PEARY CARIBOU CONSERVATION STUDIES, BATHURST ISLAND COMPLEX, NORTHWEST TERRITORIES, JULY-AUGUST 1993

Frank L. Miller

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Room 200
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ABSTRACT. Seventeen Peary caribou (Rangifer tarandus pearyi) were captured within the Bathurst Island complex, Northwest Territories, between 27 July and 1 August 1993, using an aerial net-gun technique and a Bell 206L-1 turbo-helicopter. Ten cows were captured on Bathurst Island, 3 cows on Alexander Island, 2 cows and 1 bull on Massey Island, and 1 bull on Ile Vanier. Fifteen of the caribou captured were maternal cows, each with a calf at heel, and the remaining 2 caribou were prime bulls. All 17 caribou were fitted with telemetry neck collars: 7 collars housed both a Satellite Platform Transmitter Terminal package and a radio telemetry package, the other 10 collars housed only the radio telemetry package. The 17 collared caribou were relocated 2 to 5 times each during August 1993 by radio telemetry and visually identified: all appeared healthy and the 15 cows all still had their calf at heel. Sex/age composition counts were carried out from the helicopter between 16 and 24 August 1993 and 2400 caribou were counted within the Bathurst Island complex, and ca. 95% of them were on Bathurst Island. The Bathurst Island complex population of Peary caribou approximated 13% bulls, 29% breeding cows, 28% calves, 11% juvenile males, 8% juvenile females, 6% yearling males, and 6% yearling females in late August 1993, based on the sample of 2400 caribou. Caribou on Bathurst Island showed the strongest late summer affinity for northeastern interior sites, 74% of all caribou counted. Strongly significant ($P<0.005$) spatial separations as a result of the nonrandom distribution of caribou on Bathurst Island were exhibited during late summer 1993 in comparisons of numbers of caribou seen on coastal (5%) vs. interior (95%) sites, northern (93%) vs. southern (7%) areas, and eastern (86%) vs. western (14%) sections of Bathurst Island. Caribou were nonrandomly distributed among the 12 search zones on Bathurst Island by sex/age class during late August 1993. Bulls exhibited the widest-ranging preferences among search zones, with overrepresentation in the northeast, northwest, and southeast interior zones. Juvenile males showed preferences for the northeast and northwest interior zones. All other sex/age classes showed preferences only for the northeast interior zone. On average, 96.7 cows out of every 100 breeding cows each still had a calf at heel in late August 1993, suggesting that initial calf production in June 1993 was high, and indicating that both perinatal and early postnatal survival of calves was exceptionally high in 1993.

RÉSUMÉ. Dix-sept caribous de Peary (*Rangifer tarandus pearyi)* ont été capturés entre le 27 juillet et le 1er août 1993 sur le complexe de l'île Bathurst (Territoires du Nord-Ouest), à l'aide d'un filet déployé à la carabine par un tireur placé à bord d'un hélicoptère à turbomoteur Bell 206L-1. Dix biches ont été capturées sur l'île Bathurst, trois sur l'île Alexander, deux biches et un mâle sur l'île Massey et un mâle sur l'île Vanier Quinze des caribous capturés étaient des mères, chacune accompagnée d'un faon, et les deux autres étaient des mâles en pleine force. On a installé sur les 17 animaux des colliers de télémétrie : sept abritaient un bloc de transmission par satellite et un appareil de télémétrie, les dix autres seulement un appareil de télémétrie. Les 17 caribous ont été localisés deus à cinq fois chacun par radiotélémétrie pendant le mois d'août 1993 et visuellement identifiés : tous semblaient en bonne santé, et les 15 mères étaient encore accompagnées de leur faon. Des recensements visant la composition par sexe et par âge ont été effectués par hélicoptère entre le 16 et le 24 août 1993, et 2400 caribous ont été dénombrés sur le complexe de l'île Bathurst, dont 95 % environ sur l'île elle-même. La population de caribous de Peary du complexe se composait d'environ 13 % de mâles géniteurs, 29 % de femelles génitrices, 28 % de faons, 11 % de mâles juvéniles, 8 % de femelles juvéniles, 6 % de mâles d'un an et 6 % de femelles d'un an à la fin d'août 1993, d'après l'échantillon de 2400 caribous. Ce sont les caribous de l'île Bathurst qui présentaient les affinités les plus fortes à la fin de l'été pour les sites intérieurs du nord-est, avec 74 % des animaux dénombrés. Des séparations spatiales fortement significatives (P<0,005), causées par la distribution non aléatoire des caribous de l'île Bathurst, ont été observées à la fin de l'été 1993 dans la comparaison du nombre de caribous présents sur les sites côtiers (5 %) par rapport aux sites de l'intérieur (95 %), dans les régions du nord (93 %) par rapport au sud (7 %), et l'est (86 %) par rapport à l'ouest (14 %) de l'île Bathurst. Les caribous étaient répartis de façon non aléatoire entre les 12 zones de recherche de l'île Bathurst par classe de sexe et d'âge à la fin d'août 1993. C'est chez les mâles adultes qu'on observait les préférences les plus variées parmi les zones de recherche, avec surreprésentation dans les zones intérieures du nord-est, du nord-ouest et du sud-est. Les mâles juvéniles montraient des préférences pour les zones intérieures du nord-est du nord-ouest. Toutes les autres classes de sexe et d'âge avaient des préférences pour la zone intérieure du nord-est seulement. En moyenne, 96,7 % des génitrices étaient encore accompagnées d'un faon à la fin d'août 1993, ce qui semble indiquer que la production de petits était élevée en juin 1993, mais aussi que la survie périnatale et néonatale des faons était exceptionnellement élevée en 1993.

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INTRODUCTION

The Peary caribou (Rangifer tarandus pearyi) was assigned the most dire classification of "Endangered" by the Committee On The Status Of Endangered Wildlife In Canada (COSEWIC) in April 1991. This assignment was an uplisting from the 1979 "Threatened" classification and was based on an Environment Canada, Conservation & Protection, Canadian Wildlife Service (CWS) status report on Peary caribou to COSEWIC in 1990 (Miller 1990b), resulting from the most recent (1984-88) reevaluation of the status of Peary caribou by CWS. The Peary caribou is unique to arctic Canada and it is a socially important and economically valuable part of Canada's natural heritage.

Peary caribou on the southwestern and south-central Queen Elizabeth Islands (QEI) of the Canadian Arctic Archipelago were dangerously low in number during the late 1980s (Gunn et al. 1979, 1981, Miller 1987a, 1987b, 1988, 1989, 1990b). The three major islands of significance 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 were 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 are known to have shown signs of recovery from the 1973-74 low (Miller 1987a, 1987b, 1988, 1989). Caribou within the Bathurst Island complex appear to have been in a steady state of population growth since about the mid 1980s (Miller 1987a, 1989, 1991, 1992, 1993, 1994) and now approach, at least, 70% of the number estimated in 1961 (Tener 1963).

Bathurst Island was a principle caribou hunting area for the Inuit of Resolute Bay, Cornwallis Island, prior to the cataclysmic die-off of 1973-74. The general lack of caribou on Bathurst Island thereafter resulted in the imposition of a voluntary ban on caribou hunting on Bathurst Island in 1975 by the Inuit hunters of Resolute Bay (Freeman 1975, Ferguson 1987). The ban was apparently honoured until 1990 although a desire to re-initiate 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). An additional 6 or 7 were reportedly shot on Bathurst Island by polar bear hunters out of Resolute Bay, Cornwallis Island, in late winter 1991 (T. Manik, Resolute Bay, pers. commun., 1991). At least 14 caribou were killed on Bathurst Island in early winter 1992 (H.E. Welch, pers. commun., 1992: the best hearsay information available also indicates a kill of 25-35 caribou on Cornwallis Island in summer 1992 and at least an additional 13 caribou in early winter 1992, but whether those caribou were year-round residents of Cornwallis Island or from elsewhere within the Bathurst Island complex remains unknown). Subsequent data indicate that the caribou population on Bathurst Island cannot be considered a truly harvestable population, except at a low level of annual harvest and preferably only when or mostly restricted to male caribou (Miller 1994).

The CWS has selected Bathurst Island to continue ecological studies of the relationship between Peary caribou and 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 the Inuit of Grise Fiord); (2) the Peary caribou on Bathurst Island are the most accessible within the QEI which also have, at least in theory (based on known past population size), the greatest potential for increasing in number to a level that would sustain annual harvests of meaningful sizes; and (3) only those Peary caribou on Bathurst Island (and some smaller satellite islands) are known to have experienced any marked increase in number from their 1973-74 low, while Peary caribou on Melville and Prince Patrick islands (and their respective satellite islands) showed no indication of recovery when last surveyed in 1986 and 1987 (Miller 1987b, 1988).

The following is an annual progress report on the 1993 field season activities for Peary caribou studies on Bathurst Island and some of its satellite islands. This field season was devoted primarily to the initiation of satellite and radio telemetry studies of daily and seasonal movements/migrations and year-round distributional use of range by Peary caribou.

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 and 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).

For the purposes of this study, 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, 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 (centred at ca. 76°00'N, 97°40'W).

1.2. Major satellite islands

The nine major satellite islands of Bathurst Island (in terms of possible movements or migrations of Peary caribou within the BIC) (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 northwestern 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" 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 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 not one 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 elsewhere within the BIC. These 16 small islands collectively only total about 390 km².

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 study area (Meteorological Branch 1970). Snow cover usually begins melting 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.

Weather patterns within the study area are varied. 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 (93 km apart) are the result of the research station's inland site and local topographical effects (Thompson 1971). The Atmospheric Environment Service (AES) 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: 700 km apart).

The amount and duration of snow cover, especially in spring, are critical to arctic ungulates, and 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. Despite these known conditions, detailed range-wide information on type of snow cover and the incidence of ground fast ice or ice layering is generally unavailable for the QEI.

METHODS

1. Capture, Handling, And Collaring Of Caribou

A Bell 206L-1 (Jet Long Ranger) turbo-helicopter on high skid gear was used as the pursuit aircraft for the capture effort. The helicopter was flown at 60 to 90 m above ground level (agl) and a cruising speed of ca. 180 km•h^{-1} while searching for likely target groups of caribou. Air speeds were reduced to between 50 and 90 km•h^{-1} during close approach and pursuit of animals.

Caribou were captured by use of an aerial net-gun technique (Barrett et al., 1982). I used a 4-person team, plus the pilot, as the aerial net-gun capture crew. Two net-guns, a 4-barrel gun and a 3-barrel gun, with a spare net for each gun were carried on board the helicopter. When a likely target group or groups of caribou were spotted, the helicopter was landed several hundred metres away from the animals on the best vantage point available. Two of the crew members disembarked; removed the right rear door, which was equipped with "quick release pins"; and placed the door on the ground along with all extra equipment and gear not needed for the actual capture. The helicopter then took-off and was manoeuvred into position for pursuit with the net-gunner in the right rear door and one crew member in the left front seat to select the target animal. Once the net was fired and it was on the animal, the helicopter was landed ca. 30 m from the animal and the two crew members got out of the helicopter and secured the animal in the net. The helicopter returned to and picked up the two previously positioned crew members waiting on the ground: the right rear door was put back on and the equipment and gear reloaded on the helicopter. They then returned to the capture site and assisted in the handling and collaring of the animal.

Telemetry packages for both the Satellite Platform Transmitter Terminal (PTT) collars and for the conventional very-high-frequency (VHF) radio telemetry collars were built by Telonics Telemetry, Electronics Consultants, 932 E. Impala Avenue, Mesa, Arizona 85204-6699, U.S.A. (App. 2-4). The PTT-year (366 days) was divided into four seasons: season 1, 70 days duration (22 Jul-30 Sep), with a 5-day duty cycle of 12 h on/108 h off; season 2, 46 days (1 Oct-15 Nov), 2-day duty cycle of 12 h on/36 h off; season 3, 180 days (16 Nov-14 May), 5-day duty cycle of 12 h on/108 h off; and season 4, 70 days (15 May-23 Jul), 2-day duty cycle of 12 h on/36 h off. The 164 MHz range was used as the VHF frequency band. Collars were colour-coated bright yellow to make them highly visible to observers and Inuit hunters.

The Argos "Data Collection and Location System" is carried by 2 National Oceanic and Atmospheric Administration (NOAA) satellites in simultaneous low earth orbit (Service Argos, 1989: ca. 800 km altitude). Each orbit period around the earth (one revolution) takes ca. 102 min; therefore, each satellite makes ca. 14 revolutions a day (with a maximum combined potential of 24 usable passes per day by the 2 satellites at north of 72^{0} N latitude). Pertinent information on satellite telemetry is thoroughly covered in Service Argos Inc. Users Manual (1988) and System Guide (1989) and in the U.S. Fish and Wildlife Service publication by Fancy et al. (1988) in which they present (1) an overview of the Argos Data Collection and location system; (2) a history of tracking wildlife by satellite; (3) description of system components, satellite transmitters, satellites used with the data collection and location system, satellite orbits, signal acquisition and transfer to processing centres, and location determination;

(4) applications to wildlife research and management, transmitter manufacturers, specifications, costs, sensor development and calibration, location accuracy and precision in wildlife applications, reliability of transmitter packages, real-time processing with a local user terminal, and effects of the collar on the animal; (5) geographic information systems; (6) a description of a software package for processing Argos data; (7) data retrieval, Argos file types (dispose files, telex files, ajour file), and Argos commands; (8) an explanation of satellite orbital elements; (9) a glossary of special terms; and (10) how to get started with Service Argos.

Argos location data are retrieved in quality "Location Classes". The highest Location Class being, Class 3, followed in descending order of quality by Class 2 and Class 1. Class 0 locations are provided as a special service and must be requested from Service Argos at extra costs. Quality control for a Class 3 location is "very strict", requires a minimum of 5 messages, with at least 420 s between first and last received messages; a Class 2 location has "standard" quality control, also requires a minimum of 5 messages, with at least 420 s between first and last received messages; and a Class 1 location has only "loose" quality control, requires a minimum of 4 messages, with at least 240 s between first and last received messages. A Class 0 location has no quality control, requires only a minimum of 2 messages, with at least 4 s and less than 240 s between the first and the last received message.

2. VHF Radio Tracking Of Collared Caribou

The Bell 206L-1 turbo-helicopter on high skid gear also was used as the VHF radio tracking aircraft. The helicopter was flown at 600 to 1500 m agl and cruising speed (ca 180km•h^{-1}) while searching for VHF radio signals in the 164 MHz range. When a collared caribou was detected close by, we descended to 30 to 60 m agl to make visual verification of the collared animal and to determine the sex/age composition of the companion animals (social grouping).

I used a 3-person tracking crew: pilot-navigator-spotter (right front seat); navigator-spotter (left front seat); and radio-tracker (right rear seat). Both the helicopter's Global Positioning System (GPS) and 1:250 000 topographical maps were used for navigation. For each collared animal located, the radio-tracker recorded: (1) date; (2) animal I.D. no.; (3) location, based on helicopter GPS; (4) composition of animals sighted, as bull, cow, calf, juvenile male, juvenile female, yearling male, or yearling female; and (5) remarks, if any. The animals were circled, if necessary, to determine their number and sex/age composition (all 3 crew members participated in the determinations).

3. Nonsystematic Helicopter Searches

I divided Bathurst Island into 12 "search zones" for the purpose of nonsystematic aerial searches: (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); (11) north coast, eastern section (NCE); and (12) Polar Bear Pass (PBP). 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). Zone 12 (Polar Bear Pass) includes all of the lowlands from the middle of the valley north to the crest of high ground and a nearly equal distance to the south from near the head of Goodsir Inlet through the pass to near the head of Bracebridge Inlet. All coastal search zones consist of strips of land that extend 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 Stratum (St.) II and St. III, 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 ca. 99° 00' W meridian (passing just west of the head of Bracebridge Inlet at the north end to just west of Dyke Ackland Bay on the south coast.

The Bell 206L-1 turbo-helicopter on high skid gear also was used as the search aircraft. The helicopter was flown at 60 to 90 m agl and air speed of ca. 96 to 180 $km \cdot h^{-1}$ during the searches (usually at cruising speed when searching for animals). Slower speeds were temporarily maintained when examining groups of caribou.

I used a 3-person aerial search team: pilot-navigator-spotter (right front seat); navigator-spotter-observer (left front seat); and a right rear seat observer-recorder. Both the helicopter's GPS and 1:250 000 topographical maps were used for navigation. The right rear seat observer recorded all observations in a field book: (1) date; (2) location; (3) composition of animal(s) sighted in each group or as solitary individuals, as bull, cow, calf, juvenile or yearling (juv. and yrl. 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).

4. Numbers, Distributions, And Movements/Migrations

Relative numbers of caribou by search zone and by island within the BIC were determined by nonsystematic helicopter searches. The maximum count obtained during a discrete search period can provide some insight into the likely seasonal population levels by island and for the entire BIC. 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 of caribou within the BIC was obtained by VHF radio tracking helicopter flights.

5. 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.

5.1. Sex/age classification

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

5.1.1. "Bulls" (mature males, assumed 4+ yr-old) are recognized in May through mid June 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 are 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. By late June the distinction between the larger antlers of bulls compared to those of juvenile males becomes more obvious, and there is no chance of confusing the two sex/age classes during July and August, with one possible exception. Males just coming of age, "borderline bulls", are classified as "bulls" when their antler growth is characterized by large-diameter main beams that are directed strongly posteriad, and considerable terminal growth on the main beam is yet to occur. When the main beams of the antlers are directed posteriorally but have already begun to curve anteriorally along the middle and terminal portions of the main axes, and the antlers, seemingly, are going to be only slightly longer than the anterio-posteriad axis of the head, from the nose to the back of the neck, the animal is classified as a "juvenile male".

5.1.2. "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 in 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 usually remains clearly recognizable into August of the year (individual variation, however, may be important after late 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). Empirical impressions formed over several years of spring and summer (May-August) aerial searches indicate that the adult cow-like characteristics ascribed to a "breeding cow" apply to all paturient females regardless of age. Therefore, a certain but unknown, and most likely annually changing, percentage of "breeding cows" in each year would actually be pregnant juvenile or yearling females. On occasion, obviously small-sized "breeding cows" are recognized but consistent comparative size distinctions over time are not currently feasible or possible. Thus, "breeding cows" represent the sum total of all females (1+ yr-old) in the population that have either produced a calf (viable or nonviable) or carried a fetus to near- or full-term in that year.

5.1.3. "Juvenile/yearling males" (males, assumed 1-3 yr-old) are recognized in May through mid June by their new pelage, and their relatively small body size (especially that of yearlings), which, 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). By late June and early July there could be some confusion between the diagnostic characteristics of some juvenile male antlers (most likely those of 2-yr olds) and those of some females, especially nonpregnant females and particularly those females just "coming of age". At this time, it appears that the most accurate basis for separation of some juvenile males from heavily antlered females lies in the comparative shapes and priorities of antler growth. That is, the growth of juvenile (and, seemingly, yearling) male antlers is directed to the development of strongly posteriorally curved main beams. When viewed from above (from a low-level helicopter) the two main beams of males are directed both backwards and outwards, the pair giving a posteriorally inclined "V-shaped" appearance from above. Such male main beams are devoid of any terminal growth of lateral tines. Most often, one or more of usually the 1st (bez) or occasionally the 2nd (trez) tine(s) are well-developed in an oblique, upwards, anteriorad direction, usually well exceeding 50% of the lineal growth of the main beams in length. The same conditions but on a smaller scale appear to apply to yearling males during the same time period (except that the terminal portion of one or both main beams may be beginning to fork). Whether our ability to identify and separate juvenile/yearling males from some cows (especially nonbreeders) or possibly even from some juvenile/yearling females is reduced in late July through August of the year is unknown.

5.1.4. "Juvenile/yearling females" (females, assumed 1-2 yr-old) are recognized in May through mid June by their new pelage, new antler growth, 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 and yearling males from juvenile and yearling females.) In late June and early July, antler growth of some juvenile females vs. some juvenile (and possibly some yearling) males becomes more difficult to separate. It appears that the main diagnostic characters of juvenile females (and nonpregnant cows) with relatively large antlers are more of form and apparently of growth priorities than of size. The main beam of the juvenile female antler tends to be more upright in its earlier stages of growth than that of the juvenile or yearling male. The main beam of a female exhibits initial curvature in an anteriorad direction at a relatively early stage compared to at least juvenile and possibly yearling males. Also, relatively little growth appears to be devoted to the development of proximal (bez and trez) tines in females, with such growth of those tines on females usually being much less than 50% of the length of the main beams. Highly stained pelage in the area of the vulva appears to be essentially characteristic of females only. The occurrence of "scours" in some juvenile or yearling males could lead to possible confusion in a few cases in most years. Group association with "breeding cows" just prior to, during, or immediately after calving, seemingly, strongly favours classification of juvenile/yearling animals of undetermined sex as females (as does association of juvenile/yearling males with bulls, but apparently to a lesser extent for juvenile/yearling males than for juvenile/yearling females associated with "breeding cows"). Whether our ability to identify and separate juvenile/yearling females from some cows (especially nonbreeders) or possibly even from some junvile/yearling males is reduced in late July through August of the year is unknown.

5.1.5. "Calves" (male or female, assumed newborn in June of the year) are obvious throughout summer 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.

5.2. 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 individual caribou are considered as one group even if they are more than 100 m apart but moved together when disturbed by the survey aircraft.

5.2.1. 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 anomaly 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 cow is 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.

5.2.2. Male-only caribou group

A "male-only caribou group" can be composed of mature males only (assumed 4+ yr-old bulls with 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.

6. Calf Production And Early Survival Of Calves

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 100 1+ yr-old females in grouped samples of different individuals obtained by aerial searches in August 1993. 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 August 1993.

RESULTS AND DISCUSSION

We carried out a reconnaissance survey on 25 and 26 July 1993 (App. 1) to cursorily determine the relative numbers and distributions of caribou on northern and southern Bathurst Island. The majority of caribou were on northern Bathurst Island, as expected from previous information and observations made in mid summer (e.g., Miller 1987a, 1989, 1991, 1992, 1993, 1994). Most of the caribou seen at that time on both northern and southern Bathurst Island were on higher elevation inland areas, apparently in response to the mid summer availability of green plants on interior plateaus at higher elevations.

1. Capture, Handling, And Collaring Of Caribou

Seventeen caribou (15 maternal cows, each with a calf at heel; and 2 bulls) were captured by aerial net-gunning (cf. Barrett, et al. 1982). We captured 10 cows on Bathurst Island, 3 cows on Alexander Island, 2 cows and 1 bull on Massey Island, and 1 bull on Ile Vanier between 27 July and 1 August 1993 (Table 1; App. 2, 3, 4). All 17 caribou were fitted with telemetry neck collars: 7 collars housed both a satellite PTT package and a VHF radio telemetry package; while the other 10 collars housed only the VHF package.

The capture effort required 31.8 h of helicopter flying time (App. 1). Searching for target animals throughout the BIC expended 88% (28 h) of the flying time devoted to the capture effort. Only 2.5 h of the flying time was needed for the actual approach and pursuit phases associated with the capture of the 17 caribou. That is, once a likely target group of caribou was sighted, the helicopter was landed, 2 crew members and extra gear were off-loaded, the right rear door was removed, and the helicopter was again airborne to start the approach.

Actual "approach time" to the target animal varied greatly, range 2 to 23 min (mean 6.2 ± 1.69 SE min). This variation resulted because several factors markedly influenced the duration of the airborne approach. The target group was lost from sight on some occasions when the helicopter was landed, and the group had to be relocated once the helicopter was again in the air. It sometimes required several minutes to do so and on 2 occasions the original group never could be relocated. We had to switch to another target group or target animal on some occasions because the original animals selected stayed on unsuitable terrain or were not responding in a manner that made the capture attempt feasible (e.g., running on a heavily rock strewn area, running downhill, running downwind during periods of strong winds, etc.). Sometimes we had to allow the target animal time to move to a better capture site. We sometimes encouraged the direction of movement on such occasions by positioning the helicopter so that the caribou would respond by moving to a suitable capture site (these attempts often were not successful). In several instances we aborted final chases because of the terrain the caribou were on or because the animals were not responding in a way that lent itself to their capture (e.g., caribou made quick turns and runs perpendicular to the helicopter's flight path, some caribou turned back under the aircraft, some caribou began to gallop recklessly upon close approach of the helicopter, etc.).

The actual "pursuit time" during the final chase leading to the capture of the animal ranged from only 1.5 to 4 min (mean 2.6 ± 0.22 SE min). I conclude that actual pursuit time should not exceed 3 $min{\cdot}event^{-1}$ and that it preferably be less (1.5 - 2.5 min) based on 1993 results. If the same animal has to be pursued more than once each chase should be restricted to a 3-min duration with at least a 5-min interval between chases. Only the 3 caribou pursued for 4 min exhibited continuous heavy, uncontrolled breathing essentially throughout their period of restraint, but the 3 had regained control over their breathing by the time they were released. All 3 of those caribou struggled frequently and often with strong bursts of leg movements throughout all or most of the time that they were restrained. Three of the 6 caribou pursued for 3 min exhibited some initial short bouts of rapid, uncontrolled breathing, interspersed with equal or longer periods of controlled breathing, and eventually continuous controlled breathing during restraint. Their struggling varied from moderate to strong brief bursts, especially during the initial period of restraint. The remaining 11 caribou, which were pursued for 1.5 to 3 min, all exhibited continuously controlled light breathing throughout the entire period of restraint. Three of those 11 caribou struggled briefly and lightly and the other 8 essentially did not struggle at all during the period of restraint. Therefore, I judge that at least 3 of the 17 caribou captured were heavily stressed, 3 others were moderately stressed, 3 were moderately to lightly stressed, and 8 were only mildly stressed during capture based on their rates and intensities of breathing and struggling during restraint.

Five of the 15 netted cows broke both of their velvet stage antlers (5-18 cm) from the fall to the ground or while initially struggling in the net (this condition appeared somewhat more prevalent, when the heavy net for the 4-barrel net-gun was used than when we used the lighter net for the 3-barrel net-gun). Four cows broke only one growing antler (5-20 cm each), with bits of velvet being scraped or ripped off the intact antler. The remaining 8 cows did not break either antler during capture but all had, at least, minor scrapes and a few had larger rips in the antler velvet from contact with sharp rocks or abrasion from the net. The 2 bulls received no antler damage during capture other than some minor scraping and ripping of the antler velvet.

Ten of the 15 maternal cows got quickly to their feet after being released by the handlers. Three of those 10 subsequently walked quietly away; 2 walked, with brief interspersed bursts of trotting; 2 trotted slowly away; 1 trotted, with interspersed brief runs; and 2 ran away without hesitation. One of the cows that rose quickly, then walked and trotted away, had a deep vertically elongated wound on the media-posterior area of the right rump (semimembranous muscle) that was bleeding severely (apparently from falling on a relatively large sharp rock, when she was brought down by the net).

The remaining 5 maternal cows that we captured all rose slowly with some degree of hesitation upon release, which was noticeable to the onlookers. Two of them walked away, 1 walked and trotted, 1 trotted, and 1 ran away from their capture sites. Two of the cows that rose slowly upon release appeared disoriented and hesitant upon rising. One of them became lively after ca. 0.5 min and trotted and ran away (it seemed that the cow could not see, when the blindfold was first removed). The other cow acted more disorientated and walked around in a circle for about 1 min, then appeared to become focused and walked and trotted away.

Evaluating how an animal rose to its feet after its release, or why it did what it did, is confounded by several factors. The positions of the 5 people (4 crew members and the pilot) around the animal; the presence of the helicopter, and especially, whether the animal focused on it upon rising; any attempt by the crew to direct the animal towards its social group (and whether the social group was still in sight or not); bright sunlight causing temporary blindness or blurred vision, when the blindfold is first removed; and other conditions, all contribute to the type and speed of the animal's response upon release. Whether an animal walks, trots, or runs away (or uses some combination of those gaits) does not appear to be related to the length of "pursuit time" or "handling time" or the apparent degree of stress experienced by the animal while restrained and being handled. Even disorientation upon release is not necessarily truly indicative of the degree of stress caused by capture, restraint, and handling. Perhaps, the best indication of a favourable event is when the animal quickly and easily rises to its feet and departs under a sure gait, regardless of whether it is a walk, trot, run or any combination thereof.

We expended 1.3 h of helicopter time on 8 unsuccessful capture attempts (in addition to the 17 successful captures). We approached and chased the target animal on 3 of those occasions but did not fire the net, because it was judged that the conditions during each attempt were not right for a favourable outcome (either due to the animal's response to the chase or the terrain of the potential capture site). The net was fired on 3 other occasions but missed each of the target animals. An additional cow was netted but escaped from under the net before crew members could get to the animal on the ground. One young bull was successfully netted but died accidentally when the tips of both antlers contacted and stuck into the soft wet ground. That is, 5 bulls were running along a flat wet area, as we flew over them in the helicopter. When the net was fired over one of them, the bull ducked its head as the net came over the top of him. Unfortunately, the main beams of the bull's antlers were just long enough for them to stick into the soft wet ground. The momentum of the running bull carried his body forward onto and severely bent his neck. The bull's neck snapped and he was essentially dead when he struck the ground. The spinal column was separated between the 1st (atlas) and 2nd (axis) cervical vertebrae just before the skull at the foramen magnum, with associated massive spinal cord damage.

Location data subsequently have been retrieved from each of the 7 PTT-collared caribou. Data from Service Argos monthly location-data computer diskettes have been consolidated in a master file. Accuracy determinations have been made for each pair of latitude/longitude values from each pass received from August through March 1994 (2 sets of location coordinates are given for each pass and the correct set must be determined and selected for future calculations). At present, "quick-map" location maps are being produced for further evaluation of satellite location-data information.

2. VHF Radio Tracking Of Collared Caribou

Weather conditions were particularly bad for VHF radio tracking flights during the first 2 weeks of August, from 2 August 1993 onward. Several snowfalls between 2 and 4 August left essentially the entire Bathurst Island complex locked in a "blanket of white". The following 10 days were subject to widespread fog cover and more or less continuous low overcast conditions that seriously hindered and usually prevented high altitude radio tracking helicopter flights. We could not fly at all on 9 of those 13 days. We attempted radio tracking flights on 3 August but they were unproductive and aborted because of deteriorating weather conditions (extensive low overcast and fog). The helicopter had to return to Resolute Bay on 13 August; however, the weather was not suitable for radio tracking flights on Bathurst Island. Aerial VHF radio tracking of caribou was only possibly on northern Bathurst Island on 5 August and southern Bathurst Island on 10 August during the first 2 weeks of the month. Nine of the 10 caribou collared on Bathurst Island were relocated by VHF radio telemetry and visually identified on northern Bathurst Island on 5 August 1993. Each of those 9 cows had been reunited with her calf and all appeared healthy (fully functional and socially accepted). The 10th cow, the one not detected on 5 August, was relocated on northeastern Bathurst Island on 15 August. Subsequently, all 10 cows were relocated and visually identified with their calves on 15 (1 on 17 Aug) and 21 August 1993.

It was 16 August 1993 before we could fly radio tracking searches over the 4 western major satellite islands of Alexander, Marc, Massey, and Vanier. All 7 caribou that had been collared on Alexander Island (3), Massey Island (3), and Ile Vanier (1) were relocated and visually identified on 16 and 21 August. The 5 cows each had a calf at heel and the 2 bulls had rejoined male-only groups. The relocations and visual identifications were of particular importance for the 2 bulls and 1 cow. The bull collared on Ile Vanier had swum across the ice-free channel from Ile Vanier to Massey Island; the bull collared on Massey Island had swum from Massey Island to Ile Marc; and most importantly, 1 of the cows collared on Massey Island had swum with her 2-month-old calf from Massey Island to Ile Marc. These crossings all involved swims of ca. 2 km or more in frigid sea water. The phenomenon of inter-island movements across the sea ice is reasonably well documented for caribou on the Arctic Islands (e.g., Miller et al. 1977b, 1982; Miller and Gunn 1978, 1980; Miller 1990a). Thus, these accounts of Peary caribou swimming between islands (Miller 1995) adds yet another dimension to the ecological adaptation of Peary caribou to life in the Canadian Arctic Archipelago.

Thus, we were able to relocate all 17 collared caribou 2-5 times each (mean 2.6 ± 0.19 SE) in 17.9 h of VHF radio tracking flights (Tables 2, 3; App. 1, 5). None of the 10 collared caribou on Bathurst Island showed any consistent unidirectional movements between capture and 21 August 1993 (Tables 2, 3). All but one of the 9 caribou captured north of Polar Bear Pass remained on the northern half of Bathurst Island throughout August. One cow captured on northeast Bathurst Island moved south of Polar Bear Pass some time between 10 and 15 August and then remained in the same general area until, at least, 21 August 1993. The one caribou captured south of Polar Bear Pass moved slightly north, but still remained south of the pass, sometime between 31 July and 5 August; then, returned further south and east of where it was captured sometime between 5 and 17 August; and was still on the southern half of Bathurst Island when last detected and seen on 21 August 1993. The greatest latitudinal change for any of those 10 caribou was ca. 38 km south for 93-14(F) sometime between 10 and 15 August and the greatest longitudinal change was ca. 18 km east between 27 July and 5 August by 93-04(F).

The same pattern or relatively localized movements was also exhibited by those 7 caribou collared on the western major satellite islands of Alexander, Massey, and Vanier (Tables 2,3). The greatest latitudinal change for any of those 7 caribou was for 93-11(F), who moved 14 km north on Alexander Island sometime between 16 and 21 August. The greatest longitudinal change was by 93-12(M), a large prime bull, who moved ca. 26 km west (and south) from Ile Vanier to Massey Island sometime between 30 July and 16 August.

The size and sex/age composition of collared caribou social groupings varied nonsignificantly in size and in no apparent set pattern in composition with time from late July 1993 to late August 1993 (Table 4). The social groups of collared caribou were the same on 14 (31%) occasions during VHF radio relocations as when the caribou were captured. On 21 (47%) other occasions the size and composition of the social groups varied in ways that could have allowed all of the original companion animals (those present at the time of capture) to still be present along with some new companions. The social groups had undoubtedly changed individuals from the time of capture on 10 occasions during VHF radio relocations. On 5 of those 10 occasions, the change involved the collared cow and her calf travelling by themselves at the time of relocation. There is some indication of possible longer term reunions among some social groups that exhibited interspersed short-term instability (Table 4).

3. Nonsystematic Helicopter Searches

We carried out 33.8 h of nonsystematic helicopter searches within the BIC between 16 and 24 August 1993 (App. 1). Bathurst Island received 87% (29.4 h) of the aerial search effort on 4 days under excellent flying and viewing conditions from 17 to 20 August 1993.

We were only able to fly searches of 3 of the 5 western major satellite islands (9%, ca. 3 h). Alexander, Marc, and Massey islands were searched on 16 August 1993 in flat light under low overcast and occasional fog patches, which sometimes hindered our effort. We could not aerially search either Ile Vanier or Cameron Island because of low cloud cover and persistent extensive fog patches over both islands. We did make one cursory exploratory flight around the coast of Ile Vanier, often nearly down to the ground in fog. We also made one flight along the south and east coast of Cameron Island in essentially the same weather conditions. No caribou were seen on either island on that date. We do know, however, from 4 east-west flights at nearly equally spaced intervals along the long axis of Ile Vanier during our capture activities on 30 July 1993 that there were at least 15 caribou (8 bulls, 4 juv. males, and 3 yrl. males) on Ile Vanier at that time. It is likely that a low number of caribou, mostly or solely males, also were on Cameron Island, as consistently has been the case on both of these islands during early and mid summer over, at least, the past several years (Miller 1987a, 1989, 1991, 1992, 1993). None of the 16 caribou seen on Ile Vanier on 30 July were included in the 1993 caribou count, as we had no way of knowing whether they were still on Ile Vanier on 16 August or had already moved elsewhere. We could not search the 2 northern major satellite islands of Helena Island and Sherard Osborne Island, as they were capped in low cloud cover and fog each time we travelled to them. We did, out of desperation, make one low-level flight around the coast of Helena and the south coast of Sherard Osborne in exceptionally poor light and frequent fog banks on 16 August and no caribou were seen. We made no attempt to search the 2 eastern major satellite islands of Cornwallis and Little Cornwallis in 1993, because of limited funding.

Eleven of the 16 secondary satellite islands were searched in 1993 (4%, 1.4 h). Moore Island in Intrepid Passage was searched on 17 August 1993. Fog prevented us from getting to Bradford Island in Graham Moore Bay on 17 August 1993, and on 2 earlier occasions. We were able however, on 17 August to search the largest island in Gramham Moore Bay, which is unnamed but we refer to it as "Bull Island". Subsequently, we were able to search 10 more of the 16 named secondary satellite islands on 24 August 1993. In Barrow Strait we searched only 3 of the 7 secondary satellite islands: Garrett, Hamilton, and Young; but Browne, Griffith, Lowther, and Somerville were not searched in 1993. In McDougall Sound we searched all 6 secondary satellite islands: Crozier, Kalivik, Milne, Neal, Truro, and Wood; and Baker Island in Intrepid Passage.

4. Numbers, Distributions, And Movements/Migrations

We counted 2400 caribou (1732 1+ yr olds and 668 calves) within the BIC between 16 and 24 August 1993 (Table 5). We saw 2273 of those caribou (1636 1+ yr olds and 637 calves) on Bathurst Island between 17 and 20 August 1993 (Tables 5-9).

Caribou on Bathurst Island showed the strongest late summer affinity for northeastern interior sites, 74% of all the caribou counted between

17 and 20 August 1993 (Tables 6-9; App. 6). Strongly significant ($P<0.005$) spatial separations as a result of the nonrandom distribution of caribou on Bathurst Island was exhibited during late summer 1993 in comparisons of numbers of caribou seen on coastal (5%) vs. interior (95%) sites, northern (93%) vs. southern (7%) areas, and eastern (86%) vs. western (14%) sections of the island (Tables 8-9; App. 6). Preference for northern over southern parts of the island is a consistent trait of, at least early and mid summer distributions of caribou on Bathurst Island from year to year (Miller 1987a, 1989, 1991, 1992, 1993, 1994). In most years the stronger selection of northeastern areas over northwestern areas also pertains. The strong late summer preference for interior sites is, however, in marked contrast to the consistent preference for coastal locations in spring and early summer.

This late summer distribution appears to be in response to the relative "freshness" of forage plants on higher interior plateaus during mid and late summer. Plant phenology within the study area progresses from lower coastal areas in early summer to the intermediate and higher coastal and interior areas in mid and late summer. The strongest visual indicator associated with the shifts in caribou distributions throughout the summer is provided by 2 plants, purple saxifrage (Saxifraga oppositifolia) and arctic poppy (Papaver radicatum). In early summer, Saxifraga oppositifolia flowers are in perfusion and many large tracks of land take on a purple hue that is quite obvious to airborne and ground observers alike. Purple saxifrage is the first forage plant to bloom and the caribou immediately turn to concentrating their grazing on the blossoms. By mid July the caribou are switching and expanding their diets to include greater amounts of different kinds of forage plants, as most of the caribou follow the progression of plant "greening" and flowering inland or to a lesser extent to higher coastal areas. Once the arctic poppy bloom is on, the caribou become strongly associated with areas dominated by blossoms of Papaver radicatum, which create a bright yellow hue that identifies such areas, especially to airborne observers. Their is some evidence that many Peary caribou return to mainly coastal areas in autumn as winter sets in (e.g., Miller and Barry 1992).

The distribution of caribou on Bathurst Island was uneven with over 92% of them on northern Bathurst and 85% of those 2105 caribou were on northeastern Bathurst vs. 315 on northwestern Bathurst. In addition, counts were made on 16 August on only 3 of the 9 major satellite islands (caribou were not counted in 1993 on Vanier, Cameron, Helena, Sherard Osborn, Little Cornwallis, and Cornwallis islands). We saw 63 caribou (49 1+ yr-olds and 14 calves) on Alexander Island; 23 caribou (19 1+ yr olds and 4 calves) on Ile Marc; and 28 caribou (16 1+ yr olds and 12 calves) on Massey Island. On 17 August, we saw 7 bulls on "Bull Island". No caribou were seen on Moore Island in Intrepid Passage on 17 August 1993. Ten more of the 16 named secondary satellite islands were searched on 24 August 1993. In Barrow Strait we saw 3 juvenile males and 1 yearling male on Young Island (no caribou were seen on Garrett or Hamilton islands). In McDougall Sound, caribou were seen only on Milne Island: 1 cow/calf pair (no caribou were seen on Crozier, Kalivik, Neal, Truro, and Wood). No caribou were seen on Baker Island on 24 August 1993 in Intrepid Passage.

5. Sex/Age Composition And Social Groupings

We carried out aerial sex/age counts of Peary caribou within the BIC between 16 and 24 August 1993 (muskoxen also were counted, App. 7). All of the caribou were classified by sex and age class: bulls, adult males 4+ yr old; juvenile males, 2-3 yr old; yearling males, 1-yr olds; breeding cows, mostly 3+ yr old (females that showed signs of having carried a fetus or produced a calf or actually had a calf at heel when seen in 1993 - maternal cows); juvenile females, 2-yr olds and possibly some 3-yr olds or a few older females that were not pregnant in 1992/93; and yearling females (1-yr olds).

We segregated 2400 caribou by 7 sex/age classes during our nonsystematic aerial searches within the BIC (Table 5). It appears, based on that sample, that the precalving BIC population of caribou approximated 18% bulls, 40% breeding cows, 15% juvenile males, 11% juvenile females, 8% yearling males, and 8% yearling females. Yearling recruitment was high at 16.5%, suggesting that at least 55% of the previous year's (1992) calves survived to their second summer of life. The late summer sex/age composition of the postcalving population was 13% bulls, 29% breeding cows, 28% calves, 11% juvenile males, 8% juvenile females, 6% yearling males, and 6% yearling females.

The sex/age structure of the overall sample of 2400 caribou is indicative of a healthy and potentially fast-growing population, with (1) 70 1+ yr-old males•100 1+ yr-old females^{-1}, (2) 65 2+ yr-old males•100 2+ yr-old females^{-1}, (3) 45 bulls•100 breeding cows^{-1}, (4) 30% of the animals in the juvenile and yearling classes, and (5) 59 1+ yr-old females•100 1+ yr-old caribou^{-1}. It now appears evident that the BIC population of Peary caribou has been in a state of growth from at least the mid 1980s and possibly from the early 1980s.

Bathurst Island contributed nearly 95% of the 2400 caribou to the overall sample and, thus, caribou on Bathurst Island closely follow the overall proportional distributions by sex and age class (Table 5). Proportional representativeness among bulls, cows, and juvenile/yearlings is nonsignificantly lower for cows and calves on the 3 western major satellite islands and the 11 secondary satellite islands sampled in 1993 than on Bathurst Island. This results in an apparently slightly lower percentage of calves (24.4%) among all 127 caribou not on Bathurst Island and also lower rates of calves at heel among those 51 females (93.9 calves:100 breeding cows, 66.0 calves:100 2+ yr-old females, and 60.8 calves:100 1+ yr-old females). The greatest discrepancy between the sex/age composition of caribou in the count from Bathurst Island vs. the count for the remainder of the BIC sampled in 1993 appears to be for yearling recruitment: Bathurst Island, 16.9% yearling recruitment or 56% survival of 1992 calves to 1-year of age vs. only 10.4% and 34.7%, respectively, for the satellite islands. The low value of yearling recruitment on the satellite islands is, however, essentially masked out in the sample for the entire BIC, due to the relatively small contribution of caribou from the satellite islands in 1993.

Caribou were nonrandomly distributed among the search zones on Bathurst Island by sex/age class during late August 1993 (Table 10). Bulls exhibited the widest-ranging preferences among search zones, with overrepresentation in 3 zones (NEI, NWI, and SEI), followed by juvenile males in 2 zones (NEI and NWI). All of the remaining 5 sex/age classes showed a preference for only the NEI. The usual June-July spatial separation by search zone between bulls (and usually juvenile males, if not also yearling males) and cows was not evident in late August 1993. This condition resulted, at least, in part from the wide distribution of bulls and juvenile males sometimes in association with cows and juvenile and yearling females in social groupings. Twenty-six percent of the bulls and 14% of the juvenile males had already begun stripping velvet from their antlers and bloodied antlers were strongly in evidence during the third week of August 1993.

Distributions by sex/age class could not be discerned for the low-density samples of caribou on the 3 western major satellite islands and the 3 secondary satellite islands where they were found in late August 1993. In past years, early and mid summer distributions on, at least, the major satellite islands indicated a general shift from coastal to interior sites as summer progressed (Miller 1991, 1992, 1993, 1994). None of the secondary satellite islands is apparently large enough or has enough terrain relief from coastal to interior areas to cause the summertime shift in caribou distribution observed on larger islands in response to the phenology of forage plants.

The sex/age composition of the population of 1+ yr-old caribou within the BIC favoured adult animals (Table 5) at 137 adults:100 juvenile/yearlings or 57.8% of all 1+ yr-old caribou were adults. There were 105.8 juvenile/yearlings:100 breeding cows or 235.8 juvenile/yearlings:100 bulls. Males were well represented at 44.9 bulls:100 breeding cows, 82.3 2+yr-old males:100 breeding cows, or 103.3 1+ yr-old males:100 breeding cows. The ratio of yearling males to yearling females, 102.8 yearling males:100 yearling females or 50.6% males among all yearlings is essentially in total agreement with the "secondary sex ratio" of 51-55 males to 45-49 females at birth for the species (e.g., Kelsall 1968, Skoog 1968, Miller 1974, 1982, Bergerud 1978).

The apparent overrepresentation of juveniles compared to yearlings cannot be fully explained with complete confidence but there are plausible considerations. Much of the apparent inflation in the number of juvenile males most likely results from the sex/age class being contributed to by, at least, 2 age classes (2-yr-old and 3-yr-old males) and possible also from a 3rd age class by some 4-yr-old bulls with relatively poor antler development. The apparent inflation in the juvenile female sex/age class could come from a contribution of unknown size of nonpregnant cows and even some cows that were pregnant but lost their fetus before, or their neonate at or about, the time of calving. Such animals could be mistakenly identified as juvenile females because of their better pelage (advanced change in pelage) and relatively advanced antler development (new growth). This condition could pertain more in 1993 that in previous years because of the timing of the segregation counts in late August 1993 compared to early July counts in past years. Although we might have erred in this direction on some few occasions, I do not believe that we consistently made this type of error in our sex/age identifications.

Caribou were seen on 448 sites within the BIC between 17 and 24 August 1993 (Tables 11, 12). Groups of two or more individuals contributed 97.8% of those observations. The remaining 2.2% of the observations were of solitary animals: 8 bulls; 1 juvenile male; and 1 juvenile female. All groups (n = 438) averaged 5.5 ± 3.16 (SD) and ranged from 2 to 26 members each: mixed sex/age groups (n = 347), mean 5.9 ± 3.31 (SD), range 2-26; and male-only groups (n = 91), mean 3.8 ± 1.63 (SD), range 2-9. Eighty-five percent (n = 2047) of all sightings were of caribou in mixed sex/age social groups; 14.3% (n = 343) were in male-only groups; and only 0.4% occurred as solitary animals. Only 3 of the 7 sex/age classes were represented by solitary individuals.

Overall, mixed sex/age groups averaged significantly larger than male-only groups (t-test; $P < 0.05$). The overall mean group size for mixed sex/age groups with calves present also averaged significantly greater than the mean for mixed sex/age groups without calves present (Table 11: t-test; $P < 0.05$). The presence of newborn calves in those groups accounted for the significant difference, when calves were excluded vs. those that had no calves (Table 11: t-test; $P > 0.05$). The largest male-only group seen was only 35% as large as the largest mixed sex/age group with calves present (9 vs. 26, respectively).

Calves were present in 97.1% (n = 337) of all mixed sex/age groups seen or 76.9% of all social groupings. Nearly 99% (n = 684) of the breeding cows were in groups with calves present, and 96% (n = 314) of all juvenile/yearling females were in those groups. Nearly 44 % of all 1-yr-old males seen (bulls = 52, juv/yrl = 292) occurred in those mixed sex/age groups with calves present. The possibility of seeing a caribou group with no females was 1 in 3.8 on average.

On an island basis, only the sample for social formations on Bathurst Island was large enough to be meaningful, and it closely followed the same general patterns exhibited in 1985 (Miller 1987a), 1988 (Miller 1989), 1989 (Miller 1991), 1990 (Miller 1992), 1991 (Miller 1993), and 1992 (Miller 1994).

6. Calf Production And Early Survival Of Calves

We obtained no direct count of initial calf production in June 1993. We can, however, assume that initial production of viable neonates had to be high in 1993, based on our late August 1993 segregation counts. Calves represented 27.8% of all caribou seen and counted in late August 1993 (Table 5). This indicates that the theoretical maximum annual rate of population growth for the species (e.g. Bergerud 1978, 1980) was, at least, closely approached in June-July 1993 and that obtaining 93% of the maximum value was still possible in late August 1993. Perhaps, of even more importance, is the exceptionally high rate of early survival of calves born in 1993. On average, 96.7 cows out of every 100 breeding cows each still had a calf at heel in late August 1993. It appears, therefore, that only ca. 3.3% of the calves born in June 1993 had died by late August 1993. This finding compares quite favourably with other reported rates of initial (perinatal and early (until Sep) calf mortalities in caribou (e.g., Tener 1961, 1963; Zhigunov 1961; Bergerud 1971, 1974, 1978, 1980; Miller 1974, 1991, 1992, 1993, 1994; Miller and Broughton 1974; Parker et al. 1975; Fischer and Duncan 1976; Miller et al. 1977a, 1988; Baskin 1983; Mauer et al. 1983, Whitten et al. 1984).

Calf:female ratios of 76.2 calves:100 2+ yr-old females and 65.6 calves:100 1+ yr-old females suggest that 92.9% and 91.1% of the average maximum expected annual rates of reproduction among female caribou still persisted in late August 1993 (based on the assumptions that (1) on average, 82% of all 2+ yr-old females should calve annually (Bergerud 1980) and (2) 72% of all 1+ yr-old females should be pregnant annually (Dauphine 1976).

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LITERATURE CITED

BARRETT, M.W.; NOLAN, J.W.; and ROY, L.D. 1982. Evaluation of a hand-held net-gun to capture large mammals. The Wildl. Soc. Bull. 10:108-114.

BASKIN, L.M. 1983. The causes of calf reindeer mortality. Acta Zool. Fenn. 175:133-134.

BERGERUD, A.T. 1961. Sex determinations of caribou calves. J. Wildl. Manage. 25:205.

___. **1964.** A field method to determine annual parturition rates for Newfoundland caribou. J. Wildl. Manage. 28:477-480.

___. **1971.** The population dynamics of Newfoundland caribou. Wildl. Monogr. 25:1-55.

___. **1974.** Decline of caribou in North America following settlement. J. Wildl. Manage. 38:757-770.

___. **1978.** Caribou. In: J.L. Schmidt and D.L. Gilbert (eds.). Big game of North America, ecology and management. Wildlife Management Institute, Washington, D.C. and Stackpole Books, Harrisburg, PA. 83-101 pp.

___. **1980.** A review of the population dynamics of caribou and wild reindeer in North America. In: E. Reimers, E. Gaare, and S. Skjenneberg (eds.). Proc. 2nd Int. Reindeer/Caribou Symp. Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 556-681 pp.

BISSETT, D. 1968. Resolute: an area economic survey (vol. II of Lancaster Sound Survey). Industrial Div., Dep. Indian Aff. and North. Dev., Ottawa. 175 pp.

BLAKE, W. Jr. 1964. Preliminary account of the glacial history of Bathurst Is., Arctic Archipelago. Geol. Surv. Can. Pap. 64-30. Queen's Printer, Ottawa. 8 pp.

DAUPHINE, T.C. 1976. Biology of the Kaminuriak Population of barren-ground caribou. Part 4: Growth, reproduction and energy reserves. Can. Wildl. Serv. Rep. Ser. No. 38. 69 pp.

DUNBAR, M.; and GREENAWAY, K.R. 1956. Arctic Canada from the air. Can. Defense Res. Board. Queen's Printer, Ottawa. 541 pp.

EDLUND, S.A. 1983. Bioclimatic zonation in a High Arctic region: central Queen Elizabeth Islands. In: Current Research, Part A, Geol. Surv. Can. Pap. 83-1A:381-390.

FANCY, S.G.; PANK, L.F.; DOUGLAS, D.C.; CURBY, C.H.; GARNER, G.W.; AMSTRUP, S.C.; and REGELIN, W.L. 1988. Satellite telemetry: a new tool for wildlife research and management. U.S. Department of the Interior, Fish and Wildlife Serv. Washington, D.C. Resource Publ. 172:1-54.

FERGUSON, M.A.D. 1987. Status of Peary caribou and muskox populations on Bathurst Island, N.W.T., August 1981. Arctic 40:131-137.

FISCHER, C.A.; and DUNCAN, E.A. 1976. Ecological studies of caribou and muskoxen in the Arctic Archipelago and northern Keewatin. Renewable Resour. Consulting Serv. Ltd., Edmonton, AB. 194 pp.

FORTIER, Y.O.; BLACKADAR, R.G.; GREINER, H.R.; MCLAREN, D.J.; MCMILLAN, N.F.; NORRIS, A.W.; ROOTS, E.F.; SOUTHER, J.G.; THORSTEINSSON, R.; and TOZER, E.T. 1963. Geology of the north-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin). Geol. Surv. Can., Ottawa, Mem. 320. 671 pp.

FREEMAN, M.M.R. 1975. Assessing movement in an Arctic caribou population. J. Environ. Manage. 3:251-257.

GUNN, A.; MILLER, F.L.; and THOMAS, D.C. 1979. Peary caribou, a status report. Can. Wildl. Serv. unpubl. rep. prepared for Committee On the Status of Endangered Wildlife In Canada (COSEWIC), Edmonton, AB. 32 pp.

___; ___; and ___. 1981. The current status and future of Peary caribou (Rangifer tarandus pearyi) on the Arctic Islands of Canada. Biol. Conserv. 19(1980-81):283-296.

KELSALL, J.P. 1968. The migratory barren-ground caribou of Canada. Can. Wildl. Serv. Monogr. No. 3. Queen's Printer, Ottawa. 339 pp.

KERR, J.W. 1974. Geology of Bathurst Island Group and Byam Martin Island, Arctic Canada (Operation Bathurst Island). Geol. Surv. Can. Mem. 378. 152 pp.

MAUER, F.J.; GARNER, G.W.; MARTIN, L.D.; and WEILER, G.J. 1983. Evaluation of techniques for assessing neonatal caribou calf mortality in the Porcupine herd. In: G.W. Garner, and P.E. Reynolds, (eds.). 1982 update report baseline study of the fish, wildlife and their habitats. U.S. Fish and Wild. Serv. Anchorage, AK. 201-226 pp.

MAXWELL, B. 1981. Climatic regions of the Canadian Arctic Islands. Arctic 34:225-240.

METEOROLOGICAL BRANCH DEPARTMENT OF TRANSPORT, CANADA. 1970. Climate of the Canadian Arctic. Can. Hydrographic Serv., Mar. Sci. Br., Dep. Energy, Mines and Resour., Ottawa. 71 pp.

MILLER, F.L. 1974. Biology of the Kaminuriak Population of barren- ground caribou. Part 2: Dentition as an indicator of sex and age; composition and socialization of the population. Can. Wildl. Serv. Rep. Ser. No. 31. 88 pp.

___. **1982.** Caribou Rangifer tarandus. In: J.A. Chapman and G.A. Feldhamer (eds.). Wild mammals of North America: biology, management, and economics. John Hopkins Univ. Press, Baltimore. 923-959 pp.

___. **1987a.** Peary caribou and muskoxen on Bathurst, Alexander, Marc, Massey, Vanier, Cameron, Helena, Lougheed, and Edmund Walker islands, Northwest Territories, July 1985. Tech. Rep. Ser. No. 20. Can. Wildl. Serv., West. & North. Reg., Edmonton, AB. 45 pp.

___. **1987b.** Peary caribou and muskoxen on Prince Patrick Island, Eglinton Island, and Emerald Isle, Northwest Territories, July 1986. Tech. Rep. Ser. No. 29. Can. Wildl. Serv., West. & North. Reg., Edmonton, AB. 65 pp.

___. **1988.** Peary caribou and muskoxen on Melville and Byam Martin islands, Northwest Territories, July 1987. Tech. Rep. Ser. No. 37. Can. Wildl. Serv., West. & North. Reg., Edmonton, AB. 58 pp.

___. **1989.** Reevaluation of the status of Peary caribou and muskox populations within the Bathurst Island complex, Northwest Territories, July 1988. Tech. Rep. Ser. No. 78. Can. Wildl. Serv., West. & North. Reg., Edmonton, AB. 86 pp.

___. **1990a.** Inter-island movements of Peary caribou: a review and appraisement of their ecological importance. In: C.R. Harington, (ed.). Canada's missing dimension: science and history in the Canadian Arctic Islands. Can. Mus. Nature, Ottawa. Vol. 2:608-632.

___. **1990b.** Peary caribou status report. Environment Canada, Can. Wildl. Serv. West. & North. Reg. Edmonton, AB. 64 pp.

___. **1991.** Peary caribou calving and postcalving periods, Bathurst Island complex, Northwest Territories, 1989. Tech. Rep. Ser. No. 118. Can. Wildl. Serv. West. & North. Reg. Edmonton, AB. 72 pp.

___. **1992.** Peary caribou calving and postcalving periods, Bathurst Island complex, Northwest Territories, Canada, 1990. Tech. Rep. Ser. No. 151. Can. Wildl. Serv. West. & North. Reg. Edmonton, AB. 87 pp.

___. **1993.** Peary caribou calving and postcalving periods, Bathurst Island complex, Northwest Territories, Canada, 1991. Tech. Rep. Ser. No. 166. Can. Wildl. Serv. West. & North. Reg. Edmonton, AB. 99 pp.

___. **1994.** Peary caribou calving and postcalving periods, Bathurst Island complex, Northwest Territories, 1992. Tech. Rep. Ser. No. 186. Can. Wildl. Serv. Prairie & North. Reg., Edmonton, AB. 99 pp.

___. **1995.** Inter-island water crossings by Peary caribou, south-central Queen Elizabeth Islands. Arctic 48:8-12.

___; **and BARRY, S.J. 1992.** Nonrandom distribution of antlers cast by Peary caribou bulls, Melville Island, Northwest Territories. Arctic 45:252-257.

___; **and BROUGHTON, E. 1974.** Calf mortality on the calving grounds of the Kaminuriak caribou. Can. Wildl. Serv. Rep. Ser. No. 26. 26 pp.

___; ___; **and GUNN, A. 1988.** Mortality of migratory barren-ground caribou on the calving grounds of the Beverly herd, Northwest Territories, 1981-83. Can. Wildl. Serv. Occas. Pap. No. 66. 26 pp.

___; **EDMONDS, E.J.; and GUNN, A. 1982.** Foraging behaviour of Peary caribou in response to springtime snow and ice conditions. Can. Wildl. Serv. Occas. Pap. No. 48. 41 pp.

___; **and GUNN, A. 1978.** Inter-island movements of Peary caribou south of Viscount Melville Sound, Northwest Territories. Can. Field-Natur. 92:327-333.

___; **and ___. 1980.** Inter-island movements of Peary caribou (Rangifer tarandus pearyi) south of Viscount Melville Sound and Barrow Strait, Northwest Territories, Canada. In: E. Reimers, E. Gaare and S. Skjenneberg, (eds.). Proceedings Second International Reindeer/Caribou Symposium, Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 99-114 pp.

___; **RUSSELL, R.H.; and GUNN, A. 1977a.** Distributions, movements and numbers of Peary caribou and muskoxen on western Queen Elizabeth Islands, Northwest Territories, 1972-74. Can. Wildl. Serv. Rep. Ser. No. 40. 55 pp.

___; ___; **and ___. 1977b.** Interisland movements of Peary caribou (Rangifer tarandus pearyi) on western Queen Elizabeth Islands, Arctic Canada. Can. J. Zool. 55:1029-1037.

PARKER, G.R.; THOMAS, D.C.; MADORE, P.L.; and GRAY, D.R. 1975. Crashes of muskox and Peary caribou populations in 1973-74 in the Parry Islands, Arctic Canada. Can. Wildl. Serv. Prog. Notes No. 56. 10 pp.

POTTER, J.G. 1965. Snow cover. Dep. Transport, Meteorol. Br., Ottawa. Climatol. Stud. No. 3. 69 pp.

SAVILE, D.B.O. 1961. The botany of the northwestern Queen Elizabeth Islands. Can. J. Bot. 39:909-942.

SERVICE ARGOS INC. 1988. User manual. Version 1. Landover, MD, USA.

SERVICE ARGOS INC. 1989. System guide. Issue 1. Landover, MD, USA.

SKOOG, R.O. 1968. Ecology of the caribou (Rangifer tarandus granti) in Alaska. Ph. D. Thesis, Univ. California, Berkeley. 699 pp.

TENER, J.S. 1961. Queen Elizabeth Islands game survey. Can. Wildl. Serv. Rep. CWSC 972. 94 pp.

___. **1963.** Queen Elizabeth Islands game survey, 1961. Can. Wildl.Serv. Occas. Pap. No. 4. 50 pp.

THOMPSON, J. 1971. A comparison of meteorological observations from May 1970 through April 1971, National Museum Bathurst Island Station 75°43'N 98°25'W, Resolute Airport 74°43'N 94°59'W. Atmos. Environ. Serv. unpub. rep. 15 pp.

THORSTEINSSON, R. 1958. Cornwallis and Little Cornwallis islands, District of Franklin, Northwest Territories. Geol. Surv. Can. Mem. 294. 134 pp.

WEIN, R.W.; and RENCZ, A.N. 1976. Plant cover and standing crop sampling procedures for the Canadian High Arctic. Arctic and Alpine Res. 8:139-150.

WHITTEN, K.R.; GARNER, G.W.; and MAUER, F.J. 1984. Calving distribution, initial productivity and neonatal mortality of the Porcupine caribou herd, 1983. In: G.W. Garner, and P.E. Reynolds (eds.). 1983 update report baseline study of the fish, wildlife and their habitats. U.S. Fish and Wildl. Serv. Anchorage, AK. 201-226 pp.

ZHIGUNOV. P.S. (ed.). 1961. Reindeer husbandry. (Translated from Russian) Publ. for U.S. Dep. Inter. and Natl. Sci. Found., Washington, D.C. by Israel Program Sci. Trans. Jerusalem, 1968. 2nd rev. edition. 348 pp.

Table 1. Peary caribou captured by aerial net-gunning, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, 27 July-1 August 1993 (all females were maternal cows, each with a calf at heel; and both males were prime bulls)

		Handling time (min)	Collar type	PTT ID no.	VHF frequency (MHz)
Bathurst	F	15	PTT	10800	164.040
		14		10801	.170
		16		10802	.180
		15		10803	.240
		16		10804	.260
		15	VHF	-	.570
		16		-	.590
		17		-	.610
		16		-	.650
		22		-	.660
Vanier	M	20		-	.540
Massey	F	18	PTT	10805	.280
		19	VHF	-	.000
	M	16	PTT	05029	.320
Alexander	F	17	VHF	-	.300
		19		-	.420
		17		-	.460

Table 2. Locations and distances travelled by 17 collared caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, July-August 1993 (data obtained by non-systematic VHF radio tracking helicopter flights)

Animal I.D. (sex) Island	Date 1993	Location[a]		Distance travelled[b]	
		Latitude	Longitude	Latitude	Longitude
93-1	27 Jul[c]	76.096	98.138	-	-
(female)	5 Aug	76.032	98.597	0.064S	0.459W
Bathurst	15 Aug	75.968	98.546	0.064S	0.051E
	21 Aug	76.292	98.735	0.324N	0.189W
93-2	27 Jul	76.180	98.192	-	-
(female)	5 Aug	76.099	98.552	0.081S	0.360W
Bathurst	15 Aug	75.977	98.568	0.122S	0.016W
	21 Aug	76.022	98.451	0.045N	0.117E
93-3	27 Jul	75.984	98.398	-	-
(female)	5 Aug	76.002	98.442	0.018N	0.044W
Bathurst	15 Aug	76.006	98.230	0.004N	0.212E
	21 Aug	76.035	98.435	0.029N	0.205W
93-4	27 Jul	76.024	99.238	-	-
(female)	5 Aug	76.106	98.580	0.028N	0.658E
Bathurst	15 Aug	75.900	98.429	0.206S	0.151E
	21 Aug	75.968	98.717	0.068N	0.288W
93-5	27 Jul	76.358	99.201	-	-
(female)	15 Aug	76.114	98.599	0.244S	0.602E
Bathurst	21 Aug	76.164	98.868	0.050N	0.269W
93-6	29 Jul*	75.926	103.614	-	-

Continued

Table 2. Continued

Animal I.D. (sex) Island	Date 1993	Location[a] Latitude	Location[a] Longitude	Distance travelled[b] Latitude	Distance travelled[b] Longitude
(female)	16 Aug**	75.850	103.720	0.076S	0.106W
Massey*	21 Aug**	75.869	103.764	0.019N	0.044W
Marc**					
93-7	29 Jul	75.926	103.670		
(female)	16 Aug	75.928	103.817	0.002N	0.245W
Massey	21 Aug	75.971	103.239	0.043N	0.578E
93-8	29 Jul*	75.930	103.696	-	-
(male)	16 Aug**	75.880	103.452	0.050S	0.245E
Massey*	21 Aug	75.876	103.688	0.004S	0.236W
Marc**					
93-9	29 Jul	75.954	102.138	-	-
(female)	16 Aug	75.947	102.098	0.007S	0.040E
Alexander	21 Aug	75.940	102.138	0.007S	0.040W
93-10	30 Jul	75.894	102.706	-	-
(female)	16 Aug	75.866	102.646	0.028S	0.060E
Alexander	21 Aug	75.943	102.396	0.077N	0.250E
93-11	30 Jul	75.825	102.717	-	-
(female)	16 Aug	75.806	102.929	0.019S	0.212W
Alexander	21 Aug	75.932	102.568	0.126N	0.361E
93-12	30 Jul*	76.098	103.735	-	-
(male)	16 Aug**	75.985	102.788	0.113S	0.947W

Continued

Table 2. Continued

Animal I.D. (sex) Island	Date 1993	Location[a]		Distance travelled[b]	
		Latitude	Longitude	Latitude	Longitude
Vanier*	21 Aug**	75.940	103.534	0.045S	0.746E
Massey**					
93-13	31 Jul	75.536	98.748	-	-
(female)	5 Aug	75.548	98.705	0.012N	0.043E
Bathurst	17 Aug	75.211	98.665	0.337S	0.040E
	21 Aug	75.318	98.870	0.107N	0.205W
93-14	1 Aug	75.848	98.458	-	-
(female)	5 Aug	75.812	98.240	0.036S	0.218E
Bathurst	10 Aug	75.785	98.281	0.027S	0.041W
	15 Aug	75.447	98.463	0.338S	0.182W
	17 Aug	75.447	98.478	0.000	0.015W
	21 Aug	75.444	98.476	0.003S	0.002E
93-15	1 Aug	76.071	98.056	-	-
(female)	5 Aug	76.209	97.800	0.138N	0.256E
Bathurst	15 Aug	75.994	98.181	0.215S	0.381W
	21 Aug	76.029	98.147	0.035N	0.034E
93-16	1 Aug	76.228	98.675	-	-
(female)	5 Aug	76.263	98.904	0.035N	0.229W
Bathurst	15 Aug	76.149	98.764	0.114S	0.140E
	21 Aug	76.123	99.092	0.026S	0.328W

Continued

Table 2. Continued

Animal I.D. (sex) Island	Date 1993	Location[a]		Distance travelled[b]	
		Latitude	Longitude	Latitude	Longitude
93-17	1 Aug	76.454	98.468	-	-
(female)	5 Aug	76.416	98.704	0.038S	0.236W
Bathurst	15 Aug	76.179	98.526	0.237S	0.178E
	21 Aug	76.239	98.794	0.060N	0.268W

[a] Locations given in degrees to 1/1000th of a degree.
[b] Distance travelled given in 1/1000th of a degree, followed by direction of travel: N equals north, S equals south, E equals east, W equals west.
[c] First date given for each animal is the location of the capture site taken from the helicopter Global Positioning System.

Table 3. Minimal distances moved by collared caribou between VHF radio relocations, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, July-August 1993

Animal I.D. (sex)[a] Island	1993	Distance travelled: Latitude N (km)	Latitude N Dir.[b]	Longitude W (km)	Longitude W Dir.[b]	Shortest straight-line distance (km)	Shortest straight-line distance Dir.[b]
93-1 (F)	05 Aug	7.1	S	12.4	W	14.3	W/SW
Bathurst	15 Aug	7.1	S	1.4	E	7.3	S/SE
	21 Aug	36.1	N	5.0	W	36.5	N/NW
93-2 (F)	05 Aug	9.0	S	9.6	W	13.2	W/SW
Bathurst	15 Aug	13.6	S	0.4	W	13.6	S/SW
	21 Aug	5.0	N	3.2	E	5.9	N/NE
93-3 (F)	05 Aug	2.0	N	1.2	W	2.3	N/NW
Bathurst	15 Aug	0.4	N	5.7	E	5.7	E/NE
	21 Aug	3.2	N	5.5	W	6.4	W/NW
93-4 (F)	05 Aug	9.1	N	17.6	E	19.8	E/NE
Bathurst	15 Aug	23.0	S	4.1	E	23.3	S/SE
	21 Aug	7.6	N	7.8	W	10.9	W/NW
93-5 (F)	15 Aug	27.2	S	16.1	E	31.6	S/SE
Bathurst	21 Aug	5.6	N	7.2	W	9.1	W/NW
93-6 (F)	16 Aug	8.5	S	2.9	W	9.0	S/SW
Marc	21 Aug	2.1	N	1.2	W	2.4	N/NW
93-7 (F)	16 Aug	5.6	S	6.7	E	8.7	E/SE
Massey	21 Aug	0.4	S	6.4	W	6.5	W/SW
93-8 (M)	16 Aug	0.2	N	6.4	W	6.4	W/NW

Continued

Table 3. Continued

Animal I.D. (sex)[a] Island	1993	Distance travelled Latitude N (km)	Dir.[b]	Longitude W (km)	Dir.[b]	Shortest straight-line distance (km)	Dir.[b]
Marc	21 Aug	4.8	N	15.6	E	16.3	E/NE
93-9 (F)	16 Aug	0.8	S	1.1	E	1.3	E/SE
Alexander	21 Aug	0.8	S	1.1	W	1.4	W/SW
93-10 (F)	16 Aug	3.1	S	1.6	E	3.5	S/SE
Alexander	21 Aug	8.6	N	6.8	E	10.9	N/NE
93-11 (F)	16 Aug	2.1	S	5.8	W	6.2	W/SW
Alexander	21 Aug	14.0	N	9.8	E	17.1	N/NE
93-12 (M)	16 Aug	12.6	S	25.6	W	28.5	W/SW
Massey	21 Aug	5.0	S	20.2	E	20.9	E/SE
93-13 (F)	05 Aug	1.3	N	1.2	E	1.8	N/NE
Bathurst	17 Aug	37.6	S	1.1	E	37.6	S/SE
	21 Aug	11.9	N	5.9	W	13.3	N/NW
93-14 (F)	05 Aug	4.0	S	6.0	E	7.1	E/SE
Bathurst	10 Aug	3.0	S	1.1	W	3.2	S/SW
	15 Aug	37.7	S	5.2	W	38.0	S/SW
	17 Aug	0.0	-	0.4	W	0.4	W
	21 Aug	0.3	S	0.1	E	0.3	S/SE
93-15 (F)	05 Aug	15.4	N	6.8	E	16.8	N/NE
Bathurst	15 Aug	24.0	S	10.3	W	24.9	S/SW
	21 Aug	3.9	N	0.9	E	4.0	W/NW

Continued

Table 3. Continued

Animal I.D. (sex)[a] Island	1993	Distance travelled: Latitude N (km)	Dir.[b]	Longitude W (km)	Dir.[b]	Shortest straight-line distance (km)	Dir.[b]
93-16 (F)	05 Aug	3.9	N	6.0	W	8.2	W/NW
Bathurst	15 Aug	12.7	S	3.7	E	15.6	S/SE
	21 Aug	2.9	S	8.8	W	9.2	W/SW
93-17 (F)	05 Aug	4.2	S	6.1	W	7.4	W/SW
Bathurst	15 Aug	26.4	S	4.7	E	26.8	S/SE
	21 Aug	6.7	N	7.1	W	9.7	W/NW

[a] Sex: female (F); and male (M).
[b] Direction: Dir.

Table 4. Size and sex/age composition for each social grouping with a collared caribou present, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, July-August 1993 (data obtained at time of capture and subsequently during each VHF relocation)

		Sex/age composition							
Animal I.D. (sex)[a]	Date 1993	Bull	Cow	Calf	Juv.[b] M[a]	Juv. F[a]	Yrl.[b] M	Yrl. F	Group size
93-1 (F)	27 Jul		2	2					4
	05 Aug		3	3	1	1	1		9
	15 Aug		2	2					4
	21 Aug	1	3	3	1	1	1		10
93-2 (F)	27 Jul		1	1		1			3
	05 Aug		3	3		1		1	8
	15 Aug		2	2					4
	21 Aug		2	2	3	2		2	11
93-3 (F)	27 Jul		3	3				1	7
	05 Aug		1	1					2
	15 Aug		1	1					2
	21 Aug		3	3	2			1	9

Continued

Table 4. Continued

Animal I.D. (sex)[a]	Date 1993	Sex/age composition: Bull	Cow	Calf	Juv.[b] M[a]	Juv. F[a]	Yrl.[b] M	Yrl. F	Group size
93-4 (F)	27 Jul		1	1					2
	05 Aug		12	11					23
	15 Aug		5	5		3		1	14
	21 Aug		1	1					2
93-5 (F)	27 Jul		3	3					6
	15 Aug		2	1				1	4
	21 Aug	2	6	6		1		1	16
93-6 (F)	29 Jul		3	3					6
	16 Aug		3	3					6
	21 Aug	1	2	2	2		1		8
93-7 (F)	29 Jul		1	1					2
	16 Aug		1	1					2
	21 Aug		3	2	2	1			8

Continued

Table 4. Continued

Animal I.D. (sex)[a]	Date 1993	Sex/age composition: Bull	Cow	Calf	Juv.[b] M[a]	Juv. F[a]	Yrl.[b] M	Yrl. F	Group size
93-8 (F)	29 Jul	4			1				5
	16 Aug	4			1				5
	21 Aug	4							4
93-9 (F)	29 Jul		2	2					4
	16 Aug		2	2					4
	21 Aug		3	3					6
93-10) (F)	30 Jul		1	1					2
	16 Aug		3	3		1			7
	21 Aug		3	3		3	1	1	11
93-11 (F)	30 Jul		2	2					4
	16 Aug		2	2					4
	21 Aug		1	1				1	3

Continued

Table 4. Continued

Animal I.D. (sex)[a]	Date 1993	Sex/age composition							Group size
		Bull	Cow	Calf	Juv.[b] M[a]	Juv. F[a]	Yrl.[b] M	Yrl. F	
93-12 (M)	30 Jul	7			1				8
	16 Aug	7			1				8
	21 Aug	4	1	1	1				7
93-13 (F)	31 Jul		2	2		2		1	7
	05 Aug		4	2		3		2	11
	17 Aug		2	2		2			6
	21 Aug		3	3				1	7
93-14 (F)	01 Aug		2	2	2				6
	05 Aug	1	3	3		1			8
	10 Aug		2	2					4
	15 Aug		2	2					4
	17 Aug		2	2					4
	21 Aug		2	2					4

Continued

Table 4. Continued

Animal I.D. (sex)[a]	Date 1993	Bull	Cow	Calf	Juv.[b] M[a]	Juv. F[a]	Yrl.[b] M	Yrl. F	Group size
		Sex/age composition							
93-15 (F)	01 Aug		2	2	1				5
	05 Aug		1	1	1				3
	15 Aug		1	1					2
	21 Aug		1	1					2
93-16 (F)	01 Aug		3	3	3	1			10
	05 Aug		2	2					4
	15 Aug		7	7		4			18
	21 Aug		3	3	2				8
93-17 (F)	01 Aug		1	1					2
	05 Aug		1	1					2
	15 Aug		3	3		3			9
	21 Aug		2	2					4

[a] Sex: male (M); and female (F).
[b] Juveniles (Juv.) and yearlings (Yrl.).

Table 5. Numbers and sex/age composition counts of Peary caribou, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, 1993

	Sex/age composition								Search
Date (month/day)	Bulls	Cows	Calves	Juv.[a] M[b]	Juv. F[b]	Yrl.[a] M	Yrl. F	N	effort (min)
Bathurst Island									
08/17-08/21	287	658	637	243	172	139	137	2273	1765
Alexander Island									
08/16	9	16	14	10	7	5	2	63	91
Ile Marc									
08/16	7	4	4	1	5	0	2	23	22
Massey Island									
08/16	0	12	12	2	2	0	0	28	65
Alexander, Marc and Massey islands									
08/16	16	32	30	13	14	5	4	114	178
Bathurst Island plus 3 western satellite islands									
08/16-08/21	303	690	667	256	186	144	141	2387	1943

Continued

Table 5. Continued

Date (month/day)	Sex/age composition								Search effort (min)
	Bulls	Cows	Calves	Juv.[a] M[b]	Juv. F[b]	Yrl.[a] M	Yrl. F	N	
Secondary satellite islands (n=11)									
08/17 & 08/24	7	1	1	3	0	1	0	13	85
Bathurst Island complex (all of the above)									
08/16-08/24	310	691	668	259	186	145	141	2400	2028

[a] Juveniles (Juv.) and yearlings (Yrl.).
[b] Sex: male (M); and female (F).

Table 6. Aerial counts of Peary caribou by 12 search zones on Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993

Search zone[a]	Caribou seen: 1+ yr olds	Caribou seen: calves	Zone total	% calves	Caribou (•100 min $^{-1}$)
NEC	27	9	36	25.0	80.0
NEI	1180	503	1683	29.9	278.6
SEC	0	0	0	-	0.0
SEI	126	30	156	19.2	133.3
SC	0	0	0	-	0.0
SWC	0	0	0	-	0.0
SWI	9	3	12	3/12[b]	12.0
NWC	7	1	8	1/8	9.1
NWI	236	68	304	22.4	113.8
NCW	2	1	3	1/3	2.3
NCE	49	22	71	31.0	45.5
PBP	0	0	0	-	0.0

[a] 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-west section; NCE, north coast-east section; PBP, Polar Bear Pass.

[b] Fractions given instead of percentages, when total caribou seen in search zone equal less than 30 animals to avoid possible distortion of proportions.

Table 7. Percentage distribution of Peary caribou compared to landmass of each of the 12 search zones, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993

Search zone[a]	% of total caribou	% of total land area	Expected caribou by land area	Observed/ expected Index
NEC	1.6	2.7	61.37	0.59
NEI	74.0	25.9	588.70	2.86
SEC	0.0	4.9	111.38	0.00
SEI	6.9	9.5	215.94	0.72
SC	0.0	3.2	72.74	0.00
SWC	0.0	4.1	93.19	0.00
SWI	0.5	9.4	213.66	0.06
NWC	0.4	5.8	131.83	0.06
NWI	13.4	12.9	293.22	1.04
NCW	0.1	6.6	150.02	0.02
NCE	3.1	10.4	236.39	0.30
PBP	0.0	4.6	104.56	0.00

[a] 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; NCE, north coast, eastern section; PBP, Polar Bear Pass.

Table 8. Rate of occurrence of Peary caribou by major land divisions, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993

Number divisions	Number of different caribou sighted	Time spent searching (min)	Rate of occurrence (caribou•100 min^{-1})
Coastal vs.	115	677	17.0
interior***	2158	1088	198.3
North*** vs.	2105	1342	156.8
south	168	423	39.7
East*** vs.	1946	1037	187.6
west	327	728	44.9

*** Caribou overrepresented by relative size of land division and by rate of occurrence in comparison ($P < 0.005$).

Table 9. Distribution of 2273 Peary caribou by major land divisions, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993 (data obtained by nonsystematic helicopter searches)

Land area	% of total caribou seen	% of total land area	Expected sightings based on land area	Observed/ expected caribou index
Coastal vs.	5.1	42.3	961.48	0.12
interior	94.9	57.7***	1311.52	1.64
North vs.	92.6	66.6***	1513.82	1.39
south	7.4	33.4	759.18	0.22
East vs.	85.6	57.3***	1302.43	1.49
west	14.4	42.7	970.57	0.34

*** Caribou overrepresented in paired comparison ($P<0.005$).

Table 10. Sex/age composition, numbers and distributions of Peary caribou by search zones, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993 (data obtained by nonsystematic helicopter searches)

Search zone[a]	Time (min)	Sex/age composition: Bull	Cow	Calf	Juv.[b] male	Juv. female	Yrl.[b] male	Yrl. female	Total caribou	Caribou (•100 min^{-1})
NEC	45	6	9	9	9	0	2	1	36	80.0
NEI	604	164**	518**	503**	170**	111**	121**	96**	1683**	278.6
SEC	52	0	0	0	0	0	0	0	0	0.0
SEI	117	45**	32	30	11	22	2	14	156	133.3
SC	42	0	0	0	0	0	0	0	0	0.0
SWC	78	0	0	0	0	0	0	0	0	0.0
SWI	100	2	4	3	0	2	0	1	12	12.0
NWC	88	5	1	1	0	0	1	0	8	9.1
NWI	267	54**	70	68	48**	32	9	23	304	113.8
NCW	132	0	1	1	0	1	0	0	3	2.3
NCE	156	11	23	22	5	4	4	2	71	45.5
PBP	84	0	0	0	0	0	0	0	0	0.0

Continued

Table 10. Continued

[a] 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; NCE, north coast, eastern section; and PBP, Polar Bear Pass.

[b] Juveniles (Juv.) and yearlings (Yrl.).

** Significant at (P<0.005).

Table 11. Group statistics for Peary caribou social formations, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, August 1993 (data obtained from nonsystematic helicopter searches)

		Group statistics				
Island	Group type	N	Mean	± SD	Range	95% CI
Bathurst	Male-only groups	84	3.7	1.64	2- 9	3.35-4.05
	All mixed sex/age groups	332	5.9	3.30	2-26	5.52-6.23
	Mixed sex/age groups with calves	332	5.9	3.31	2-26	5.59-6.31
	calves included	322	5.9	3.31	2-26	5.59-6.31
	calves excluded	322	4.0	2.38	1-15	3.71-4.23
	Mixed sex/age groups without calves	10	3.7	1.64	2- 7	2.53-4.87
	Solitary individuals	10				
Alexander	Male-only groups	4	4.0	0.82	3- 5	2.70- 5.30
	All mixed sex/age groups	6	7.8	3.87	4-14	3.77-11.89
	Mixed sex/age groups with calves	6	7.8	3.87	4-14	3.77-11.89
	calves included	6	7.8	3.87	4-14	3.77-11.89
	calves excluded	6	5.5	2.88	3-10	2.48- 8.52
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				

Continued

Table 11. Continued

Island	Group type	N	Mean	± SD	Range	95% CI
		Group statistics				
Marc	Male-only groups	1	5.0	0.00	5- 5	5.00- 5.00
	All mixed sex/age groups	2	9.0	5.66	5-13	-41.82-59.82
	Mixed sex/age groups with calves	2	9.0	5.66	5-13	-41.82-59.82
	calves included	2	9.0	5.66	5-13	-41.82-59.82
	calves excluded	2	7.0	4.24	4-10	-31.12-45.12
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				
Massey	Male-only groups	0				
	All mixed sex/age groups	6	4.7	2.42	2-8	2.12-7.21
	Mixed sex/age groups with calves	6	4.7	2.42	2-8	2.12-7.21
	calves included	6	4.7	2.42	2-8	2.12-7.21
	calves excluded	6	2.7	1.86	1-6	0.71-4.62
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				

Continued

Table 11. Continued

Island	Group type	Group statistics: N	Mean	± SD	Range	95% CI
Young	Male-only groups	1	4.0	0.00	4-4	4.00-4.00
	All mixed sex/age groups	0				
	Mixed sex/age groups with calves	0				
	calves included	0				
	calves excluded	0				
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				
Milne	Male-only groups	0				
	All mixed sex/age groups	1	2.0	0.00	2-2	2.00-2.00
	Mixed sex/age groups with calves	1	2.0	0.00	2-2	2.00-2.00
	calves included	1	2.0	0.00	2-2	2.00-2.00
	calves excluded	1	1.0	0.00	1-1	1.00-1.00
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				

Table. 12. Group statistics for Peary caribou social formations by search zones, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, August 1993 (data obtained from nonsystematic helicopter searches)

		Group statistics				
Island	Group type	N	Mean	± SD	Range	95% CI
Northeast coast	Male-only groups	2	5.0	1.41	4- 6	-7.71-17.71
	All mixed sex/age groups	5	5.2	3.11	2-10	1.33- 9.07
	Mixed sex/age groups with calves	5	5.2	3.11	2-10	1.33- 9.07
	calves included	5	5.2	3.11	2-10	1.33- 9.07
	calves excluded	5	3.4	2.07	1- 6	0.83- 5.97
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				
Northeast interior	Male-only groups	45	3.7	1.54	2- 7	3.22- 4.12
	All mixed sex/age groups	255	5.9	3.04	2-19	5.55- 6.30
	Mixed sex/age groups with calves	247	6.0	3.06	2-19	5.60- 6.37
	calves included	247	6.0	3.06	2-19	5.60- 6.37
	calves excluded	247	3.9	2.21	1-14	3.67- 4.22
	Mixed sex/age groups without calves	8	4.1	1.55	2- 7	2.83- 5.42
	Solitary individuals	7				

Continued

Table 12. Continued

Island	Group type	Group statistics N	Mean	± SD	Range	95% CI
Southeast interior	Male-only groups	13	3.9	2.02	2- 8	2.70- 5.14
	All mixed sex/age groups	26	4.0	1.82	2-10	3.23- 4.70
	Mixed sex/age groups with calves	25	4.0	1.81	2-10	3.29- 4.79
	calves included	25	4.0	1.81	2-10	3.29- 4.79
	calves excluded	25	2.8	1.65	1- 8	2.16- 3.52
	Mixed sex/age groups without calves	1	2.0	0.00	2- 2	2.00- 2.00
	Solitary individuals	2				
Southwest interior	Male-only groups	1	2.0	0.00	2- 2	2.00- 2.00
	All mixed sex/age groups	1	10.0	0.00	10-10	10.00-10.00
	Mixed sex/age groups with calves	1	10.0	0.00	10-10	10.00-10.00
	calves included	1	10.0	0.00	10-10	10.00-10.00
	calves excluded	1	7.0	0.00	7- 7	7.00- 7.00
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				

Continued

Table 12. Continued

Island	Group type	Group statistics N	Mean	± SD	Range	95% CI
Northwest coast	Male-only groups	2	3.0	0.00	3- 3	3.00- 3.00
	All mixed sex/age groups	1	2.0	0.00	2- 2	2.00- 2.00
	Mixed sex/age groups with calves	1	2.0	0.00	2- 2	2.00- 2.00
	calves included	1	2.0	0.00	2- 2	2.00- 2.00
	calves excluded	1	1.0	0.00	1- 1	1.00- 1.00
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				
Northwest interior	Male-only groups	18	3.5	1.76	2- 9	2.63- 4.37
	All mixed sex/age groups	35	6.9	3.81	2-20	5.59- 8.12
	Mixed sex/age groups with calves	34	7.0	3.77	2-20	5.73- 8.27
	calves included	34	7.0	3.77	2-20	5.73- 8.27
	calves excluded	34	5.0	3.02	1-14	3.99- 6.01
	Mixed sex/age groups without calves	1	2.0	0.00	2- 2	2.00- 2.00
	Solitary individuals	1				

Continued

Table 12. Continued

		Group statistics				
Island	Group type	N	Mean	± SD	Range	95% CI
North coast, west section	Male-only groups	0				
	All mixed sex/age groups	1	3.0	0.00	3-3	3.00-3.00
	Mixed sex/age groups with calves	1	3.0	0.00	3-3	3.00-3.00
	calves included	1	3.0	0.00	3-3	3.00-3.00
	calves excluded	1	2.0	0.00	2-2	2.00-2.00
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				
North coast, east section	Male-only groups	3	4.7	1.53	3- 6	0.87- 8.46
	All mixed sex/age groups	8	7.1	7.95	2-26	0.47-13.78
	Mixed sex/age groups with calves	8	7.1	7.95	2-26	0.47-13.78
	calves included	8	7.1	7.95	2-26	0.47-13.78
	calves excluded	8	4.4	4.57	1-15	0.56- 8.19
	Mixed sex/age groups without calves	0				
	Solitary individuals	0				

[a] No caribou were seen in four of the 12 search zones: Southeast coast; South coast; Southwest coast; and Polar Bear Pass.

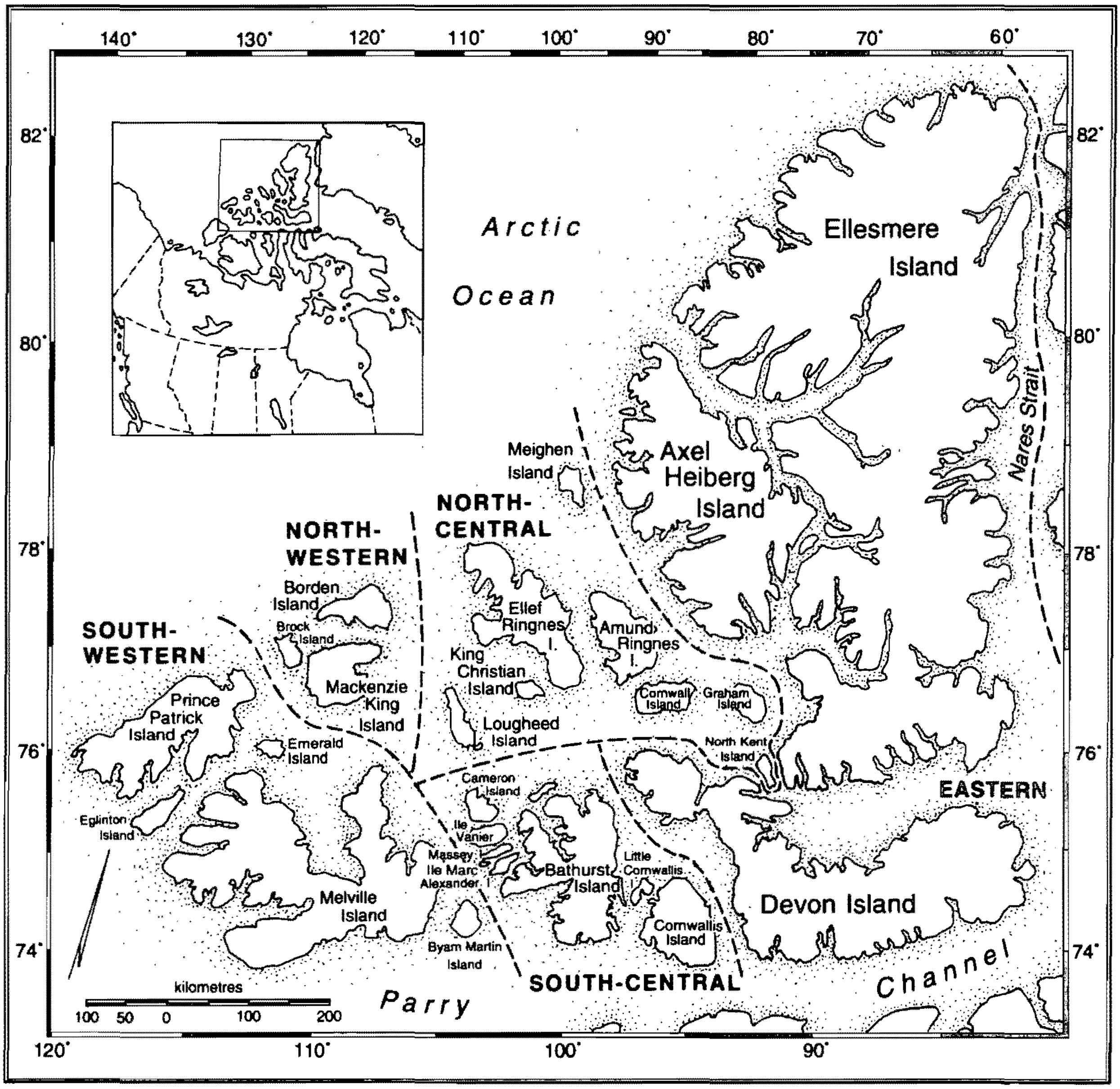

Fig. 1. Queen Elizabeth Islands of the Canadian Arctic Archipelago

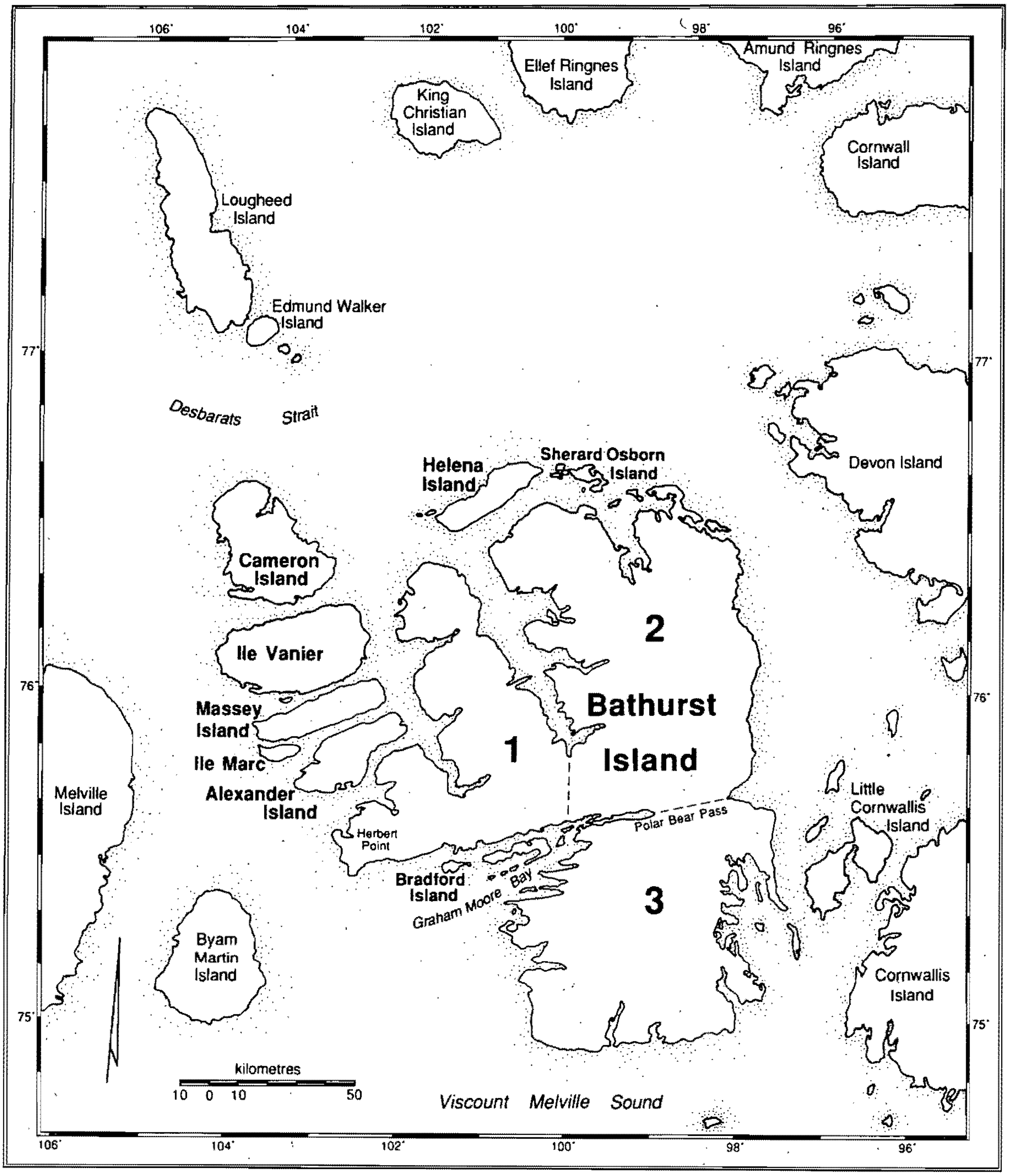

Fig. 2. Locations of nine of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the principal island, Bathurst; the five western major satellite islands, Alexander, Marc, Massey, Vanier, and Cameron; the two northern major satellite islands,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

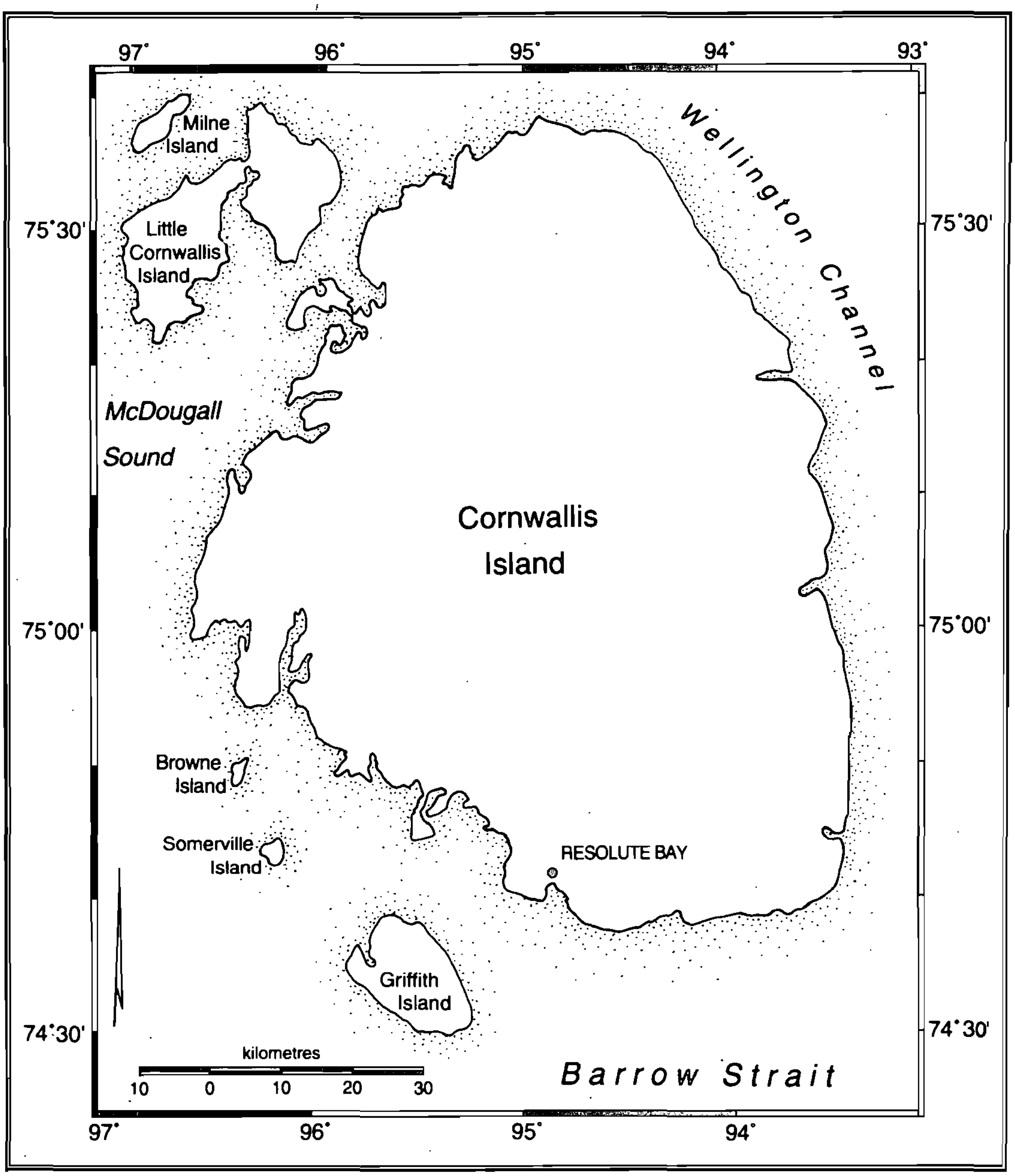

Fig. 3. Locations of two of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the two eastern major satellite islands, Cornwallis and Little Cornwallis

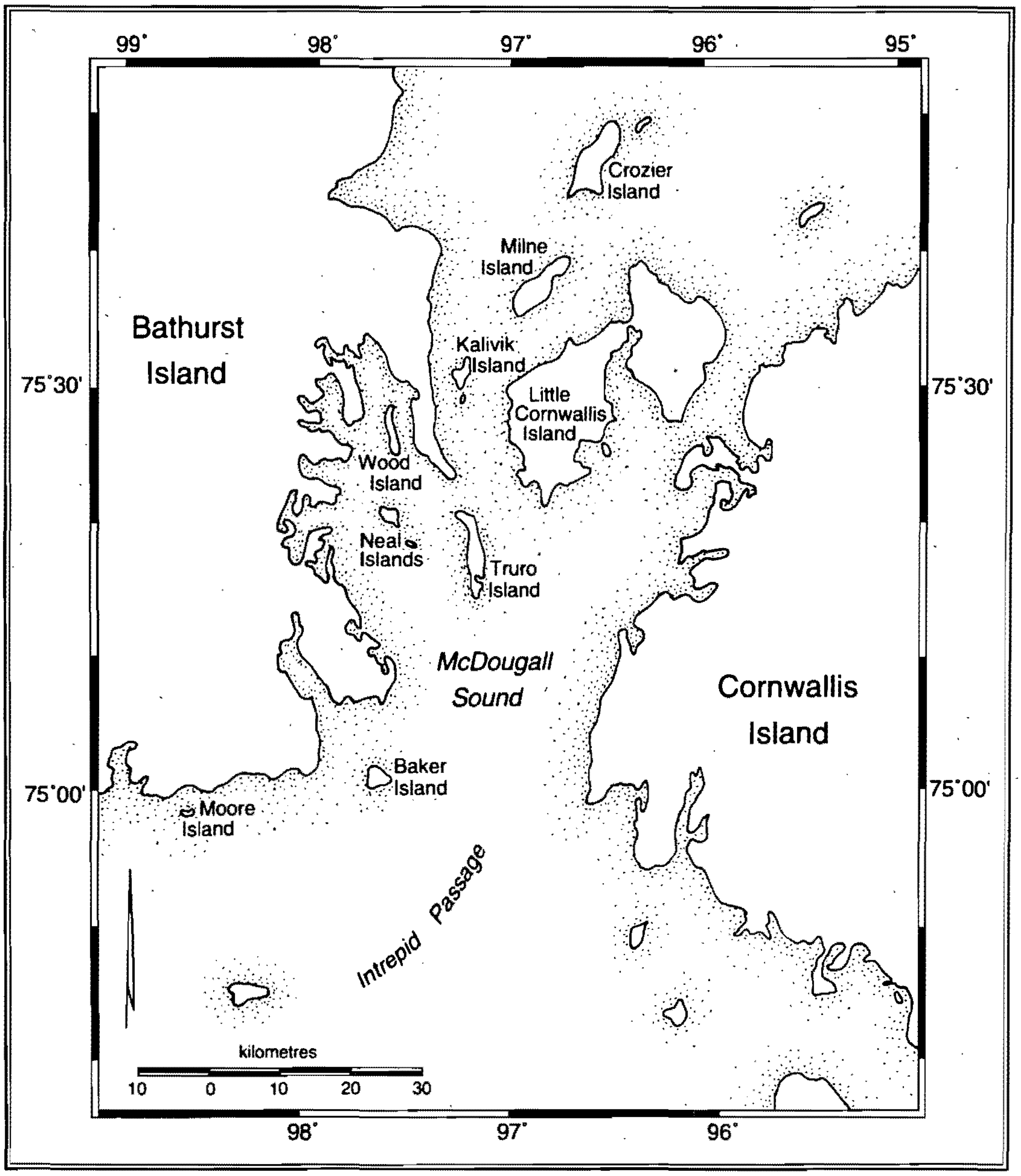

Fig. 4. Locations of eight of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the six secondary satellite islands in McDougall Sound, Crozier, Kalivik, Milne, Neal, Truro, and Wood; and the two secondary satellite islands in Intrepid Passage,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

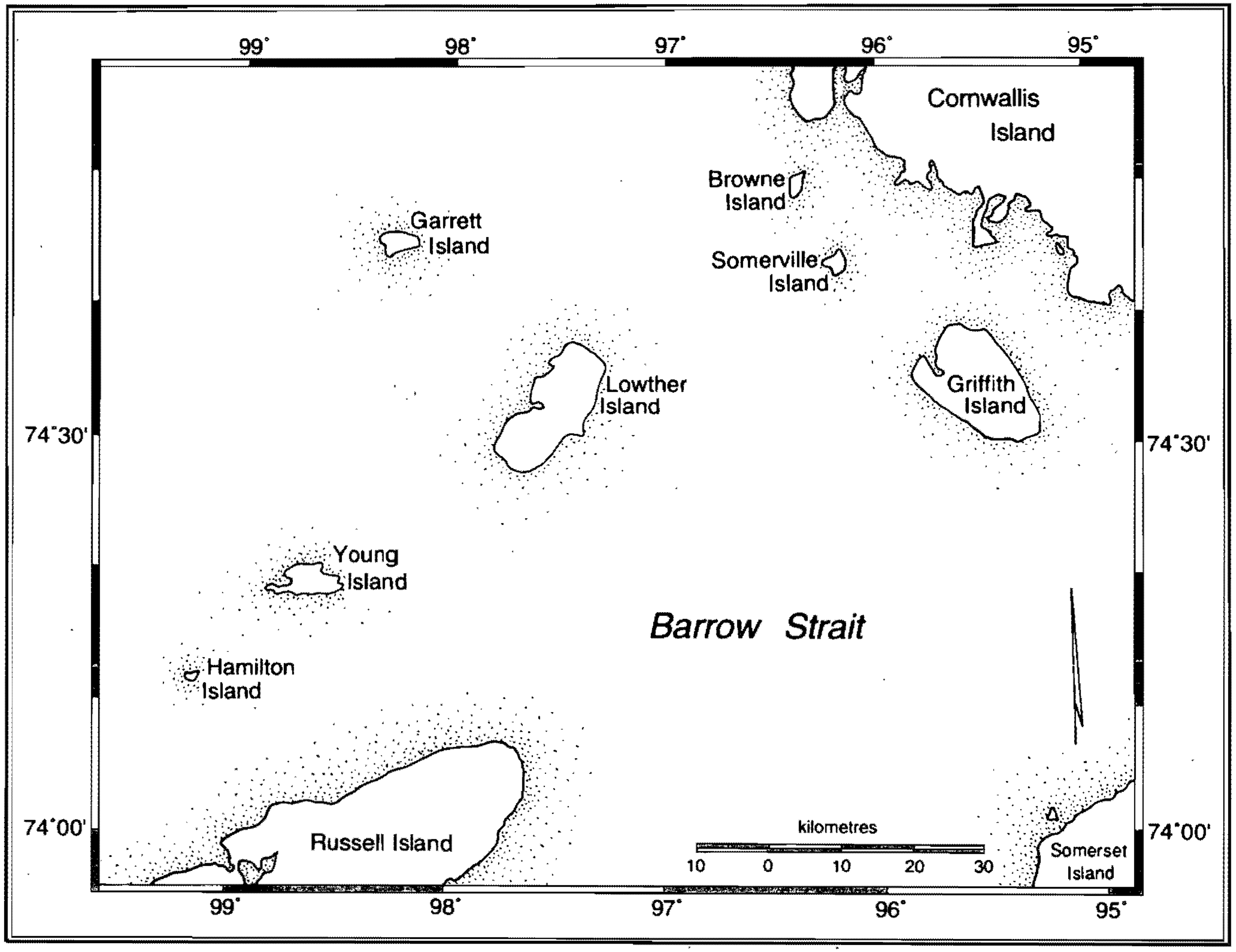

Fig. 5. Locations of seven of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the seven secondary satellite islands in Barrow Strait, Browne, Garrett, Griffith, Hamilton, Lowther, Somerville, and Young

Appendix 1. Distribution of 122.5 h of Bell 206L-1 turbo-helicopter flying time by activities, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, 25 July - 24 August 1993

Activity	% of total time	Dates
Cursory survey	5.7	25-26 Jul
Net-gun capture effort	26.0	27 Jul - 1 Aug
VHF radio tracking[a]	17.9	5, 10, 15-17, 21 Aug
Nonsystematic aerial searches	27.6	16-20, 24 Aug
Positioning and aborted flights	19.0	25 Jul - 24 Aug
Ferrying	3.8	25 Jul, 13, 15, 24 Aug

[a] VHF radio tracking on 16 and 17 August was carried out in association with the nonsystematic aerial searches on those dates.

Appendix 2. Satellite Platform Transmitter Terminals (PTT) test data, Mesa, Arizona, 23 March 1993

ID code	System number	RF board S/N digital	Battery S/N
10800	6680	012	181, 182
10801	6681	014	179, 180
10802	6682	017	169, 170
10803	6683	018	168, 177
10804	6684	019	193, 194
10805	6685	021	171, 192
05029	6686	022	195, 196

Appendix 3. VHF test data for the 7 1993 Satellite Platform Transmitter Terminal collars, Mesa, Arizona, 23 March 1993

VHF serial number	XMTR frequency (MHz) Designed frequency	Actual frequency	Pulse width	Period data (mSec/BPM) Active period 1
8987	164.040	164.0408	14.5	1336
8988	164.170	164.1704	14.5	1305
8989	164.180	164.1812	14.9	1308
8990	164.240	164.2402	14.6	1337
8991	164.260	164.2593	14.2	1318
8992	164.280	164.2817	14.6	1339
8993	164.320	164.3201	14.5	1381

Appendix 4. VHF test data for 10 conventional radio telemetry collars, Mesa, Arizona, 23 March 1993

VHF serial number	XMTR frequency (MHz) Designed frequency	XMTR frequency (MHz) Actual frequency	Pulse width	Period data (mSec/BPM) Active Period 1	Battery serial number
2453	164.000	164.0021	15.0	805	95142
2454	164.300	164.2999	15.2	840	95140
2455	164.420	164.4177	15.0	844	95144
2456	164.460	164.4596	15.4	852	95141
2457	164.540	164.5430	15.0	825	95143
2458	164.570	164.5718	15.0	834	95265
2459	164.590	164.5874	14.9	828	95266
2460	164.610	164.6111	14.9	786	95267
2461	164.650	164.6511	17.8	828	95268
2462	164.660	164.6602	18.2	846	95269

Appendix 5. Approximate standards used for conversion of degrees of latitude and longitude to minimal straight-line distances (km) used for calculating minimal displacements of collared caribou between relocations, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories, July-August 1993

Variable		Intersect position			Unit value (m)
1^0 latitude		75^0 00' N			111 503.700
		76^0 00' N			111 514.960
At latitude ^{0}N	1-min of longitude equals	At latitude ^{0}N	1-min of longitude equals	At latitude ^{0}N	1-min of longitude equals
75^0 10'	28 972	75^0 22'	496	75^0 34'	019
11'	932	23'	456	35'	27 980
12'	892	24'	416	36'	940
13'	853	25'	376	37'	900
14'	813	26'	337	38'	861
15'	773	27'	297	39'	821
16'	734	28'	258	40'	781
17'	694	29'	218	41'	742
18'	654	30'	178	42'	702
19'	615	31'	28 138	43'	662
20'	575	32'	099	44'	622
21'	535	33'	059	45'	583
46'	543	01'	948	16'	352
47'	503	02'	908	17'	313
48'	464	03'	868	18'	273

Continued

Appendix 5. Continued

At latitude °N	1-min of longitude equals	At latitude °N	1-min of longitude equals	At latitude °N	1-min of longitude equals
49'	424	04'	829	19'	233
50'	384	05'	789	20'	194
51'	345	06'	749	21'	154
52'	27 305	07'	710	22'	114
53'	265	08'	670	23'	075
54'	226	09'	630	24'	035
55'	186	10'	591	25'	25 995
56'	146	11'	551	26'	959
57'	106	12'	511	27'	916
58'	067	13'	472	28'	876
59'	027	14'	432	29'	836
76° 00'	26 987	15'	392	30'	796

Appendix 6. Sizes and percentage representations of search zones and major land areas of Bathurst Island (16 090 km^2), south-central Queen Elizabeth Islands, Northwest Territories

No.	Zone	Size (km^2)	% of stratum	% of island
Search zones No. 1-12 (16 090 km^2)				
01	NEC	428.6	-	2.66
02	NEI	4163.5	-	25.88
03	SEC	793.7	-	4.93
04	SEI	1533.8	-	9.53
05	SC	515.7	-	3.20
06	SWC	659.2	-	4.10
07	SWI	1503.8	-	9.35
08	NWC	933.6	-	5.80
09	NWI	2076.4	-	12.91
10	NCW	1070.0	-	6.65
11	NCE	1669.6	-	10.38
12	PBP	742.1	-	4.61
Stratum I (4080 km^2)				
08	NWC	933.6	22.88	5.80
09	NWI	2076.4	50.89	12.91
10	NCW	1070.0	26.23	6.65
		4080.0	100.0	25.36
Stratum II (6650 km^2)				
01	NEC	428.6	6.44	2.66
02	NEI	4163.5	62.61	25.88
11	NCE	1669.6	25.11	10.38
12 (52%)	PBP	388.3	5.84	2.41
		6650.0	100.00	41.33

Continued

Appendix 6. Continued

No.	Zone	Size (km^2)	% of stratum	% of island
Stratum III (5360 km^2)				
03	SEC	793.7	14.81	4.93
04	SEI	1533.8	28.61	9.53
05	SC	515.7	9.62	3.20
06	SWC	659.2	12.30	4.10
07	SWI	1503.8	28.06	9.35
12 (48%)	PBP	353.8	6.60	2.20
		5360.0	100.00	33.31
NE Bathurst Is. (6650 km^2 = St. II)				
01	NEC	428.6	-	2.66
02	NEI	4163.5	-	25.88
11	NCE	1669.6	-	10.38
12 (52%)	PBP	388.3	-	2.41
		6650.0		41.33
NW Bathurst Is. (4080 km^2 = St. I)				
08	NWC	933.6	-	5.80
09	NWI	2076.4	-	12.91
10	NCW	1070.0	-	6.65
		4080.0		25.36
SE Bathurst Is. (2694.5 km^2)				
03	SEC	793.7	-	4.93
04	SEI	1533.8	-	9.53
05 (30%)	SC	154.7	-	0.96
12 (29%)	PBP	212.3	-	1.32
		2694.5		16.74

Continued

Appendix 6. Continued

No.	Zone	Size (km^2)	% of stratum	% of island
SW Bathurst Is. (2665.5 km^2)				
06	SWC	659.2	-	4.10
07	SEI	1503.8	-	9.35
05 (70%)	SC	361.0	-	2.24
12 (19%)	PBP	141.5	-	0.88
		2665.5		16.57
N Bathurst Is. (10 730.0 km^2)				
01	NEC	428.6	-	2.66
02	NEI	4163.5	-	25.88
08	NWC	933.6	-	5.80
09	NWI	2076.4	-	12.91
10	NCW	1070.0	-	6.65
11	NCE	1669.6	-	10.38
12 (52%)	PBP	388.3	-	2.41
		10 730.0		66.69
S Bathurst Is. (5360.0 km^2)				
03	SEC	793.7	-	4.93
04	SEI	1533.8	-	9.53
05	SC	515.7	-	3.20
06	SWC	659.2	-	4.10
07	SWI	1503.8	-	9.35
12 (48%)	PBP	353.8	-	2.20
		5360.0		33.31

Continued

Appendix 6. Continued

No.	Zone	Size (km^2)	% of stratum	% of island
E Bathurst Is. (9344.5 km^2)				
01	NEC	428.6	-	2.66
02	NEI	4163.5	-	25.88
03	SEC	793.7	-	4.93
04	SEI	1533.8	-	9.53
05 (30%)	SC	154.7	-	0.96
11	NCE	1669.6	-	10.38
12 (48%)	PBP	212.3	-	1.32
		9344.5		58.07
W Bathurst Is. (6745.5 km^2)				
05 (70%)	SC	361.0	-	0.88
06	SWC	659.2	-	4.10
07	SWI	1503.8	-	9.35
08	NWC	933.6	-	5.80
09	NWI	2076.4	-	12.91
10	NCW	1070.0	-	6.65
12 (19%)	PBP	141.5	-	0.88
		6745.5		41.93

Appendix 7: Muskox numbers and distribution, Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories (data obtained by nonsystematic helicopter searches)

We recorded sightings of muskoxen between 17 and 20 August 1993 (Tables 7.1-7.3) because the Government of the Northwest Territories Renewable Resources Officer at Resolute Bay requested that we do so. We counted 888 muskoxen (730 1+ yr olds and 158 calves) on Bathurst Island. In addition, we also saw 35 muskoxen (29 1+ yr olds and 6 calves) on Alexander Island. No muskoxen were seen on any of the other islands that we searched in 1993. Although most of the muskoxen (423) were seen on northern Bathurst Island, the rate of occurrence for them (32.7 muskoxen per 100 min of search effort) was lower than on southern Bathurst Island (361 muskoxen at 92.8 muskoxen per 100 min of search effort); and in Polar Bear Pass (104 muskoxen at 123.8 muskoxen per 100 min of search effort). All muskox calves (N = 164) seen among all muskoxen (N = 923) equalled 17.8%. Although the number or proportion of bulls was not fully enumerated, they appeared plentiful with at least one bull (and usually more) in every group seen, with the exception of one group of 5 muskoxen in which no bull could be discerned.

Appendix 7. Table 7.1. Aerial counts of muskoxen by 12 search zones, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993

Search	Muskox seen		Zone	%	Muskoxen
zone[a]	1+ yr olds	calves	total	calves	(∘100 min $^{-1}$)
NEC	22	2	24	2/24[b]	53.3
NEI	75	24	99	24.2	16.4
SEC	31	6	37	16.2	71.2
SEI	9	5	14	5/9	12.0
SC	55	6	61	9.8	145.2
SWC	108	15	123	12.2	157.7
SWI	99	27	126	21.4	126.0
NWC	38	13	51	25.5	58.0
NWI	152	35	187	18.7	70.0
NCW	23	7	30	23.3	22.7
NCE	25	7	32	21.9	20.5
PBP	93	11	104	10.6	47.6

[a] 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-west section; NCE, north coast-east section; PBP, Polar Bear Pass.

[b] Fractions given instead of percentages, when total muskoxen seen in search zone equal less than 30 animals to avoid possible distortion of proportions.

Appendix 7. Table 7.2. Percentage distribution of muskoxen compared to landmass of each of the 12 search zones, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993

Search zone[a]	% of total muskoxen	% of total land area	Expected muskoxen by land area	Observed/ expected Index
NEC	2.7	2.7	23.98	1.00
NEI	11.1	25.9	299.99	0.43
SEC	4.2	4.9	43.51	0.85
SEI	1.6	9.5	84.36	0.16
SC	6.9	3.2	28.42	2.15
SWC	13.8	4.1	36.41	3.38
SWI	14.2	9.4	83.47	1.51
NWC	5.7	5.8	51.50	0.99
NWI	21.1	12.9	114.55	1.63
NCW	3.4	6.6	58.61	0.51
NCE	3.6	10.4	92.35	0.35
PBP	11.7	4.6	40.85	2.55

[a] 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-west section; NCE, north coast-east section; PBP, Polar Bear Pass.

Appendix 7. Table 7.3. Distribution of 888 muskoxen by major land divisions, Bathurst Island, south-central Queen Elizabeth Islands, Northwest Territories, 17-20 August 1993

Major divisions	Number of different muskoxen sighted	Time spent searching (min)	Rate of occurrence muskoxen (∘100 min^{-1})
Coastal** vs.	462	677	68.2
interior	426	1088	39.2
North vs.	475	1342	35.4
south***	413	423	97.6
East vs.	258	1037	24.9
west***	630	728	86.5

** Muskoxen over-represented by relative size of land division and by rate of occurrence ($P < 0.01$).
*** Muskoxen overrepresented by relative size of land division and by rate of occurrence ($P < 0.005$).