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Population Dynamics, Winter Ecology and Social Organization of Coats Island Caribou

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ABSTRACT. The indigenous caribou population of Coats Island, N.W.T., suffered major declines from winter mortality in the winters of 1974-75 (a 71% loss) and 1979-80. There was a minor die-off in the winter of 1983-84. Apparently in the major declines the entire calf cohorts (1974 and 1979) died. In the less drastic decline in 1983-84 males, calves and adults, died at greater rates than females. The over-winter losses occurred at different densities and hence were density independent, resulting from snow accumulation and a sparse food supply. Reproductive success was low following severe winters, with 3.7% calves in June 1975 and 8.5% in June 1980. In other years, despite poor winter nutrition, the herd was productive: fall calf: cow ratios of 76:100 in 1981, 57:100 in 1982 and 102:100 in 1983. Apparently cows that survived winter starvation were able to recover despite a short growing season, in the absence of insect and predation influences, and to conceive the following autumn. High summer calf survival in the absence of predation, plus the high proportion of cows in the herd (83%), provided the means for rapid recovery in numbers ($r = 0.21$) when winter conditions ameliorated sufficiently that starvation did not occur.

Key words: island caribou, winter mortality, population regulation, social organization

RÉSUMÉ. La population indigène de caribous de l'île Coats, aux T. N.-O., a souffert des baisses importantes entraînées par la mortalité hivernale au cours des hivers de 1974-75 (une perte de 71%) et de 1979-80. Des pertes moins importantes furent ressenties durant l'hiver de 1983-84. Au cours des baisses majeures (1974 et 1979), il semble que tous les veaux périrent. Lors de la baisse moins sérieuse de 1983-84, les mâles, jeunes et adultes, moururent en plus grand nombres que les femelles. Les pertes hivernales se produisaient à différentes densités, donc indépendemment de celles-ci, résultant de l'accumulation de neige et de la nourriture insuffisante. Le taux de reproduction était peu élevé suivant les hivers rigoureux, comptant 3.7% de veaux en juin 1975 et 8.5% en juin 1980. Même à une pauvre alimentation hivernale, le troupeau était productif lors des autres années: le taux automnal veau:vache était de 76:100 en 1981, de 57:100 en 1982 et de 102:100 en 1983. Les vaches ayant survécu à l'inanition hivernale purent apparemment s'en remettre même face à une courte saison de croissance et en l'absence de prédation et de problèmes entraînés par les insectes, et ensuite concevoir l'automne suivant. Un taux élevé de survivance estivale de veaux dans l'absence de la prédation, ainsi qu'une proportion élevée de vaches dans le troupeau (83%), assurèrent un retour rapide des nombres ($r = 0.21$) lorsque les conditions hivernales s'amélioraient au point où elles ne causaient aucune inanition.

Mots clés: caribou des îles, mortalité hivernale, contrôle de la population, organisation sociale

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INTRODUCTION

Survival and fecundity of caribou and reindeer in island populations are influenced to a greater extent by weather and forage than are wild continental populations. Arctic island environments (above both 60°N and treeline) tend to be harsher than continental ones and the mobility that characterizes mainland herds is restricted by the geography of islands. Constraints on population growth can result from density-dependent interactions with vegetation, as seen on South Georgia in the south Atlantic (Leader-Williams, 1980, 1982) and on St. Paul and St. Matthew islands in the Bering Sea (Scheffer, 1951; Klein, 1968) where reindeer were introduced. In the Svalbard Nature Reserve in Norway (Reimers, 1977, 1982, 1983) reindeer are strongly influenced by climatic factors, particularly snow and ice, as they restrict forage availability during the winter.

Historically on Svalbard reindeer grazing completely or partially eliminated terricolous lichens, vegetation most sensitive to grazing (Reimers, 1983). Reimers (1982) reported that graminoids and mosses replaced lichens in the winter diet. He hypothesized that since the digestible energy content of the winter diet is very low, the animals are more susceptible to starvation in severe winters and the resulting increased mortality and decreased calving in such years prevent overgrazing. In Peary caribou (*R. t. pearyi*) sporadic adverse snow and ice conditions have caused catastrophic mortality during the winter (Miller *et al.*, 1977); inter-island movements and wolf predation are also factors in their population dynamics. Winter diets consist mainly of monocots, willows and mosses (Thomas and Edmonds, 1983).

The population dynamics of the indigenous barren ground caribou (*R. t. groenlandicus*) on Coats Island exhibit similarities to Svalbard reindeer and to Peary caribou. Coats Island caribou are subject to high mortality during severe winters. They subsist on lichen depauperate range, foraging primarily on vascular plants, which are frequently scarce. This paper reviews what is known about the dynamics of the Coats Island population.

STUDY AREA

Coats Island, approximately 5600 km^2 in area, is located in north central Hudson Bay, Northwest Territories, Canada (Fig. 1). The island has a recent geological origin, ca. 8000 years (Gillett, 1976), and we observed that it is composed of rewashed glacial drift mixed or overlain by uplifted marine sediments. The interior of the island is dominated by barren elevated shorelines, wave modified ridges, glacial morainal deposits and frost shattered limestone bedrock with sparse vegetation cover (<10%), similar to polar semi-deserts found in the High Arctic (Svoboda, 1977). Elevated shorelines of marine origin are the only prominent feature around the periphery of the island with the exception of a limited area of elevated rolling upland of Precambrian granite and gneiss bedrock at the northeast end.

The cold waters of Hudson Bay contribute to a cool, windy climate similar to that found on arctic islands of higher latitude

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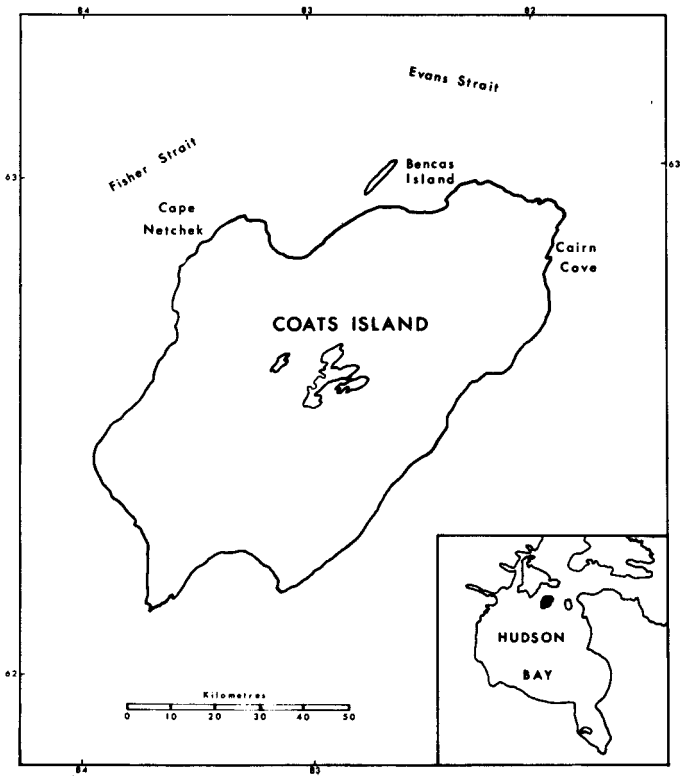

FIG. 1. The study area, Coats Island, N.W.T.

(Thompson, 1967). The average wind speed at Coral Harbour on Southampton Island, the nearest weather station, located about 100 km north of Coats Island, is 20 km·h, total annual precipitation is 25.8 cm and annual mean daily temperature is –11.1°C. On Coats Island in July and August temperatures rarely exceed 15°C and mean daily temperature during the warmest period is about 8°C. Snowfall at Coral Harbour is twice as high as at Baker Lake on the mainland at a similar latitude, 132.7 cm vs 57.2 cm (Thompson, 1967).

The growing season for vegetation is short on Coats Island, typically beginning in late June and ending by mid-August. Summer temperatures may be cooler on Coats Island than on larger Southampton Island. Land-fast ice or pack ice around the coast can persist until late July in some years.

Snow may fall during any month of the year and generally persists from late September to mid-June. Wind blows snow from high areas and redeposits it in lower lying areas and in sheltered sites. Redeposited snow is hard packed and composed of fine-grained crystals. Snow depth can reach 65 cm in the low-lying well-vegetated areas, and depths are greatest in late April, when the only exposed sites may be the crests of raised beaches or high centered polygons.

Vegetation in the rocky areas and on raised beaches is sparse and consists of associations of *Dryas integrifolia, Saxifraga oppositifolia, Carex misandra, Cassiope tetragona* and scattered lichens, mainly *Cetraria cucullata* and *C. nivalis*. Sheltered and low-lying areas are generally well vegetated compared to higher, more exposed sites, such as raised beaches, which suffer the effects of low soil moisture and high exposure to wind (Reznicek and Svboda, 1982). Low-lying, poorly drained areas located particularly in the southern and coastal areas support discontinuous to continuous wetland vegetation dominated mainly by *Carex* spp. in association with *Salix arctica, S. reticulata* and mosses. These wetlands provide the greatest density of caribou forage when snow cover does not prevent access to them. Lichens are not abundant anywhere on the island.

The earliest record of caribou on Coats Island was made in 1919 by Captain Henry Toke Munn (Polunin, 1948). Their origin is unknown but it is possible that they arrived from Southampton Island, the nearest point of which is 70 km to the north. In recent years, at least, movement between the islands would have been difficult because open water was present throughout the winter.

METHODS

All surveys of Coats Island caribou since 1975 have been conducted by personnel of the Department of Renewable Resources, Government of the Northwest Territories. The first systematic census was conducted on 28-29 June 1975 following a report of many dead caribou on the island (Helmer and McNeil, 1975). Other aerial censuses were conducted on 22 April 1976 (Helmer, 1976), 22-25 November 1978 (Kraft and Gates, 1979), 27-29 April 1980 and 28-29 June 1980 (present authors) and 6-7 July 1984 (Heard and Decker, 1984). High-wing aircraft were used for all surveys (Twin Otter in 1975, Cessna 185 in 1976, DH-Beaver in 1978 and 1980 and Cessna 337 in 1984). The aircraft were flown at 120 m above ground level and caribou were counted along 0.4 km strips on each side by observers sitting in the rear seats. Transects were spaced at equal intervals to provide approximately 14% coverage in 1975, 10% in 1976, 19% in 1984 and >20% coverage in other years. In 1975, 1976 and 1984 the entire island was sampled. In 1978 all but the very center of the island was sampled. In 1980 the center region of the island was excluded from the census after reconnaissance failed to reveal any caribou there.

Caribou were recorded as adults (>1 yr old) or calves (<1 yr old). Dead caribou were also recorded along the transects. Population estimates and variances were calculated following procedures of Jolly (1969) using Method 2 for unequal transect lengths. Statistical comparisons of census estimates were made with a t-test (Sokal and Rohlf, 1969).

Composition surveys were conducted in May 1983 and May 1984. Limited aerial reconnaissance indicated that few caribou were in the interior of the island. All but the central region of the island was searched by observers using snow machines. The search pattern avoided biased sampling due to spatial segregation of the sexes by searching the entire area in which caribou were distributed. Caribou were classified as cows (females >1 yr old), juvenile males (1-3 yr old), mature males (>4 yr old) and calves (<12 mo). There may have been some overlap in distinguishing mature males from juvenile males. Female calves were distinguished from males by observation of a vulva.

Incidental observations provided composition data for caribou in a restricted area near a base camp on the southern end of the island in November 1982 and October 1983. An aerial composition survey was carried out in November 1981 using a fixed-wing aircraft; calves and mature males were distinguished from other caribou.

Calf sex ratios and differential association with probable dams were analysed using the G-test (Sokal and Rohlf, 1969).

Caribou harvest data were collected by wildlife officers living in Coral Harbour, the only community that hunts caribou on Coats Island. Data were gathered by interviewing hunters returning from hunts and by personnel who participated in the

hunt. Data were not available for some years between 1968 and 1984 when a wildlife officer was not present in the community.

RESULTS

Population Estimates

A severe die-off occurred during the winter of 1974-75. In June 1975 there were 1814 ± 320 (S.E. — standard error) living adult caribou and 4415 ± 735 carcasses estimated from transect data. Totals of 702 dead and 311 living caribou were counted on the transects. In addition, 78 dead caribou were counted on Bencas Island, a small island near the northeast coast of Coats Island. Mortality was calculated to have been 71% over the winter period. One-year-old caribou were not seen during the census. Thirteen carcasses were examined. Six of the carcasses were calves born in June 1974 (5 males and 1 female), 4 were adult females and 3 were adult males. The medullae of femurs in all carcasses were either hollow or contained traces of red gelatinous marrow, indicating that little or no fat was present at the time of death.

Weather records were not available for Coats Island in 1974-75. However data collected at Coral Harbour showed that snow depth was considerably greater than normal in winter 1974-75 compared with the 10-year average from 1970 to 1980 (Fig. 2). Caution is warranted in extrapolating from Coral Harbour snow records to Coats Island since snow conditions at Coral Harbour do not necessarily parallel conditions on Coats Island. The authors have occasionally observed differences in weather between the two areas.

Coats Island caribou were censused again in April 1976, a time of year when light-coloured caribou are difficult to detect against the snow-covered ground. The estimated population of 868 ± 335 did not differ significantly from the estimate of living caribou made in June 1975 ($p<0.05$) (p—probability). However the 1975 census estimate was more precise (C.V. = 0.13 vs 0.39) (C.V. — coefficient of variation) and was probably more accurate because of better visibility.

In the November 1978 census, visibility was good and caribou were easy to see since their dark early winter pelage contrasted with the snow-covered background. Caribou were most frequently seen near the coastline in areas characterized by elevated shorelines. There were an estimated 4236 ± 376 caribou on the island. A total of 993 caribou was counted within the transects, of which 113 (11.4%) were calves. The adult population was estimated at 3753 ± 333 by subtracting calves.

In the April 1980 census, visibility was hampered by fog and patchy low clouds. Poor lighting reduced the contrast between the light-coloured caribou and the snow-covered background. The caribou were lethargic, frequently bedded and unresponsive to the aircraft, making detection difficult. The total population was estimated to be 1191 ± 223. No calves (10 mo old) were identified among animals sighted from the air. Caribou seen from the air and from the ground were not responsive to disturbance. In several instances it was possible to approach a bedded animal to within 30 m on the ground without it rising. This behaviour contrasted with observations made on the Kaminuriak and Southampton Island populations in April 1980, where caribou generally ran short distances in response to aircraft disturbance and longer distances when approached on the ground.

Most caribou were seen on or near elevated shorelines or high centered polygons, areas with shallow or no snow. There was no evidence of feeding in other areas. Measurements taken in a number of locations on ponds and adjacent sedge-willow meadows indicated that the snow was 40-60 cm deep (Fig. 2). There was no evidence of ice layers or ground fast ice in the snow column.

When examined in April 1980, a cow that had died recently had no internal fat and the femoral marrow was red and gelatinous. Two other adult female caribou were shot: both were emaciated, with atrophied muscles, no obvious subcutaneous or visceral fat deposits and yellow-pink gelatinous femoral marrow. None of the females was pregnant, although each had a large corpus luteum in one ovary and regressing cotyledons and soupy locia in the uterus, suggesting recent fetal abortion (S. Tessaro, Animal Pathology Laboratory, Saskatoon, pers. comm.). Digesta in the reticulo-rumen lacked the usual strong odour, suggesting that fermentation was much reduced.

Another census was conducted on 28-29 June 1980 to confirm the extent of losses. By that time snow had melted and caribou, still in their light-coloured winter coats, were highly visible against the dark background. The southwest and east sections of the island held the greatest densities of caribou. There were 170 ±40 dead and 1672 ± 224 living caribou, excluding calves of the year. The greatest number of dead caribou was seen on the northeast side of the island, where there were 0.23 carcasses·km^{-2}. No dead caribou were seen on Bencas Island. Thirty-two calves of the year, 342 living and 34 dead caribou were counted. Only 2 one-year-old caribou were sighted. On 3-4 July, 21 carcasses were examined, including 5 adult females, 1 adult male, 3 yearling females (<24 mo at death) and 4 female and 9 male calves of the previous year. Femur marrow consistency indicated starvation in each case. Seventeen carcasses were found on the tops of elevated shorelines, 3 were found on the slopes of elevated shorelines, and 1 was found on a high centered polygon.

In June 1984 the estimated adult population of 2130 ± 228 was similar to the 1980 estimate ($p>0.05$). There were 0.38 caribou·km^{-2}. Only 3 carcasses were seen during the survey. However, ground-based researchers working near the southeast corner of the island found 23 dead calves (9-11 mo old) and a dead bull in March and May in a small area. Neonatal calves constituted 28% of caribou counted on the transects (n = 568).

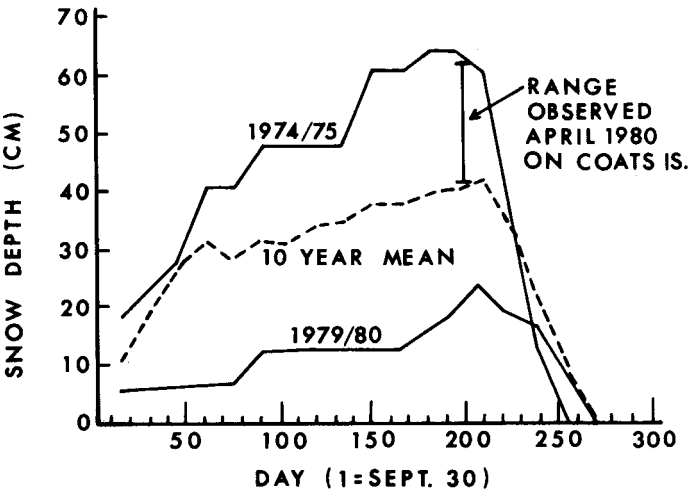

FIG. 2. Monthly snow depths at Coral Harbour during the winters of 1974-75 and 1979-80 compared to a 10-year average for the period 1970-80 and snow depths observed on Coats Island during April 1980.

Group Size and Composition

Sociability varied between seasons. The caribou were least gregarious during late winter (Table 1). Between 33 and 51% of caribou seen in April 1980 and in May 1983 and 1984 were solitary. Group size was larger in June after snow melt had occurred. Caribou were most gregarious in early November 1981 near the end of the rutting period.

Of 78 calves (11 mo old) seen in May 1983, 46% accompanied adults, which probably included their dams. Eighty-six percent of calves not associated with probable dams were alone or associated with other calves; the remainder were associated with bulls. In May 1984, 49% of calves accompanied cows that might have been their dams (n = 58). Of the remainder, 95% were alone or in the company of other calves.

In late winter there was a stronger tendency ($G = 5.099$, $p < 0.025$) for female than for male calves to associate with their presumptive dams (Table 2). In May 1983 and May 1984, 46% and 53% of female calves respectively accompanied possible dams, while only 33% and 23% of male calves accompanied probable dams.

The population sex ratio was highly biased toward females (Table 3). Mature males (presumed to be 4+ yr old) were less than 10% of adults. The adult sex ratio was approximately 20 males:100 females. In late winter the sex ratio in calves deviated from an expected value of 53% males at birth (Bergerud, 1980). The sex ratio of 62 calves classified in May 1983 favoured females, which were 71% of the total ($G = 12.758$, $p < 0.005$). The sex ratio was similarly biased toward female calves in May 1984, when 62.1% of 58 calves were females ($G = 5.011$, $p < 0.05$). Sex ratio among calves that presumably died from starvation in 1975 (5M:1F) and in 1980 (9M:4F) differed significantly from an expected proportion of 53% males ($G = 7.702$, $p < 0.01$).

Calf production was severely depressed following the starvations that occurred in 1975 and 1980. Only 3.7% of caribou counted in 1975 were calves. Calf percentage was marginally higher (8.5%) in June 1980. Abortion was indicated in two emaciated cows collected in May 1980. In early May 1984, 15 cows were sighted with blood stains. Since this was a month before normal calving, the observation suggested abortion or premature birth. Fewer than half of the cows in the population were accompanied by calves in late June 1984 (Table 3).

In a favourable year calves can make up a large proportion of the population. In November 1981 calves of the year were 38.8% of 918 caribou classified from the air, or 76.1 calves:100 cows. Based on incidental sightings of caribou made by workers in October 1983, 96 calves were associated with 94 cows. Excluding that peculiar sample, the calf:cow ratio in late winter ranged from 0.9:100 in April 1980 to 29.8:100 in May 1983, assuming that females were 83% of the adult population. Many calves seen during the latter survey appeared emaciated and some may not have survived until snow melt, which occurred about 3 weeks after the survey.

Harvesting

Inuit from Coral Harbour on Southampton Island have harvested caribou from Coats Island for several decades. They travel to the island in long-liner boats that can transport about 50 caribou carcasses. Hunting takes place once the pack ice breaks up in Fisher and Evans straits, generally in late July. Several trips may be made, but the hunting season is brief since weather becomes unfavourable for navigation in early September. Hunting generally takes place in the northern third of the island, particularly around Cape Netchek and Cairn Cove, areas with suitable harbours.

The annual harvests from 1968 to 1983 show that the annual kill has ranged from 35 to 290 caribou, with a mean of 139 ± 20 (S.E., range 35-290). The kill has tended to increase in recent years, reaching 290 in 1984. Limited information indicates that there was selection for males in the kill. At least 55 out of 60 caribou harvested in August 1970 were males (Parker, 1975). In July and August 1981 one of us (JA) accompanied hunters to Coats Island; of 175 caribou killed for which the sex was known, 72% were males. In 1984, 61% of the harvest was males. During the accompanied hunts in 1981 the hunters appeared to be nonselective; there appeared to be a predominance of males in the area hunted.

TABLE 1. Group sizes of caribou on Coats Island in different seasons and years

Date	No. of caribou	Percent singles	No. of groups incl. singles	Mean group size ± S.E.	Maximum group size
Apr '80	264	43.2	175	1.5 ± 0.08[a]	14
May '83	386	32.9	127	1.7 ± 0.09[a]	7
May '84	564	51.2	299	1.9 ± 0.07[a]	8
June '80	434	9.0	140	3.1 ± 0.22[b]	15
June '84	407		121	3.4 ± 0.25[b]	14
Nov '81	918	0.9	146	6.3 ± 0.40[c]	21

Mean group sizes with different superscripts differ significantly, $p < 0.05$.

TABLE 2. Sex differential in the frequency of association of male and female calves with probable dams in late winter

Calf association with dam	1983		1984		Combined	
	Female	Male	Female	Male	Female	Male
Associated	20	6	19	5	39	11
Not associated	24	12	17	17	41	29
G statistic	0.078[n.s.]		5.295*		5.099**	

n.s. = not significant
* = $p < 0.01$
** = $p < 0.025$

TABLE 3. Composition of the caribou population on Coats Island (%)

Date	Total >1 yr	Mature males	Juvenile males	Cows	Calves	Calves: 100 cows
Jun '75	311				12	
Nov '78	880				113	
Jun '80	342				32	
Nov '81	562	60(10.7)			356	76.1[a]
Nov '82	67	7(10.4)	2(3.0)	58(86.6)	33	56.9
May '83	311	31(9.8)	22(7.0)	262(83.2)	78	29.8
Oct '83	94			94	96	102.1
May '84	506	26(5.1)	63(12.5)	417(82.4)	58	13.9
Jun '84	407				161	47.6[a]

[a] Cows were assumed to be 83.2% of adults.

After allowing for a common adjustment of 20% to the 1984 census estimate for caribou overlooked on transect (Thomas, 1969; Thompson and Fischer, 1979), the sex ratio and number of caribou in the population was compared to the harvest (Table 4). Including yearlings, 33.7% of the male population was harvested, compared with only 5.9% of the female population.

TABLE 4. Comparison of the structure of the Coats Island caribou population and the reported harvest for 1984[1]

		Population in summer 1984			
		Yearling males	2+ males	Yearling females	2+ females
Population estimate	N	83	337	136	1574
	%	3.9	15.8	6.4	73.9
Adjusted estimated	N	104	421	170	1968
		Harvest			
		Males		Females	
Number killed		177		113	
% of adjusted estimate		33.7		5.3	

[1]The census estimate is adjusted by 20% for caribou presumed to have been overlooked on transect. Composition is based on the May 1984 survey results.

DISCUSSION

Caribou numbers on Coats Island were relatively unstable. Large over-winter losses occurred in 1975 and 1980 at different caribou densities and hence were density independent. Weather was foremost among environmental factors contributing to the wide variation in population trend. The large die-off in winter 1974-75 was correlated with greater than average snow depth recorded at Coral Harbour. Snow depth increased throughout the winter, reaching a peak in mid-May, when the energy status of caribou is critical. The die-off and poor reproduction of caribou on Coats Island in 1980 was not explained by snow records collected at Coral Harbour, but based on subjective observations snow appeared sufficiently deep in April to limit access to forage.

Deep snow does not necessarily limit forage availability; reindeer will feed in snow up to 91 cm deep (Helle, 1984). However snow cover in the Arctic is characteristically hard packed, ranging from 1500 to over 10 000 $g \cdot cm^{-2}$ (Thomas and Edmonds, 1983). Under these conditions snow restricts forage availability at shallower depths than when snow cover is less compact.

In Peary caribou restricted access to forage in winter results in increased consumption of relatively poorly digestible forage, especially mosses (Thomas and Edmonds, 1983; Thomas and Kroeger, 1982). Under these conditions they select wind-blown, snow-free patches or cratering areas with shallow snow (<20 cm). Similarly, caribou on Coats Island were observed to select areas of low snow cover in late winter and carcasses were found on the tops of ridges and other sites offering micro-relief. These sites — raised beaches, high centered polygons and small rises where snow cover was relatively thin — are typically poorly vegetated. Plant cover includes poorly digestible species such as *Dryas integrifolia* and *Saxifraga oppositifolia*. Well-vegetated sites dominated by graminoids and willow generally have deeper snow cover and are more likely to be unavailable in winter, depending on snow depth.

In Peary caribou the proportion of graminoids in the winter diet appears to be positively correlated with fat reserves, while the opposite relationship was evident for mosses; lichens are a minor component of the winter diet (Thomas and Edmonds, 1983). We expect that the feeding ecology of caribou on Coats Island is similar to that of Peary caribou, although this remains to be examined.

In contrast to continental populations of barren ground caribou, which exist in large aggregations throughout much of the year, the caribou on Coats Island tended to be more solitary, especially during the winter. We think that the lack of gregarious behaviour in winter is related to the structure and availability of foraging patches. Scattered small patches containing a low biomass of forage dictate small group sizes. The foraging behaviour of Peary caribou in late winter was similar under similar conditions, where 30 of 36 groups contained 3 or fewer individuals (Miller *et al.*, 1982).

In continental caribou populations maximum aggregation occurs during the post-calving period. This behaviour is thought to be an important antipredator tactic to reduce the vulnerability of young calves (Bergerud, 1974; Cumming, 1975). Harassment by biting and sucking insects may also be a stimulus for post-calving aggregation (Kelsall, 1968). These factors are absent or reduced on Coats Island; there are no wolves, and insect annoyance is lower than on the mainland due to the influence of the ocean on summer climate. Group size during summer was correspondingly low. Aggregation was greatest during the breeding season, behaviour that would enhance mating efficiency.

Winter nutrition is likely a major factor determining reproductive success or failure in female caribou on Coats Island, although summer nutrition may be important as well. Low calf production in 1975 and 1980 and reduced production in 1984 followed harsh winters. Reduced natality has been seen in other caribou herds following severe winters. In 1972 no calves were seen among Peary caribou classified on Melville Island during the summer, and in 1974 after another severe winter there were only 1.1% calves (Miller *et al.*, 1977); on Nordenskiold Land in Svalbard calf production was 5.9% following severely restricted access to forage in late winter 1974 (Alendal and Byrkjedal, 1976).

Severe nutritional stress can result in premature termination of pregnancy through embryonal or fetal death or in a low birth weight and poor vigour of the neonate (McGowan, 1966; Neiland *et al.*, 1968; Roine *et al.*, 1982; Thomas, 1982). The observations of probable abortions in late winter 1980 and 1984 indicate that conditions on the island were unfavourable for reproduction for those females.

Over 80% of the adult population on Coats Island consisted of females. In years when yearlings are a small percentage of adults — as in 1981, due to the poor calf crop in 1980 — the calf crop could represent as much as 40% of the population. In fact in November 1981 the percentage of calves approached this level (38%). Consequently, the population has the capacity to increase rapidly in response to winter conditions favourable to calf survival. The apparent high rate of increase seen between June 1975 and fall 1978 ($r = 0.21$) was likely a consequence of

the skewed sex ratio and favourable conditions for calf production and survival.

Compared to other populations of *Rangifer*, the proportion of adult males seen on Coats Island (17%) is very low. Males typically constitute 30-42% of adults in wild populations (Bergerud, 1980). As in many species of polygynous ungulates, adult male caribou suffer greater mortality than females (Bergerud, 1980; Reimers, 1977). This asymmetry has been attributed to costs associated with male reproductive competition. The rut imposes an energy deficit on adult males entering the winter and leads to a greater risk of winter starvation than in females, for which reproductive investment comes later (Dauphine, 1976). For example, mortality of mature males on Svalbard was twice that of females (Reimers, 1977), and nearly the entire male population on St. Matthew Island died (one survived, A.T. Bergerud, pers. comm.) under extreme nutritional deprivation (Klein, 1968). Since winter starvation is common on Coats Island, mortality of adult males due to this cause is likely an important contributor to the distorted sex ratio.

Differential survival of male and female calves was also evident. The higher survival of female calves during the winter may have been related to a higher level of maternal care than for male calves, since female calves were more commonly found in association with probable dams. Association of a calf with its dam after weaning benefits the calf in two ways. If while searching for a food patch the calf observes its dam, it doubles the amount of information it receives about patch location. It benefits more directly if it can feed in the same crater or if the cow permits the calf to displace her from the crater, a behaviour reported for caribou (Thing, 1977).

Clearly the harvest of males is a major factor causing the skewed sex ratio on Coats Island. Intensive selection was evident in three years for which harvest composition data were available. In 1984 males were selected 1.7 times their proportion in the adjusted population estimate, and 33.7% of the estimated male population was harvested. Selective hunting has caused reductions in the sex ratio in other caribou populations. In the Western Arctic Herd of Alaska the ratio of males to females declined from 63:100 in 1968-70 to 45:100 in 1975-78 (Davis *et al.*, 1980), and in Newfoundland selective hunting reduced the percentage of males from 32 to 23% and increased the exponential rate of increase (Bergerud, 1971). In Newfoundland fertility remained high and females continued to conceive in their first estrus. Bergerud (1978) suggested that if the sex ratio declined to 1:5-9 there is a risk that all females may not be bred. The sex ratio among adults on Coats Island was at this level. However there was no indication of reproductive failure, as calf production achieved a high level in 1981 and 1982.

Based on observations made during hunts in 1981, we believe that the predominance of males in the harvest was a function of availability rather than overt selection; males were more abundant in the area hunted than were represented in the population. The decline in percentage of males in the kill from 92% (1970) to 72% (1981) to 61% (1984) indicates that the harvest has had an impact on the availability of males.

The current composition of the population tends to maximize production in favourable years, providing for a maximum potential meat harvest for Inuit hunters from Coral Harbour. Quotas should be tailored to maintain the current proportion of males in the population and should be related to annual productivity, i.e., calf production and recruitment of yearlings.

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