations penetrated further and further west and south, in larger and larger numbers, and the caribou started to linger in the more distant areas. The recovery of the George River herd has been dramatic and well documented. The caribou reached a population of some 600,000 animals, one of the largest *Rangifer* herds in the world, and re-occupied by the end of the 1980s the old range of the herd all the way to the coast of James and Hudson Bay (Jackson 1986; Messier et al. 1988; Couturier et al. 1990).

Juniper (1979) referred to the George River herd as an "irrupting" population. But was the population change a real cycle? Was it a real re-colonization of the former range? And perhaps even more interesting, if the dramatic decline of the caribou at the turn of the century was due to the aboriginal hunter and the improved hunting technology, how then was it possible that the caribou population was increasing with such force in the 1970s and the 1980s, in the presence of vastly greater numbers of aboriginal hunters with even better guns and transportation technology, including snowmobiles?

The fact of the matter is, caribou population increases and decreases are a scientific problem yet unresolved. The conventional biological view of caribou does not include population cycles simply because no one has a sufficiently long data set to study them. Ten-year cycles of snowshoe hares and lynx lend themselves to scientific analysis, but the multi-generational caribou cycle (if it is a cycle) does not.

Suffice to say that some ecologists think that the fluctuations of caribou numbers are the result of complex and interrelated processes, including the slow growth (50-100 year) of lichens, the winter food of caribou. If conditions are favorable, individual caribou are healthy and have extra energy reserves (fat); the reproduction rate is high and calf mortality low. Under such conditions, caribou numbers can build up quickly by exponential growth. By the time predator numbers catch up, the range may be overgrazed and the caribou not so healthy, resulting in a depression of caribou population to very low levels. Population remains depressed for a long time, before lichens slowly recover and conditions become favorable to caribou once more.

The effects of other factors such as hunting pressure, climate change and fires, can add complexity to this general pattern. For example, the effect of heavy hunting during the decline phase can knock down the population size even lower, while the same thing during the increase phase merely

dampens the fluctuation. Calf survival is an important factor and can be affected by weather (wind and temperature) as well as by predator mortality. Biologists do have an overall model of caribou population changes, based on population surveys, computer simulation studies, and knowledge of other cycling species. But the science of caribou is still uncertain. Many ecologists are reluctant to refer to caribou as a cycling species for the lack of hard data. Western science has simply not recorded a full cycle of increase -- decline -- increase.

Aboriginal Hunters and Traditional Knowledge of Caribou

By contrast, aboriginal hunting peoples of Alaska and Northern Canada have experienced many full cycles. For example, the Inuit who live to the north of the Cree above the treeline, believe that there is a natural population cycle in caribou (Milton Freeman, pers. comm.). To the Cree also, caribou population fluctuations are cyclical, but these are not predictable, periodic cycles. Cree elders' wisdom predicts the return of the caribou but says nothing about its timing, consistent with the Dene notion about the unpredictability of the ways of the caribou. To the Cree, caribou declines and increases are mysterious -- but only in part. They are partially explainable in terms of hunter-animal relationships. Declines are related to the ethical transgressions of hunters, as explained in the last Chapter. Whereas Elton's (1942) data come from biological science and from the records of missionaries and traders, the "data" of the Cree hunter come from culturally transmitted traditional knowledge, stories told by elders, and from the hunter's own day-to-day observations. The caribou are part of the living landscape shared by the Cree and other beings.

However, Cree caribou knowledge is not likely to be as rich as the Dene (Northern Athapascans) who occupy the broad swath of the subarctic from Manitoba to Alaska, and who are among the great experts of caribou. According to Smith (1978), the very social organization of the Dene groups of central Canadian subarctic can be explained in terms of adaptation to caribou movements. Rules regarding kinship and marriage favored the formation of social links across a broad front.

Hunting groups were strategically situated in a long narrow front (of some 1000 km), with relatively shallow depth, near the treeline, from a point west of Hudson Bay to Great Slave Lake... They were thus potentially in contact with all the constituent herds of the Kaminuriak, Beverly and Bathurst populations of caribou. The hunting groups may be viewed as strategically situated reconnaissance patrols for collecting information on caribou movements and intentions... Survival resulted from the spatial placement of regional and local bands and hunting groups, bound to one another by complex ties of kinship and marriage, which provided a communications network extending through those bands dependent on the caribou (Smith 1978, pp. 75, 83).

The spatial arrangement of the bands followed the transition zone from forest to tundra, making it possible for the hunters to exploit either zone. Local band centers were located at fishing lakes to provide a reliable food supply. Summer excursions to the north of the treeline kept the Dene well informed of caribou distributions. According to the archaeological record, this spatial arrangement had considerable time depth, allowing hunters to accumulate great many generations of data (Smith 1978). This reconnaissance system of the central subarctic Dene is unusual among traditional knowledge and management systems because of its ability to collect *synchronic* data (short time-series over a large area) as well as *diachronic* data (long time-series). It shows that under certain circumstances, synoptic systems of data collection characteristic of Western scientific systems, can also

develop among traditional peoples. It is the capability of collecting such traditional ecological knowledge that made the Dene the experts on the caribou.

By contrast, anthropologists and other Western scholars do not associate eastern James Bay Cree with caribou. Many of their neighbors, the Inuit of Northern Quebec and the Innu (Naskapi and Montagnais) of the eastern part of the Quebec-Labrador Peninsula, are all well known caribou specialists, although probably not to the same degree as some of the Dene groups. By contrast, the eastern James Bay Cree have seen and hunted the occasional small groups of caribou over the past century, but certainly not the great migrations of caribou. Thus, the notion of "Cree traditional knowledge of caribou" is at odds with the fact that most Chisasibi Cree had never seen a caribou until the 1980s. Caribou herds were last present in the area in the 1910s (Speck 1935, p. 81; Elton 1942). Records of the Hudson's Bay Company (HBC) from the 1600s to the 1800s indicate that caribou were periodically abundant in the area. It was one of the major food resources of the James Bay Cree in the area north of Eastmain, and a source of irritation to HBC traders because Cree hunters would periodically take off after the caribou instead of concentrating on trapping furs for the HBC (Francis and Morantz 1983, p. 7).

Hunting grounds of the Chisasibi Cree people are rich in caribou-related place names. Examples include Point Attiquane (Caribou Point) where caribou antlers from ancient hunts may still be found, and Maanikin Lake, *maanikin* being a caribou aggregating device, a corral. The official name of the lake on the map is Lake Darontal, near the much larger Lac Julian. Caribou-related expressions are found in Cree language as well. For example, a late spring snowfall is called *attiksthaw*, newborn-caribou-footprint-snow. Chisasibi hunting lore is likewise rich with caribou natural history. Examples include, "How do you tell the sex of animals in the herd you are following?" (From the shape of digging marks in snow, "feeding craters" to reach lichens; males and females dig differently.) "How do you tell if there is a really big bull in the group?" (His tracks in the snow would go wide around trees because the big bull takes care not to entangle his large antlers. This is important to know for safety reasons: caribou are not usually dangerous, but Cree hunters are wary of big bulls.)

A traditional winter caribou hunt was a communal affair, and targeted not individual animals but groups of caribou. A *maanikin* would be constructed with posts placed like a fence. The fence would get narrower and narrower and force the caribou into a single file. Snares would then be used to tangle up and stop them, and the animals would be dispatched with bows and arrows and spears. To lead the caribou into the corral, the ancient hunters used trees in the general shape of human figures, dotting the land to deflect caribou into the area toward the *maanikin*. The Cree technique is similar to the traditional practices of the Dene of the central subarctic. The Dene used what Smith (1978) calls "chute and pound", made of cut trees with a maze within the pound in which the caribou were caught in snares or speared. A variant was a drift fence that directed caribou along certain paths. The *inukshuk* of the Inuit, built of stone in the shape of human figures, served a similar purpose to the Cree and Dene drift fences, showing that these ethnically distinct groups shared certain traditional practices.

Caribou Return to the Land of the Chisasibi Cree

Chisasibi hunters saw their first large caribou hunt of this century in the winter of 1982/83. According to information from hunters, most of the kills occurred in the far eastern portion of the community hunting area, and amounted to some 100 animals. The following winter, large numbers of caribou appeared further west, in an area accessible by road. In fact, many were right on the road

serving a newly constructed hydroelectric dam in the eastern part of the community area. Hunters said "large numbers" were taken, probably several hundreds but the actual kill was unknown, and the hunt was a frenzied affair. The caribou stayed in the area only for a month or so. Chisasibi hunters used the road, bringing back truckloads of caribou. There was so much meat that, according to one hunter, "people overdosed on caribou" and some people even allowed meat to spoil.

People were excited about the return of the caribou. However, community leaders were concerned, not because of large numbers killed, but because some hunters had been shooting wildly, letting wounded animals get away, killing more than they could carry, wasting meat, not disposing of wastes properly. Chisasibi Cree hunters' code speaks strongly about wastage and calls for burning or burying of animal remains. The leaders were worried that hunters' attitude and behavior signaled a lack of respect for the caribou, a serious transgression of the traditional code in which ritual respect ensures that animals will continue to make themselves available. It is a system of mutual obligations: "show no respect and the game will retaliate".

In the following winter, 1984/85, there were almost no caribou on the road. Hunters in trucks waited and waited and many left empty-handed. Those who had the skills to go into the bush and hunt without causing disturbance nevertheless came back with reasonable kills. According to information from hunters, about 300 caribou were taken, only a fraction of the hunt in the previous year. Back in town, many people were now worried: Had the caribou decided not to come to the Chisasibi hunting grounds after all? The time was right for elders and leaders to do something about their concerns and to draw some lessons from the apparent reluctance of the caribou to come back.

A community meeting was called. Two of the most respected elders stepped forward. Among the Chisasibi Cree, there is no one traditional chief. The elected chief occupies a political position and may change from election to election. The real leadership is a corporate leadership provided by a group of senior hunters and respected elders, as represented in this case by the two elders who came forward. The elders did not voice their concerns and neither did they criticize the hunters who had been breaking the code of ethics. Instead they told a story. It was the story of the disappearance of the caribou shortly after the turn of the century. Caribou had been declining on the James Bay coast in the latter decades of the century but continued to be plentiful in the Caniapiscou area, near the center of the Labrador Peninsula. This was a great caribou hunting area and a culturally important region where neighboring groups mixed. The Cree of Chisasibi came from the southwest, the Cree of Mistassini came from the south, the Cree of Great Whale came from the northwest, the Naskapi and Montagnais (Innu) of Labrador came from the east, and the Inuit of Ungava Bay came from the north to hunt the great migrating herds of caribou as they crossed the Caniapiscou River.

It was here, in the 1910s, that a disaster occurred, the elders told. Hungry for caribou and equipped with repeating rifles which had just become widely available, previously respectful hunters became dizzy with new-found power over animals, lost all self-control and slaughtered the caribou at the crossing points on the Caniapiscou, in an area known as Limestone Falls. Instead of "taking care of the caribou", the hunters killed too many and wasted so much food that the river was polluted with rotten carcasses, the elders told, working up to the lesson of the story. The following year, the hunters waited and waited, and there was no caribou. None at all. The caribou had disappeared and they were not to be seen for generations.

The elders were now coming to the point of the teaching. The story they were telling was in fact familiar to most, if not all, of the hunters. The slaughter and the subsequent disappearance of the caribou were etched in the collective memory of Chisasibi Cree, and had become part of their oral

history. But the disappearance of the caribou was not permanent, the elders reminded the hunters. All changes occurred in cycles, and all was not lost. Subsequent to the disaster, the elders continued their story, the wise men had made a prediction: the caribou would once again become plentiful. The caribou would return one day, but the hunters had to take good care of them if the caribou were to stay. It was this prediction that the elders were now retelling, some 70 years later, in Chisasibi in the winter of 1984/85.

By all accounts, the elders' words had a profound effect on the younger hunters. The caribou had indeed come back, true to the old peoples' prediction, validating oral history. But, by violating traditional ethics, were they about to lose the caribou once again?

In the winter of 1985/86, the hunt was carried out very differently. It was a productive hunt and 867 caribou were taken, about two per household, according to the survey done by the Chisasibi Cree Trappers Association (CTA). The CTA had now taken on itself the responsibility to monitor the hunt. Overseen by the elders, hunting leaders and other hunters who make up the membership of the CTA, the hunt was conducted in a controlled and responsible manner, in accordance with traditional standards. There was little wastage, no wild shooting. The harvest was transported efficiently, and wastes from butchering were cleaned up promptly. The Cree exercised their self-management rights under the *James Bay Agreement* signed ten years previously. The Cree hunters devised the solutions themselves, and government resource managers were not even involved (Drolet et al. 1987).

The caribou kept coming. To the Cree it seemed that the caribou were responding to the restoration of proper hunting ethics and respect. They were moving much deeper into the Chisasibi area. Some of the largest numbers were seen halfway between the coast and the eastern limit of the Chisasibi community hunting area. Hunters were ecstatic. In the spring of 1986, caribou were seen right on the James Bay coast for the first time in living memory. Some hunters were passing up the chance to hunt the small, scattered groups of caribou near the coast, until the caribou re-established themselves; instead the hunters concentrated on the larger aggregations of caribou to the east. By 1990, hunters' observations of tracks showed that caribou had reached the sea all along the James Bay coast, re-establishing the former range of the 1900s. Their observations were consistent with the results of surveys carried out by government biologists.

Conclusions

No doubt the caribou will decline again some day, and the eternal cycle will continue. The story told in this chapter unfolded over a six-year period. I was not a participant in the development of the hunt and the re-design of the caribou management system, but merely a bystander and a witness who happened to be present at the right time and the right place. I was, after all, studying the Cree fishery, not wildlife management. But I was engaged in participatory research, living and eating with the people of Chisasibi, socializing in the community, going on fishing and hunting trips, and learning about traditional knowledge and practice by doing as well as listening.

Nevertheless, this chapter does not claim to provide a detailed analysis of the events around the caribou case. It merely tells a story, and suggests a likely way in which conservation ethic may have developed or changed on the basis of historical experience and social learning. As far as the Crees were concerned, the disappearance of the caribou in the 1910s was unambiguously linked to the last, big, wasteful hunt. The slaughter was not merely an aboriginal myth; it can be located in historical time through the records Elton (1942) used. The lesson of the transgression, once learned, survived for 70

years in Cree oral history, and it was revived precisely in time to re-design the hunting system when the caribou returned. Had there been government intervention to regulate the Chisasibi caribou hunt, it could not possibly have had as much impact on the hunters as did the teachings of the elders (Drolet et al. 1987). The lesson delivered (not to kill too many and not to waste) came right at the heels of the validation of the elders' prediction that the caribou would return one day, and it was too powerful to take lightly, even for the most skeptical young hunter.

The caribou story debunks the "noble savage" myth. The Cree hunter's actual behavior can and does deviate from the ideal and the ethical. However, self-control is a strong social value among the Cree (Preston 1979), and the community provides the support, and the necessary social coercion, to help the hunter remain ethical. The key role in this dynamic is played by the holders of the knowledge and the values -- the elders. Cree society relies on oral history, and the elders span the generations to provide information feedbacks. What makes elders "wise"? Certainly, not all old people have wisdom. In my opinion, the "wisdom" in the present case is in the elders' timing (they waited for a whole year after the transgression until people were likely to be receptive to their message), their choice of message (the well known story of the caribou overkill at Limestone Falls), and their effective use of myth (the ancient prophecy that the caribou will return).

The starting hypothesis in this Chapter was that a conservation ethic can develop if a resource is *important* or limiting, *predictable* and *depletable*, and if it is effectively under the *control* of the social group in question so that the group can reap the benefits of conservation. Choosing caribou as the example made the task challenging. The caribou are important, but the remaining prerequisites (predictability, depletability, control) for the development of a conservation ethic are not easily met. The caribou are certainly not predictable, but once they return, certain distributional and behavioral aspects of caribou become predictable, as discovered by the hunter who verifies for his own satisfaction that the caribou were in precisely the area where his grandfather said they were last seen. On the question of depletability, however, information is still missing until it is supplied by historical experience and social learning so there is now a compelling reason to limit harvests. Note that the Cree are not unusual in this regard (Nelson 1982). The Chipewyan (Dene) also did not have a prohibition against waste when caribou were abundant (Heffley 1981; Nelson 1982).

Finally, the question of control comes up explicitly in 1987/88 when there is a threat that the caribou resource will be opened up to uncontrolled numbers of outsiders. It is interesting to note that the Chisasibi Cree do not see other aboriginal groups as a problem; in fact, they are constantly exchanging information with them (Eastmain, Great Whale) to keep track of large-scale caribou movements. But sport hunters are not part of this network, and are not in the sphere of a conservation ethic that is recognizable to the Cree. Hence, starting in 1988, the Cree take political steps to safeguard "their" resources.

Consistent with the findings of other studies on large mammal management of Northern indigenous hunters (Winterhalder 1983; Feit 1987), the story in this chapter suggests that the Cree management system for caribou monitors much the same information base as does Western science -- geographic distributions, migration patterns and their change, individual behavior, sex and age composition of the herd, fat deposits in caribou, and the presence/absence and effect of predators. Of these indicators, the fat content of the caribou seems to receive relatively more attention by the Cree than by biologists.

This finding may be significant because there is evidence that other traditional peoples and their management systems may also be monitoring fat content. According to discussions in a September

1997 traditional knowledge workshop in Labrador, examples include the Inuit of Northern Quebec and Labrador, and the Innu of Labrador. It is commonly known by resource managers (Anne Gunn, pers. comm.) that indigenous hunters belonging to a number of different groups in the Northwest Territories of Canada also monitor caribou fat content. Nicholas Flanders (pers. comm.) reports that the recording of the fat content will be a major study method in a project in Alaska to integrate Inupiat traditional knowledge and Western science about the Western Arctic Caribou Herd. As a rule of thumb, the monitoring of fat content for caribou management makes a great deal of sense because it provides an index of health of both the individual animal and the herd. Fat as indicator of population health integrates the combined effects of a number of environmental factors, such as the condition of feeding range, acting on the caribou population. It is therefore not surprising that the monitoring of caribou fat content is not merely an area-specific bit of *local knowledge* but rather a *principle of traditional ecological knowledge* widely applicable across the full range of caribou distribution from Labrador to Alaska.

The Cree system has many similarities to the Western science of caribou management. But at the same time, it is fundamentally different from Western science which often gives priority to *quantitative* population models for management decision-making. The Cree system, by contrast, neither produces nor uses estimates of the population size. Rather, it uses a *qualitative* mental model which provides hunters with an indication of the *population trend over time*. This qualitative model reveals the *direction* (increasing/decreasing) in which the population is headed; it does not require the quantitative estimation of the population size itself for making management decisions.

Such traditional knowledge is complementary to Western scientific knowledge, and not a replacement for it. Monitoring fat content alone will not lead to good management decisions, for example, in the case of predator-limited (as opposed to range-limited) caribou populations, and in the case of a caribou population affected, say, by two or three successive bad winters (Anne Gunn, pers. comm.). On the other hand, exclusive reliance on biological population survey data will not lead to good management decisions either. There are several cases in the Canadian North and Alaska, with caribou and other wildlife, in which the results of biological censuses mislead management decisions, and were subsequently corrected by the use of other biological perspectives *and* traditional knowledge of indigenous groups (Freeman 1989, 1992). Such cases illustrate the complementarity of traditional and Western knowledge at a practical level, and highlight the need for conceptual pluralism in resource and ecosystem management.

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