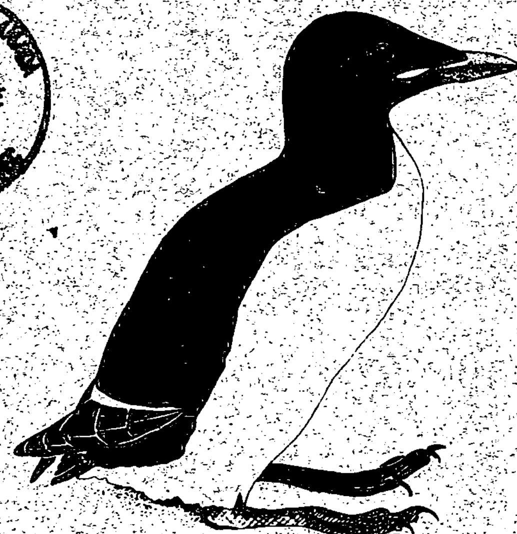
PEARY CARIBOU CALVING AND POSTCALVING PERIODS, BATHURST ISLAND COMPLEX, NORTHWEST TERRITORIES, 1990

Frank L. Miller



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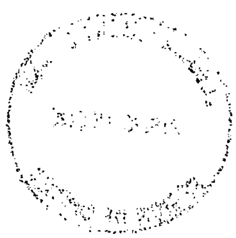

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ABSTRACT. Peary caribou (Rangifer tarandus pearyi) were aerially surveyed on south-central Queen Elizabeth Islands, Northwest Territories, Canada, in May, June, and July 1990 to obtain data on relative numbers, sex/age composition, distributions, movements, chronology of calving period, calf production, and early survival of calves. The sex/age composition of caribou on Massey Island was skewed and bulls were essentially lacking there. The frequencies of occurrence of caribou on Alexander Island and Massey Island were greater than expected by chance alone ($P < 0.005$) when compared on a relative landmass basis with the other three western major satellite islands and Bathurst Island. Nonsystematic aerial searches yielded sightings of a maximum of 470 different individual caribou between 22 and 24 June and 871 caribou between 6 and 10 July 1990. Most of the caribou were seen on Bathurst Island: mostly on the northern part of the island, north of Polar Bear Pass; and mainly on coastal areas in June, shifting to interior areas in early July. Caribou continued to move counterclockwise around Bathurst Island, beginning some time before May and persisting into, at least, July 1990. Calving peaked during the middle of the 4th week of June and continued into the first week of July 1990. By 10 July 1990 there were only 73 and 35 newborn calves seen per 100 breeding cows and per 100 1+ year-old females, respectively. It appears that about 40% of the potential maximum production of calves within the Bathurst Island complex either did not occur in 1990 or was lost by early July 1990. Snow depth measurements were obtained from 7866 sample sites at 71 stations during May-June 1990. Snow cover was highly variable and some small patches of snow-free ground existed on exposed sites. Measured snow depths ranged from 1 to 100 cm before snow melt began in mid June 1990. Where snow cover persisted on individual sample sites, it averaged 22-31 cm between 28 May and 16 June on the 7.5-km snow/ice course and 19-26 cm between 2-19 June on the 1-km course. Subsequently, ground fast ice accumulated at 65% of the stations and 51% of the sample sites. Ground fast ice on the 7.5-km course averaged 5.6 cm ($\pm$3.23 cm SD) and ranged from 1 to 19 cm in thickness, while on the 1-km course it averaged 5.2 cm ($\pm$2.51 cm SD) and ranged from 1 to 12 cm in thickness. No evidence, direct or indirect, was obtained for Peary caribou foraging or even attempting to dig forage craters in the snow cover at any time between 26 May and 1 July 1990 anywhere within the Bathurst Island complex.

RÉSUMÉ. On a fait un relevé aérien du caribou de Peary (Rangifer tarandus pearyi) dans le centre-sud des îles de la Reine-Élisabeth (Territoires du Nord-Ouest) au Canada, en mai, juin et juillet 1990 afin d'obtenir des données sur les nombres relatifs, la composition selon l'âge et le sexe, la répartition géographique et les déplacements de cet animal, ainsi que sur la chronologie de la période de mise bas, la reproduction et la survie initiale des faons nouveau-nés. Sur l'île Massey, la composition selon le sexe et l'âge était asymétrique, et on a noté une pénurie d'adultes mâles. La fréquence d'apparition de caribous sur les îles Alexander et Massey a été statistiquement plus importante que prévu ($P < 0{,}005$) si l'on compare la masse terrestre relative de ces îles à celle des trois grandes îles satellites à l'ouest, et de l'île Bathurst. Lors de recherches aériennes non systématiques, on a dénombré, au total, 470 différentes bêtes du 22 au 24 juin, et 871 bêtes du 6 au 10 juillet 1990. La plupart des caribous se trouvaient sur l'île Bathurst, surtout dans le nord de l'île, au nord du col Polar Bear. En juin, ils sone restés principalement dans les zones côtières, tandis qu'au début de juillet ils se sont déplacés à l'intérieur de l'île. Les caribou ont continué à se déplacer autour de l'île Bathurst dans le sens antihoraire quelque temps avant mai et ont continué au moins jusqu'au juillet 1990 en partie. La mise bas a plafonné au milieu de la quatrième semaine de juin et s'est poursuivie pendant la première semaine de juillet 1990. Au 10 juillet 1990, il n'y avait que 73 faons nouveau-nés pour 100 biches reproductrices, et 35 pour 100 biches d'un an et plus. Il semble qu'environ 40 % du nombre maximum possible de faons à naître en 1990 sur l'île Bathurst ne sont pas nés ou sont décédés avant le début de juillet 1990. On a mesuré l'épaisseur de la neige à 7 866 sites d'échantillonnage de 71 stations durant mai et juin 1990. Le manteau nival variait grandements et il y avait des parcelles de terre sans neige dans les sites battus par le vent. La profondeur de la neige variait de 1 à 100 cm avant le début de la fonte, vers la mi-juin 1990. À certains sites où la neige persistait, la couche moyenne mesurait de 22 à 31 cm sur la ligne de relevés de 7,5 km du 28 mai au 16 juin, et de 19 à 26 cm sur la ligne de relevés de 1 km, du 2 au 19 juin. Par la suite, de la glace fixée sur le sol s'est formée à 65 % des stations et à 51 % des sites d'échantillonnage. Sur la ligne de relevés de 7,5 km, l'épaisseur de la glace mesurait, en moyenne, 5,6 cm (± 3,23 cm ET) et variait de 1 à 19 cm, tandis que sur la ligne de relevés de 1 km elle mesurait, en moyenne, 5,2 cm (± 2,51 cm ET) et variait de 1 à 12 cm. On n'a trouvé aucune preuve directe ou indirecte laissant supposer que les caribous de Peary avaient fourragé ou même essayé de fourrager dans la neige du 26 mai au 1^er^ juillet 1990, à un endroit ou un autre de l'île Bathurst.

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INTRODUCTION

Peary caribou (Rangifer tarandus pearyi) on the southwestern and south-central Queen Elizabeth Islands (QEI) of the Canadian Arctic Archipelago remain dangerously low in number (Gunn et al. 1979, 1981, Miller 1987a, 1987b, 1988, 1989, 1990). The three major islands for Peary caribou have been and still are Melville, Bathurst, and Prince Patrick in descending order (Fig. 1), based on the number of caribou estimated on each compared to numbers on all other QEI in 1961 (Tener 1961, 1963), 1972-74 (Miller et al. 1977a), and 1985-88 (Miller 1987a, 1987b, 1988, 1989). Peary caribou on the two major southwestern QEI of Melville and Prince Patrick remain in apparent continual decline since 1961 (Tener 1963, Miller et al. 1977a, Miller 1987b, 1988). The south-central island of Bathurst, where Peary caribou underwent the greatest proportional loss in number on an island basis during the catastrophic winter of 1973-74 (Miller et al. 1977a), is the only major island where the caribou have shown any sign of recovery from the 1973-74 low (Miller 1987a, 1989). The Peary caribou on Bathurst Island remain significantly below the number estimated in 1961 (Tener 1963), however, and cannot currently be considered a harvestable population, except at a token level and only then, when restricted to male caribou (Miller 1989, 1991).

Bathurst Island was a principle caribou hunting area for the Inuit of Resolute Bay, Cornwallis Island, prior to the cataclysmic loss of caribou in 1974. As a result of the 1973-74 die-off and the general lack of caribou on Bathurst Island thereafter, the Inuit hunters of Resolute Bay imposed a voluntary ban on caribou hunting on Bathurst Island in 1975 (Freeman 1975, Ferguson 1987). The ban was apparently honoured until 1990 but a desire to reinitiate caribou hunting on Bathurst Island was voiced in 1988 and 1989. Six caribou were reported to have been killed there in winter 1989-90 and four were shot on the small island of Baker, ca. 8 km off the southeast coast of Bathurst Island, in late winter 1990 (G. Eckalook, J. Hunter, T. Manik, Resolute Bay, pers. commun. 1990).

The Canadian Wildlife Service (CWS) has selected Bathurst Island to continue ecological studies of the relationship of Peary caribou to their environment as (1) the Inuit of Resolute Bay have resumed hunting caribou there (which makes those caribou essentially the only hunted population of Peary caribou on the QEI, except for some limited hunting on southern Ellesmere Island by people from Grise Fiord); (2) the Peary caribou on Bathurst Island are the most accessible within the QEI that also have, at least in theory, the potential for increasing in number to a level that would sustain annual harvests of meaningful sizes; and (3) apparently only the Peary caribou on Bathurst Island (and some smaller satellite islands) are currently experiencing any marked increase in number from their 1973-74 low, while Peary caribou on Melville and Prince Patrick islands (or their respective satellite islands) show no indication of recovery.

The following is an annual progress report on the 1990 field season activities for Peary caribou studies on Bathurst Island and some of its satellite islands. The 1990 field season was the first operational period for most of those studies, as 1989 was devoted mainly to planning, initial logistics, and establishing a field base camp on northeastern Bathurst Island. Exceptions being studies on (1) spring-summer distributions and movements; (2) aerial sex/age segregation counts; (3) documentation of the chronology of the calving period; (4) a measure of calving success (% calves among all caribou seen and calf: female ratios); and some insight into early calf losses, which were also investigated in 1988 and 1989 (Miller 1989, 1991).

STUDY AREA

1. Bathurst Island Complex

The study area of the current project is termed the "Bathurst Island complex" (BIC) and for the purpose of this research includes a complex of 26 islands that lie within the south-central portion of the QEI or to the south in the immediately adjacent waters of Viscount Melville Sound and Barrow Strait (Figs. 1-5). The study area lies between 74° and 77°N latitude and 93° and 107°W longitude, and the collective landmass of the 26 islands equals ca. 27 000 km². The islands are mostly low-lying and mainly below 150 m above mean sea level (amsl) in elevation. Geology, topography, and vegetation within the study area have been described in detail (e.g., Dunbar and Greenaway 1956, Thorsteinsson 1958, Savile 1961, Fortier et al. 1963, Tener 1963, Blake 1964, Kerr 1974, Wein and Rencz 1976, Edlund 1983).

The 26-island study area is divided into three levels of importance: (1) one principal island; (2) nine major satellite islands(each island >50 km²); and (3) 16 secondary satellite islands (each island <50 km²).

1.1. The principal island

The principal island is Bathurst Island (16 090 km²) which is the largest and most important "game" island within the south-central QEI (Figs. 1 and 2). A "primary study area" for intensive ground studies has been selected on a northeastern coastal site (ca. 100 km²) between the Walker and Moses Robinson rivers (centered at ca. 76°00'N, 97°40'W).

1.2. Major satellite islands

The nine major satellite islands of Bathurst Island (Figs. 1-3) are the "five western major satellite islands" of Vanier (1130 km²), Cameron (1060 km²), Alexander (490 km²), Massey (440 km²), and Marc (56 km²) on the western coast; the "two northern major satellite islands" of Helena (220 km²) and Sherard Osborn (60 km²) off the northern coast; and the "two eastern major satellite islands" (in terms of possible movements or migrations of Peary caribou within the BIC) of Cornwallis (7000 km²) and Little Cornwallis (410 km²).

1.3. Secondary satellite islands

The 16 secondary satellite islands (Figs. 1-5) are the nine southern secondary satellite islands of Browne, Garrett, Griffith, Hamilton, Lowther, Somerville, and Young in Barrow Strait, and Baker and Moore in Intrepid Passage; the six eastern secondary satellite islands of Crozier, Kalivik, Milne, Neal (Neal Islands are treated as one island), Truro, and Wood in McDougall Sound; and the one western secondary satellite island of Bradford in Graham Moore Bay.

These 16 small secondary satellite islands are known to or are likely to receive migrant caribou from Bathurst Island during periods of springtime environmental stress (e.g., Bissett 1968, Miller and Gunn 1978, 1980) and thus are included in the study area. All of these islands are poorly vegetated and none is of a size that could support any significant number of Peary caribou on a year-round basis. Because of their usually exposed nature, however, these small islands could collectively provide, and sometimes have provided, valuable temporary relief for caribou fleeing widespread forage unavailability within the BIC. These 16 small islands collectively only total about 390 km^2.

2. General Climate

The climate of the study area is characterized by long cold winters, short cool summers and low precipitation. Air temperatures average below -17.7°C from December to March. Mean daily temperatures generally do not rise above 0°C until after 1 June on the extreme south of the study area, and 15 June on the north of the survey area (Meteorological Branch 1970). The snow cover usually starts to melt in early June, and often rapidly dissipates to bare ground through mid-June, except for snowbanks in sheltered sites (Potter 1965). Summer is the period when the ground is generally snow-free, and lasts from the beginning of July to the end of August. Winter starts when the mean daily temperature falls below 0°C, usually about 15 September. September and October are the stormiest months and much of the annual snowfall may occur in those months. From December to March, anticyclones dominate the weather causing frequent calms, clear skies and light snowfall.

A comparison of 1 year's weather data from the Canadian Museum of Nature research station in Polar Bear Pass on central Bathurst Island with data from Resolute Bay, Cornwallis Island, suggests that the differences in the weather between the two locations are the result of the research station's inland site and local topographical effects (Thompson 1971). The Atmospheric Environment Service weather station at Mould Bay, Prince Patrick Island, tends to have cooler, drier and less stormy weather than the weather station at Resolute Bay, Cornwallis Island (Maxwell 1981).

The amount and duration of snow cover, especially in spring, are critical to arctic ungulates, but also critical are the types of snow cover and incidences of freezing rain. Wind removes the snow from exposed slopes and redeposits it as shallow but hard compacted cover and drifts in more sheltered and relatively well-vegetated sites. Freezing rain in autumn that results in ground fast ice before snow cover accumulates, ice layering in the snow cover, crusting of the snow, and the formation of ground fast ice in spring (e.g., Miller et al. 1982) compound the stress of forage unavailability on arctic ungulates. Unfortunately, essentially no range-wide information on type of snow cover or the incidence of ground fast ice or ice layering is available for the QEI.

METHODS

1. Nonsystematic Helicopter Searches

For the purpose of aerial searches Bathurst Island was divided into 11 "search zones": (1) northeast coast (NEC); (2) northeast interior (NEI); (3) southeast coast (SEC); (4) southeast interior (SEI): (5) south coast (SC); (6) southwest coast (SWC); (7) southwest interior (SWI); (8) northwest coast (NWC); (9) northwest interior (NWI); (10) north coast, western section (NCW); and (11) north coast, eastern section (NCE). All of the land area divisions (search zones) were tied to the three aerial survey strata of Bathurst Island (Fig. 2) used by Miller et al. (1977a) and Miller (1987a, 1989). All coastal areas were strips of land that extended about 5 km inland from the sea coast. The middle lowlands of Polar Bear Pass through central Bathurst Island were used to divide Bathurst into north and south sections (the common boundary of survey Station (St.) I and St. II, Fig. 2). The northern portion of Bathurst Island was divided into eastern and western halves along the common land and water boundaries of St. I and St. II (Fig. 2). The southern portion of Bathurst Island was divided in half on an east and west basis along about the 99°00'W meridian (passing just west of the head of Bracebridge Inlet at the north end to just west of Dyke Acland Bay on the south coast.

1.1. Aircraft

A Bell-206B (Jet Ranger) turbo-helicopter on high skid gear was used as the search aircraft in May, June and July 1990.

1.2. Observers

A 3-person aerial search team was used: pilot-navigator-spotter, (right front seat); navigator-spotter-observer (left front seat); and only a right rear seat observer (weight limitations with a full fuel tank restricted the crew size to only 3 people). Navigation was carried out by the pilot and the left front seat person. The left front seat observer and the right rear seat observer recorded observations for their respective side of the aircraft: (1) date; (2) location; (3) composition of animal(s) sighted, as bull, cow, calf, juvenile, or yearling (juv. & yr. were separated by sex); and (4) remarks, if any. The animals sighted were circled, if necessary, to determine their number and sex/age composition (all 3 crew members participated in the determinations).

1.3. Altitude

Altitude of the helicopter varied between 10 and 90 m above ground level (agl) during the nonsystematic helicopter searches over land. The helicopter was flown as low as 5 m agl, when examining tracks, determining the direction of travel along trails, or following poorly visible trails. Helicopter searches over sea ice in 1990 were all flown at ca. 150 m amsl due to poor visibility (lack of depth perception).

1.4. Helicopter air speed

The air speed of the helicopter varied between about 96 and a cruising speed of 160 km · h^{-1} during the searches (usually at cruising speed when searching for animals). Slower speeds were temporarily maintained when examining tracks or animals and the helicopter was sometimes hovered for better inspection of tracks.

2. Relative Numbers

Relative numbers of caribou by search zone and by island within the BIC were determined by nonsystematic helicopter searches. The technique does not necessarily provide accurate population estimates on an island basis or for the inter-island population within the entire BIC. The maximum count obtained during a discrete search period can, however, provide some insight into the likely seasonal population levels by island and for the entire BIC.

3. Distributions And Intra- Or Inter-island Movements/migrations

Distributions and intra-island movements and seasonal migrations by search zone or an entire island were determined by nonsystematic helicopter searches over land areas of the various islands within the BIC. Evidence for inter-island movements or seasonal migrations of caribou within the BIC was to be obtained by low-level nonsystematic helicopter searches over the interjacent sea ice and adjacent coastal areas of the 26 islands within the BIC.

Direction of travel on trails on the sea ice would be determined and, if possible, exact origins and termini. Animals sighted on the sea ice would be left undisturbed. We would have first back tracked along their trails to find where they left the land (point of origin). Then, we would have subsequently followed the trail in the direction of travel from about where we first saw the animals to determine the terminus.

Comparison of the sex/age structure of caribou on the five western major satellite islands of Bathurst Island vs. that for Bathurst Island only could provide indirect evidence for inter-island movements or migration, and the possible selection of calving areas. The skewedness of the distribution of sex/age classes of caribou among the islands of the BIC also could serve as indirect evidence for seasonal inter-island movements/migrations; and thus, the existence of an inter-island population of caribou. Comparison of the sex/age composition of caribou seen on the various areas of Bathurst Island could allow some indirect evaluation of intra-island movements/migrations, and the degree of spatial segregation of caribou on Bathurst Island, at least at one season of the year.

4. Sex/age Composition And Social Groupings

Segregations of caribou seen during aerial activities by sex/age classes (bulls, cows, calves, juveniles and yearlings) were used to determine the approximate sex/age structures of the "precalving" and "postcalving" population segments on an island basis and between and among islands. The overall data base from combined aerial activities allowed approximations of the precalving and postcalving sex/age compositions of the entire inter-island population of Peary caribou within the BIC. These data provide some insight into the current population dynamics and the potential for growth of the caribou population within the BIC.

4.1. Sex/age classification

Peary caribou are recognized and classified by sex/age class as follows.

4.1.1. **"Bulls" (mature males, assumed 4+ yr-old)** are recognized by the relatively large size and advanced development of their new antler growth, which is exaggerated by the presence of velvet on the antlers. Diagnostic characteristics were the large diameter of the main beams; the long, posteriorly curved main beams; and the presence of well-developed, anteriorly directed brow or bez tines. Secondary characteristics include large body size, relatively large head size; and new pelage, especially on the lateral parts of the body and on the face. When the caribou under consideration exhibits male-like antler growth, the observer distinguishes mature males from juvenile males by mentally evaluating the length of the new antler growth present in relation to the length of the animal's head (from crown of skull to tip of nose). When the antler growth is longer than the head - the animal is classified as a bull; and if shorter than the head - a juvenile male.

4.1.2. **"Cows" (mature females, assumed to be mostly 3+ yr-old)** are recognized by the retention of hard antlers from the previous year or the absence of antlers and any new growth of antlers. In a few cases, minor new growth on the simple main beams has begun (such new growth most likely occurs among individuals just coming of age or possibly a few older cows that maintained better physical condition because they did not have the added burden of carrying a fetus and nursing a calf in the current year). Cows, especially those that calved in the current year, still retain much of their previous winter's pelage and have a faded, lifeless, often patchy appearance about them (relative to other sex/age classes in July). The general drab appearance of a successful maternal cow often remains clearly recognizable into August of the year (individual variation, however, may be important after mid-July). Whenever possible, the presence of a stained "vulval patch" or a distended udder in combination with retained hard antlers in June is noted (cf. Bergerud 1961, 1964).

4.1.3. **"Juvenile/yearling males" (males, assumed 1-3 yr-old)** are recognized by their new pelage, and their relatively small body size (especially that of yearlings), when compared to adults, aids in their separation from bulls and cows. (Initially, an attempt is made to separate juvenile males from yearling males.) The advanced, well-developed, but relatively small (when compared to bulls) new antler growth of at least 2 and 3-yr olds is used to separate them from juvenile females. Yearling males are judged by their associations, relative antler development and body size, as well as the absence of a "vulval patch", when possible (cf. Bergerud 1961).

4.1.4. **"Juvenile/yearling females" (females, assumed 1-2 yr-old)** are recognized by their new pelage, new antler growth, and relatively small body size (particularly yearlings) and the presence, when visible, of a "vulval patch" (and the absence of a distended udder) (cf. Bergerud 1961, 1964). Yearling females are separated from juvenile/yearling males or juvenile females by their new antler growth appearing shorter than the ears and being restricted to small spike-like main beams or at the most, small main beams with simple branching. Antler growth characteristics together with the relatively small body size and new pelage separate juvenile/yearlings from cows or bulls. (Initially, an attempt is made to separate juvenile males from yearling females.)

4.1.5. **"Calves" (male or female, assumed newborn in June of the year)** are obvious by their relatively small size compared to other sex/age classes. No attempt is made to sex calves (cf. Bergerud 1961) during aerial composition counts.

4.2. Caribou social formations

A "caribou social group" is composed of two or more individual caribou that are seen in close association (no fixed minimum or maximum distance of separation but usually much closer than 100 m) and apparently spatially isolated from other individuals of the same species at the time of observation. Two or more individuals (of the same species) are considered as one group even if they are more than 100 m apart but moved together when disturbed by the survey aircraft.

4.2.1. Mixed sex/age caribou group

A "mixed sex/age caribou group" may be mixed by sex or age or both and contains any possible combination of bulls, cows, juveniles, yearlings, or calves (when bulls cannot be recognized, the presence of both sexes might not be determined with complete confidence).

Mixed sex/age groups can occur as any of 22 possible combinations of designated sex/age classes: (1) cow-only; (2) cow/calf; (3) cow/juvenile; (4) cow/yearling; (5) cow/calf/juvenile; (6) cow/calf/yearling; (7) cow/juvenile/yearling (8) cow/calf/juvenile/yearling; (9) bull/cow; (10) bull/cow/calf; (11) bull/cow/juvenile; (12) bull/cow/yearling; (13) bull/cow/calf/juvenile; (14) bull/cow/calf/yearling; (15) bull/cow/ juvenile/yearling; (16) bull/cow/calf/juvenile/yearling; (17) juvenile/ yearling; (18) juvenile-only; (19) yearling-only; (20) bull/juvenile; (21) bull/yearling; and (22) bull/juvenile/yearling.

The presence of a calf in a mixed sex/age group without a cow being present would be considered an unstable anomalous social grouping (a temporary gathering) and thus would not be considered as a valid mixed sex/age group. The presence of a calf (female or male) in a male-only group would also be considered an anomalism and would not be considered as a valid male-only group. Such anomalous groupings would be recorded but they would not be used in the calculation of any statistics for either mixed sex/age or male-only groups.

A juvenile or yearling caribou can be either female or male in a mixed sex/age group if at least one cow is present, but can only be female if no cows are present. Two or more juveniles or yearlings in a mixed sex/age group can be either sex or of mixed sex if at least one cow is present, and can be either all females or mixed by sex if no cows are present.

4.2.2. Male-only caribou group

A "male-only caribou group" can be composed of mature males only (bulls, assumed 4+ yr olds, relatively large antler size) or juvenile males or yearling males or any combination of bulls, juvenile males and/or yearling males. In June-July of the year both bulls and immature males (at least 2- and 3-yr olds and possibly 1-yr olds) are readily recognizable by their relatively advanced antler development from other sex/age classes of Peary caribou.

Male-only groups can occur as any of seven possible combinations of designated male age classes: (1) bull-only (2) bull/ juvenile male (3) bull/yearling male; (4) bull/juvenile male/yearling male; (5) juvenile males; (6) yearling males; and (7) juvenile male/ yearling male.

5. Calving Period

The timing of the calving period, with emphasis on the peak of calving, was determined by the measurement of the percentages of newborn calves present among all caribou segregated over time in May-July 1990. Ratios of newborn calves per 100 breeding cows and per 100 1+ yr-old females throughout the same time period also were used to determine the overall chronology and the peak of the calving period.

The multi-year collective data base of these measures obtained by aerial activities over the life of the project will be used to determine:

(1) timing of calving in relation to yearly variation in snow/ice conditions during the calving period;
(2) whether Peary caribou have evolved a later calving period in adjustment to harsh environmental conditions during calving, and often, shortly after calving; and

(3) possible between or among-year variation in calving dates, especially the peak of calving.

6. Calf Production

Initial calf production (calving success) was measured by the maximum percentage of calves among all individual caribou seen and the maximum ratios of newborn calves per 100 breeding cows and per 1+ yr-old females in grouped samples of different individuals obtained by aerial searches, May-July 1990.

The multi-year collective data base of these measures obtained by aerial activities over the life of the project will be used to determine:

(1) the influence of the previous winter's physical environmental conditions (based on AES weather records);
(2) the influence (importance) of yearly snow/ice conditions during calving; and
(3) the relationship between where cows calve and the subsequent rates of calves at heel in July of that year.

7. Early Survival Of Calves

Early survival of newborn calves was determined by examination of percentages of calves among all individual caribou seen and the ratios of calves per 100 breeding cows and per 100 1+ yr-old females in grouped samples of different individuals obtained by aerial searches in June-July 1990.

The multi-year collective data base of these measures obtained by aerial activities over the life of the project will be used to determine:

(1) the apparent influence of the previous winter's physical environmental conditions (based on AES weather records);
(2) the apparent influence of snow/ice conditions that prevailed during the calving period on subsequent early calf survival in that year; and
(3) the likelihood that the Peary caribou population within the BIC will reach a size within the near future, that would support annual sustained harvests of any appreciable number.

8. Snow/ice Measurements

Two pieces of high-quality SPS steel rod (ca. 1.6 cm in diameter) were each cut 103.6 cm in length. One end of one 103.6-cm section was milled and tapered to a blunt point for relative ease of penetration through hard snow layers or ice lenses in the snow cover. A grooved ring was scored 10 cm from the tip of the rod and every 5 cm thereafter for an overall length of 1-m. The last 1.9 cm of the rod was milled down to about 0.6 cm in diameter and threaded so that the second rod (when bored and tapped) could be attached, if desired. The bored hole in the proximal end of the second section of rod was tapped so that it would joint with the threaded distal end of the first section of rod, when necessary. The first grooved ring was scored on the second section of rod so that when meshed with the first section it formed a 5-cm distance from 100 to 105 cm. Thereafter, each 5 cm of the second section was scored off for an overall length of 2 m, when both sections are combined. The last 1.9 cm of the distal end of the second section of rod was reduced and threaded as was the first section so that either section could take a "T" handle. A hole was drilled through the centre of a 22.2-cm section of the same SPS steel rod material so that it would pass over the threaded distal portion of either of the two sections of 103.6-cm rod and could be secured by means of a winged-nut or a standard hex nut. Only the section of rod with the blunt point was used with the "T" handle attached to its distal end, when the snow cover was 1-m or less in depth.

A sampling tarpaulin was designed to permit the use of a systematic grid pattern sampling procedure for measuring snow depths. Grommets (2.5 cm inside-diameter) were set in the tarpaulin in three rows and three columns at 0.5 m on centre. This design permitted nine point samples (measurements) to be obtained on 1-m^2 at 0.5-m intervals. The steel rod was passed vertically down through each grommet hole and pushed to the bottom of the snow cover (ground surface, or top of ground fast ice when present). The thumb and index finger were then placed immediately above the surface of the snow cover and the rod was withdrawn from the hole. Snow depths were measured to the closest whole centimetre. The rod was read directly to the closest 5 cm. The difference, if any, was then measured to the closest centimetre by holding a steel measuring tape against that portion of the rod. Ice thickness measurements were made by chopping a vertical profile to ground level with an axe. Then measuring the thickness of the ice with a steel measuring tape to the closest whole centimetre.

Snow depth and ice thickness measurements were obtained from a 7.5-km snow/ice course and a 1-km snow/ice course. Markers (205-litre empty fuel drums) were dug about one-quarter of the way into the ground for the 7.5-km course in summer 1989. The 7.5-km course ran from about 30 m in from the seacoast at an elevation of ca. 4 m amsl inland in a westerly direction to a point of land on some of the highest ground in the study area (ca. 160 m amsl). The 7.5-km course consisted of 30 1-m^2 sample plots called "stations": 16 stations were spaced systematically at 0.5-km intervals along the main axis of the course from 0.0 to 7.5 km; and 14 stations were established in 7 pairs with one marker of each pair placed 250 m north and the other 250 m south of each whole kilometre station from 1.0 to 7.0 km. The 1-m sampling tarpaulin was placed about 5 paces north of each drum-marker so that the 1-m^2 sample site fell between 4 and 5 m north of each drum-marker. The 1-km course was located about 2 km inland from the seacoast. The 1-km course ran essentially north-south for 0.5 km from the 2.0-km North Station past the 2.0-km Station to the 2.0-km South Station of the 7.5-km course. Then, it made a right angle turn and ran downslope to the east toward the seacoast from the 2.0-km South Station for another 0.5 km past the 1.5-km Station and in line with the 1.0-km North Station (but not all the way to it) of the 7.5-km course. The 1-km course consisted of 41 stations each spaced systematically at 25-m intervals. Green garbage bags were partially filled with snow, tied-off, and placed every 25 m as a marker for each station (except the 3 stations that coincided with drum-markers on the 7.5-km course).

The 1-m² sampling tarpaulin was placed about 2.5 m (3 paces) eastward of each marker on the north-south running 0.5-km leg and 2.5 m northward on the east-west running 0.5-km leg of the 1-km course. Numbering of stations on both snow/ice courses was begun closest to the seacoast.

Stakes (1.2 m x ca. 5 x 5 cm) were driven about 0.3 m into the ground at each station on both snow/ice courses in July 1990 to serve as permanent markers to facilitate repeat sampling at those sites. Each stake was set on the middle point (0.5 m, no. 6 sample point of the 9-hole sampling point pattern) immediately outside the margin of each 1-m² sample site closest to the marker side of each station. Each stake was identified on two sides at the top end with the station number and the remainder of the stake was spray painted amber yellow and hi-gloss red or orange.

The nine grommet holes on the sampling tarpaulin were numbered consecutively and snow depths were always sampled in that chronological order (1 to 9) as follows: (1) 1st row, 1st column - upper left corner; (2) 1st row, 2nd column - upper centre; (3) 1st row, 3rd column - upper right corner; (4) 2nd row, 3rd column - centre right side; (5) 3rd row, 3rd column - lower right corner; (6) 3rd row, 2nd column - lower centre; (7) 3rd row, 1st column - lower left corner; (8) 2nd row, 1st column - centre left side; and (9) 2nd row, 2nd column - centre of tarpaulin.

The hook portions of standard metal coat hangers were snipped off on both sides immediately below the twisted "neck" portion. They were then straightened to ca. 78 cm and one end tightly coiled one and one-half turns so that a ca. 15 cm piece of hi-gloss orange flagging tape could be tied to the coil, leaving two ca. 7 cm tails of flagging on a ca. 76 cm shaft. A straight hanger (shaft end first) was inserted and left in the no. 5 and no. 7 holes at each station on both snow/ice courses. This procedure permitted accurate placement of the sampling tarpaulin on subsequent dates.

Patterns of the obliteration of snow cover were obtained by measuring the amounts of snow covered ground vs. snow-free ground over time on each of the 40 25-m intervals between stations 1-2 through 40-41 on the 1-km snow/ice course. A steel measuring tape was placed from the centre (no. 6 sample point) of one station to that of the next for each of the 40 pairs of stations and all segments of snow covered ground or snow-free ground were read to the closest 0.1 m and recorded in consecutive order. The amount of snow-free ground present was compiled for all 40 pairs of stations on each sample date to obtain a composite progression with time of snow-free ground on the 1-km course.

9. Environmental Conditions

Environmental conditions, especially any extreme or anomalous ones, were described qualitatively and quantified whenever possible. A general empirical description of snow/ice cover and seasonal conditions on land and on the sea ice were recorded in relation to how they might influence caribou distributions, aggregations, or movements/migrations.

9.1. On-site weather records

Weather observations at the field base camp were made twice daily at ca. 0700 and 1900. Each set of observations included (1) sky conditions and/or ceiling (100's ft, m = 30.48 x 100's ft); (2) visibility (miles, km = 1.609 x miles); (3) weather and obstruction to vision (brief description); (4) dry buld temperature (°C); (5) wind direction (at 5° intervals); (6) wind speed (knots · h^{-1}, km · h^{-1}= (1.852) knots · h^{-1}); (7) clouds and/or obscuring phenomena (types, amount); (8) maximum temperature (°C); (9) minimum temperature (°C); (10) precipitation (mm); and (11) remarks. Thermometers were housed in a modified Polar Continental Shelf Project white weather screen at ca. 1.5 m above ground level. A calibrated, transparent plastic rain gauge was mounted upright on a vertical stake ca. 1-m above ground level. Wind speed was measured with a hand-held anemometer and wind direction was approximated with the aid of a fastened streamer. Cloud types were identified from a standard Atmospheric Environment Service cloud chart and cloud cover was visually estimated in amounts by tenths of the sky from horizon to horizon.

9.2. Off-site weather records

Weather records were obtained from the Atmospheric Environment Service (AES) weather stations at Resolute Bay, Cornwallis Island, and Mould Bay, Prince Patrick Island. Only a cursory initial examination of those records was made for the current caribou-year (June 1989 to June 1990). The following variables were included: (1) monthly mean daily maximum temperature (°C); (2) monthly mean daily minimum temperature (°C); (3) monthly average of daily mean temperature (°C); (4) standard deviation of monthly average of daily mean temperature (°C); (5) monthly extreme maximum temperature (°C, for entire period of record); (6) monthly extreme minimum temperature (°C, for entire period of record); (7) rainfall (mm); (8) snowfall (cm); (9) total precipitation (mm); (10) standard deviation of each total monthly precipitation; (11) number of days per month with total precipitation greater than 1-cm; and (12) depth of snow on ground on last day of each month (cm).

10. Definitions Of Terms Or Style

10.1. Values in parentheses

When values are given in parentheses (x + y) in this report, they always equal 1+ yr-old animals plus calves: e.g., caribou (36 + 11) equals 36, 1+ yr-old caribou plus 11 caribou calves.

10.2. Measurements and units

The measurements taken and units used are as given in detail in Miller (1987a, 1987b, 1988, 1989). The reader should note that when a reported distance (km), area (km^2), or density (km^{-2}) is taken to three places to the right of the decimal point, it is done simply to allow conversion to the nearest metre or square meter and is not a reflection of or a desire to inflate the apparent accuracy of the measurements.

RESULTS AND DISCUSSION

1. Aerial Activities - Nonsystematic Helicopter Searches

Peary caribou within the BIC were surveyed by nonsystematic helicopter searches on 14 days between 31 May and 10 July 1990 (Tables 1-11, App. 1-4). Bathurst Island was aerially searched on 31 May, 1, 11, 13, 15, 17, 22-24, 27 June, and 6-7 July. The western major satellite islands of Alexander, Massey, and Marc were searched on 15, 23 June, and 8 July; and Vanier and Cameron on 17, 24 June, and 10 July. The two northern major satellite islands of Helena and Sherard Osborn were only searched once, on 24 June. Limited resources did not permit the two eastern major satellite islands of Cornwallis and Little Cornwallis to be searched in 1990.

Aerial searches were carried out between 31 May and 1 June 1990 on 14 of the 16 secondary satellite islands in the BIC. No caribou were seen on any of those islands. All 14 islands were heavily snow covered and it was judged that snow-free areas represented less than 10% of each island, based on visual inspection during aerial searches. Griffith Island in Barrow Strait was shrouded by "white-out" conditions and could not be searched. Crozier Island in McDougall Sound was surrounded by several kilometres of open water and no attempt was made to reach the island for safety reasons (the helicopter was on skid gear and the pilot would not fly there). Baker Island in Intrepid Passage was also searched on 13, 22, 27 June, and 7 July 1990 and no caribou were seen there.

Helicopter support was available only between 31 May-1 June, 11-27 June, and 6-10 July 1990 (App. 1). Most (70.3%) of the time was spent on aerial searches between 31 May and 27 June. Bathurst Island received 75% of this search effort; the five western major satellite islands 21.5%; the two northern major satellite islands 2.4%; and Baker Island 1.1%. The remaining 29.7% of time spent in aerial searches was expended between 6 and 10 July: 64.4% on Bathurst Island; 34.9% on the five western satellite islands; and 0.7% on Baker Island.

About 72% of the overall aerial search effort was devoted to Bathurst Island (App. 1). Allotment of effort among the 11 zones of Bathurst Island varied between 2 and 19% (mean time by zone = 314.5 ±

178.7 min (SD)). The five western major satellite islands received ca. 25% of the overall effort: of which 37.0% was allotted to Vanier; 15.3% to Cameron; 17.8%, Alexander; 25.9%, Massey; and 4.0%, Marc (mean time per island = 245.0 ± 151.1 min (SD)). The two northern major satellite islands received less than 2% of the search effort and Baker Island only 1%.

An average of 43.3 sightings of caribou · 100 min^{-1} of search effort was obtained during nearly 80 h of actual helicopter searches (App. 1-3). Rates of caribou sightings were lowest between 31 May and 17 June 1990 (Table 1: 23.9 caribou · 100 min^{-1}). The frequencies of sightings then increased significantly from 50.2 caribou · 100 min^{-1} between 22-27 June to 61.4 caribou · 100 min^{-1} between 6-10 July (X^2 =16.38, 2df; P <0.005).

1.1. Relative numbers

All 871 caribou sightings obtained by aerial searches between 6 and 10 July 1990 are known to be of different individuals (Table 1). Thus, this grouped sample for Bathurst Island and the five western major satellite islands is the largest and the most spatially representative of all grouped samples obtained in 1990. Seventy-five percent (655) of those 871 caribou were on Bathurst Island, 527 of them were 1+ yr-old animals. The remaining 25% (216) of the 871 caribou were collectively on the five western major satellite islands (182 were 1+ yr-olds): (1) Alexander, 113 caribou; (2) Massey, 56; (3) Vanier, 43; (4) Cameron, 2; and (5) Marc, 2.

The mean frequency of occurrence of caribou on Bathurst Island by grouped samples increased significantly over time among all six sampling periods (X^2 = 76.50, 5df; P <0.005). Rates of caribou sightings were underrepresented during the 31 May-1 June and 11-13 June periods. The 15-17 June rate was about as expected by chance alone. Then the rates of caribou sightings were slightly overrepresented during the 22-24 June period and markedly overrepresented during the 27 June and 6-7 July periods. The mean frequency of occurrence of sightings of caribou on the five western major satellite islands did not vary significantly among the three sampling periods (X^2 = 2.64, 2df; P >0.05), although the total numbers of caribou seen during the first two periods (n = 138, 15-17 June; n = 131, 23-24 June) were only ca., 60% of the total number seen during the third period (n = 216, 8-10 July).

There is no feasible way to extrapolate population estimates for caribou on Bathurst Island, the five western major satellite islands, or within the entire BIC from the caribou sightings obtained by nonsystematic aerial searches. The 871 different individual caribou counted on Bathurst (n = 655) and the five western major satellite islands (n = 216) between 6-10 July 1990 indicate that the 1988 estimate of 1102 (± 146 SE) caribou within the entire BIC (Miller 1989) is still realistic and likely a good approximate estimate for caribou within the BIC in summer 1990. The proportion of caribou that were seen on Bathurst Island in July 1990 (75.2%) vs. the five western major satellite islands (24.8%) was essentially equal to the effort expended in the nonsystematic aerial searches on Bathurst (71.9%) and the five western major satellite islands (25.4%). The ca. 3.0:1 caribou seen on Bathurst vs. the five western major satellite islands in July 1990 is similar to the ca. 2.5:1 caribou seen on those respective land areas in July 1989 (Miller 1991). The ratios suggest that proportionately there were slightly more caribou present on the five western major satellite islands in July 1989 than in July 1990 (0.294 vs. 0.248: a 16% decrease in 1990 over the 1989 rate).

1.2. Distributions and intra- or inter-island movements/migrations

Late spring and early summer distributions and movements of caribou within the BIC appeared complex in 1990. Although the data base is fragmentary, particularly for the late May-early June period, several generalizations can be deduced from the existing information.

<u>Bathurst Island</u>. An apparently large but unknown proportion of the island's caribou were already occupying northern Bathurst Island by our arrival in late May 1990. The snow cover appeared heavy and nearly complete. There were few snow-free patches on either interior or coastal areas; only the most exposed, small patches of windblown ground were snow-free. Such snow-free patches were widely dispersed on bluffs or steeper coastal slopes and along the steeper and higher banks of large stream cuts of both interior and coastal areas. It appeared that less than 10%, and possibly much less, of Bathurst Island was snow-free during late May and the first few days of June 1990, based on visual impressions during helicopter flights. The southwestern coastal area was essentially 100% snow covered and the southwestern interior only slightly less so.

Caribou continued to move eastward along the south coast (SC) and northward along the southeast coast (SEC) and the northeast coast (NEC) throughout June into July 1990 (Tables 4 and 5). Most of the land remained snow covered until the third week of June, when the melt accelerated rapidly over the next several days. Northward movements also increased during the last 10 days of June and, at least, during the first several days of July along eastern coastal routes to the NEC and along interior routes to the northeastern (NEI) and northwestern (NWI) interiors. At the same time, caribou continued moving westward along the eastern section of the north coast (NCE) onto the western section of the north coast (NCW) and on to the northwest coast (NWC). Some caribou also crossed the sea ice to the two northern major satellite islands of Helena and Sherard Osborn. It is likely that some caribou also crossed the sea ice from the NWC or the NCW to some of the five western major satellite islands, based on changing numbers on those islands from June into July, but no direct evidence of this was obtained.

In early July 1990, caribou began pushing into the NEI and the southeast interior (SEI). The number of caribou on the NWI also increased but was masked by the proportionally greater increases on other interior and coastal sites. Snow cover was greatly reduced on those areas and the "greening" of the vegetation was advancing slowly on interior sites. The phenology of the flowering plants on the high plateaus of the interior of the island was not, for the most part, advanced to the flower head state until the second or third week of July in 1990. Caribou remained scarce on southwestern coastal (SWC) and interior (SWI) sites throughout all search periods.

Eight of the 11 zones of Bathurst Island were searched between 31 May-1 June 1990, with frequencies of caribou sightings being significantly overrepresented (Table 4: $X^2 = 45.15$, 7df; $P < 0.005$) on the SC, followed by those for the SEC, NEC, and NEI. When the north coast was subsequently searched between 11-13 June, however, caribou were most frequently sighted on the NCW, followed by those on SEC and NCE sites (Table 4: $X^2 = 12.70$, 6df; $P < 0.05$). By 15-17 June the frequencies of caribou occurrence were greatest on the eastern portion of Bathurst Island (Table 5: $X^2 = 17.68$; 1df; $P < 0.005$). This condition was especially true for the northeastern part of the island where occurrences of caribou were overrepresented on the NEC, NCE, and the NEI (Table 4: $X^2 = 75.56$, 5df; $P < 0.005$). The occurrence of caribou remained highest on NEC sites during the 22-24 June period, with occurrences also being overrepresented on the SEC, NWC, and still on the NEI (Table 4: $X^2 = 79.90$, 7df; $P < 0.005$). On 27 June caribou were favouring coastal sites (Table 5: $X^2 = 28.40$; 1df; $P < 0.005$ - coastal vs. interior) and the north of the island (Table 5: $X^2 = 24.44$, 1df; $P < 0.005$ - north vs. south). Frequencies of caribou occurrence were overrepresented in descending order on the NWC, NEC, SC, and NCE on 27 June (Table 4: $X^2 = 540.89$, 9df; $P < 0.005$). Between 6-7 July caribou continued to favour northern sites (Table 5: $X^2 = 27.96$, 1df; $P < 0.005$ - north vs. south) on the eastern portion of the island (Table 5: $X^2 = 9.42$, 1df; $P < 0.005$ - east vs. west) but increased movements away from coastal sites into interior areas were also occurring. The frequencies of caribou occurrence were overrepresented in descending order on the NCE, NEC, NCW, NEI, and SEI on 6-7 July (Table 4: $X^2 = 302.02$, 10df; $P < 0.005$). The increasing number of caribou on NWI sites was masked by the proportionally greater levels in the east.

<u>Five western major satellite islands</u>. The islands of Vanier, Cameron, Alexander, Massey, and Marc were first aerially searched between 15 and 17 June. At the time, the frequencies of caribou occurrence were overrepresented on Ile Marc and Ile Vanier (Table 6: $X^2 = 60.41$, 4df; $P < 0.005$). The high rate of occurrence on Ile Marc was caused by 15 juvenile animals that were moving to the southeast along the northeast coast, apparently having come from Massey Island on their way to Alexander Island. All of the caribou seen on Vanier, Massey and Alexander islands were on the southern portions of those islands, mostly nearer the coasts than the interiors. All of the caribou seen on Cameron Island were on northeastern coastal sites. Snow cover appeared heavy and essentially complete, even on coastal sites. All existing snow-free sites were all small, usually only a few square metres in size and widely scattered.

When the five islands were again searched between 23-24 June, most of the caribou appeared to have redistributed themselves, with the highest frequencies occurring on Alexander and Massey islands (Table 6: $X^2 = 134.05$, 4df; $P < 0.005$). Most of the caribou appeared to be on Massey Island and few could be found on Ile Vanier. Snow cover on Ile Vanier looked more complete than on Massey or Alexander islands, but the coastal areas of all three islands remained mostly snow covered. Although most of the landmass of each of the five islands remained snow covered, snow-free sites appeared to be most prevalent on Alexander Island. In contrast to the 15-17 June findings, the caribou seen between 23-24 June were mostly on interior sites. The absence of caribou on Cameron Island probably reflects more the fact that only the southeastern and northeastern coastal areas were searched (due to "white-out" conditions over the remainder of the island) than the possible total absence of caribou there.

The pattern of caribou distribution among the five islands remained about the same, when last searched between 8-10 July 1990 (Table 1). The occurrence of caribou remained overrepresented on Alexander and Massey islands (Table 6: $X^2 = 171.35$, 4df; $P < 0.005$), having increased noticeably on Alexander. Although the frequency of caribou occurrence was underrepresented on Ile Vanier, the actual number of caribou had increased from 23-24 June. Cameron Island received intensive coverage during this last search period but only two caribou were found there.

On an island basis, the frequencies of caribou occurence (1) increased continually on Alexander Island (Table 6: $X^2 = 42.73$, 2df; $P < 0.005$) from mid June to early July; (2) remained unchanged on Massey Island (Table 6: $X^2 = 2.36$, 2df; $P > 0.005$); (3) declined on Ile Vanier (Table 6: $X^2 = 41.44$, 2df; $P < 0.005$) and Cameron Island (Table 6: $X^2 = 46.35$, 2df; $P < 0.005$), being lowest in late June; and (4) declined continually over time on Ile Marc (Table 6: $X^2 = 82.26$, 2df; $P < 0.005$). The changing number and frequencies of caribou occurrence among these islands, seemingly, required inter-island movements among them and probably from Bathurst Island.

<u>The two northern major satellite islands</u>. We saw 23 caribou on Helena Island and 11 on Sherard Osborn Island on 24 June 1990, during the single search of the two northern major satellite islands (App. 1-3). Most of the caribou seen on 24 June appeared to still be moving westward along the north coasts of both islands. The impression was that at least most of the caribou on Helena and Sherard Osborn islands were likely from a splinter movement of those caribou that were then moving westward along the north coast of Bathurst Island (how long those caribou remained on Helena or Sherard Osborn is unknown).

Original plans called for low-level aerial searches over the sea ice for evidence of inter-island movements by Peary caribou in the Bathurst Island complex (cf. Miller <u>et</u> <u>al</u>. 1977<u>b</u>, Miller and Gunn 1978, 1980, Miller <u>et</u> <u>al</u>. 1982). Poor visibility over the sea ice due to complete snow cover (no meltwater on sea ice) and "white-out" conditions prevailed, however, during all attempts to do so. The pilot refused to fly below 150 m while over sea ice at all times during May and June 1990, which made searching for caribou trails on the sea ice unfeasible. Some consolation can be had in the fact that the snow cover on the sea ice remained in a powdery, wintry state until late June 1990. Thus, caribou trails would not have set up in the snow and would have been obliterated by wind action within a few hours, at most, of having been put down. Evidence for inter-island movements, at least among the western satellite islands, comes from the following. (1) The highly skewed sex/age composition of caribou on the western satellite islands. (2) The apparently ongoing changes in numbers of caribou on those islands during at least June 1990.

1.3. Sex/age composition

Nonrandom distribution of 1+ yr-old caribou by sex/age classes within the BIC (among the 11 search zones on Bathurst Island and among Bathurst and each of the five western major satellite islands) markedly influenced and confounded the determination of sex/age composition at the population level. All grouped samples, except the last one (6-10 July 1990) suffer from incomplete spatial coverage and relatively small sample sizes (Table 1, App. 2).

The best information obtained during 1990 (Table 1) suggests that the sex/age composition of the population of 1+ yr-old caribou within the BIC favoured young animals, with 153 juvenile/yearlings:100 breeding cows or 233 juvenile/yearlings:100 bulls. Bulls were well represented at ca. 66 bulls:100 breeding cows and about 3 in every 10 animals were breeding cows.

Females (1+ yr-old) equalled 64.4% of all 1+ yr-old caribou, based on the actual counts (Table 1). Those segregation counts (Table 1) suggest, however, that there were only 45 juvenile/yearling males:100 juvenile/yearling females, which appears questionable as the "primary sex ratio" for the species is supposedly 51 males to 49 females at birth (e.g., Miller 1974). The percentage of 1+ yr-old females dropped by about 14% to 55.4%, when I assumed that only 50% (rather than the 68.8% obtained from the counts) of the juvenile/yearlings should have been females. Thus, the representation of females in the population appears to lie somewhere between 124 (adjusted) to 181 1+ yr-old females:100 1+ yr-old males.

Males (1+ yr-old) equalled 35.6% of all 1+ yr-old caribou, based on the actual counts (Table 1). Male representation increases by about 26% to 44.6%, however, when the juvenile/yearling animals are adjusted to a 50:50 sex ratio. Thus, the representation of males in the population appears to lie somewhere between 55 to 80 (adjusted) 1+ yr-old males:100 1+ yr-old females.

<u>Bathurst Island</u>. Aerial searches yielded 890 sightings of caribou between 31 May and 27 June and 655 sightings on 6-7 July 1990 (Table 1, App. 2). Spatial overlaps involving possible uneven distribution of sex/age classes by major land areas and temporal spans (involving possible redistributions throughout the overall sampling period) probably sometimes caused over- or underrepresentation of some sex/age classes and duplication of effort (possible repeated counts of the same individuals) in June 1990. Therefore, the grouped sample of 655 caribou known to be of different individuals on 6-7 July taken from all 11

zones on Bathurst Island is both the largest and most representative on an island-wide basis (Table 1). The second and third largest samples obtained on 22-24 (n = 305) and 27 June (n = 281) are less satisfactory because both samples were somewhat more spatially restricted (zones SWC, SWI, NCW (22-23/6), and zone NCW (27/6) were not searched) and resulted in overrepresentation of males (ca. 44% and 25% males overrepresented, respectively, when compared to the 6-7 July sample structure). Females equalled 64.3% of the 527 1+ yr-old caribou sampled on 6-7 July 1990 (Table 1), based on the actual count. It appears that the postcalving structure of the caribou population segment on Bathurst Island in early July 1990 approximated 16.5% bulls, 27.3% breeding cows, 19.5% calves, and 36.6% juvenile/yearlings of both sexes (ca. 7.0% juvenile males, 15.4% juvenile females, 5.2% yearling males, and 9.0% yearling females). When the juvenile/yearling sample (n = 240) is adjusted to an assumed 50:50 sex ratio, the percentage of 1+ yr-old females drops by 11.8% to 56.7% (juvenile/yearling females were significantly overrepresented among all juvenile/yearlings (Table 1: $X^2 = 26.14$, ldf; $P < 0.005$).

<u>Five western major satellite islands</u>. The numbers of caribou that the three aerial searches yielded during June-July 1990 varied markedly between the first two and the third search (Tables 1, 6). As the 8-10 July sample far exceeded the two prior ones, it was used to approximate the postcalving sex/age structure of the caribou population segment on the five western major satellite islands in early July 1990: 17.6% bulls, 20.4% cows, 15.7% calves, and 46.3% juvenile/ yearlings of both sexes (ca. 8.8% juvenile males, 17.6% juvenile females, 3.2% yearling males, and 16.7% yearling females). Females equalled 64.8% of the 182 1+ yr-old caribou sampled on 8-10 July 1990 based on the actual count (Table 1). When the juvenile/yearling sample (n = 100) is adjusted to an assumed 50:50 sex ratio, the percentage of 1+ yr-old females drops by 20.4% to 51.6% (juvenile/yearling females were significantly overrepresented among all juvenile/yearlings (Table 1: $X^2 = 23.04$, ldf; $P < 0.005$).

<u>Accuracy of sex/age classifications</u>. The evaluation of the airborne observer's ability to consistently visually recognize and separate juveniles from yearlings and to make accurate sex determinations for both juveniles and yearlings remains ongoing. The 1990 segregations, like those in June 1989 (Miller 1991), resulted in an unexplainable overabundance of juveniles over yearlings (1.5 juveniles:1 yearling); female juveniles over male juveniles (2.1 females:1 male); and female yearlings over male yearlings (2.3 females:1 male), based on the 6-10 July 1990 sample. It is probable that much of this overrepresentation of females, at least among the juveniles, can be explained by the mistaken classification of nonpregnant cows as juvenile females during June-July of the year. It now seems reasonable to assume that the "drab appearance" of a "breeding cow" at that time of the year is more a function of the burden of carrying a fetus to full-term or near-term and thus applies to all pregnant females regardless of age. Therefore, while most "breeding cows" will be 3+ yr old, a certain percentage, most likely varying annually, will be juveniles (2 yr old) or even yearlings (1 yr-old). This condition would explain the total lack of any juvenile or yearling females with calves at heel in June-July 1990 as well as much of the overabundance of

juvenile/yearling females in the 6-10 July 1990 sample of caribou segregated by sex and age. Proportional representation of sex/age classes in the 6-10 July sample is within previously reported levels for calves, bulls, and all 1+ yr-old females, although somewhat low for breeding cows (e.g., Miller 1974, 1982). A more complete evaluation of the results awaits a better understanding of the probable bias associated with the consistent recognition of all the individuals in all of the designated sex/age classes.

1.4. Social formations

Caribou were seen on 580 sites throughout the six search periods (Table 7). Groups of two or more individuals constituted 82% of those observations. The remaining 18% of the observations were of solitary animals: 32 bulls (5%); 23 cows (4%); and 50 juvenile/yearlings (9%). All groups (n = 475) averaged 4.1±2.76 (SD) and ranged from 2 to 23 members each: mixed sex/age groups (n = 316), mean 4.4±3.13 (SD), range 2-23; and male-only groups (n = 159), mean 3.5±1.64 (SD), range 2-10.

Overall, mixed sex/age groups averaged significantly larger than male-only groups (t-test; P <0.001). When compared as grouped data on a six-sample-period basis (Table 7), however, this significant difference pertained to only the 6-10 July 1990 period (t-test; P <0.001). The mean group size for mixed sex/age groups with calves present during 6-10 July 1990 also averaged significantly greater than the mean for mixed sex/age groups without calves present during that period (Table 8). The presence of newborn calves in those groups accounted for the significant difference; when calves were excluded from group sizes there was no significant difference between group sizes for groups that had calves excluded vs. those that had no calves (Table 8: t-test; P >0.05).

The average group size for male-only groups did not vary significantly among any of the six search periods (Tables 7 and 8). The largest male-only group seen was only 43% as large as the largest mixed sex/age group with calves present.

Group formations followed the same general patterns exhibited in 1985 (Miller 1987a), 1988 (Miller 1989), and 1989 (Miller 1991).

On an island basis, only the sample sizes for Bathurst Island were large enough to be meaningful. As in the overall sample, all mixed sex/age groups averaged significantly larger than male-only groups only during the 6-10 July 1990 sampling period (Table 8: t-test; P <0.001).

1.5. Calving period, calf production, and early survival of calves

The data suggest that only about one-third of the potential calf births within the BIC had occurred by 24 June 1990 (Tables 9 and 10). By 10 July 1990, either only 60% of the calf production remained alive or 40% of the maximum potential calf production had not been realized, based on percentage of calves in the sample (Table 10). Also, by 10 July only ca. 73 out of every 100 breeding cows were still accompanied by calves and only 35 out of every 100 1+yr-old females still had calves at heel (Table 9). Although these data indicate a relatively poor 1990 calving season within the BIC compared to 1961 (Tener 1963), 1985 (Miller 1987a), 1988 (Miller 1989), and 1989 (Miller 1991), the low rate of calf production in 1990 does not even begin to approach the almost total lack of calves during the severely environmentally impacted calving season in 1974 (Gauthier 1975, Parker et al. 1975, Fischer and Duncan 1976, Miller et al. 1977a).

The shedding of hard antlers (previous year's growth) by breeding cows was not well synchronized with calving, especially the peak calving period (Table 11, App. 4). Ninety percent of the breeding cows had cast both (ca. 84%) or one (ca. 6%) of their hard antlers before 17 June 1990, when about only 46 out of every 100 of those cows had calves at heel. Subsequently, essentially all (ca. 97%) of the breeding cows were without hard antlers before 27 June and no cows were seen after 6 July that still retained hard antlers.

Bathurst Island. Not a single newborn calf occurred among the 69 caribou segregated by sex/ age on 31 May and 1 June 1990 (Tables 1, 9 and 10). Although the helicopter was not available from 2 to 10 June, no calves were found among 21 caribou seen by ground observers in the vicinity of the CWS base camp. By 11 June, when the helicopter was again in use, only 3 (5.1%) of the 59 caribou segregated were newborn calves. Proportions of newborn calves among all caribou seen then rose slowly to 7.3% (3/41) on 13 June and averaged 11.6% (± 2.27% SE) between 15 and 27 June 1990. The helicopter was not available from 28 June to 6 July. By 7 July the proportion of calves among all caribou seen had risen to 19.5%, based on 6-7 July 1990 segregation counts. Unfortunately, no helicopter support was available after 10 July 1990 to further investigate calving in 1990.

Five western major satellite islands. Although calving on these five islands roughly paralleled that on Bathurst Island on a collective basis (Tables 1, 9 and 10), timing of calving, initial calf production, and early survival of calves varied noticeably among the five satellite islands (and Bathurst Island, on a six-island comparison basis).

Proportional representation of calves among all caribou seen was highest on Massey Island and ranged from 20.4% (9/44) on 15 June to 29.2% (21/72) on 23 June to 26.8% (15/56) on 8 July 1990. Calving also appeared to proceed faster here than elsewhere within the BIC. On 15 June 1990, 9 (37.5%) of the 24 breeding cows seen on Massey Island had newborn calves at heel, 21 (80.8%) of 26 cows had calves with them on 23 June; and 15 (88.2%) of 17 cows were accompanied by calves on 8 July. Ratios of calves:100 1+ yr-old females were ca. 26, 41, and 39, respectively, during the same time period. Early survival of calves on Massey Island appeared to decline insignificantly by ca. 8% on a percentage basis and only by ca. 3% based on changes in the ratios of calves:100 1+ yr-old females between 23 June and 8 July 1990. Ratios of calves:100 breeding cows during the same time period suggest, however, that no decline occurred and that successful calving actually continued on Massey Island after 23 June 1990 (based mainly on the fact that no juvenile/ yearling females were ever seen with a calf at heel during any of the three search periods). The above findings indicate that calving on Massey Island had peaked before 23 June 1990, while calving by that date on the other satellite islands, and on Bathurst Island, was still advancing towards the halfway point (Tables 9 and 10). Observed maximum calf production on a percentage basis was greater on Massey Island than on other islands where calves were seen within the BIC: being over 3.6 times that on Ile Vanier; by over 2.0 times that on Alexander Island; and 1.5 times that on Bathurst Island ($X^2 = 13.74$, 3df; $P < 0.005$).

The maximum rate of calves:100 breeding cows was highest on Massey Island (88.2): exceeding that on Ile Vanier (44.4) by nearly 100%; Bathurst Island (71.5) by 23%; and Alexander Island (84.2) by only 5%. The maximum ratios of calves:100 1+ yr-old females was also highest on Massey Island (41.2): exceeding that on Ile Vanier (22.2) by 86%; Alexander Island (27.6) by 49%; and Bathurst Island (37.8) by only 9%.

Thus, calving in 1990 appeared earlier and more successful on Massey Island than on any of the other satellite islands or Bathurst Island. This apparent significant difference was not well supported, however, by the comparison of maximum ratios of calves:100 breeding cows or calves:100 1+ yr-old females among those four islands. The significant difference of calves:100 breeding cows ($X^2 = 15.96$, 3df; $P < 0.005$) only pertains because of the high (65%) contribution to the Chi-square by the low maximum rate of calves:100 breeding cows on Ile Vanier (44.4). When the comparison of maximum ratios of calves:100 breeding cows was restricted to Massey, Alexander, and Bathurst islands, no significant difference was obtained ($X^2 = 1.90$, 2df; $P > 0.1$). Also, no significant difference exists among the maximum ratios of calves:100 1+ yr-old females on all four islands ($X^2 = 6.07$, 3df; $P > 0.05$), even though Ile Vanier contributed 43% to the value of the Chi-square.

No newborn calves were among the 16 caribou seen on Alexander Island on 15 June 1990 (App. 1). By 23 June, only ca. 5% (2) of the 43 caribou seen on Alexander Island were newborn calves. The maximum percentage of calves among all caribou (113) on Alexander Island was 14.2% (16) on 8 July. None of the breeding cows seen on Alexander Island on 15 June 1990 had a calf at heel; 2 of 4 cows had calves at heel on 23 June; and 16 (84.2%) of 19 cows were accompanied by calves on 8 July. Ratios of calves:100 1+ yr-old females ranged from ca. 18 (2/11) on 23 June to ca. 28 (16/58) on 8 July 1990.

Changes in the numbers of calves and cows (as well as all other caribou) on Alexander Island during June-July 1990, seemingly, mainly reflects late June movements of cow-calf pairs (and possibly associated social group members) from Massey Island to Alexander Island. The increased number of caribou on Alexander Island in early July 1990 possibly could have resulted from more complex inter-island movements among Vanier, Massey, northwestern Bathurst, and Alexander islands.

Any measure of early mortality of calves on Alexander Island is confounded by the percentage of calves and ratios of calves to breeding cows or to 1+ yr-old females each increasing over time with each subsequent search from June into early July 1990. It appears that the low percentage of calves (and thus the apparent low production of calves) was mostly a reflection of the high representation of juvenile/yearling females (ca. 40% of all 1+ yr-olds) on Alexander Island, none of which was accompanied by a calf. On the basis of ca. 84 calves:100 breeding cows on Alexander Island on 8 July 1990, both the initial calf production and early survival of calves must be considered relatively successful. The fact that apparently no juvenile or yearling females contributed to calf production in 1990, detracts somewhat from this tentative conclusion. It appears that the major problem lies in the fact that only ca. 28% of all 58 1+ yr-old females observed on 8 July had calves at heel (or had produced calves) in 1990, based on the assumption that about 70% of all 1+ yr-old females are expected to be producers in a typical year(e.g., Dauphine 1976).

Percentages of calves among all caribou on Ile Vanier were low and varied markedly in 1990: 8% of 50 caribou seen on 17 June; no calves or female caribou were seen among 11 caribou on 24 June; and ca. 7% of 43 caribou seen on 10 July. Four of the nine breeding cows seen on Ile Vanier had calves at heel on 17 June; and only 3 of 8 cows were still accompanied by calves on 10 July 1990.

It appears that calf production was poor on Ile Vanier in 1990. It is likely that unfavourable snow-ice conditions caused most cows and their associated group members to leave Ile Vanier in late June in search of better foraging conditions. Although there is no direct evidence for the assumed movement, the probability is supported by the fact that the 24 June helicopter search of Ile Vanier was intensive and approached 100% coverage. The general lack of caribou, especially females, appeared real (and it is my opinion that we did not miss any significant number of caribou on Ile Vanier during the 24 June 1990 helicopter search). I believe that the return of observed caribou to nearly equal numbers and composition on 10 July as seen on 17 June 1990 can best be explained by subsequent reversal of movements (most likely by the same caribou) to Ile Vanier in late June 1990.

No cows (or calves) were seen on Cameron Island or Ile Marc during any of the three search periods in June-July 1990 (App. 1). This condition is consistent with findings for those islands during the same temporal period in 1985 (Miller 1987a), 1988 (Miller 1989) and 1989 (Miller 1991).

Interpretation of initial calf production and early survival of calves in June-July 1990 is complicated by the sometimes highly skewed sex/age composition of the various samples both on an island-basis and between or among islands. Therefore, the most feasible approach to analyzing these results in more detail appears to be by first applying a given set of assumptions applicable to the entire BIC caribou population.

(1) **Assumption 1**. That the 36 males:64 females among the 709 1+ yr-old

caribou sampled within the BIC, 8-10 July 1990, is an accurate representation of the sex structure of the BIC inter-island population of caribou.

(2) Assumption 2. That we can expect ca. 70% of all 1+ yr-old females to, at least, be pregnant if not produce calves in an average year (based on literature for barren-ground caribou (R. t. groenlandicus) e.g., Dauphine 1976).

(3) Assumption 3. That all caribou (100%) identified as "breeding cows" during May-July of the year were indeed bred and that each subsequently lost their fetus, produced a nonviable offspring, or produced a viable neonate. (A corollary to this assumption is that adult cows who were not successfully bred the previous autumn would not appear as adult cows in the next spring and would thus be classified as juvenile females, especially females just "coming of age", because of their better general appearance, advanced new antler growth, and no obviously distended udder.)

The above set of three assumptions allows a reevaluation of calving by caribou within the BIC in 1990 as follows.

Based on the above assumptions it appears that (1) ca. 40% of the potential maximum production of calves within the BIC did not occur in 1990 (no dead calves were found) (2) ca. 27% of the breeding cows either did not produce calves (bring fetuses to full-term) in 1990 or had lost their calves by 10 July 1990; and (3) only half (50%) of the maximum potential production and early survival of calves among all 1+ yr-old females was realized in June-July 1990.

Although much of the calving appeared late in 1990 (after 27 June on Bathurst Island), the time lapse between subsequent calving and 6-10 July was likely great enough for all initial and essentially all early calf mortality to have taken place. This assumption is based on the related literature that indicates that essentially all early mortality of caribou calves occurs within the first few hours or days of life (e.g., Zhigunov (1961), Miller and Broughton (1974), Baskin (1983), Mauer et al. (1983), Whitten et al. (1984), and Miller et al. (1988).

The following tentative conclusions can be drawn on an island-basis.

Bathurst Island. On Bathurst Island it appears that (1) only ca. 63% (19.5/31.0) of the maximum potential calf production occurred in 1990 or 37% was lost by 7 July 1990; (2) ca. 29% (100.0 - 71.5/100.0) of the breeding cows either never produced calves in 1990 or lost their newborn offspring by 7 July 1990; and (3) only 54% of the maximum potential reproduction and early survival of calves for all 1+ yr-old females was realized as of 7 July 1990.

Massey Island. On Massey Island the apparent high maximum production of calves (29.2%) obtained on 23 June 1990 must be adjusted to compensate for the missing male segment by assuming that the 51 1+ yr-old females should equal 64% of the sample of 1+ yr-old caribou. Therefore, the adjusted sample size becomes 101 (51/0.64 + 21 calves) and the proportion of calves is reduced by ca. 29% to only 20.8% of all caribou on Massey Island on 23 June 1990 (which is more similar to the maximum proportion of calves on Bathurst Island on 7 July 1990). Thus, we must assume that ca. 33% (31.0 - 20.8/31.0) of the maximum potential calf production also either did not occur before 23 June in 1990 or some unknown portion beyond 33% was produced and lost before that date. When the sample of 56 caribou, 26.8% calves, seen on Massey Island on 8 July 1990 is adjusted for the missing male segment to 76 (39/0.64 + 15 calves) the percent calves drops to 19.7% (essentially equal to that for Bathurst Island on 7 July 1990). This condition suggests that only ca. 5% early mortality of calves occurred between 23 June and 8 July 1990 on Massey Island. Production or survival of calves among breeding cows on Massey Island was more favourable than elsewhere at only ca. 12% loss (100.0 - 88.2/100.0). But only 59% (41.2/70.0) of the maximum potential calf production and early survival for all 51 1+ yr-old females was realized on Massey Island by 23 June 1990. This value dropped to 55% (38.5/70.0) of the 39 1+ yr-old females seen on Massey Island on 8 July 1990, suggesting a calf loss of only ca. 7% between 23 June and 8 July 1990.

<u>Alexander Island.</u> When the 58 1+ yr-old females seen on Alexander Island on 8 July 1990 are adjusted to compensate for missing males the adjusted sample size is reduced by ca. 5% to 107 (58/0.64 + 16 calves). Therefore, the observed 14.2% calves is slightly increased to 15%. This suggests that about half (52%) of the maximum potential calf production on Alexander Island in 1990 either did not occur or was lost. Production or survival of calves among breeding females was, however, relatively high compared to that for Bathurst Island and Ile Vanier. Only ca. 16% (100.0 - 84.2/100.0) of the breeding cows either never produced calves or lost them by 8 July 1990: 90% higher than on Ile Vanier; ca. 18% higher than on Bathurst Island; and only ca. 5% lower than on Massey Island. However, only ca. 39% of the potential maximum calf production and early survival of calves for all 58 1+ y-old females was realized on Alexander Island in early July 1990.

<u>Ile Vanier.</u> Unlike the other islands where calves were seen, the highest representation of calves on Ile Vanier occurred on 17 June 1990. Representation of 1+ yr-old females was markedly low at 39% (18/46). Adjustment of that sample size to equal 64% results in an adjusted sample size of only 32 (18/0.64 + 4 calves). Thus, the value of 8% calves is increased to 12.5% (4/32) calves (only slightly less (17%) than the proportion of calves on Alexander Island on 8 July 1990). This condition suggests that 60% (31.0 - 12.5/31.0) of the potential maximum calf production on Ile Vanier either never occurred or was lost by 17 June 1990. When the 10 July sample was used for Ile Vanier, the adjusted sample size became 36 (21/0.64 + 3 calves) and yielded only ca 8% calves, suggesting that only ca. 26% of the potential maximum survival of calves was realized on Ile Vanier by 10 July 1990. In turn, it appears that on Ile Vanier, 56-62% (100.0 - 44.4, 17 June; and 100.0 - 37.5, 10 July) of the breeding cows, and 69-80% (70.0 - 22.2/70.0, 17 June; and 70.0 - 14.3/70.0, 10 July) of the 1+ yr-old females either had not produced

calves or had lost their calves by 10 July 1990.

2. Ground Activities

2.1. Snow depth measurements

Snow depth measurements (including zero values) were obtained from 7866 sample sites at 71 sampling stations along the 7.5-km and 1-km snow/ice courses during May-June 1990. Sampling effort on both the 7.5-km and 1-km snow/ice courses was governed mainly by noticeably marked changes in prevailing weather or the snow pack (e.g., continual positive and especially increasingly high ambient temperatures; prolonged marked changes in wind velocity or prolonged major directional changes in prevailing winds; and increasing wetness or settling (compaction) of the snow cover). Only 13 of the 71 snow/ice stations were entirely snow-free and terminated by 22 June 1990 (App. 5 and 6). By 21 June, however, the snow cover was in an advanced state of deterioration and travel by snowmobile or on foot was difficult and could not be done without marring the landscape. Therefore, I arbitrarily decided to terminate all sampling stations when the mean value of snow depth for all nine sample sites became 10 cm or less. By 24 June, travel became most difficult with standing water turning the thawed ground to ooze on most areas; therefore, I decided to terminate all remaining stations regardless of the amount of snow cover persisting on each.

7.5-km Snow/ice Course. Snow depths (n = 2700) were measured, or recorded as zero values, on 10 different days at all 30 stations (270 sample sites) from 28 May to 25 June 1990 (Table 12). Time intervals between samples averaged 3.1 d (±1.73 d, SD) and ranged from 1 to 7 d. Snow cover on the 7.5-km course was highly variable, both within the sets of 9 sample sites at each of the stations and among all sample sites at all stations. Where snow cover persisted on individual sample sites, it averaged 22-31 cm and ranged from 1 to 100 cm in depth during the 28 May-16 June period (Table 12).

When the 7.5-km snow/ice course was first sampled on 28 May 1990 all but one of the 270 sample sites at the 30 stations were snow- covered (Table 12). Snow-free sample sites then increased to ca. 11% by 4 June. Fresh snowfalls and major shifts in the directions of prevailing winds caused a reduction in snow-free sample sites to ca. 7% by 7 June and ca. 2% by 11 June. Percentages of snow-free sample sites increased to ca. 13% by 14 June and 18% by 16 June. By 20 June ca. 27% of the sample sites were snow-free. After 22 June 1990, the temporal aspect of naturally occurring snow-free sample sites could not be accurately tracked at each station because of the need for altering the sampling procedures (i.e., most stations were terminated from 22 to 25 June while some or all of the sample sites at each of those stations were still snow-covered).

Only seven stations on the 7.5-km snow/ice course became entirely snow-free and were terminated before 22 June 1990 (App. 5). On 22 June, 16 more stations were terminated: 5 were entirely snow-free; 7 were still partially snow-covered (5-8 snow-free sample sites each); and 4 still each had all 9 sample sites snow-covered. Six of the remaining 7 stations were closed out on 24 June, 3 were partially snow-covered (2-7 snow-free sample sites each), and 3 were still entirely snow-covered. The last station was still entirely snow-covered when terminated on 25 June 1990.

1-km Snow/ice Course. Snow depths (n = 5166) were measured, or recorded as zero values, on 14 different days at all 41 stations (369 sample sites) from 2 to 25 June 1990 (Table 13). Time intervals between samples averaged 1.8 d (± 0.55 d, SD) and ranged from 1 to 3 d. As on the 7.5-km course, snow cover on the 1-km course was highly variable both within sample site sets and among all stations. Where snow cover persisted on individual sample sites, it averaged 19-26 cm and ranged from 1 to 97 cm during the 2-19 June period (Table 13).

The 1-km snow/ice course was established to permit more intensive sampling of the then prevailing snow cover and any subsequent formation of ground fast ice. The 1-km course was located on the coastal slope about midway between the seacoast and the first rise of high ground toward the interior of the island. When the 1-km course was first sampled on 2 June, all but one of the 369 sample sites at the 41 stations were snow-covered (Table 13). Snow-free sample sites then increased to ca. 3% for the 2-4 June period. Fresh snowfalls and major changes in the directions of prevailing winds caused a reduction in snow-free sample sites to ca. 2% by 8 June and none (0%) by 10 June. Percentages of snow-free sample sites then increased slowly to ca. 2% by 13 June and 4% by 15 June. It was 17 June before ca. 12% of the sample sites were snow-free. Snow-free sample sites then increased more rapidly from ca. 22% on 19 June to 46% by 21 June. The temporal aspect of naturally occurring snow-free sample sites could not be accurately tracked at each station after 21 June because of the need for altering the sample procedures (i.e., most stations were terminated from 21 to 25 June while some or all of the sample sites at each of those stations were still snow-covered).

Only six stations on the 1-km course became entirely snow-free and were terminated before 21 June 1990 (App. 6). On 21 June, 24 more stations were terminated: 8 were entirely snow-free; 11 were still partially snow covered (1-8 snow-free sample sites each); and 5 still each had all 9 sample sites snow-covered. Three additional partially snow-covered stations (1-7 snow-free sample sites each) were terminated on 23 June. Four of the remaining eight stations were closed out on 24 June (3 were partially snow-covered with only 2-5 snow-free sample sites on each and one was totally snow-covered). The last four stations were still entirely snow-covered when terminated on 25 June 1990.

2.2. Patterns of snow obliteration

Obliteration of the snow cover along the 1-km snow/ice course was determined by exact measurements along each of the 40 25-m segments between the centres of each pair of stations on 21 different days from 28 May to 1 July 1990 (Tables 14 and 15, App. 7 and 8). The 1-km course was 100% snow covered on 28 May 1990 (Table 14). Snow cover then remained greater than 92% until 15 June, being reduced only slightly during the first week and returning to 100% on 10 June (due to fresh snowfalls and major directional shifts in the then prevailing winds). The snow cover on the 1-km course then began to deteriorate more rapidly during the third week of June with the onset of continual positive temperatures. On 21 June, however, the 1-km course was still ca. 55% snow-covered. The obliteration of the snow cover on the 1-km course continued throughout June to 1 July 1990 but was greater than 90% complete by 27 June (Table 14).

Considerable variation in the patterns of snow cover ablation occurred among the 40 25-m segments (Table 15). No one segment was completely snow-free until 17 June 1990, when the first and only one became so. Subsequently, only six (15%) of the 25-m segments were completely snow-free by 21 June. The number of totally snow-free 25-m segments then increased rapidly to 24 (60%) by 24 June, 34 (85%) on 27 June, and all 40 on 1 July 1990.

2.3. Ground fast ice measurements

<u>7.5-km Snow/ice Course</u>. The formation of ground fast ice occurred at 56.7% of the 30 stations and 40.4% of the 270 sample sites in June 1990 (Table 16, App. 5). No ground fast ice was found at any of the seven stations (63 sample sites) that became totally snow-free on or before 20 June 1990. Ground fast ice was detected after that date, however, at 73.9% (17) and 52.6% (109) of the remaining 23 stations and 207 sample sites, respectively. Ground fast ice averaged 5.6 ± 3.23 cm (SD) and ranged from 1 to 19 cm in thickness (Table 16).

<u>1-km Snow/ice Course</u>. The formation of ground fast ice occurred at 70.7% of the 41 stations and 59.1% of the 369 sample sites in June 1990 (Table 17, App. 6). No ground fast ice was found at any of the six stations (54 sample sites) that became totally snow-free on or before 19 June 1990. Ground fast ice was detected after that date, however, at 82.8% (29) and 69.2% (218) of the remaining 35 stations and 207 sample sites, respectively. Ground fast ice averaged 5.2 cm ± 2.51 cm (SD) and ranged from 1 to 12 cm in thickness (Table 17).

2.4. On-site weather data

Empirically, it appeared that the season was late with large snow-covered areas persisting into late June. Light to moderate snowfalls occurred on 4 days between 1-15 June 1990. Essentially no rainfall occurred throughout June, with only a trace amount falling on 30 June. Then, ca. 10 mm of rain fell between 1-27 July 1990: trace amounts on 9 days; and measurable amounts on only 18 July (1.0 mm), 20 July (5.0 mm), 24 July (1.0 mm), and 25 July (2.5 mm).

Mean temperatures remained below 0°C until 15 June 1990, with only two exceptions (App. 9). During that period, maximum temperatures remained in the negative range until 19 June 1990, with one exception (17 June). All temperatures remained in the positive range from 20 June to the end of the field season on 27 July 1990. The extreme maximum and highest mean temperatures occurred on 17 July 1990, but the highest minimum temperature occurred on 7 July.

2.5. Off-site weather data

Monthly average maximum, minimum, and mean temperatures paralleled each other at Mould Bay and Resolute Bay throughout June 1989 to June 1990 (Table 18). Monthly extreme highs ran slightly lower at Resolute Bay than at Mould Bay throughout that period. Monthly extreme lows showed slightly more variation between the two stations (Table 18). Extreme lows were slightly stronger from July to October 1989 at Resolute Bay; then, switched to Mould Bay during November 1989 through February 1990; and again reversed to Resolute Bay for March through June 1990.

The total snowfall from September 1989 through June 1990 at Resolute Bay (138.0 cm) exceeded that at Mould Bay (99.8 cm) by 38.3% (Table 19). Although the monthly snowfall at Resolute Bay in September 1989 was 3.6 times greater than at Mould Bay in that month, subsequent monthly snowfalls at Mould Bay slightly exceeded those at Resolute Bay from October 1989 through February 1990. The pattern then reversed itself and monthly snowfalls from March through June 1990 at Resolute Bay exceeded those at Mould Bay. Total snowfall in May 1990 was low but two times greater than that at Mould Bay. The monthly snowfall at Resolute Bay in June 1990 was relatively high and far exceeded that at Mould Bay by 7.2 times.

The exceptionally heavy snowfalls of September and early October 1989 at Resolute Bay were associated with periods of freezing rain on 5 days. On 13 and 14 September 0.4 mm and a trace of freezing rain fell in association with 3.4 and 8.6 cm of snowfall, respectively. Both traces of rain and snow occurred on 20 September. Then on 1 and 2 October, traces of freezing rain occurred along with 0.8 and 0.2 cm of snowfall, respectively.

It is credible that a combination of seasonally, early (Sep-Oct) deep snow cover and likely ice layering in that snow cover could have in some way directly hindered the success of the rut in autumn 1989. It is also probable that the seasonally heavy snowfall in early winter (1989-90) and icing in the snow cover markedly restricted forage availability or seriously increased the energy requirements for forage intake throughout the winter of 1989-90. The environmental stress resulting from those unfavourable snow/ice conditions could have stressed pregnant females to the point of in-utero complications, loss of fetuses, premature births, stillbirths, or the production of otherwise nonviable neonates in spring 1990. That the 1990 calving period was both detectably late and relatively poor in terms of overall apparent initial calf production argues strongly for some form of prolonged environmental stress over, at least, the winter of 1989-90 impacting on the pregnant cows. The possibility of direct influence on the success of the rut in 1989 cannot, however, be ruled out at this time.

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Table 1. Grouped sex/age segregation counts of Peary caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990

Date (month/day)	Sex/age composition: Bulls	Cows	Calves	Juv.[a] males	Juv. females	Yrl.[a] males	Yrl. females	N	Search effort (min)	Caribou sighted ($\cdot 100\ min^{-2}$)
Bathurst Island										
05/31-06/01	12	15	0	11	12	10	9	69	713	9.7
06/11-06/13	10	51	6	0	19	1	13	100	530	18.9
06/15-06/17	12	61	20	2	28	4	8	135	299	45.2
06/22-06/24	84	67	22	31	41	31	29	305	611	49.9
06/27	66	73	36	19	32	24	31	281	387	72.6
07/06-07/07	108	179	128	46	101	34	59	655	920	71.2
Vanier, Cameron, Alexander, Massey, and Marc										
06/15-06/17	26	41	13	12	31	13	2	138	310	44.5
06/23-06/24	20	30	23	13	16	11	18	131	417	31.4
07/08-07/10	38	44	34	19	38	7	36	216	498	44.5
Helena and Sherard Osborn islands										
06/24	12	5	2	4	5	3	3	34	80	42.5

Continued

Table 1. Continued

Date (month/day)	Sex/age composition Bulls	Cows	Calves	Juv.[a] males	Juv. females	Yrl.[a] males	Yrl. females	N	Search effort (min)	Caribou sighted (· 100 min^{-2})
Bathurst Island plus five western satellite islands										
06/15-06/17	38	102	33	14	59	17	10	273	609	44.8
06/22-06/24	104	97	45	44	57	42	47	436	1045	41.7
06/22-06/24[b]	116	102	47	48	62	45	50	470	1108	42.4
07/06-07/10	146	223	162	65	139	41	95	871	1418	61.4

[a] Juv. equals juvenile animals and Yrl. equals yearling animals.
[b] Includes Bathurst, Vanier, Cameron, Alexander, Massey, Marc, plus Helena and Sherard Osborn islands.

Table 2. Approximation of sex/age composition of "precalving" and "postcalving" populations of Peary caribou within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, based on segregation counts obtained from 6-10 July 1990 during nonsystematic helicopter searches

		% sex/age composition			
Search area	N	Bulls	Cows	Calves	Juvenile/ Yearlings
Precalving					
Bathurst Island	527	20.5	34.0	-	45.5
Five western major satellite islands	182	20.9	24.2	-	54.9
Bathurst island complex	709	20.6	31.5	-	47.9
Postcalving					
Bathurst Island	655	16.5	27.3	19.5	36.6
Five western major satellite islands	216	17.6	20.4	15.7	46.3
Bathurst island complex	871	16.8	25.6	18.6	39.0

Table 3. Variation in sex/age counts, based on grouped samples[a] of individual Peary caribou (1+ yr-old), Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, 31 May-10 July 1990, data obtained by nonsystematic helicopter searches

Sex/age classes	Sample periods (N)	% sex/age composition Mean	± SD	95% CI	Range
Bathurst Island					
Bulls	6	19	8	11-27	10-30
Cows	6	36	14	22-50	22-54
Juvenile/yearlings	6	45	9	35-54	35-61
Five western major satellite islands					
Bulls	3	20	1	18-23	19-21
Cows	3	28	4	20-36	24-33
Juvenile/yearlings	3	52	5	43-60	46-55
Bathurst Island complex					
Bulls	3	21	5	11-31	16-27
Cows	3	33	9	17-49	25-43
Juvenile/yearlings	3	46	4	39-53	42-49

[a] Sample sizes of number of individuals involved by each grouped sample are given in Table 1.

Table 4. Frequency of occurrence of Peary caribou in 11 search zones during six periods of sampling, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Zone[a] by sampling period (month/day)	Number of different caribou sighted	Time spent searching (min)	Frequency of occurrence caribou (· 100 min^{-1})
05/31-06/01			
NEC	9	77	11.7
NEI	16	210	7.6
SEC	12	101	11.9
SEI	3	65	4.6
SC	29	170	17.0
SWC	0	15	0.0
NWC	0	60	0.0
NCE	0	15	0.0
06/11-06/13			
NEC	18	117	15.4
NEI	4	28	14.3
NCW	39	160	24.4
NCE	11	50	22.0
06/15-06/17			
NEC	35	55	63.6
NEI	19	44	43.2
NWC	0	20	0.0
NWI	7	20	35.0
NCW	8	40	20.0
NCE	66	120	55.0

Continued

Table 4. Continued

Zone[a] by sampling period (month/day)	Number of different caribou sighted	Time spent searching (min)	Frequency of occurrence caribou (· 100 min^{-1})
06/22-06/24			
NEC	85	93	91.4
NEI	57	116	49.1
SEC	24	45	53.3
SEI	8	38	21.0
SC	21	55	38.2
NWC	78	147	53.1
NWI	14	56	25.0
NCE	18	61	29.5
06/27			
NEC	86	56	153.6
NEI	44	89	49.4
SEC	25	43	58.1
SEI	0	10	0.0
SC	18	23	78.3
SWC	0	8	0.0
SWI	2	44	4.5
NWC	44	23	191.3
NWI	23	35	65.7
NCE	39	56	69.6
07/06-07/07			
NEC	91	89	102.2
NEI	143	182	78.6
SEC	11	57	19.3

Continued

Table 4. Continued

Zone[a] by sampling period (month/day)	Number of different caribou sighted	Time spent searching (min)	Frequency of occurrence caribou (· 100 min^{-1})
SEI	24	32	75.0
SC	7	31	22.6
SWC	16	62	25.8
SWI	0	24	0.0
NWC	41	85	48.2
NWI	22	69	31.9
NCW	135	167	80.8
NCE	165	122	135.2

[a] Search zones equal (1) northeast coast (NEC), (2) northeast interior (NEI), (3) southeast coast (SEC), (4) southeast interior (SEI), (5) south coast (SC), (6) southwest coast (SWC), (7) southwest interior (SWI), (8) northwest coast (NWC), (9) northwest interior (NWI), (10) north coast, western section (NCW), and (11) north coast, eastern section (NCE).

Table 5. Frequency of occurrence of Peary caribou by major land divisions during six sampling periods, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Major divisions by sampling period (month/day)	Number of different caribou sighted	Time spent searching (min)	Frequency of occurrence caribou (· 100 min^{-1})
05/31-06/01			
Coastal vs.	50	438	11.4
interior	19	275	6.9
North vs.	25	362	9.5
south	44	351	12.5
East vs.	55	553	9.9
west	14	160	8.8
06/11-06/13			
Coastal vs.	96	502	19.1
interior	4	28	14.3
North vs.	72	355	20.3
south	28	175	16.0
East vs.	51	288	17.7
west	49	242	20.2
06/15-06/17			
Coastal vs.	109	235	46.4
interior	26	64	40.6
North vs.	135	299	45.2
south	0	0	0.0
East vs.	120	219	54.8
west	15	80	18.8

Continued

Table 5. Continued

Major divisions by sampling period (month/day)	Number of different caribou sighted	Time spent searching (min)	Frequency of occurrence caribou (· 100 min^{-1})
06/22-06/24			
Coastal vs.	226	401	56.4
interior	79	210	37.6
south	53	138	38.4
East vs.	203	381	53.3
west	102	230	44.3
06/27			
Coastal vs.	212	209	101.4
interior	69	178	38.8
North vs.	236	259	91.1
south	45	128	35.2
East vs.	203	266	76.3
west	78	121	64.5
07/06-07/07			
Coastal vs.	466	613	76.0
interior	189	307	61.6
North vs.	597	714	83.6
south	58	206	28.2
East vs.	438	498	88.0
west	217	422	51.4

Table 6. Frequency of occurrence of Peary caribou on the five western major satellite islands of Vanier, Cameron, Alexander, Massey, and Marc during three sampling periods, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, June-July 1990, data obtained by nonsystematic helicopter searches

Island by sampling period (month/day)	Number of different caribou sighted	Time spent searching (min)	Frequency of occurrence caribou (· 100 min^{-1})
06/15			
Alexander	16	55	29.1
Massey	44	97	45.4
Marc	15	16	93.8
06/17			
Vanier	50	92	54.3
Cameron	13	50	26.0
06/23			
Alexander	43	56	76.8
Massey	72	129	55.8
Marc	5	20	25.0
06/24			
Vanier	11	202	5.4
Cameron	0	10	0.0
07/07			
Alexander	113	107	105.6
Massey	56	91	61.5
Marc	2	13	15.4
07/10			
Vanier	43	160	26.9
Cameron	2	127	1.6

Table 7. Group statistics by search period for Peary caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Search period (month/day)	Group type	Group statistics				
		N	Mean	± SD	Range	95% CI
05/31-06/01	Male-only groups	9	3.1	1.96	2- 8	1.60-4.62
	All mixed sex/age groups	11	3.3	1.74	2- 7	2.11-4.44
	Mixed sex/age groups with calves					
	calves included	0				
	calves excluded	0				
	Mixed sex/age groups without calves	11				
	solitary individuals	5				
06/11-06/13	Male-only groups	0				
	All mixed sex/age groups	28	3.2	0.90	2- 5	2.83-3.53
	Mixed sex/age groups with calves					
	calves included	4	3.3	0.96	2- 4	1.73-4.77
	calves excluded	4	1.8	0.50	1- 2	0.95-2.55
	Mixed sex/age groups without calves	24	3.2	0.92	2- 5	2.78-3.55
	Solitary individuals	11				

Continued

Table 7. Continued

Search period (month/day)	Group type	N	Mean	± SD	Range	95% CI
		Group statistics				
06/15-06/17	Male-only groups	16	3.4	1.03	2- 5	2.89-3.99
	All mixed sex/age groups	63	3.2	1.53	2-10	2.81-3.57
	Mixed sex/age groups with calves					
	calves included	26	3.0	1.85	2-10	2.25-3.75
	calves excluded	26	1.7	1.40	1- 7	1.16-2.30
	Mixed sex/age groups without calves	37	3.3	1.27	2- 8	2.91-3.73
	Solitary individuals	17				
06/22-06/24	Male-only groups	54	3.3	1.85	2-10	2.79-3.77
	All mixed sex/age groups	69	3.8	2.45	2-13	3.23-4.39
	Mixed sex/age groups with calves					
	calves included	27	4.6	3.17	2-13	3.34-5.85
	calves excluded	27	2.9	1.99	1- 8	2.06-3.64
	Mixed sex/age groups without calves	42	3.3	1.70	2-10	2.79-3.82
	Solitary individuals	30				

Continued

Table 7. Continued

Search period (month/day)	Group type	N	Mean	± SD	Range	95% CI
		Group statistics				
06/27	Male-only groups	24	3.4	1.56	2- 7	2.72-4.03
	All mixed sex/age groups	50	3.7	1.80	2- 9	3.16-4.16
	Mixed sex/age groups with calves					
	calves included	26	3.9	1.94	2- 9	3.14-4.71
	calves excluded	26	2.5	1.73	1- 7	1.84-3.24
	Mixed sex/age groups without calves	24	3.4	1.64	2- 7	2.68-4.07
	Solitary individuals	17				
07/06-07/10	Male-only groups	56	3.8	1.55	2- 8	3.40-4.21
	All mixed sex/age groups	95	6.7	4.17	2-23	5.82-7.50
	Mixed sex/age groups with calves					
	calves included	60	8.1	4.45	2-23	6.94-9.19
	calves excluded	60	5.4	3.16	1-16	4.57-6.17
	Mixed sex/age groups without calves	35	4.3	2.08	2-11	3.57-4.95
	Solitary individuals	25				

Table 8. Group statistics for Peary caribou seen during the 6-10 July 1990 search period, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, data obtained by nonsystematic helicopter searches

		Group statistics				
Island	Group type	N	Mean	± SD	Range	95% CI
Bathurst	Male-only groups	42	4.0	1.59	2- 8	3.52-4.48
	All mixed sex/age groups	71	6.7	4.03	2-23	5.72-7.60
	Mixed sex/age groups with calves					
	calves included	49	7.9	4.20	2-23	6.68-9.03
	calves excluded	49	5.2	3.04	1-16	4.39-6.10
	Mixed sex/age groups without calves	22	4.0	1.77	2- 8	3.21-4.79
	Solitary individuals	14				
Alexander	Male-only groups	8	4.1	0.99	2- 5	3.30-4.95
	All mixed sex/age groups	10	7.6	4.74	3-17	4.21-10.99
	Mixed sex/age groups with calves					
	calves included	4	10.8	5.62	6-17	1.81-19.69
	calves excluded	4	6.8	3.30	3-10	1.49-12.01
	Mixed sex/age groups without calves	6	5.5	2.88	3-11	2.48-8.52
	Solitary individuals	4				

Continued

Table 8. Continued

Island	Group type	N	Mean	± SD	Range	95% CI
		Group statistics				
Marc	Male-only groups	1	2.0	0.00	2- 2	2.00-2.00
	All mixed sex/age groups	0				
	Mixed sex/age groups with calves					
	calves included	0				
	calves excluded	0				
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				
Massey	Male-only groups	0				
	All mixed sex/age groups	7	7.7	6.02	2-17	2.15-13.28
	Mixed sex/age groups with calves					
	calves included	5	10.0	5.61	4-17	3.03-16.97
	calves excluded	5	7.0	3.87	3-12	2.19-11.81
	Mixed sex/age groups without calves	2	2.0	0.00	2- 2	2.00-2.00
	Solitary individuals	2				

Continued

Table 8. Continued

Island	Group type	Group statistics N	Mean	± SD	Range	95% CI
Vanier	Male-only groups	4	2.0	0.00	2- 2	2.00-2.00
	All mixed sex/age groups	7	4.3	1.98	2- 7	2.46- 6.11
	Mixed sex/age groups with calves					
	calves included	2	3.0	1.41	2- 4	-9.71-15.71
	calves excluded	2	1.5	0.71	1- 2	-4.85- 7.85
	Mixed sex/age groups without calves	5	4.8	2.05	3- 7	2.26- 7.34
	Solitary individuals	5				
Cameron	Male-only groups	1	2.0	0.00	2- 2	2.00-2.00
	All mixed sex/age groups	0				
	Mixed sex/age groups with calves					
	calves included	0				
	calves excluded	0				
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				

Table 9. Percent "breeding cows", percent "1+ yr-old females", and associated chronology of "calf:female ratios" for Peary caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Date (month/day)	N	Females of % of N: Breeding cows	Females of % of N: 1+ yr-old females	Calves:100 breeding cows	Calves:100 1+ yr-old females
Bathurst Island					
05/31-06/01	69	21.7	52.2	0.0	0.0
06/11-06/13	100	51.0	83.0	11.8	7.2
06/15-06/17	135	45.2	71.8	32.8	20.6
06/22-06/24	305	22.0	44.9	32.8	16.0
06/27	281	26.0	48.4	49.3	26.5
07/06-07/07	655	27.3	51.8	71.5	37.8
Vanier, Cameron, Alexander, Massey, and Marc islands					
06/15-06/17	138	29.7	53.6	31.7	17.6
06/23-06/24	131	22.9	48.9	76.7	35.9
07/08-07/10	216	20.4	54.6	77.3	28.8
06/15-06/17	273	37.4	62.6	32.4	19.3
06/22-06/24	436	22.2	46.1	46.4	22.4
06/22-06/24[b]	470	21.7	45.5	46.1	22.0
07/06-07/10	871	25.6	52.5	72.6	35.4

[a] Includes Bathurst, Vanier, Cameron, Alexander, Massey, Marc, plus Helena and Sherard Osborn islands.

Table 10. Chronology of observed and "adjusted[a]" proportions of newborn calves among all Peary caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Date (month/day)	N	% calves	Adjusted N	Adjusted % calves
Bathurst Island				
05/31-06/01	69	0.0	56	0.0
06/11-06/13	100	6.0	135	4.4
06/15-06/17	135	14.8	170	11.8
06/22-06/24	305	7.2	234	9.4
06/27	281	12.8	247	14.6
07/06-07/07	655	19.5	654	19.6
Vanier, Cameron, Alexander, Massey, and Marc islands				
06/15	138	9.4	128	10.2
06/23-06/24	131	17.6	122	18.8
07/08-07/10	216	15.7	217	15.7
06/15-06/17	273	12.1	298	11.1
06/22-06/24	436	10.3	357	12.6
06/22-06/24[b]	470	10.0	379	12.4
07/06-07/10	871	18.6	871	18.6

[a] Adjusted by assuming that the 64.46% 1+ yr-old females obtained in the grouped sex/age sample of 1+ yr-old caribou (457/709 = 0.6446) for caribou 6-10 July 1990 was the true proportion of 1+ yr-old females in the BIC.
[b] Includes Bathurst, Vanier, Cameron, Alexander, Massey, and Marc islands, plus Helena and Sherard Osborn islands.

Table 11. Chronology of hard antler casting by Peary caribou breeding cows, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Sampling period (month/day)	N	% that had cast both hard antlers	% that had cast one hard antler only	% with both hard antlers retained
05/31-06/01	15	6.7	0.0	93.3
06/13-06/17	153	83.7	6.5	9.8
06/22-06/27	175	96.0	0.6	3.4
07/06-07/10	223	100.0	0.0	0.0

Table 12. Statistics for snow depth measurements made on 7.5-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, May-June 1990

Date		Snow depth (cm)				
(month/day)	N	Mean	± SD	Minimum	Maximum	95% CI
05/28	30[a]	29.1	20.4	7.6	100.0[b]	21.5-36.7
	269[c]	29.2	20.2	4.0	100.0	26.8-31.6
06/04	27	28.4	22.2	6.4	100.0	19.6-37.2
	240	28.7	22.1	4.0	100.0	25.9-31.5
06/07	29	27.4	23.3	1.3	100.0	18.6-36.3
	252	28.4	23.0	1.0	100.0	25.5-31.2
06/11	30	30.4	22.3	3.7	100.0	22.1-38.7
	264	31.0	22.0	1.0	100.0	28.3-33.6
06/14	27	30.2	22.3	1.0	100.0	21.4-39.1
	236	31.1	21.8	1.0	100.0	28.3-33.9
06/16	25	29.8	22.0	3.6	100.00	20.7-38.9
	221	30.3	21.8	3.0	100.00	27.4-33.2
06/20	23	22.0	20.9	2.7	83.2	13.0-31.0
	198	22.8	20.8	1.0	86.0	19.9-25.7
06/22	19	19.4	24.5	1.0	73.8	7.6-31.2
	129	24.4	25.6	1.0	77.0	20.0-28.8

Continued

Table 12. Continued

Date (month/day)	N	Snow depth (cm) Mean	± SD	Minimum	Maximum	95% CI
06/24	7	13.7	13.1	1.0	32.8	1.6-25.9
	49	14.1	12.8	1.0	38.0	10.5-17.7
06/25	1	28.3	-	-	-	-
	9	28.3	3.9	19.0	32.0	25.4-31.3

[a] N equals the number of different stations sampled that were not entirely snow-free and the statistics are based on the mean of the summation of the mean of all snow-covered sites in each set of 9 sites at each station.
[b] One station (4.0 km north) had all 9 sites covered with 100 plus centimetres of snow and was recorded as 100 cm until the sites dropped below that value by 20 June 1990.
[c] N equals the total number of different sites sampled that were not entirely snow-free and the statistics are based on the summation of all snow-covered sites.

Table 13. Statistics for snow depth measurements made on 1-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, June 1990

Date		Snow depth (cm)				
(month/day)	N	Mean	± SD	Minimum	Maximum	95% CI
06/02	41[a]	20.6	15.0	1.0	78.3	15.9-25.3
	368[b]	20.6	15.1	1.0	83.0	19.1-22.2
06/03	40	20.9	15.0	4.6	72.0	16.1-25.7
	359	20.9	15.1	2.0	82.0	19.4-22.5
06/04	40	20.7	15.0	2.9	78.0	15.9-25.5
	358	20.8	15.0	1.0	83.0	19.2-22.4
06/11	30	30.4	22.3	3.7	100.0	22.1-38.7
	264	31.0	22.0	1.0	100.0	28.3-33.6
06/14	27	30.2	22.3	1.0	100.0	21.4-39.1
	236	31.1	21.8	1.0	100.0	28.3-33.9
06/16	25	19.8	22.0	3.6	100.0	20.7-38.9
	221	30.3	21.8	3.0	100.0	27.4-33.2
06/06	41	20.9	14.9	1.3	78.7	16.2-25.6
	363	21.2	14.9	1.0	84.0	19.7-22.8
06/08	40	22.2	14.8	6.6	78.8	17.4-26.9
	360	22.2	14.8	5.0	81.0	20.6-23.7
06/10	41	26.0	16.6	3.7	93.7	20.7-31.2
	369	26.0	16.5	1.0	97.0	24.3-27.6

Continued

Table 13. Continued

Date (month/day)	N	Snow depth (cm) Mean	± SD	Minimum	Maximum	95% CI
06/13	40	25.4	16.1	6.4	91.3	20.3-30.6
	360	25.4	16.1	4.0	95.0	23.8-27.1
06/15	40	22.8	16.1	4.0	88.8	17.6-27.9
	353	23.1	16.0	3.0	91.0	21.5-24.8
06/17	38	21.2	15.7	3.2	84.7	16.0-26.3
	325	22.0	15.6	1.0	90.0	20.3-23.7
06/19	35	19.2	15.0	6.0	80.0	14.1-24.4
	288	20.4	15.2	3.0	86.0	18.6-22.1
06/21	27	11.9	15.2	1.0	69.6	5.9-17.9
	200	13.9	16.0	1.0	76.0	11.7-16.1
06/23	11	14.6	16.8	1.8	57.4	3.3-25.8
	86	16.1	16.8	1.0	63.0	12.6-19.7
06/24	8	16.0	16.3	1.3	50.8	2.4-29.6
	62	18.1	15.7	1.0	55.5	14.2-22.0
06/25	4	22.2	15.6	7.6	43.9	-2.5-47.0
	36	22.2	13.9	5.0	50.0	17.5-27.0

[a] N equals the number of different stations sampled that were not entirely snow-free and the statistics are based on the mean of the summation of the mean of all snow-covered sites in each set of 9 sites at each station.
[b] N equals the total number of sites sampled that were not entirely snow-free and the statistics for each date are based on the summation of all snow-covered sites.

Table 14. Obliteration of snow cover along the 1-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990

Date	% bare ground	Change in amount of bare ground from previous sample date (m)	Extent of remaining snow cover (m)
28 May	0.0	0.0	1000.0
2 June	1.9	+ 18.2	981.2
3	3.6	+ 17.0	964.2
4	4.3	+ 11.1	953.1
6	2.8	- 19.0	972.1
8	5.6	+ 28.2	943.9
10	0.0	- 56.1	1000.0
13	2.3	+ 23.0	977.0
15	8.0	+ 57.1	919.9
17	17.4	+ 95.4	824.5
19	20.7	+ 75.9	748.6
21	44.7	+195.4	553.2
23	62.2	+185.7	367.5
24	76.1	+128.1	239.4
25	81.1	+ 51.4	188.0
26	87.3	+ 61.0	127.0
27	93.4	+ 61.4	65.6
28	97.8	+ 43.1	22.5
29	98.4	+ 6.6	15.9[a]
30	99.8	+ 13.7	2.2[a]
1 July	100.0	+ 2.2	0.0

Table 15. Snow-covered ground statistics for snow obliteration along the 1-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, June-July 1990[a]

Date	Number of snow patches	Length of snow-covered patches (m)				
		Mean	± SD	Minimum	Maximum	Median
2 June	7	140.2	236.4	0.7	531.4	3.3
3	18	53.6	118.0	0.3	385.4	2.9
4	22	43.3	92.2	0.3	384.2	2.2
6	10	97.2	150.3	1.0	386.0	8.4
8	16	60.0	104.4	0.3	384.5	5.4
10	1	-	-	1000.0	1000.0	1000.0
13	6	162.8	137.1	15.0	384.5	113.1
15	13	70.8	95.9	0.9	352.1	44.5
17	37	22.3	49.5	0.3	261.3	3.0
19	40	18.7	38.0	0.3	182.3	3.0
21	31	17.8	35.7	0.3	166.4	3.9
23	30	12.2	21.5	0.3	96.1	4.1
24	22	10.9	20.0	0.3	74.4	3.0
25	28	6.7	16.3	0.3	72.6	1.4
26	15	8.5	15.0	0.2	57.3	2.5

Continued

Table 15. Continued

Date	Number of snow patches	Length of snow-covered patches (m)				
		Mean	± SD	Minimum	Maximum	Median
27 June	14	4.7	6.1	0.6	18.0	1.7
28	3	7.5	6.7	0.6	14.0	7.9
29	2	8.0	3.0	5.8	10.1	10.0
30	4	0.6	0.5	0.3	1.3	0.3
1 July	0	-	-	0	0	0

[a] The 1-km snow/ice course was completely snow-covered when established on 28 May 1990.

Table 16. Statistics for ice thickness measurements made on 7.5-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, June 1990

Date		Ice thickness (cm)				
(month/day)	N	Mean	± SD	Minimum	Maximum	95% CI
06/22	12[a]	5.0	2.1	2.0	10.0	3.7- 6.3
	76[b]	5.4	2.7	1.0	12.0	4.9- 6.0
06/24	4	4.8	0.6	4.0	5.4	3.9- 5.8
	24	4.7	1.6	1.0	8.0	4.0- 5.4
06/25	1	9.7	-	9.7	9.7	-
	9	9.7	6.6	1.0	19.0	4.6-14.8

[a] N equals the number of different stations sampled that had ground fast ice present and the statistics are based on the mean of the summation of the mean of all sites covered with ground fast ice in each set of 9 sites at each station.

[b] N equals the total number of different sites sampled that had ground fast ice present and the statistics for each date are based on the summation of all sites with ground fast ice present.

Table 17. Statistics for ice thickness measurements made on 1-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, June 1990

Date		Ice thickness (cm)				
(month/day)	N	Mean	± SD	Minimum	Maximum	95% CI
06/21	18[a]	4.4	2.4	1.0	8.6	3.2-5.5
	124[b]	5.0	2.6	1.0	12.0	4.5-5.4
06/23	3	4.0	1.5	2.3	5.2	0.3-7.8
	25	4.0	1.8	1.0	7.0	3.2-4.8
06/24	4	5.1	1.7	3.5	6.8	2.3-7.8
	33	5.1	2.0	1.0	10.0	4.4-5.8
06/25	4	7.0	1.3	5.1	8.0	4.9-9.1
	36	7.0	1.9	3.0	12.0	6.3-7.6

[a] N equals the number of different stations sampled that had ground fast ice present and the statistics are based on the mean of the summation of the mean of all sites covered with ground fast ice in each set of 9 sites at each station.
[b] N equals the total number of different sites sampled that had ground fast ice present and the statistics for each date are based on the summation of all sites with ground fast ice present.

Table 18. Monthly statistics for air temperature (C°) at Atmospheric Environment Service weather stations, Resolute Bay, Cornwallis Island, and Mould Bay, Prince Patrick Island, Northwest Territories, June 1989-June 1990

AES[a] weather station	Month 1989-1990	Daily temperatures C° Monthly mean max.	Monthly mean min.	Monthly mean aver.	Monthly extreme high	Monthly extreme low
RB[a]	Jun	2.2	- 1.8	0.2	6.4	- 5.0
MB[a]		2.8	- 1.5	0.7	8.1	- 6.1
RB	Jul	6.2	0.8	3.5	14.2	- 1.7
MB		7.7	0.5	4.1	16.0	- 1.6
RB	Aug	4.4	- 0.4	2.0	8.2	- 3.0
MB		5.7	0.2	3.0	9.2	- 2.7
RB	Sep	- 2.6	- 7.4	- 5.0	1.6	-18.8
MB		- 2.1	- 6.1	- 4.1	4.5	-16.7
RB	Oct	-12.6	-17.4	-16.0	- 2.5	-35.5
MB		-13.7	-20.9	-17.3	- 2.5	-32.7
RB	Nov	-23.4	-30.0	-26.7	-12.5	-39.4
MB		-26.2	-33.0	-29.6	-12.3	-39.7
RB	Dec	-27.3	-35.0	-31.2	-20.5	-42.2
MB		-27.1	-33.9	-30.5	-16.1	-42.5
RB	Jan	-28.2	-34.5	-31.4	-23.7	-39.1
MB		-29.3	-35.0	-32.2	-20.5	-40.8
RB	Feb	-33.9	-40.6	-37.3	-25.1	-48.7
MB		-36.5	-42.7	-39.6	-22.3	-49.8
RB	Mar	-24.9	-33.0	-29.0	-17.0	-40.2
MB		-23.6	-31.7	-27.7	-14.9	-39.7
RB	Apr	-18.2	-26.0	-22.1	- 7.5	-33.0
MB		-14.8	-23.7	-19.3	- 1.0	-30.5

Continued

Table 18. Continued

AES[a] weather station	Month 1989-1990	Daily temperatures C° Monthly mean max.	Monthly mean min.	Monthly mean aver.	Monthly extreme high	Monthly extreme low
RB	May	- 6.9	-13.5	-10.2	- 1.3	-24.4
MB		- 4.7	-10.1	- 7.4	+ 1.3	-15.5
RB	Jun	- 2.5	- 2.9	0.3	10.1	- 7.5
MB		- 4.7	- 0.3	2.2	13.7	- 6.0

[a] AES equals Atmospheric Environment Service; RB equals Resolute Bay; and MB equals Mould Bay.

Table 19. Monthly statistics for precipitation at Atmospheric Environment Service weather stations, Resolute Bay, Cornwallis Island, and Mould Bay, Prince Patrick Island, Northwest Territories, June 1989-June 1990

AES[a] weather station	Month 1989-1990	Rainfall (mm)	Snowfall (cm)	Total precipitation[b] (mm)	Depth of snow on ground[c] (cm)	Days with 1.0 cm precipitation or more
RB[a]	Jun	10.8	4.4	15.2	Trace	6
MB[a]		7.8	0.8	8.6	0	2
RB	Jul	18.9	3.6	22.5	0	7
MB		10.1	1.6	11.6	0	4
RB	Aug	28.2	1.2	39.4	0	8
MB		12.8	1.6	19.4	0	6
RB	Sep	0.8	54.4	54.6	36	15
MB		7.0	15.1	20.7	6	4
RB	Oct	Trace	15.4	14.9	32	6
MB		0	18.9	16.9	15	3
RB	Nov	0	7.6	7.6	26	2
MB		0	10.6	10.4	20	4
RB	Dec	0	5.2	5.2	28	2
MB		0	16.4	14.6	35	4

Continued

Table 19. Continued

AES[a] weather station	Month 1989-1990	Rainfall (mm)	Snowfall (cm)	Total precipitation[b] (mm)	Depth of snow on ground[c] (cm)	Days with 1.0 cm precipitation or more
RB	Jan	0	1.4	1.4	22	0
MB		0	8.4	7.4	40	3
RB	Feb	0	6.0	6.0	23	3
MB		0	6.4	6.4	24	2
RB	Mar	0	10.2	10.0	29	4
MB		0	8.0	6.6	24	2
RB	Apr	Trace	10.0	9.7	32	3
MB		0	8.8	8.2	20	3
RB	May	0	9.4	7.1	33	3
MB		0	4.6	4.4	10	2
RB	Jun	Trace	18.7	18.5	Trace	3
MB		1.2	2.6	3.8	Trace	1

[a] AES equals Atmospheric Environment Service; RD equals Resolute Bay; and MB equals Mould Bay.
[b] Total precipitation (mm) equals "snowfall water equivalent (mm)" plus rainfall (mm); therefore, "total precipitation" can be a value equal to or slightly less than "total rainfall" plus "total snowfall".
[c] On last day of each month.

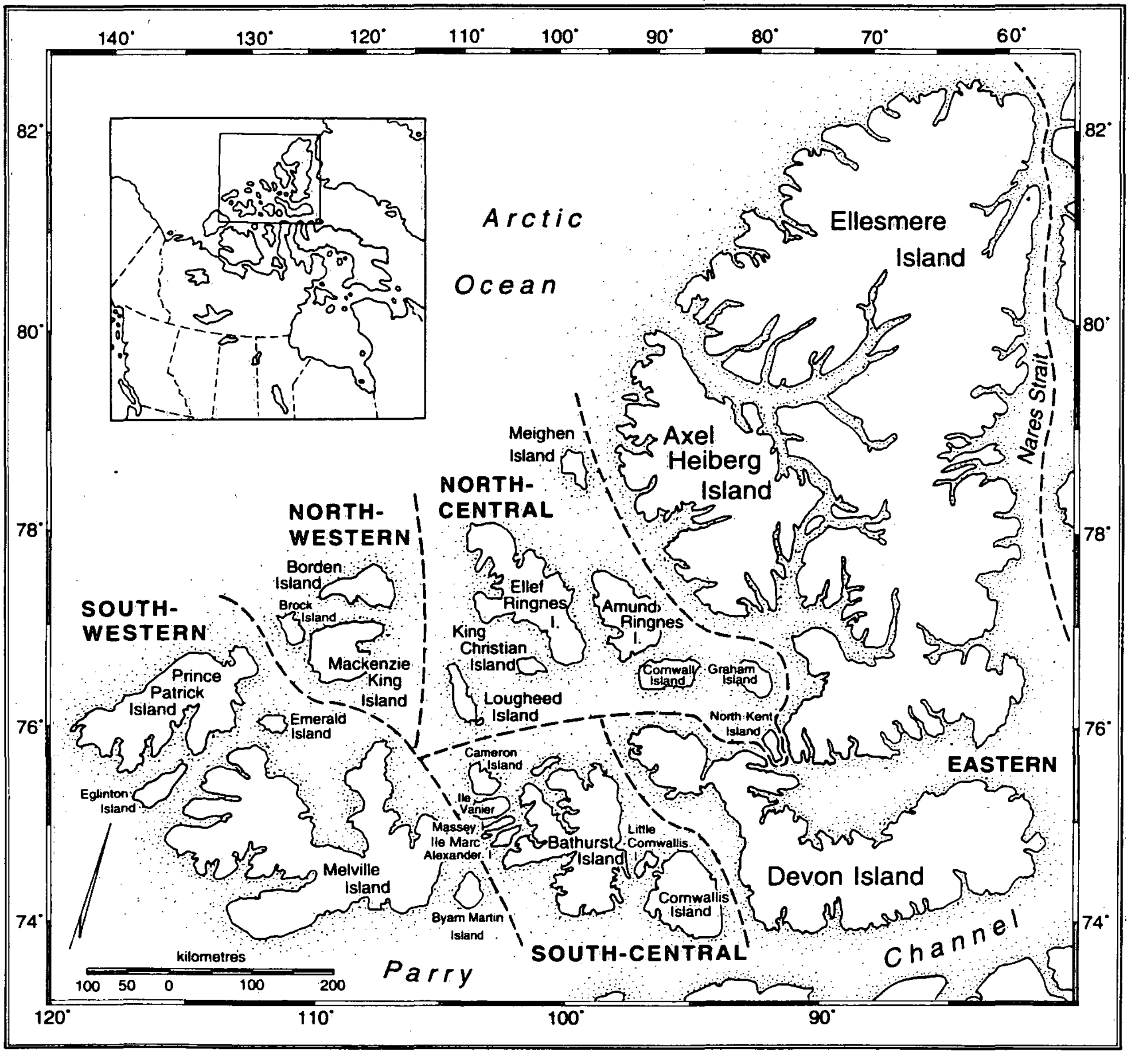

Fig. 1. Queen Elizabeth Islands of the Canadian Arctic Archipelago

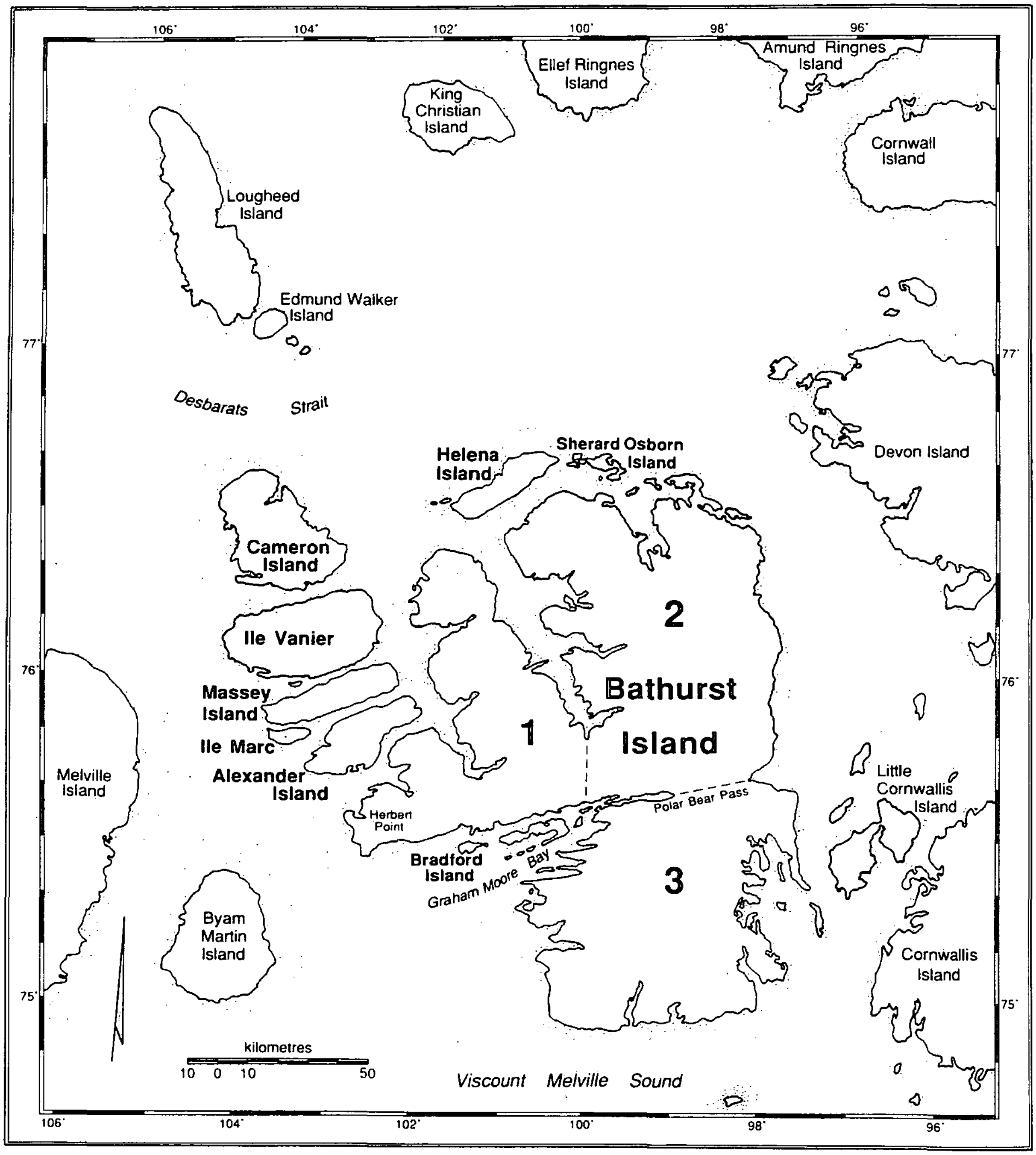

Fig. 2. Locations of nine of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the principal island, Bathurst; the five western major satellite islands, Alexander, Marc, Massey, Vanier, and Cameron; the two northern major satellite islands, Helena and Sherard Osborn; and the one western secondary satellite island, Bradford

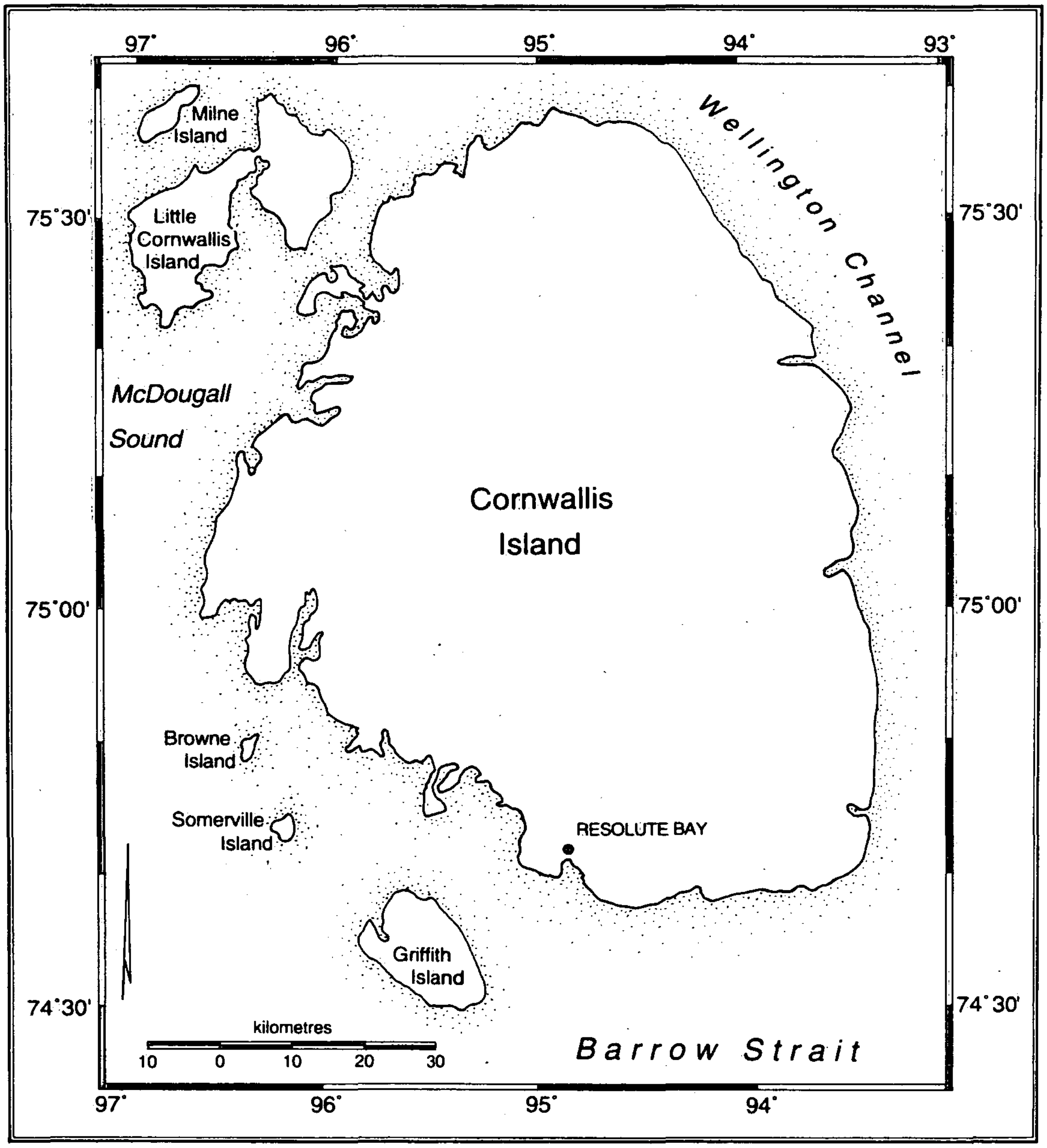

Fig. 3. Locations of two of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the two eastern major satellite islands, Cornwallis and Little Cornwallis

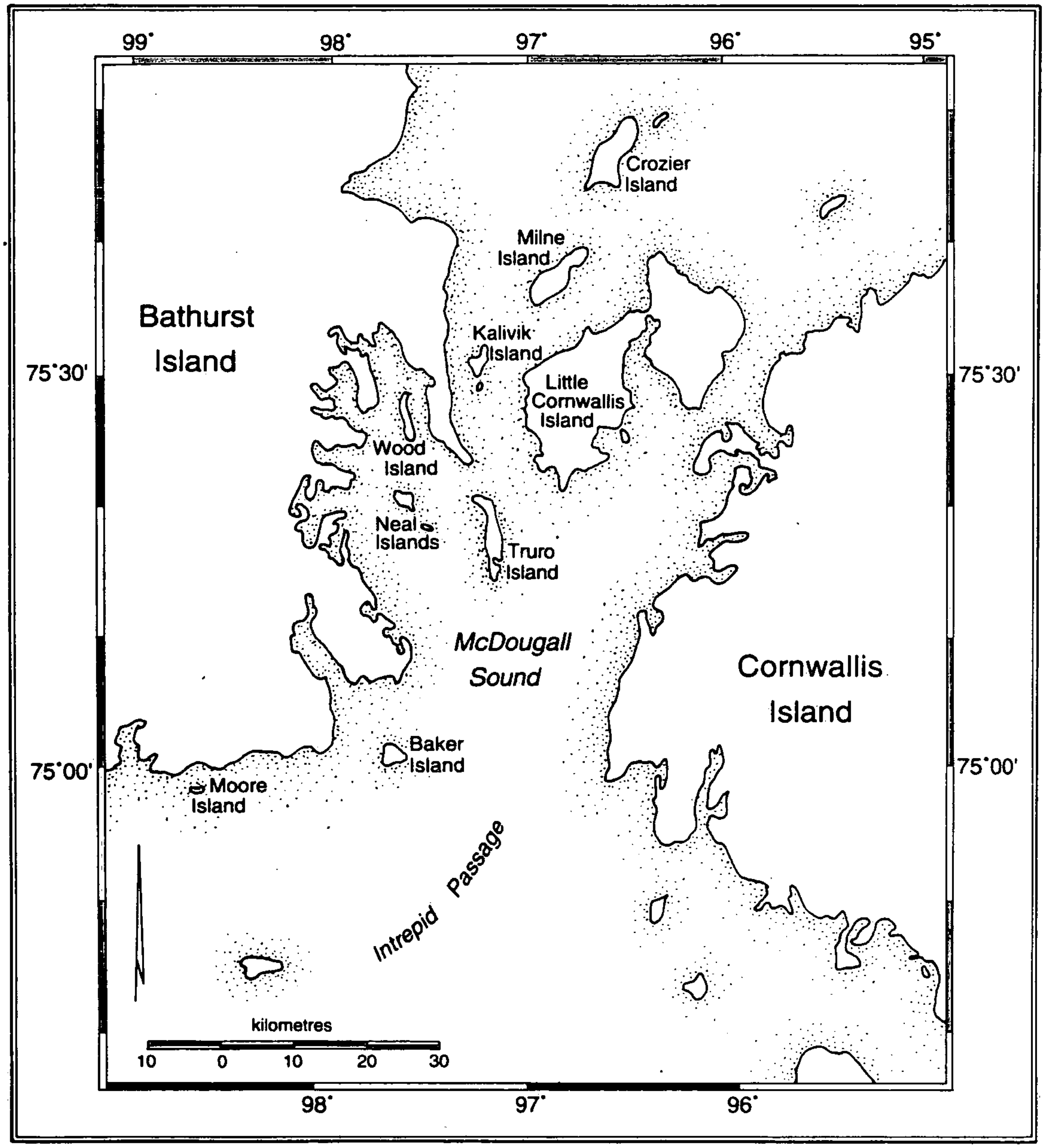

Fig. 4. Locations of eight of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the six secondary satellite islands in McDougall Sound, Crozier, Kalivik, Milne, Neal, Truro, and Wood; and the two secondary satellite islands in Intrepid Passage, Baker and Moore

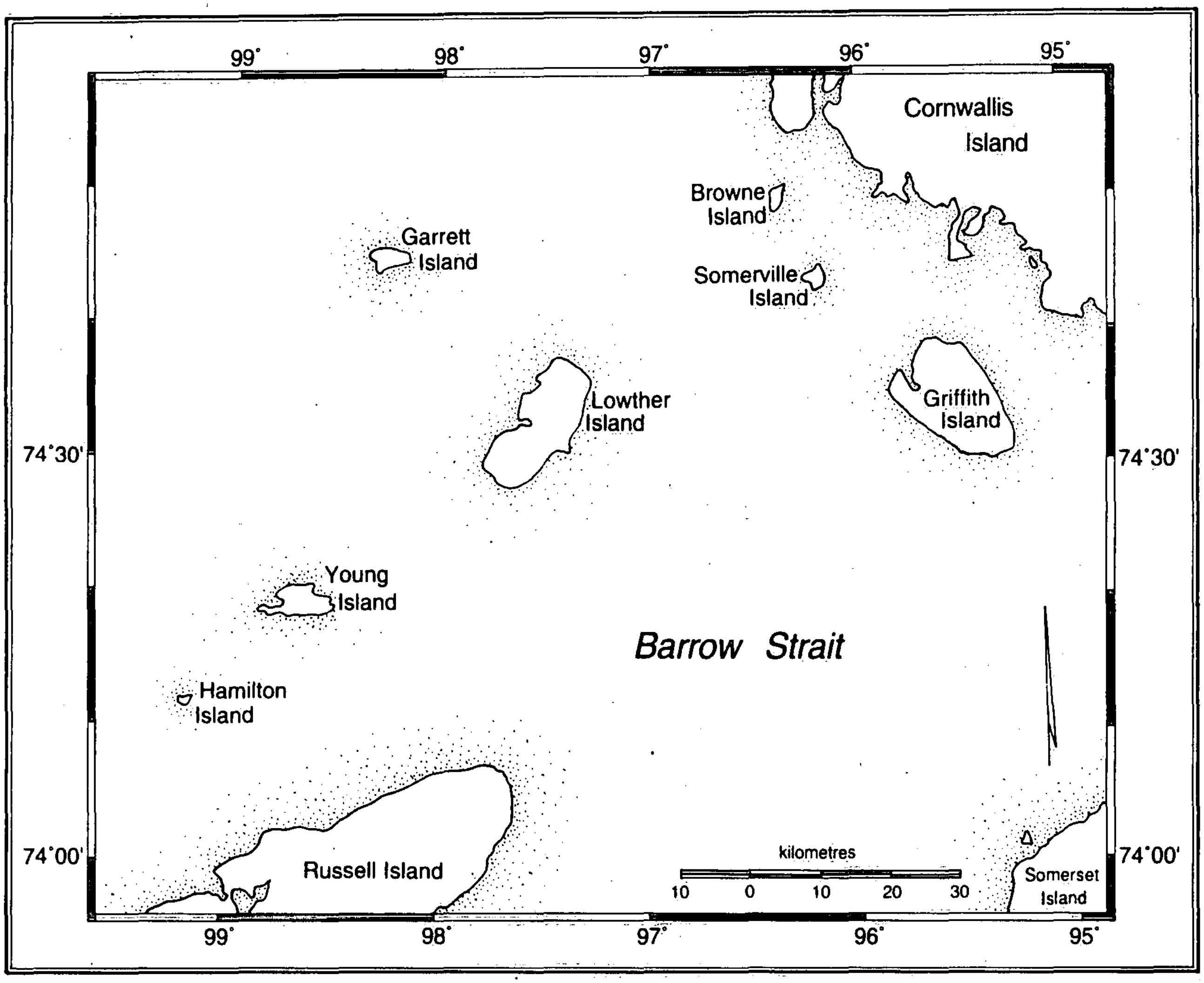

Fig. 5. Locations of seven of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the seven secondary satellite islands in Barrow Strait, Browne, Garrett, Griffith, Hamilton, Lowther, Somerville, and Young

Appendix 1. Time spent carrying out nonsystematic aerial sex/age segregation counts of Peary caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990

Search zones	Minutes by date (month/day) 5/31	6/01	6/11	6/13	6/15	6/17	6/22	6/23	6/24	6/27	7/06	7/07	7/08	7/10	Total time by search zone (min)
Bathurst[a]															
NEC	52	25	67	50	0	55	93	0	0	56	89	0	0	0	487
NEI	95	115	23	5	19	25	25	75	17	89	75	107	0	0	669
SEC	101	0	0	68	0	0	45	0	0	43	0	57	0	0	314
SEI	20	45	0	0	0	0	38	0	0	10	0	32	0	0	145
SC	100	70	0	50	0	0	55	0	0	23	0	31	0	0	329
SWC	0	15	0	57	0	0	0	0	0	8	0	62	0	0	142
SWI	0	0	0	0	0	0	0	0	0	44	0	24	0	0	68
NWC	0	60	0	0	20	0	72	75	0	23	0	85	0	0	335
NWI	0	0	0	0	20	0	5	51	0	35	30	39	0	0	180
NCW	0	0	160	0	25	15	0	0	0	0	167	0	0	0	367
NCE	0	15	50	0	0	120	55	6	0	56	122	0	0	0	424
Alexander	0	0	0	0	55	0	0	56	0	0	0	0	107	0	218
Marc	0	0	0	0	16	0	0	20	0	0	0	0	13	0	49
Massey	0	0	0	0	97	0	0	129	0	0	0	0	91	0	317
Vanier	0	0	0	0	0	92	0	0	202	0	0	0	0	160	454
Cameron	0	0	0	0	0	50	0	0	10	0	0	0	0	127	187
Helena	0	0	0	0	0	0	0	0	70	0	0	0	0	0	70
Sherard Osborn	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10
Baker	10	0	0	7	0	0	10	0	0	10	0	10	0	0	47
Daily total	378	345	300	237	252	357	397	412	309	397	483	447	211	287	(4812)

Continued

Appendix 1. Continued

* For the purpose of nonsystematic aerial searches Bathurst Island was divided into 11 "search zones": NEC= northeast coast, NEI = northeast interior, SEC = southeast coast, SEI = southeast interior, SC = south coast, SWC = southwest coast, SWI = southwest interior, NWC = northwest coast, NWI = northwest interior, NCW = north coast, western section, and NCE = north coast, eastern section.

Appendix 2. Sex/age structure of samples of Peary caribou by sample day, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Search date (month/day)	N	Sex/age composition						
		Bulls	Cows	Calves	Juv.[a] males	Juv. females	Yrl. males	Yrl. females
05/31	47	7	10	0	11	6	9	4
06/01	22	5	5	0	0	6	1	5
06/11	59	4	30	3	0	10	0	12
06/13	41	6	21	3	0	9	1	1
06/15	88	8	35	11	6	23	4	1
06/17	185	30	67	22	8	36	13	9
06/22	214	60	43	6	22	36	24	23
06/23	211	39	54	39	19	21	15	24
06/24	45	17	5	2	7	5	6	3
06/27	281	66	73	36	19	32	24	31
07/06	501	52	155	109	31	84	23	47
07/07	154	56	24	19	15	17	11	12
07/08	171	22	36	31	15	31	6	30
06/10	45	16	8	3	4	7	31	6

[a] Juv. equals juvenile animals and Yrl. equals yearling animals.

Appendix 3. Sex/age structure of samples of Peary caribou by island and search zone, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

			Sex/age composition						
Island	Zone	N	Bulls	Cows	Calves	Juv.[a] males	Juv. females	Yrl. males	Yrl. females
Bathurst	1	324	66	77	28	21	63	34	35
	2	283	22	104	64	4	45	5	39
	3	88	28	21	6	9	14	6	4
	4	35	8	8	7	4	7	1	0
	5	79	20	15	4	24	6	16	4
	6	24	14	5	0	2	0	3	0
	7	2		2					
	8	163	77	13	3	26	11	24	9
	9	66	4	26	11	2	11	1	11
	10	182	34	53	27	11	29	4	24
	11	299	19	122	62	16	47	10	23
Alexander	12	172	35	31	18	26	24	15	23
Marc	13	22	3	0	0	3	14	2	0
Massey	14	172	3	67	45	0	31	0	26

Continued

Appendix 3. Continued

Island	Zone	N	Bulls	Cows	Calves	Juv.[a] males	Juv. females	Yrl. males	Yrl. females
Vanier	15	104	36	17	7	13	16	9	6
Cameron	16	15	7	0	0	2	0	5	1
Helena	17	23	11	4	2	3	1	2	0
Sherard Osborn	18	11	1	1	0	1	4	1	3

[a] Juv. equals juvenile animals and Yrl. equals yearling animals.

Appendix 4. Chronological listing of hard antler casting by Peary caribou breeding cows, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990, data obtained by nonsystematic helicopter searches

Date (mo./d)[a]	N	Number that cast both hard antlers	Number that cast one hard antler only: Left	Number that cast one hard antler only: Right	Number with both hard antlers retained
05/31	10	1	0	0	9
06/01	5	0	0	0	5
06/11	30	19	1	0	10
06/13	21	17	1	0	3
06/15	35	33	0	1	1
06/17	67	59	6	1	1
06/22	43	40	0	1	2
06/23	54	51	0	0	3
06/24	5	5	0	0	0
06/26	73	72	0	0	1
07/06	155	155	0	0	0
07/07	24	24	0	0	0
07/08	36	36	0	0	0
07/10	8	8	0	0	0

[a] (mo./d) equals (month/day).

Appendix 5. Termination dates for 30 snow/ice stations (270 sample sites) and the number of sample sites at each of those stations with or without ground fast ice present when the station became inactive on the 7.5-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990

Station number	Date station became inactive (month/day)	Number of sample sites	
		No. with ice	No. without ice
0.0	6/20	0	9
0.5	6/16	0	9
1.0	6/14	0	9
1.0-N	6/16	0	9
1.0-S	6/22	9	0
1.5	6/22	9	0
2.0	6/25	9	0
2.0-N	6/22	3	6
2.0-S	6/22	9	0
2.5	6/22	9	0
3.0	6/24	0	9
3.0-N	6/24	5	4
3.0-S	6/22	0	9
3.5	6/22	0	9
4.0	6/20	0	9
4.0-N	6/24	0	9
4.0-S	6/14	0	9
4.5	6/14	0	9
5.0	6/22	9	0
5.0-N	6/22	0	9
5.0-S	6/22	9	0
5.5	6/22	1	8
6.0	6/22	3	6

Continued

Appendix 5. Continued

Station number	Date station became inactive (month/day)	Number of sample sites	
		No. with ice	No. without ice
6.0-N	6/24	9	0
6.0-S	6/22	0	9
6.5	6/22	3	6
7.0	6/22	9	0
7.0-N	6/24	2	7
7.0-S	6/22	3	6
7.5	6/24	8	1

Appendix 6. Termination dates for 41 snow/ice stations (369 sample sites) and the number of sample sites at each of those stations with or without ground fast ice present when the station became inactive on the 1-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, May-July 1990

Station number	Date station became inactive (month/day)	Number of sample sites	
		No. with ice	No. without ice
1	6/21	7	2
2	6/25	9	0
3	6/23	9	0
4	6/21	5	4
5	6/24	8	1
6	6/21	7	2
7	6/19	0	9
8	6/21	3	6
9	6/21	8	1
10	6/21	2	7
11	6/21	0	9
12	6/24	5	4
13	6/21	9	0
14	6/25	9	0
15	6/24	9	0
16	6/24	8	1
17	6/23	9	0
18	6/21	9	0
19	6/21	0	9
20	6/21	8	1
21	6/21	9	0
22	6/19	0	9
23	6/13	0	9

Continued

Appendix 6. Continued

Station number	Date station became inactive (month/day)	Number of sample sites	
		No. with ice	No. without ice
24	6/21	0	9
25	6/21	4	5
26	6/21	0	9
27	6/17	0	9
28	6/21	9	0
29	6/24	8	1
30	6/25	9	0
31	6/25	9	0
32	6/23	7	2
33	6/21	9	0
34	6/17	0	9
35	6/21	9	0
36	6/19	0	9
37	6/21	0	9
38	6/21	0	9
39	6/21	5	4
40	6/21	3	6
41	6/21	9	0

Appendix 7. Chronology of when profile of 25-m segments between the centres of each pair of stations on the 1-km snow/ice course became 100% snow-free, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, June-July 1990

Station pair	Date	Station pair	Date	Station pair	Date	Station pair	Date
1- 2	6/28[a]	2- 3	6/27	3- 4	6/24	4- 5	6/25
5- 6	6/27	6- 7	6/23	7- 8	6/27	8- 9	6/24
9-10	6/24	10-11	6/21	11-12	6/26	12-13	6/27
13-14	6/26	14-15	6/28	15-16	6/28	16-17	6/26
17-18	6/27	18-19	6/24	19-20	6/23	20-21	6/23
21-22	6/24	22-23	6/17	23-24	6/21	24-25	6/23
25-26	6/23	26-27	6/21	27-28	6/23	28-29	6/27
29-30	7/01	30-31	7/01	31-32	6/28	32-33	6/24
33-34	6/23	34-35	6/24	35-36	6/24	36-37	6/23
37-38	6/22	38-39	6/21	39-40	6/24	40-41	6/24

[a] Month/day.

Appendix 8. Bare ground (snow-free) statistics along 40 25-m segments of the 1-km snow/ice course, northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, June-July 1990

		Number of snow-free patches per 25-m segment		Length of snow-free patches (m)			
Date	25-m segments sampled	Min. no.	Max. no.	Mean	± SD	Minimum	Maximum
2 June	40	0	4	0.5	2.08	0.0	9.5
3	40	0	6	0.9	2.61	0.0	10.4
4	40	0	6	1.2	3.27	0.0	13.1
6	40	0	3	0.7	2.42	0.0	12.7
8	40	0	3	1.4	3.75	0.0	15.5
10	40	0	0	0.0	0.00	0.0	0.0
13	40	0	1	0.6	1.83	0.0	7.9
15	40	0	2	2.0	4.72	0.0	19.5
17	40	0	8	4.4	6.59	0.0	25.0
19	39	0	6	5.8	7.40	0.0	23.5
21	39	0	5	10.8	9.51	0.0	25.0
23	34	0	4	14.2	9.70	0.0	25.0
24	26	0	7	15.8	9.82	0.0	25.0
25	16	0	6	13.2	9.59	0.0	25.0

Continued

Appendix 8. Continued

Date	25-m segments sampled	Number of snow-free patches per 25-m segment		Length of snow-free patches (m)			
		Min. no.	Max. no.	Mean	± SD	Minimum	Maximum
26	15	0	3	16.5	10.20	0.0	25.0
27	12	1	6	19.5	8.02	2.4	25.0
28	6	1	3	21.3	6.18	10.4	25.0
29	2	2	2	17.0	3.04	14.9	19.2
30	2	2	4	23.9	1.13	23.1	24.7
1 July	2	1	1	25.0	0.00	15.0	25.0

Appendix 9. Summary of maximum, minimum, and mean temperatures recorded at the Canadian Wildlife Service "Walker River base camp", northeastern Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 26 May to 27 July 1990

Date	Temperature[a] C°		
(month/day)	Maximum	Minimum	Mean
5/26	- 3.4	-12.2	- 7.8
5/27	0.0	- 7.6	- 3.8
5/28	+ 1.5	- 5.4	- 2.0
5/29	+ 2.4	- 5.5	- 1.6
5/30	- 1.5	- 8.3	- 4.9
5/31	- 3.6	- 7.5	- 5.6
6/01	- 2.3	- 7.8	- 5.5
6/02	+ 0.2	- 2.8	- 1.3
6/03	+ 0.5	- 3.0	- 1.3
6/04	+ 1.5	- 6.0	- 2.3
6/05	+ 3.5	- 6.5	- 1.5
6/06	- 0.5	- 7.5	- 3.5
6/07	- 0.5	- 6.0	- 3.3
6/08	+ 5.5	- 2.5	+ 1.5
6/09	+ 0.6	- 1.4	- 0.4
6/10	+ 0.2	- 6.1	- 3.0
6/11	0.0	- 6.0	- 3.0
6/12	+ 1.5	- 2.0	- 0.3
6/13	+ 2.4	- 3.0	- 0.3
6/14	+ 2.5	- 1.3	+ 0.6
6/15	+ 2.5	- 2.8	- 0.2
6/16	+ 2.8	+ 0.4	+ 1.6
6/17	+ 3.6	- 0.5	+ 1.6
6/18	+ 2.4	- 1.5	+ 0.5
6/19	+ 2.0	- 0.5	+ 0.8

Continued

Appendix 9. Continued

Date (month/day)	Temperature[a] C°		
	Maximum	Minimum	Mean
6/20	+ 5.2	+ 0.4	+ 2.8
6/21	+ 4.0	+ 0.8	+ 2.4
6/22	+ 7.5	+ 0.5	+ 4.0
6/23	+ 8.0	+ 3.3	+ 5.7
6/24	+ 5.5	+ 1.2	+ 3.4
6/25	+ 7.0	+ 2.8	+ 4.9
6/26	+ 9.8	+ 3.2	+ 6.5
6/27	+ 9.5	+ 5.2	+ 7.4
6/28	+ 10.3	+ 4.5	+ 7.4
6/29	+ 11.5	+ 5.5	+ 8.5
6/30	+ 11.6	+ 5.5	+ 8.5
7/01	+ 11.6	+ 5.3	+ 8.5
7/02	+ 10.7	+ 5.5	+ 8.1
7/03	+ 10.1	+ 4.3	+ 7.2
7/04	+ 7.9	- 0.2	+ 3.9
7/05	+ 7.3	+ 1.0	+ 4.2
7/06	+ 14.1	+ 3.5	+ 8.8
7/07	+ 15.2	+ 6.9	+ 11.1
7/08	+ 14.0	+ 4.0	+ 9.0
7/09	+ 8.0	+ 2.1	+ 5.1
7/10	+ 6.6	+ 2.1	+ 4.4
7/11	+ 7.5	+ 1.5	+ 4.5
7/12	+ 10.5	+ 3.9	+ 7.2
7/13	+ 9.3	+ 3.0	+ 6.2
7/14	+ 8.2	+ 1.3	+ 4.8
7/15	+ 9.4	+ 1.0	+ 5.2

Continued

Appendix 9. Continued

Date (month/day)	Temperature[a] C°		
	Maximum	Minimum	Mean
7/16	+ 14.3	+ 1.1	+ 7.7
7/17	+ 17.5	+ 5.5	+ 11.5
7/18	+ 15.5	+ 2.8	+ 9.2
7/19	+ 4.7	+ 1.7	+ 3.2
7/20	+ 4.3	+ 0.8	+ 2.6
7/22	+ 5.6	+ 1.9	+ 3.8
7/23	+ 5.0	+ 0.5	+ 2.8
7/24	+ 5.6	+ 1.1	+ 3.4
7/25	+ 3.2	+ 0.5	+ 1.9
7/26	+ 6.3	+ 1.0	+ 3.7
7/27	+ 6.0	+ 1.7	+ 3.9

[a] Temperatures were recorded at ca. 0700 and 1900 each day; therefore, temperatures for each date actually range from 1900 the previous day to 1900 that day.