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Collection and Analysis of Traditional Ecological Knowledge about a Population of Arctic Tundra Caribou

MICHAEL A.D. FERGUSON[1] and FRANÇOIS MESSIER[2]

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ABSTRACT. Aboriginal peoples want their ecological knowledge used in the management of wildlife populations. To accomplish this, management agencies will need regional summaries of aboriginal knowledge about long-term changes in the distribution and abundance of wildlife populations and ecological factors that influence those changes. Between 1983 and 1994, we developed a method for collecting Inuit knowledge about historical changes in a caribou (*Rangifer tarandus*) population on southern Baffin Island from c. 1900 to 1994. Advice from Inuit allowed us to collect and interpret their oral knowledge in culturally appropriate ways. Local Hunters and Trappers Associations (HTAs) and other Inuit identified potential informants to maximize the spatial and temporal scope of the study. In the final interview protocol, each informant (i) established his biographical map and time line, (ii) described changes in caribou distribution and density during his life, and (iii) discussed ecological factors that may have caused changes in caribou populations. Personal and parental observations of caribou distribution and abundance were reliable and precise. Inuit who had hunted caribou during periods of scarcity provided more extensive information than those hunters who had hunted mainly ringed seals (*Phoca hispida*); nevertheless, seal hunters provided information about coastal areas where caribou densities were insufficient for the needs of caribou hunters. The wording of our questions influenced the reliability of informants' answers; leading questions were especially problematic. We used only information that we considered reliable after analyzing the wording of both questions and answers from translated transcripts. This analysis may have excluded some reliable information because informants tended to understate certainty in their recollections. We tried to retain the accuracy and precision inherent in Inuit oral traditions; comparisons of information from several informants and comparisons with published and archival historical reports indicate that we retained these qualities of Inuit knowledge.

Key words: Inuit knowledge, methodology, wildlife population fluctuations and ecology, caribou, *Rangifer tarandus,* Baffin Island, Nunavut

RÉSUMÉ. Les peuples autochtones veulent voir leurs connaissances sur l'environnement utilisées dans la gestion de la faune sauvage. Pour ce faire, il va falloir que les organismes chargés de la gestion possèdent des résumés à l'échelle régionale du savoir autochtone sur les changements à long terme dans la distribution et l'abondance des populations fauniques et des facteurs écologiques influençant ces changements. Entre 1983 et 1994, on a mis au point une méthode de collecte du savoir inuit sur les changements survenus d'environ 1900 à 1994, changements qui ont affecté une population de caribous (*Rangifer tarandus*) dans la partie méridionale de l'île de Baffin. Des conseils donnés par les Inuit nous ont permis de recueillir et d'interpréter leur savoir oral selon des modalités pertinentes au plan culturel. Les Associations des chasseurs et des trappeurs (ACT) locales et d'autres Inuit ont indiqué des répondants potentiels, de façon à maximiser l'envergure spatiale et temporelle de l'étude. Lors du dernier protocole d'interview, chaque répondant a 1) établi sa carte biographique et sa ligne de temps, 2) décrit les changements dans la distribution et la densité du caribou au cours de sa vie, 3) discuté des facteurs écologiques qui auraient pu causer des changements dans les populations de caribous. Les observations sur la distribution et l'abondance du caribou émises par les répondants eux-mêmes ou leurs parents étaient à la fois fiables et précises. Les Inuit qui avaient chassé le caribou en des temps de pénurie offraient plus d'information que les chasseurs qui avaient surtout chassé le phoque annelé (*Phoca hispida*); les chasseurs de phoque n'en donnaient pas moins des renseignements sur des régions côtières où la densité du caribou ne pouvait satisfaire les besoins des chasseurs de cet animal. La formulation de nos questions a influencé la fiabilité des réponses des personnes interrogées; les questions suggestives en particulier posaient des problèmes. Après avoir analysé la formulation des questions ainsi que des réponses, à partir d'une traduction des transcriptions, on a seulement retenu l'information jugée fiable. Cette analyse peut avoir exclu des renseignements fiables car les répondants avaient tendance à sous-estimer l'exactitude de leurs souvenirs. On a essayé de préserver l'exactitude et la précision inhérentes à la tradition orale inuit; des comparaisons d'informations venant de plusieurs répondants ainsi que des comparaisons avec des rapports publiés ou archivés indiquent que ces qualités du savoir inuit ont été préservées dans l'étude.

Mots clés: savoir inuit, méthodologie, fluctuations dans la population et écologie de la faune sauvage, caribou, *Rangifer tarandus*, île de Baffin, Nunavut

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[1] Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories, Pond Inlet, Northwest Territories X0A 0S0, Canada

[2] Department of Biology, University of Saskatchewan, 112 Science Place, Saskatoon, Saskatchewan S7N 5E2, Canada

INTRODUCTION

In remote parts of the world, the ecological knowledge of indigenous peoples is often geographically and temporally more extensive than scientific knowledge (e.g., Johnson, 1992; Reid et al., 1992; Freeman, 1993). In this paper, "traditional ecological knowledge" denotes the insights that indigenous peoples, through their traditional methods, have gained about the interrelationships among animals, plants, and the physical environment. We use "traditional" ("indigenous," "Inuit" or "aboriginal") and "scientific" to indicate how and why the knowledge was acquired. We do not imply any connotation about the intrinsic value of either form of knowledge or the validity of the terminology. Freeman (1985), Feit (1988), Gunn et al. (1988), and Berkes (1993) have discussed distinctive characteristics of indigenous and scientific ecological knowledge.

Aboriginal peoples have requested that their extensive knowledge be incorporated into the management of wildlife populations (Wavey, 1993). Major mapping projects (Freeman, 1976; Brice-Bennett, 1977; Riewe, 1992) have emphasized aboriginal land use for land claim negotiations. However, ecologists (e.g., Freeman, 1975; Johannes, 1980; Nakashima, 1993) have only begun to document traditional ecological knowledge for wildlife management purposes. For example, the Beverly-Qamanirjuaq Caribou Management Board has striven toward that goal since its creation in 1982, yet the knowledge and views of aboriginal hunters may not be understood adequately to incorporate them effectively into caribou management (Usher, 1993).

One reason for this problem has been the limited availability of Inuit knowledge beyond local communities. A methodology is required to compile aboriginal knowledge of long-term regional changes in wildlife populations and the ecological factors that may influence these changes. Such a methodology must preserve the inherent accuracy and precision of observations by individual Inuit informants (Arima, 1976; Woodman, 1991; Freeman, 1993). Understanding Inuit knowledge is dependent on the investigative techniques used to record it, the researcher's assumptions about the cultural basis for that knowledge (Woodman, 1991), and the researcher's conscious and unconscious assumptions derived from his or her own culture. Beginning in 1983, Ferguson worked with Inuit and others to develop and implement a methodology for compiling Inuit knowledge of historical distributions, densities, and ecology of caribou on southern Baffin Island. He assumed, as did Woodman (1991), that Inuit knowledge was factual. The ultimate goal was to integrate Inuit and scientific knowledge to broaden the historical and ecological context of future caribou management.

This paper describes our method, which could be adapted for other wildlife species or geographic regions to allow the compilation of regional histories of changes in wildlife distributions, densities, and ecology using indigenous knowledge. Some specific historical examples illustrate that the regional compilation retained the inherent veracity of the oral knowledge of individual informants. We also discuss insights provided by Inuit advisors that proved critical to the collection and interpretation of Inuit ecological knowledge.

METHODS

General Development

In this account of the methodology and its development, "we" refers to all who participated in the interviews as named below. Initially, we attempted to use a detailed questionnaire to standardize interviews. In 1983, Goo Arlooktoo and Ferguson interviewed the late Simonie Alainga in Iqaluit (Fig. 1) to test the draft questionnaire. Acting on comments from Goo and Simonie, Ferguson made major revisions to the questionnaire in 1984. In 1985, Pauloosie Kilabuk used the revised questionnaire to interview ten elders and hunters in Iqaluit, but this questionnaire also proved impractical. The written questions did not mesh well with the manner in which Inuit informants relayed information, often through detailed accounts of hunting trips. Pauloosie recorded most of the informants' information on plastic overlays over 1:250 000 topographic maps.

Subsequently, the questionnaire was abandoned in favour of a standard, yet flexible interview protocol. Michel Labine and Martha Jaw tested a preliminary protocol during seven interviews in Cape Dorset in 1985. These interviews were tape-recorded and later translated into English and transcribed. The geographic information was recorded on 1:250 000 maps.

After consulting Inuit elders and advisors, we devised a final interview protocol, which was used during 1990–94 in eight interviews in Pangnirtung and five interviews in Kimmirut (Lake Harbour). Peter Kilabuk, Amie Nashalik, and Jonah Kilabuk of Pangnirtung and Matthew Akavak of Kimmirut participated in these interviews as interpreters. Ferguson wrote notes during the tape-recorded interviews. Geographic information was recorded on plastic overlays over 1:500 000 maps. All tapes were later translated into English and transcribed.

The 1985 interviews in Iqaluit were not tape-recorded, making many details required by the final protocol unavailable for analysis. Therefore, Ferguson compiled a series of map overlays showing a preliminary analysis of the information provided by Iqaluit informants. In 1994, Aiju Peter and Ferguson met with all available Iqaluit informants to obtain missing details, resolve apparent discrepancies, and update the information from 1985 to 1994. Six of the original ten and one new informant participated in the meeting. Two of the original informants had died, another was ill, and one could not take time from his job.

To maintain consistency, the transcripts of interviews conducted by Labine and Jaw in 1985 were analysed on the basis of the requirements of the final interview protocol. Ferguson briefly interviewed four former or current residents of Cape Dorset by telephone in 1995 to update information from 1985 to 1994. Finally, George Koonoo and Joe Tigullaraq conducted one partial interview in Pond Inlet in 1995.

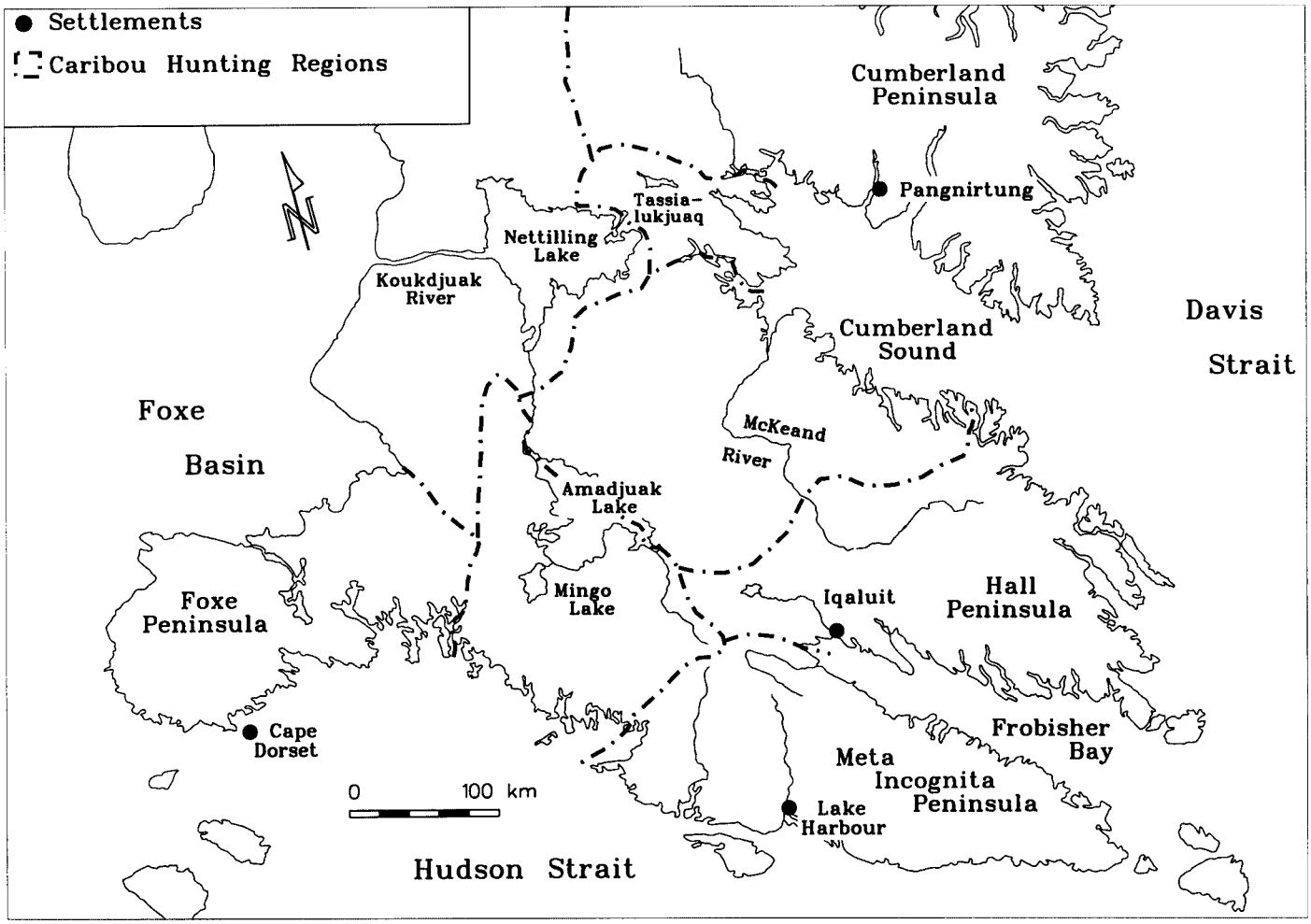

FIG. 1. Settlements and caribou hunting regions on southern Baffin Island, Northwest Territories, Canada.

Community Consultation and Selection of Informants

We interviewed all persons that HTA members and other local advisors had identified as "local caribou experts," i.e., persons recognized by their peers as knowledgeable about caribou. Besides local experts, we selected additional potential informants who would maximize the geographic and temporal scope of the study. While identifying additional informants, we asked local advisors to avoid selecting persons whose information would largely overlap that of earlier informants because this would have increased our costs. Nevertheless, enough overlap was obtained to evaluate concurrence among informants' observations. Elders and older active hunters were selected over younger hunters because they had firsthand knowledge covering longer periods, and the HTAs wanted to record the elders' knowledge before they died. Women were not explicitly excluded from the study; however, HTAs or other advisors did not recommend any women for interviews because most women did not usually accompany men on the caribou hunt.

Other criteria that determined whether individuals would participate included their willingness to be interviewed, their availability while the interviewer was in the community, and the likely reliability of their information as judged by local advisors. Only one potential informant refused to participate, apparently because of his concerns about confidentiality. On the other hand, two people whose participation was not solicited asked to be interviewed (and were).

In 1994, L. Siddon of the Science Institute of the Northwest Territories recommended that we ask all future informants to review and sign a consent form before conducting full interviews. The consent form (available from Ferguson upon request) described the study's objectives and methods. It allowed each informant to specify where raw data must be deposited, who must approve other uses of the data, and whether the informant had to be acknowledged for his contribution. All informants specified similar conditions: tapes, maps, and transcripts from each interview had to be deposited at a local resource centre (i.e., not in government or university archives); permission for further use should be obtained from the informant or his named heir (i.e., not from a local committee); and his contribution had to be acknowledged. The tapes and transcripts contain many personal details of each informant's life, which caused some concern about future unauthorized use of the raw data. At the outset, we agreed that each informant personally owns the information

that he provided to us for the explicit purpose of developing a collective description of caribou distributions and ecological factors on southern Baffin Island.

Interview Preparation, Duration, and Decorum

The interview team usually included an interviewer and an interpreter. Each interpreter was trained for one to three hours, depending on his or her experience, to explain the goals and rationale, the interview process and the interpreter's role. The ideal interpreter could effectively express literal meanings and nuances of questions and answers, advise the interviewer on cultural sensitivities, and contribute scientific and Inuit technical terminology, including placenames. As Johnson and Ruttan (1992) pointed out, indigenous peoples have many technical terms that cannot be readily translated into English. In this study, the interview team accepted the onus of understanding terminology used by the informants. We avoided using technical scientific terminology. For example, instead of asking about "the density of caribou," the interviewer asked the informant to describe how many caribou he saw in a specific area in relation to other periods or places and to his family's needs.

Interviews, including coffee breaks, lasted from two to seven hours. Interviews lasting more than three hours were broken into two or more parts, separated by breaks of at least one hour. The duration of each interview depended on the clarity and detail of information that the informant willingly provided, the ability of the interview team to understand the information, the map-reading skills of the informant, and the endurance and time commitments of the informant and interview team. Interviews occurred in closed meeting rooms to reduce interruptions and background noise.

Many informants provided information by recalling a factual event (or story) that best answered each question, as opposed to making generalizations from several observations. The interviewer accepted the position of a student who, in Inuit culture, must listen to the elder's complete story that contains the important points to be learned. Effective interpreters did not allow the interviewer to interrupt when the informant paused if they sensed that the informant was not yet finished. Although Inuit generally do not question elders and hunters about their information (Nelson, 1969), the interviewer discreetly tried to obtain any details that the informant omitted and clarify what he did not understand. Some questions pertained to how frequently an informant may have undertaken similar hunts and how the distributions and densities of caribou differed from those of the hunt that the informant described in detail. Usually, the informant either gave a concise summary of the variations, or recounted several similar hunting trips, emphasizing the differences in caribou observations. If the interview team detected resistance by the informant to a particular line of questioning, they abandoned it. Consequently, some information was not obtained during some interviews. We suspect that informants probably found the interviews somewhat rigorous, but when asked to return for subsequent sessions, they willingly did so.

From 1983 to 1993, most informants were given gifts in appreciation for their contributions. Most elders stated that they did not expect payment. However, some HTAs questioned why the informant (or teacher) was not paid, and in 1994, we paid each informant at an hourly rate if his interview lasted at least one hour.

The Final Interview: Biographies and Time Lines

To begin, the interview team explained the objectives, procedures, and products of the study. The informant read the consent form, either an Inuktitut or English version, requested clarification if needed, and then completed and signed the form.

Then, to develop a biographical map and time line, we asked the informant to indicate where and when he was born. His birthplace was marked as Location 1 on clear plastic over a 1:500 000 map. If the informant expressed doubt about his officially recorded birthdate, his best estimate of his birth year was used. The informant was then asked to show in sequence the base camps or settlements where he had lived during his life and to indicate when he had moved there. These were marked as Locations 2, 3, etc.

Reliable determination of the years when an informant moved was difficult, because many Inuit on Baffin Island did not have calendars until the 1970s. To establish a time line, we determined one or more memorable events that roughly coincided with each move and could be dated through published or archival records. If the informant remained in one location for more than seven years, we asked him to recall additional dateable events to obtain a minimum precision of ± 3 years (arbitrarily chosen as an acceptable limit).

For an informant's childhood, calendar years were often estimated from his year of birth and recollections of his maturity and activities. Some elders remembered seeing or hunting caribou while being carried by their mothers on summer hunting trips (i.e., usually 2 to 5 years old); walking on long summer trips, but remaining with their mothers while hunters went to find caribou (i.e., 4 to 7 years old); following their fathers on summer hunts and learning to hold a rifle (i.e., 6 to 9 years old); going with their fathers on winter hunts and learning to clean and gut caribou (i.e., 8 to 13 years old); being a teenager and starting to hunt with persons other than his parents (i.e., 12 to 19 years old); and getting a dog team and becoming an independent hunter (i.e., 15 to 25 years old). These approximations were refined for each informant using additional information about his family's circumstances (e.g., the presence, health, and age of his parents, as suggested by Hantzsch, 1977), and dateable events that occurred during his youth.

Recollections of events that affected the informant personally (e.g., death of a family member) were most reliable. With permission from the informant, we examined death, birth, and marriage records to help establish dates of these events. Death records, if found, were usually accurate. Sometimes, we could estimate when an informant's grandparent or parent was born from the parent's age on a death certificate. Before

1940, many births were not recorded until several years later; thus some records were unreliable. Marriage records also could be inaccurate because Inuit often had traditional marriages years before having them officially recorded. Other methods were used to cross-reference date estimates along each time line. By recalling and counting each summer (or winter) that they had lived at a certain location, informants could usually estimate how many years they had hunted in certain areas (i.e., if fewer than 8–10 years). Several informants could reliably remember specific years for important events in their lives. One informant provided information from a short personal diary of events dating back more than 30 years. All of his records agreed with the official records.

Other cross-references were memorable historic events that had occurred during an informant's life. Examples included overland expeditions by Dewey Soper (*Kiameatie*, in Inuktitut) and Tom Manning (*Kupanuak*); the opening of Hudson's Bay Company (HBC) posts, Royal Canadian Mounted Police (RCMP) detachments, the Pangnirtung hospital, and the Distant Early Warning system; importation of reindeer by the Hudson's Bay Reindeer Company; the beginning and ending of World War II; caribou bag limits imposed on the Inuit by the RCMP; an epizootic that killed most sled dogs in Cumberland Sound (Fig. 1); and ear-tagging of caribou on the Koukdjuak River and eastern Nettilling Lake. Such historical events were used mainly to verify or resolve conflicts in time lines established from other information.

The Final Interview: Historical Caribou Distributions, Movements, and Ecology

To start the second part of the interview, we explained that we wanted information about the informant's own observations of caribou or those of his parents. We asked him to tell us whenever he provided secondhand information from other hunters. Secondhand information was often vague both spatially and temporally, and thus potentially misleading. Next, the informant was asked to recall his first memory about caribou (e.g., the first time he ate caribou meat or saw caribou) and show where he lived then. All informants could recall details about the first caribou that they had killed. The informant was next asked to recall his observations of caribou for each place that he had lived in sequential order. If he had lived at a location for many years, he was asked to describe caribou distributions for each period between dateable events along his time line.

On the map, the informant outlined each area where caribou were seen and each area where none were seen. For each area, we attempted to obtain information on where, when (i.e., month or season), and how many caribou or tracks were seen, what sex and age the caribou were, and what direction the caribou travelled. We sequentially numbered each area, while tape-recording the numbers, Inuktitut names, and descriptive information. Because the interviewer could not learn the Inuktitut names for all locations across southern Baffin Island, he relied mainly on the mapped numbers. Inuktitut place-names can be informative about the use of an area by caribou and other wildlife (G. Williams, pers. comm. 1995). The interviewer learned such names whenever their significance became apparent.

Each informant could readily describe caribou densities on the basis of seasonal and interannual changes in relative abundance that he had personally observed, differences in abundance between each of his hunting areas, and the needs of his extended family. For times when caribou were rare, many informants could recall details of individual hunting trips that had occurred up to 60 years previously. However, for times when caribou were more abundant than their needs required, their recall usually became more generalized. Most informants mapped the routes that they had travelled and the areas that they had searched in order to illustrate typical distributions of caribou between dateable events.

In the final part of the interview, informants were asked to discuss ecological factors that might cause either short- or long-term changes in the caribou populations. This part of the interview was less structured. Our aim was to let the informant select factors that he viewed as important.

Data Analysis and Presentation

Each tape was translated into English and transcribed by an experienced interpreter, usually not the same interpreter who had participated in a particular interview. This maximized the likelihood of detecting alternative interpretations, or nuances, in the Inuktitut portion of the interviews. Translators with knowledge of local dialects and place-names were selected, if possible. Ferguson scrutinized translated transcripts for inappropriate wording of questions and eliminated answers thus affected (see examples in Discussion). As well, Ferguson examined the wording of answers to determine the level of certainty that the informant expressed in his reply.

The caribou observations of each informant were summarized chronologically and plotted on clear plastic over a 1:500 000 map for each decade, producing a time series of overlays. The written summaries and overlays for all informants were merged to compile the collective knowledge of Inuit informants about long-term changes in caribou distribution and density (Ferguson, unpubl. data).

Occasionally, we could not meet the minimum precision of ± 3 years, usually because of inadequate interviewing rather than the inadequacy of an informant's memory. If precise timing was not crucial to the relevance of the informant's knowledge (e.g., typical seasonal migration patterns), such information was used; otherwise, temporally imprecise information was ignored.

The reliability of each informant's observations was ranked according to the source of each observation, as follows: (1) "personal" information, or firsthand observations by the informant; (2) "parental" information, or secondhand knowledge from parents, grandparents, or other family members who assumed responsibility for training the informant in his youth (Laughlin, 1968); (3) "secondhand" information from other hunters; and (4) "speculative" information, or unconfirmed extrapolations from observations. Parental information

was accepted as reliable because of the importance that it had for the survival of the parent's offspring. This importance was evident in the greater detail of parental information provided by informants, as compared with secondhand information from other hunters. Secondhand information from other hunters was used only if it was at least partially corroborated by personal or parental knowledge.

Speculative information was considered least reliable. This type of information commonly arose after animal densities decreased in a given area. When animal numbers apparently increased in an area soon after declining in another area, informants sometimes speculated that the animals had moved between the two areas. However, the trends in each local population may have been independent (e.g., animals may have immigrated from or emigrated to a third, unknown area). This could be true for both seasonal migrations and long-term population changes. Speculative information about caribou abundance and distribution was not used, but speculation about ecological factors that might cause population change was included.

Inuit recognize six ecological seasons based on changes in sea and terrestrial snow and ice conditions and daylight period (e.g., Brody, 1976, Map 45). The timing of these seasons within southern Baffin Island varies with differences in sea ice (e.g., the proximity of the floe edge) and terrain conditions (e.g., elevation and aspect). Inuit informants usually described seasonal movements of caribou for their own seasons, which were then translated into appropriate months of the year according to the usual timing of a season near each settlement. This translation was somewhat artificial, because a given ecological season may occur in certain months in most years, but may have occurred in different months in the year(s) for which the informant was describing seasonal caribou distributions.

RESULTS

Arima (1976) found a high degree of concurrence between published recollections of Inuit informants and written records from other sources. Inuit do not need written evidence to confirm the veracity of their oral knowledge and traditions, and we do not question this inherent veracity. Nevertheless, we needed to assess whether or not we unintentionally introduced inaccuracies while establishing time lines for individual informants, and then accumulated possible inaccuracies while compiling information for all informants. We examined concurrence between the time lines and other data of different informants (e.g., when the parental knowledge of one informant overlapped the personal observations of older informants). We found no contradictory evidence in any such comparisons, although parental knowledge was usually somewhat vague compared with personal observations (e.g., references to Amadjuak Lake as a whole, as opposed to the northeastern shore of the lake). Many comparisons involved the personal observations of two or more informants hunting caribou in the same or adjacent areas at the same time. Although we examined all such cases, no clear examples of contradictory evidence could be found.

The precision, accuracy, and detail of Inuit recollections also agreed with written archival records. For example, Paulassie Pootoogook (pers. comm. 1985) stated unequivocally that in 1944 he had received a large supply of caribou skins and meat from his brother and brother-in-law living at Nettilling Lake. In the May 1944 diary summary for the Hudson's Bay Company post in Cape Dorset (HBC, 1944), the post manager remarked that two members of the Pootoogook family had been at Nettilling Lake for a full year and returned on 18 May 1944 with a supply of caribou skins and meat for the next year. We did not detect any cases in which an informant incorrectly stated a year or other fact without expressing some doubt about its accuracy himself.

Overlapping information among informants for 1945–58 initially suggested that our methods might have produced some gaps and discrepancies, but historical information verified that none existed. In the following case description, years stated directly by informants are worded to reflect any uncertainty stated by the informants. Years obtained from time lines are shown in brackets, [ ], some with examples of the dateable events used to establish those time lines.

- No Cape Dorset informants reported hunting near Nettilling Lake [during 1946–50], although caribou were not found closer to the coast of Hudson Strait [until the 1950s] (Ferguson, unpubl. data). During 1946–48, hunters from Cape Dorset who lived at Nettilling Lake began travelling to Pangnirtung to trade (Jamesie Mike, Pangnirtung, pers. comm. 1994). This suggested a temporal gap in information obtained from Cape Dorset informants.
- During a "ban" on caribou hunting [in the late 1940s], Pauloosie Angmarlik (Pangnirtung, pers. comm. 1990) was asked by the HBC to change his fox-trapping area from Nettilling Lake to southeastern Cumberland Peninsula for two years. Jamesie Mike suggested that the "ban" started sometime during the period from 1943 to 1945. Jamesie and other hunters moved with Pauloosie to Cumberland Peninsula where they lived during 1946–48.
- Jaco Evic (Pangnirtung, pers. comm. 1990) reported that during 1945–50, Inuit in Cumberland Sound were told by the RCMP to stop harvesting caribou during the winter and to take no more than five caribou during the summer. Several informants in Pangnirtung had heard of these "regulations," but understood several versions of them. Only one Cape Dorset family, originally from Pond Inlet, lived at Nettilling Lake during this five-year "ban," and the RCMP told that family to leave Nettilling Lake because they were no longer allowed to hunt caribou in winter (J. Evic, pers. comm. 1990).
- John Tongak (Pond Inlet, pers. comm. 1995) moved with his parents and grandparents from Pond Inlet to Igloolik, to Cape Dorset, and finally to Nettilling Lake [during the 1940s]. His first dateable recollection while living in Nettilling Lake was learning about the sinking of the RMS *Nascopie* near Cape Dorset [in 1947 (Appleton, 1968)].

John's father and grandfather had initially travelled to Cape Dorset to trade. Later, a Pangnirtung elder, Aksayuk, guided them to Pangnirtung, where John's father and grandfather subsequently traded. More than a year later, John's family moved to Cumberland Sound until his grandfather returned to Pond Inlet in 1951 on the medical ship CCGS *C.D. Howe* [which was launched in 1950 (Appleton, 1968)], and his father's family returned in 1952.

- Lucassie Nutaraluk (Iqaluit, pers. comm. 1994) moved in 1951 from Cape Dorset to Iqaluit, where the RCMP told him that he could take only two caribou each year. Harry Kilabuk (Iqaluit, pers. comm. 1985) reported that for about four years beginning around 1950, he was allowed to harvest five caribou in winter and any number in summer.
- Sandy Akavak (Kimmirut, pers. comm. 1994) reported that the RCMP first limited caribou hunting by Kimmirut Inuit in 1953 or 1954, when caribou first returned to Meta Incognita Peninsula (Fig. 1). A married hunter could take five caribou annually, while a single Inuk could take only one (S. Akavak, pers. comm. 1994). The law was implemented for four or five years near Kimmirut [i.e., until 1957–59].

To resolve the apparent information gaps and timing discrepancies, we first examined the federal Northwest Game Act and Regulations, which did not limit caribou harvesting by Inuit during the 1940s. The Northwest Game Act was repealed in April 1949 and replaced by the NWT Game Ordinance. In September 1949, Section 33 of the Ordinance was amended to permit hunting of caribou on Baffin and Bylot Islands only from August 1 to September 15, up to a limit specified on each hunter's license. In June 1953, the Ordinance was revised, and Section 25 specified that a hunter with a family could take five caribou and single hunters could take only one caribou during the summer season. These limitations were removed via Section 3(2) in June 1955, and then reenacted from January 1957 to January 1958 through amendments to Sections 3(2), 3(3), and 25. This legislative history suggested that the accounts of L. Nutaraluk, H. Kilabuk, and S. Akavak in Iqaluit and Kimmirut in the 1950s were correct, but that the timing of those of J. Evic, J. Mike, J. Tongak, and P. Angmarlik near Pangnirtung [during the late 1940s] was off by five years.

All of the apparent gaps and discrepancies were resolved through a March 1947 letter from R.A. Gibson, Deputy Commissioner of the Northwest Territories, to R.H. Chesshire of the HBC regarding government concerns about depletion of caribou numbers on southern Baffin Island (HBC, 1947). That letter stated the following:

- In summer 1945, 17 families from Cape Dorset lived year-round near Nettilling Lake. During 1945, the HBC and Baffin Trading Company in Cape Dorset agreed not to outfit Inuit to trap foxes near Nettilling Lake. By summer 1946, 15 of the 17 families had returned to Cape Dorset.
- In autumn 1946, the RCMP in Pangnirtung reported that the remaining two families originally from "Igloolik" visited Pangnirtung and "promised … [to] return to Igloolik before spring (1947)."
- Gibson asked Chesshire to again "instruct" HBC Post Managers at Cape Dorset and Pangnirtung to "discourage …[the Inuit] in the excessive taking of caribou."

Gibson's letter confirms that our selection of Cape Dorset informants did not accidentally create the only information gap identified in the study's temporal coverage. The letter also corroborates information provided by Inuit almost 50 years later; including active government-directed discouragement of caribou harvesting by Cape Dorset and Pangnirtung Inuit before legislation was set up in 1949. Combined with probable linguistic misinterpretations, the lack of specific regulations in the 1940s, RCMP discretion in specifying harvest limits on individual licences during 1949–53, and the on-and-off effect of amendments during 1955–58 probably account for the variety of restrictions understood by individual hunters. The HBC Post Managers in Cape Dorset and Pangnirtung effectively met the goals outlined by Gibson. After committing to a five-year "ban" near Pangnirtung (J. Evic, pers. comm. 1990), the RCMP apparently used considerable discretion about where and when they applied the legislated regulations during the 1950s. They apparently had little success limiting the harvest of caribou along Hudson Strait, at least during 1952 and 1953 (Scott, 1953–54).

DISCUSSION

Our methodology had several similarities to that of Freeman (1976) and others who used map biographies to document aboriginal land use. Although precise time lines might be generated from his raw data (Usher, pers. comm. 1995), Freeman (1976) did not present the results with sufficient precision to allow wildlife managers to identify population changes that may have been ecologically important. Additionally, much of the questioning in our interviews focused on differentiating between areas with target animals (i.e., animals of specific sex and age categories), areas with animals at densities too low for efficient hunting, areas with non-target animals, and areas without animals (e.g., travel routes). Given that Freeman (1976) focused on land use (i.e., areas that Inuit used for any purpose), his data probably did not attain the detail sought in our study.

Factors That Influenced the Results

The firsthand and parental knowledge of any given number of informants is unlikely to represent a complete picture of all indigenous knowledge about historical changes within any wildlife population. In this study, each informant provided new insights, suggesting that we had not exhausted all potential information available from Inuit in Pangnirtung, Iqaluit, Kimmirut, and Cape Dorset. Logistical constraints inevitably

limit the number of settlements and informants that can be included in any study. As a result, local consultation is critical in identifying the potential informants with the most extensive and reliable knowledge, and researchers must find a balance between the conflicting demands of thoroughness, accuracy, precision, and cost.

Other factors that may have created some response bias during each interview include reluctance of informants to reveal proprietary or sensitive knowledge; withholding of information that the informant assumes is known or obvious to the interview team; lack of recall of specific facts during the interview; intentional deference to other informants who may be seen as more knowledgeable; inadequate or inappropriate questioning by the interview team; and inadequate comprehension by the interview team of information that was provided. Briefing the interpreters and informants before and during the interviews reduced the potential effects of these factors, which depended largely on the trust and patience of the interview team and the informants. Discussion of the consent form allowed the interview team to familiarize themselves with the concerns of each informant and take steps not to inflame his sensitivities.

An informant may filter some information if he or she perceives the interviewer as an expert who might either disbelieve or misuse the information. Relating examples of similar information from informants in other settlements or from scientific research helped to lower such barriers. Barker and Cross (1992) also used this technique in Africa. The researcher must be convinced of the authenticity of each example, and of aboriginal knowledge overall, or informants may detect the researcher's skepticism or misunderstanding in the relaying of Inuit knowledge. As well, an interviewer who draws on closely overlapping examples may lead informants to provide only corroborating evidence that they think the interviewer wants to hear. Several informants were reluctant to provide information about which other informants were viewed as having more expertise. However, these informants often provided their information after they were given examples of how similar information from several informants refined spatial and temporal details, as in the case described in the Results.

Johannes (1993) suggested that the reliability of an informant's evidence can be determined by asking a series of plausible questions for which the informant could not know the answer. We discourage any attempt to employ such a tactic with Inuit informants. The greatest potential for incorrect conclusions occurred when the interviewer asked leading questions, like "Did caribou migrate from Foxe Peninsula to Nettilling Lake in spring 1925?" For many Inuit, questioning other persons about their facts is impolite (J. Tigullaraq, pers. comm. 1993). When we inadvertently asked such leading questions, the Inuit informants usually responded affirmatively, but sometimes without any personal knowledge, assuming that the interviewer had a sound basis for the question. To disagree openly, an Inuk may need to have personal knowledge to the contrary, and also to consider that stating that disagreement is sufficiently important. Perhaps more important, once any informant suspects that the interviewer intentionally employs Johannes' (1993) tactic, the interviewer risks losing credibility with all informants.

The long seasonal migrations of Baffin Island caribou (i.e., up to 240 km), as depicted by Brody (1976: Map 46), suggest that Freeman (1976) accepted speculative information. During the 1985 interviews in Cape Dorset, the interviewer extracted agreement from several informants about similar long-distance migrations, using leading questions. However, no informant suggested that he had followed caribou throughout their migrations. When leading questions were avoided, the precision of the informants' knowledge became readily apparent. Informants usually described seasonal migrations only within their immediate hunting areas by placing small arrows at specific locations on maps, and in some cases by refusing to suggest any migration. For example, Etuangat Aksayuk (Pangnirtung, pers. comm. 1990) indicated that he saw caribou along the north and south shores of Koukdjuak River in summer during the time from approximately 1916 to 1923. However, he stated that he did not know whether the caribou had migrated across the river, because he never saw them crossing the river. Most informants displayed similarly disciplined memories of empirical facts.

After the interviewer initially explained the importance of personal and parental information over secondhand and speculative information, informants usually prefaced secondhand or speculative information with phrases such as "I have not seen it myself, but …." Although secondhand and speculative information may be correct, extensive reliance on it could lead to wrong conclusions and leave the incorrect impression that Inuit knowledge is not dependable. Local indigenous experts are as concerned about correct facts as any scientific researcher (Johannes, 1993).

Different types of Inuit hunters (e.g., seal and caribou hunters) differ in the extent and types of knowledge that they can provide (P. Kilabuk, pers. comm. 1990). As well, different hunters have differing levels of demand for different species, and consequently expend differing amounts of effort to harvest each species (P. Kilabuk, pers. comm. 1990). Seal hunters usually harvest caribou opportunistically along the coast, rather than undertaking extensive trips inland to areas with higher caribou densities. Seal hunters usually had fragmentary information about caribou: for example, seal hunters were often the first to detect the return of caribou to coastal areas after years of absence. However, their knowledge rarely duplicated that of caribou hunters.

The differing characteristics of seal and caribou hunters were incorporated into our data collection and analysis. Most hunters born before 1930 on southern Baffin Island were caribou hunters, while those born during the late 1930s and 1940s were predominately seal hunters, probably because caribou densities were low during the latter period (Ferguson, unpubl. data). When initiating interviews in a new area, we intentionally scheduled younger hunters before older hunters, if possible. When an older caribou expert was interviewed first, the interviewer sometimes became confused by extensive, detailed information. Sensing a lack of full

comprehension, some informants appeared to withhold some details to make their interviews more efficient. On the other hand, by interviewing younger seal hunters first, the interviewer built a background that enabled him to comprehend adequately the details provided later by local caribou experts.

Caribou hunters who had witnessed gradual changes among caribou over several decades sometimes had difficulty recalling when and where specific population changes had occurred. Sometimes this problem can be overcome by having the informant recall details of specific hunting trips (i.e., once every four to six years, if possible). As well, other hunters who hunted the same area less frequently could indicate more precisely the timing of major changes in caribou density and distribution because their observations were separated by longer periods. This became most evident in observations of the period after 1960, when several informants temporarily left their traditional homes to take jobs for five to ten years in other settlements. When each returned to hunt caribou in his traditional area, he could define specific temporal and spatial changes in caribou distribution. If he had hunted extensively near his temporary home, he could provide specific information about that area too. Therefore, the observations of transient and part-time hunters should not be ignored.

Resolving Apparent Discrepancies

Seal and part-time hunters had less demand for caribou than did caribou hunters, and the demands of individual hunters changed depending on the size of their extended families, availability of store goods, and other factors. Consequently, comparative descriptions of caribou abundance in different areas and periods were important in resolving apparent discrepancies related to the needs of different hunters.

Attention was also given to the year, season, and sex and age of the caribou observed. Two different informants (or one informant at different points in the interview) might apparently give contradictory information for a given area; but in fact they would be discussing distributions from different seasons, years or sex or age groups (L. Nutaraluk, pers. comm. 1994). Generally, informants were patient, allowing many questions to clarify such potentially confusing details.

Inevitably, apparent discrepancies arose in estimates of spatial and temporal changes in caribou distribution based on the observations of different informants. For example, some informants provided valuable information for their traditional hunting areas in some years, but not in other years. In some years, circumstances (e.g., employment, health problems) may have reduced the informant's hunting opportunities, causing the geographic coverage to shrink. Superficially, his observations might suggest a reduction in the spatial distribution of caribou, in apparent contradiction with the observations of other informants. Informants' biographies and time lines were critical in determining which informants had had adequate opportunities to observe changes during specific years in specific areas. If circumstances changed for one informant, we sought additional informants who could fill the apparent gaps.

Informants' wording also allowed assessment of the relative weight to give to their observations. On occasion, an interpreter suggested that the informant was certain of a specific point, but examination of the translated transcript revealed some uncertainty (and vice versa). In some situations, informants suggested that the observations of another informant should be trusted more than their own, or recommended additional persons who could provide greater detail. Although useful and valid, this approach was not always logistically possible. With few exceptions, Inuit informants tended to understate, rather than overstate, their confidence in their knowledge.

The personal knowledge of some informants may also appear to conflict with that of other informants because of preferences for traditional hunting areas. In the early 1900s, several families from Cumberland Sound hunted female and immature caribou west of Nettilling Lake during summer and autumn (E. Aksayuk and P. Angmarlik, pers. comm. 1990), although caribou were available in several other areas (Ferguson, unpubl. data). Similarly, J. Evic (pers. comm. 1990), Simeonie Keenainak (pers. comm. 1995) and their families hunted in southern Nettilling Lake during autumn in the 1980s, while most other informants got caribou near the coast of Cumberland Sound. Secondhand knowledge helped determine whether an informant was implying that caribou were not present outside his preferred hunting area. However, the researcher should not depend on secondhand information to delineate specific areas where caribou occurred.

Usher and Wenzel (1987) reported that subsistence hunters can recall precise quantities of their harvest when harvesting is rare or done under special circumstances. They found that when they harvested at higher rates, hunters recall only whether they obtained enough. In this study, several informants provided precise estimates of total numbers seen and harvested by themselves or members of their hunting party, especially when numbers were insufficient to meet their needs. Most of these informants had worked for non-Inuit employers and developed some understanding of numerical quantification. Several individuals could state numerical rates (e.g., number of caribou harvested per hunter) and interpret such numerical concepts in terms understandable to other hunters who had limited numerical abilities. In the analysis, these informants were used as primary sources to assign indices of relative densities for specific areas during specific years. Nevertheless, all informants could express caribou densities in terms of comparison with other geographic areas, other periods, and their own needs.

By accurately and precisely placing these estimates of relative densities along seasonal and yearly time lines, we were able to resolve almost all potential discrepancies in density estimates. An example of a remaining conflict arose in reports for northeastern Cumberland Sound during the 1940s. Most informants reported that they had needed to take all the caribou that they could. Only one informant reported that he was always selective in his harvesting and never had to take all that he saw. This and similar responses by this informant were typical of a hunter who was satisfied with

fewer caribou than most caribou hunters. When resolving such apparent conflicts, we accepted the views of older informants who could express relative densities over broad temporal and spatial backgrounds and who were identified as the primary caribou hunters in the area.

Potential Improvements in the Methodology

After breaks during interviews, informants often provided clarification of answers to previously asked questions. During a break, an informant may recall new relevant information, or may think of alternative ways to present his information to the interview team. After each interview, we usually reviewed the time line data and subsequently discussed any confusing information with the informant if necessary. We recommend strategic breaks to separate the three main parts of each interview: the informant's biography and time line, historical changes in the wildlife population, and ecological factors influencing those changes. Usher (pers. comm. 1996) recommends that follow-up interviews be planned for a day or two later.

The first stage of the interview, the mapped biography and recollection of dateable events, could be followed by a break, so that the interview team could consult written archival information to establish the informant's time line. In the second stage of the interview, the interview team could review the informant's time line with him and correct or improve it, if necessary. Then, the interview could continue with the recording of the informant's knowledge about wildlife distributions and relative densities. The time line could be used during the remainder of the interview, and the informant could keep a copy for his records.

Before the last stage of the interview, the interview team should review the responses obtained during the second stage to identify important information that may have been missed or misunderstood. During the third stage, the interview team could clarify this information with the informant, and then collect information about ecological factors that may have caused changes in animal distribution and density. At the end of the interview, the researcher could ask whether the informant hunted caribou as much or less than most hunters in his settlement, and if and when that status changed during his life. Because many Inuit often understate their personal abilities as hunters, we advise against asking informants if they hunted more than others; a good hunter may answer "No" to avoid being boastful.

A checklist of subject areas could guide the interview team (Johnson and Ruttan, 1992) and reduce errors of omission. Inuit often organize their oral knowledge with a complex chronological flow (i.e., recall is not necessarily sequential) (R.G. Williamson, pers. comm. 1995). Inuit informants apparently found it natural to recall their observations of wildlife from their childhood through to the present. Use of any checklist should not restrict the flow that an informant wishes to follow. Questionnaires lack sufficient flexibility to be useful tools in these interviews.

Some studies of traditional ecological knowledge have collected information during meetings of groups of informants (Johnson, 1992). The meeting of informants held in Iqaluit in 1994 successfully met its limited objectives of obtaining missing information, resolving apparent discrepancies, and updating information. However, such group interviews can be confusing (Johnson and Ruttan, 1992). At the Iqaluit meeting, some informants, especially seal hunters, did not participate as fully as others. Individual interviews are probably preferable in most situations to reduce the confusion felt by the interview team (Johnson and Ruttan, 1992), and so that each informant can participate fully in the study. Nevertheless, the findings of such studies should be presented at local meetings of informants and other hunters to learn if the results are supported by a consensus.

Another consideration is the location and atmosphere of the interview. We opted for private interview rooms to maximize the efficiency of the interviews and enable audible tape recording. However, informants may be most comfortable when interviewed in their own homes. In such a setting, the informant could consult other family members about the timing of events and the exact locations of caribou seen. As a compromise, a preliminary meeting in the informant's home could be held 12 to 48 hours in advance to discuss the consent form and the interview protocol. The informant could then discuss the subjects of the interview with family and friends before the main interview (R.G. Williamson, pers. comm. 1995).

The appropriate gender of informants should be discussed directly with local advisors (e.g., HTAs). This study may have missed the oldest available data because in some settlements women are the oldest Inuit. Although women did not hunt extensively, they have direct observations and extensive spousal and parental knowledge (R.G. Williamson and G. Williams, pers. comm. 1995), and they may be more likely to recall numbers of animals retrieved by hunters (Usher and Wenzel, 1987). From their traditional roles in butchering and preparing carcasses, women also know wildlife anatomy, food habits, physical condition, and diseases, knowledge that may be pertinent to ecological factors affecting wildlife populations.

The appropriate age and gender of interviewers and interpreters also should be discussed locally. Young or female interviewers may be slow to gain credibility with informants in some cultures and areas of study (Barker and Cross, 1992; Johnson and Ruttan, 1992). On the other hand, older male interviewers sometimes seemed reluctant to ask about knowledge that they should already have and may have had difficulty maintaining objectivity about specific information.

Johnson and Ruttan (1992) pointed out that four months of training during an 18-month study was inadequate to train local interviewers with little experience. On the other hand, outside researchers could have misinterpreted indigenous knowledge without extensive cultural training by local people (Johnson and Ruttan, 1992). A team with a local interpreter and an outside researcher can provide both the local, cultural knowledge and the objectivity needed for successful interviews.

FUTURE DIRECTIONS

Indigenous peoples see a need for linkage of traditional and scientific ecological knowledge to deal with environmental problems, yet they are concerned about how scientists may participate and how managers may ultimately use their knowledge (Wavey, 1993). Once traditional ecological knowledge with its inherent geographic, time-specific detail about wildlife populations becomes available, it could be considered equitably with scientific data in the management of Arctic wildlife populations. Full integration may not (and perhaps should not) be accomplished because of unique assumptions and decision-making processes inherent to each (aboriginal and Euro-scientific) culture (Feit, 1988). Nevertheless, co-management of wildlife should be aided by conscientious efforts to integrate indigenous and scientific databases.

Our goal was to develop a method that could allow aboriginal and scientific ecologists to accomplish this integration. The methodology was developed over 12 years during which Ferguson worked and lived with Inuit on Baffin Island. Such experience and cooperation is needed to gain trust and insights shared between aboriginal people and researchers (Usher and Wenzel, 1987; Berkes, 1990). Aspects of the methodology may not be culturally appropriate for other indigenous peoples or Inuit in other areas, given their social diversity (Damas, 1968). To successfully adapt and carry out this methodology with other indigenous peoples or for other wildlife species, researchers need a sound understanding of the cultural basis of aboriginal knowledge. Whenever ecologists undertake such efforts, the onus will be on researchers to conserve the accuracy and precision of aboriginal knowledge, and to understand the assumptions in each culture that could lead to either enlightenment or misunderstanding.

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This paper is dedicated to the memory of Simonie Alainga, who died at sea along with seven other Iqaluit hunters during a walrus hunt in late 1994—a tragic reminder of the survival basis underlying Inuit ecological knowledge. Simonie played a critical role as our first informant, helping to develop the methodology and being an active participant as recently as February 1994.

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