CHAPTER 8

UNDERSTANDING & COMMUNICATING ABOUT ECOLOGICAL CHANGE:

DENESOLINE INDICATORS OF ECOSYSTEM HEALTH

Brenda Parlee (University of Manitoba)
Micheline Manseau (Parks Canada and University of Manitoba)
and *Lutsel K'e Dene First Nation*

INTRODUCTION AND BACKGROUND

Ecological indicators are used by many indigenous peoples to understand and communicate about ecological change (Berkes 1999; Berkes *et al.* 2000a). "They have been used for centuries to guide environmental and livelihood planning and action, long before scientific knowledge attempted to understand the processes of environmental change and development" (Mwesigye 1996, 74). Among the Cree and Inuit of western Hudson Bay, indicators are the voices of the earth that are always talking to us (Tarkiasuk 1997). For many Aboriginal peoples, physical and spiritual signs and signals that the land is healthy are very important to their own feelings of health and well-being and that of their communities. As described by a Cree man from Chissasibi, "If the land is not healthy, how can we be?" (Adelson 2000: 6).

Recent work on traditional knowledge and ecological indicators has focused on specific resource management issues such as agricultural land management, desertification, sustainability in mountain forests, and climate change (Mwesigye 1996; Berkes *et al.* 2000; Kofinas *et al.* 2002). In some cases, the research has provided direct insight into the links between environmental and human health. An emerging body of literature on First Nations health in Canada, for example, reveals how indicators of environmental decline correspond directly with many social and human health problems (Hambly 1997). While the most meaningful indicators may be those that are developed on a site-specific basis (Berkes *et al.* 2000b, 388), there are commonalities in the way indigenous peoples interpret changes in the health of their environment. For example, the percentage of body fat of birds, caribou, and other animals at harvest is one ecological

Patty Lockhart classifying fish from Stark lake, near Lutsel K'e, Northwest Territories. Photo by Jeanette Lockhart, Lutsel K'e Dene First Nation, 2002.

health indicator which appears to be common among many indigenous groups, including the Cree of northern Quebec (Berkes 1998, 8), the Gwich'in of Alaska (Kofinas *et al.* 2002), and the Maori of southern New Zealand (Lyver 2002). Many indigenous groups in circumpolar regions use similar indicators related to ice and weather conditions to communicate about complex changes associated with global warming (Riedlinger and Berkes 2001; Krupnik and Jolly 2001). As part of the key findings, these studies have provided insight into the sophisticated knowledge systems of local land-based cultures and their capacity to learn and adapt to ecological change.

This chapter focuses on ecological indicators developed by the *Denesoline* of Lutsel K'e Dene First Nation in the Northwest Territories to understand and communicate about changes in the health of their ecosystem or the "land"; this includes changes that have taken place over a long time period, at different geographic scales and change beyond natural variation. The study of these indicators also builds on previous arguments about the capacity of land-based cultures to learn and adapt to complex ecological change and the value of traditional knowledge in resource management (Berkes *et al.* 2000a).

THE *DENESOLINE* AND THEIR COMMUNITY

Lutsel K'e, formerly called Snowdrift, is a community of 377 Chipewyan Dene (*Denesoline*) located on the east arm of Great Slave Lake in the Northwest Territories. It is the most northerly Chipewyan-speaking Dene community, situated at the treeline (62°24′ N / 110°44′ W). Like many other northern Dene communities, Lutsel K'e has experienced significant social and economic change over the last fifty years. Traditionally the *Denesoline* were known as the most widely travelled of the Athapaskan peoples, inhabiting a vast area from Great Slave Lake east to Hudson Bay and from the mouth of the Coppermine River near the Arctic Circle to Wallaston Lake in present day Saskatchewan (Smith 1981, 271). Although the *Denesoline* now live in a more permanent settlement on Great Slave Lake, they still retain many aspects of their traditional harvesting economy, frequently travelling in an area of over 500 square kilometres from present day Yellowknife east to the Thelon River and from Aylmer Lake to Nanacho Lake in the south. Of particular significance is the Lockhart River; its headwaters flow southeast from MacKay Lake to Artillery Lake and then to Great Slave Lake (Figure 7.1). Straddling the border between the boreal forest and the tundra, the Lockhart River and Artillery Lake area is a rich ecosystem hosting a diversity of wildlife, vegetation, and landscape features representative of six different terrestrial eco-regions (Northwest Territories Centre For Remote Sensing 1998, March 13). Negotiations are underway between Lutsel K'e Dene First Nation and the federal government to protect this area as a National Park.

DEFINING ECOLOGICAL INDICATORS

Denesoline knowledge of this ecosystem was documented during the *Preliminary Traditional Knowledge Study in the Gahcho Kué Study Region* and *The Traditional Ecological Knowledge in the Kaché Kué Study Region* (Parlee *et al.* 2001). These projects were carried out in collaboration with Lutsel K'e Dene First Nation Chief and Council, the Wildlife, Lands and Environment Committee, and an Elders' Committee. *Denesoline* elders from Lutsel K'e defined the Artillery Lake and Lockhart River as the area of interest during project scoping in 1996 and again in 1999 (Parlee *et al.* 2001; Bielawski and Lutsel K'e Dene First Nation 1992). On the recommendation of the elders being interviewed, the identification of the indicators followed the *Denesoline* harvest calendar, beginning with waterfowl in early spring (May) followed by fish (June-August), caribou (August-October), and fur-bearing animals (December-February).

Community researchers were the primary information gatherers for both projects. Additional support was attained from an academic advisory committee. The community-based research effort for these projects was involved and substantial. Data collection occurred through individual and small group semi-directed interviews with twenty-seven to fifty *Denesoline* elders and harvesters. Most interviews were audio and/or video recorded by community researchers using translators during on-the-land workshops with elders and caribou harvesters. Data were also collected on 1:250,000 and 1:50,000 scale maps and integrated into the community geographic information system. Stories shared during small group interviews and elders' meetings were also recorded through minutes.

RESULTS

Over many generations, the *Denesoline* have developed a significant body of knowledge about the Lockhart River and Artillery Lake

area. Much of this knowledge has accumulated through traditional harvesting practices, including hunting, trapping, and the gathering of berries and plants for food and medicine. Over 112 species of birds, wildlife, fish, and habitats were named and defined in Chipewyan, and ecological indicators were documented for those species most commonly harvested.

Barren ground caribou (*Rangifer tarandus groenlandicus*) is the most important source of traditional food for the Lutsel K'e Dene; the movements of the Bathurst and Beverly caribou herd have been recognized as a key driver of their traditional land use patterns and social organization (Irioto 1981; Jarvenpa and Brumbach 1988). In spring and fall, the *Denesoline* also include several species of geese and ducks as part of their diet; northern pintail (*Anas acuta*), scaup (*Aythya* spp.), and white winged scoter (*Melanitta fusca*). Lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), round whitefish (*Prosppium cylindraceum*), and lake herring (*Coregonus artedi*) are also an important part of the diet in summer months, as are many berries and plants, including cranberries (*Vaccinium vitis-idaea*), blueberries (*Vaccinium uliginosum*), Labrador tea (*Ledum groenlandicum*), and spruce gum (*Picea glauca, P. mariana*). During the winter trapping season, wolverine, wolf, and fox are also harvested in the region. The indicators, or signs and signals, used by the *Denesoline* to understand and communicate about change in the health of these species revolve around four major themes: body condition (Table 8.1), species abundance and distribution (Table 8.2), quality of land and water (Table 8.3), and *Denesoline* cultural landscapes and land features (Table 8.4).

Indicators can be defined and presented in many different ways (Meadows 1998); the indicators presented here are purposely framed as questions in terms that have meaning in the community of Lutsel K'e. Framed as questions, they become more than tools for describing ecological change; they become tools for ongoing learning and communication with the elders and harvesters that hold and have ownership of this knowledge.

Body Condition

The percentage of body fat is an indicator commonly used by *Denesoline* to interpret and communicate about the health of waterfowl, fish, caribou, and fur-bearing animals; if the animal is fat then the hunter is happy (JBR 10 15 98). In a caribou workshop in 1999, elder J.B. Rabesca described how a fat caribou could be identified by a wide chest, tail hidden in hindquarter, busy set of antlers, and a well-developed coat (JBR 10 15 98). Wildlife behaviour can also be an important sign of good body condition; if the caribou is jittery it is a signal to hunters that the animal is young and the meat more tender (JBR 10 15 98). Hunters can tell if the birds are fat by their behaviour during flight; fatter birds will fly lower over the water and are slower and clumsier when taking off or landing. Harvesters evaluate the length/weight ratio of fish to determine if they are fat; if the fish is expected to be fat but is found skinny, it is considered "sick" (Parlee *et al.* 2001).

Table 8.1
***DENESOLINE* INDICATORS OF BODY CONDITION**

Size / shape	• Is the animal of normal size and shape? • Is the weight in proportion with the length of the fish? • Are there any deformities?
Fat	• Is the animal fat? Are they skinny? • Is there some fat around their organs?
Clean Organs	• Are there cuts, marks or parasites (white spots, dark spots) in their stomach, on their liver or other organs?
Colour / Texture and Taste of Fish Flesh	• Is the flesh firm or soft? • Is the flesh tasty? Does it taste like stagnant water? • Is the trout flesh red? • Is the whitefish flesh a good white or is it brownish / greyish?

Table 8.2
***DENESOLINE* INDICATORS OF SPECIES ABUNDANCE, DISTRIBUTION AND DIVERSITY**

Animal Population	• Are there abundant fish and wildlife of all kinds? Are there abundant fish and wildlife valued as traditional food? Have the population of these species changed from the past? Have people seen some species of fish or wildlife that are uncommon or have never been seen before? Are there some fish that you don't see anymore?

Table 8.3
***DENESOLINE* INDICATORS OF LAND AND WATER QUALITY**

Land	• Does the land (in this place) look and smell clean? • Has there been garbage left? • Is the ground or vegetation disturbed? • Have there been any machines or vehicles there? Were there any spills or leaks of fuel or other dangerous material?
Water Levels	• Does the water look higher or lower than normal? • Are there any small streams, creeks that have dried up? • Is travel more difficult in some areas as a result of lower water levels? • Has there been damage to boats and motors as a result of hitting the bottom? • Are there portages that were very good in the past but are now too wide or long?
Water Quality	• Are there some areas where the water is no longer good to drink and the fish good to eat? • Is your drinking water tasty? Does it turn black in tea? • Are you worried about contaminants in the water? • Are you worried about the chlorine in the water?

Table 8.4
***DENESOLINE* INDICATORS RELATED TO CULTURAL LANDSCAPES AND LAND FEATURES**

Dechen Nene *forested areas south of the treeline dry flatland/wet Marshy Land*	• Is the animal of normal size and shape? • Is the weight in proportion with the length of the fish? • Are there any deformities?
Hazu Kampa *at the treeline*	• Are the animals fat? Are they skinny? • Is there some fat around their organs?
Hazu Nene *Barrenlands*	• Are there cuts, marks or parasites (white spots, dark spots) in their stomach, on their liver or other organs?
Eda *Caribou Crossing*	• Is the flesh firm or soft? • Is the flesh tasty? Does it taste like stagnant water? • Is the trout flesh red? • Is the whitefish flesh a good white or is it brownish / greyish?
Ts'u dzaii / Ts'u dza aze *Small Stands of Trees at the Treeline and in the Barrenlands*	• Were there ever or are there now hunting or trapping camps in this place? • Was this place ever used for shelter? • Is there drywood available for fuel? • Is there clean water nearby? • Is there green wood available for tent poles?
K'a *Heights of Land with Erratics*	• Was this area ever used as a hunting blind for caribou?
Thai t'ath *Eskers*	• Were there ever or are there now hunting or trapping camps in this place? • Was this area ever used for shelter? • Are there any wolf, fox or bear dens?
Nikele *Dry Flatland*	• Are there cranberries growing in this area? • Are there other berries or plants growing here that might be used for traditional medicine?
Ni horelghas nene *Wet Hummocky Land*	• Are there blueberries, cloudberries or cranberries growing in this area? • Are there other berries or plants growing here that might be used for traditional medicine?

The outward appearance, including well-developed plumage, scales or coat, also indicate whether the bird, fish, or animal is healthy. Any internal injury or disease such as broken limbs, lesions, parasites, poor colour, or smell is often a sign to hunters that the animal is unhealthy. The texture as well as the colour of the fish flesh is also important; if the flesh is too soft, for example, the fish are described as "spoiled." In some cases injuries or diseases are also signals that something is wrong locally or in the broader ecosystem as in the case fish in Nanacho Lake and Stark Lake (PM 04 20 00). For example, caribou arriving from their fall migration with shorn or broken legs are signs to elders that development activities in the region, including roads and other structures, may be negatively affecting caribou.

Wildlife Abundance, Distribution and Diversity

Indicators of species abundance, distribution, and diversity are also used by the *Denesoline* to understand and communicate about ecological health (Parlee *et al.* 2001). The abundance of caribou is particularly significant. Elders nostalgically describe periods when caribou were more abundant – "there were so many caribou, it would just feel like the ground was moving" (HC 02 02 00). They also describe periods when there were very few caribou and people were very hungry (AM 06 11 97). Today, there is still tremendous joy associated with the return of the caribou and fear associated with a population decline (JBR 09 15 99). The abundance of wolves and foxes is also a sign that the land is healthy and can also signal hunters of caribou in the area. Trappers are particularly happy when animals are abundant for social and economic reasons; as with other harvesting activities, species abundance increases opportunities and success of harvesting.

Species abundance is an indicator of ecological health strongly associated with respect. If people do not respect the animals then they will not come back, give themselves, or return to the people. For example, chasing caribou is forbidden. Hunters are also careful not to be arrogant toward the ducks and geese or play with (catch and release) the fish (JBR 09 15 99; EC 06 29 99).

The *Denesoline* associate the abundance of each species with different places in the Artillery Lake/Lockhart River area. If large numbers of birds are using the same staging areas and migration routes each year, it is a sign that the birds and the land are healthy. Changes in the range and habitat of different species are often signs to elders that something has changed in the region. For example, recent increases in the number of bears around the community and moose along the treeline in the Artillery Lake area have caused anxiety and confusion. To some elders it is a sign of habitat disturbance or loss in their region and to the south (JC 01 15 01; PC 01 15 01).

Characteristics and Quality of the Land and Water

Indicators related to wildlife habitat largely revolve around the cleanliness of the land and water as the base of the food chain. The cleanliness of the water is of particular concern (PC 01 29 01; ML 09 15 99).

That the land and water is free of visible signs of waste is particularly important; leaving garbage is a significant sign of disrespect in *Denesoline* culture. Many *Denesoline* are even more concerned about the waste on the land and in the water that they cannot see, including long-range pollutants (POPs), leaks and spills from vehicles and equipment, and bacteria and disease originating from remote locations. While most people feel that their land and water is generally very clean, there is concern about certain areas where development has taken place in the past or may occur in the future. Of particular concern is

the quality of drinking water from lakes and rivers. Elders often highlight the increased levels of mercury in the Talston River and Nanacho Lake caused by a 1960s hydroelectric project and the perceived contamination of Stark Lake as a result of uranium exploration in the 1950s. The current and potential effects of diamond mining activity on the health of the land and water are also a concern. One elder talking about mining in the region remarked, "soon we won't even be able to drink our water from our own lake" (PM 04 02 00 in Parlee *et al.* 2001).

Denesoline Cultural Landscapes and Land Features

Signs and signals of ecological changes can also revolve around specific places or areas of the landscape commonly used by the *Denesoline*. Places such as *eda cho* "big caribou crossing," "*desnethch'e* "where the water flows out" and *des delghai* "white water river" also refer to specific areas of ecological as well as social significance. In addition to the information they provide about the biophysical landscape, they inform us of the ecosystem as a whole and the role of the *Denesoline* within the system.

For example, the *Denesoline* associate the fall migration of the caribou with key water crossings or bifurcation points on the caribou range. Caribou movements through these crossings are signals of where and when to look for caribou during the winter months. A large number of caribou crossing at *eda cho* at Artillery Lake, for example, is a signal that the herd is likely to over-winter in the eastern part of their range. Their use of crossings from McKay to Benjamin Lake indicate the winter grounds may be further to the west. Another useful land feature are the *ts'u aze di a si* or the small stands of black spruce (krummolhz) and willow found in the valleys and along rivers on the barrens. Given the scarcity of shelter and firewood on those open landscapes, these clumps of dwarf trees are valuable, particularly during winter. Hunters also use them as campsites and meeting places to exchange information about caribou movements, numbers, and behaviour (Parlee *et al.* 2001).

Some place names reflect on the *Denesoline* culture and spirituality. One of the most important cultural and spiritual sites is *tsankui theda*, or the "old lady of the falls," located on the Lockhart River; the *Denesoline* visit the site every year to seek spiritual guidance and direction. Other sacred sites in the Artillery Lake area include Beaver Dam and Hachoghe's Shovel; the significance and origins of the landscape features are also explained in *Denesoline* legends that have been passed on through oral histories.

These place names reflect these many different social, cultural, spiritual, and ecological values as an integrated whole. *Kahdele*, for example, is more than a physical descriptor for "areas of open water in winter"; the *Denesoline* have named, used, and recognized these places for thousands of years as critical for their own well-being as well as that of many wildlife species (Parlee *et al.* 2001). Early or permanent open water on rivers, lakes, and estuaries or *askui* is valued similarly among the Innu of Labrador (Innu Nation 2001). Birds depend on those areas to feed in spring, when returning from migration. Fish benefit from the high primary productivity of these areas. Fur-bearing animals depend on the abundance of food around those areas of open water at key times of the year when prey become scarce. The potential loss of those areas of open water means more than a change in the ice or freezing pattern; it relates to changes of an entire ecosystem.

DISCUSSION

The indicators developed by the *Denesoline* have enabled them to understand and communicate about complex changes in their environment for many generations. They reflect or capture different aspects of ecological health, and they provide us with insight into the quality and condition of species of key importance to the *Denesoline*. Furthermore, the indicators also reflect on the interconnections between individual species and the "land." Similar to the concept of ecosystem, the "land," or *nene* in the Chipewyan language, reflects on all aspects of the physical as an integrated whole; the Chipewyan concept also perceives a spiritual dimension. The *Denesoline* conceptualization of the land is also based on the understanding that human beings and the environment are interconnected. An undisturbed and productive tundra landscape lends itself to a stronger and healthier caribou population; clean water is critical for healthy populations of whitefish and trout and sustainable harvesting of these species is the foundation of sustainable and healthy communities.

The indicators themselves are not necessarily different from those already in use by NGOs and in government programs such as the Arctic Borderlands Knowledge Coop, EMAN North and the Department of Fisheries and Oceans (see the DVD at the back of this volume). More important, perhaps, than their technical character, these indicators are cultural symbols that reflect how the *Denesoline* see, hear, and feel about change in their environment. In addition to marking and measuring ecological change as part of their oral history, the *Denesoline*, like other land-based peoples, have experienced those changes, their sensitivity heightened by their dependence on resources for survival. As explained by one *Denesoline* elder: "Some people who don't care so much won't notice the changes" (ML 05 11 00).

Diachronic Indicators: Reflecting Change over a Long Time Period

Denesoline legends, as well as archaeological evidence, provide clues as to the longevity of their knowledge system, including their indicators of ecosystem health. For example, *Denesoline* knowledge of caribou movements around Artillery Lake is likely five thousand years old. Elders say this area has always been good for caribou; stone lanceolates (arrowheads used for killing caribou) found in that area have been dated back to 3000 BCE (Macneish 1951; Noble 1981). Some *Denesoline* legends, including "the Old Lady of the Falls" and "How the Bear who Stole the Sun," suggest that *Denesoline* knowledge of this area may date back to the post-glacial period.

> After the world was created, things were not always the same. There were ups and downs. One time, the sun disappeared. After the sun was gone, it was only winter and there was lots of snow falling. There was no sun and that is how people stayed. (Excerpt from ZC in Parlee *et al.* 2001)

> All of the other Dene people followed Hachoghe who was chasing another beaver down the river. They were heading toward the east arm of Tue Nedhe. After a while, the people noticed that the woman was still back at the falls. So Hachoghe picked two healthy people to go back and look for her. They went all the way back up the Lockhart River and they found her sitting at the falls. She had been sitting there a long time and so she was stuck in the earth. The two people told her that Hachoghe was asking for her to return to Tue Nedhe. She said, "I cannot return with you. I have been sitting here too long and now I will be here for all eternity." (Excerpt from ZC in Parlee *et al.* 2001)

The exact time period in which these legends originated is not clear; the connection between such narratives and signs and signals used today to understand ecological change is not always obvious. Both legends describe significant ecological events: glaciation and changing patterns of water drainage. Other Dene legends with similar geomorphological references have been dated to about 8000 BCE (Hanks 1997, 182).

Stories about the importance of respecting animals and about the behaviour of men and women are told more as cautionary tales with very human characters. This might suggest that these stories originated more recently, or within the past several generations. Other knowledge and experience with ecological change, such as the changes that occurred as a result of the Talston hydroelectric project and the Stark Lake uranium mine (1950s–60s) developed in the very recent past.

While the oral history about events that occurred a thousand years ago are clearly less detailed than information generated in the recent past, it is useful to consider how information about critical events has been retained through time and how this information is integrated as a whole over time. The strength of *Denesoline* traditional knowledge is not in accumulating objective empirical observations or "data" about isolated events that can be compared a thousand years from now. The strength is arguably in the capacity of the *Denesoline* to interpret and use their empirical observations day after day, year after year, and decade after decade. The test, of course, is survival; for without accurate knowledge of their environment, they would have succumbed to the harsh Subarctic environment.

Scaling-Up of Denesoline Knowledge

Indicators presented here reflect an understanding of ecosystem health around the Lockhart River and Artillery Lake. However, *Denesoline* knowledge was not limited to this geographic area; the large-scale movements of the Bathurst caribou herd meant that the *Denesoline* travelled, observed, and communicated observations over large areas.

Most *Denesoline* knowledge of caribou and caribou movements reflect their vantage point on the fall and winter range of the herd. The elders' characterization of the migration cycle begins when the caribou return to the Lockhart River/Artillery Lake region in the fall and ends when the caribou leave the area in March. In contrast, Inuit elders from the Bathurst Inlet area describe the migration from the spring and summer range of the herd (Thorpe *et al.* 2001).

Effective harvesting of the caribou required an understanding of caribou movements beyond the Lockhart River/Artillery Lake area. As a result, the *Denesoline* hunting parties were known to share information about caribou movements with one another to maximize the opportunities for harvesting. Such extensive social networking was made possible in part because of the *Denesoline* predilection for widespread travel; they are recognized as the most well travelled of all the Athapaskan peoples (Smith 1981). Successful interpretation and communication about ecological events or processes that would affect their movement on the land, such as changes in water levels, ice conditions, weather patterns, or grizzly sightings would also been key to successful hunts.

Traditionally, this scaling up of knowledge was important for successful harvesting; increasingly, there are other issues that make knowledge networking important.

In the western Hudson Bay region, for example, Inuit and Cree observations of weather and sea ice conditions were linked together to provide a regional picture of climate change (McDonald *et al.* 1997). The Arctic Borderlands Knowledge Coop provides a forum for communities in the Porcupine Caribou range to share their observations and experiences around such issues as non-renewable resource development and climate change (*www.taiga.net*). A circumpolar project, 'Rangifer,' aims to pull together local knowledge with respect to caribou (*www.rangifer.com*). In all these examples, a composite picture of regional ecological change is drawn from the local observations and the knowledge of local communities.

Recognizing Change beyond Natural Variation

While these indicators of health provide a general picture of how the *Denesoline* understand and communicate about the land, they are by no means employed uniformly; they are applied using traditional knowledge of natural variation. Based on continued interactions with the land and communication over the generations, the *Denesoline* are in a favourable position to determine whether changes are related to natural variation or anthropogenic activities (McDonald *et al.* 1997). For example, female caribou arriving at the treeline in early fall are

much skinnier and rougher in appearance than later in the fall because they have been nursing their calves; harvesters do not consider these animals to be unhealthy. Fish in some barren land lakes are softer and skinnier than in lakes along the treeline; however, harvesters interpret this as "normal." Other examples of this natural variation relate to the abundance and diversity of waterfowl and fish. The population of fish in the east arm of Great Slave Lake is perceived as good or greater than in the past (EC 06 29 99). However, according to the elders, the abundance and diversity of waterfowl has declined. There used to be many more ducks and geese in the past compared to today (AM 04 20 00). They suggest that the population of black ducks or white-winged scoter (*Melanitta fusca*) is much lower today than it was in the past.

The capacity to understand and communicate about change beyond natural variation is expressed in the following way: elders distinguish between natural change as *edo* and change that is perceived as unnatural – *edo aja* – which translates directly as "something has happened to it"; what is considered unnatural disturbance is generally a disturbance that the community perceives as interrupting or interfering with recognized ecological patterns relationships or cycles. Many of the interferences described as *edo aja* are anthropogenic; the environmental effects of mining, hydroelectric development and long-range contaminants are all perceived as unnatural. Ecological events or changes that have not been documented within the social memory of the community are also described in terms of *edo aja*. For example, decreasing water levels in the region are described here by elder Maurice Lockhart:

> We have been losing water but I don't know why. All the small lakes [ponds] on the barrenlands are disappearing as well as the small streams and creeks that flow between them. That is why the water is no longer healthy to drink. (ML 08 28 00)

Other elders observing erratic weather events, including unseasonably warm weather and unpredictable winds and storms, attribute the change to global warming.

> The climate is changing. The wind blows harder than it did in the past. Its different – the wind picks up quickly and changes quickly. Now I don't know what has happened.… A long time ago my sister and I traveled on the Snowdrift River to Siltaza Lake. We never saw any rocks along that river but today you can see lots of rocks [the river is shallow]. (ND 05 11 00)

Of particular concern is the increased incidence of lightning storms and forest fires in the region. Elders have said that until recently (the last five years) they had never seen a forest fire caused by lightning. (PM 11 06 00)

> Regarding the forest fires – some scientists say it's good for new growth. But do you know what the caribou eat? If the lichen burns, it will take over 100 years for the plants to grow back. Some scientists say the forest fires are good, but it's not like that for us. We look after the land and we respect the land and the animals. (PM 11 06 00)

This capacity to differentiate between natural and unnatural change in their local environment is key to understanding a variety of resource management problems. One major problem exists in the Nanula Tue area. In the 1960s, a hydroelectric dam developed on the Talston River, flooded Nanula Tue, which was once an important fishing and trapping area as well important habitat for overwintering for caribou. As a result of this activity, the Lutsel K'e Dene are no longer able to fish, trap, or hunt in that area, and winter travel through that area has become dangerous (Bielawski and Lutsel K'e Dene First Nation 1992). Some of the problems that are now visible are described here by elder Pierre Marlowe.

> Long ago at Nanula Tue, before they built the dam there were good fish – just like Great Slave Lake fish. Now they have a dam on the Talston River and the fish are different. I remember before they built the dam, I trapped around there.… When the dam was built there – there were lots of changes. You can't eat the fish now because it's soft and skinny. (PM 1999)

Another such problem exists in a nearby lake, once a key fishing area for *Denesoline* hunters. In 1952, however, exploration for uranium in the area resulted in the development of a small mining operation on a peninsula of land in the lake. Today the elders recount their concerns about the water and the fish being spoiled as a result of this uranium exploration.

> The fish in Stark Lake are a problem. Since the mine [uranium exploration site] was put there … the fish are different – the water too. In another ten years, maybe we won't be able to drink the water from our own lake. There are lots of elders who have passed away from cancer already because of it. (PM 04 20 00)

These changes not only have implications for the long-term health of the biophysical environment; they also have profound effects on the health of the community. People worry about what will happen to the land and their children in the future. As in other communities that depend significantly on the land and resources for their livelihood, these unnatural changes are the cause of significant anxiety.

> People living directly from the land and water around them are acutely aware of indications that things are right or wrong with the natural world.… Unnatural disruptions – for example river impoundment and regulation, or environmental contamination – are profoundly disturbing and give rise to deep seated anxiety and insecurity. (Usher *et al.* 1992, 114)

Jonas Catholique and J.B. Rabesca share their knowledge on the north shore of Great Slave Lake, NWT. Photo by Jeanette Lockhart, Lutsel K'e Dene First Nation, 2002.

As Usher *et al.* (1992) point out, the traditional economy is grounded in peoples' sense of security about their ability to access an abundant natural resource base. If the security of that resource base or their access to it is compromised, or is threatened, so too is the community. Bielawski (1992), in her work on the impacts of the Talston River hydroelectric development, suggested that the greatest impact was the frustration over their inability to prevent the damage that occurred, as much as it was the impact of the damage itself.

Communicating about Ecological Change

Where indicators have meaning within a community, they can also be vehicles of cultural continuity. Such symbolic indicators are sometimes described as "community indicators" because of their meaning to a specific community or people, or "beloved indicators" (Meadows 1998). At a very basic level these indicators are cultural symbols that help convey or tell others about a given experience or observation.

The symbolic value associated with the indicators developed by the *Denesoline* is visible in their cultural narratives. For example, the importance of the Artillery Lake as a caribou crossing is well defined in stories passed on by *Denesoline* elders. Other stories describe changing water levels in different lakes or rivers (ND 05 11 00), common migration routes for ducks and geese, and dangerous areas for travel in winter. Stories about the impacts of the Talston River hydroelectric project or the Stark Lake uranium exploration site are also told and retold to ensure that current and future generations are aware of the dangers of harvesting in those areas. In some cases, stories or words are not necessary to share information. For example, information about the fatness of ducks can be conveyed through the smells and sounds of meat cooking over an open camp fire. Traditionally, hunters could gain insight about the movements of caribou across their fall range by the numbers of animals harvested at different fall camps. Insights about the abundance of fish in a given location could be gained by observing family stores of dry-fish.

Learning and Adapting to Ecological Change

Historically, the capacity of the *Denesoline* to use these indicators to learn and adapt to their changing environment has been critical to their survival. Empirical observation over a long time period is the foundation of that capacity to learn and adapt. Such observations revolve around a diversity of indicators and measures as described in this chapter. Some indicators may be quantitative, as in the abundance of caribou or whitefish, or based on qualitative perception. In Lutsel K'e, *Denesoline* hunters used the information about movements and abundance of caribou and other wildlife to make decisions about where and when to hunt in order to feed their families. They watched signs of changing weather and ice conditions to ensure safe travel while trapping for furs in the barrens. Careful inspection of the condition of animals being harvested was important in preventing illness. However, empirical observation is only the first stage of knowledge generation (Berkes 1999; Roots 1998). Critical to a discussion on the role of TK in resource management is the recognition of how observation becomes knowledge and wisdom in Aboriginal culture. Observations of one hunter or elder in a community cannot necessarily be construed as traditional knowledge; it is only after these observations are verified and interpreted along with other observations from the past and present that it may be considered to be knowledge. Traditionally, this verification and interpretation would have occurred informally through family groups. Today, elders' committees and harvester councils often fulfil that role.

The capacity of the *Denesoline* to successfully adapt to their changing environment may be based on the horizontal or non-hierarchical nature of their traditional social order (Smith 1981). Although there were some important and wise elders who exerted influence over large numbers of people from time to time, decisions about how to work together, where and when to hunt, trap, and fish were fundamentally made by individuals within small family groups. The size of camps would increase or decrease depending on the size of the family and social need as well as on the work involved in harvesting. For example, the groups associated with caribou harvesting were traditionally larger than those associated with duck hunting or fishing because of the uncertainty associated with finding caribou in the vast geography of the fall and winter range.

This non-hierarchical social order still influences how decisions are made today, including how the *Denesoline* deal with ecological change. In the case of diamond mining activity, for example, individuals representing different family groups seek to be involved at all levels of planning and management of these projects, from the act of observation and monitoring to data interpretation

and analysis, site management, and policy making. Although these roles and tasks are framed very hierarchically in a government or industry setting, for the *Denesoline*, they cannot be separated from one another. This is illustrated in the following quote from J.B. Rabseca, who, in one short statement, shares his empirical observations, hypotheses about potential effects, and recommendations for managing and mitigating those effects

> I have seen the caribou around that place [the mine]. I am concerned that if the caribou start eating the food around the mine area. Anything that spills on the ground is taken up by the plants. There is muskeg in that area too. The spills will stay in that area. Someone said that they would put up a fence in that area but they haven't done anything yet. If they put a fence in that area – we wouldn't worry about the caribou. It's not good to have caribou in the mining area. (JBR 02 14 01)

This integrated approach demonstrated by the *Denesoline* can be a guide to building an integrated resource management approach in which land users play a fundamental role, not simply as technical assistants or stakeholders, but as decision makers with a well developed understanding of complex ecological change.

CONCLUSION

> The report that has been put together is about our culture and our way of life. The documents show how we see things.… It tells what we understand about the animals and how they behave and how we live on the land.… We are not playing around. It is not a game. What we are talking about it is very serious.… (ZC 28 06 00 MT)

The health of northern ecosystems is changing at an alarming rate; "the earth is moving faster now" (Krupnik and Jolly 2001). The current and potential effects of non-renewable resource development, the presence of POPs and other contaminants in the food chain, and the impact of climate change are causes of significant anxiety for the *Denesoline* and others who have lived off the land for many generations. Addressing these issues of ecosystem health is complex; "environmental change does not lend itself to analysis by conventional approaches" (Berkes and Folke 2002, 336). In addition to addressing tough biophysical questions, there are many complex social, economic, and cultural implications to consider. This human dimension of ecosystem change is often overlooked; the debate over climate change is one example (Riedlinger and Berkes 2001).

The indicators presented here provide useful insight into some of the complex ecological changes being observed and experienced by northern communities, however, indicators are not an end result; they are only a window into what remains a relatively untapped system of local and traditional knowledge about our changing environment.

ACKNOWLEDGMENTS

This chapter is dedicated to the community members of Lustel K'e Dene First Nation whose knowledge, generosity, and commitment have made this work possible. Particular thanks to the Band Council, Wildlife Lands and Environment Committee, Florence Catholique, Evelyn Marlowe, Wally Desjarlais, Marcel Basil, Terri Enzoe, Nancy Drybones, Bertha Catholique, Archie Catholique, Lawrence Catholique, Charlie Catholique, August Enzoe, JB Rabesca, Albert Boucher, Jeanette Lockhart, Shawn Catholique, Stan Desjarlais, and James Marlowe. Funding for the research was provided by the West Kitikmeot Slave Study Society. Additional thanks to Dr. Fikret Berkes and the University of Manitoba for their support.

REFERENCES

Adelson, N. 2000. *Being Alive Well: Health and Politics of Cree Well-being*. Toronto: University of Toronto Press.

Berkes, F. 1998. Do Resource Users Learn from Management Disasters? Indigenous Management and Social Learning in James Bay. Paper read at Crossing Boundaries – 7th Annual Conference of the International Association for the Study of Common Property, at Vancouver, British Columbia.

———. 1999. *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Philadelphia: Taylor and Francis.

———, and C. Folke. 2002. "Back to the future: Ecosystem dynamics and local knowledge." In *Panarchy: Understanding Transformations in Human and Natural Systems*, edited by C. S. Holling. Washington, DC: Island Press.

———, J. Colding, and C. Folke. 2000a. "Rediscovery of traditional ecological knowledge as adaptive management." *Ecological Applications* 10: 1251–62.

———, J. S. Gardner, and J. Sinclair. 2000b. "Comparative aspects of mountain land resources management and sustainability: Case studies from India and Canada." *International Journal of Sustainable Development and World Ecology* 7: 375–90.

Bielawski, E., and Lutsel K'e Dene First Nation. 1992. The Desecration of Nanula Tue: Impact of the Talston Hydro Electric Project on the Dene Soline. Ottawa: Royal Commission on Aboriginal Peoples.

Hambly, H. 1997. *Grassroots Indicators for Sustainable Development*. Vol. 23:1, *Grassroots Indicator Project*: International Development Research Centre. *http://www.idrc.ca/books/reports/V231/susdev.html*

Hanks, C.C. 1997. "Ancient knowledge of ancient sites: Tracing Dene identity from the late Pleistocene and Holocene." In *At a crossroads: Archaeology and First Peoples in Canada*, edited by T. D. Andrews. Burnaby, BC: Archaeology Press.

Innu Nation. 2001. The Askui Project Symposium. Paper read at Knowledge, Culture and the Innu Landscape: A multidisciplinary symposium, at Halifax, NS.

Irioto, T. 1981. "The Chipewyan caribou hunting system." *Arctic Anthropology* 18(1): 44–56.

Jarvenpa, R., and H. J. Brumbach. 1988. "Socio-spatial organization and decision-making processes, observations from the Chipewyan." *American Anthropology* 90(3): 598–615.

Kofinas, G., Aklavik, Arctic Village, Old Crow, and Fort McPherson. 2002. "Community Contributions to Ecological Monitoring." In *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*, edited by I. Krupnik and D. Jolly. Fairbanks, AK: ARCUS.
Krupnik, I., and D. Jolly. 2001. *The earth is moving faster now: indigenous observations of arctic environmental change*. Fairbanks, AK: ARCUS.
Lyver, P. 2002. "Use of traditional knowledge by Rakiura Maori to guide sooty shearwater harvests." *Wildlife Society Bulletin* 30(1): 29–40.
Macneish, R. S. 1951. An Archaeological Reconnaissance in the Northwest Territories. *Annual Report for 1949–50. National Museum of Canada Bulletin* 123: 24–41.
McDonald, M., L. Arragutainaq, and Z. Novalinga. 1997. "Voices from the Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay Bioregion." *Northern Perspectives* 25(1).
Meadows, D. 1998. Indicators and Information Systems for Sustainable Development: A Report to the Balton Group. Hartland: Four Corners: The Sustainability Institute.
Mwesigye, F. 1996. "Indigenous language use in grassroots environment indicators." In *Grassroots indicators for desertification: experience and perspectives from Eastern and Southern Africa*, edited by H. V. Hambly and T. Onweng Angura. Ottawa: IDRC.
Noble, W. C. 1981. "Prehistory of the Great Slave Lake and Great Bear Lake region." In *Handbook of the North American Indians: Subarctic*, edited by H. Helm. Washington, DC: Smithsonian Institute.
Northwest Territories Centre For Remote Sensing. 1998, 13 March. Terrestrial Ecoregions of the Northwest Territories. Yellowknife: Government of the Northwest Territories. *http://www.gov.nt.ca/RWED/pas/images/ecoreg1.jpg*
Parlee, B., M. Basil, and N. Drybones. 2001. Traditional Ecological Knowledge in the Kache Kue Study Region: Final Report. Yellowknife NT: West Kitikmeot Slave Study Society. *http://www.wkss.nt.ca*
———, M. Manseau, and Lutsel K'e Dene First Nation. 2005. "Using Traditional Knowledge to Adapt to Ecological Change: *Denesoline* Monitoring of Caribou Movements." *Arctic* 53: 1.
Riedlinger, D., and F. Berkes. 2001. "Contributions of traditional knowledge to understanding climate change in the Canadian Arctic." *Polar Record* 37: 315–28.
Roots, F. 1998. "Inclusion of different knowledge systems in research." In *Terra Borealis: Proceedings of a workshop on traditional and western scientific environmental knowledge*, edited by M. Manseau, 42–49. Labrador: Institute for Environmental Monitoring and Research.
Smith, J. G. 1981. "Chipewyan." In *Handbook of North America Indians – Subarctic*, edited by J. Helm. Washington: Smithsonian Institute.
Tarkiasuk, Q. 1997. "Voices from the Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay Bioregion." *Northern Perspectives* 25(1).
Thorpe, N., N. Hakongak, and S. Eyegetok. 2001. Tuktu and Nogak Project: A Caribou Chronicle. Yellowknife: West Kitikmeot Slave Study Society. *http://www.wkss.nt.ca*
Usher, P.J., P. Cobb, M. Loney, and G. Spafford. 1992. Hydro-Electric Development and the English River Anishanabe: Ontario Hydro's Past Record and Present Approaches to Treaty and Aboriginal Rights, Social Impact Assessment and Mitigation and Compensation. In *Report for Nishanawbe Aksi Nation: Grand Council Treaty #3 and Tema-Augama Anishanabai*. Ottawa: PJ Usher Consulting.