Monitoring Caribou Body Condition: Workshop Proceedings

G. Kofinas, D. E. Russell and R. G. White

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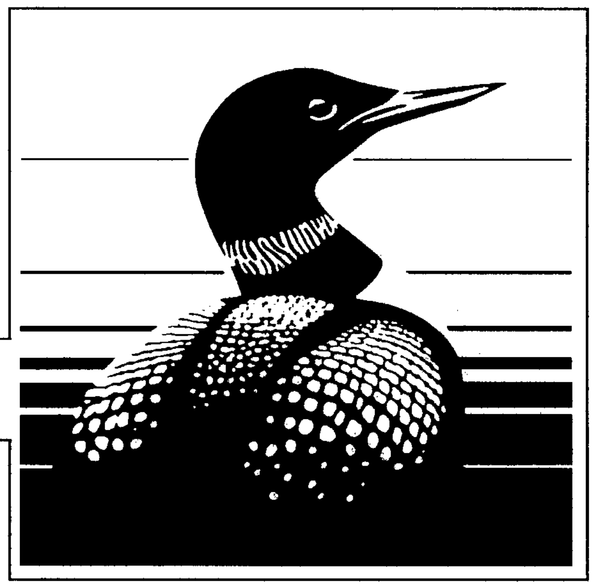

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Monitoring Caribou Body Condition: Workshop Proceedings

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Abstract

These proceedings summarize the body condition monitoring technical workshop held February 16-18, 2000 in Whitehorse, Yukon, Canada. Scientists from across North America gathered to discuss the role that communities can play in monitoring caribou body condition.

Attention was focused on surveying current body condition monitoring programs. The current state of knowledge on linking body condition to productivity was also discussed. Participants evaluated the advantages and disadvantages of monitoring techniques and then proposed formats for local communities to monitor body condition. Finally, in order to further our understanding of how to monitor the health of caribou herds, a detailed inventory of research needs was created.

Résumé

Ce rapport précise le contenu de la conférence sur le suivi de la condition physique du caribou. De divers chercheurs se sont rassemblés à Whitehorse le 16 au 18 février, 2000 afin de discuter le rôle des communautés autochtones dans les programmes de suivi.

Les participants ont discuté leurs connaissances des liens entre la condition physique et la productivité des troupeaux de caribous. Les programmes actuels de suivi de la condition physique du caribou ont été analysés. Les chercheurs ont évalué les avantages et désavantages des techniques de suivi et ensuite ont proposé des formats de participation des communautés autochtones au suivi du caribou. De plus, un catalogue détaillé des besoins scientifiques a été créé dans le but d'améliorer les techniques de suivi de la santé du caribou.

Acknowledgements

This workshop was part of the "Integrating Traditional Knowledge and Science in Large Mammal Research Project" (OPP-9709971) funded by the U.S. National Science Foundation. The Canadian Wildlife Service provided specific funding for the workshop through the Climate Change Action Fund. Participants were funded by their individual agencies, including the governments of the Yukon, Northwest Territories, and Nunavut, the Alaska Department of Fish and Game, Dartmouth College, the University of Manitoba, the University of Alaska Fairbanks, and the Kotzebue IRA[1]. The authors thank all those who participated in the workshop.

[1]IRA refers to agencies created under the Indian Reorganization Act

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Introduction

Over the last four decades, many research projects (Dauphiné 1976, Adamczewski et al.1987, Huot 1989) have provided valuable data on the health and condition of arctic caribou herds in North America (Figure 1). These studies, undertaken primarily by biologists, were largely isolated studies meant to address specific questions about specific herds. Taken collectively, though, they provide snapshots of fat and protein cycles for the species and document linkages between body condition and individual and/or herd productivity (Cameron and ver Hoef 1994, Russell et al. 1998). However, the array of indices measured and techniques employed (Huot 1988, Huot and Picard 1988) are almost as varied as the number of studies undertaken. As a result, it is difficult to compile these data in order to conduct a comparative assessment of herds across North America, especially since the reports summarize the data by various age classes and time periods. Furthermore, community concerns regarding the methods used to compile body condition data affect the willingness of caribou users to cooperate with biologists.

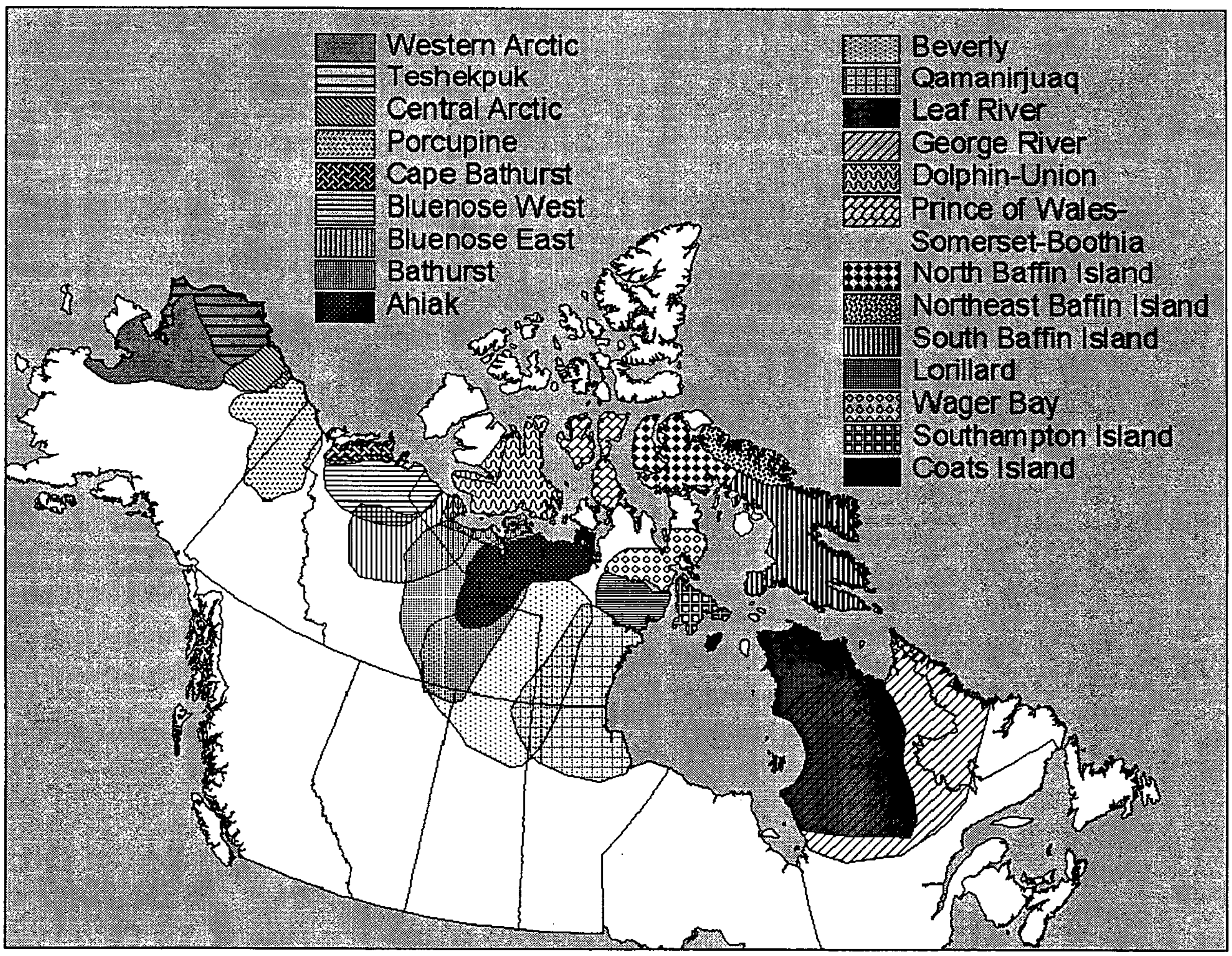

Figure 1 **Migratory caribou herds in this report**

With the increase in demand for northern natural resources and the current climate change trends, especially in northwestern North America, cost-effective ways of monitoring these impacts are needed. Moreover, as northern indigenous groups gain more control and thus, assume more responsibility for the management of wildlife resources, it is becoming increasingly important to initiate projects that have a major community involvement.

This workshop was organized with the objective of bringing together as many caribou researchers as possible in order to:

- discuss the role communities can play in monitoring caribou body condition
- discuss the current state of knowledge on linking body condition to productivity,
- evaluate the advantages and disadvantages of techniques being used to assess body condition,
- survey current body condition monitoring programs,
- propose cost-effective and practical methods to monitor body condition, especially involving caribou user communities, and
- set out a list of action items (to be completed over the coming year) to further our understanding of how to monitor the health of caribou herds.

As a group, the following overall objective was defined for the workshop:

> Establish a community-based system for monitoring caribou that tracks individual and herd well-being (body condition and disease status), detects change in environmental conditions, and contributes to a co-management assessment of future impacts

The workshop took place in Whitehorse, Yukon, Canada from February 16 to 18, 2000. A brief workshop report was written at that time. The authors have rewritten the report and provided an update on follow-up activities. We have decided to publish the workshop proceedings under the Canadian Wildlife Service Technical Report series for wider distribution and ease of reference.

Section 1. Community based monitoring – *has the time come?*

The local caribou user communities of the North would like to be involved in monitoring, management, and research. They want to contribute their knowledge and build the community capacity to manage their caribou. Community input is crucial in setting a research program's objectives; communities and hunters must be involved in building a database of observations, explaining those observations, and interpreting relationships between caribou health and environmental conditions.

Historically, managers and user communities have grappled with recurring conflicts regarding local concerns about science-based research methods. While there are clearly cultural differences between science and traditional knowledge of caribou, body condition monitoring and assessment represent areas of potentially complementary activities. Thus, collaboration need not become an issue of traditional knowledge versus science; cooperation among groups can improve overall understanding and help all groups to know how to best respond to changing conditions.

As demonstrated by the Arctic Borderlands Ecological Knowledge Coop (Kofinas et al. 2002), communities are very willing to share their on-the-land observations and explanations of a wide range of topics, such as:

- observed anomalous events or conditions
- observed long-term environmental change
- observed recent environmental trends
- human feedbacks to ecological systems

This knowledge has addressed specific areas, such as the quality and quantity of fish, weather conditions affecting annual berry crops, intensity and timing of cotton grass bloom, and fatness of animals.

Locals want to know more about caribou disease, parasites, and causes of population decline. Managers want to know about body fat levels so they can predict pregnancy and calf survival. The two key questions we must address to meet these objectives are:

- How can local caribou hunters' observations of body condition contribute to a monitoring effort?
- Can we design and implement a system that answers important biological and resource management questions, and is appropriate for communities, while being transferable between herds?

It is important to be very clear about exactly what we need from a community caribou monitoring program and what is possible to achieve through its means. For example, if we were only looking for pregnancy rates, a collection of cow fecal samples and a jaw would be sufficient.

Local and traditional ecological knowledge of caribou encompasses a range of topic areas, much of which parallels science-based research. Some parallel topics include migratory patterns, annual distribution, disturbance, range conditions, range fidelity, body condition, causes of mortality, diet, population dynamics, intra-specific competition, predation, taxonomic distinctions, response to severe events, taste of meat, and social behaviour.

Traditional knowledge of caribou includes indicators of body condition commonly used by subsistence hunters in the field (Table 1). These vary by region and from hunter to hunter.

Table 1 Indicators of good caribou body condition and overall health, reported by indigenous Porcupine Caribou hunters (Kofinas 1998)

Indicators hunters look for when selecting caribou	• Size of rump • Gait or waddle of walk • Whiteness of mane • Size of rack • Symmetry & overall shape of rack • Number of configurations or points on rack • Size & shape of shovel • Greyness of rack • Social role of individual in group • Posture of animals when moving
Post-mortem indicators of caribou health	• Quantity of "backfat" (i.e. rump) • Quantity of stomach fat • Colour of marrow • Tone & colour of lungs (lungs stuck to chest indicate poor health) • Colour of kidneys and liver • Absence of pus bags on kidneys • Absence of "water" in muscles (water produced when animal is worked) • Contents of stomach (grass-filled may indicate sick animal) • Presence of parasitic larvae in kidneys

One of the major opportunities afforded by using hunter activities to help monitor caribou condition is the tremendous sample size potentially available. For example, approximately 3,000 caribou/year are harvested from the Porcupine Caribou Herd, 25,000 caribou/year from the Western Arctic Herd, and 40,000 caribou/year from the George River Herd. Community harvest levels are significantly higher than sample sizes typically available to biologists.

Sampling using a community-based approach presents challenges, including:

- Sampling sufficient animals to obtain the range of adult body condition and health.
- Differentiating yearlings from sub-adults.
- Organizing logistics of monitoring year-round or seasonal community harvests with local hunters.
- Determining when and to what extent the community harvest is affected by selective hunting, which could lead to seasonal and regional biases.
- Sampling regionally to account for distribution and movements of herd(s).
- Knowing which herd is being sampled.

Community monitoring using a common set of variables collected with similar protocols would enable the comparison of ecological conditions and herd health across herds. Ultimately, current conditions of herd well-being could be compared with a meaningful long-term data set that is based on many populations. Co-management boards could then use these comparisons in an integrated assessment of populations for public policy deliberations.

The protocol for hunters to determine body condition and health should be simple to use in the field under extreme environmental conditions. In its simplest form, the protocol would rank each animal as being in either good or poor condition, and as diseased or not diseased. The protocol could be in the form of a dichotomous key with each variable recorded as present or absent, yes or no, or more or less. The sequence of completing the questionnaire should not lead to a bias by the hunter/recorder.

Local hunters should be employed to carry out error checks, summary analyses, and an initial interpretation of the outcome from the field protocol. Raw results and an initial scientific interpretation must be returned to communities for their analysis and interpretation. Ideally, active local hunters, elders, community organizations, and regional co-management groups would review the findings, clarify local observations, and provide interpretation from regional and long-term perspectives.

Data bias issues also need to be considered, but if the criteria for data collection are the same from year to year, then the trends can be followed as an index. We need, as a minimum, a method where findings will be comparable between different collections and communities. Our contribution from this workshop is the input of technical and theoretical scientific expertise. We can provide input into various monitoring methods.

Fundamentally, much of the success will be determined by the relationship between the biologists and local hunters. Some monitoring programs may depend on individual hunters or work with quickly trained individuals. Other situations may call for developing a group of community-based technicians. Biologists may also hire locals as guides, but would sample and assess the caribou themselves. Monitoring techniques may use visual assessments, harvested animals, special collections, or commercial hunts.

An effective community monitoring protocol must be sensitive to cultural values. The protocol should capitalize on existing hunters' methods and knowledge, local systems of community members, and local biologists' methods. An effective protocol should provide a physical assessment of harvested animals and annual trend information on the population as a whole. Contributions to regional monitoring and to assessing food quality for communities (i.e. human health implications relating to the consumption of meat) would also be valuable. Other factors determining success include the cost of labour and material, the amount of special training required, and the need for continuity of individuals. Success is of course related to the extent to which the system is predictive.

Section 2. Body condition, productivity and weaning strategies – *what do we know?*

Studies over the last couple of decades have linked caribou body condition to many productivity parameters. Understanding the relationship between body condition and reproductive performance is necessary to determine what measures are applicable to management of caribou herds.

There is a direct link between body condition and reproductive success. It is well established that pregnancy rate is directly related to fall body condition of the cow (Cameron et al. 1993, Cameron and ver Hoef 1994, Gerhart et al. 1997). Furthermore, early embryonic mortality is directly related to low fat reserves in cows at the time of the rut (Russell et al. 1998).

A female must utilize her own body protein reserves to grow her foetus as she obtains little protein from winter forage (Gerhart et al. 1996a). Fat reserves supply energy to convert the maternal protein to foetal tissue. Thus, a female with low winter fat reserves may not grow a full-sized foetus, even if protein reserves are adequate. Similarly, females with low protein reserves, will likely yield low birth weight calves (Allaye Chan 1991), even if they have adequate fat reserves. Body condition is not measured by fat alone; the protein content of the animal is also important. Therefore, the measurement of body mass in association with a body fat index is considered optimal (Gerhart et al. 1996b).

Body condition of cows upon arrival at the calving ground, and conditions on calving grounds are important for reproductive success. Perinatal mortality, is likely a function of body condition of cows arriving on the calving grounds, and is not affected by forage conditions on the calving grounds (Griffith et al. 2002). However, early calf mortality (mortality to one month) is largely related to forage conditions on the calving grounds (Griffith et al. 2002).

Lactation doubles the energy demands of the female soon after giving birth (White and Luick 1984, Russell et al. 1993). Caribou milk is rich in milk fat, which is derived from body fat. Milk protein is synthesized from body protein reserves and forage protein, the latter being seasonally available (White and Luick 1984). The use of plant protein for milk protein synthesis requires three times more energy if metabolized from forage instead of fat reserves. Both the fat and protein reserves of the calving female can therefore limit milk production. Also, if green-up is late, both forage protein and forage metabolizable energy can limit milk production (White 1992).

From captures and recaptures of female caribou and their calves conducted between 1990 and 1995, it was determined that weaning strategy was an important determinant of productivity in the Porcupine Caribou Herd (Russell and White 2000). From these captures, five weaning strategies were identified:

Post-natal weaning occurs when biomass during the first week in June and rate of plant growth over the next three weeks are insufficient to maintain growth rates in the calf. Upon weaning, the calf dies and the cow increases her potential for pregnancy in autumn.

Summer weaning occurs when cow protein reserves fail to get replenished. The most likely cause is accidental injury or disease in the cow, or possibly prolonged insect harassment that limits feeding, as we do not consider nitrogen availability limiting in the summer range of the Porcupine Caribou Herd. Upon weaning, the calf dies and the cow increases her potential for pregnancy in autumn.

Early autumn weaning occurs when the fat reserves of the cow are below a specified threshold primarily due to a combination of the factors listed above and a particularly bad insect year. As a result, the survival rate of the calf declines and the age of first reproduction of the calf is likely advanced. For the cow, this strategy enhances her survival through winter and increases her chance of getting pregnant.

Extended lactation until the spring can be common in the Porcupine Caribou Herd and is associated with low fat reserves in the calf. As a consequence, the cow reduces her probability of getting pregnant due to "lactational infertility" but increases the survival of her calf (Gerhart et al. 1997). Calves with lower fall body weights attain spring weights similar to heavier individuals if they benefit from extended lactation through the winter. The energy cost of lactation is high, and cows lactating in late winter usually have the lowest body condition scores (an indication of poor body condition).

Normal weaning is initiated during the rut and results in higher pregnancy rates for the cow. In this case, both cow and calf have healthy levels of fat and protein reserves.

Age of first reproduction is directly correlated with female calf growth rate and female calf birth weight. Calf growth rates, in turn, are highly dependent on milk intake. Research done at the University of Alaska Fairbanks shows that calves with fully developed rumen (as determined by rumen fill measurements at greater than 3 weeks old) maintain themselves on forage, but their growth rates depend on milk consumption (White 1992). Lactation clearly affects population dynamics and is driven by body condition.

From the above discussion, it is clear that body condition and reproductive success are interdependent, which makes body condition an important consideration for community monitoring and management. Indeed, pregnancy rates, body condition, and/or lactation status of harvested animals can be reported to local biologists, making reproductive success easy to report (i.e. requires minimal training). Fat and protein composition of cow and calf can be monitored through body condition scores.

A community monitoring program that records milk in udders can tell us a lot about the condition of the cows and the weaning strategy employed on an annual basis. For example, in the autumn of 1990, Porcupine Caribou hunters reported that cows were in very poor shape. In response to these concerns, biologists sampled a number of females that fall. These November captures indicated that cows were thin and that most of them had already dried up milk production. Further analysis indicated that those in poorest shape experienced early embryonic loss (Russell et al. 1998).

Section 3. Body condition – *how was it measured in the past?*

Phil Lyver presented a review of the various indices, methods, and techniques that have been published in the past and discussed the advantages and disadvantages of each measure. The workshop participants then offered their assessments. The review and discussions are incorporated under subjective (Table 2) and objective measures (Table 3).

Table 2 Comparison of subjective techniques to assess body condition

Technique	Advantages	Disadvantages
Body Condition Index Scores Manual estimate at three sites (withers, ribs, & base of tail)	• Sound basis in animal science • Calibrated for barren ground caribou • Success in the past with little experience with the method • Can be done with a group of observers (collaborate) • Good experience with woodland caribou, Western Arctic caribou, & Western Arctic moose • Can condense number of points (simplify method) • Fat & protein score gained	• Protocol differences for different herds currently limits comparisons • Hunters in the Porcupine Caribou Study voiced reluctance towards this method (do not want to palpate the animals) • Problems looking for variability when animals have seasonally similar body condition– differences may appear based on season and or sex
Body Condition Index Scores Manually estimated from the short-ribs	• Successfully used by beef cattle farmers • Simple one spot manual palpation	• Cannot see difference, must feel • Hunters in the Porcupine Caribou Study voiced reluctance towards this method (do not want to palpate the animals)
Body Reserve Index Body condition score times body mass	• Has quantification in literature • Good predictor of pregnancy	• Requires body mass for index (see disadvantages for body mass)
Visual	• Non-invasive • Valuable comparison with numerical appraisal of body condition scores	• Hunter may not use ranked order system (may use binary method) • Confounded by season

Table 3 Comparison of objective techniques to assess body condition

Technique	Advantages	Disadvantages
Body Mass	• Straight forward • Objective • Precise • Repeatable • Robust measurement • Provides body protein score if body fat is known • Can be done for a single season	• Difficult for hunters to weigh animals • Requires extra gear • Requires extra time • Requires other characteristics (age/sex) • Subject to inconsistent sampling (head on/off, skinned/not skinned, variable gut fill)
Carcass Mass	• No problems with variable gut fill • Hunters can provide carcass mass more easily than body mass	• Subject to inconsistent sampling (head on/off, skinned/not skinned)
Subcutaneous Back Fat Depth	• Non-invasive on live animals • Simple procedure • Does not affect meat • Where present, good correlation with other measures (hip palpation/back fat)	• No correlation below 6% total body fat (first to be used during undernutrition) • Animals with no back fat still become pregnant • Requires training to identify maximum fatness locations on caribou • Subject to inconsistent sampling (location on animal) • Biopsy needle may infect live animals • Locals may disagree with biopsy needle
Ultrasound measure of backfat	• Non-invasive on live animals • Potential as a more objective measure of back fat thickness • Easy to use & quick to learn • More sensitive than visual appraisal	• Difficult to determine where maximum fatness is located • Requires highly technical, fragile gear • Expensive
Kidney Fat	• Good correlation with dissectible fat • At the low end of the body condition range, it is expected to be a good index • Standardized procedure (Riney Index)	• Time of year affects correlation with total body fat • Subject to inconsistent sampling (amount of fat removed with kidney) • Not a sensitive measure of body fat in obese animals • Ccorrelation with body fat below 6% body fat needs checking
Heart Mass & Heart Fat	• Good correlation with heart mass & muscle mass • Might be possible for hunters to cut heart out consistently • Can be collected later • Low heart mass and fat may be indicators of extreme conditions (last to be used during undernutrition)	• Requires other characteristics (age/sex) • Prized part of the animal for consumption • Fat in the cardiac/ coronary groove/ pericardium is difficult to remove

Technique	Advantages	Disadvantages
Femur Marrow Fat %	• Good correlation with body fat in thin, starving animals • Good correlation with total body fat when total fat is removed from the bone, weighed, & assayed for total fat • High potential for use in community monitoring if a rating system of texture and colour is developed (Kistner et al. 1980, Torbit et al.1985) • Often left in natural mortality situations	• Unknown how femur marrow fat relates to overall body condition in fatter animals • Difficult to remove it all • Colour alone (visual assessment) is a low predictor of marrow fat % • Requires other characteristics (age/sex) • Hunters may not want to touch the marrow of an animal in "poor" condition • Subject to inconsistent sampling (location within the bone)
Mandible Fat	• Published regressions available • Often left in natural mortality situations • Fat easily extracted once jaw removed	• Heads are desirable by trophy hunters • Lots of handling of the animals
Chemical Extraction Extract fat with solvent from animal "sawdust"	• Good correlation of muscle fat with body fat even when fat levels are below 6%	• Requires large meat sample (research method, not community monitoring tool) • Subject to inconsistent sampling (amount of fat extracted depends on the solvent used) • Requires laboratory analysis • Expensive & labour intensive
Marbling Index Score		• Caribou meat does not marble
Leptin	• Easy to collect blood and store for analysis (freeze) • Can sample live animals	• Insufficient research to support method • Requires laboratory analysis • Sensitive to time of day • Correlation with body fat is not always significant
Hydrogen Isotopes (Deuterium Dilution)	• Very accurate technique to measure total body water &, by difference, total body fat	• Hunters will not accept the idea • Ineffective for short timeframe in field • Equilibrates too slowly for field work • Requires subduing animal for long time
Blood	• Can determine health & disease with blood • Establish identity of herd (DNA) • Simple procedure • Pregnancy indicator from November to parturition (progesterone) • Provides early warning to problems with condition	• Cannot freeze (i.e. 4 good samples from 39 kills in Nunavut) or get too warm • Requires centrifuge at sampling location or soon after collection • Requires coagulation

Technique	Advantages	Disadvantages
Fecal Progesterone	• Pregnancy indicator from November to parturition • Calibrated for caribou • Good correlation with pregnancy	• Requires other characteristics (age/sex) • Requires laboratory analysis
Indicator Muscle & Bones	• Good correlation with body fat & body protein	• Subject to inconsistent sampling • Requires training & practice

Section 4. Monitoring initiatives – *what is currently happening?*

Workshop participants presented ongoing programs designed to monitor body condition of caribou. These and other studies that participants were aware of are compiled in Table 4.

Fall/Spring Collection of Calves: a Monitoring Technique for Caribou
(NB: Pat Valkenburg submitted a written contribution to the workshop.)

An annual collection of October body weights of female calves can be used to determine summer range condition. If both male and female calves are sampled, then the sample size required to keep statistical power from declining will double. Annually measuring back fat depth on bulls could be a useful index but the logistics and sampling problems are more difficult (age could be a confounding factor). Using adult females to monitor herd condition is also limited by sampling errors and logistic factors (e.g. distinguishing lactating vs. non-lactating; old vs. young; pregnant vs. non-pregnant).

Female calves are selected because the weight of a calf entering its first winter is highly correlated with the age of first breeding, which is an important control over reproductive rate in caribou. A statistically significant difference emerges with a sample size of 10-15 calves when means differ by about 4 kg. Decreases in the fall body weight of calves correlate with major population declines however; a collection (or handling) needs to be undertaken every year to distinguish between annual variation and long term trends. Collections should include variables that assess the quality of annual winter range (e.g. fecal samples and snow depth) to be most useful for tracking effects of climate change.

In many local communities, shooting calves is considered inappropriate hunting behaviour, therefore, while one indigenous community may be willing to harvest calves, others may find it difficult to justify. Local communities may not tolerate scientific sampling of calves particularly with airplanes and helicopters harassing caribou in order to shoot calves. Composition counts done in September/October can provide additional support to trends developed from data collected through community monitoring. But because hunting can occur from August through to March, the seasonal variability of hunting reduces the validity and strength that fall compositions counts would provide in combination with the body condition community monitoring data.

Veterinary Methods for Assessing Health of Caribou

(NB: John Blake and Todd O'Hara submitted a written contribution to the workshop.)

Histopathology can be a tool to assess animals for tissue and cellular atrophy (inactivity of digestion, muscle wasting etc.), serious atrophy (utilization of fat stores), and digestive tract changes (stunted ruminal papilla, inactive mucosa). It can also provide information such as percent lipid or protein in selected tissues (muscle or liver), and normalized DNA content (controls for cellularity). Hunters can contribute to the monitoring of caribou health through observation and reporting of lesions/spots on body/organs as well as collections and delivery of tissue samples such as liver or muscle. Hunters often report sick or unusual animals to conservation officers or regional biologists.

Parasites and Body Condition

Anne Gunn

Parasites affect foraging, behaviour, digestion and the immune system, and are potentially simple to monitor. Fecal samples can be easily collected to obtain fecal progesterone and parasites. This makes parasite monitoring appear logistically viable to community monitoring. However, parasites may not directly influence body condition, and the analysis must be undertaken by a parasitologist rather than by the local community.

Sampling Bias: Problems And Challenges

Ray Cameron

Caribou undergo reproductive pauses when declining body condition reduces the relative amounts of body protein and fat. In order to accurately describe the conditions of adult female caribou, there are many sub-groups with different "reproductive histories" to sample. The sub-groups need to be sampled in proportion to their occurrence in order to accurately describe the condition of females at the population level. Rigorous random sampling approach is necessary to get a representative sample.

Porcupine Caribou Body Condition Study

Dorothy Cooley

A body condition project for Porcupine Caribou began with Chan-McLeod's dissertation research in 1987 (Allaye Chan 1991, Allaye Chan-McLeod et al. 1999), and on-going herd monitoring began in 1989. Among other objectives, Chan-McLeod focused on establishing indices of free ranging caribou that would best predict body fat, body protein, and body weight. Her thesis led to the development of the Porcupine Caribou Body Condition Study, now conducted by the Yukon Government out of its Dawson City office.

The study has gone through several changes in the last few years with an effort to simplify methods to allow community hunters to assume more direct responsibility of data collection. This system worked well when an elder, who is a skilled hunter, was present and another person recorded findings. Elder involvement and dedication in a project is crucial. The factors that were monitored in this project did not serve as an early warning during the recent population decline of that herd so we have been able to eliminate these factors as possible causes. At a bare minimum, this study is tracking the fatness of caribou.

The revised measures monitored in the Yukon Government study include estimated body fat (Chan-McLeod's equation), presence of calf, presence of milk in udder, location of kill, hunter's name, and weight of front shoulder (estimate of body weight/protein). Hunters collect teeth and jaws (jaw length to body size correlation), left kidneys, and metatarsus. From 1989 to present, the Yukon Government has used kidney samples to measure contaminants. The laboratory analysis is done in Dawson.

Differences in body condition from March to June would be important in understanding annual body condition dynamics. Currently, no animals are collected in June. From a community perspective, this month is a bad time to shoot cows, yet biologists feel that these data are important to understanding herd productivity.

This study has encountered its share of problems. In its first phase, biologists conducted all field collections with locally hired assistants. The program costs $10 000 per year and hunters are compensated for their time and use of gear. The migration habits of caribou pose logistical difficulties because the caribou are sometimes absent when biologists are in the field. More recently, an effort has been made for local hunters to assume primary responsibility for collections. To date, the program has not attracted dedicated local participants, so samples have not been regularly collected. For the program to be successful, hunters need to believe in the program, because the extra handling time at a kill site is crucial, especially in March.

There are a number of problems that need to be rectified as the program continues:

- The program may need to increase numbers of participating hunters to increase its sample size.
- Logistical problems, such as getting samples frozen (freezer space) need to be addressed.
- Administration at the local level needs to be coordinated, including internal pay logistics and residency issues.
- Hunters tell biologists and their co-management board that the collection is considered to be "messing" with the animals too much by handling the carcasses more than hunters feel is absolutely necessary (i.e. traditionally acceptable).
- There has been concern by Old Crow hunters that the fall collection of cows is causing calves to die from predation (Russell et al. 1991, Kofinas 1998).
- Seasonal hunting of bulls in the fall and cows in the spring reduces the monitoring program's sample size if it continues to monitor only cows.

- Fort McPherson hunters do not generally skin their caribou in the field, which effects weight measures.
- Samples are not necessarily random or independent, because hunters select for fat and healthy animals.
- Our field trial of marrow colours in relation to marrow fat percents produced no significant relationship.

Western Arctic Herd Studies
Jim Dau and Augie Nelson

In the Western Arctic Herd, controlled hunts were done (calf collections) for Alaska Department of Fish and Game biologist, Pat Valkenburg. Hunters and community members stated that they like the idea that "we are looking at the herd more carefully" but they did not want to have "gun ships [shooting caribou] in the name of science." Reindeer harvests, which have used helicopters and guns, have resulted in bad public relations within its associated community. Significant and consistent data were collected while the calf collection was operating, but the study was terminated because:

- Collectors did not believe in the project
- Yearlings were accidentally harvested instead of just calves
- Samples were not obtained from all the regions
- Locals would not take the calf meat

In Kotzebue and Kiana, interview forms are now being completed by recall (after the hunter returns from hunting trip) and are facilitating the gathering of information on the body condition and general health of Western Arctic Caribou. Gas, shells, and meat are provided to each hunter when he completes and submits the survey form. Presently in Kotzebue, there are 45 hunters on the list, half of whom are active. Through word of mouth, 20 individuals filled out survey forms within a two-week period. In Kotzebue, shallow snow reduced hunting in 2000. Hunters fill out the survey forms by recall but in some cases not until a week after the hunts, making the information less reliable. There is no warning when survey forms will be completed so contact with local hunters is difficult to schedule.

Funding for this National Science Foundation project will end in three years and we do not know what will happen then. It is important that we do not "monitor for the short term"; this is a waste of time and social capital. The community is aware that the project belongs to them and not to the government.

Years ago, 90% of Alaska's hunters voluntarily submitted bear skulls for scientific measuring in a black bear study. The numbers of submissions decreased over time when hunters saw no results from their efforts. We must ensure that the communities see consistent feedback from their efforts.

Remote Sensing and Caribou Dynamics

Brad Griffith

Remote sensing methods can provide a wealth of information about caribou performance as well as opportunities to support and complement community monitoring of body condition. Remote sensing produces strong statistical relationships between vegetation dynamics and calf survival and offers an opportunity to relate global change to community monitoring of body condition. Communities can contribute to remote sensing through local observation of plant phenology, temperature, wind speed, insect severity, snow depth, and details on the snow pack. Using weather satellite data, we can monitor plant growth timing, intensity, and distribution. We have used these data to successfully relate early plant growth characteristics with early calf survival in the Porcupine Caribou Herd.

Current Body Condition Programs in North America

From the preceding presentations and further input during discussions, Table 4 is presented as an initial list of current monitoring programs.

Table 4 North American studies incorporating body condition assessment

Objective	Researcher	Herd	Methods
Herd Assessment	Farnell	Yukon Woodland	Whole body carcass analysis External assessment of live animals
	Gunn	Dolphin Union	Whole body carcass analysis
	Patterson	Bluenose	Whole body carcass analysis
	Valkenburg	Various Alaskan herds	Fall/spring collections of calves
Routine Monitoring	Cooley	Porcupine	Hunter assisted collections
Protocol Development	Adamczewski	Coats Island	Whole body carcass analysis
	Chan-McLeod	Porcupine	Whole body carcass analysis
Body Condition - Reproductive Performance Research	Cameron	Central Arctic	Capture/recapture of marked animals External assessment of live animals
	Gerhart, White, Russell	Porcupine	Capture/recapture of marked animals External assessment of live animals
Community Based Pilot Projects	Dau	Western Arctic	Single value visual assessment
	Kofinas, Eamer	Porcupine (Knowledge Co-op)	Post-season qualitative assessments by hunters
	Kofinas, Nelson, White	Western Arctic (Kotzebue/Kiana)	Simple yes/no answers
	Lyver	Bathurst (Łútsël K'é)	Hunter assisted collections End-of-season interviews with elders

Section 5. Proposed protocol – how can we standardize?

The following is a summary of discussions that took place in plenary, prior to breaking into two groups. The discussion refocused the group on the advantages and disadvantages of community-based monitoring for caribou condition. The group were presented with a dichotomous key developed by Bob White (Figure 2). It was suggested that each group consider the validity of Bob White's draft decision tree and explore how to collect body condition data in a way that is compatible with community harvesting activities. As well, the two groups were asked what to measure on the basis of management implications and science. For example, if one measures variables appropriate for very healthy caribou, like subcutaneous back fat, and during a population crash the marrow fat in the animals becomes red and runny, the monitoring program may miss an opportunity to monitor and potentially intercept a population crash if the variables appropriate for unhealthy caribou (such as marrow fat percent) are not measured. Therefore, we should develop a method that includes indices reflecting all levels of body condition (such as presented in Figure 2), while keeping it simple enough for the community to incorporate into their hunts.

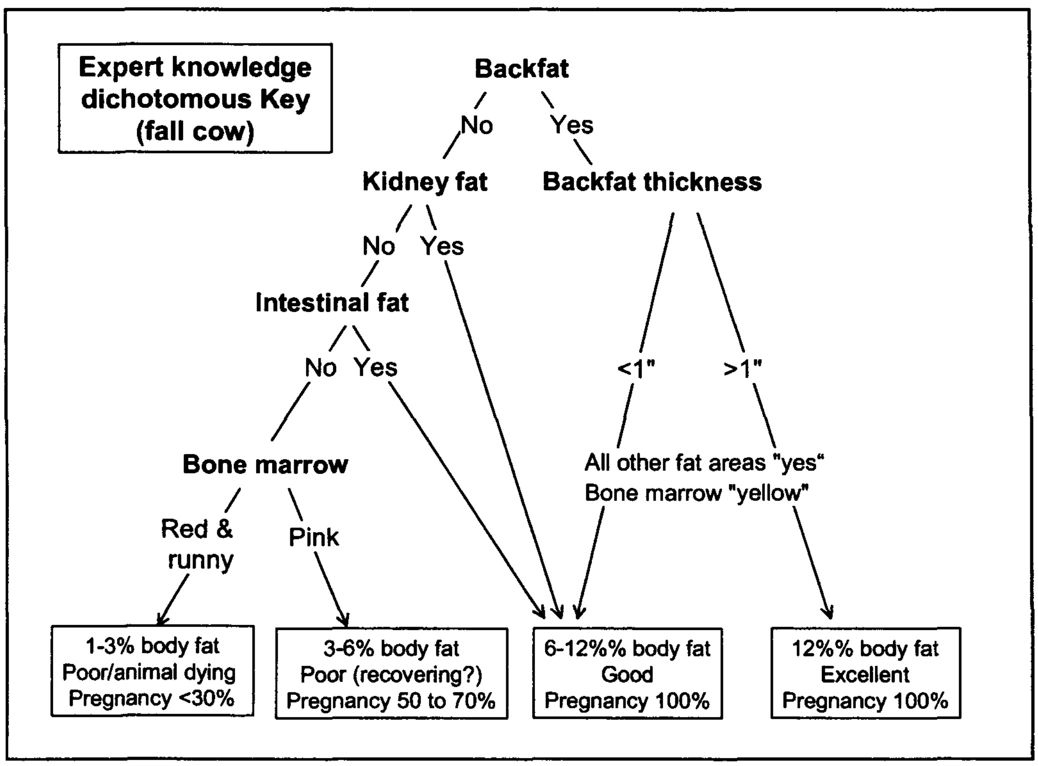

Figure 2 White's key for simple assessment of caribou body condition

Discussion also focused on the feasibility of using hunter kills as a basis for monitoring herd condition. On the positive side, the potentially large sample size is desirable. As well, hunter kills could allow sampling year-round and enable us to track seasonal variation in body condition.

However, if the goal is to target the animals people are eating, biologists should understand that this would not be a random sample. For example, differences in spring weights of harvested animals are highly correlated to body protein. Body fat, or at least a percentage of it, is being retained for lactation while body weight goes down (from protein catabolism). This may lead to an overestimation of body condition, if based solely on a measure of weight. Furthermore, in the spring, hunters will select against skinny unhealthy looking animals. During the fall harvest, animals should be in good condition so that little selection is likely to occur. For any monitoring program that we devise, we have to assume that the community selects for the healthier animals. As a consequence, it is possible that if there were a herd wide depression, we may not be able to predict it based on body condition trends monitored from a selected harvest.

Statistical variance and mean are equally significant. If the variance is known, sample size can be predicted, and although we are aiming for large sample sizes, we are sampling at different times of year, and including both sexes, so an idea of sample size would be a useful tool.

Protocol Development Exercise:
Participants divided into two groups and drafted field sampling forms that reflected three levels of sampling intensity:
- visual appraisal,
- completion of form,
- use of form and sampling.

Group 1's discussions are reflected in Table 5.

Group 2 (Table 6) discussed the importance of stratification and sample size, which will be dictated by the level of hunter interest and/or the degree of the biological problem. All information is driven by stratification, sample size, calibration, and potentially independent validation.

Implementation should be done through interviews of individuals/groups, field surveys (calibration, comparison, area coverage) and where possible, be complementary to existing programs.

Complementary areas for community monitoring incidental to hunter-based body condition observations:
- Phenology
- Plants - three most common ones (bloomed/died)
- First leaf/flower, first fall colour (on willows?)
- Mushroom abundance/timing of occurrence

- Insect frequency, intensity
- Migrations - waterfowl, caribou, passerines
- Plant abundance (cotton-grass - berries, flowers)
- Weather at more sites
- Snow depth, consistently recorded (school project)
- Water body freeze up, break-up, ice thickness (thinner or thicker)
- Fire frequency, extent, and intensity/locations
- Harassment and disturbance (human, global events, etc.)

Table 5 Group 1's format for three monitoring levels

Level 1: Visual Appraisal	Level 2: Field Form	Level 3: Field Collection and Measurements
Hunter Recalls	Hunter Interview Form	Hunter Sampling
• One per season • Date/season • Location • Sex • General fatness (condition) • Any unhealthy caribou seen • Use the hunter's criteria/ words for condition in addition to system survey • May include questions compatible with other ongoing projects	• One per caribou • Must include all key hunters • Include everything from hunter recall • Pregnant/ lactating	• One per caribou • Key followed by biologist • Collect variables needed in Figure 2 (presence/ absence) • Back fat depth • Jaw length • Samples: blood collection, bone marrow (lower leg), jaw, tooth, body condition score)
Hunter Visual Assessment	Dichotomous Key	Biologist Assisted Collection
• Number assigned to each live caribou • Date (season) • Location • Sex • Snow depth • Spring thaw • Number of calves • Plant phenology	• One per caribou • Collect variables needed in Figure 2 (presence/ absence) • Pregnant/ lactating • Date of kill • Location of kill	• Intensive sampling by biologist • Answer specific question(s) • Can measure all indices • Look at monthly trends to get baseline data and standardize data sets

Table 6 Group 2's format for three monitoring levels

Level 1: Visual Appraisal	Level 2: Field Form	Level 3: Field Collection and Measurements
• Date • Location • Age • Sex • 3/5 classes of overall visual assessment (from "skinny" to "fat") • Comments	• Include everything from lower level • Lactating/pregnant • Abnormalities - liver, wounds, limping, joint condition, lesions in organs, etc. • Body condition score • Back fat depth • Bone marrow colour/consistency • Kidney fat • Brisket fat • Opportunistic tissue samples	• Field measurements (include everything from lower levels) • Shoulder weight • Marrow fat sample (metatarsus/femur) • Abnormal tissue samples • Contaminant tissue samples • Blood sample • Fecal sample • DNA sample (skin) for herd identification

Section 6. Action items and research needs – *where do we go from here?*

At the close of the workshop, participants suggested a number of research needs and follow-up action items to help meet the workshop objective. Given the time between the end of the workshop and this publication of the formal proceedings, our approach in this section is, not only to list the suggestions, but also to report on any progress in addressing these items.

Item 1: Produce and distribute proceedings of this workshop – CWS lead
Informal proceedings were drafted and distributed to workshop participants in summer 2000. Since that time, enquiries from researchers and managers to access the report have prompted us to rewrite the proceedings and publish as a CWS Technical report.

Item 2: Collate and compile existing data on body condition of caribou in North America and conduct a comparative analysis – CWS lead
From an initial list of possible datasets (Table 7), CWS, Whitehorse canvassed researchers across North America and created a file of body condition data, summarized in Table 8. A comparative analysis of the herds based on this dataset will be completed by March 2003.

Item 3: Involve communities in development and participation in community monitoring programs by:

- Spending time in the community and develop a good relationship
- Introducing the concept of community monitoring to the communities and engage in discussions on how the project might better meet their needs and objectives
- Ensuring people in the regions feel they are part of building the program
- Documenting terminology used by locals and comparing it to scientific terminology
- Introducing community monitoring at the North American Caribou workshop

A number of participants returned to their communities and projects and worked towards better engaging communities in body condition monitoring. Regarding the last item, many participants attended the 10th North American Caribou Workshop in Kuujjuaq. Two papers were presented that pertained to this workshop:

Towards a protocol for community monitoring of caribou body condition
Gary Kofinas, Phil Lyver, Don Russell, Robert White, Augie Nelson

Sustainability of caribou depends on effective ecological monitoring. Of all the indicators that can be monitored, body condition is useful because it integrates many ecological factors that influence caribou productivity and is recognized by biologists and hunters alike as meaningful. We draw on experience working with North American indigenous communities to develop a body condition monitoring protocol for harvested caribou. Local knowledge provides a broad set of caribou health indicators and explanations of how environmental conditions may affect body condition. Findings from previous research are the basis of a simple dichotomous key that managers can use to estimate percent body fat and the likelihood of pregnancy from hunters information on the presence of back fat, intestinal fat, kidney fat and marrow fat. The potential contribution of community body condition monitoring can be realized through continued comparative analysis of datasets, better communication among hunters and scientists, and the refinement of data collection and analysis methods.

A North American caribou database – a step in assessing impacts of climate change and industrial development
Don Russell, Colin Daniel

In recent years much focus has been directed to the fate of our large migratory caribou herds. Climate change and numerous development projects combine to pose a potential threat to the well being of these herds. Management agencies and co-management bodies need to have the best information possible to generate effective policy decisions related to the mitigating possible impacts. A recent survey across the north indicates that there is a wide disparity in the amount of baseline data that is available for these herds. We feel that by integrating all the data that exists for the populations and their habitats, we can create herd specific datasets that can be input for an integrated assessment tools. To that end, a MS Access database is being developed for mainland migratory caribou in North America. In this presentation we discuss the structure of the database, provide a few examples of comparisons among herds and outline a process to use the database as an integrated assessment tool.

Item 4: Investigate applicability and calibration of body condition indices to measures of whole body composition, herd productivity, and environmental conditions.

Suggested topics were:

- Convert results for simple classifications from continuous data sets available
- Design the "Ideal Dichotomous Key" from Chan-McLeod's data set and test the results on independent data set such as Adamczewski's or Cooley's
- Review variables collected during Chan-McLeod's study for verification
- Establish if the same results are attained in continuous and categorical data
- Assess applicability of indices and results across herds and geographic areas
- Establish simple/statistically significant method of assigning fat/protein values
- Calibrate:
  - ❖ Shoulder weight with total body weight or body protein correlation
  - ❖ Total body, carcass, and shoulder weights with "un-skinned" vs. "skinned" weights
  - ❖ Marrow appearance and location in bone with body condition and marrow fat percent
  - ❖ Body condition estimates with environmental quality
  - ❖ Body condition estimates with population demography
  - ❖ Disease-specific data with body condition
  - ❖ Visual assessment techniques with body condition

Item 5: Evaluation of existing studies

Three studies were highlighted that could contribute to developing a standardized community monitoring protocol.

- The Western Arctic study – Gary Kofinas, Augie Nelson, Jim Dau
- The Porcupine Caribou Herd study – Dorothy Cooley, Yukon Government
- The Łútsël K'é/Bathurst caribou study – Phil Lyver

<u>The Western Arctic Herd Study</u>

Several meetings were held with community members from user communities of the Western Arctic Herd to evaluate if and how the current monitoring program might be expanded. Recommendations were made to include additional communities from across the range to address the problem of regional variability in body condition. Another monitoring program based on local hunters' journals of the year's caribou-related events was also recommended. Both of these initiatives have been funded and are in their implementation stage. Additional funding has been awarded by the Selewick National Wildlife Refuge for the inclusion of the community of Selewick in the study. An initial analysis of community data from the program has been completed.

<u>Porcupine Caribou Body Condition Study - New monitoring system</u>

The project reassessed its protocol after participating in the Body Condition Workshop (this report). At that meeting northern caribou biologists gathered to develop a system that can be used by hunters across the north to track the body condition for any caribou herd. This system uses a dichotomous key approach to three fat indices and predicts the level of fatness and related probability of pregnancy. We have customized this system slightly so that we still get the samples needed to use Allaye Chan's equations, and will start using the system in 2002.

By obtaining samples over the entire winter rather than during 3 short collection periods and by enlisting more hunters as data collectors, we should significantly increase the sample size, and therefore, confidence in the results. By using this standardized system, we will be able to more directly compare the Porcupine Caribou Herd body condition and population dynamics to other herds.

Objectives for this project are to use hunter submitted samples to:

- Monitor the estimated body weight, body fat and body protein of adult cow caribou over the winter, and monitor trends over time,
- Monitor selected fat depots of adult bull caribou over the winter to document trends over time.
- Further investigate the relationship of these trends to other indicators, such as pregnancy rate, calf survival, herd size, timing of spring thaw, fall storm patterns, and winter range snow depth.
- Compare body condition to other herds being monitored using the same standardized system across the north.
- Monitor levels of heavy metal contaminants in submitted caribou kidney samples.

The standard data collection method allows for comparison of Porcupine Caribou body condition and population dynamics with results from studies of other herds across the north that are using the same system. The results will contribute to our understanding of the relationship between caribou body condition and other ecosystem components.

Łútsël K'é Caribou Monitoring Project 1999-2001 Progress Report

The study's objective was to use Dënesůłine (Chipewyan) contemporary and traditional knowledge and scientific methodologies to monitor barren ground caribou (*Rangifer tarandus groenlandicus*). This was part of a wider community-based environmental monitoring project. An aim was to determine whether Łútsël K'é hunter's impressions of caribou could be used to predict more detailed and semi-objective body condition indices. Hunters were accompanied on hunting forays during late winter 2000 and 2001. Variation in late winter body condition predictions was assessed between the two years. The relationship between body condition estimates and pregnancy probabilities was evaluated. Hunters' impressions of female caribou body condition recorded in interviews at the end of the late winter-spring hunting period were compared with impressions obtained in the field. Interviews were conducted with elders and hunters to assess annual, temporal, and spatial changes in adult female caribou body condition and environmental conditions. Elders' and hunters' knowledge of Dënesůłine terminology for caribou, past and present caribou migration patterns, and their explanations for any perceived changes in movements were also recorded.

Field data was used to examine traditional knowledge constructs, such as the use of antlers to predict body condition. It is proposed the community-based monitoring of caribou in Łútsël K'é will continue in the short-term supported by a Gordon Foundation grant. To date, six staff members from the Łútsël K'é community have been trained to collect body condition indices and/or conduct semi-directed and directed interviews with elders and hunters respectively. External researchers will return to the community in January 2003 to present results back to the community, standardize monitoring techniques, and assist with training additional staff members.

Item 6: Communication and cooperation

As a follow-up to the meeting a number of communication issues were raised:

- Establish common protocol among monitoring areas
- Introduce program to communities/identify funding sources and co-operators
- Establish strong communication links with veterinarians, animal science department staff, managers, regional biologists, and community contacts
- Develop list server (web site): A list serve was established for future discussion on the topic of community-based caribou body condition monitoring.

Table 7 Data from ongoing and past studies that will contribute to coordinated body condition monitoring project

Herd	Contact	Level 2 Form	Historic Data	Calibration Data
Beverly/Bathurst	Lyver	✓		✓
Bluenose	Patterson	✓	✓	✓
Coats Island	Adamczewski		✓	
Dolphin Union	Gunn		✓	
North West Bay	Gunn		✓	✓
Porcupine	Cooley	✓	✓	✓
Porcupine	Kofinas, Eamer	✓		
Porcupine	White, Chan-McLeod		✓	
Porcupine	White, Gerhart		✓	
Western Arctic	Kofinas	✓		
Yukon Woodland	Farnell	✓	✓	

Table 8 Summary of body condition dataset, with number of animals with data for each variable, by sex

Herd	Baffin Island South				Baffin Island Northeast		Bathurst				Beverly						Bluenose East	
Dataset	BS-1		BS-2		BN-1		BT-1		BT-2		BV-1		BV-2		BV-3		BE-1	
Sex	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Body Weight	24	20					14		64	37	18	38	825	393	26	10		
Body Length	10	6	33	16	19	4	27	5	88	59	18	38			26	10	45	8
Chest Girth			33	16	19	4	27	5	68	48			416	238	26	10	45	8
Lactation (Y/N)		22	33	16	19	4	24	5		69	4	38		402	26	10	45	8
Pregnancy (Y/N)	21	22	33	16	19	4	27	5	36	69		38	847	402	26	10	23	8
Foetus Sex		22					13		37	69		38	854	402	22	10		8
Foetus Weight		22					13		36	69		38	431	402	22	10		8
Back Fat			33	16	19	4	27	5	96	60			828	395	26	10	45	8
# of Warbles			33	16	19	4	27	5	55	39			789	361	11			
Rumen Weight									64	39					11	10	38	8
Heart Weight					19	4	14		67	38					26	10		
Left Kidney Weight			14	5			14		26	16					22	9		
Right Kidney Weight							14		26	16					26	10	44	8
Kidney Weight					18	4	14		86	52			810	386	22	9		
Left Kidney Fat			14	5			14		26	16					22	9		
Right Kidney Fat							14		26	16					26	10	44	8
Kidney Fat					18	4	14		86	52			810	386	22	9		
Gastrocnemius			14	5			14		103	51					11		44	8
Metatarsal Length			14	5					107	62			763	363	15	10	17	5
Femur Length							14		104	56			767	355	26	10		
Metatarsal Fat									82	57			189	83			16	5
Femur Marrow Fat									87	52			718	348				
Tibia Marrow Fat													164	74				
Dissected Fat													801	380				
Condition Score																		

Table 8 cont'd

Herd	Boothia East		Cape Bathurst		Central Arctic		Coats Island				Dolphin-Union				George River					
Dataset	BO-1		CB-1		CA-1		CI-1		CI-2		DU-1		DU-2		GR-1		GR-2		GR-3	
Sex	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Body Weight	2	5			96		77	19		14	99				139	19	76	16	97	6
Body Length	2	5	2	14			77	19	1	15			9	7	140	19	76	12	96	6
Chest Girth	2	5	2	14			73	17		14			9	7	139	19	77	10	58	6
Lactation (Y/N)	2	5	2	14	45		69	19		23			9	7		19	24	16	108	13
Pregnancy (Y/N)	2	5	2	14	51		54	19		23	100		9	7	140	19	67	16	33	13
Foetus Sex				14			31	19		23	70				105	19	75	16		13
Foetus Weight				14			31	19		23	71					19	58	16	13	13
Back Fat	2	5	2	14			76	18	1	23	111		9	7	134	19	73	15	103	13
# of Warbles	2	5					57	15			91		9	7	133	19	75	16	27	3
Rumen Weight							67	17												
Heart Weight							62	14									66	11	52	6
Left Kidney Weight							76	19			113				127	19	61	11	120	13
Right Kidney Weight							75	17							113	16	59	11	118	13
Kidney Weight	2	5					75	17					9	7	108	16	59	11	118	13
Left Kidney Fat							67	19			113				127	19	59	9	102	13
Right Kidney Fat							68	17							113	16	58	10	100	13
Kidney Fat	2	5					66	17					9	7	108	16	57	9	100	13
Gastrocnemius							75	17			103								57	6
Metatarsal Length					38		69	18												
Femur Length	2	5					76	18					9	7						
Metatarsal Fat																			59	10
Femur Marrow Fat	2	5					75	17			85		9	7	137	19			102	13
Tibia Marrow Fat																				
Dissected Fat																				
Condition Score																				

Table 8 cont'd

Herd	Leaf River		Pelly Bay		Porcupine								Qamanirjuaq		Southampton Island			
Dataset	LR-1		PB-1		PC-1		PC-2		PC-3		PC-4		QA-1		SI-1		SI-2	
Sex	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Body Weight	15				62		338		473	8	194	47	564	419	127	48	30	2
Body Length	15				59		242						567	415	144	50	30	2
Chest Girth					61		234		387	8	15	27	20	20	61	26	30	2
Lactation (Y/N)	15		10	3	45		370		385			49	220	420		51	30	2
Pregnancy (Y/N)			20	3	17		231		174			49	207	420	90	51	20	2
Foetus Sex				3			34					49		420	90	51	19	2
Foetus Weight				3			34					49		420	90	51	19	2
Back Fat			14	2	62		332						17	20	147	50	30	2
# of Warbles			17												144	49	29	2
Rumen Weight															128	48	30	2
Heart Weight							298								145	49	10	
Left Kidney Weight	15		20	2	62		353								23	10	30	2
Right Kidney Weight	15		17	3	62		196								23	10	30	2
Kidney Weight	15		17	2	62		192								146	50	30	2
Left Kidney Fat			20	2	62		351								23	10	30	2
Right Kidney Fat			18	3	62		193								23	10	30	2
Kidney Fat			18	2	62		187						17	20	146	50	30	2
Gastrocnemius			11	2	61		308								139	48	30	2
Metatarsal Length			17	2	62		213		479	8	193	48	20	20	147	49	30	2
Femur Length					62										167	49	30	2
Metatarsal Fat			17	2	62		124								111	39		
Femur Marrow Fat					62		137						17	20	160	49	19	2
Tibia Marrow Fat					61		53											
Dissected Fat																		
Condition Score									473	8	33	25						

Table 9 Description of datasets summarized in Table 8

Dataset	Source	Year(s)	# Animals	Description
BS-1	Dauphine	1965	46	Early study on condition, growth and reproduction of barren-ground caribou
BS-2	Elkin	1992, 1999	49	Part of ongoing herd assessment study
BN-1	Elkin	1992	23	Part of ongoing herd assessment study
BT-1	Elkin	1995, 2000	32	Part of ongoing herd assessment study
BT-2	Heard	1987, 1990-92	177	Animals collected during spring migration study
BV-1	Dauphine	1968	56	Early study on condition, growth and reproduction of barren-ground caribou
BV-2	Thomas	1980-87	1257	Long term study on the health, reproduction and growth of the Beverly Herd
BV-3	Elkin	1994, 2000	36	Part of ongoing herd assessment study
BE-1	Elkin	1997-98	53	Part of ongoing herd assessment study
BO-1	Elkin	1993	7	Part of ongoing herd assessment study
CB-1	Elkin	1994	16	Part of ongoing herd assessment study
CA-1	Cameron	1987-91	96	Live animal measurements looking at linkage between body condition and reproduction
CI-1	Adamczewsk i	1982-84	96	Part of PhD thesis work, assessing body condition of island populations
CI-2	Parker	1970	24	Part of ongoing herd assessment study
DU-1	Gunn	1970, 1987-92	121	Part of ongoing herd assessment study
DU-2	Elkin	1993	16	Part of ongoing herd assessment study
GR-1	Parker	1980	159	Study to assess condition of females and juveniles in spring, assess state of population
GR-2	Schmelzer	1978-85	93	Incidental collection of individual animals collected by Newfoundland Wildlife biologists (especially S. Luttich)
GR-3	Huot	1983-84, 1988,1993	134	Samples from a number of Huot's studies, including drowned caribou from 1984
LR-1	Huot	1988	15	Part of ongoing herd assessment study
PB-1	Patterson	1999	25	Part of ongoing herd assessment study
PC-1	Allaye Chan	1987-88	62	Part of PhD study to identify indices that could be used to determine body fat and protein
PC-2	Cooley	1989-98	370	Collection of animals from an ongoing body condition monitoring program
PC-3	Russell	1990-95	487	Measurements from live captured animals, study to determine linkage between body condition and productivity
PC-4	Griffith	1992-94	243	Measurements on live calves as part of study to examine growth, survival and habitat use
QA-1	Dauphine	1966-68	993	Early study on condition, growth and reproduction of barren-ground caribou
SI-1	Heard	1986-91	218	Part of ongoing herd assessment study
SI-2	Adamczewsk i	1983-84	32	Part of PhD thesis work, assessing body condition of island populations

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APPENDIX 1: List of Participants

Workshop organizers:
Gary Kofinas, University of Alaska, Fairbanks
Don Russell, Canadian Wildlife Service, Whitehorse
Bob White, University of Alaska, Fairbanks

Attendees:
Jan Adamczewski, Government of the Yukon, Watson Lake
Ray Cameron, University of Alaska, Fairbanks
Dorothy Cooley, Government of the Yukon, Dawson City
Jim Dau, Alaska Department of Fish and Game, Nome
Rick Farnell, Government of the Yukon, Whitehorse
Brad Griffith, University of Alaska, Fairbanks
Anne Gunn, Government of the North West Territories, Yellowknife
Loralee Laberge, Government of the Yukon, Whitehorse
Phil Lyver, University of Manitoba, Winnipeg
Augie Nelson, Kotzebue IRA, Kotzebue, Alaska
Brent Patterson, Government of Nunavut, Kugluktuk
Graham Van Tighem, Canadian Wildlife Service, Whitehorse

Invited but unable to Attend:
John Blake, University of Alaska, Fairbanks
Anne Chan-McLeod, University of British Columbia, Vancouver
Serge Couturier, Quebec Wildlife and Parks
Karen Gerhart, University of California, Davis, California
Jean Huot, University of Laval, Montreal
Micheline Manseau, Parks Canada, Winnipeg
Todd O'Hara North Slope Borough, Barrow
Pat Valkenburg, US Department of Fish and Game, Fairbanks