THE WINTER ECOLOGY OF BARREN-GROUND CARIBOU IN NORTH-CENTRAL CANADA: A SHORT REVIEW OF CURRENT KNOWLEDGE

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CANADIAN WILDLIFE SERVICE

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1. Introduction

This is a brief review of some of the things that are and are not known about caribou winter range, caribou in the winter, and the relationships between them. It is not written for scientists. They have their own jargon and must acknowledge the sources of all their information. Most of the remarks apply only to the winter ranges of barren-ground caribou in the Beverly and Kaminuriak herds. Most of the comments are general. Details and sources of information are in a review paper which will be available by June 1983.

2. Carrying Capacity of Winter Ranges

The most important question concerning winter range of barren-ground caribou is "How many caribou can the present range support?" That is often referred to as the carrying capacity of the range.

The carrying capacity for sustaining a population at a high level is reached when a certain proportion of the annual growth (productivity) of forage (food) is consumed annually without damage to the range. That is only a simple working definition because animals prefer certain plant species and those species may be damaged long before other species are adversely affected.

In an ideal system, where the food supply regulated the size of the caribou herd, the reproduction of the caribou would decrease or natural mortality (all deaths from causes other than hunting) would increase as the forage supply was depleted. There is little evidence that caribou numbers are regulated or controlled by the food supply, with the possible exception of caribou on islands where predators are absent. One example may be the Slate Islands in Lake Superior.

More frequently, forage inaccessibility on the winter ranges caused by snow and ice results in periodic die-offs or lowered reproduction and higher mortality. This may occur at population levels far below the carrying capacity of the winter ranges. An example was the 1973-74 die-off of Peary caribou on the arctic islands in Canada.

There are examples where assumed depletion of lichens and periodic forage unavailability in winter seemingly limit caribou populations. One is on the Svalbard Islands in Norway, the other on the South Georgia Islands. In both cases, predators are absent, hunting mortality is negligible, and grasses and sedges, not lichens, are the staple winter diet. The populations reach a certain level as dictated by the annual production of the grasses and sedges. Population fluctuations still occur because of annual variability in the productivity of the ranges and other climatic effects such as freezing rain during the calving period. Severe winters periodically restrict forage availability and the populations are reduced.

There is considerable evidence that if predators are present, caribou populations are kept below the carrying capacity of the ranges. If hunting is also a significant source of mortality, the populations are usually well below the carrying capacity of the ranges. In such cases, only severe winters result in nutritional stress, which is expressed in high mortality of calves and lowered fertility.

The Beverly and Kaminuriak herds are examples where the combined effects of wolf predation and hunting are believed to maintain the herds well below the normal carrying capacity of the ranges. Only winters such

as 1961-62 cause somewhat reduced fertility and high mortality of calves. Few, if any, calves born in 1962 in the Kaminuriak Herd survived to 1 year of age.

If wolf predation and hunting were removed as controllers, the herd would build until the winter range was overused and damaged. Mortality would increase and fertility would be lowered somewhat. The herd would fluctuate in numbers within a narrow range until a severe winter caused high mortality. It is unlikely that massive die-offs would occur even though the primary food source, ground lichens, are susceptible to overgrazing and damage from trampling. This is because snow disturbed at sites cratered during the winter becomes hard and largely prevents further cratering until the snow becomes soft in late winter. Exceptions occur where craters are widely spaced and caribou can crater in the undisturbed areas between the craters dug earlier. This hardening of snow at feeding sites acts as a safety valve, preventing overuse of lichens in any one winter. Furthermore, in years of deep snow the tree lichens provide an alternative food source. A third reason why die-offs are unlikely is that the caribou are mobile in winter and they will travel to sites where forage is available. They may even leave the forested regions and seek forage on the tundra.

3. Estimating Carrying Capacity

There are essentially two ways of measuring carrying capacity. The first method is to map the winter range in great detail, sample the vegetation on all the units and calculate its annual productivity in terms of caribou forage, determine the availability of the forages in an

assumptions about forage availability, nutritional adequacy of depleted forages, use of the range by the caribou, and other assumptions. Clearly this method is beyond the available resources, considering the sizes of

average winter, calculate the energy and nutritional requirements of caribou over the winter period, and then calculate how many caribou could be supported by the winter range. This method was used on Southampton Island to calculate its carrying capacity after caribou were reintroduced to the island.

The technique requires an intensive mapping exercise, a tremendous sampling program for measuring vegetative productivity, and several assumptions about forage availability, nutritional adequacy of depleted forages, use of the range by the caribou, and other assumptions. Clearly this method is beyond the available resources, considering the sizes of winter ranges occupied by the Beverly and Kaminuriak herds.

A second approach is to monitor the caribou and determine at what stocking level the winter range becomes inadequate. This method has many advantages. It can be accomplished with much less effort and resources, it can be coordinated with hunters to obtain the necessary data, it is sensitive to depletion of critical forages that may not be detected by the other technique, and it is insensitive to abrupt changes in the age composition of the winter ranges caused by changes in fire rates. This method is used by many ranchers and managers of livestock and by reindeer herders in Europe. In order to detect when the winter range becomes limiting, we must establish criteria to assess the status of caribou leaving the winter range and evaluate those criteria in light of environmental conditions on the winter range. Snow and ice are clearly the most important variables and we must be in a position to measure their role in the winter ecology of caribou.

4. The Effect of Burns on the Caribou

4.1 Carrying Capacity

Burns clearly affect the carrying capacity of the winter ranges. If all the winter range was burned, the carrying capacity for caribou would be reduced to near zero. The availability of forage in early growth phases would be nearly zero by late winter because of drifted snow. The effect that absence of fires (total fire suppression) would have on carrying capacity is uncertain. Few areas escape fire for more than 200 years and therefore it is difficult to measure the changes in forage production that might occur in old stands. Some biologist predict that the canopy would open with increasing age over 200 years; others predict the opposite. Species diversity likely would decrease. Most of the jackpine would disappear but other changes are uncertain. They would be influenced by changes in the canopy and many other factors.

Climate largely determines the fire rate and human influences have been minor. Therefore, caribou are adapted to or tolerant of a winter range that is constantly changing because of fire. We do not know what rate of burning or what distribution of burns produces the optimum range for caribou. There is one viewpoint that an average burn rate of 0.5-1% per year may be the optimum rate for barren-ground caribou. That rate implies an average burn interval of between 200 and 100 years. The assumption is that forests older than 150-200 years become less productive in terms of forage production. That has not been proven, however it is certain that fire initiates a series of regrowth stages that creates

species diversity. The value of that diversity for caribou is uncertain and difficult to prove.

4.2 Movements and Distribution

There are many observations that caribou will move through burns if conditions are suitable. Unsuitable conditions are crusting of the snow caused by drifting or warm temperatures followed by low temperatures, and tangles of fallen dead trees. I have observed the first condition in March but also noted where many caribou travelled through a burn on one set of tracks that were made before crust formation or during the afternoon when the snow became soft. The second condition does not seem to occur frequently. It arises when thick stands of young pine are killed by a fire of low intensity and the dead trees fall after their bases rot.

The type of movement is important when assessing the effects of burns on movement patterns. During autumn and spring migrations, caribou tend to maintain a certain direction of movement and they seem reluctant to deviate from it. During mid-winter the caribou tend to stay in regions where forage is available and therefore they usually work their way around regions burned in the last 30-50 years.

The size of the burn is important when considering movements and distributions of caribou. There is some evidence that very large burns, e.g., over 500 km^2, may change the movement pattern. In October 1982, a large portion of the Beverly herd was on a near westerly course until they encountered a 1979 burn of some 1456 km^2 located west of Delight Lake. The burn appeared to cause the movement to slow down or stop after

the forefront of it penetrated 20-25 km into the burn. It also appeared to cause the movement to split into segments that moved to the north and south. What we cannot predict is what the caribou would have done had the burn not been there. The tentative conclusion is that the burn affected the movement because it was well within the usual winter range of the herd and a definite east to west movement ceased after the burn was penetrated.

Another important consideration is the amount of area unburned within burns and its distribution. Caribou tend to travel along water courses and often some of the lowland areas escape fire. Thus, caribou are able to obtain some forage, notably sedges, as they pass through such burns. Of course, areas that completely escaped burning are utilized by caribou when they are encountered in a burn. Some shrubs that grow rapidly after fire are utilized to some extent in burns. Dwarf birch and willow appears to be favoured over other birches and alders. In general, however, an insignificant amount of forage is obtained from areas burned in the last 30-50 years.

5. Mapping Burns

Burns were mapped on aerial reconnaissance flights by the Northern Forest Service as early as the late 1950s. Coverage of the "Caribou Range" began in 1966 and the majority of areas burned since then have been mapped visually using aircraft. Few burns older than 16 years are mapped.

Burns were mapped in northern Manitoba in the 1950s as part of a study of vegetation by interpretation of photographs used to map the area

by the Surveys Branch in Ottawa. Once that systematic mapping of burns began, it was possible to calculate average burn rates for various time periods. LANDSAT imagery was enhanced to map vegetation types and recent burns on the caribou ranges in northern Manitoba. Only burns up to about 10 years old could be mapped. LANDSAT imagery is useful in mapping burns since 1972 by viewing images from each year.

An area in northern Saskatchewan was mapped in 1961 and age classes were assigned to all the stands, based on tree heights. The accuracy of the technique was not great and calculated rates of burning at various time periods was confounded by many areas being reburned in the last 150 years.

Satellite imagery makes it possible to map burned areas quickly on an annual basis. This should be done for all the forested winter ranges of barren-ground caribou in Canada. Long-term committments should be obtained from the various jurisdictions that an annual updating of burn maps will be achieved.

Attempts should be made to obtain the ages or age-classes of all large uniform stands older than 10-15 years so that estimates can be made of the proportions of essentially non-productive and productive components of the winter ranges. That is probably best accomplished by systematic aerial surveys, visual mapping, and frequent ground checks.

6. The Mapping of Caribou Ranges

Mapping to-date has consisted of general ecological zonation of the 1:1,000,000 Lockhart River map sheet, which includes the "Caribou Range", and vegetative mapping of winter range of the Kaminuriak Herd in

northern Manitoba. In the first exercise, the forested portions of the winter range were divided into three ecoregions and eight ecodistricts, based on several criteria including vegetation, soils, topography, and surface geology. The stratification is a useful starting point for mapping caribou ranges but it is too general to provide any clues as to the relative value of the units for caribou.

The vegetation mapping done in northern Manitoba is more valuable but it is still only a beginning in the assessment of the relative values of the vegetation communities identified. The primary objective was to use the resulting 1:250,000 maps to assess the status of the winter range for barren-ground caribou. That objective was not realized. Only recent burns were mapped (spruce less than 1 m tall) and the relative values of the vegetation types were not measured. Variability in productivity within the units and among them would preclude such estimates. Productivity estimates could only be made with further grouping and subdivision of the units mapped from the digitally enhanced LANDSAT images.

Another approach is to map segments of the winter range into productive and non-productive (burned in the last 30-50 years) components. This cannot be done with existing imagery but estimates can be obtained by visual mapping assisted by numerous field checks. In order to predict the status of the winter range at some future date it will be necessary to determine the proportion of the range in various age classes and be able to predict, measure, or control the rate of burning in the intervening years.

7. Caribou Movement Patterns

The movements of few caribou herds have been monitored all winter. The Beverly Herd, for example, was monitored regularly only during 1957-58. In some other years, e.g., 1958-59, 1959-60, 1977-82, there were surveys with variable completeness at two or three periods during the winter. In most other years the data consists of only one or two surveys and no movement pattern can be deduced from the observations. The existing data indicates considerable annual variability in movement patterns with little indication of their causes. Obviously the late-summer distribution largely dictates where the caribou enter the forested winter range. If they enter on one side of the winter range, the caribou tend to travel toward the opposite side of the range. For example, in 1982 the majority of the Beverly Herd entered the forested areas between Damant and Wholdaia lakes and then migrated almost due west towards Delight Lake.

Movements slow during the rut in late October and in the coldest period - January and February. It is not unusual for the caribou to spread out over a large portion of the winter range after the rut. Usually two or more rather distinct distributions develop with the majority of the bulls being in one of them. Bull groups usually occur deeper within the forested region or, more accurately, closer to the edge of the winter range. During March, a major segment of the caribou herd which contains most of the cows, often migrates to the edge of the tundra or on it and then returns into the forested region.

Autumn migration usually reaches tree line in September or early October. Departure of the leaders of the spring migration varies from

March to mid-May with late April being the most frequent time for departure. The last caribou to migrate, the bulls, may not reach the tundra until well into June. In years of high snowfall or a late Spring, e.g., 1957 and 1979, departure from the forest may not begin until mid-May.

8. Range Selection by Caribou

Caribou feed in all community types and mostly in regions that have not been burned in the past 30-40 years. At one site there will be a preference for lowland communities dominated by stunted spruce. At another site, most of the cratering will be on upland ridges where large widely spaced jackpine and variable sized spruce dominate the canopy. At a third site, the majority of feeding craters are in the transition zone between uplands and lowlands. The impression gained from examination of feeding sites in late winter is that caribou primarily are seeking ground lichens and green parts of sedges. The sedges are obtained in meadows, fens, and along water courses.

The most heavily utilized sites are adjacent to lakes, water-courses, meadows and fens. These are the favoured travel routes and resting places. Caribou appear to prefer to feed at sites where they can see another caribou (or wolves) for at least 20 m. This may be one of the reasons that the primary winter range of the caribou lies almost entirely in the "open forest" zone.

Caribou also prefer to rest on lakes and in clearings where predators can be seen for at least 50 m. This and other behavioral traits

mean that all portions of the winter range are not used with equal intensity and some areas are little used because of their geographic setting.

9. Diets and Digestibilities

Analysis of the contents of rumens indicate that lichens that grow on the ground usually account for 50-60% of the contents during mid and late winter. The technique tends to underestimate the importance of lichens because studies indicate that lichens are highly digestible and pass through the stomach system rapidly compared with most other forages in the diet, such as leaves of shrubs and dried grasses and sedges. The most important lichens are species of Cladina, Cetraria, and Stereocaulon. The Cladonia species are utilized but they seldom grow in sufficient densities to account for much of the diet. Peltigera species appear to be sought after by the caribou, probably because of their relatively high nitrogen content. In that regard, the green shoots and leaves of sedges and some grasses are important sources of nitrogen, which is almost lacking in the common surface lichens with the exception of Stereocaulon species.

In the autumn, mushrooms form an important food source. There is more variety in the diet then as most plants are lightly covered by snow. Horsetails are nutritious plants that are eaten where they occur.

Tree lichens appear to be little used except in late winter of some years when the snow is exceptionally deep. They are seldom sufficiently abundant to form much of a food source although they occur everywhere except in young forest stands. Usually they are tightly bound to

twigs, and bark must be ingested with many species. Bark of evergreens is poorly digested and may inhibit the digestion of other plants. An interesting finding is that many plants contain chemicals that discourage animals from eating them. The chemicals probably have a disagreeable taste and they may inhibit the digestion of food in the stomachs, which is done by bacteria and small animals called protozoa. The needles of pine and spruce are avoided by most animals but many more species such as labrador tea and cranberry may contain some chemicals that discourage animals from eating large quantities of them.

Caribou and most other animals require a variety of forages in order for them to obtain all their nutritional requirements. Caribou and reindeer fed only lichens were found to lose weight. The conclusion that lichens were not a good food supply was faulty. Lichens do not supply all the needs of caribou, but along with other forages they are an excellent source of energy. Without them there would be few if any barren-ground caribou in northern Canada.

10. Snow and Ice

Snow is a major factor in the winter ecology of caribou, however, caribou are well adapted to cope with snow. Their large rounded hooves are well suited for excavating snow from feeding sites. The hooves and remainder of the foot, which extends to the functional dew claws, provides a large surface area for support in snow. Nevertheless, snow plays a significant role in the energetics of caribou. Deep or crusted snow increases the costs of movements, although caribou economize energy by walking in each others tracks and avoiding snow conditions that seriously

impede movements and crater excavations. There is evidence that caribou move down snow gradients of depth and hardness, to a point. In late winter of 1981-82, the Beverly Herd moved from where snow was 60 cm or more in depth, when measured, to areas with 50-60 cm of snow. They did not continue to regions where only 40-50 cm of snow was present.

In March, when above-freezing temperatures during the afternoon result in a surface crust for the rest of the day, the caribou move little during the night and morning and largely remain in the forest where the snow is soft. If they begin to migrate at this time, the movement is on trails made in the afternoon. Thousands of caribou may pass on one trail which may be followed for 50-100 km or more.

The primary stimulus for migration may be the effect of changing daylight on the nervous system. However, a snowfall seems to trigger autumn migration from the tundra and melting snow in the spring seems to spur migration northward.

Ice formation on the vegetation in the fall and spring can adversely affect availability of lichens on the ground. In March 1980, ice lenses at the surface of the ground vegetation were a common feature on the winter range of the Beverly Herd within the N.W.T. At Scott Lake, most of the feeding craters were on the lee side of trees and large boulders where the ice was less or absent.

11. Human Activities

The human activities that seems to have had the greatest impact on the caribou is use of improved transportation and communication facilities and greater trapping effort. Extension of roads into northern

Saskatchewan has provided access to the southern portions of the winter range of the Beverly Herd. That was one of the reasons for a large kill of caribou in 1979-80 when the herd wintered around Wollaston Lake. There is a proposal to extend the road to Stony Rapids. The winter road to Uranium City has not increased the kill significantly because few caribou winter in the region around Williams River.

The use of aircraft to hunt and transport caribou has increased the kill. The change from dogs to snowmobiles for transport has more than compensated for this increase because, in the past, dogs consumed more caribou than the hunters driving them. The new (1982) regulation that requires a 12 hour wait period between landing an aircraft and the shooting of caribou in the N.W.T. will reduce the use of aircraft, because of increased costs, but the regulation is difficult to enforce.

The almost universal use of side-band radios by trappers has resulted in knowledge of where the caribou are throughout the winter. This allows trappers to travel to where the caribou are, either by aircraft or snowmobile.

The disturbance of caribou from aircraft flying over them in the winter is not a serious problem. The greatest disturbance of caribou is from hunters, something the caribou have lived with for centuries. The widespread use of snowmobiles adds a new dimension, however. Prolonged chasing of caribou in extremely cold weather could be damaging.

12. Caribou Behavior

Caribou behavior on the winter range is influenced by inherent migratory urges, the rut, social structures, foraging requirements, the

daylight regime, cloud, wind, temperature, snow characteristics, topography, and probably several other factors. Feeding occurs for 3-5 hours around sunrise, there is a rest period of 2-4 hours and then another feeding period. The length of a feeding and resting or moving period varies during the winter and is related to the time needed to fill the rumen. As the snow deepens and food becomes more difficult to obtain, proportionately more time is spent in digging craters and less in resting and moving. In mid to late winter the caribou usually are sedentary, compared with other periods of the annual cycle.

The caribou are in mixed groups of 5-100 individuals as they enter the winter range in September or early October. During the rut, which peaks during the last week of October, the movement slows and the groups break up and spread over a larger area. After the rut, in November and December, the bulls over 4 years of age separate from the others and move to the south into Saskatchewan or west as far as the Hill Island Lake region. The groups containing the cows and caribou up to 3-4 years of age may move throughout the winter range but they tend to remain in the more central parts of the winter range.

13. Information Needs

1) Is the present winter range adequate for the present population of caribou?
2) How many caribou could the present winter range support on a sustained yield basis?
3) What is the effect of burned regions of various sizes and types on the movement patterns of barren-ground caribou?

4) What effect do burned regions have on the winter distributions of caribou?

5) What factors influence the movement patterns of caribou in the winter?

6) What components of the winter range are used by caribou for food sources and other requirements?

7) How does forage production relate to age of stands, i.e., interval since the last fire?

8) What proportion of the winter range in various geographical zones, e.g. 1:250,000 map sheets, is suitable for maintaining caribou in the winter?

9) What is the age distribution of the forest in various zones of the winter range?

10) How has the rate of burning changed over the last 50–200 years?

11) At what interval post-burn are forests used by caribou for their various needs in the winter?

12) Does the productivity of caribou forages decline in old stands?

13) What decline in the condition of caribou over the winter is normal?

14) How does variations in the loss of condition in winter effect the survival of calves?

15) What is the relationship between physical condition of caribou and parasite loads?

16) Do the caribou have any diseases that affect survival and reproduction?

17) What variables of the winter ranges should be monitored annually in order to better understand the winter ecology of caribou?

18) What physical or physiological components of caribou should be monitored in order to understand or predict caribou productivity?

19) What is the relationship between winter diets of caribou and changes in physical condition?

20) What is the role of fire management in the management of winter ranges of caribou?

The above questions are an incomplete list of some of the things we should try to obtain answers for in order to understand more about the winter ecology of barren-ground caribou.

14. Concluding Remarks

Our knowledge of the winter ecology of barren-ground caribou is rather poor. We have few data on the movement patterns throughout the winter and only guesses of what caused them. The reasons for this are the lack of long-term comprehensive studies because of their costs, the vast area involved, and the belief among many biologists that the winter ranges of caribou herds could support several times the present populations. The same biologists would admit, however, that range deficiencies are difficult to detect. They could affect growth, reproduction, and deaths only marginally, but nevertheless significantly.

Range deficiencies can go undetected and be accepted as part of what is termed normal"environmental resistance", that is, the hardships that caribou are faced with, such as long migrations, snow, ice lenses over forage, freezing rain, insects, parasites, diseases, and predators.

We must recognize the complexity of range evaluations and the magnitude of work necessary to measure the effects of fire. The tree cover is remarkably uniform compared with the surface vegetation. The surface vegetation is predictable but its distribution highly irregular. It is almost impossible to measure the amount or normal growth of forage in various range types with the precision demanded by scientific methodology. Therefore, we must look for ways of evaluating the winter range within our resources and capabilities. We must rely to a great extent on observations and judgements or what is called subjective as opposed to objective or "hard" data. We must not delude ourselves into thinking that all the winter range problems can be answered by one or two studies. The hope is that each study will add a few more bricks to our house of knowledge concerning the winter ecology of barren-ground caribou and that sensible judgements can be made regarding management of the winter range.