PR-86-7

THE STATUS AND LIFE HISTORY

OF THE

PORCUPINE CARIBOU HERD (1983)

First Draft 1983

Second Draft 1986

Prepared for the Department

of Renewable Resources

by

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INTRODUCTION

A great deal has been written about the Porcupine Herd in the past 30 years but this material has never been completely summarized under one cover. This report is designed as a readable encyclopedia of Porcupine caribou information to be used primarily as a reference for particular topics but also as a detailed account for those involved with research and management. For others who wish merely to obtain a rapid overview of the herd, the summaries at the end of each section are recommended.

As with other caribou herds, much of the early work on this one was attended by considerable theorizing and speculation some of which, along the way, became converted to dogma. This report attempts a fresh summary of the original observations unencumbered by the conjecture of their time, and also provides concluding statements that hopefully do not exceed the capacity of the data to support them. This serves to pare down the mountain of information to what is truly known about the herd.

Originally written in 1983, this report has recently been redrafted and the population section updated. Otherwise the background information is only current to 1983.

TAXONOMY

All existing caribou belong to the tarandus species and separate Rangifer genus of the deer family (Cervidae) in the order of even-toed ruminants (Artiodactyla). Porcupine caribou together with the migratory barren-ground caribou of Alaska compose the subspecies granti.

The other four current subspecies in the genus refer to the arctic mainland in the Northwest Territories (groenlandicus), the arctic island (pearyi), woodland and mountain (caribou), and reindeer (tarandus) types.

The classification of caribou has a complex history of alternating subdivision and amalgamation with attendant controversies over proper nomenclature. The most thorough analysis was produced in 1961 by A.W.F. Banfield and has since been considered by the majority as the definitive version.

The earliest fossil evidence of caribou comes from Germany and has been dated to about 440,000 years ago (Banfield, 1961). It has been suggested that caribou reached Alaska before the next to last glaciation (Illinois) and persisted in North America throughout both the Illinois and Wisconsin Glaciations in the Alaska-Yukon refugium as well as in a tundra belt at the south edge of the ice sheet during the latter glaciation.

The extinct species Rangifer muscatinensis has been linked to various fossil forms from the Wisconsin age and is tentatively considered to be the progenitor of both the modern groenlandicus and granti subspecies (Banfield, 1961).

DESCRIPTION

Caribou are deer which have become highly adapted to survival in regions of prolonged snow coverage and low temperatures. Unlike the feet of most other deer, theirs have blunt toes, crescent-shaped sharp-edged hooves and functional dew claws (Russell and Martell, 1983). Also the toes bend almost horizontally and in winter, the feet are covered by a dense growth of coarse

hair so that caribou can virtually "float" over the snow on little "bear paw" snowshoes, (Russell and Martell, 1983). Other distinctive adaptations to cold and snow are a blunt, fully furred muzzle; valvular nostrils; short, heavily furred ears; a short well furred tail and a compact body covered with a thick coat of hollow guard hairs and fine crinkly underfur (Banfield, 1974).

Porcupine caribou are among the smaller of the North American subspecies. Mature males average 113 cm to the shoulder and 125 kg in weight, while mature females are substantially smaller at 103 cm and 89 kg respectively (Yukon Wildlife Branch, 1983). By comparison males of the larger subspecies in central Alaska, northern British Columbia, Ungava and Quebec weigh 181 - 272 kg and females are usually 91 - 136 kg (Bergerud, 1978).

The coat colour of Porcupine caribou varies seasonally and individually but generally these animals are considerably darker than those in the High Arctic and somewhat lighter than the woodland subspecies. The most typical colour pattern in winter consists of a dark face, back, flanks and dorsal tail surface; a light neck, belly, rump, under surface of the tail and hindquarters; and dark legs with white "socks" just above the hooves.

Caribou are the only deer that produce antlers in both sexes. The proportion of antlered females varies greatly among North American herds (Bergerud, 1978) with the Porcupine Herd belonging to the upper extreme having about 95-97% of females with antlers (A. Martell, pers. comm.). Bulls begin to develop antlers around March and employ them during rutting contests in October when the antlers are full size and out of velvet (Banfield, 1974). Older males begin to shed their antlers by early November while younger ones

may keep them until February (Banfield, 1974). Cow antlers do not commence growth until the summer months and are retained throughout the winter when they may be used in the defence of feeding craters from larger but antlerless bulls (Banfield, 1974).

BEHAVIOUR

Porcupine caribou, like the rest of their genus, are highly gregarious, pursuing daily and seasonal activities (except parturition) either in small groups, large bands or massive aggregations. Consequently, they exhibit both individual and group responses to varying situations often with the latter evolving from the former, such as the selection of migration trails, the initiation of river crossings and the response toward predators.

Prerutting and rutting behaviour is similar to that of other deer in which bulls vocalize, execute threat displays and spar among each other with their antlers (Banfield, 1974; Kelsall, 1968). Such engagements can result in injuries and even fatalities at times (Calef, 1981; Bergerud, 1978), although most contests terminate with little or no apparent damage (Kelsall, 1968). Dominant bulls pursue and mate with cows in the large mixed bands comprising all age and sex classes which are usually migrating southward during the rut (Calef, 1981; Kelsall, 1968). Subdominant males present in such bands are prevented from mating with cows by the constant vigilance of the dominant bulls (Calef, 1981; Kelsall, 1968). Energy demands upon rutting bulls are extreme and a dramatic loss of condition is associated with this period (Calef, 1981).

Calving is probably the only major solitary activity that Porcupine caribou regularly engage in. Although pregnant cows reach the calving grounds in

large groups, parturient females isolate themselves for the period required to give birth and attend the calf until it is mobile (Calef, 1981; Kelsall, 1968; Banfield, 1974). Thereafter, most cows, calves and many yearlings usually coalesce into large post-calving aggregations (Bente and Roseneau, 1978; Yukon Wildlife Branch, 1979; Whitten and Cameron, 1980).

Migratory behaviour of Porcupine caribou has been extensively documented mainly as an aspect of distribution and movement studies. Such observations may be summarized as follows:

a) Initial migratory movements often coincide with major environmental changes such as rapid temperature declines plus snowstorms in the fall (Thompson, 1979; Surrendi and De Bock, 1976) and early thaws with consequent snow loss in the spring (Thompson and Roseneau, 1978).
b) The direction, duration and speed of migrations are strongly influenced by travelling conditions which in turn are related to weather patterns (Surrendi and De Bock, 1976; Thompson, 1979; Whitten, 1982).
c) Caribou follow contours in hilly terrain, traversing side hills rather than travelling perpendicularly (Le Resche, 1975).
d) Caribou tend to travel in narrower lanes in steep terrain and to spread out on a broader front in flatter areas (Le Resche, 1975).
e) Caribou tend to course natural features such as rivers, steep slopes and cut banks for some distance before crossing them, regardless of the relative ease of crossing at the point of first encounter (Le Resche, 1975).
f) Caribou tend to follow previous caribou trails, their inclination to do so being in direct relation to the age of the trails (Le Resche, 1975).

g) During winter, caribou frequent frozen lakes and water courses for travelling and resting (Surrendi and De Bock, 1976).

h) Traditional water crossings are used by the Porcupine Herd.

i) Porcupine caribou movement rates peak during the spring migration, the post-calving period and the fall migration. Movement rates are lowest during the calving period, August dispersal and winter. Average movement rates are greater during the post-calving period than during either seasonal migration (Russell, H.J. and Farnell, 1981).

j) In conjunction with movement behaviour, other activity patterns such as feeding and resting vary considerably during the year. In October and November, about 35% of the non-bedded time is spent in walking and trotting while for other months, from December through March, these activities decrease from 14% to 4% of the non-bedded time. Feeding intensity on the other hand is higher during the same four months than in either October - November or April. Such behavioural variations constitute energy budgeting strategies by Porcupine caribou to adjust costly activities such as walking and trotting in relation to food supply (Russell and Martell, 1980).

Behaviour toward industrial facilities and disturbances by Porcupine caribou can only be described so far as obvious short-term reactions to some elements of industrial developments and activities. These may be summarized as follows:*

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*See also Dempster Highway Section.

a) Escape responses to aircraft disturbance increased dramatically when exposure was below approximately 75 m (Surrendi and De Bock, 1976).

b) Seasonal variations in response to aircraft disturbance was evident among Porcupine caribou. Peaks of sensitivity occurred in spring and early winter with the most sensitive period being June. By contrast, the greatest tolerance of overflights occurred in July (Surrendi and De Bock, 1976).

c) Caribou in open habitats (arctic tundra, alpine areas, frozen lakes) reacted less to overflights than did animals in heavily forested areas (Surrendi and De Bock, 1976).

d) Porcupine caribou have little difficulty crossing the Dempster Highway under light to moderate snow conditions. Caribou use the highway for travel as they would a frozen river (Russell, 1982).

e) Avoidance of the Dempster Highway will occur if the road is associated with significant wolf predation (Russell, 1982).

f) At 1982 levels of traffic, the Dempster Highway is perceived by Porcupine caribou as a slightly negative element (Russell, 1982).

g) Caribou react more negatively to vehicles approaching at high speeds (Horejsi, 1981).

h) Disturbed caribou frequently crossed the Dempster Highway at night after traffic ceased (Surrendi and De Bock, 1976).

i) Caribou approaching the Dempster Highway in forested areas seemed more apprehensive than those doing so in open areas (Surrendi and De Bock, 1976).

j) Caribou quickly associate the Dempster Highway with hunting and consequently avoid sections where hunting has occurred (Russell, 1982).

SEASONAL DISTRIBUTIONS AND MIGRATIONS

It may be said of the Porcupine Herd that it is in continual motion. It is also true that the herd seldom exhibits uniformity in the timing and direction of its movements but functions rather as a composite of individuals and groups which choose from a variety of movement options throughout the year. Still, with rare exceptions, a basic pattern of annual distribution does occur that by convention has been subdivided into the seasonal categories of spring migration, calving ground distribution, post-calving movements, August dispersal, fall migration, and winter distribution.

Each phase, however, being subject to considerable variation, cannot be described in full detail but only according to its major features. It must be stressed that such descriptions do not represent the "norm", an attribute which caribou movements unfortunately do not possess, and that major deviations, while anomalous to the theoretical standard cannot be interpreted as abnormal, particularly since reliable documentation covers only the past 13 years of the herd's history.

Given the above considerations and constraints, the distribution of the Porcupine herd is presented as follows:

1. Winter Range

The winter distribution of the Porcupine Herd may be considered as the area occupied between the fall and spring migrations. The duration of winter range occupancy therefore varies in length depending upon the end of the preceeding fall migration (mid-November to mid-December)* and the beginning of the following spring migration (mid-January to mid-May)*. Although some historical records of wintering caribou in the Yukon do exist (Thompson and Roseneau, 1978), their relevance is compromised by the lack of distinction made prior to 1970 between Porcupine caribou and those of adjacent migratory herds. Such sitings are included in this summary, however, since the majority likely pertain to the Porcupine Herd and thus expand the history of the herd's winter range. Historical records of caribou wintering in northern Yukon are as follows:

a) Along the Arctic Coast in the vicinity of Herschel Island (Franklin, 1828; Jackson, 1892-1908; Russell, 1898; Harrison 1908; Olson, 1959).
b) Richardson Mountains (Isbister, 1845; Porsild, 1945; McEwen, 1956).
c) North of the Porcupine River (Soper, 1951; McEwen, 1952a, 1952b).
d) Along the Porcupine River from Old Rampart House to LaPierre House and to its headwaters (Murie, 1935).
e) Upper Porcupine drainage (McEwen, 1956).

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*See spring and fall migration sections.

f) "Well south" of the Porcupine River (Munro, 1953).

g) In the northern Ogilvie Mountains (Olsen, 1958; Keele, 1910; Clarke, 1944).

h) In the Black River drainage of Alaska and Yukon (Hemming and Pegau, 1970).

i) Old Crow Flats (Kevan, 1970).

j) Whitefish Lakes area (Kevan, 1970).

k) Northern Richardson Mountains west of Aklavik (Hemming, 1971).

Winter range surveys have been flown annually since 1970-71 either for general distribution data or in conjunction with radio-tracking studies. The compiled results from all these investigations produce a total winter range for the Porcupine Herd encompassing borderline areas of the N.W.T., most of the Yukon north of Dawson and a substantial portion of north-eastern Alaska from east of Fairbanks to the Arctic Coast (Fig. 1) (Thompson and Roseneau, 1978; Yukon Wildlife Branch, 1980c; Yukon Wildlife Branch, 1981d; Whitten, 1982; Yukon Wildlife Branch, 1983). Within this vast area, Porcupine caribou may winter in a number of regions, with concentrations over the past 13 years being most common in a) the Ogilvie Mountains, b) the Chandalar region and c) the Richardson Mountains (Thompson and Roseneau, 1978; Whitten, 1982; Yukon Wildlife Branch, 1983). Sometimes most of the herd will be located in one region while at other times a few large separate concentrations may exist, or alternatively, caribou may be broadly dispersed in varying concentrations throughout the winter range (Thompson and Roseneau, 1978; Yukon Wildlife Branch, 1983). A further complexity is that "new", i.e. previously undocumented distributions, may arise such as in 1982 when part of the herd wintered southwest of the Yukon River in what was

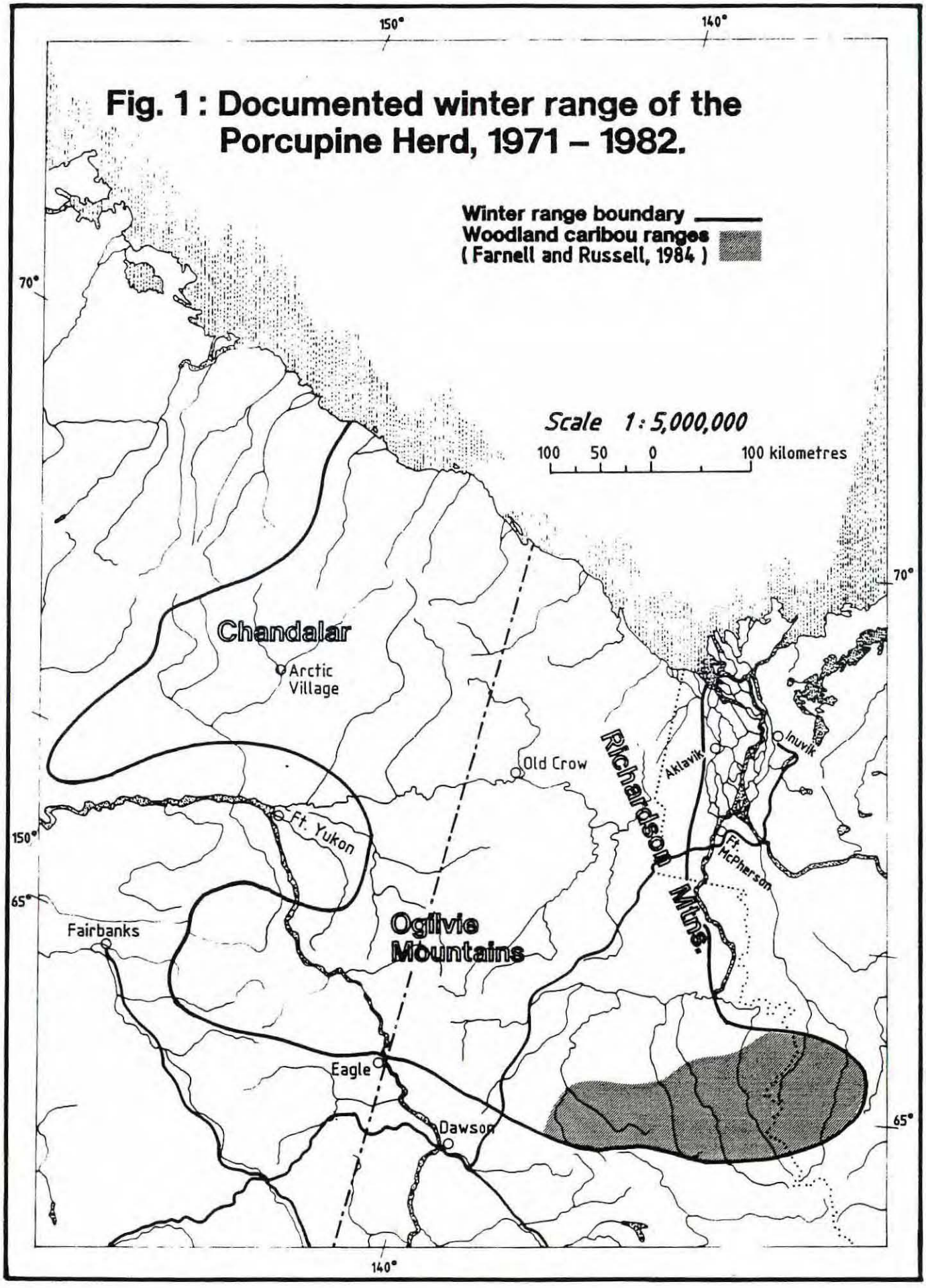


Fig. 1 : Documented winter range of the Porcupine Herd, 1971 – 1982.
Winter range boundary
Woodland caribou ranges
(Farnell and Russell, 1984)
Scale 1 : 5,000,000
100 50 0 100 kilometres
150°
140°
70°
65°
Chandalar
Arctic Village
Old Crow
Richardson Mtns.
Aklavik
Inuvik
Ft. McPherson
Ft. Yukon
Fairbanks
Ogilvie Mountains
Eagle
Dawson

previously considered to be the exclusive winter range of the Forty-mile Herd (Whitten, 1982).

Winter distributions also vary greatly in the amount of local movement that occurs within the general wintering region occupied. Winter range selection is stongly associated with prevailing snow conditions, which when they deteriorate, induce caribou to seek better feeding areas (Russell and Martell, 1983). Thus some winters entail considerable local movements due to extensive unfavourable snow conditions, while in other winters with generally favourable conditions, local movements are small (Whitten 1982, Surrendi and De Bock, 1976). Similarly, dispersal over the winter range is greater when snow conditions are generally favourable but can be very limited when conditions are generally unfavourable (Surrendi and De Bock, 1976). Extensive winter range shifts may also occur.

Another factor influencing winter range occupancy may be the particular fall migration route taken which lead caribou to certain traditional winter ranges (Whitten 1982).

Considering the variation in winter range occupation and movements that are possible, it is very risky to attempt delineations of major winter range areas (Thompson and Roseneau, 1978) based on accumulated survey data which seldom depicts the total range used for the entire winter season in any year. Consequently such ranges are best referred to by name alone lest such calculations become misleading.

Since the aforegoing winter range description is of necessity complex and apt to be confusing, it is perhaps easier to perceive winter range use by this herd as a sequence of decreasing probabilities as follows:

1) Most Porcupine caribou will winter south of the Arctic coast and within their known range.

2) The majority of the herd will winter in or near the Ogilvie mountains with lesser numbers wintering in both or either the Chandalar and Richardson regions and scattered groups elsewhere up to the Arctic coast.

3) The majority of the herd will winter in either the Chandalar or Richardson region with lesser numbers in the Ogilvie region and one or other of the former regions and scattered groups elsewhere up to the Arctic coast.

4) Almost the entire herd will be located in one of the major winter ranges with few animals elsewhere.

5) The herd will be widely dispersed in scattered groups of varying size throughout most of its winter range.

6) In addition to any of the above, a significant number of caribou will winter in a previously undocumented area.

2. <u>Spring Migration</u>

Among barren-ground caribou, the spring migration has been differentiated from winter movements by appearing "direct and

purposeful" as well as "goal oriented" (Kelsall 1968). This migration is initiated by the pregnant cows which are destined for the calving grounds. Bulls and many juveniles may start later than the cows (Russell, H. J. and Farnell, 1981) and use different routes which generally take them to "staging areas" on the periphery of the calving grounds (Farnell 1979b). All such movements are usually most apparent in April and May but they have been recorded as early as February and March (Thompson 1978, Whitten and Cameron, 1982). With the advantage of radio-tracking it has been shown that cows may begin to drift northward as early as January (Russell, H. and Farnell, 1981). Steady travelling however seldom precedes significant snow loss which usually occurs in April or May but may vary as much as a month or more among years (Thompson and Roseneau, 1978). In springs with extremely late snowmelt, the migration may be delayed to the extent that some cows calve enroute to the calving grounds.

The spring migration is considered to have ended when the last cows reach the calving grounds which is usually in early June, (or later when the migration has been delayed). Thus the spring migration covers an entire potential period of about five months from mid-January to mid-June during which the greater movements are undertaken in April and May. Even after calving is underway many bulls and yearlings may still be moving northward or drifting towards the calving grounds (Yukon Wildlife Branch 1980f, Yukon Wildlife Branch 1981b).

Spring migration trails used by Porcupine caribou are numerous and also highly variable among years. They may however be grouped into three or four major routes or corridors which seem to be widest at the southern

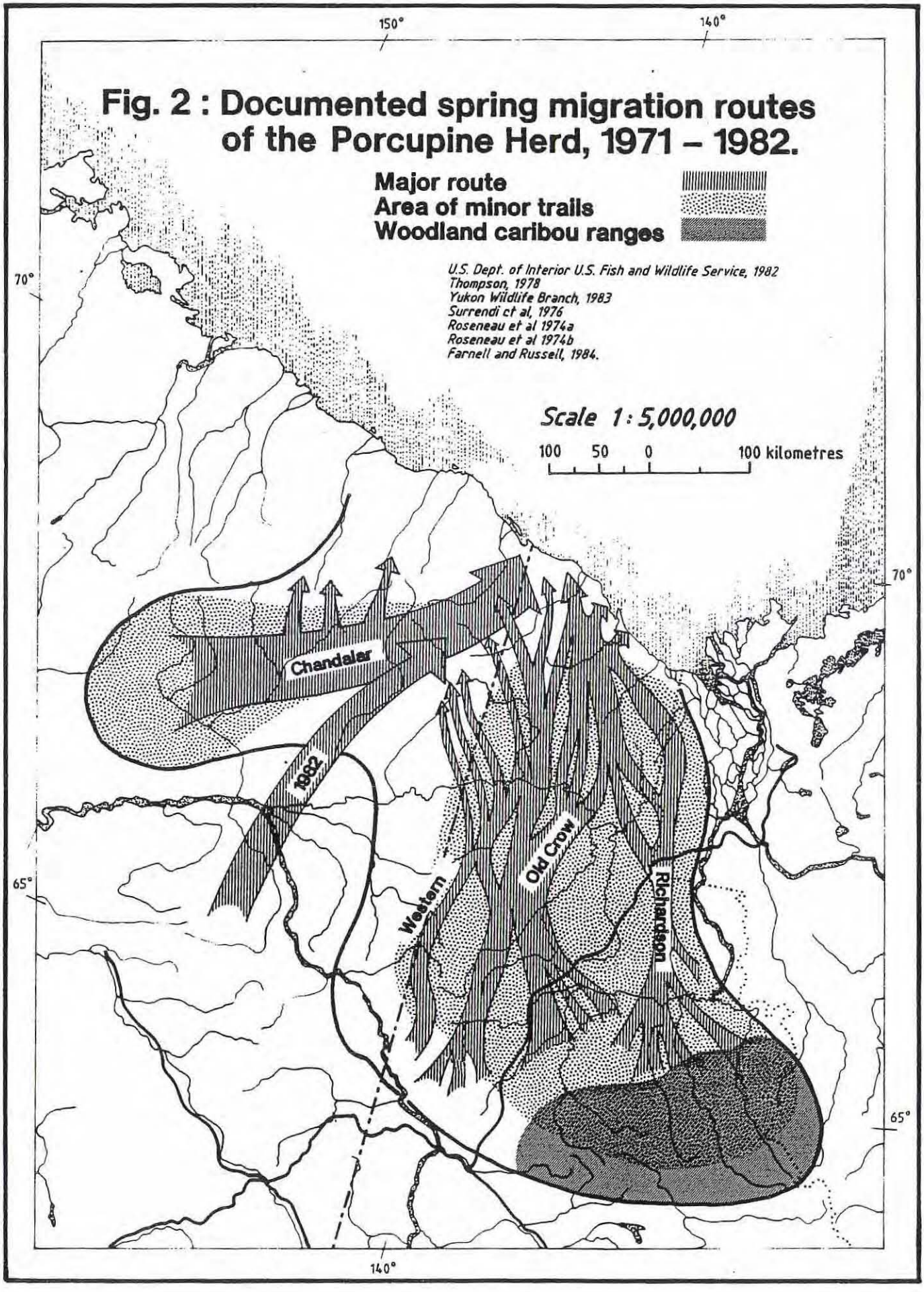
end and more constricted towards the north (Thompson 1978). Within each corridor the paths chosen in any given year are largely determined by prevailing snow conditions (McCourt et al., 1974). The major corridors may be described as follows:

a) The Old Crow Route:

Originally designated in 1974, (Jakimchuk et al., 1974) this route has been consistently used by most or part of the herd since 1971 when accurate monitoring began (Thompson and Roseneau, 1978; Farnell 1979b; Russell and Farnell, 1980; Yukon Wildlife Branch, 1981b; Whitten and Cameron, 1982). The Old Crow Route gathers trails from widely dispersed winter ranges in the Ogilvie Mountains from north of Dawson eastward to the Hart River (Fig. 2) and funnels them through the Keele range across the Porcupine River east and west of Old Crow, and onward through Old Crow Flats to eventually join the Richardson Route in the vicinity of the Western Barn Mountains (Thompson 1978).

b) The Western Route:

First described as a separate route in 1976 (Surrendi and De Bock, 1976), this small route has since been included in the Old Crow Route (Thompson and Roseneau, 1978) but may deserve special attention in view of the 1979 and 1982 spring migrations in which caribou wintering in the Tatonduk River drainage traversed the same route described in 1976 until it converged with the Old Crow Route near the upper Salmon Fork River (Fig. 2), (Whitten and Cameron, 1982; Yukon Wildlife Branch, 1983b).


150°
140°
Fig. 2 : Documented spring migration routes of the Porcupine Herd, 1971 – 1982.
Major route
Area of minor trails
Woodland caribou ranges
U.S. Dept. of Interior U.S. Fish and Wildlife Service, 1982
Thompson, 1978
Yukon Wildlife Branch, 1983
Surrendi et al, 1976
Roseneau et al 1974a
Roseneau et al 1974b
Farnell and Russell, 1984.
Scale 1 : 5,000,000
100 50 0 100 kilometres
70°
65°
Chandalar
1982
Western
Old Crow
Richardson

c) Richardson Route:

Also designated first in 1974 (Jakimchuk et al., 1974) this route has apparently been used by the majority of Yukon wintering caribou four times in the past twelve years (Thompson 1978, Yukon Wildlife Branch 1983b). In the remaining years, the proportion of Yukon wintering animals following the Richardson Route has ranged from a few thousand animals (Thompson 1978) to nearly half of the Yukon wintering herd (Roseneau et al., 1975). Originating in the Wind, Bonnet Plume, Snake and Arctic Red river areas this route crosses the Peel River and follows the long axis of the Richardson Mountains to the Fish Creek - Rapid Creek - Blow River area where it turns northwest along the Barn and British Mountains to the Alaska border (Fig. 2) (Thompson 1978).

The migration along the Richardson Route typically occurs in two waves, the first representing animals that wintered north of the Peel River and the second being composed of those wintering south of the Peel River which are often delayed by more severe snow conditions (Thompson 1978).

d) The Chandalar Route:

Sometimes also referred to as the Arctic Village - South Brooks Range Route (U.S. Dept. Interior and U.S. Fish and Wildlife Serv. 1982, U.S. Fish and Wildlife Serv. 1983), this route had been used only by Porcupine caribou wintering in the Arctic Village region until 1982 when a substantial portion of the herd moved northwards through previously undocumented spring migration territory to link up with the Chandalar Route and the Old Crow Route in the general vicinity of Bear Mountain (Fig. 2).

The longer Chandalar Route leads northeast from Chandalar Lake across the East Fork of the Chandalar River towards the British Mountains in the vicinity of the Firth River (Fig. 2) (U.S. Fish and Wildlife Serv. 1983, Yukon Wildlife Branch 1983). Alternatively, caribou may travel northwards from the Chandalar region to reach the Arctic Coast of Alaska via a number of mountain passes in the Brooks range, the most heavily used pass being at the head of the East Fork of the Chandalar River (U.S. Dept. of State 1980, Whitten et al 1982, Roseneau et al 1974).

It should not be misconstrued from the preceding route descriptions that all Porcupine caribou traverse these entire routes every spring. Rather, the length of each route travelled depends upon the late winter distribution of various herd segments such that some animals, for example those wintering in the northern Richardson Mountains, travel only a small portion of the route compared to those wintering in the Peel River region. As for caribou which winter on or near the Arctic Coast there may be little or no distance remaining between them and the calving grounds. The migratory behaviour of such animals remains undocumented but it is conceivable that they remain virtually stationary throughout the spring migration period.

A major obstacle to migrating caribou is hazardous watercrossings where injuries, drownings and hunting may occur. For the Porcupine herd on its spring migration the principal rivers to be crossed are the Porcupine, Blow, Babbage and Firth rivers (Thompson 1978, Yukon Wildlife Branch 1983). Caribou often cross at traditional sites on these rivers

where topographical features seem to foster such efforts (D. Russell, R. Farnell, pers. comm.).

Another important aspect of the spring migration is that many other trails exist between the major migration corridors although such routes appear to be "only sporadic and rather inconsistent with regard to the general routes that are followed" (Thompson 1978). Also the major routes depicted in Figure 2 should be considered as a map of potential pathways in which an endless variety of combinations is possible. For example in 1982, most animals wintering in the Ogilvie Mountains moved up the main trunk of the Ogilvie route but turned westward south of Old Crow and met up with the latter part of the Chandalar Route (Whitten and Cameron, 1982; Yukon Wildlife Branch, 1983).

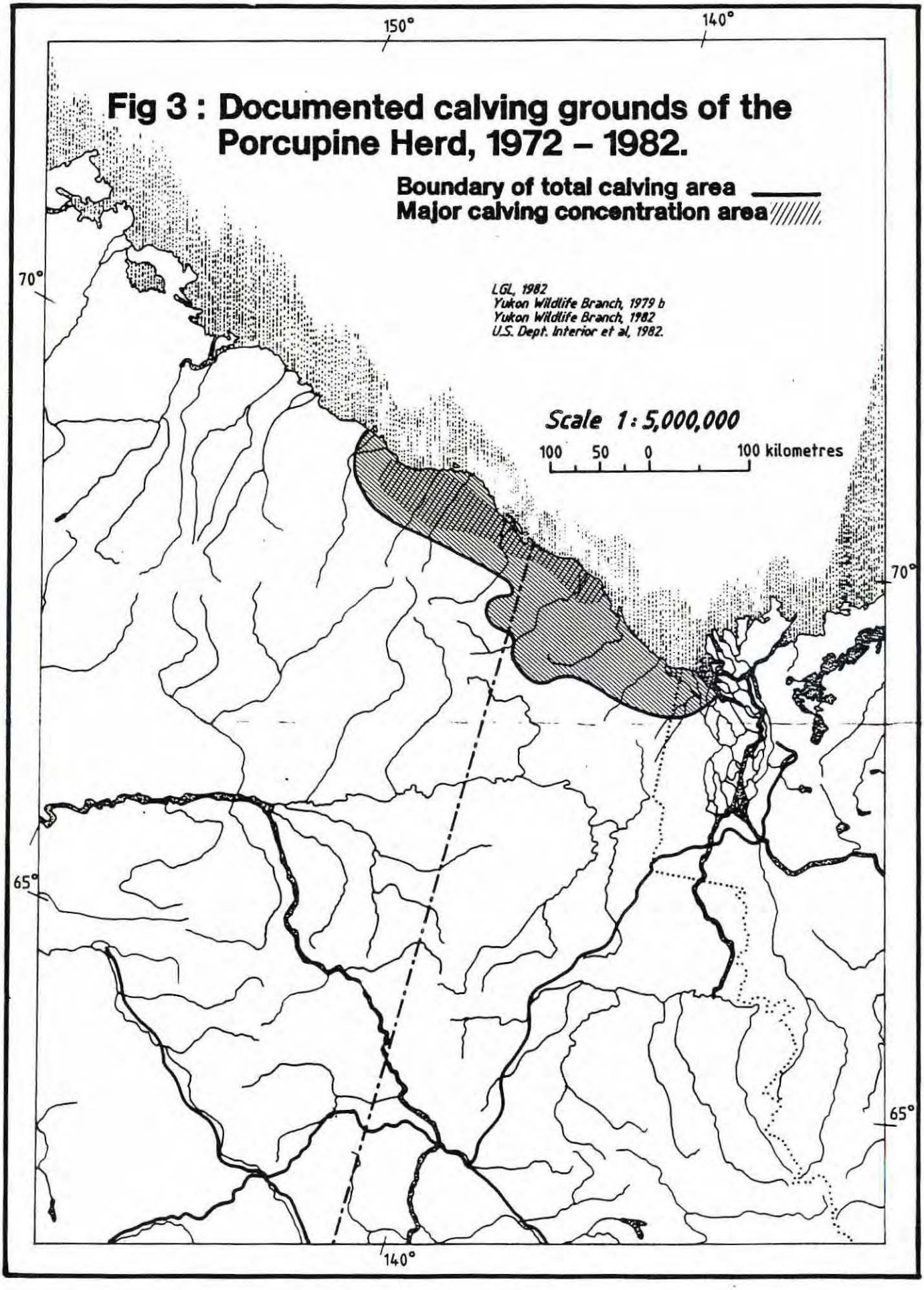
A graphic perception of the spring migration could be to imagine the herd as a giant amoeba gradually shifting its mass northward by a process that entails the rapid streaming of cytoplasm (caribou) in some sections while elsewhere the cytoplasm is hardly moving at all or is slowly flowing in different directions. Yet the overall effect is one of a coordinated reorganization that eventually transfers the cell (Porcupine herd) to a position along the coastal regions of Yukon and northeast Alaska. Each spring this shift occurs in a unique combination of cytoplasmic withdrawals and amalgamations but always produces a similar distribution by early June.

3. <u>Calving Ground Location</u>

Since 1971 annual calving ground surveys of the Porcupine herd indicate that calving has occurred throughout the Arctic Slope from the Canning

River, Alaska to Shallow Bay, N.W.T. and as far south as the northern drainages of Old Crow Flats (Fig. 3) (LGL Ltd. 1982, Yukon Wildlife Branch 1979b, Yukon Wildlife Branch 1982, U.S. Dept. of Interior and U.S. Fish and Wildlife Service 1982). Within this general area, the calving ground boundaries have shifted annually, often excluding areas east of the Babbage River, but always including a central portion between the upper Jago River and the Firth River. Also, each year the calving herd has been concentrated in one or more high density areas and distributed in varying but lesser densities in the remainder of the calving ground. Over the last 12 years three core areas have been located between the Katakuvuk River, Alaska and some distance east of the Firth River, Yukon (Fig. 3) (LGL Ltd. 1983, Yukon Wildlife Branch 1982). The composition of the calving herd also varies from sections where bands are almost exclusively adult females to other parts where bands contain more juveniles and some bulls (Yukon Wildlife Branch 1981c, Yukon Wildlife Branch 1979b). It should also be noted that the calving ground is never completely occupied by calving caribou at any time but that it represents the total area in which calving caribou move during the calving period (U.S. Fish and Wildlife 1980).

Although most calving usually takes place in the foothills of the Brooks Range and the British Mountains (U.S. Dept. of State 1980, LGL Ltd. 1982) it may sometimes occur across the coastal plain to the shoreline of the Arctic Ocean (Yukon Wildlife Branch 1981c, LGL Ltd. 1982). It has been suggested that factors influencing annual calving ground locations may include winter range distributions of the previous winter, the timing of spring migration and routes taken, as well as the progress of the snowmelt (Yukon Wildlife Branch 1979b). Such considerations have


150°
140°
Fig 3 : Documented calving grounds of the Porcupine Herd, 1972 – 1982.
Boundary of total calving area
Major calving concentration area
70°
LGL, 1982
Yukon Wildlife Branch, 1979 b
Yukon Wildlife Branch, 1982
U.S. Dept. Interior et al, 1982.
Scale 1 : 5,000,000
100 50 0 100 kilometres
70°
65°
65°
140°

prompted the prediction that early spring migrations will result in most calving occurring in Alaska whereas late spring migrations would shift the calving grounds into the Yukon (Surrendi and De Bock, 1976; U.S. Dept. of Interior, 1983). Within the general North Slope region, the choice of specific calving areas may be related to snowmelt conditions which, when late, may make the comparatively snow free uplands of the Arctic Slope initially preferable for calving but, when early, may expose the coastal plain sufficiently for calving or at times may produce a shift from the foothills to the plains as the snowmelt progresses (Yukon Wildlife Branch 1979b, 1980f, 1981c). It has also been observed that the earlier arriving cows may not occupy the calving ground's remotest areas and that some cows coming later may actually penetrate further into the calving grounds.

During the calving period most of the bulls, many juveniles and some dry cows*, become located on the southern and eastern peripheries of the calving ground and/or some distance south of it (Fig. 4) (Martell 1982, Yukon Wildlife Branch 1979b, 1982). Two commonly mentioned "staging areas" for the bull segments are the Firth and Babbage River regions (Farnell 1979b, LGL Ltd. 1982).

Based on past documentation it appears that consistent features of the calving ground distribution are:

a) that a portion of the calving ground will be located between the upper Jago and Firth Rivers;

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* cows that do not have calves

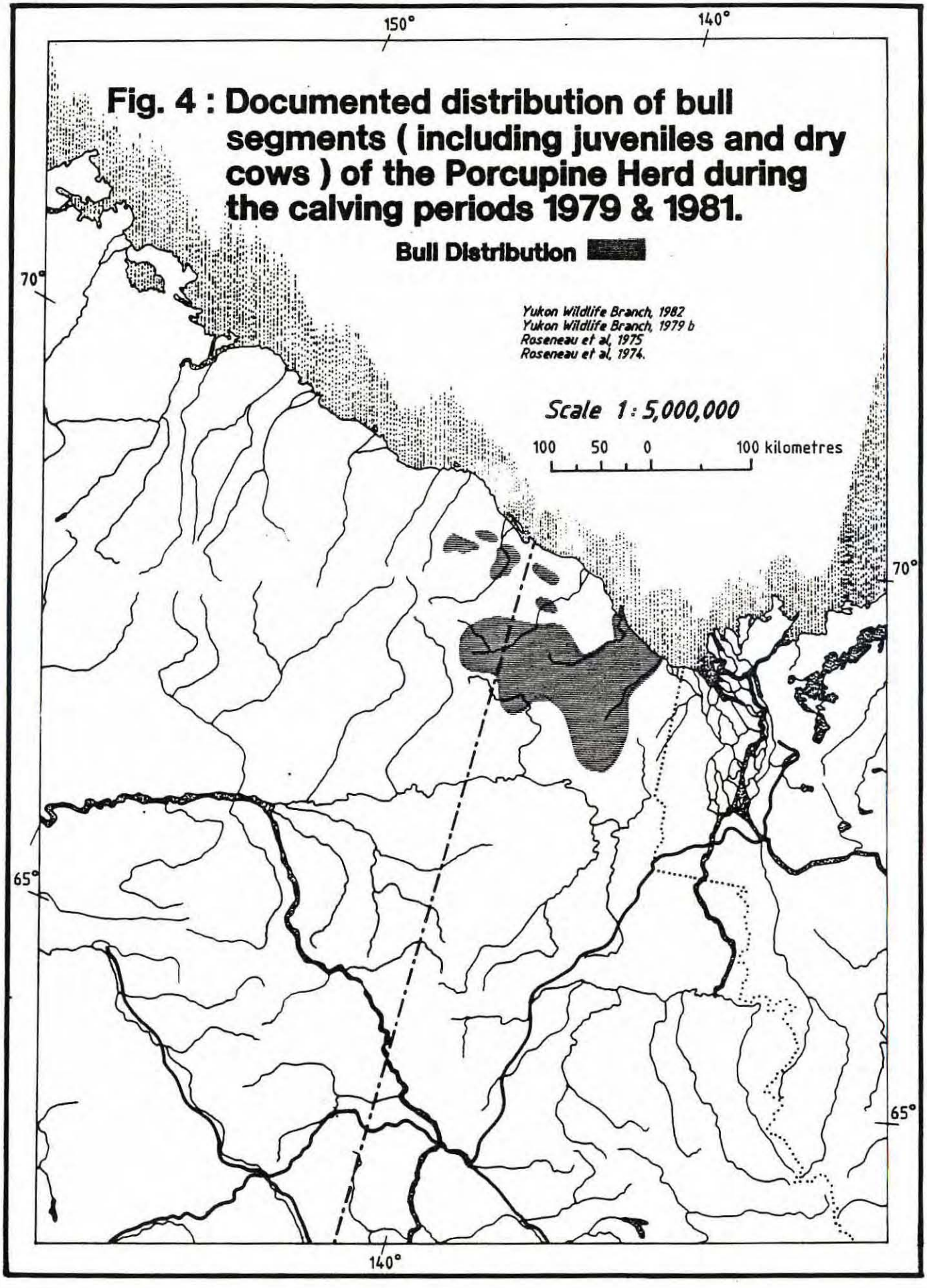


Fig. 4 : Documented distribution of bull segments (including juveniles and dry cows) of the Porcupine Herd during the calving periods 1979 & 1981.

b) that the composition of the calving herd will vary from nearly exclusive adult female bands to mixed groups including cows, juveniles and some bulls;

c) that most of remaining Porcupine caribou will be located on the southern or eastern peripheries of the calving herd or some distance south of it;

d) that the timing, origination and progress of the spring migration likely determines the particular location of the calving grounds;

e) that relative snow conditions on the North Slope may influence the choice between the foothills and the coastal plain as the major calving area.

4. Summer Movements

During the summer, the movements and behaviour of the Porcupine herd usually involves two phases referred to as post-calving aggregation and August dispersal. These are described separately as follows:

a) Post-calving aggregation:

Immediately following calving, the Porcupine herd is arranged with the majority of non-calving groups situated east and south of the calving herd. This relative positioning occurs annually regardless of the particular location of the calving ground. In some years when the calving herd is located across the Alaska-Yukon border, the non-calving segments will be generally further east and south in Yukon. If the calving ground is mainly in Alaska, the non-calving segments may be concentrated on the Alaska-Yukon border, still east of the calving herd but much further westward

than in the previous example (Yukon Wildlife Branch 1983c). By mid June, cows and calves have begun to form "nursing bands" that continue to grow in size until practically all the females and their young are gathered into a few large calving herd aggregations and some small peripheral groups. This formation is completed towards the end of June or in early July (Davis, 1978; Le Resche, 1975; Roseneau and Curatolo, 1976; Whitten and Cameron, 1980). During this period the animals are usually moving eastward but often head northward and even westward as well as towards the coast (LGL Ltd. 1983, Roseneau et al., 1974).

Meanwhile the bull segments that have been moving westward and/or northward encounter and amalgamate with the calving herd aggregations in early to mid July to form massive post-calving aggregations, some of which are very compact while others may be less densely organized (Whitten and Cameron, 1980; Calef, 1981). Animals that are not involved in the post-calving aggregations near the coast are most often distributed along the coastal plain or in the foothills of the Arctic Slope (Whitten and Cameron, 1980). In some years the post-calving aggregations do not completely form (Bente and Roseneau, 1978) but remain as scattered bands over a broad area (Yukon Wildlife Branch 1981d). Such variations are possibly related to reduced fly harrassment associated with inclement weather (Yukon Wildlife Branch 1981d).

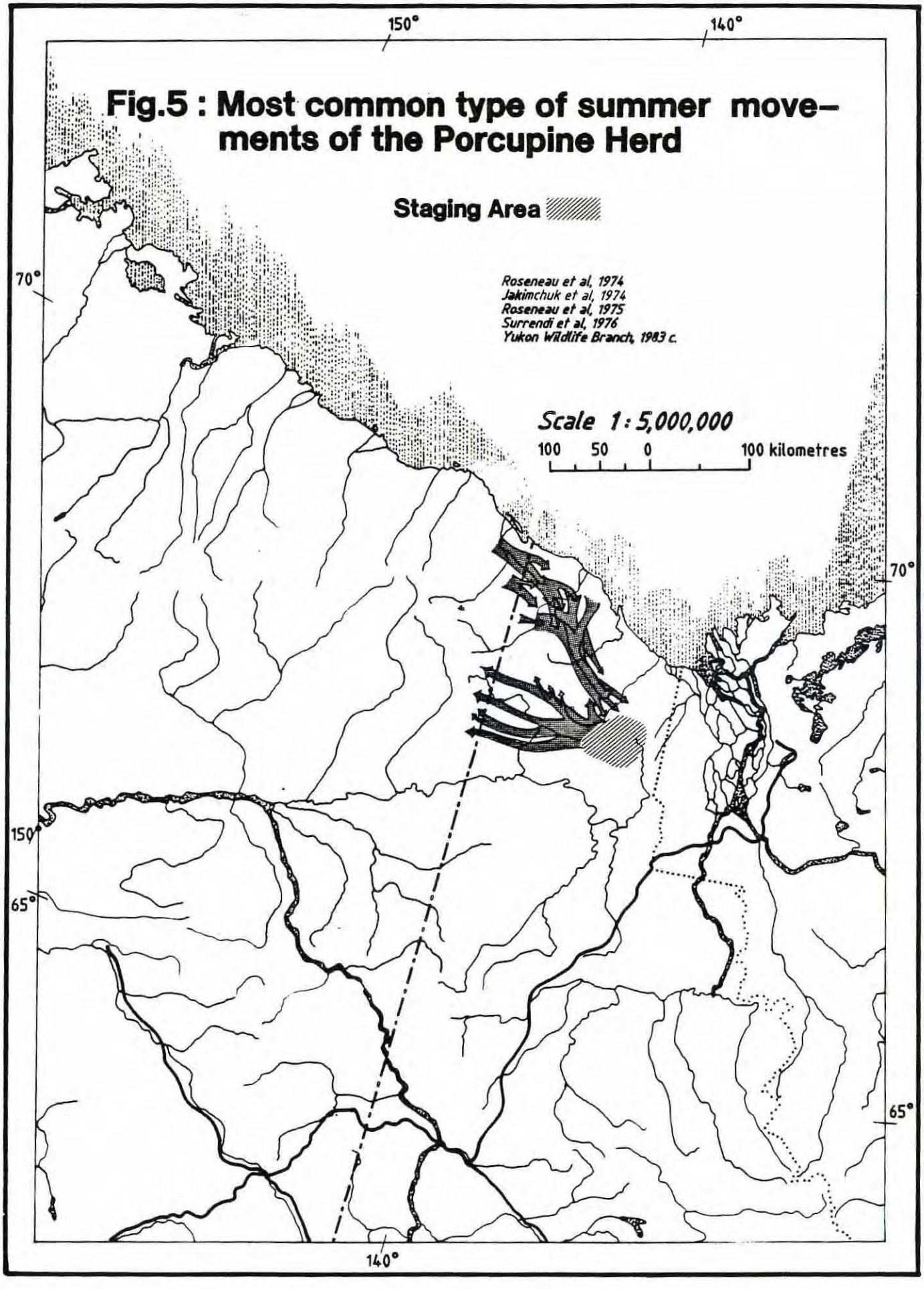
During the remainder of July the post-calving aggregations tend to move southeastward or southwestward toward the Yukon side of the border, often reaching points anywhere from the upper Firth River

to the N.W.T. border by late July (Roseneau et al., 1975; Surrendi and De Bock, 1976; Jakimchuk et al., 1974; Roseneau et al., 1974; Yukon Wildlife Branch, 1983c) (Fig. 5).

b) August dispersal:

In late July and throughout much of August, the large aggregations progressively dissociate into smaller bands, most of which usually travel quite rapidly into Alaska while the rest disperse in the northern Yukon (Roseneau et al., 1975; Roseneau et al., 1974; Surrendi and De Bock,1976; Ealey, 1979). In the past 12 years the only exception has been in 1975 when the majority remained in the western Yukon (Thompson 1979). By about the third week of August much of the herd is usually in Alaska and some of it may already be returning to the Yukon (Roseneau et al., 1975; Surrendi and De Bock, 1976). Those which had remained in the Yukon could be scattered in the British and Barn Mountains, the northern Richardson Mountains and probably the periphery of Old Crow Flats (Jakimchuk et al., 1974; Roseneau et al., 1975; Ealey, 1979). Although many or most caribou often return to the Yukon in late August and early September, in some years substantial numbers remain on the Alaska side of the border and also above the continental divide in Alaska (Rosenau et al., 1974).

As with the other phases of the Porcupine herd's distribution, a very basic pattern exists upon which annual variations are superimposed. The general sequence of movements can be best summarized chronologically except for the least likely events which are mentioned last as follows:


150°
140°
Fig.5 : Most common type of summer move-
ments of the Porcupine Herd
Staging Area
70°
Roseneau et al, 1974
Jakimchuk et al, 1974
Roseneau et al, 1975
Surrendi et al, 1976
Yukon Wildlife Branch, 1983 c.
Scale 1 : 5,000,000
100 50 0 100 kilometres
70°
150°
65°
65°
140°

a) Around mid to late June the calving herd aggregates on or near the Alaskan and/or Yukon arctic coast.

b) During the latter part of the calving period and onward into mid to late June the bull groups tend to coalesce and move towards the calving herd aggregations.

c) Around late June to early July the bull herds eventually encounter and mix in with the calving herd aggregations to form large and sometimes massive post-calving aggregations with the remaining caribou scattered about the coastal plain and the foothills.

d) During the remainder of July the post-calving aggregations in Alaska usually move southeastward into Yukon while the aggregations already in Yukon may move south or southwestwards.

e) Towards the end of July and during the first half of August the large aggregations split into smaller bands, most of which travel westwards into Alaska while the rest disperse in the northeastern Yukon.

f) By late August a return from Alaska to Yukon is underway while the Yukon contingent remains dispersed.

g) Caribou which did not leave Alaska become scattered in groups about the North Slope of the Brooks range.

h) Sometimes large post-calving aggregations do not completely form.

5. Fall Migration

As with the spring migration, the fall migration is a complex of movements that vary in timing, direction and duration, not only among years but among different herd segments in the same year. Most authors consider the eastward return of caribou from Alaska to Yukon in late August to early September as part of the fall migration. At that time caribou may also be dispersed in northern Yukon and along the north slope of Alaska (Roseneau et al., 1975; Jakimchuk et al., 1974; Roseneau et al., 1974b).

Thereafter, the initiation, rapidity and progress of the fall migration is strongly influenced by weather patterns in northern Yukon (Surrendi and De Bock, 1976; Thompson, 1979; Ealey, 1980). As long as the fall weather remains clement, caribou tend to move leisurely, either towards Yukon from Alaska or, having reached there, southward in a widely dispersed pattern (Thompson 1979). Presumably other herd segments in northern and coastal Yukon and Alaska also move at a comparatively slow pace in many directions. A marked change in these types of movements usually occurs shortly after rapid temperature declines and substantial snowfalls which can occur anytime in September (Thompson 1979). Subsequent movements are generally rapid and more or less uniformly southward from wherever the caribou happen to be located when the weather conditions deteriorate (Thompson 1979). However, if the weather improves again (temperatures rise, low precipitation), the migration may slow down, or halt or reverse (Jakimchik et al., 1974; Ealey, 1980). At such times caribou may begin to drift northward sometimes recrossing the Porcupine River or the Dempster Highway until renewed snowfalls and temperature declines produce a resumption of the southward migrations

sometime in October (Jakimchuk et al., 1974; Ealey, 1980; Yukon Wildlife Branch, 1983d). Occasionally however, weather improvements do not affect the southward migration which maintains its orientation and strength despite ameliorating conditions (Yukon Wildlife Branch 1980g).

The timing and progress of the fall migration may vary annually to the extent that caribou may reach a particular region in the southern extremity of their winter range (i.e. the lower Tatonduk River) anytime between late September and early November (or of course not at all), (Yukon Wildlife Branch 1983d, Roseneau and Curatolo 1976). Similarly, caribou may be crossing the Porcupine River throughout September and even up to mid October (Thompson and Roseneau 1979) and peak crossings can occur anytime between September 1 and October 4 (Ealey 1980).

The fall migration is considered to have ended when steady movements have ceased and the migratory bands begin to disperse on the winter range. Such events have often been recorded between late October and late November (Thompson 1979, Russell and Martell 1980, Yukon Wildlife Branch 1983d) but sometimes migratory type movements can persist into December (Whitten and Cameron 1982). An 'exceptional' fall migration occurred in 1981 when caribou crossed the Yukon River in the vicinity of Eagle, Alaska. Such movements had not occurred since the 1950's when presumably the Porcupine herd performed similar manoeuvers, which at the time were confused with those of then large 40-Mile herd (Whitten and Cameron 1982).

Documented fall migration routes are if anything more diverse than the spring ones, primarily because snow conditions are seldom a limiting factor (Thompson 1979). Still the fall routes can be generally grouped into the spring corridors (Fig. 6) which are described in reverse as follows:

a) Old Crow Route:

Originating primarily in the British and Barn Mountains, the paths of this corridor cross the Porcupine River in numerous locations but principally between Bell River and Lard Creek and also west of Old Crow (Thompson 1979). Beyond the Porcupine River this broad corridor leads south generally within the Keele Range and mostly west of Eagle Plains. Upon reaching the Ogilvie Mountains, routes either continue south to the Tatonduk region winter range or branch westward towards the same area. Other routes diverge eastward to winter ranges in the Hart and Blackstone winter ranges.

b) Richardson Route:

The major Richardson Route penetrates the Richardson Mountains north of McDougall Pass and extends south along the long axis of this mountain chain to the Peel River while minor routes reach the Peel River by crossing the Bell, Rock or Eagle Rivers and travelling along the western flanks of the Richardsons (Thompson 1979). The majority of caribou appear to cross the Peel River between the Bonnet Plume and Wind rivers but crossings may occur as far west as north of Hungry Lake (Thompson 1979). After crossing the Peel River migration routes proceed to winter ranges in the

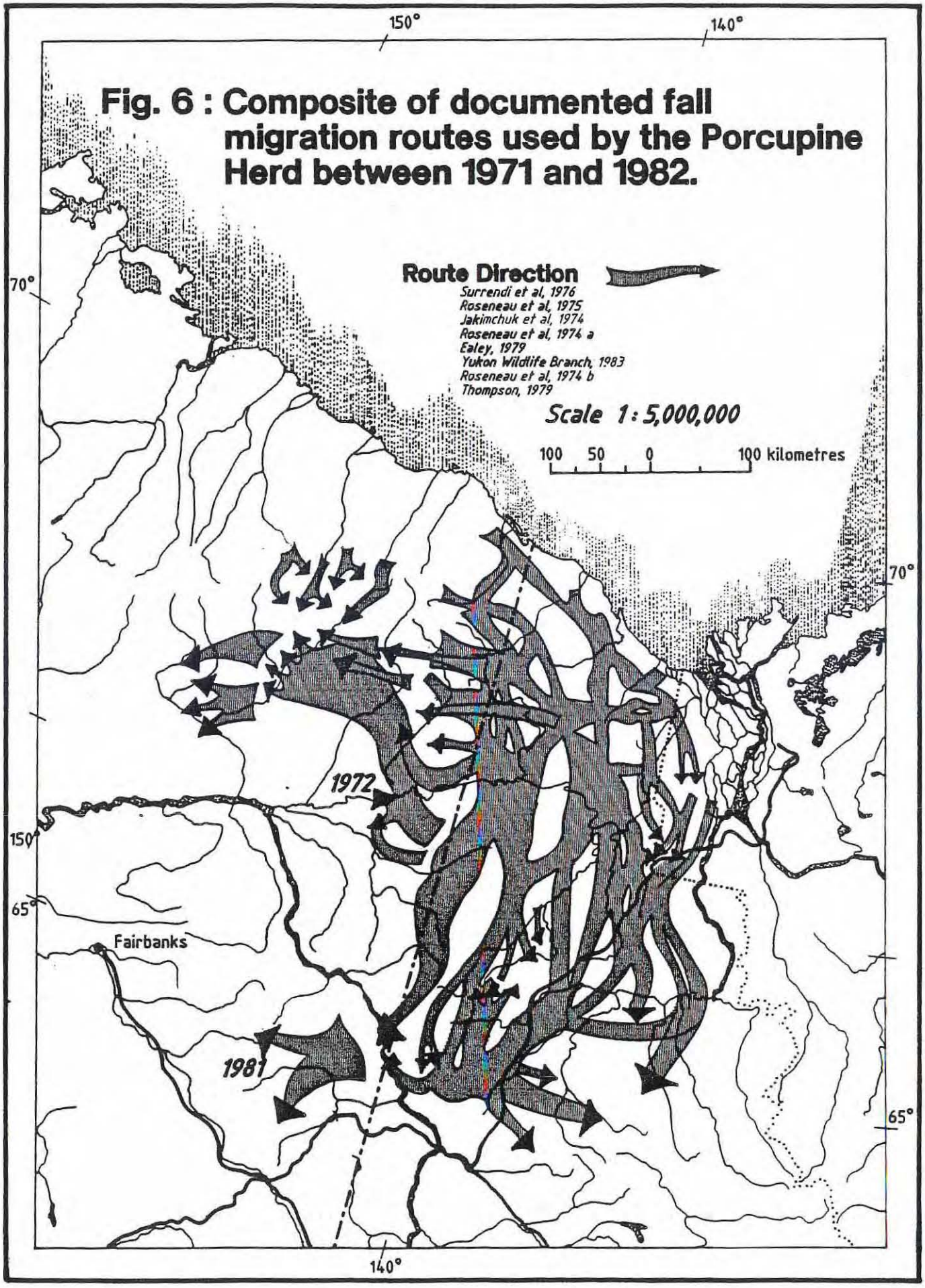


Fig. 6 : Composite of documented fall migration routes used by the Porcupine Herd between 1971 and 1982.

Swake, Hart, Blackstone, Bonnet Plume and Wind River drainages (Thompson 1979).

c) Western Route:

Originally identifed as a distinct Spring Migration Route (Surrendi and De Bock 1976), this corridor has always been included as an extreme western component of the Old Crow Route. It has however, appeared as a principal route in the 1974, 1977 and 1981 fall migrations (Roseneau et al. 1975, Bente and Roseneau 1978, Yukon Wildlife Branch 1983d) and should perhaps receive separate recognition on those accounts. The route essentially parallels the Alaska - Yukon border from the Upper Salmon Fork River to the Tatonduk River. Caribou using this route have reached winter ranges as far east as the Hart River (Bente and Roseneau 1978) and as far west as Delta Junction and Central Alaska (Whitten and Cameron, 1982; Yukon Wildlife Branch, 1983d).

d) Chandalar Route:

This route consists of a major component that extends westward from Old Crow Flats across the Alaska-Yukon border to the Chandalar River drainage (Fig. 6) essentially covering the same territory involved in the August dispersal movements. The minor component comprises trails through passes in the Brooks Range that are used by caribou migrating southward from the Arctic Slope. These caribou are usually the "residuals" (Roseneau and Stearn, 1974a) that did not join the large post-calving aggregations nor participate in the basic summer movements of the majority of the herd.

A noteworthy variation of the Chandalar Route occurred in 1972 when many fall migrants crossed the Porcupine River in Yukon but shortly thereafter swung northwestward, recrossing the Porcupine River in Alaska and merging with the Chandalar Route in the Coleen River region (McCourt et al., 1974).

It must be emphasized that the preceding corridor descriptions are gross simplifications of an extremely complex process. Not only do migration trails vary considerably within the corridors but additional albeit minor trails exist between them - particularly the Old Crow and Richardson routes. Also caribou may begin the migration in one corridor but later switch to another (Jakimchuk, 1974; Ealey, 1980). Thus it is not possible to state unequivocally that the late summer distribution of the herd will indicate which migration routes the majority will take. The migration corridors and their constituent routes are best perceived as a complex road map in which turns may be made at any junction but in which certain combinations are used more frequently than others. An additional feature of the fall migrations that should be kept in mind is that all caribou seldom if ever follow the entire routes described but may winter at intermediate locations such that the winter distribution most often consists of a number of disjunctive winter ranges located at various points along the routes. Judging from winter distribution records, some caribou may not migrate at all but remain from one summer to the next and perhaps for a few consecutive years on the North Slope or north of the Porcupine River in Yukon.

In view of the preceding considerations, a summary of the basic fall migration pattern for the Porcupine Herd should contain the following highly generalized elements:

a) Each fall most caribou move southward from late summer locations.

b) In all but one year in the past 12, caribou have moved eastward from Alaska into Yukon prior to turning south.

c) The fall migration often begins in late August to early September with the beginning of the eastward return from Alaska to Yukon.

d) The fall migration is eventually accelerated by inclement weather (temperature declines, substantial snowfalls), occurring sometime in September, which often produces a southward movement in Yukon segments that have not already turned south.

e) Subsequent improvements in weather conditions sometimes slow, halt or reverse the Yukon migrations but not always.

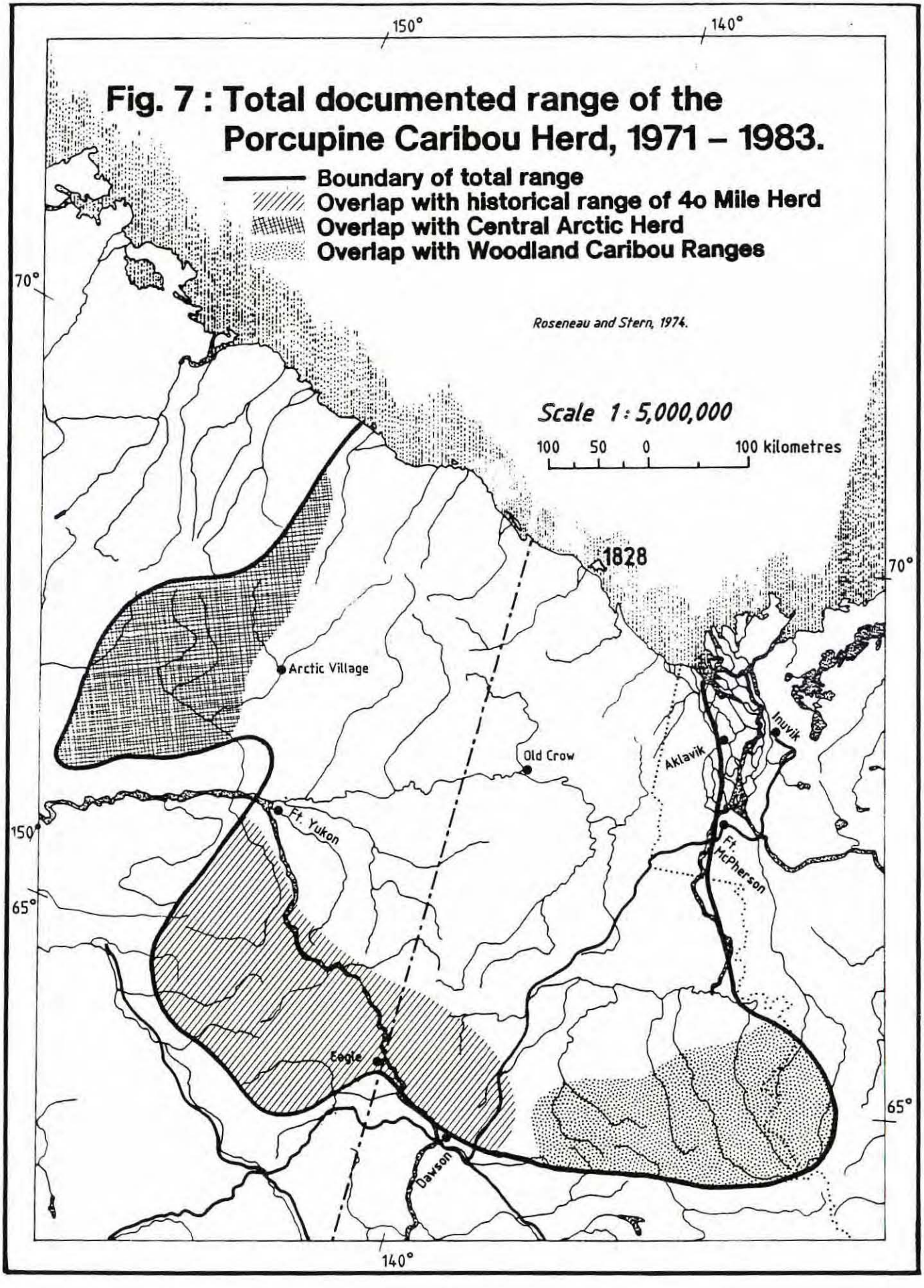
f) The fall migration may end anytime between late October and early December. In the same year it may also end at different times for different herd segments.

g) Each fall migration pattern is unique. Although parts of many known routes are utilized each year, new routes are continually being recorded as well.

POPULATION RANGE

The range of the Porcupine caribou herd incorporates all accurate records of its occurrence. With respect to delineation, pertinent data is restricted to the past 13 years since prior accounts cannot be reliably distinguished from those of adjacent migratory herds and resident herds of mountain caribou. However, historical records dating from the early 1800's to the early 1960's indicate that caribou have at times wintered in all the regions presently utilized by the Porcupine Herd (Thompson and Roseneau, 1978). Two noteworthy historical locations are Herschel Island (Franklin, 1828, cited by Surrendi and De Bock, 1976), where caribou have not been reported in the past 13 years and the MacKenzie Delta (Simpson, 1843, and Pullen, 1850, cited by Surrendi and De Bock, 1976), where few Porcupine caribou have recently been observed and then only at the extreme western perimeter (Thompson, 1979). Additional confirmation of long term use of present summer and fall migration routes exists in the remnant of Kutchin caribou fences in northeastern Alaska and northern Yukon which date to the late 1800's (Warbelow et al., 1975). Traditional crossing points on the Porcupine River near the Old Crow River are believed to be at least 30,000 years old and archaeological evidence indicates that natives have killed caribou at such points and others along the Porcupine River for centuries (Irving and Harrington, 1973; Morlan, 1973).

The documented range of the Porcupine Herd, based on distribution studies since 1970, covers virtually the entire Yukon Territory north of Dawson, some bordering sections of the N.W.T. particularly west of Aklavik and Ft. MacPherson and a substantial portion of northeastern Alaska from the Arctic Coast almost to the Alaska Highway (Fig. 7).


150°
140°
Fig. 7 : Total documented range of the Porcupine Caribou Herd, 1971 – 1983.
Boundary of total range
Overlap with historical range of 40 Mile Herd
Overlap with Central Arctic Herd
Overlap with Woodland Caribou Ranges
70°
Roseneau and Stern, 1974.
Scale 1 : 5,000,000
100 50 0 100 kilometres
1828
70°
Arctic Village
Old Crow
Aklavik
Inuvik
Ft. Yukon
Ft. McPherson
150°
65°
Eagle
Dawson
65°
140°

Most of this vast area has been used regularly or intermittently in the past 13 years with the exceptions of the extreme southeastern portion in the N.W.T. which was reached twice (1971-72, 1976-77) and the extreme southwestern portion west of Fairbanks which was occupied only once (1981-82), (Thompson and Roseneau 1978; Whitten and Cameron, 1982). Prolonged range shifts or abandonments have so far not been detected within this region. The 1981-82 southwestern winter distribution may be either a range extension or merely a reoccupation after a 40+ year absence (Whitten and Cameron, 1982).

The range of the Porcupine Herd overlaps with those of the Central Arctic Herd and the 40-Mile Herd north and south of the Yukon River respectively (Fig. 6), (Roseneau and Stern, 1974; Whitten and Cameron, 1982; Yukon Wildlife Branch, 1983a). Elsewhere, the Porcupine range is distinct from other migratory barren-ground herds, however, it does cover the territories of some mountain caribou in the Hart River and Bonnet Plume herds (Farnell, 1984).

Since reliable distribution records span such a short period in the history of the herd, the boundary delineations merely signify the general range of the herd, which likely includes most but not all of the traditional range - an area that will never be completely known but which may become better identified as distribution data accumulates and is judged in relation to historical and archaeological information.

REPRODUCTION

The rutting period coincides with the fall migration but apparently has little or no influence on the timing or progress of such movements. Prerutting behaviour among Porcupine bulls usually begins around mid-September and continues to increase in intensity to mid-October (Yukon Wildlife Branch, 1980g; Russell and Martell, 1980; Calef, 1981). Rutting activity peaks about the middle to third week of October and matings occur (Russell and Martell, 1980; Calef, 1981) in those couple of weeks (Calef, 1974; Bergerud, 1978). Bull caribou are polygamous and the dominant ones mate with the receptive females in their band (Banfield, 1974). Cows can have several estrus cycles until mating occurs (Skoog, 1968; Bergerud, 1978). Age specific pregnancy rates of the Porcupine Herd have never been determined, however in other populations most females do not mature until between the ages of 29 and 41 months, although a small proportion may bear young as yearlings (Bergerud, 1978). For the Porcupine Herd it has been assumed that the pregnancy rate is 86% for 2+ year old females (Hoffman, 1975). The rut wanes rapidly in early November and the larger bulls begin to shed their antlers shortly thereafter (Calef, 1981). Although the chronology of the rut varies among barren-ground herds (Bergerud, 1978), the preceding sequence described for the Porcupine Herd closely approximates the average of others in North America (Banfield, 1974; Kelsall, 1968).,

The gestation period for caribou has been variously given as about 227 - 229 days (Bergerud, 1978) and 210 days (U.S. Dept. of Interior and U.S. Fish and Wildlife Service, 1982). In the Porcupine Herd, calving may begin as early as May 22, but more often commences about the 27th of that month (Table 1). In all recorded years, the peak of calving has occurred between June 4-8 except in 1980 when several peaks were recorded between June 2-13 for

Table 1. Documented calving periods of the Porcupine Herd 1971 - 1981

Year	Start	Peak	End	Reference
1971	June 2	June 8	June 17-19	Roseneau & Curatolo, 1976
1972**	May 28-27	June 5-7	June 13	Roseneau & Curatolo, 1976
1973*	May 27	June 7	June 15	Doll et al., 1974
1974**	May 27-31	June 6-8	June 14-19	Roseneau & Curatolo, 1976
1975	-	June 4-5	June 14-15	Roseneau & Curatolo, 1976
1980***		June 2-13		Yukon Wildlife Branch, 1980f
1981	May 22	June 4		Yukon Wildlife Branch, 1981c
*1973	June 3	June 12	June 18	Surrendi and De Bock 1976
**1972-	28 = Yukon 27 = Alaska	1974-	27 = Yukon 31 = Alaska	

***Suggested possible progression of peaks from west to east on calving grounds.

different parts of the calving ground (Table 1). Calving is essentially completed by about the third week of June. Normally a single calf is born to each female although twinning has been reported but is believed to be rare (Banfield, 1974; Kelsall, 1968; Bergerud, 1978). Caribou calves are extremely precocious, being able to stand and suckle within a few hours of birth (Banfield, 1974; Kelsall, 1968) and to graze within their first day or so (Kelsall, 1968). Weaning probably is completed for most calves by early September, although instances of suckling extending into winter have been recorded (Kelsall, 1968; Banfield, 1974). Such observations pertain to barren-ground herds of the N.W.T., but a similar developmental sequence is likely for Porcupine caribou calves as well.

Further considerations of reproduction such as productivity, sex ratios, etc. are discussed in the following section.

MORTALITY

Prior to European contact, all mortality factors affecting the Porcupine Herd could have been classed as natural. Now, however, it is necessary to separate natural mortality factors from those involving human activities which no longer bear a purely survival relationship to caribou. These two categories are discussed separately as follows.

Natural Mortality

1. Predation

Porcupine caribou share their range with predators common to most caribou herds. This aspect of mortality, however, has seldom been seriously investigated and existing data is mostly incidental observations of predators and occasionally predation recorded during other studies.

a) Wolf:

The wolf population of the Porcupine range has never been properly assessed. In 499 hours of surveying the Yukon portion of the Porcupine range in 1971, 159 wolves were observed in 69 sightings - the largest pack containing 14 members (Jakimchuk et al., 1974). Of 133 wolf kills examined at that time, 131 were caribou and two were moose. Wolf predation on caribou was observed throughout the study period, and it appeared that wolves not involved with denning followed caribou (Jakimchuk et al., 1974). A subjective estimate of the northern Yukon population was 300-400 wolves between the Peel River drainage route and the Beaufort Sea (Jakimchuk, et al., 1974). A total of 154 wolf sightings were made during 1972 and 1973 caribou surveys, and like those of 1971 their distribution was

quite broad and "sporadic" throughout the northern Yukon (Doll et al., 1974b). Wolves were often associated with caribou; of the 154 sightings 31 were either at caribou kills or of wolves hunting caribou, while in 1972 of the 122 sightings that year only two were at moose kills (Doll et al., 1974b). Wolves were reported to be numerous in the Richardson Range in the winters of 1972/73 and 1974/75 and to kill calves and old bulls most frequently in a diet that consisted exclusively of caribou (Hoffman, 1975).

In March 1980, nine wolves were observed in the Keele Range and one was sighted on the Ogilvie Plains. Since wolves were not sighted during many hours of winter range surveys, it was suggested that wolf populations were concentrated in the Keele Range and Porcupine River area and that caribou were not followed further south into the winter ranges (Yukon Wildlife Branch, 1980b).

Active wolf dens have been recorded in the mountainous terrain of the Hulahula, Canning and Kongakut drainages, however, none have so far been found on the coastal plain of the Arctic National Wildlife Refuge (U.S. Dept. of Interior and U.S. Fish and Wildlife Service, 1982). This has been attributed partly to the preference of wolves for the foothills of the Arctic Slope and the mountains of the Brooks Range where prey such as Dall sheep and moose are found (U.S. Dept. of Interior and U.S. Fish and Wildlife Service, 1982). Furthermore when caribou are abundant on the coastal plain (May and June), most wolves are probably confined to the mountains where denning activities restrict their hunting radius to about 32 km (U.S. Dept. of Interior and U.S. Fish and Wildlife Service, 1982).

Aerial hunting up to the early 1970's and some continued aerial poaching have received credit for the existence of low wolf numbers on the Alaskan Arctic Slope (Roseneau and Curatolo, 1976). In Yukon no wolf dens have so far been reported within the calving grounds (D. Russell and R. Farnell, pers. comm.). Also, despite numerous aerial surveys of the calving grounds since 1971, the number of wolf sightings each year has always been very low (Table 2).

In view of the conflicting evidence concerning wolf numbers on the Porcupine winter ranges, it is difficult to establish the potential significance of wolf predation on the herd. Certainly the level of predation must be lower than for adjacent N.W.T. herds, where wolves are commonly sighted during winter range surveys; on the other hand it is unlikely that wolf predation is insignificant as a mortality factor.

b) Grizzly Bear:

Grizzly bears are by contrast quite common on the Porcupine calving grounds (Table 2) and at times appear to be gathered where calving activity is most concentrated (Yukon Wildlife Branch, 1979b). Of 25 bear sightings made on the calving grounds in 1975, two single bears were at fresh caribou kills and two other attempts by bears to kill caribou were observed (Roseneau and Curatolo, 1976). In 1974, four out of nine grizzly observations made on the calving grounds involved bears at caribou kills (Roseneau and Curatolo, 1976). Of 45 sightings on the calving ground in 1979, two lone grizzlies were observed chasing caribou and three lone grizzlies

Table 2. Predator Sightings on the Porcupine Caribou Range 1971 - 1982 Urquhart 1983

PREDATOR	DATE	NUMBER	LOCATION	REFERENCE
Wolf	1971	159*	Most of Yukon range	Jakimchuk et al 1974
Wolf	1972	2+	Calving grounds	Roseneau & Curatolo 1976
Wolf	1973	2	July post-calving area	Roseneau & Curatolo 1976
Wolf	1972+73	154*	Northern Yukon	Doll et al 1974b
Wolf	1974	1	July post-calving area	Roseneau & Curatolo 1976
Wolf	1975	6	Kongakut R. densite	Roseneau & Curatolo 1976
Wolf	1975	several	south of Barter Island	Roseneau & Curatolo 1976
Wolf	1975	several pups	densite(?)SadlerochitR.	Roseneau & Curatolo 1976
Wolf	1979	2	calving grounds	Y.W.B. 1979b
Wolf	1980	9	Keele Range	Y.W.B. 1980b
	1980	1	Ogilvie Basin	
Wolf	1982	some	calving grounds	Mauer et al 1983
Grizzly	1971	93	Northern Yukon	Jakimchuk et al 1974
Grizzly	1972	12	calving grounds	Roseneau & Curatolo 1976
Grizzly	1973	144*	Northern Yukon	Doll et al 1974b
Grizzly	1973	4	calving grounds	Roseneau & Curatolo 1976
Grizzly	1974	9	calving & post-calving grounds	Roseneau & Curatolo 1976
Grizzly	1975	25	calving grounds	Roseneau & Curatolo 1976
Grizzly	1979	45*	calving grounds	Y.W.B. 1979b
Grizzly	1981	24	calving grounds	Y.W.B. 1981c
Grizzly	1982	50	calving grounds and vicinity	Garner & Reynolds 1983
Golden Eagle	1972 1973	Numerous	post-calving grounds	Roseneau & Curatolo 1976
Golden Eagle	1974	57*	post-calving grounds	Roseneau & Curatolo 1976
Golden Eagle	1975	45	calving & post-calving grounds	Roseneau & Curatolo 1976
Golden Eagle	1981	3	calving grounds	Y.B.W. 1981c
Golden Eagle	1982	Numerous	calving grounds	Mauer et al 1983

*not necessarily separate **including repeats

were at kills - two of which were calves (Yukon Wildlife Branch, 1979b). On two occasions in 1981, grizzlies were observed feeding on calf carcasses on the calving grounds and one sow was seen chasing caribou (Yukon Wildlife Branch, 1981c). In 1982 only one instance of grizzly predation was noted in a calf mortality study on the calving grounds (Mauer et al., 1983), but on six other occasions grizzlies were observed at caribou kills in a separate study which captured 50 bears on the coastal plains and adjacent foothills of the Arctic National Wildlife Refuge in 1982 (Garner and Reynolds, 1983).

Of 93 sightings in 1971 throughout northern Yukon, 52 involved grizzlies associated with caribou either as kills or in proximity to live animals (Jakimchuk et al., 1974). Between March and November 1973, 144 grizzly bears were observed in northern Yukon, apparently somewhat segregated in distribution according to family units and solitary animals (Doll et al., 1974b). An apparent southward shift in distribution away from the coast in September was also noted (Doll et al., 1974b). Recorded denning sites in Yukon are all well south of the coast (Jakimchuk et al., 1974). It has been suggested that as calving and post-calving progresses, large mammalian predators become more numerous as individuals are attracted to these concentrations, however, it has also been noted that in northeastern Alaska at least, both wolves and grizzlies are relatively scarce north of the Brooks Range (Roseneau and Curatolo, 1976). Of 38 den locations made in 1982 in the Arctic National Wildlife Refuge, only one was on the coastal plain and the

remainder were in the foothills and mountains of the Brooks Range (Garner and Reynolds, 1983).

c) Golden Eagle:

Between 1972 and 1975 reports of Golden Eagle numbers and calf predation on the calving grounds indicated that this species, particularly the non-nesting sub-adults, was the most important predator on the calving and post-calving grounds (Roseneau and Curatolo, 1976). The sub-adults being neither confined to nesting territories nor involved in the reproductive cycle, are highly mobile and the majority appear to maintain almost constant contact with the calving and post-calving herds (Roseneau and Curatolo, 1976). In a 1982 study of calf mortality, Golden Eagles were involved in 50% of the total mortality either as the probable predator or a predator/scavenger (Garner and Reynolds, 1983).

From the preceding information it is not possible to determine the relative importance of these three species as predators of the caribou herd nor can the relative contribution of predation to overall mortality of the herd be determined. While in order of importance the major calving ground predators are eagles, grizzlies and wolves respectively, neither eagles nor grizzlies are likely to be very significant predators of adult caribou whereas wolves are. The apparent scarcity of wolves on the major winter ranges in recent years suggests that wolf predation is probably low during the winter season, however, the amount of predation in winter, spring or fall cannot, at this time, even be estimated. Still, in comparison to many other North American herds, wolf predation seems to be relatively low, while eagle predation is relatively high.

2. Accidents

Porcupine caribou are prone to accidents throughout the year, but they may sustain more injuries in certain periods such as during migrations and post-calving movements. A common cause of mortality is river crossings where animals are either drowned or injured. In the 1971 spring migration, 28 caribou were killed while trying to cross the Porcupine River which was carrying moving ice pans which, when too many trapped animals tried to climb on them, overturned causing death by crushing and drowning (Jakimchuk et al., 1974). In 1975 a cow with a ruptured abdominal cavity was found near the Kongakut River bank from which it was inferred that the animal had impaled itself on a rock or limb while crossing (Roseneau and Curatolo, 1976). In 1982 a collared calf apparently drowned while attempting to cross the Firth River with a nursery band on June 30 (Mauer et al., 1983).

Another likely source of injury and sometimes eventual mortality is running from predators or from insect harrassment. Post-calving aggregations in particular seem prone to such accidents perhaps partially because insect harrassment peaks at this period and partially because the aggregations appear susceptible to panic stampeding (Roseneau and Curatolo, 1976). These aggregations also at times move extensively and rapidly, crossing many rivers in a relatively short interval (Roseneau and Curatolo, 1976). In July 1972, of 32,784 caribou which had been moving rapidly across the coastal plain for some time and reacting violently as well to insect harrassment, limping individuals were conspicuous among the last 1,000-2,000 animals to pass, and an estimated 200 or so were seriously injured and seemed unlikely to travel much farther (Roseneau and Stearn, 1974). Such post-calving movements

have also been credited with contributing significantly to calf mortality (Calef and Lortie, 1973). Not only would calves be exhausted by hard travelling at such an early age and thus vulnerable to accidents and predation, but other factors such as calf abandonment would likely be increased by numerous river crossings and erratic stampeding.

3. Sickness, Disease and Parasitism

Information concerning diseases and parasitism of adult Porcupine caribou is very limited. The only noteworthy disease which has so far received comment is "lumpy jaw". Calves may die from exposure or starvation during their first few weeks of life (Mauer et al., 1983). Starvation usually results from abandonment which may have a number of causes such as predator disturbance, neglect by inexperienced young females, and physiological disorders such as mastitis that interfere with suckling (Mauer et al., 1976); as well as other factors such as cow mortality or accidental separation, especially at water crossings. In 1982, one radio-collared calf died of exposure following high winds (42.6 kph) and 'mild temperatures' (3.8^{o}C), (Mauer et al., 1983).

4. Neonatal Mortality

Since calf mortality has been discussed in the previous three sections, it is only necessary to state that as an age class, calves have the highest mortality rate owing to their vulnerability to predation, accidents, exposure and starvation. That the Porcupine caribou population has apparently increased slowly over the past decade despite apparently low hunting and predation pressures, may signify that neonatal mortality rates in this herd are quite high. A further discussion of mortality rates in relation to population dynamics is presented in the following section.

Human Related Mortality

1. Hunting

Humans have apparently hunted caribou on the Porcupine Range for at least 27,000 years (Irving and Harrington, 1973) employing, no doubt, the typical strategies of ambush, spearing at water crossings etc., but also erecting long driftwood fences and corrals such as those used by the Kutchin tribes (Warbelow et al., 1975). Aboriginal dependence upon Porcupine caribou likely fluctuated with the availability of other food sources such as fish, muskoxen and marine mammals for the Inuit and fish, moose, Dall sheep and woodland caribou for the inland Athapaskans. At times the failure of Porcupine caribou to arrive at a critical period resulted in starvation among both Inuit and Athapaskan communities as recently as the early 1900's (Stefansson, 1914).

The nature of the caribou harvest began to change significantly with the advent of the whalers in the early 1800's followed by the fur traders, prospectors, trappers and miners. At the height of the arctic whaling industry in the 1890's up to 5,000 caribou may have been taken annually for provisioning (Calef, 1974). Professional meat hunting was a common occupation in the period 1890-1910, and as late as the 1930's thousands of caribou were used as dog food by trappers and miners (U.S. Department of State, 1980). Other factors influencing the caribou harvest were a shift from subsistence lifestyles to a greater dependence on imported food and clothing, centralization of human settlements, adoption of snowmachines in preference to dog teams (U.S. Department of State, 1980), as well as the population status of native and white groups plus of course the increasingly widespread use of rifles and the availability of ammunition.

The influence of such factors, in conjunction with the variability of caribou distribution, have determined the size of the caribou harvests over the past century, but since none of the factors can be quantified, the net effect on the harvest is difficult to judge for any given period. For example, although it has been suggested that the harvest peaked during the height of the whaling era, and that "use by whites was practically non-existent by the 1930's" (Le Resche, 1975), another opinion is that hunting pressures were also extreme in the 1930's (USFWS, 1980).

A similar analysis for the Bathurst Herd in the N.W.T. which was subjected to most of the same factors concluded that the greatest hunting pressure in the 20th century may have occurred between the two World Wars (1918-1940) (Urquhart, 1981).

Harvest data for the Porcupine Herd was probably first recorded from 1932 to 1948, when Game Return forms were distributed to R.C.M.P. detachments in the N.W.T. and Yukon, (Banfield and Jakimchuk, 1980). Beginning in 1953, hunters in the N.W.T. reported their harvest on their General Hunting License, and analyses of these returns for the period 1964 to 1972 yielded an average of 1,345 as a reported harvest from the settlements of Aklavik, Ft. MacPherson and Inuvik (Hoffman, 1975), (Table 3). A separate analysis of returns from Aklavik and Ft. MacPherson plus reports for Old Crow and the Dempster Highway produced an average annual harvest of 1,183 for the same period (Surrendi and De Bock, 1976). Such analyses, however, are fraught with errors since the returns are incomplete, individually inaccurate in many cases, and

ignore a significant segment of the hunting community altogether (Table 3). Other harvest data for the Porcupine Herd have been acquired mainly by hunter interviews and field observations. Since 1976-77 hunters in Alaska have been required to submit a harvest report to transport caribou south of the Yukon River (Davis, 1978). These reports, however, account for a very small portion of the total harvest from Game Management units 25 and 26c which cover the Porcupine Range in Alaska. Otherwise, as in Canada, Alaskan harvest figures are based on a combination of interview, observation and conjecture.

Such methods vary greatly in reliability, but the types of errors involved tend to reduce harvest figures and thus the annual harvest totals (Table 3) are minimal, and since most totals are incomplete due to unreported regions, the figures are further reduced. It is also impossible to meaningfully compare harvests among years because the annual values in addition to their inherent errors, have been compiled by a variety of methods each with its own biases. Also, no two sets of data represent all the same settlements and regions.

Interpretations of harvest data are thus severely constrained by the data quality and about all that can be determined with some confidence is that the annual reported harvests of the Porcupine Herd fluctuate between a low of around a couple of thousand and a high in the neighbourhood of 5,000. Not withstanding these limitations, one version is that the total mortality of the Porcupine population is 8,500 annually consisting of 3,000-5,000 animals from hunting, and the remainder being made up by natural factors (McCourt, 1980). This seems to imply that a) mortality is a constant, and b) that natural mortality

Table 3. Documented Harvests from the Porcupine Herd 1964 - 1982

PERIOD	TOTAL	HARVEST	COUNTRY	SETTLEMENT		REFERENCE
1969	465	465	CAN	Aklavik	Lic.ret.	Jakimchuk et al 1974
Early 1970s	2500-4000	800-1100	CAN	Old Crow, Demp. Hwy	Estimate	Calef 1974*
1970-71	1309	1309	CAN	Aklavik, Ft. MacPherson Old Crow	Lic.ret. & est.	Jakimchuk et al 1974
1964-72ave	1183	1183	CAN	Aklavik,Ft.MacPherson Old Crow, Demp. Hwy:	Lic.ret. & rep.	Surrendi et al 1976
Sprg72 - sprg 73	4175	1500	U.S.	Arctic Vill, Kaktovik Venetie, Chalyittisik, Ft. Yukon	Estimate	LeResche 1975
		2675	CAN	Aklavik, Inuvik, Ft. MacPherson, Arctic Red, Tuk, Old Crow, Demp.Hwy.		
1971-74ave	478-769	478-769	CAN	Old Crow	?	Stager 1974*
Jun73-jun74	2000	2000	CAN	Aklavik,Ft.MacPherson, Inuvik	Intvw.	Hoffman 1975
Winter74-75	2000+	2000+	CAN	Aklavik	Estimate	Hoffman 1975
1975	950-1500	950-1500	U.S.	Kaktovik,Arctic Vill., (out of unit hunters)	Reports	Dept of State 1980
1975-76	3000-4500	1500	U.S.	Alaska and Canada	?	ADF & G 1978*
		1500-3000	CAN			
1972-77ave	3352	3352	CAN&U.S.	?	Unp.Data	Martell & Russell
1977-78		400-500	U.S.	Kaktovik,Arctic Vill., (Out of unit hunters)	Guess	1981
	1469-1569					
		1069	CAN	Demp.,Old Crow, Ft. MacP., Aklavik,Inuvik,Arctic Red		Davis 1978
1978-80		162	U.S.	Arctic Vill., Kaktovik (out of unit hunters)	Reports	Whitten et al 1980
	962					
		800	CAN	Yukon only	Intvw. & Obs.	Y.W.B. 1980e
1980-81			CAN	Demp. Hwy., Old Crow, Ft. MacPherson	Intvw., Cts & Estimate	Y.W.B. 1981e
Fall 1981	1000	1000	CAN	Old Crow	Report	Whitten & Cameron 1982
1982		1400	CAN	Ft. MacP. (Demp. Hwy)	Report	Russell 1982

* Not Seen

somehow compensates for harvest fluctuations. If this is so, then it is a unique and highly fortuitous relationship.

Annual harvests vary considerably not only in total, but also for particular communities depending upon the specific migration routes and winter ranges chosen by the majority of the herd. In particular, the communities in the N.W.T. on the eastern periphery of the range exhibit the highest variability among annual harvests (U.S. Department of State, 1980), but others such as those in the Chandalar winter range also experience years of extreme scarcity and abundance (Le Resche, 1975; Whitten and Cameron, 1980; Whitten and Cameron, 1982). In general, however, more caribou are harvested annually in Canada than in the U.S. perhaps within the suggested range of 50+% to 75% (U.S. Department of State, 1980) but probably by more than that, such as in 1980 when the reported Canadian harvest was 83% of the reported total which did not include the N.W.T. component (Table 3).

To properly assess the significance of hunting as a mortality factor, the effect of crippling loss must also be considered. Accounts of "flock shooting" and poor marksmanship exist in hunting reports for the Porcupine Herd from which a crippling loss of 10% was suggested (Hoffman, 1975). Another suggestion put the crippling loss as high as 33% (Jakimchuk et al., 1974). A popular figure employed arbitrarily in many such harvest analyses for other herds is 25% which if applied to the Porcupine caribou harvest would increase the approximate range of the annual caribou kill to between about 2,500 and around 6,000+.

2. Non Hunting Factors

Apart from hunting, other human activities may directly or indirectly be involved in caribou mortalities. An obvious danger is from traffic on the Dempster Highway, and although few road kills have so far occurred (D. Russell, pers. comm.), increased traffic levels might eventually result in significant mortality levels.

On some caribou ranges, such as that of the Tuktoyaktuk Reindeer Herd, animals occasionally become entangled in blasting wire and die from such injuries (A. Martell, pers. comm.).

Caribou are vulnerable to harrassment either by snowmachines (Hoffman, 1975) or aircraft (Surrendi and De Bock, 1976) which stress animals and could conceivably contribute to mortality at certain times of the year.

So far none of the preceding possibilities constitute significant mortality for the Porcupine population but they might pose a threat if industrialization and other activities increase on the herd's range.

Although mortality factors have so far received little research attention and most data are incidental to other studies, a few tentative conclusions are provided as follows:

a) In order of significance, the major caribou predators on the Porcupine calving grounds are golden eagles, grizzly bears and wolves respectively.
b) In order of significance the major caribou predators on the rest of the Porcupine range probably are wolves and grizzly bears.

c) In recent years wolf predation has apparently been quite low.

d) Accidents contribute to mortality in the Porcupine population chiefly through mishaps at river crossings, but also from injuries sustained in stampedes either from predators or insect harrassment.

e) Some caribou succumb to starvation and exposure and probably also disease, although the latter has never been documented as a mortality factor.

f) Neonatal mortality results from a variety of factors including predation, starvation, exposure and accident.

g) Porcupine caribou have been hunted by humans for millenia.

h) European contact and succeeding stages of human history on the Porcupine range drastically altered hunting methods and harvest levels of Porcupine caribou.

i) Peak harvest periods may have occurred in the late 1800's and perhaps again around the 1930's.

j) Harvest data for the Porcupine Herd are generally incomplete and inaccurate to the extent that little substantive information can be obtained from them.

k) Annual harvests fluctuate considerably for most communities on the Porcupine range, primarily due to the variability in migration routes and winter ranges selected by the herd.

l) Total reported harvests fluctuate between around 400 animals and around 5,000, but totals rarely include all communities.

m) The total mortality resulting from hunting is substantially higher than the actual harvest due to crippling losses which may account for an additional 10-33% of the actual harvest.

n) Generally more caribou are harvested annually in Canada than in the U.S., with the Canadian portion sometimes exceeding 80% of the reported total.

o) So far human activities other than hunting have caused negligible mortality in the Porcupine population, but some of these could become significant if the levels of activity (i.e. traffic) were substantially increased.

POPULATION DYNAMICS

The Porcupine Herd is a population of interbreeding caribou that is continually (but not constantly) losing individuals throughout the year (mortality), and once each year receives a quantity of new members (productivity). These contending events produce a dynamic that determines the characteristics of the Porcupine population such as its size and composition. Information concerning various aspects of the Porcupine population dynamics are discussed under the following topics:

Composition

The discussion in this and the following subsection are based upon composition data obtained from the Porcupine Herd at various seasons. Typically these data are acquired by trained observers using spotting scopes and hand tally counters. The observers are moved by aircraft to various locations in order to obtain a reliable sample distribution. Occasionally caribou are classified by helicopter or from aerial photographs.

Since the composition of the Porcupine Herd is never homogeneous, it is imperative that the total sample size be around 10% of the entire population or in the range of about 10,000 animals, and that this total be composed of

several well dispersed samples. Applying these criteria to the data summarized in Table 4, it is apparent that some of the estimates are of doubtful reliability due to inadequate sample sizes. In addition all of the July samples are taken from the post-calving aggregrations, and therefore do not represent the entire population since bull and yearling components are highly variable at that time. Thus the only value of the July data is the calf:cow ratio since it is likely that all but a few cows are comprised by the aggregations. Even then, however, errors may arise such as in 1977 when the calf:cow ratio in July was 11% smaller than the October - November figure. This was attributed to calves being missed in oblique photographs (Davis, 1978).

Productivity and Survival

The productivity of the Porcupine population is the number of calves born in June each year. The best measure of the calf crop is the proportion of calves per 100 cows. Ideally this calf:cow ratio should be obtained immediately after calving, but this is not possible since the calving herd is still widely dispersed and cannot be sampled accurately. Also a significant number of non-breeding cows may not have reached the calving grounds and thus cannot be accounted for. Consequently calf:cow ratios are determined from the early to mid-July post-calving aggregations, but as such represent only the proportion of calves that have survived the first 2-4 weeks of life. These ratios vary annually within the range of 47 to 66 calves:100 cows (Table 4) for reliable samples. If about 86% of the females are pregnant each year as they were in 1974 (Hoffman, 1975), then about 54% to 76% of the calves survive until mid-July.

TABLE 4. **Age and Sex Structure of the Porcupine Herd 1972 - 1980**
(Note see text page 62 for interpretation)

	COW	CALF	YRL	BULL	CALF:COW	YRL: COW	BULL: COW	SAMPLE SIZE	METHODS	REFERENCE
June 8/72	1636	987			55:100			2,623	Helicopter	LeResche 1975
June 1972	1167	897			77:100			2,069	Ant. cows ground	LeResche 1975
July 4/72	53%	26%	9%	12%	50:100			11,921	?	LeResche 1975
Oct/72	49%	15%	9%	28%	30:100	18:100	57:100	2,997	?	Calef & Lortie 1973
July 3-8/73	58%	27%	6%	10%	47:100			19,101	Ground cts	Roseneau et al 1974b
July 13-14 1974	55%	37%	3%	5%	66:100			14,127	Ground cts	Roseneau et al 1075
July 1-6/75	52%	27%	9%	12%	51:100			18,814	Ground cts	Roseneau & Curatolo 1976
July 1976*	55%	32%	10%	2%	59:100			13,762	?	Davis 1978
July 6-9/77	61%	24%	11%	4%	39:100			25,520	Ground cts - air photos	Davis 1978
Oct 26 - Nov 13/77	39%	19%	12%	30%	48:100	78:100	31:100	8,940	Ground cts	Davis 1978
July 1978	35%	17%	14%	34%	50:100			?	Ground cts ?	Y.W.B. 1980d
Oct 27/78	48%	30%	6%	15%	62:100	33:100	14:100	?	?	Y.W.B. 1980g
Mar 31/79	58%	15%**	-	27%	25:100**			1,752	Ground cts	Farnell 1979a
July 3-7 1979***	45%	25%	8%	23%	54:100			23,320	Ground & air photos	Whitten & Cameron 1980
Mar 9-12/80	45%	24%**	15%	16%	55:100			4,014	Ground cts	Y.W.B. 1980d
July 4/80	40%	26%	11%	23%	66:100			9,046	Ground cts	Y.W.B. 1980d
Oct 10-25/80	43%	23%	8%****	26%	54:100	19:100	60:100	13,911	Ground cts	Y.W.B. 1980g

*1st half of July; **short yearlings (ie. 10 mo.old); *** recalculated from (Whitten and Cameron 1980); ****incomplete segregation.

Calves continue to die throughout the summer and fall. The 1980 composition counts indicate that about 82% of the early July calf population survived to mid-October (Table 4). If the 1972 October ratio is accurate, then only 66% of the calves survived that year between July and October (Table 4).

Recruitment

Since the mortality rate of calves is so high, their contribution to the population cannot be gauged until the following spring at the earliest - after the winter has taken its toll. Spring segregations are rarely attempted for the Porcupine Herd, because of the extreme difficulty of obtaining reliable samples. For example, the March 1980 calf:cow ratio of 55:100 was higher than the July 1979 ratio of 54:100 indicating that the March data is inaccurate.

The July composition counts are also unreliable due to the previously mentioned variability of bull and yearling mixes in the post-calving aggregations (Whitten and Cameron, 1980). The only remaining data therefore are the fall composition counts which range between 8% and 12% of the herd (Table 4) that actually represent 15 month old animals or "long yearlings". Unfortunately, only the 1977 figure of 12% can be used, since the 1972 sample size is too small and the 1980 sample was incomplete for yearling segregations (Yukon Wildlife Branch, 1980g). Thus the recruitment rate for the Porcupine Herd might be considered to be in the neighbourhood of 12%, but must fluctuate according to the previous years' calf crop and its mortality rate over the succeeding 15 months.

The documented recruitment rate of 12% for the Porcupine Herd is somewhat lower than average spring recruitment rates of 15-16% reported for Canadian

Arctic caribou populations (Kelsall, 1968) and similar figures for the Western Arctic Herd in Alaska (Lent, 1966). This may indicate higher calf mortality rates for the Porcupine Herd than for the other herds mentioned and may be related to the levels of golden eagle and grizzly predation on the calving grounds as well as significant calf losses during the period of rapid movement often undertaken by the post-calving aggregations. On the other hand, the 12% figure is a fall estimate and may be lower on that account alone compared to spring figures for younger animals.

Another recruitment parameter is the yearling to cow ratio which can only be reliably taken from the fall segregations. For the Porcupine Herd the only reliable estimate is 31:100 for 1977 as the 1972 and 1980 samples are unreliable. Since the 1976 July calf:cow ratio was 59:100, then 53% of the 1976 July calves survived the following 14 months of life that year.

Mortality Rates

There is only one complete analysis of differential mortality rates for the Porcupine caribou population (Martell and Russell, 1981). This was based on the age and sex of jaws from hunter kills on the Dempster Highway in the falls of 1972, 1973, 1977 and the winter of 1973-74 harvest by Ft. MacPherson residents. When only the jaws of known sex were used, the mortality rate for females greater than three years of age (3+ females) was 0.20, while for the 3+ males it was 0.41 (i.e. each year 20% of the 3+ females and 41% of the 3+ male die). For combined sexes over three years of age the rate was 0.25. The estimates for females and combined sexes are consistent with those for other herds, where the same analytical method was employed. The male mortality rate (0.41) is intermediate between the lightly sport-hunted Kaminuriak Herd (0.34), (Miller, 1974) and the heavily sport-hunted Nelchina

Herd (0.51), (Bos, 1973) where the same analytical method was employed (Martell and Russell, 1983).

When unsexed jaws were included in the data, the mortality rate for all age classes was estimated to be .27, and for 3+ animals the rate was 0.28, employing a somewhat different analytical method than for the sexed jaws data only. In this version the estimates are slightly higher than the Kaminuriak Herd (0.24 and 0.24 respectively), (Miller, 1974) and for Northern Canada (0.21 and 0.22), (Banfield, 1955).

Using census, recruitment and hunting parameters for the Porcupine Herd, the total mortality rate for the population was calculated to be 0.07 comprised of hunting 0.03 and natural mortality 0.04. The total rate (0.07) is extremely low and likely inaccurate, since it depends on two parameters - yearling recruitment and harvest levels that are not reliable for this population.

About all that can be concluded from the preceding analyses is that the Porcupine population does not exhibit drastically different mortality rates from those of other herds when the same analytical methods are employed. The estimates therefore should be considered as indices of comparison with other herds, but not as actual mortality rates for the Porcupine Herd alone.

Herd Structure

The sex and age composition of the Porcupine Herd is known from the segregation counts conducted in various seasons (Table 4). As mentioned previously in subsection "Composition data", however, most of these data are inadmissable due to the unreliability of the samples. The best available

data is contained in the fall segregation of 1972, 1977 and 1980, but each of these is flawed as well. However, it appears from these that in the fall, adult cows constitute slightly less than half of the herd and adult bulls about a quarter of the herd with the remainder divided between calves and long yearlings. As the year progresses, the calf proportion in particular, drops substantially with the effect of elevating all the other proportions. Thus, by spring the percentage of adult females and adult males in the herd will be much greater. Also, it is likely that the proportion of adult bulls to adult cows will vary throughout the year as each sex experiences greater or lesser mortality in different seasons.

Three of the four bull:cow ratios from fall segregations range between 58:100 and 78:100 (Table 4), the fourth ratio of 33:100 is likely biased (Bente and Roseneau, 1978). These figures concur with those for lightly hunted herds in Alaska and Canada (Pegau and Hemming, 1972; Skoog, 1968; Kelsall, 1968), whereas for heavily hunted herds the bull:cow ratios are much lower (Bergerud, 1971; Bos, 1974). This effect of course only pertains to populations with bull only hunting restrictions or no sex hunting restrictions in which latter case there is usually some selection for bulls.

The age distribution of the Porcupine Herd based on hunter kill data from 1972 to 1977 indicated that 77% of the population is younger than six years old, but that Porcupine caribou can reach the age of 13 years (Martell and Russell, 1981).

Population Size

As with other herds, attempts to estimate the Porcupine population were made long before a reliable method had been developed. Without going into the numerous details of how and why population estimates are unreliable, suffice

it to say that the cumulative errors in each estimate contrive to make it a virtually unique figure that cannot be compared with any others to provide a trend except by the grossest standards (Table 5). This pertains particularly to estimates made prior to 1972 which by modern standards are highly questionable (even when they agree). In the 1950's and 1960's the theory of population shifts among adjacent caribou herds became quite popular and was used to help explain changes in the Porcupine population estimates from that period. Results from subsequent tagging and radio-collaring studies however, have shown that exchanges of animals among caribou herds is very slight, (Parker 1972, Whitten and Cameron 1982).

Since 1972, population estimates have been based on a technique termed Aerial-Photo-Direct-Count-Extrapolation (APDCE). Basically this method relies on aerial photographs of the large post-calving aggregations which in "good" years comprise essentially the entire herd. These photographs can be analysed in several ways to generate a total population figure. The chief advantage of this technique is that the total number of animals counted in the photographs represents a relatively solid figure although subsequent analyses are always subject to interpretation. Nevertheless in 1979, 105,683 caribou were counted from the photos, in 1982 about 125,339 were counted and in 1983 135,284 were counted.

Traditionally, the population estimates of the Porcupine Herd have usually included calves. This may suit biologists but it can become confusing for managers and the public since calf crops can vary substantially among years. Thus a poor calf crop, although significant to the herd, will have an exagerated influence on the population estimate and apparent trend. From a management standpoint, it seems better to consider only the adult population

Table 5. Population Estimates of the Porcupine 1953 - 1983

Year	Estimate		Reference
	Adults	Total	
1953		30,000 (spring)	Munro 1953
1953		55,000 (spring)	Skoog 1963a
1961	110,000 (summer)		Skoog 1963b
1962	unavailable		
1964	140,000 (summer)		Skoog 1968
1971		60,000 (spring)	Renewable Resources 1972
1971		21-30,000 (spring)	Calef & Lortie 1972
1971		60,000 (summer)	Calef & Lortie 1972
1972	84,965* (fall) (±11,640)	99,959 (fall) (±13,711)	LeResche 1975
1977	85,685* (fall) (±22,792)	105,126 (fall) (±28,009)	Bente & Roseneau 1978
1979	84,700* (fall)	110,000 (summer)	Whitten & Cameron 1980
1982	123,000** (summer)	137,000 (summer)	Whitten 1986
1983	104,168*** (fall)	135,284 (summer)	Whitten 1986

* calculated for this report from data in references.

** author assumed only 10.6% calves, adults would = 105,490 if 23% calves (see Note).

*** assuming 23% calves (see Note) (average of reliable October figures).

Note: The 23% calves was derived from 19% calves in October 1977 and a calf survival rate of 82% from July to October (1979 data). Therefore the percent of calves in July might be 19 divided by .82 = 23%.

1983 may be, in fact, only a moderate fluctuation in a relatively stable system that has prevailed for a number of decades.

From a management standpoint, there is no need to become excited over the results of any "latest" survey unless it indicates a drastic change in the herd's status. Current methods are quite capable of detecting such changes, and with periodic monitoring should alert managers in time to take action.

In summary, the population dynamics of the Porcupine Herd are incompletely known. Some aspects have been quite well documented while others remain poorly understood. Given the constraints of existing information, the following statements can be made.

a) The productivity (as of July) of the Porcupine Herd has varied between 44 and 66 calves per 100 cows.
b) If the pregnancy rate in the Porcupine Herd is fairly constant, then variations in July calf:cow ratios would be due primarily to neonatal mortality.
c) The age and sex structure of the Porcupine Herd changes over the period of a given year according to the survival rates of the various age and sex classes but particularly calves.
d) In the falls of the last 10 years (from 1983) adult cows probably comprised slightly less than half of the herd and adult bulls about a quarter of the herd.
e) Semi-reliable fall bull:cow ratios for the Porcupine herd range between 57:100 and 78:100 indicating a lightly harvested population.

f) The Porcupine caribou population is probably young with the majority of animals being less than 6 years of age with a potential longevity of about 13 years.

g) There is no reliable evidence to support any of the reported population changes between 1900 and 1972 actually ocurred.

h) Proposed emigrations of Porcupine caribou to adjacent herds and immigrations of Forty-mile caribou to the Porcupine Herd likely did not occur.

i) The Porcupine caribou population presently numbers around 100,000 adults.

j) The herd has either remained relatively stable since 1972 or increased slightly.

UTILIZATION

Subsistence hunting constitutes the bulk of the Porcupine caribou harvest, most of which is taken by native peoples in Alaska, Yukon and the Northwest Territories. Non-native residents also hunt caribou for subsistence and perhaps a few hunt for trophies. Non-resident hunters are considered to account for an average of 1-2% of the annual harvest (U.S. Fish and Wildlife Service 1980).

Commercial sport hunting enterprises operate in Alaska and Yukon parts of the Porcupine range but constitute a very minor portion of the total harvest.

Hunting regulations are different for each jurisdiction managing the Porcupine herd. Also, such regulations are modified so often that any account of them is almost immediately obsolete. This history therefore summarizes regulations up to the summer of 1983 and should not be considered

as accurate after that date. In Alaska, hunting restrictions concerning Porcupine caribou did not exist prior to 1975 and commercial hunting was permitted on part of the range until that year. Beginning in 1976, a 10 caribou limit per hunter was instituted (U.S. Fish and Wildlife Service 1980). Also no more than two caribou per hunter could be removed from the Game Management Units covering the Porcupine range. In the Yukon, non-natives are limited to an annual limit of one caribou which must possess antlers with one or more forks. Registered trappers may take two caribou per year and native people have no limit but no one may hunt females in the spring. Hunting along the Dempster corridor is the subject of an ongoing regulatory controversy. Non-native people were prohibited from hunting within a five mile limit of the highway until 1985. Native people including a significant number from the N.W.T. do use the Dempster Highway for access to Porcupine caribou. Since caribou may be lawfully transported across the Yukon-N.W.T. border, native hunters from N.W.T. may take Porcupine caribou from Yukon and sell them in settlements of the N.W.T. (U.S. Fish and Wildlife Service, 1980). In the N.W.T. there is no bag limit for native people but non-natives are restricted to a maximum of two animals per year, reduced in 1979 from a maximum of 5 (U.S. Fish and Wildlife Service, 1980).

Tourism within the Porcupine range is relatively undeveloped. Some companies offer river-rafting trips in Alaska and as the Dempster Highway in Yukon becomes the focus of greater tourism promotion by the territory, the presence of Porcupine caribou is being recognized as a valuable asset.

Research interest in the Porcupine herd burgeoned in the early 1970's with the proposed MacKenzie Valley Pipeline and attendant environmental impact studies. Since then the herd has been subjected to numerous ecological

studies in the past decade. As industrial proposals for the Porcupine range multiply, it is likely that research will increase as well.

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