Ecological Studies of Caribou and Muskoxen in the Arctic Archipelago and northern Keewatin

by

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ABSTRACT

Research on caribou and muskoxen population numbers and distribution, habitat use and behavior was conducted during 1974 and 1975 in the central Canadian Arctic.

Approximate numbers of caribou on the arctic islands and the mainland as derived from aerial surveys during 1974 and 1975 were: eastern Melville Island, 760; Bathurst Island, 290; Cornwallis Island, 30; Russell Island, 120; Prince of Wales Island, 4,600; Somerset Island, 570; Boothia Peninsula, 1,200; and north-central District of Keewatin, 1,600. Approximate numbers of muskoxen were: eastern Melville Island, 210; Bathurst Island, 280; Cornwallis Island, 40; and Prince of Wales Island, 660. The ratio of calves to total animals observed during summer transect flights in 1974 and 1975 was approximately 20:100 for caribou (range 0:100 to 35:100) and 7:100 for muskoxen (range 0:100 to 16:100). Successive population estimates of caribou on Prince of Wales and Somerset islands, and Boothia Peninsula suggest a net movement of approximately 1,400 animals across Peel Sound between the summers of 1974 and 1975.

Habitat studies of caribou and muskoxen were carried out during summer 1975 on northeast Prince of Wales Island. Pellet group counts and examination of diet through histological analysis of plant fragments

in fecal material indicate that, in summer, caribou select areas with a high frequency of willow (Willow-Sedge Meadows and Open Willow Hummocks) because of forage preferences for this species. In winter, caribou utilize upland areas (Dryas Plateaus) to a greater extent than in summer because of a higher frequency of lichens in these locations. Muskoxen select lowland habitat types (Willow-Sedge Meadows) year-round because of the high frequency of occurrence of sedges and willows in these areas. Muskoxen diet in summer was comprised mainly of willow (51%); the winter diet was mostly sedges (36%) and mosses (52%).

Observations of caribou during the summer demonstrated that adult animals were engaged in foraging activity approximately two-thirds of the time and resting during the remaining one-third. Peaks in foraging activity occurred during mid-morning and late afternoon.

Mean group sizes of caribou on the arctic islands and Boothia Peninsula declined from 4.0 in late winter to 2.8 in early summer, and rose to 8.8 by mid-summer. Mean group sizes of muskoxen on eastern Melville, Bathurst, Cornwallis, and Prince of Wales islands declined from 10.1 in late winter to 6.5 in summer.

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This report supersedes the 1974 preliminary interim report on land mammals. Some revisions have been made in 1974 ungulate population estimates as a result of re-analysis of original data. We acknowledge the personnel involved in 1974 field work for their contribution to the project.

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INTRODUCTION

Recent discoveries of natural gas in the Canadian Arctic Islands have prompted the Polar Gas study group to conduct feasibility studies on the transportation of this fossil fuel southward to the Canadian mainland. The method currently receiving most serious consideration is a buried gas pipeline. Several routing locations for this pipeline are presently being evaluated (Figure 1). One route extends from Sabine Peninsula, Melville Island, to Longlac, Ontario, via Bathurst, Cornwallis and Somerset islands, Boothia Peninsula, the District of Keewatin (west of Hudson's Bay), and Manitoba. A second route under consideration parallels the eastern coast of Hudson's Bay through Quebec. A third alternate extends from the northern Manitoba border to near Winnipeg, Manitoba.

To assess the environmental impact of such a pipeline an environmental study program was organized by Polar Gas. Its primary objective is to provide information to evaluate the environmental impact of such a pipeline and to suggest measures to avoid or minimize the impact of pipeline construction and operation. Since 1974, Polar Gas has engaged Renewable Resources Consulting Services Ltd. to conduct field studies for the collection of baseline data on mammal populations along the proposed routes. This report presents results of the land mammal studies during 1975 and supersedes the 1974 Preliminary Report.

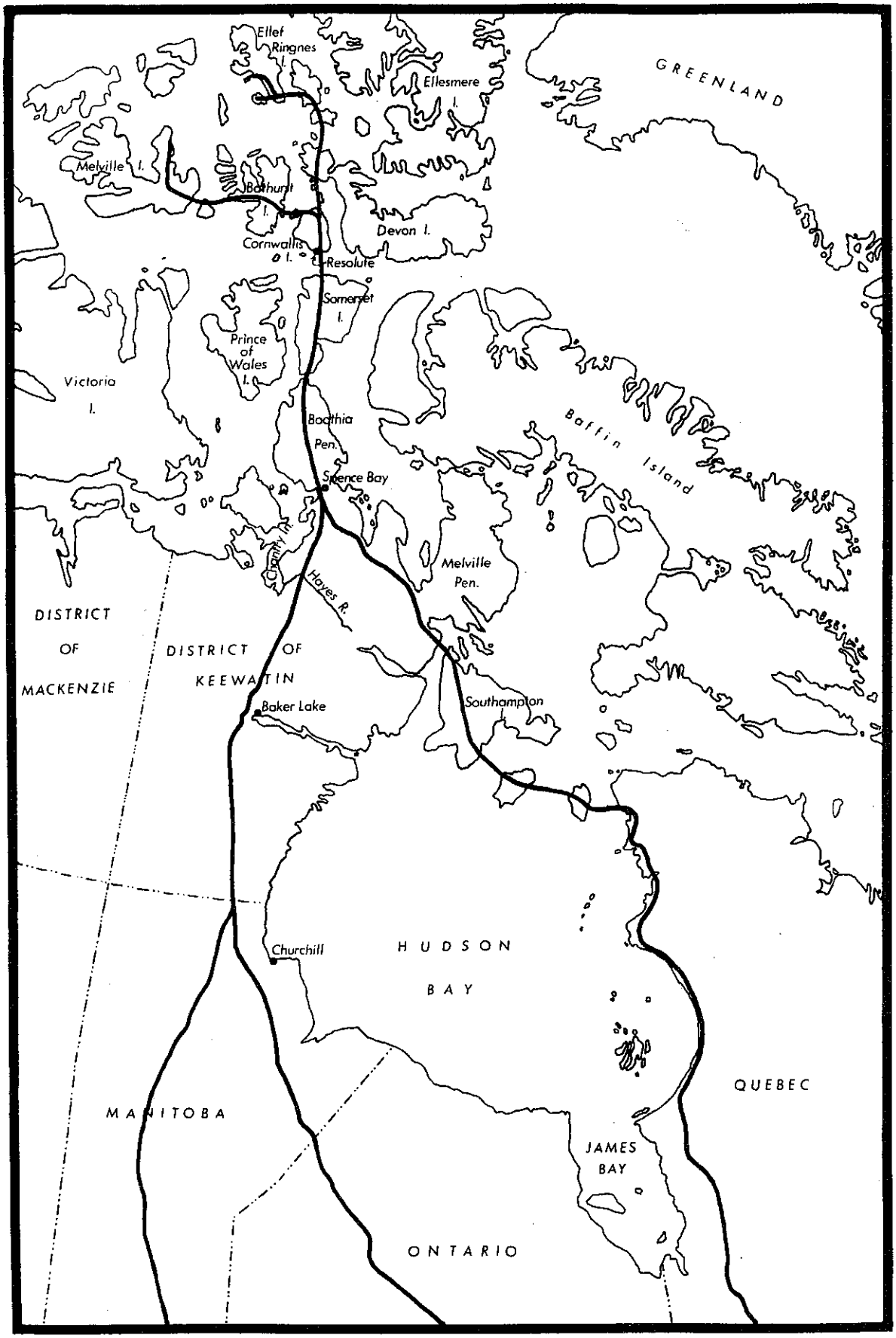


Figure 1. Proposed pipeline routing alternatives through arctic and mainland Canada

The study area, which includes the various pipeline route alternatives, is divided into five regions. Region I, the High Arctic, includes the Arctic Archipelago and Boothia Peninsula. Region II includes the District of Keewatin; Region V, Manitoba and Ontario. Northern and southern Quebec represent Regions III and IV. During 1974 and 1975, land mammal studies were concentrated within Region I. However, aerial surveys were also conducted in the northern portion of Region II in 1975.

Approach

An environmental impact study can be divided into three phases: base-line studies, experimental studies, and monitoring studies. Base-line studies consist of population inventory and distribution, studies of the relationships of populations to their habitats, and research on population dynamics. Relating this information to the various aspects of pipeline location, and construction and operation procedures enables the identification of potential impacts.

Experimental studies are designed to determine the probable impact of pipeline operations on representative populations or individuals prior to actual construction of the pipeline. Knowledge gained from these studies further clarifies the scope and effect of these impacts and can be used to avoid or reduce undesirable effects on populations.

Monitoring studies are carried out during and after construction of the pipeline. They are necessary to determine whether predicted impacts are verified and to detect any unpredicted impacts. In order to ascertain changes in the status of populations, base-line information on population dynamics is required prior to monitoring studies.

This program to date is involved with base-line studies of certain mammal species which might be encountered along pipeline routes. The approach to these base-line studies was governed by the anticipated vulnerability of these species to disturbance during pipeline construction and operation. Large mobile mammals, such as Peary caribou *(Rangifer tarandus pearyi)* and muskoxen *(Ovibos moschatus)* were considered to be most vulnerable because a significant portion of the population could be exposed to disturbance in a localized area (extensive zone of influence but a narrow zone of interaction). Consequently, studies were concentrated on these animals.

To understand the ecology of an animal and how it may be affected by disturbance, it is necessary to study the animal on as much of its home range as possible. Hence, studies of mobile species with a possible large zone of influence were not restricted to the pipeline corridor.

Methods for obtaining base-line information on caribou and muskoxen included aerial surveys, habitat studies and observations of animal behavior. Aerial surveys provided information on population numbers and regional distribution during various seasons of the year. Because ungulates in the Arctic are not exploiting all available habitat areas at any one given time, habitat studies were undertaken to characterize areas receiving consistent use in various seasons on a more local basis. Combining this information on use of specific habitats with maps delineating these habitat parameters along the pipeline corridor will allow an assessment of existing habitats along the corridor. Information gathered on animal behavior will permit an evaluation of potential impact of pipeline-associated activities on ungulates and will provide data on which to base mitigating recommendations.

Objectives

The overall objective of our mammal studies is to obtain information on mammal numbers, seasonal distribution and movement patterns, population dynamics, and behavior (especially in relation to man-induced disturbances) in order to assess the nature, duration, and significance of potential impacts and to make recommendations with regard to location,

scheduling, design, and management of pipeline construction and operation to minimize these impacts.

The specific objectives of the 1975 program were to:

1) continue studies of the distribution and abundance of caribou and muskoxen on the arctic islands and Boothia Peninsula and initiate similar studies on the mainland north of Baker Lake, N.W.T.;

2) locate caribou calving areas and determine productivity of caribou and muskoxen;

3) determine habitat utilization patterns of caribou and muskoxen;

4) study the influence of food habits of caribou and muskoxen on habitat use;

5) document normal activity patterns of caribou on the arctic islands from June to August; and

6) on an opportunistic basis, document the behavioral response of caribou and muskoxen to a variety of features which might simulate disturbances associated with pipeline construction and operation such as natural barriers, predators, human activity and aircraft.

THE STUDY AREA

The area studied in association with the proposed pipeline routes includes five major islands in the Arctic Archipelago, Boothia Peninsula and north-central District of Keewatin, N.W.T. The study area is approximately 215,000 km^2 and is located between latitudes 64°N and 77°N (1,430 km) and longitudes 90°W and 110°W (610 km).

North of Parry Channel in the Queen Elizabeth Islands, Melville (east of longitude 110°30'W), Bathurst, Cornwallis, and smaller associated islands were studied (Figure 1). South of Parry Channel, research was conducted on Russell, Prince of Wales and Somerset islands, Boothia Peninsula and mainland Canada between Spence Bay and Baker Lake, N.W.T. The mainland between Spence Bay and Baker Lake was divided into two sections. Spence Bay to Hayes River included the land south of Spence Bay and north of the Hayes River, roughly between longitudes 92°W and 95°W. Hayes River to Baker Lake encompassed land north of Baker Lake to the Hayes River and Chantry Inlet, roughly between longitudes 94°W and 98°W. Areas of individual study sites ranged from 57,370 km^2 for Hayes River to Baker Lake, to 940 km^2 for Russell Island (Table 1).

Climate

Most of the study area experiences a continental climate for more than seven months of the year (October to May) with maritime influences predominating during the remainder (Thompson, 1967). Winters are long

Table 1. Location and geographical area of study sites in arctic and mainland Canada.

Study Site	Location		Area (km^2)[1]
	Latitude (N)	Longitude (W)	
East Melville Island	75°30'	107°30'	16,939
Byam Martin Island	75°10'	104°00'	1,150
Bathurst Island[2]	76°00'	99°00'	19,145
Cornwallis Island	75°10'	95°00'	6,996
Russell Island	74°00'	98°30'	940
Prince of Wales Island[3]	72°30'	99°00'	33,750
Somerset Island	73°20'	93°00'	24,786
Boothia Peninsula	70°30'	94°30'	32,680
Spence Bay - Hayes River	68°00'	93°30'	20,310
Hayes River - Baker Lake	65°50'	95°00'	57,370

[1] Areas of arctic islands from Canada Year Book (1972, 1973).

[2] Includes Cameron, Ile Vanier, Massey, Alexander and Helena islands.

[3] Includes Prescott Island.

and extremely cold; summers are short and cool. Precipitation totals are very low with about half of the annual precipitation accruing from winter snowfall.

Temperatures

With the lack of significant amounts of incoming solar radiation, temperatures over the study area average well below -18°C for the months between December and March, and over the islands north of Parry Channel, during April as well. The mean daily temperature at Baker Lake (in the southern portion of the study area) during January, the coldest month of the year, is -32.9°C with mean daily maximums and minimums of -29.4°C and -36.4°C (Thompson, 1967). At Resolute, Cornwallis Island, the coldest month is February with a mean daily temperature of -33.7°C and mean daily maximums and minimums of -30.1°C and -37.2°C, respectively.

With lengthening periods of daylight and incoming solar radiation, temperatures begin climbing slowly in March and more rapidly in April. However, above freezing temperatures are not generally reached until May or early June. The average spring date on which mean temperatures exceed 0°C ranges from 5 June in the south to 15 June in the north (Bird, 1967). Daily temperatures during July and August in the southern portion of the study area average about 10°C; in the northern portion, about 4°C. Mean monthly maximum temperatures for July and August approach 24°C in the south and 14°C in the north. Freezing temperatures

may occur during either month in the north. The mean daily temperature during July at Resolute is 4.6°C with mean daily maximums and minimums of 7.3°C and 1.9°C. At Baker Lake, the mean daily temperature during July is 10.7°C; mean daily maximums and minimums are 15.7°C and 5.8°C.

By September, mean daily temperatures are again below freezing in the Queen Elizabeth Islands, and by the end of the month they are below freezing throughout the study area. Below-zero readings prevail by mid-October in the northern portions and by mid-November in the southern portions of the study area.

Precipitation

Mean annual precipitation throughout the study area ranges from about 10 cm in the northwest to over 20 cm in the central and southern portions. At Resolute, mean annual precipitation is 13.0 cm with about half (6.2 cm) falling as rain during the period between June and September (Thompson, 1967). The remainder (6.8 cm) falls in the form of snow (mean annual snowfall = 68.1 cm) during all months of the year with heaviest snowfall occurring in October (mean = 16.3 cm).

At Baker Lake, mean annual precipitation (20.9 cm) is 50% higher than at Resolute. All of this excess occurs as rain during the months between May and October (mean annual rainfall = 15.0 cm). Mean annual

snowfall at Baker Lake is 58.2 cm with heaviest snowfall occurring in the months of October (10.4 cm) and April (9.4 cm).

Physiography

Four main structural divisions make up the study area: Precambrian Shield, Paleozoic Basins, Innuitian Folded Region, and Arctic Coastal Plain (Dunbar and Greenaway, 1956). As there is considerable variation in physiography within and between mainland Canada and the arctic islands, structure and associated topography will be discussed for each major land mass.

Keewatin Mainland

The entire portion of the study area within the District of Keewatin, except for Cape Colville Peninsula (northwest of Shepherd Bay), lies within the Precambrian Shield (Dunbar and Greenaway, 1956). South of a line running approximately from Wager Bay to Chantry Inlet, the terrain is rolling and even with occasional outcrops of bedrock in an otherwise drift-covered landscape. North of this line, the terrain becomes higher and rougher with more exposed bedrock. Cape Colville Peninsula lies within the Paleozoic lowlands and exhibits flat terrain with glacial deposits and patches of weathered limestone.

Boothia Peninsula

A north-south oriented belt of Precambrian upland spans the entire length of central Boothia Peninsula (Dunbar and Greenaway, 1956). Rugged, rocky hills characterize the north and southeast with some peaks near 600 m in elevation. The central portion of the peninsula gradually increases in elevation from the southwestern coastal lowlands until a smooth, rolling, featureless plateau predominates. The Precambrian upland is bounded on the northeast and southwest by well-vegetated Paleozoic lowlands. These areas are mostly flat and consist mainly of limestones.

Somerset Island

On Somerset Island, Precambrian upland occurs to the west of a line between Aston Bay and the eastern end of Bellot Strait. The upland is extremely rugged with peaks in excess of 400 m with well-vegetated valleys and steep coastlines. On the eastern edge of this upland a narrow lowland belt extends from Stanwell-Fletcher Lake to Aston Bay. The southern portion of this lowland is particularly well vegetated. Somerset Island east of the Precambrian upland is included within the Paleozoic lowlands structural division. Much of this area is a barren limestone and sandstone plateau over 300 m in elevation and is characterized by deep river gorges and steep coastal cliffs.

Prince of Wales and Russell Islands

Precambrian upland occurs on Prince of Wales Island on the extreme east-central coastline (Dunbar and Greenaway, 1956). It consists of a narrow, rugged band of red-shale upland reaching from Prescott Island to Strzelecki Harbor. The remainder of the island is located within the Paleozoic lowlands and is divided into lowland and northeastern upland physiographic regions. The lowland lies west of a line between Cape Eyre on the southeast coast and Cape Berkeley on the northwest coast and extends to the western shore. This area is primarily flat and featureless except for frequent small lakes and a region of parallel ridges of greater relief in the Fisher Lake area. East of this line, including Russell Island, uplands of limestones and sandstones prevail. The terrain is most rugged in the northeast with elevations in excess of 400 m. To the southwest, the hills become more rounded and separated by wide valleys. Low hills and small plateaus dominate the southeastern portion.

Cornwallis Island

Cornwallis Island is located within the Innuitian Folded Region (Dunbar and Greenaway, 1956). It is composed primarily of limestone and is mostly polar desert (Thorsteinsson, 1958). The southeastern quarter of the island is an undulating remnant plateau; the remainder of the island possesses a generally more rugged terrain. A small, well-vegetated lowland is found in the northwestern corner of the island.

Bathurst and Byam Martin Islands

Bathurst Island lies within the Innuitian Folded Region and is divided into two distinct zones by an east-west line located approximately 30 km south of Bracebridge-Goodsir inlets (Dunbar and Greenaway, 1956). Folded upland is found north of this line and on Byam Martin Island. It is characterized by numerous east-west valleys composed of sandstone and limestone sediments. South of this line is the southern plateau, a rolling limestone region. The terrain is undulating with increasing relief in proximity to the southern coast. The southwestern corner is a low, essentially barren, marine plain.

Eastern Melville Island

Two structural divisions occur on Eastern Melville Island (Dunbar and Greenaway, 1956). The northern portion of Sabine Peninsula (north of Eldridge and Sherard bays) is found within the Arctic Coastal Plain. The terrain is generally low-lying with few lakes and patchy vegetation cover. South of this area lies the folded upland of the Innuitian Region. The terrain is quite rugged with occasional steep escarpments and frequent rock outcrops of limestone, sandstone and shales.

Flora

The vegetation of the study area is classed as tundra and is characterized by absence of trees, although shrubs are widely distributed

throughout. The Arctic presents an extremely harsh environment for plants with short growing seasons which may be interrupted by frosts at any time. Consequently, the vegetation is dominated by perennials, many depending on vegetative reproduction. The availability of water, in addition to temperature, is an important determinant of vegetative development. The moisture regime is influenced strongly by permafrost and the restricted drainage it creates. Low areas with fine-grained soils and a shallow active layer are often characterized by heavy vegetative growth. In many localities, extensive soil movement (i.e. congeliturbation and solifluction) through frost action is a factor precluding vegetative development.

Within the Arctic, Polunin (1942) recognized three latitudinal vegetative belts which he classed as High, Middle and Low Arctic. The High Arctic includes those islands in the study area north of Boothia Peninsula (latitude 72°N) and is characterized by a general lack of vegetative cover except in the more favored localities. Babb and Bliss (1974) suggested that within the Queen Elizabeth Islands, 35% of the land is polar desert (0 to 3% plant cover), 20% ice caps, 43% polar semi-desert (5 to 20% plant cover), and only 2% wet sedge-grass tundra. The Middle Arctic zone includes Boothia Peninsula and is characterized by a higher degree of plant cover but with frequent open areas. The Low Arctic zone extends from Spence Bay (latitude 69°N) south to the tree line and possesses essentially continuous vegetative cover.

METHODS

Field research during 1974-75 on caribou and muskoxen can be divided into three components: 1) population numbers, distribution, and productivity, 2) habitat studies, and 3) animal behavior. As data collection techniques varied between components, methods of obtaining information will be presented for each.

Population Numbers, Distribution, and Productivity

Data Collection

Information on population numbers, distribution, and productivity was obtained mainly through aerial surveys. Limited information on distribution was obtained through discussions with Native residents.

Aerial surveys were timed to provide information for four seasonal periods: late winter (March to April), spring (May to mid-June), summer (mid-June to mid-August) and fall (mid-August to September). In 1974, surveys were carried out within Region I (Boothia Peninsula north) between May and September. Surveys in 1975 were conducted in Regions I and II beginning in March and continuing to early July.

A Dornier D.O. 28 aircraft was used for most of the aerial survey work in 1974, though it was supplemented with a Cessna 337 Skymaster in June. Surveys in 1975 were carried out exclusively in the Dornier. Both

aircraft were equipped with full IFR instrumentation including radar altimeter and Global Navigation System (GNS - 200).

The primary operations base for Region I was Resolute; for Region II, Baker Lake. Additional short-term bases included Rae Point (Melville Island), Crooked Lake (Prince of Wales Island), Creswell Bay (Somerset Island) and Spence Bay (Boothia Peninsula).

Survey flights were carried out with two or three observers in addition to the pilot. During 1974 and March to May 1975, the front-right observer also acted as navigator and plotted checkpoints on the map. For the remainder of survey flights in 1975, the pilot assumed the main responsibility for navigating as this allowed the front-right observer to concentrate exclusively on observing. Both the front-right and left-rear observer recorded data.

In-flight data were recorded on portable audio-tape recorders. Each time animals or animal signs were encountered, the observation was recorded as a checkpoint (e.g. checkpoint 1) and the checkpoint number was plotted on the appropriate 1:250,000 scale topographical map. For each observation, data recorded included time, species, total number of animals, animal sex and age (when identified), animal activity and response to aircraft, height above ground level (from radar altimeter), estimated horizontal distance to animal(s), whether animal(s) were on or off transect (for transect surveys), and snow cover. Information concerning general terrain and vegetation was also noted. Data from tape

records were later transcribed to data recording forms and keypunched onto computer cards for analysis and storage. Although the aerial surveys were designed for caribou and muskoxen, information was recorded for all animals encountered including wolves, artic foxes, polar bears and marine mammals.

Aerial surveys were of two types: spotcheck surveys and transect surveys. Spotcheck surveys were designed to sample selected areas within the study regions. Due to limited time and the large size of the study area, repeated surveys of entire regions could not be carried out. Areas selected on the basis of transect survey results were surveyed to note change in distribution over time, to obtain sex and age ratios, or to obtain more detailed information (e.g. distribution along the pipeline route).

Transect surveys were designed to sample entire land masses within the study area and were modelled after the method of Miller *et al.* (1973). Parallel transect lines were flown either 6.4 km or 16 km apart in 1974. In 1975, spacing of transect lines was randomized with mean spacings of either 8 km or 16 km. Animals were counted in 0.8 km strips on either side of the aircraft. Animals observed outside this strip were recorded separately as "off-transect". Transect width was estimated with observers periodically checking their estimates against points of known spacing on the ground while flying at survey altitude. Navigation along transects was greatly facilitated by the use of GNS-200 in the aircraft as it allowed

a constant heading to be maintained and gave a readout of the distance travelled. Transect lines were initially oriented to provide maximum interception with the coastline, but through experience we learned that the GNS-200 was most accurate when oriented along north-south flight lines. Subsequent transects were oriented along north-south lines.

Surveys through June 1974 were flown at 150 m above ground level to correspond with Miller *et al.* (1973) and to avoid potential stress to animals from aircraft disturbance in the critical spring period. Thereafter, survey altitude was reduced to 90 m as it was felt this height gave a better silhouette of the animals. The speed at which surveys were flown varied from 150 to 220 km per hour.

Other authors have discussed the many problems inherent in the aerial survey techniques (Tener, 1963; Thomas, 1969; Miller *et al.*, 1973). The following problems are the most applicable to this project:

1) The most significant problem is the difficulty of seeing light-colored Peary caribou against a background of snow, especially snow-melted patches. Population estimates of Peary caribou are made best in summer. Conversely, muskoxen are best observed against a light background due to their dark pelage.

2) Observer estimation of transect width may have introduced some error in population estimates. However, assuming that observer bias (if present) was consistent between locations and years,

valid comparisons between these variables can be made.

3) Weather conditions occasionally precluded surveying an area in its entirety in one period of time. Movement of animals during the period of inclement weather may have caused us to miss some animals or count others more than once.

4) The angle of incidence of sunlight is important also. With the sun at the observer's back, animals are easily spotted; however, observing into the sun reduces the visibility of animals to the observer.

5) Observer fatigue and differences in observer experience may have introduced some variation in the results.

Data Analysis and Interpretation

Population estimates of caribou and muskoxen were calculated by dividing the total number of animals observed on transect by the proportion of the total area surveyed. In instances where coverage of an area varied because of survey design or equipment malfunction (i.e. tape recorder failure), population estimates were calculated for each stratum and totalled to provide an estimate for the entire area.

As there is a possibility of underestimating animal populations due to observers overlooking animals, it is important to realize that most estimates are probably conservative. To obtain an estimate of the per-

centage of total caribou missed during our summer (snow-free) surveys, a series of six "test transects" were flown during the period 27 June to 2 July 1975. A transect line, 32 km in length by 1.6 km in width, was repeatedly surveyed until the observers were confident that all animals along the transect had been counted. The number and location of all animals observed were carefully noted to minimize errors occasioned by animal movement on and off the transect. The results indicate that during snow-free periods approximately 23% of the total caribou on the transect were unobserved during the first pass (Table 2). These findings are in general agreement with Banfield *et al.* (1955), Bergerud (1963), and Watson and Scott (1956) who suggested a figure of approximately 20% for the number of animals missed.

Additionally, to check the influence of transect width on population estimates of caribou and muskoxen, animals observed during transect surveys in 1975 were plotted by distance from the aircraft. Results indicate that a transect width of 1.6 km (0.8 km on either side of the aircraft) probably provides the best estimates for both caribou and muskoxen. A total of 925 caribou were observed within 0.4 km of the aircraft; 727 between 0.4 km and 0.8 km of the aircraft (Table 3). While this 21% reduction in numbers of caribou observed indicates slightly lower visibility of animals within the latter category, we felt that including the 0.4 km to 0.8 km category was justified because of the increased coverage it provided. For muskoxen, the number of animals observed within the 0.4 km to 0.8 km category (141) was higher

Table 2. Number of caribou observed on first pass during transect flights and number of additional caribou counted on successive passes. Transects were located on Prince of Wales Island and Boothia Peninsula and were flown during 27 June - 2 July 1975.

Transect Number	Number of previously unobserved caribou counted during pass				Total Caribou Observed
	Pass 1	Pass 2	Pass 3	Pass 4	
A	12	3	2	0	17
B	12	1	1		14
C	10	3	0		13
D	17	0	0		17
E	15	0	0		15
F	14	6	7		27
MEAN	13.3	2.2	1.7	0	17.2
%	77	13	10	0	

Table 3. Number of caribou and muskoxen observed within various distances from the aircraft during March - July 1975.

Distance from aircraft (km)	Number of animals observed	
	Caribou	Muskoxen
0.0 - 0.4	925	109
0.4 - 0.8	727	141
0.8 - 1.2	377	94
1.2 - 1.6	359	66
>1.6	208	166

than the number within the 0 to 0.4 km category (109). Miller *et al.* (1973) obtained similar results and suggested that the disturbance associated with aircraft approach may have caused muskoxen to move away from the anticipated flight path of the aircraft.

Habitat Studies

In our habitat studies of ungulates in the High Arctic, we have concentrated mainly on studying ungulate use of plant communities. Consequently, we have described habitat mainly in terms of dominant plant communities and total vegetative cover. However, as other factors are also likely to influence animal distribution (e.g. snow cover in winter), some variation between areas in the use of similar plant communities may be expected.

In 1975, ground studies of habitat use were conducted mainly on northern Prince of Wales Island between 14 June and 14 August. Field camps were located at Scarp Brook, Beams Brook, Allen Lake, and Marnie Lake (Figure 2). During the period between 17 and 25 August, limited studies were also conducted on Somerset, Cornwallis, and Bathurst islands.

Habitat Description

Vegetation communities were classified in the field according to the International Biological Program (IBP) method proposed by Fosberg (1967).

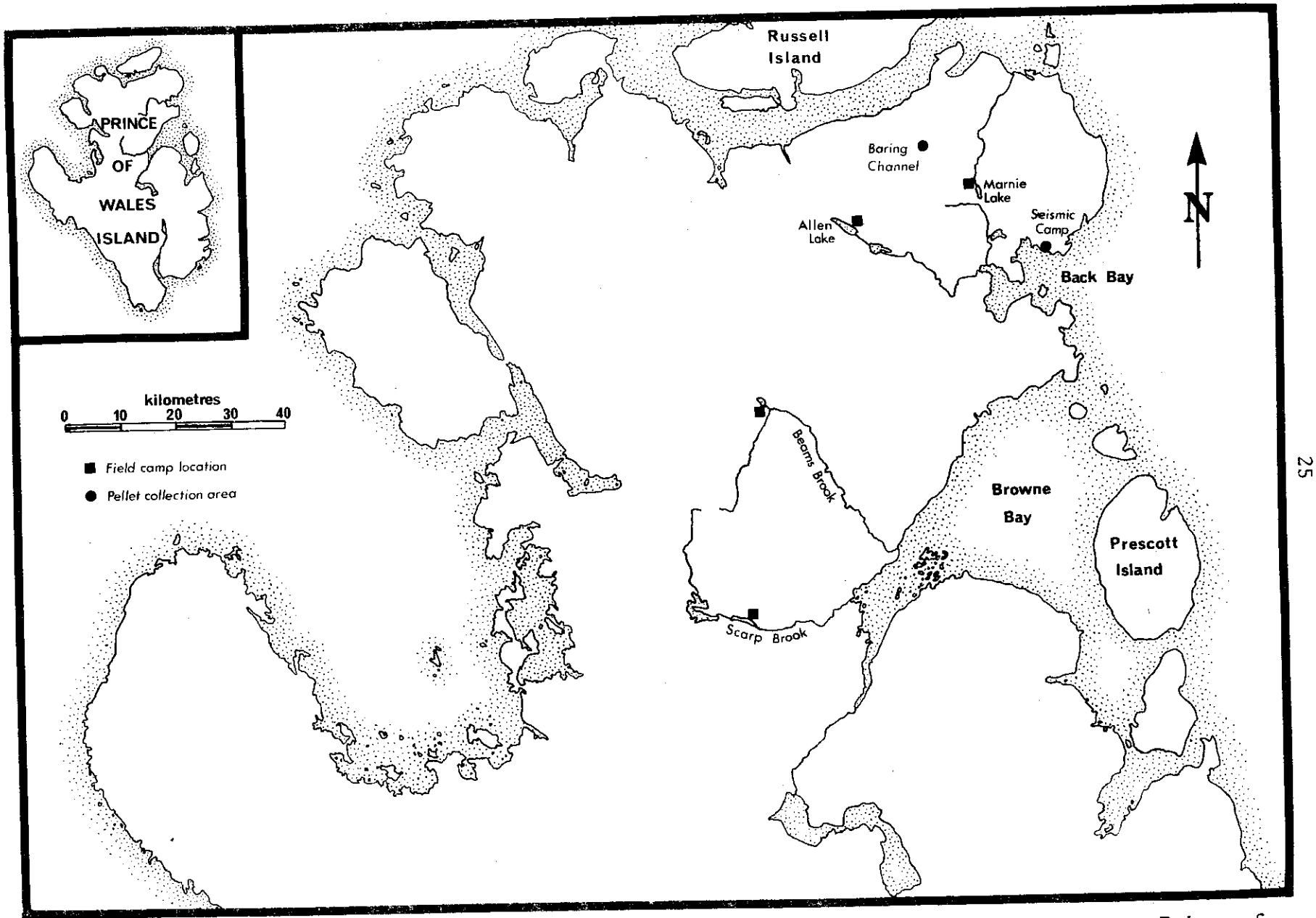


Figure 2. Locations of summer 1975 field camps and pellet collection localities on northeastern Prince of Wales Island.

The key is based on vegetative cover and plant life-form. Initially, a vegetatively homogeneous area is assigned one of three possible cover classes: closed (plants predominantly touching or overlapping), open (plants mostly discrete but separated on the average by not more than twice their diameters), or sparse (plants mostly more than twice their diameter apart). Then the community is further classified on the basis of the dominant life-form among plants present. Fosberg (1967) lists six possible life-forms; however, no trees or tall shrubs exist in the High Arctic. The four life-forms present include dwarf shrubs, herbs, lichens, and mosses. Dwarf shrubs take precedence in the key, i.e. a community is classified as dwarf-shrub even if another life-form with a higher cover-class rating is present.

The frequency of occurrence of plant species within vegetation communities was determined by recording the plant species or substrate directly beneath each of 100 points spaced equidistantly along a 25 m line-transect. Each line-transect was randomly located along a pellet-group transect within a community, pulled taut on the ground, and a pencil point lowered at each 25 cm interval until it intersected a plant species or substrate. Sub-layers of vegetation (all species directly beneath the first plant encountered at the point) were additionally noted. The percent frequency of each species within a community was then calculated based on the total number of points read within that community. Plant specimens were collected and pressed. Plant nomenclature was according to Porsild (1964).

Total vegetative cover within plant communities was estimated within a 5 m^2 plot at the beginning of each transect. Cover classes followed Braun-Blanquet (1932) and included the following divisions: 1(1-5%), 2(5-25%), 3(25-50%), 4(50-75%), and 5(75-100%). Crustose lichens and patina were included in estimates of total vegetative cover. The term "patina" indicates a ground holding substance which is probably a black crustose lichen of the genus *Lecidia* in dry upland situations. In wet lowland areas this "black crust" may be a mixture of lichen, moss, and algae although no identification of the substance has yet been made.

During analysis, vegetation communities were combined into habitat types based on similarities in species composition, cover, topographical position and utilization.

Habitat Utilization

Information on seasonal habitat use by caribou and muskoxen was obtained from two sources: pellet-group counts and diet analysis. As techniques of gathering data varied for each, the methods will be presented separately.

Pellet-Group Counts

On Prince of Wales Island, caribou and muskoxen pellet-groups were sampled on the basis of landform units which were delineated on aerial photographs (scale 1:60,000) by R.M. Hardy and Associates. They defined

these landform units on the basis of genetic origin, material, topography, and drainage. Within each landform unit, we randomly placed 20 pellet transects (and associated vegetation line-transects), each entirely within a vegetation community. Randomness in transect location was achieved through random selection of distance and direction of spacing between transects.

Pellet transects consisted of 1 to 10 segments, each 50 m in length by 2 m in width (1 m to each side of a line). The number of segments in a transect depended on the size of the vegetation community. Along each segment, summer and winter pellets from caribou and muskoxen were counted. One observer paced each segment while the other followed and counted pellet groups. Pellet groups generally consisted of a number of pellets deposited within a small area; they were tallied only if five or more individual pellets were present and if more than half of the group was within the belt transect.

Winter and summer pellet groups for caribou and muskoxen were distinguishable on the basis of morphology. In winter, the individual pellets of caribou are small and oval in outline; those of muskoxen are larger and more spherical. In summer, caribou and muskoxen pellets coalesce into an overall mass but the characteristic differences in size and shape are still prominent.

At each segment, the elevation, terrain (crest, upper or lower slope, depression, or level), slope (level, 0-2°; gently sloping, 3-5°;

moderately sloping, 6-10°; strongly sloping, 11-25°; or steep, >25°), aspect (direction of slope or no slope), and surface moisture (hydric, mesic, or xeric) were recorded. A 100-point vegetation transect was randomly located and read once along each transect.

During analysis, pellet-group distribution was analyzed by vegetative cover-class and, more specifically, by habitat type.

During August, the availability of a helicopter enabled a ground crew to initiate limited sampling on Somerset, Cornwallis, and Bathurst islands to determine whether vegetation communities and usage patterns were similar to those on Prince of Wales Island. On each island, locations for sampling were arbitrarily chosen along the proposed pipeline route. Vegetation line-transects were established and data recorded in the same manner as before but, due to the fact that landform-unit maps were not available for these other islands, pellet-transect locations were chosen differently. At the point of landing, a random direction was chosen and the first transect initiated. Walking in that same direction a new transect was started each time a different vegetation community was reached. Transects were a maximum of ten segments in length.

Diet Analysis

Information regarding the seasonal diet of caribou and muskoxen was obtained from histological analysis of pellet (feces) material.

In the field, pellet groups of caribou and muskoxen were divided into three categories on the basis of their morphology. Two of these categories correspond to the phenological periods of winter and summer. The third category consists of pellets deposited during the transition period between winter and summer. Pellets of both species from this category are typically intermediate in morphological characteristics between the other two categories.

Whenever recently (< 1 yr old) deposited fecal material was encountered in the field, two pellets were collected from each pellet group. If necessary, these were air-dried. Pellets from different groups were then combined into a composite sample according to their morphological types. Caribou pellets were gathered from five localities, four of which were located on Prince of Wales Island and the fifth on Somerset Island. Muskoxen pellets were gathered from two localities on Prince of Wales Island, but owing to the small sample size from each area, they were subsequently combined into one composite sample for each of the three morphological types.

Percent composition by dry weight of plants within the diets of Peary caribou and muskoxen was estimated by histological analysis of pellet material. The technique was described by Baumgartner and Martin (1939), and was later refined by Dusi (1949) and Sparks and Malechek (1968). The work was performed by Dr. R.M. Hansen, Department of Range Science, University of Colorado, Fort Collins. For the past several years, Dr. Hansen has been actively employing histological techniques in

describing diets of a broad spectrum of vertebrates (Hansen and Reid, 1975; Hansen and Cavender, 1973; Hansen, 1974).

A plant collection, made up of 55 plant species from the vicinity where the pellets were collected, was forwarded along with the pellets to Dr. Hansen's laboratory to assist in identification of plant remains in the pellets.

In the laboratory, composite pellet samples were ground in a mill over a 1.0 mm screen and then washed over a 0.1 mm screen (Sparks and Malechek, 1968). This ensures that particles will be randomly distributed over each slide. Twenty slides from each sample were then prepared with Hertwig's solution and Hoyer's solution (Baker and Wharten, 1952); they were subsequently dried at 60°C for approximately 72 hr.

Tissues of plants collected in the study area were mounted on microscope slides according to Brusven and Mulkern (1960). Identification of plant remains in the pellets was based on epidermal characteristics (Davies, 1959; Brusven and Mulkern, 1960; Storr, 1961) of known sample plant tissues on the study slide.

Twenty microscope fields were located on each of the 20 slides prepared for each pellet mixture. A compound binocular microscope was used at 100X magnification. Each recognized plant species within each field was recorded. A percent frequency for each plant species was then derived; the percent frequency equals the number of fields in which

a species occurred expressed as a percent of the total number of fields examined (400). Percent frequency was then converted to particle density per field using a table developed by Fracker and Brischle (1944). Relative density was calculated for each food item; the relative density equals the number of particles of a plant species expressed as a percent of the total number of particles of all plant species (Curtis and McIntosh, 1950). Relative density was then used as an estimate of the percent relative dry weight of each food item in the diet (Sparks and Malechek, 1968).

Animal Behavior

Data obtained on ungulate behavior included information on caribou activity patterns in summer and group sizes of caribou and muskoxen observed during aerial surveys in late winter and summer.

Caribou Activity Patterns

Ground observations of Peary caribou on Prince of Wales Island were made during the summer field season with the primary objective of determining activity patterns. Caribou were approached on foot to within a distance of 100 to 300 m and were kept under observation with the aid of Bushnell spotting scopes (20X) and binoculars (7 x 35 mm).

In sequential 10-minute intervals, the behavior of known animals was recorded, i.e. whether an individual was grazing, resting, standing,

walking, or running. Individuals were identified to sex and age when possible. At each sampling interval, the vegetation community where a behavior occurred was classified according to Fosberg (1967) and the percentage of ground covered by vegetation was estimated. Terrain type, and degree and aspect of slope were also recorded along with existing weather conditions. Two teams of observers were used. Data collected by both teams were pooled in all analyses.

Peary caribou are not exposed to a 24-hr cycle of light and darkness in the summer like ungulates living in more southerly latitudes. Accordingly, the patterns of behavioral activity of this species could be different. A 24-hr pattern of behavioral events was constructed from the total sample of observations on all individuals recorded during the ground studies. Only two general categories of behavior were of concern, resting and foraging. Foraging included all activities in which caribou were not bedded down. This is justifiable, as walking individuals generally grazed while moving, and standing individuals were typically interrupting their foraging only momentarily. The high incidence of foraging at all times, except when animals have bedded down, has been commented on by others (Skoog, 1956).

Ungulate Group Sizes

The mean group size and frequency distribution of group sizes of caribou and muskoxen were determined from aerial surveys conducted between 1 March and 9 July 1975. For caribou, a total of four phenological

periods were recognized within this interval: late winter (1 March - 30 April), spring (1-30 May), calving (1-27 June) and post-calving (28 June - 9 July). Only two periods were recognized for muskoxen because of low sample sizes and restricted survey dates of the arctic islands. These periods were late winter (1 March - 30 April) and early summer (1 June - 9 July).

The data on frequency distribution of group sizes were analysed for differences between areas and time periods. The Kolmogorov-Smirnov two-sample test (Sokal and Rohlf, 1969) was employed to test for significant differences in group size distribution. Individual group-size categories from 1 through 10 were used in the test; groups over 10 were totalled into one category (>10). Differences were recognized as significant at the .05 level of probability.

RESULTS

Population Numbers, Distribution, and Productivity

Eastern Melville Island

Transect surveys of eastern Melville Island were conducted during the summers of 1974 and 1975. Dates of these surveys were 7 to 9 August 1974 and 1 July 1975; survey coverage was 9.8% and 10.6% of eastern Melville, respectively.

Caribou

Results

During August 1974, we observed a total of 288 caribou during transect flights and estimated a population of 898 animals (Table 4). During July 1975, 158 caribou were observed during surveys for an estimated population of 613 animals. The density of caribou observed on transect was 5.3/100 km^2 in 1974 and 3.6/100 km^2 in 1975.

During both surveys, most caribou were observed in southern and eastern portions and located within 15 km of the coast (Figure 3). Only one caribou was observed on Sabine Peninsula in 1974; two in 1975. Groups with calves were widely distributed along the south and east coastal areas (Figure 4).

Table 4. Population estimates of caribou and muskoxen on eastern Melville Island during summer, 1974 and 1975.

Species	Survey Dates	% Coverage	Number Observed		Population Estimate
			On Transect	Total	
Caribou	7-9 August 1974	9.8	88	288	898
	1 July 1975	10.6	65	158	613
Muskoxen	7-9 August 1974	9.8	21	69	214
	1 July 1975	10.6	4	49	(38)[1]

[1] Calculated estimate is lower than total number observed.

Figure 3. Eastern Melville Island surveys
Caribou: 7-9 August 1974
1 July 1975

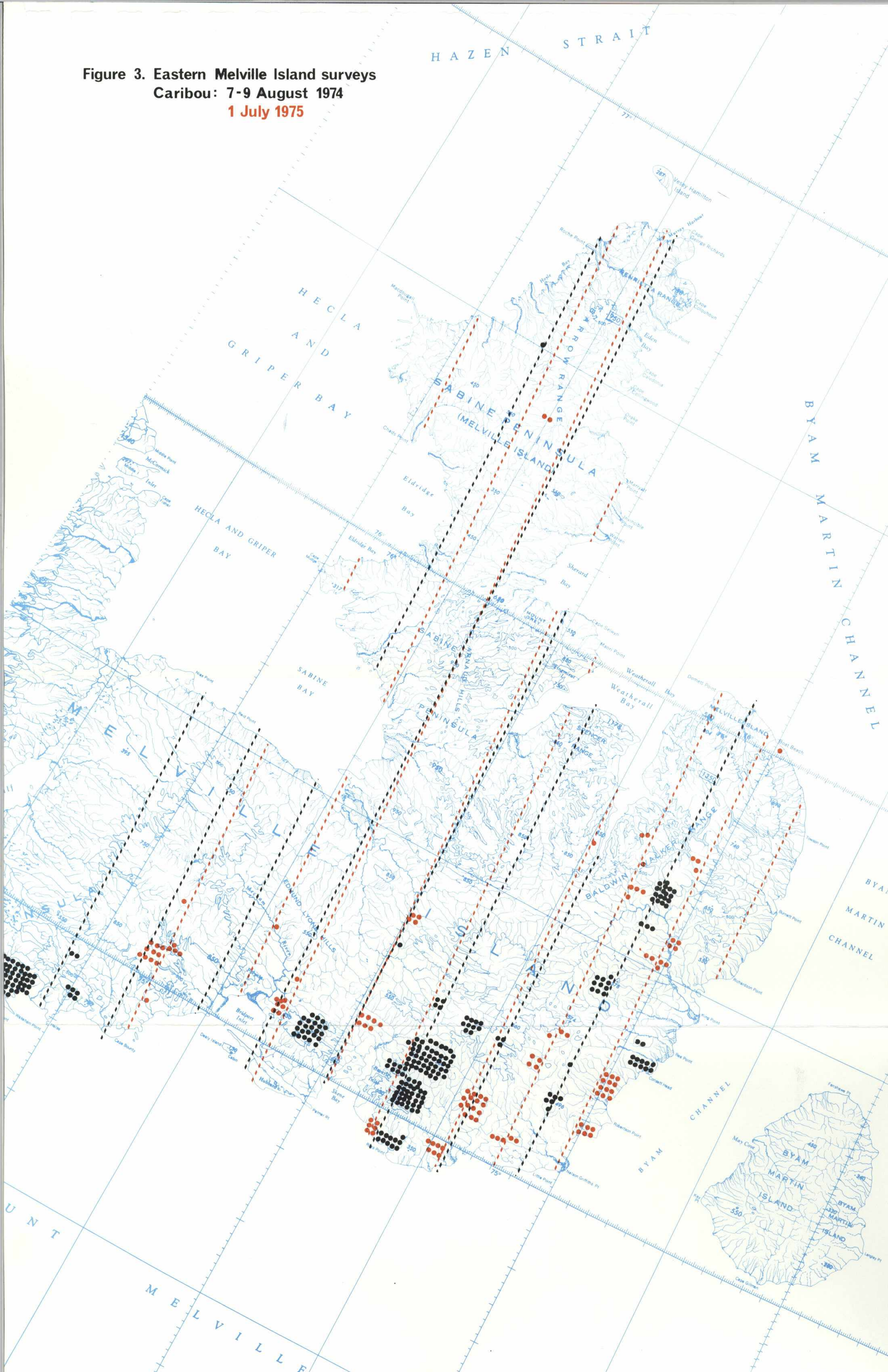


Figure 4. Eastern Melville Island surveys
Caribou cow-calf pairs: 1 July 1975

Of 116 animals classified in 1974, no calves were observed. During 1975, 25% (40) of 158 caribou were calves (Table 5).

Discussion

Aerial surveys of caribou and muskoxen on Melville Island were purposely limited because this island has been surveyed several times by the Canadian Wildlife Service in recent years. In July 1961, Tener (1963) surveyed 6.0% of Melville Island and estimated 622 caribou (13.1/100 km^2) on Sabine Peninsula and 8,202 (43.5/100 km^2) on the remainder of eastern Melville including Dundas Peninsula. Miller *et al.* (1973) estimated 612 caribou (4.4/100 km^2) on eastern Melville Island (east of a line between Bridport Inlet and Sabine Bay) in a survey conducted between 18 March and 7 April 1972, and 1,080 (7.8/100 km^2) in a survey between 7 and 25 August 1972. Again on eastern Melville Island, Miller and Russell (1974a) estimated 728 caribou (5.2/100 km^2) in a survey between 19 March and 7 April 1973, and 1,488 (10.7/100 km^2) in a survey between 5 and 29 July 1973. Survey coverage during these flights was 25%. Miller and Russell (1975) suggested that their winter estimates of Peary caribou were probably biased lower than the summer estimates by a factor of about 20% because of the difficulty of spotting the light-colored animals against a background of snow. Accordingly, these winter surveys probably underestimate the actual population.

Between 1961 and 1973, the caribou population on Melville Island appears to have undergone a 73% reduction in numbers, from 12,799 to

Table 5. Percentage of calves in caribou observed during aerial surveys of arctic islands and Boothia Peninsula between 15 June and 31 August 1974 (mean date = 21 July) and between 15 June and 9 July 1975 (mean date = 29 June).

Location	Year	Transect Surveys			Spotcheck Surveys			Mean % Calves (Weighted)
		Calves	Total	% Calves	Calves	Total	% Calves	
Eastern Melville Island	1974	0	116	0	-	-	-	0
	1975	40	158	25	-	-	-	25
Bathurst Island	1974	5	47	11	0	8	0	9
	1975	17	48	35	-	-	-	35
Cornwallis Island	1974	1	6	17	2	8	25	21
	1975	0	0	-	-	-	-	-
Russell Island	1974	-	-	-	2	38	5	5
	1975	23	123	19	-	-	-	19
Prince of Wales Island	1974	136	662	21	115	677	17	19
	1975	185	855	22	180	672	27	24
Somerset Island	1974	5	18	28	50	191	26	26
	1975	34	132	26	-	-	-	26
Boothia Peninsula	1974	14	63	22	83	294	28	27
	1975	40	239	17[1]	301	967	31	31[2]
Total	1974	161	912	17.7	249	1,216	20.5	19.3
	1975	299	1,316	22.7[2]	481	1,639	29.3	26.4

[1]Productivity probably underestimated as survey was flown during 5-12 June, most likely prior to completion of calving.
[2]Transect survey of Boothia Peninsula not included.

3,433 (Miller and Russell, 1975). To provide an indication of recent population trends during summer on eastern Melville Island, we have calculated estimates of adult caribou for each of the July-August surveys above, during 1972-75. This yields July-August densities of approximately 7.8, 8.8, 5.3, and 2.7 caribou per 100 km^2 during 1972-75, respectively. However, because of the fact that caribou are extremely mobile (movements between Eglinton and Melville islands have been documented (Miller and Russell, pers. comm.)) and only 40% of Melville Island was included in our study area, these trends may not reflect those of the entire island.

The distribution of caribou over eastern Melville Island appears to be quite variable. In late-winter 1972, Miller *et al.* (1973) found 76% of the total caribou population of Melville Island on Sabine Peninsula. The following winter, 82% of the caribou on Melville Island were on the eastern portion of the island but only 4% were on Sabine Peninsula (Miller and Russell, 1974a). The remainder were mostly in the central inland portions. During August 1972, most caribou were located inland, whereas in July and August 1973 they were distributed mostly along the coast (<15 km), although a movement inland was occurring by mid-August (Miller and Russell, 1974a). During summer surveys in August 1974 and July 1975, most caribou were within 15 km of the southern and eastern coasts. As the summer 1972 survey was conducted at a later date than summer surveys in 1973-75, it is possible caribou may have completed a movement inland by the time of the survey. If so, animals may indeed be selecting coastal regions for use during summer, while choosing inland

areas during late winter and fall.

There appears to be considerable annual variation in the productivity of caribou on Melville Island. Tener (1963) found 19% calves among caribou observed in July 1961. Miller *et al.* (1973) observed no calves in August 1972 while Miller and Russell (1974a) found 17% calves among caribou observed in July and August 1973. This compares with a 0% and 25% calf crop observed during surveys in August 1974 and July 1975. Winter severity may be a major determining factor of annual caribou productivity.

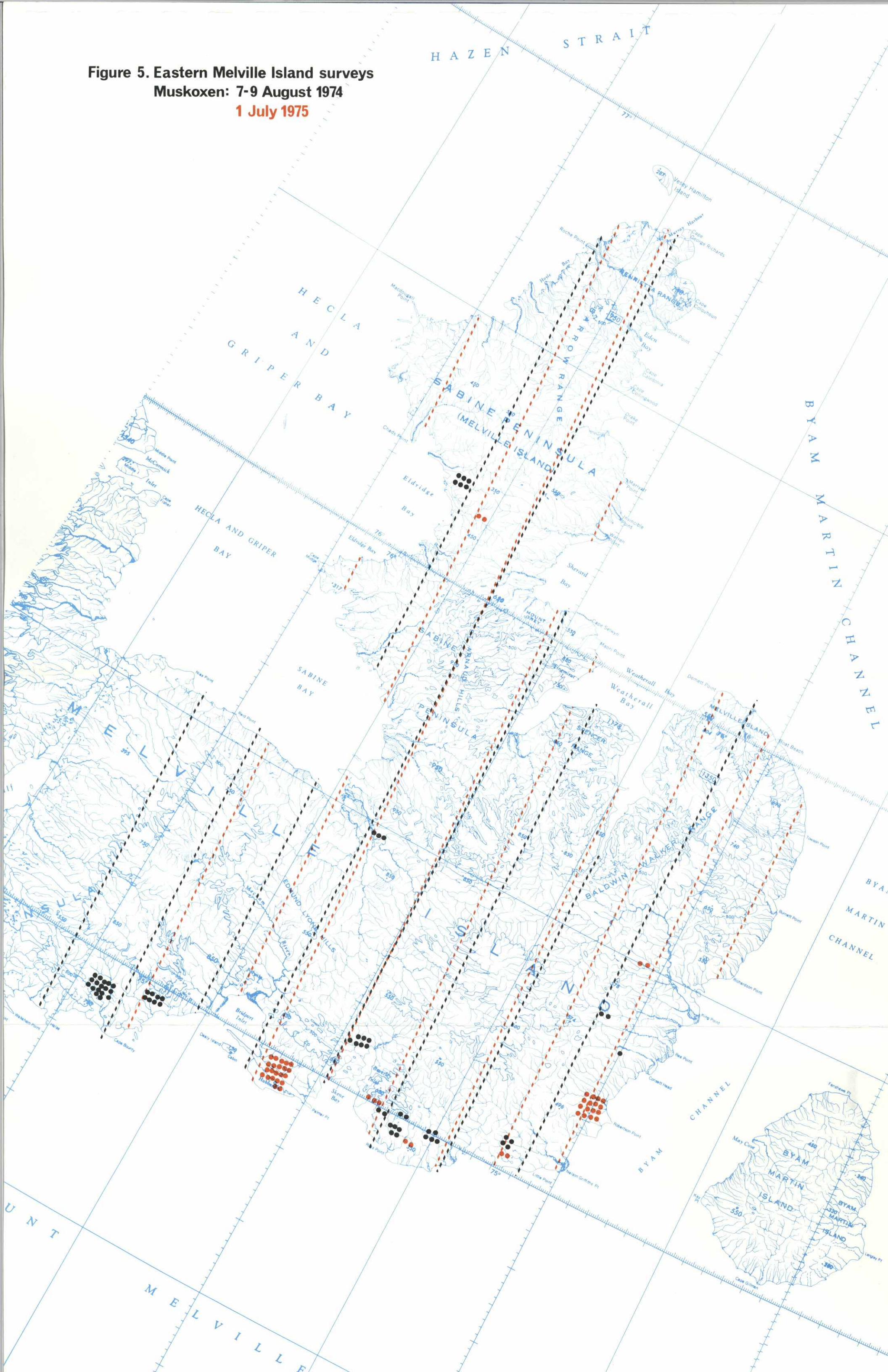
Muskoxen

Results

During survey flights in August 1974, a total of 69 muskoxen were observed and the estimated population was 214 (1.3/100 km^2) on eastern Melville Island (Table 4). The following year, July 1975, 49 muskoxen were seen, only 4 of which were on transect. The estimate of 38 animals (0.2/100 km^2) on eastern Melville Island was lower than the total number of animals observed.

During both years, most muskoxen were within 10 km of the southern and southeastern coasts (Figure 5). Only six and two animals were observed on Sabine Peninsula during 1974 and 1975, respectively.

Figure 5. Eastern Melville Island surveys
Muskoxen: 7-9 August 1974
1 July 1975



No calves were observed in 1974 among 53 animals identified as to age during transect surveys, or among 9 animals seen during a survey of the pipeline route on 20 June (Table 6). In 1975, two calves (7%) were counted among 29 animals classified during transect surveys.

Discussion

Muskoxen have been abundant on Melville Island at least since the time of earliest exploration when Parry reported their presence (Hone, 1934). From his general observation, Anderson (1930) estimated the population of the entire island at 4,000. A systematic survey was not attempted until 1961. During a survey in July, Tener (1963) estimated a population of 1,000 for the entire island based on a survey of 6% of the land surface. The distribution of animals was found to be highly skewed; accordingly, an accurate estimate was not possible. Miller *et al.* (1973) estimated the population at 3,408 (8.1/100 km^2) based on a survey during March and April 1972 which covered 25% of the land surface. During a follow-up survey in March and April 1973, Miller and Russell (1974a) estimated 3,040 muskoxen (7.2/100 km^2). Hence, there appears to have been a three-fold increase in numbers between 1961 and 1972-73. On eastern Melville Island specifically, the population density was estimated at 3.2 (Miller *et al.*, 1973) and 3.6 (Miller and Russell, 1974a) per 100 km^2 during March and April, 1972 and 1973. During July-August 1972-74, the adult (>1 year of age) population density was estimated at 2.5 (Miller *et al.*, 1973), 2.6 (Miller and Russell 1974a) and 1.3 (this report) per 100 km^2. As the percent coverage

Table 6. Percentage of calves in muskoxen observed during aerial surveys of arctic islands between 14 May and 26 August 1974 (mean date = 12 July) and between 15 June and 9 July 1975 (mean date = 1 July).

Location	Year	Transect Surveys			Spotcheck Surveys			Mean % Calves (Weighted)
		Calves	Total	% Calves	Calves	Total	% Calves	
Eastern Melville Island	1974	0	53	0	0	9	0	0
	1975	2	29	7	–	–	–	7
Bathurst Island	1974	–	–	–	1	135	1	1
	1975	7	69	10	–	–	–	10
Cornwallis Island	1974	3	19	16	–	–	–	16
	1975	0	0	–	–	–	–	–
Prince of Wales Island	1974	7	101	7	43	306	14	12
	1975	9	81	11	14	95	15	13
Total	1974	10	199	5	44	450	10	8
	1975	18	179	10	14	95	15	12

during 1974 was lower than during 1972 and 1973 and the numbers of animals seen fewer, the lower density may be a result of undersampling the population. Alternatively, as only the eastern 40% of the island surface was sampled during 1974, muskoxen may have emigrated to the western portion during that year.

In July 1961, only 11% of total muskoxen sightings were on the eastern half of Melville Island (Miller and Russell, 1974b); a few herds were located on Sabine Peninsula and none on Dundas Peninsula (Tener, 1963). In March-April 1972 and 1973, 28% of total muskoxen sightings for the island were on eastern Melville Island (Miller and Russell, 1974b). In 1972, animals on eastern Melville Island were concentrated only on the central portion of Sabine Peninsula and on the south-central coast between Bridport Inlet and Winter Harbor (Miller *et al.*, 1973). In 1973, only 4% of total sightings were on Sabine Peninsula; most observations in the eastern half of the island were on Dundas Peninsula.

In July-August 1972 and 1973, muskoxen were found in the same general areas as in the preceding March-April surveys, except they were located slightly farther inland. During surveys in July-August 1974 and 1975, most muskoxen were concentrated in southern and southeastern coastal areas. Hence, it appears that animals are consistently using these areas for summering and moving closer to the coast in winter.

Productivity of observed muskoxen on Melville and eastern Melville Island has fluctuated annually. In July 1961, Tener (1963) observed 17% calves in 273 total muskoxen classified. In March-April 1972, Miller *et al.* (1973) found that 13% of muskoxen observed were yearlings, indicating that the calf crop in 1971 was somewhat greater than 13%. In August 1972, 11% of muskoxen classified were calves (Miller *et al.*, 1973); in 1973, 19% were calves (Miller and Russell, 1974a). We found no calves in 1974, and in 1975, only 7% were calves.

Bathurst Island

Three transect surveys of the entire Bathurst Island group were made during 1974-75. In 1974, a survey which covered 26.8% of the land surface was conducted between 18 and 25 August. In 1975, transect surveys were carried out during the periods from 15 to 20 April and 25 to 26 June. Survey coverage during both 1975 surveys was 8.3%.

Caribou

Results

In August 1974, 77 caribou were observed during transect flights on the Bathurst Island group (Table 7). Based on this survey, the estimated total population was 228 caribou (1.2/100 km^2). During flights in April and June 1975, 10 and 48 caribou were observed; estimated total

Table 7. Population estimates of caribou and muskoxen on Bathurst Island during late winter and summer, 1974 and 1975.

Species	Survey Dates	% Coverage	Number Observed		Population Estimate
			On Transect	Total	
Caribou	18-25 August 1974	26.8	61	77	228
	15-20 April 1975	8.3	10	10	120
	25-26 June 1975	8.3	30	48	361
Muskoxen	18-25 August 1974	26.8	66	189	246
	15-20 April 1975	8.3	26	59	313
	25-26 June 1975	8.3	0	69	(0)[1]

[1] Calculated estimate was lower than total number observed.

numbers were 120 (0.6/100 km^2) and 361 (1.9/100 km^2) caribou.

During both summer surveys, most animals were scattered over the northwestern one-half of the island (Figure 6). Fifteen caribou (20%) were found south of Bracebridge-Goodsir inlets (Polar Bear Pass) in 1974; only one (2%) in 1975. All 10 caribou observed during April 1975 were immediately south of Goodsir Inlet.

During transect surveys in 1974, five calves (11%) were seen in 47 total caribou classified; no calves were seen in 8 caribou observed during spotcheck surveys on 27 June and 11 July (Table 5). In 1975, 17 calves (35%) were present among 48 caribou classified. In both years, calving groups were widely distributed in areas of greater relief in the northwestern portion of the island (Figure 7).

Discussion

Tener (1963) estimated the caribou population on Bathurst and associated islands at 3,565 animals (18.1/100 km^2) during a survey in June and July 1961 which covered 7.8% of the land surface. In a survey which covered 25% of the land surface between 29 March and 3 April 1973, Miller and Russell (1974a) estimated the population of the Bathurst Island group (including Cameron, Helena, Vanier, Massey, Marc, and Alexander islands) at 611 caribou (3.2/100 km^2).

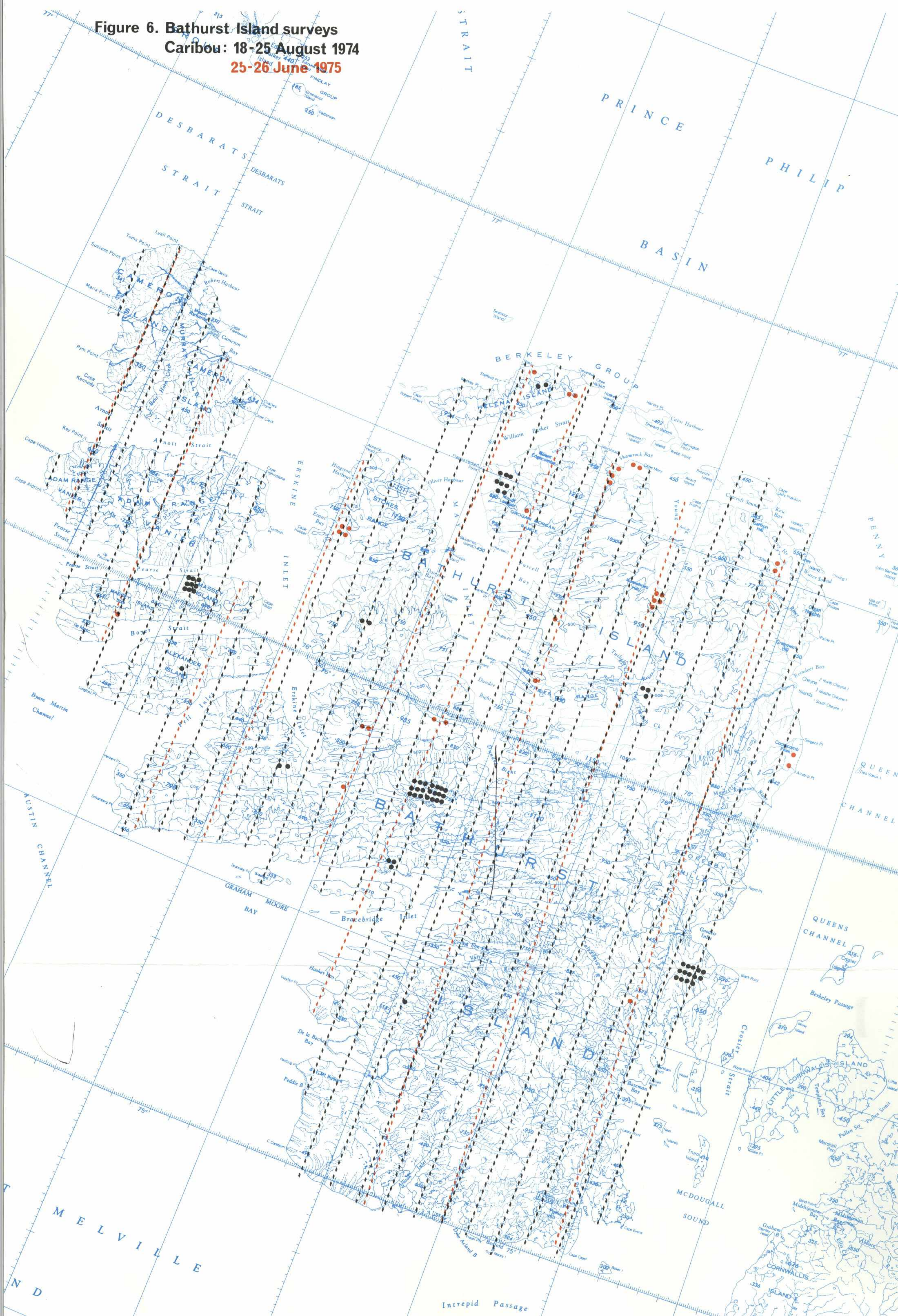


Figure 6. Bathurst Island surveys
Caribou: 18-25 August 1974
25-26 June 1975

Figure 7. Bathurst Island surveys
Caribou cow-calf pairs: 18-25 August 1974
25-26 June 1975

Between 25 and 31 March and 25 and 26 August 1974, Miller and Russell (1975) surveyed 12.5% to 25% of Bathurst Island proper (not including associated islands) and estimated populations of 231 (1.4/100 km^2) and 278 (1.7/100 km^2) caribou, respectively. In a survey during September 1974, Slaney (1975a) estimated 275 caribou (1.4/100 km^2) on the Bathurst Island group.

Estimates of adult (>1 year of age) population densities (per 100 km^2) for the above summer surveys are 14.5 (Tener, 1963) in 1961, 1.7 (Miller and Russell, 1975) and 1.1 (this report) in 1974, and 1.2 (this report) in 1975. Hence, there appears to have been a reduction in numbers of approximately 90% between 1961 and 1974. Further, Miller and Russell (1975) noted a decline of about 57% between March-April 1973 and March 1974. The reasons for these observed reductions are not clear. Miller and Russell (1974) stated that the decline from 1961 to 1974 fitted an overall pattern of declining caribou populations on the western Queen Elizabeth Islands. A primary factor contributing to the decline between 1973 and 1974 may have been the severity of the winter. Reports of a hard-packed crust which formed in fall 1973 in Polar Bear Pass (Gill, pers. comm.) along with reports of deep snow and ice-encrusted snow in nearby areas support this hypothesis. Twenty-two caribou carcasses were located during aerial surveys in 1974; none appeared to have been the result of predation. In contrast, no caribou carcasses were seen during surveys of Bathurst Island in 1975. Numbers of adult caribou in 1975 appeared to be at a level similar to that in 1974.

Tener noted that virtually all (99.6%) of the caribou he observed in June and July 1961 were north of a line joining Bracebridge-Goodsir inlets (Miller and Russell, 1975). The caribou north of this line were almost equally distributed in the northeast (54%) and northwest (45%). In late August 1974, Miller and Russell (1975) observed 41 caribou on transect; none were in the south, 83% were in the northeast, and 17% in the northwest. During surveys in September 1974, Slaney (1975a) saw 41 animals on transect flights of Bathurst Island; none were in the south. These results are consistent with our findings which indicate most caribou are located in northern Bathurst Island during summer.

During late-winter flights (March-April) in 1973 and 1974, Miller and Russell (1975) found 60% and 78% of caribou observed on transect in the south. Total caribou observed on these flights were 134 and 58, respectively. That most caribou are wintering in southern Bathurst is indicated by these surveys along with the fact that numerous discarded antlers were found near Allison Inlet and caribou carcasses were found on southern Bathurst in summer 1974. Gray (pers. comm.) saw caribou moving north across Polar Bear Pass in spring and moving south in fall. Miller and Russell (1975) state that local hunters believe caribou make regular seasonal movements on Bathurst Island. Between 29 May and 2 June 1974, we observed only two caribou during transect flights of southern Bathurst Island which covered 25% of the land surface. Hence, movement of animals northward in 1974 must have occurred between 25 March and 29 May.

Caribou productivity on Bathurst Island has been somewhat erratic over the past years. In 1961, Tener (1963) found calves comprising 20% of 257 animals classified. In 1974, Miller and Russell (1975) observed no calves while we observed 9% calves in 55 animals classified over the summer. During 1975, productivity again appeared high as 17 calves (35%) were observed in 48 animals classified during transect surveys. It appears the severe winter of 1973-74 reduced caribou productivity in 1974.

Muskoxen

Results

In August 1974, 189 muskoxen were observed during transect flights on the Bathurst Island group (Table 7). Based on this survey, the total population estimate was 246 muskoxen (1.3/100 km^2). During flights in April and June 1975, 59 and 69 muskoxen were observed; the estimated total number in April was 313 (1.6/100 km^2). No muskoxen were observed on transect in June; however, as the total number of muskoxen observed in June was similar to April, any changes in population numbers were probably not great.

During April and June 1975 surveys, animals were widely distributed over the southeastern two-thirds of the island, mostly within 6 km of the coast (Figure 8). About one-half of the animals observed were north

Figure 8. Bathurst Island surveys
Muskoxen: 15-20 April 1975
25-26 June 1975

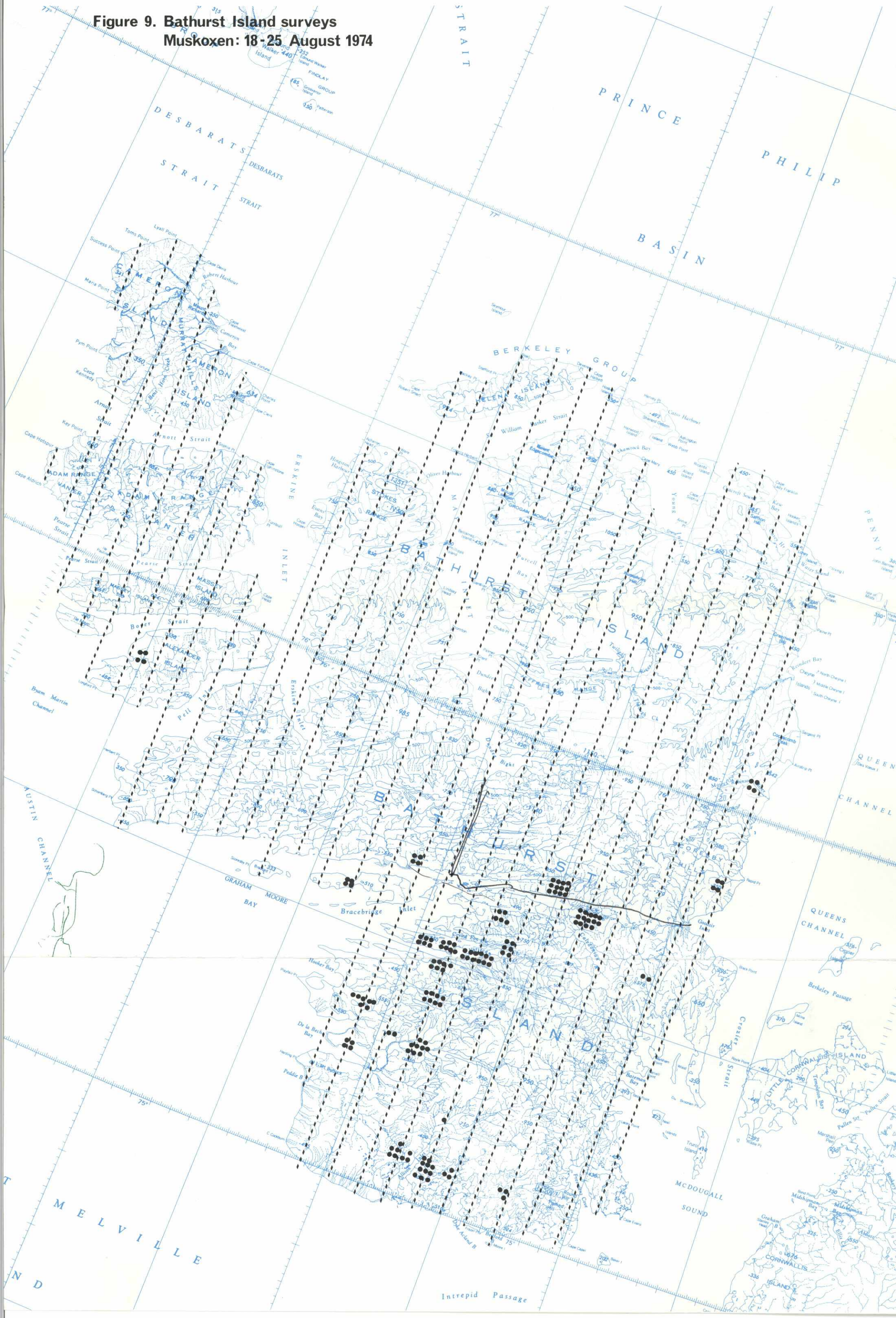
of Bracebridge-Goodsir inlets. In August 1974, animals were more concentrated immediately south and east of Bracebridge Inlet with only 20% located north of Bracebridge-Goodsir inlets (Figure 9).

During August 1974 transect flights, a concerted effort to classify animals by age was not made. However, during a spotcheck flight conducted on 20 June over the south and west coast of Bathurst, 135 muskoxen were counted (Table 6). Of these, only one (1%) was a calf. This indicates reproduction success was very low in 1974. During transect flights in 1975, seven calves (10%) were seen in a total of 69 muskoxen classified indicating moderate reproductive success in 1975.

Discussion

On the basis of his ground travels, Anderson (1930) estimated the muskoxen population of Bathurst Island at 1,500. Tener (1963), in the first systematic survey of the Queen Elizabeth Islands, estimated a population of 1,161 (5.9/100 km^2) on the Bathurst Island group. His estimate was based on a survey in June and July which covered 8% of the land surface. Miller and Russell (1974a) estimated a population size of 736 (3.9/100 km^2) for the Bathurst Island group based on a March-April survey in 1973 of 25% of the area. In surveys of Bathurst Island proper (not including satellite islands) in 1974, Miller and Russell (1975) estimated 533 muskoxen (3.3/100 km^2) in March and 183 (1.1/100 km^2) in August. Survey coverage ranged from 12.5% to 25%. Slaney (1975a)

Figure 9. Bathurst Island surveys
Muskoxen: 18 - 25 August 1974



estimated a population of 210 muskoxen (1.1/100 km^2) in September 1974 with survey coverage ranging from 10% to 29%. In April-May 1975, Slaney (1975b) estimated a population of 108 muskoxen during a high altitude (300 m) survey covering 100% of the land surface.

Estimates of adult (>1 year of age) population densities (per 100 km^2) for the above summer-fall surveys were 5.4 (Tener, 1963) in 1961, 1.1 (Miller and Russell, 1975), 0.9 (Slaney, 1975a), and 1.3 (this report) in 1974. Hence, it appears muskoxen numbers dropped by about 80% between 1961 and 1974. Late-winter densities (per 100 km^2) of muskoxen were 3.9 (Miller and Russell, 1974a) in 1973, 3.3 (Miller and Russell, 1975) in 1974, and 0.6 (Slaney 1975b) and 1.6 (this report) in 1975. Apparently, muskoxen numbers dropped by about 70% between 1973 and 1975 with approximately three-fourths of this reduction occurring between 1974 and 1975.

The reason for these reductions is probably a result of a combination of low reproduction and high winter mortality. While Tener (1963) found that calves accounted for 9% of 111 muskoxen observed in 1961, Gray (1973) noted a complete absence of calves, yearlings and two-year-olds between 1968 and 1970. Additionally, he found 13 muskoxen carcasses in 1968 near the National Museum field camp in Polar Bear Pass indicating a harsh winter in 1967-68. Gray (1972) first saw calves in May 1971 when 10 were observed in a total of 308 muskoxen. That there was fair reproduction in spring 1972 and 1973 is evidenced by the fact that

Miller and Russell (1975) found short-yearlings comprising 7.4% and 9.2% of the total muskoxen observed in springs of 1973 and 1974. Productivity was apparently lower in 1974 as Miller and Russell (1975) observed no calves and we observed calves to comprise only 1% of 135 muskoxen observed. However, Slaney (1975a) reported a calf crop of 17% (69 total muskoxen observed) in the same year. Apparently, the winter of 1973-74 was extremely adverse for muskoxen as 42 carcasses were found during summer field work in 1974 (many others were probably missed). This was undoubtedly a major contributing factor to the population decline. Productivity in 1975 appeared to be moderate as calves comprised 10% of 69 muskoxen classified.

The distribution of muskoxen on Bathurst Island exhibits considerable similarity between years. In June-July 1961, Tener (1963) found 36% of muskoxen observed to be south of Polar Bear Pass, 31% in the northwestern portion of the island (west of a line extending due south of May Inlet), and 33% in the northeast. During August 1974, Miller and Russell (1975) found 69% of muskoxen observed to be south of Polar Bear Pass, 24% in the northeast, and 8% in the northwest. In September 1974, Slaney (1975a) found 74% of total muskoxen sightings to be south of Polar Bear Pass, 10% in the northeast, and 16% in the northwest. These findings are consistent with the results of our late-summer survey in 1974 which shows highest numbers of animals south of Polar Bear Pass.

During surveys in March-April 1973 and March 1974, Miller and Russell (1975) found 59% and 81% of total muskoxen sightings were south of Polar Bear Pass. In 1973, 24% were located in the northwest; in 1974, only 5%. Slaney (1975b) found a concentration of muskoxen northwest of Bracebridge Inlet during a survey from 25 April to 3 May 1975. Fifty-five percent of the animals were located in the northwest section, while only 36% were observed in the south. They suggested that some muskoxen may move from south Bathurst Island to northwest of Bracebridge Inlet prior to calving in late April or early May. Information obtained from marked animals indicated that movements across the island do occur (Gray, 1972).

Results of all aerial surveys show that most muskoxen are found in proximity to the coastline (<7.5 km) and are associated with well-vegetated areas. One of the areas consistently sustaining the largest concentrations of muskoxen on Bathurst Island is the Bracebridge-Goodsir valley. The proportion of total muskoxen, observed within this valley during aerial surveys has been as high as 69% (Tener, 1961) and has averaged 20 to 25% between 1973 and 1975. Concentrations of animals have also been frequently observed along the western edge of southern Bathurst Island and along the northern shore of Graham Moore Bay.

Cornwallis Island

Four complete aerial surveys of Cornwallis Island were made between 1974 and 1975. In 1974, surveys were flown on 13 and 14 May and 28 July.

Coverage on these surveys was 25.9% and 9.6%, respectively. Surveys in 1975 covered 9.8% of the land surface and were conducted on 16 April and 20 June.

Caribou

Results

In May 1974, only 1 caribou was observed on transect out of a total of 14 (Table 8). Consequently, the population estimate was lower than the total number of animals seen. The estimated population for the 28 July survey was 52; a total of six caribou were observed. In April 1975, an estimated 31 caribou were on the island; a total of three were observed. No caribou were seen during the survey on 20 June.

Distribution of caribou was essentially the same on all three surveys where observations of caribou were made (Figures 10 and 11). All animals except for two seen during the July 1974 survey were located in the northwestern portion of the island. Most caribou observed on all surveys were located more than 10 km inland. However, several were seen on the well-vegetated lowland on the extreme northwestern corner of the island during summer 1974. Caribou were consistently absent from the central and southeastern portions of the island, except for two animals seen in the central part during July 1974. Much of this area is essentially void of vegetation and is classed as a polar desert (Babb and Bliss, 1974).

Table 8. Population estimates of caribou and muskoxen on Cornwallis Island during late winter and summer, 1974 and 1975.

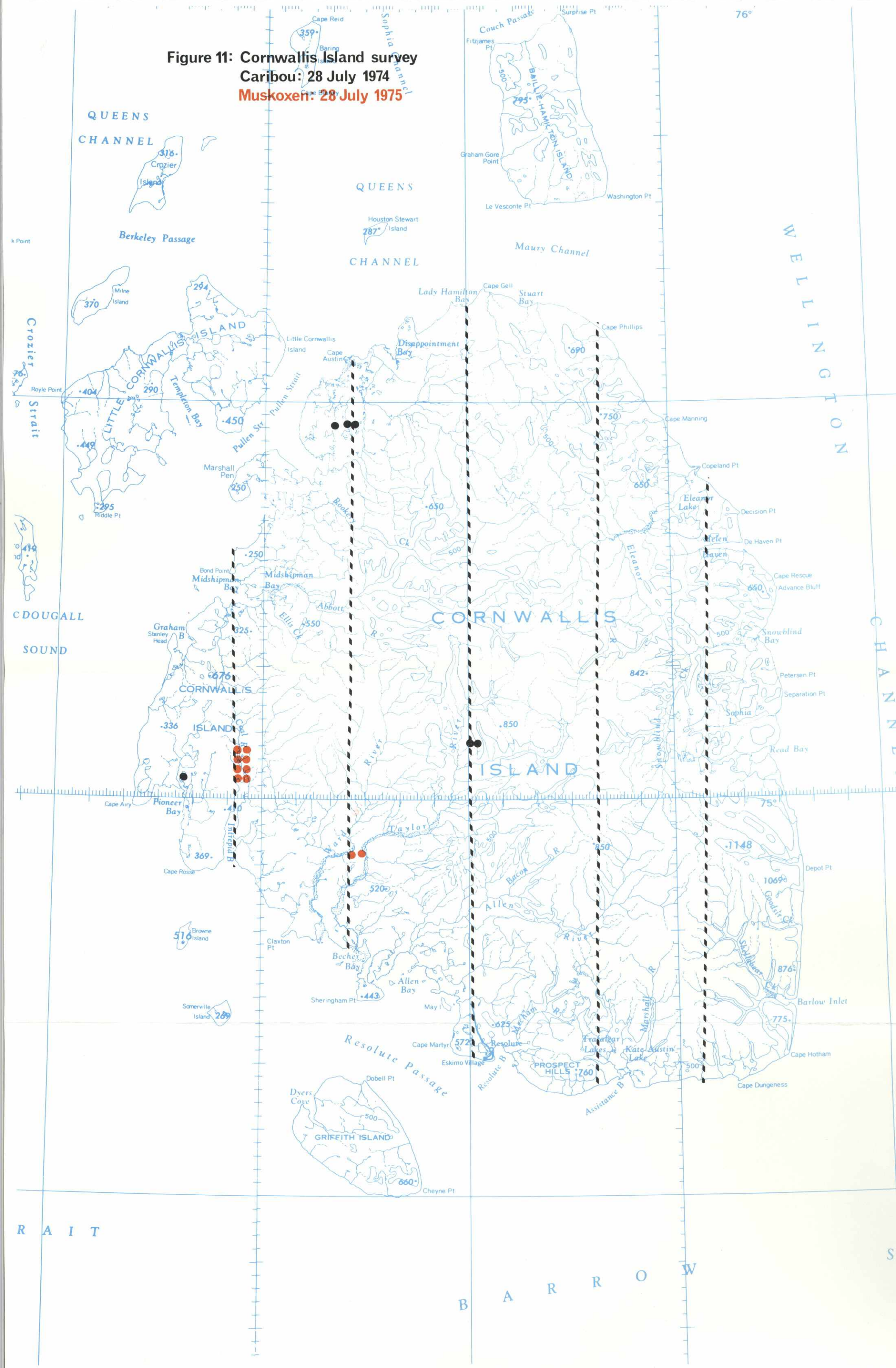
Species	Survey Dates	% Coverage	Number Observed		Population Estimate
			On Transect	Total	
Caribou	13-14 May 1974	25.9	1	14	(4)[1]
	28 July 1974	9.6	5	6	52
	16 April 1975	9.8	3	3	31
	20 June 1975	9.8	0	0	0
Muskoxen	13-14 May 1974	25.9	12	16	46
	28 July 1974	9.6	10	10	104
	16 April 1975	9.8	1	1	10
	20 June 1975	9.8	0	0	0

[1] Calculated estimate was lower than total number observed.

Figure 10. Cornwallis Island surveys
Caribou: 13-14 May 1974
16 April 1975

QUEENS CHANNEL
Crozier Island
Berkeley Passage
Baring Islands
Cape Blank
Fitzjames Pt
Graham Gore Point
Le Vesconte Pt
Washington Pt
BAILLIE-HAMILTON ISLAND
Houston Stewart Island
Maury Channel
WELLINGTON CHANNEL
Milne Island
Lady Hamilton Bay
Cape Gell
Stuart Bay
Cape Phillips
Disappointment Bay
Cape Austin
Little Cornwallis Island
LITTLE CORNWALLIS ISLAND
Templeton Bay
Pullen Strait
Royle Point
Crozier Strait
Cape Manning
Copeland Pt
Eleanor Lake
Decision Pt
Marshall Pen
Riddle Pt
Bookery
Helen Haven
De Haven Pt
Cape Rescue
Advance Bluff
Bond Point
Midshipman Bay
Abbott
Ellis Ck
CDOUGALL SOUND
Graham B
Stanley Head
CORNWALLIS ISLAND
Snowblind Bay
Petersen Pt
Separation Pt
Sophia
Coal R
Read Bay
Cape Airy
Pioneer Bay
Taylor
Depot Pt
Goodsir Ck
Cape Rose
Browne Island
Claxton Pt
Becher Bay
Allen Bay
Sheringham Pt
Allen River
Somerville Island
May I
Barlow Inlet
Resolute Passage
Cape Martyr
Resolute
Eskimo Village
Resolute Bay
Mecham R
Trafalgar Lakes
Kate Austin Lake
PROSPECT HILLS
Marshall R
Cape Hotham
Cape Dungeness
Assistance Bay
Dobell Pt
Dyers Cove
GRIFFITH ISLAND
Cheyne Pt
BARROW STRAIT

Figure 11: Cornwallis Island survey
Caribou: 28 July 1974
Muskoxen: 28 July 1975



On the basis of our limited sample, productivity in 1974 appeared to be good. During the transect survey in July, one calf was seen in a total of six animals (Table 5). During a spotcheck of western Cornwallis Island on 24 June, eight caribou were observed; two were calves. As no animals were observed during summer 1975, productivity during that year cannot be assessed.

Discussion

From his general observations, Thorsteinsson (1958) estimated about 30 caribou on Cornwallis Island between 1950 and 1953. These animals were observed in the western and northern parts of the island. In June 1961, Tener (1963) estimated 43 caribou from a survey which covered 7% of the land surface. Only three caribou were seen on transect, one in the vicinity of Eleanor River and two near Pioneer Bay. On the basis of the 1974-75 surveys, total numbers of caribou appeared to be comparable to these estimates, around 40 animals. The lack of caribou observations during the June 1975 survey may be due to either the low coverage of the island or emigration of some animals. Miller and Russell (1975) mention the possibility of movement of caribou between Cornwallis and Bathurst islands.

Muskoxen

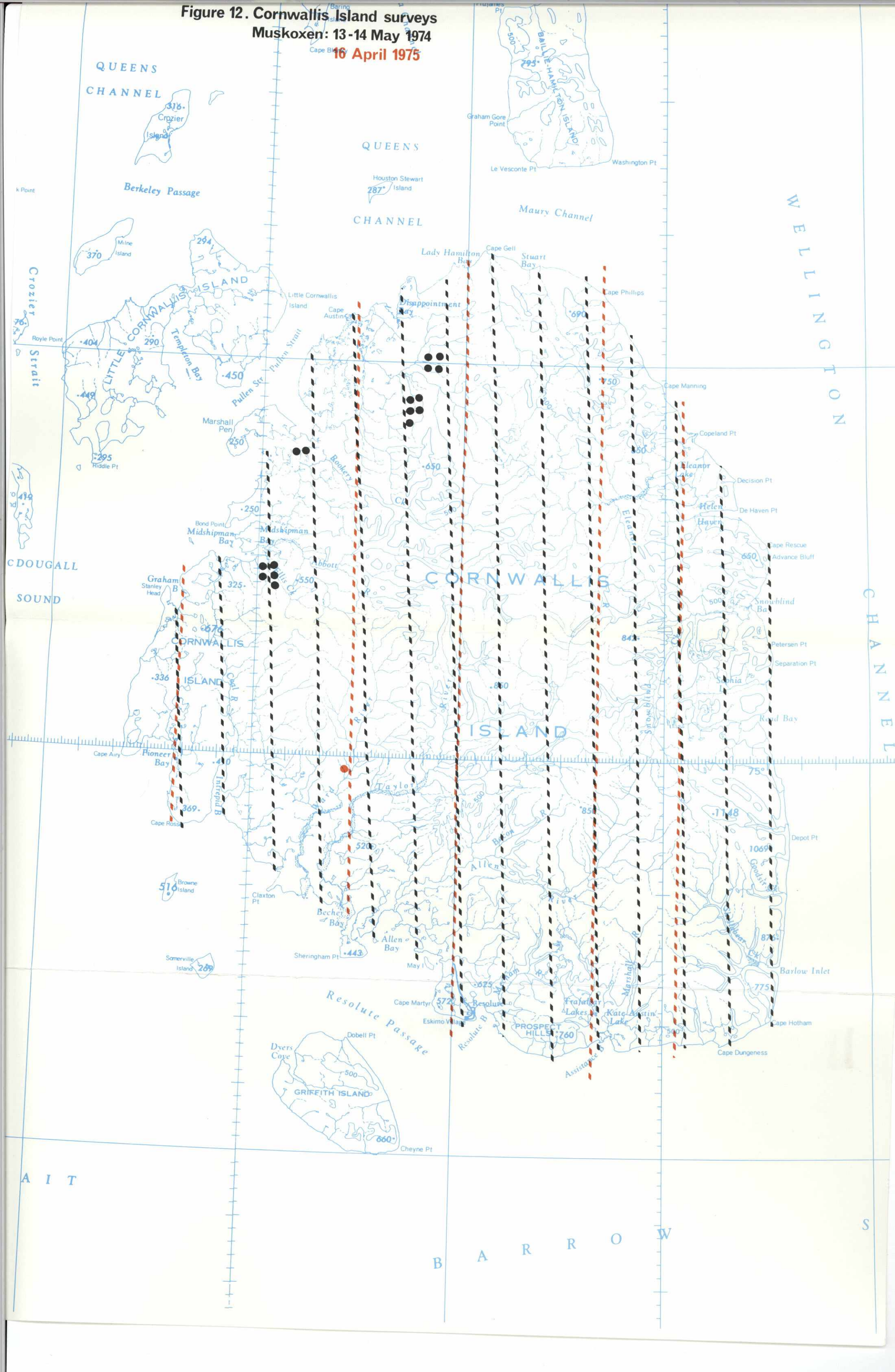
Results

During transect surveys in May and July 1974, and April and June 1975, a total of 16, 10, 1, and 0 muskoxen were observed (Table 8). Population estimates for the first three surveys were 46, 104, and 10.

On the basis of these aerial surveys, muskoxen distribution appeared to be restricted mainly to the western and northwestern portions of the island (Figure 12). One herd of muskoxen was seen near Eleanor Lake in early May 1974; in late April 1975, a herd of 14 was sighted in the same vicinity. For the most part, muskoxen were located in proximity to moist, well-vegetated areas including river valleys in the western and northeastern part of the island and in the low thermokarst area in the northwest.

Productivity of muskoxen on the island appeared to be good in 1974 (16% calves); however, only 19 animals were classified during the May and July surveys (Table 6). In May 1974, 3 of 9 animals observed were calves; in July, 0 of 10. No animals were observed during summer 1975; consequently, productivity for that year cannot be assessed.

Figure 12. Cornwallis Island surveys
Muskoxen: 13-14 May 1974
16 April 1975



Discussion

Thorsteinsson (1958), in a geological survey of Cornwallis Island between 1950 and 1953, saw several small herds of muskoxen and estimated a population of about 30 animals. Tener (1963) thought the population to be about 50 muskoxen in June 1961 based on past records and his aerial surveys which covered 7% of the island. Our estimates from 1974 to 1975 are variable, most likely a function of the limited survey coverage in relation to the low muskoxen population and their contagious distribution. Based on these surveys, we estimated a population of approximately 40 to 50 muskoxen on Cornwallis Island.

Thorsteinsson (1958) stated that muskoxen were generally found in vegetated low-lying plains and broad valley floors along the west coast. In June 1961, Tener (1963) observed 13 muskoxen northwest of Allen Bay on the southwest coast, 10 on the northwest coast and 7 along the Eleanor River in the northeast. These results are in agreement with the distribution of muskoxen observed during 1974 and 1975. Areas of concentration appear to be along the west and northwest coasts and in the vicinity of Eleanor Lake.

Russell Island

During 1975, transect flights were made over Russell Island on 4 April, 15 and 16 June, and 9 July. Coverage during these surveys was

7.1% for April, and 15.7% for June and July. No transect surveys of the island were made in 1974, though several spotcheck flights were carried out.

Caribou

During transect flights in 1975, a total of 0, 38, and 85 caribou were observed on the April, June, and July flights, respectively (Table 9). Population estimates derived from each of these surveys were 0, 159 (16.9/100 km^2) and 89 (9.5/100 km^2). In 1974, the following numbers of caribou were seen on the island during spotcheck surveys: 31 on 25 June, 14 on 14 August, 19 on 16 August, 20 on 3 September, and 141 on 18 September. There is most likely considerable movement of animals between Russell and Prince of Wales islands as the distance across Baring Channel is only 5 km.

During all surveys, caribou appeared to be widely distributed over the island (Figures 14 and 16). In 1974, 2 calves were seen among 19 caribou on 29 June and 0 among 19 on 16 August (Table 5). In 1975, 6 calves (16%) were observed among 38 caribou classified during transect surveys in June; 17 calves (20%) among 85 caribou in July.

Muskoxen

No muskoxen were observed on Russell Island during either 1974 or 1975.

Table 9. Population estimates of caribou on Russell Island during late winter and summer, 1975.

Survey Dates	% Coverage	Number Observed		Population Estimate
		On Transect	Total	
4 April 1975	7.1	0	0	0
15-16 June 1975	15.7	25	38	159
9 July 1975	15.7	14	85	89

Prince of Wales Island

Four transect surveys of Prince of Wales Island were completed during 1974 and 1975. The first survey was on 18 June 1974 and covered 10.1% of the land surface. Another survey was carried out between 29 and 30 July 1974. Because of a tape recorder malfunction on the south-eastern one-third of the island on 29 July, data were retrievable for only one observer. Hence, coverage on this portion was reduced to 5.1% compared to 8.3% on the rest of the island. For analysis purposes, these areas were divided into strata B and A, respectively. A third survey covering 8.6% of the island was flown between 4 and 14 April 1975. The final survey was conducted between 15 and 22 June 1975. Coverage was 16.7% in the northern one-third (Stratum I) of the island and 8.8% in the south (Stratum II).

Caribou

Results

There is considerable variation in population estimates of caribou on Prince of Wales Island during 1974 and 1975. On 18 June 1974, a total of 199 caribou were observed during transect flights and a population estimate of 1,040 caribou (3.1/100 km^2) was made (Table 10). Survey conditions were very poor as snow cover was mottled with numerous patches of bare ground. Consequently, this survey may have substantially underesti-

Table 10. Population estimates of caribou and muskoxen on Prince of Wales Island during late winter and summer, 1974 and 1975.

Species	Stratum	Survey Dates	% Coverage	Number Observed		Population Estimate
				On Transect	Total	
Caribou		18 June 1974	10.1	105	199	1,040
	A[1]	29-30 July 1974	8.3	435	740	5,241
	B	29-30 July 1974	5.1	10	11	196
					751	5,437
		4-14 April 1975	8.6	50	61	581
	I[2]	15-22 June 1975	16.7	153	315	916
	II	15-22 June 1975	8.8	251	551	2,852
					866	3,768

(Table 10. Continued)

Table 10. Continued

Species	Stratum	Survey Dates	% Coverage	Number Observed: On Transect	Number Observed: Total	Population Estimate
Muskoxen		18 June 1974	10.1	57	62	564
	A	29-30 July 1974	8.3	17	53	205
	B	29-30 July 1974	5.1	34	48	667
					101	872
		4-14 April 1975	8.6	78	185	907
	I	15-22 June 1975	16.7	20	46	120
	II	15-22 June 1975	8.8	17	35	193
					81	313

[1] Stratum B includes southeastern one-third of island (10,810 km^2); Stratum A includes remainder (see Figure 14).

[2] Stratum I includes northern one-third of island (10,000 km^2); Stratum II includes remainder (see Figure 13).

mated the population. Between 28 and 29 July 1974, 751 animals were observed and the estimated population was 5,437 caribou (16.1/100 km^2). In April 1975, only 61 animals were seen and the estimated population was 581 (1.7/100 km^2). Two and one-half months later, June 1975, 866 caribou were observed during transect flights and a population estimate of 3,768 caribou (11.2/100 km^2) was made.

Patterns of caribou distribution appeared similar between 1974 and 1975 for comparable surveys. During June 1974 and June 1975, caribou were mostly concentrated in the Arrowsmith Plains of southwestern Prince of Wales and in the northwestern corner of the island (northwest of a line between Scott Bay and Bellot Cliff (Figure 13)). In July 1974, locations of caribou concentrations appeared to be similar to June 1975, except that a higher proportion of animals on transect was found in the northern part of the island (Stratum I) during July (55% compared to 36%) (Figure 14). That this may have resulted from animal movement is suggested in 1975 by an apparent increase in the number of caribou on northern Prince of Wales Island between 15-22 June and 8-9 July 1975. Aerial surveys covering 16.7% of the area were flown on both dates and survey conditions were comparable. We estimated 2,437 caribou on north Prince of Wales in July (413 observed on transect) compared with an estimate of 916 in June (153 observed on transect), an increase of 166%.

Figure 13. Prince of Wales Island surveys
Caribou: 18 June 1974
15-22 June 1975

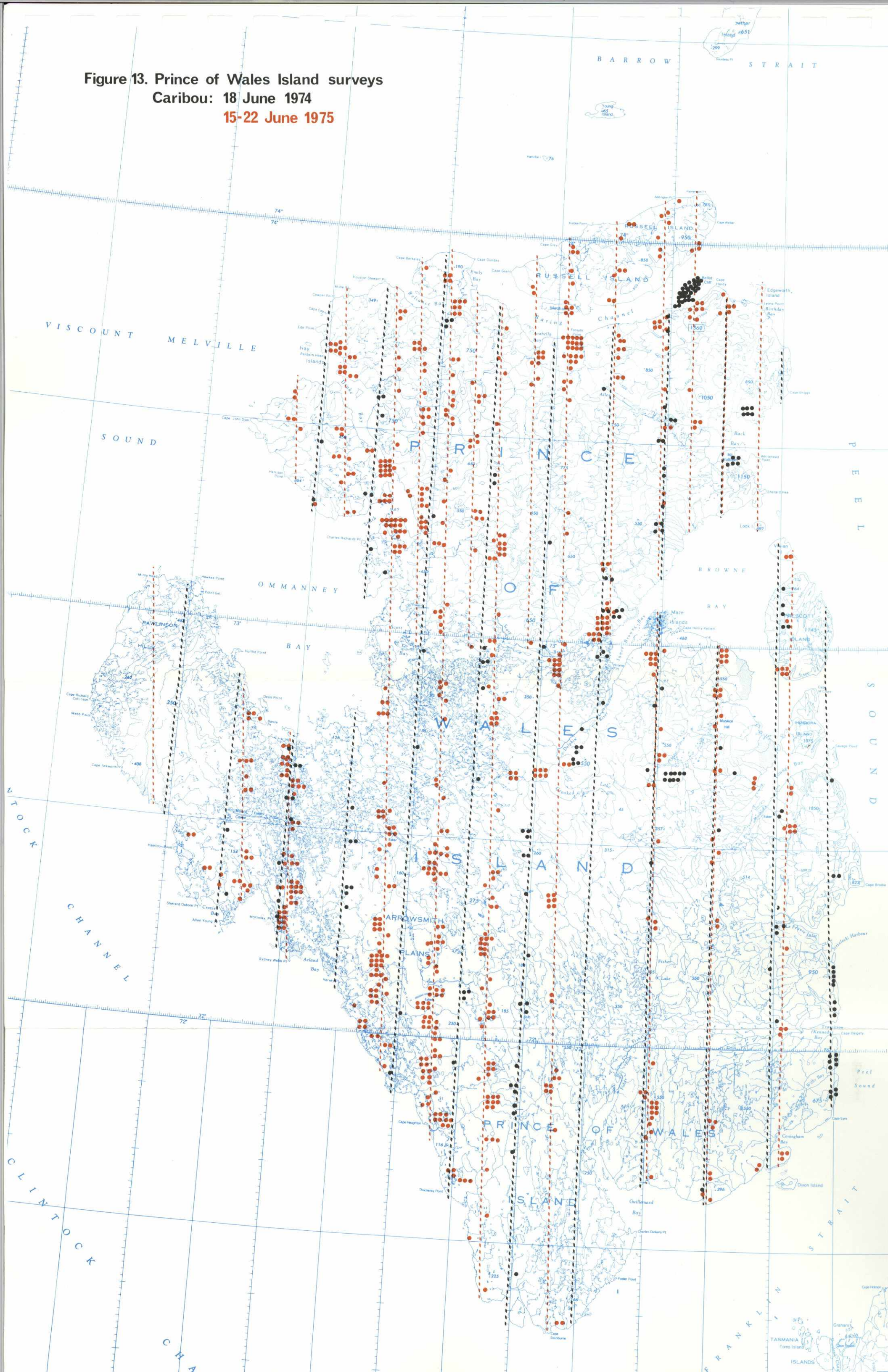


Figure 14. Prince of Wales Island surveys

Caribou: 29-30 July 1974

4-14 April 1975

---- 1 mile transect

..... 1/2 mile transect

In April 1975, most animals were found in the northern portion of the island; the remainder were mostly in the central lowlands between Ommanney Bay and the Dolphin River (Figure 14). During summer, we observed no distinction in regional patterns of distribution between caribou bulls, cow-calf pairs and all cohorts combined. While we were unable to classify all animals observed during July 1974 into sex and age cohorts, the locations of bulls which were identified indicates a scattered distribution throughout areas of caribou concentration (Figure 15). Caribou cow-calf pairs during 1974 and 1975 also tended to be scattered within the two concentration areas on southwest and northwest Prince of Wales Island (Figure 16).

Productivity of caribou on Prince of Wales Island appears to have been good during both 1974 and 1975. A total of 136 and 185 calves were seen during transect surveys in 1974 and 1975 for calf crops of 21% and 22%, respectively (Table 5). Results of spotcheck surveys during 1974 and 1975 were similar, although as spotcheck data were gathered throughout the summer at varying locations on the island, results are probably not as representative as the transect surveys.

Mortality of caribou did not appear to be severe in either year. Only 11 carcasses were found on the island in 1974; 1 in 1975.

Figure 15. Prince of Wales Island surveys
Caribou Bulls: 29-30 July 1974
- - - - 1 mile transect
..... 1/2 mile transect

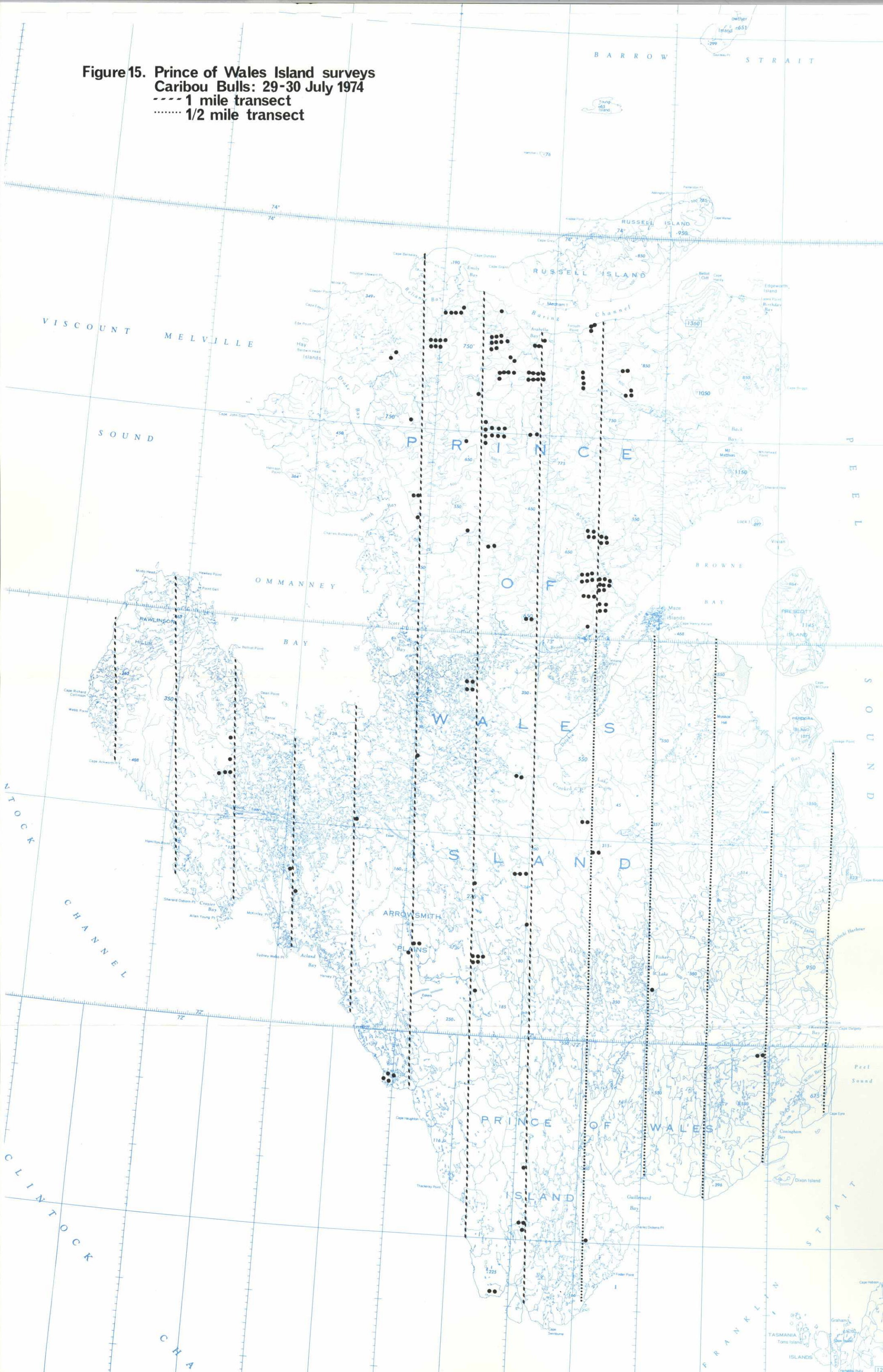
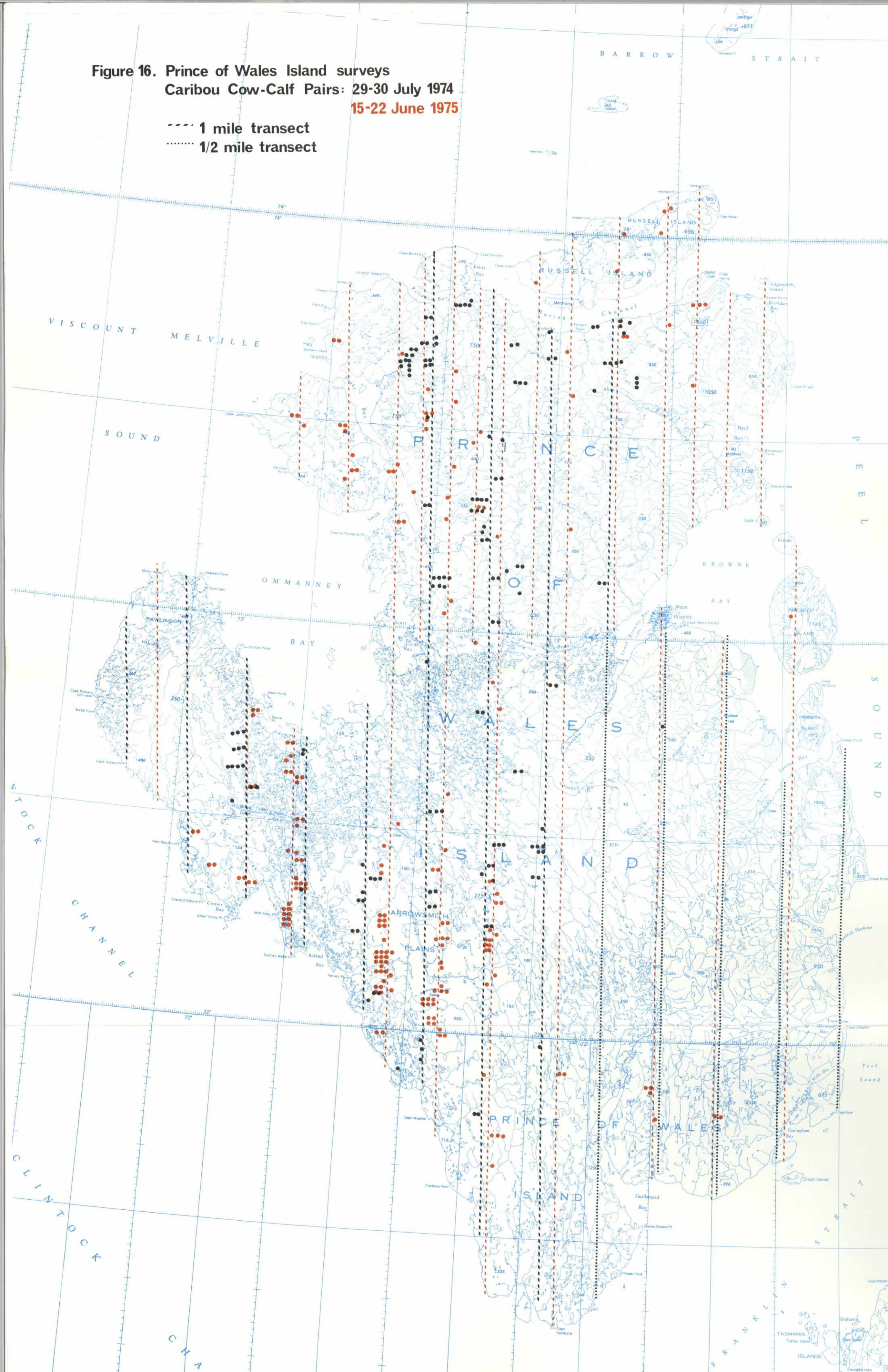


Figure 16. Prince of Wales Island surveys
Caribou Cow-Calf Pairs: 29-30 July 1974
15-22 June 1975

---- 1 mile transect
..... 1/2 mile transect



Discussion

The only previous biological investigation of Prince of Wales Island published to date is by Manning and Macpherson (1961). They estimated the caribou population of the island in 1958 to be about 500 animals based on walking surveys and limited aerial reconnaissance. From systematic aerial surveys in July 1974, when the snow melt was nearly complete and caribou were easily seen, we estimated a population of 5,437 caribou. Because survey techniques between these two studies differed, little can be concluded about changes in population size since 1958.

On 18 June 1974, the estimated population was 1,040 caribou. The snow had begun to melt at this time, but only coastal areas were bare. Thus, a large number of caribou were probably missed because they blended with the background, as was confirmed by parties on the ground.

In April 1975, the population estimate was only 581 animals. As in the case for all winter surveys of Peary caribou, the animals were somewhat difficult to see because of their white pelage against a background of snow. However, because of the extreme discrepancy (nearly 10-fold) between July 1974 and April 1975 estimates, there is the possibility some animals may have emigrated from the island. In June 1975, the caribou population estimate (3,768) was again high, but was 31% lower than the estimate in July 1974 (5,437). As the proportion of

calves to total caribou observed appeared similar between years, the difference does not appear to be the result of changes in productivity. Further, there was no evidence of excessive mortality over winter 1974-75.

Eskimos believe caribou regularly move across Peel Sound between Somerset and Prince of Wales islands (Banfield, 1961; Finley, pers. comm.). Additionally, in May 1975, personnel of the Geological Survey of Canada observed three small groups of caribou on the ice in Peel Sound off the eastern coast of Prince of Wales Island (Russell, pers. comm.). Numerous trails on the ice suggested the movements of a larger number of animals. Movement of Peary caribou between Eglinton, Melville, and Byam Martin islands has been documented by Miller and Russell (pers. comm.). The distance across Peel Sound between Prince of Wales Island and Boothia Peninsula or Somerset Island is only about 30 km. If indeed caribou did emigrate from Prince of Wales Island across Peel Sound to Somerset Island or Boothia Peninsula, the population increase on these areas should be comparable to the decrease observed on Prince of Wales Island.

In summer 1974, we estimated a total of 4,978 adult caribou on Prince of Wales and Somerset islands, and Boothia Peninsula (Table 11). A total of 4,295 were estimated on Prince of Wales Island; 683 on Somerset Island and Boothia Peninsula. The following summer (1975), the caribou population on Prince of Wales Island had apparently dropped by

Table 11. Population estimates of adult caribou on Prince of Wales and Somerset islands and Boothia Peninsula during summer, 1974 and 1975.

Location	Summer 1974	Summer 1975	Change 1974-1975
Somerset Island	245	668	+ 423
Boothia Peninsula	438	1,443	+ 1,005
Total	683	2,111	+ 1,428
Prince of Wales Island	4,295	2,939	- 1,356
Total	4,978	5,050	

1,356 animals to 2,939. Concurrently, we noted an estimated increase of 1,428 animals on Boothia Peninsula and Somerset Island to a total of 2,111. This suggests a net movement of approximately 1,400 animals from Prince of Wales Island to Boothia Peninsula and Somerset Island during winter 1974-75. While it is important to realize that most of the surveys from which population estimates were obtained covered only about 10% of the land surface, we feel the magnitude as well as the consistency of the observed changes do indeed indicate possible movement between these areas. The above calculations, of course, do assume that caribou on these three areas represented a discrete population during the period between summer 1974 and summer 1975.

Because our impression is that population estimates obtained from our late winter 1974-75 surveys may be biased low as a result of visibility factors, it is probably not meaningful to compare total numbers observed in winter 1974-75 with summer 1975. A total of 2,335 caribou were estimated on Prince of Wales Island, Boothia Peninsula and Somerset Island during winter, and 5,050 during summer 1975. However, if we assume that the bias in winter is consistent between areas, a comparison of relative percentages of caribou found on areas during winter and summer may indicate whether major shifts in distribution have occurred between these time periods. In winter 1974-75, 75% of the total caribou estimated on Prince of Wales Island, Boothia Peninsula and Somerset Island were found on the latter two areas; only 25% were on Prince of Wales Island. In contrast, during summer 1975 only 42% of the estimated numbers were

on Boothia Peninsula and Somerset Island; the remaining 58% were on Prince of Wales Island. This suggests the possibility of a return movement of a limited number of animals between late winter and summer from Boothia Peninsula and Somerset Island to Prince of Wales Island.

Again, numerous assumptions have been made in the above calculations. Consequently, the results we obtained should be understood only as being consistent with the theory of inter-island (peninsula) movement and not as proof. Conclusive evidence of traditional movement patterns can only be obtained through an intensive caribou marking program.

Muskoxen

Results

During 1974 surveys, the total numbers of muskoxen observed were 62 and 101 for the June and July surveys, respectively (Table 10). Population estimates for these two surveys were 564 (1.7/100 km^2) and 872 (2.6/100 km^2). In 1975, 185 muskoxen were seen in the April survey; the population estimate was 907 animals (2.7/100 km^2). In June 1975, a total of 81 muskoxen were observed; the estimated population was 313 (0.9/100 km^2).

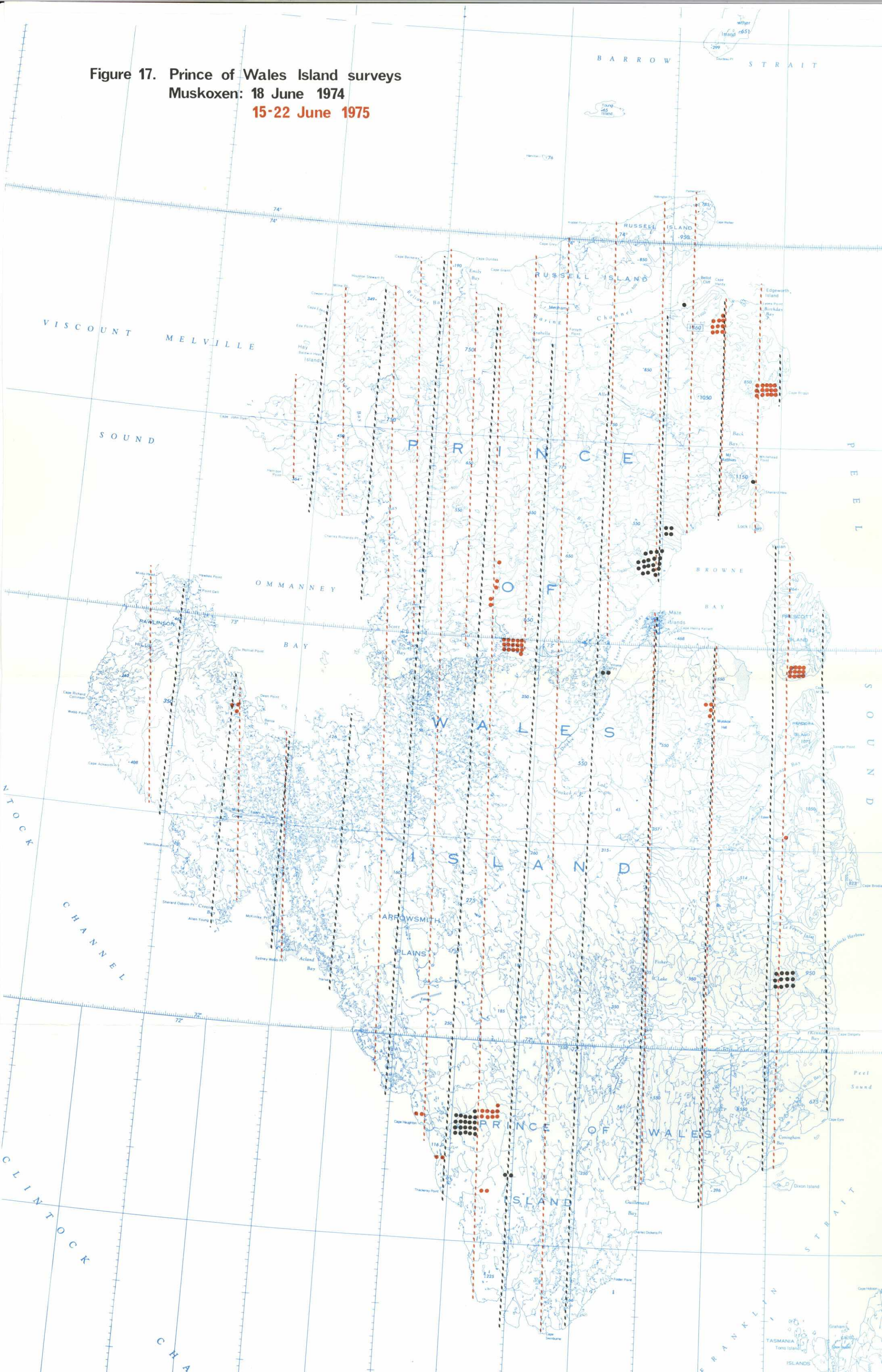
The distribution of animals in June 1974, and June and July 1975 were similar (Figures 17 and 18). Three major concentration areas were apparent. One was in the extreme south of Prince of Wales Island between Cape Haughton and Guillemard Bay; another in the area south of Young Bay and northeast of Fisher Lake. However, greatest concentrations of muskoxen were consistently found immediately south and west of Browne Bay including the Scarp Brook drainage system. Extensive well-vegetated lowlands characterize the area west of Inner Browne Bay. Concentrations of muskoxen were even more apparent within this particular locality during April 1975 (Figure 18).

Productivity of muskoxen appears to have been good on Prince of Wales Island during both 1974 and 1975. The proportion of calves observed during the July 1974 transect survey was 7%; during spotcheck surveys throughout the summer it was 14% (Table 6). During June 1975, 11% of the total muskoxen observed during transect surveys were calves, 15% during spotchecks in June and early July. No muskoxen carcasses were observed on Prince of Wales Island during either 1974 or 1975. Hence, overwinter mortality was apparently not excessive in either year.

Discussion

No previous systematic surveys have been conducted on Prince of Wales Island. Manning and Macpherson (1961) commented on the presence of muskoxen but made no attempt at a population estimate. The only

Figure 17. Prince of Wales Island surveys
Muskoxen: 18 June 1974
15-22 June 1975



previous estimate was made by Anderson (1930) who thought the population to be about 1,500 animals on the basis of his general impressions.

From the results of aerial surveys during 1974 and 1975, we estimate that approximately 600 muskoxen (1.8/100 km^2) inhabit Prince of Wales Island. While there is some variation between individual population estimates, in all cases the number of muskoxen herds observed on transect was small, ranging from 6 to 10. This, coupled with the contagious distribution of the animals and the low survey coverage, suggests that the variation observed may well be due to chance alone.

Somerset Island

Three complete surveys were flown on Somerset Island between 1974 and 1975. From 3 to 9 June 1974, a survey covering 25.3% of the land surface was conducted. In 1975, surveys covering 9.3% of the island were flown from 18 to 30 March and 23 to 24 June.

Caribou

Results

During June 1974, a total of 96 caribou were seen during transect surveys (Table 12); the estimated population was 245 (1.0/100 km^2). In 1975, population estimates were 645 (2.6/100 km^2) and 903 (3.6/100 km^2) in March and June. Total numbers of caribou observed on these surveys

Figure 18: Prince of Wales Island surveys
Muskoxen: 29-30 July 1974
4-14 April 1975

---- 1 mile transect
..... 1/2 mile transect

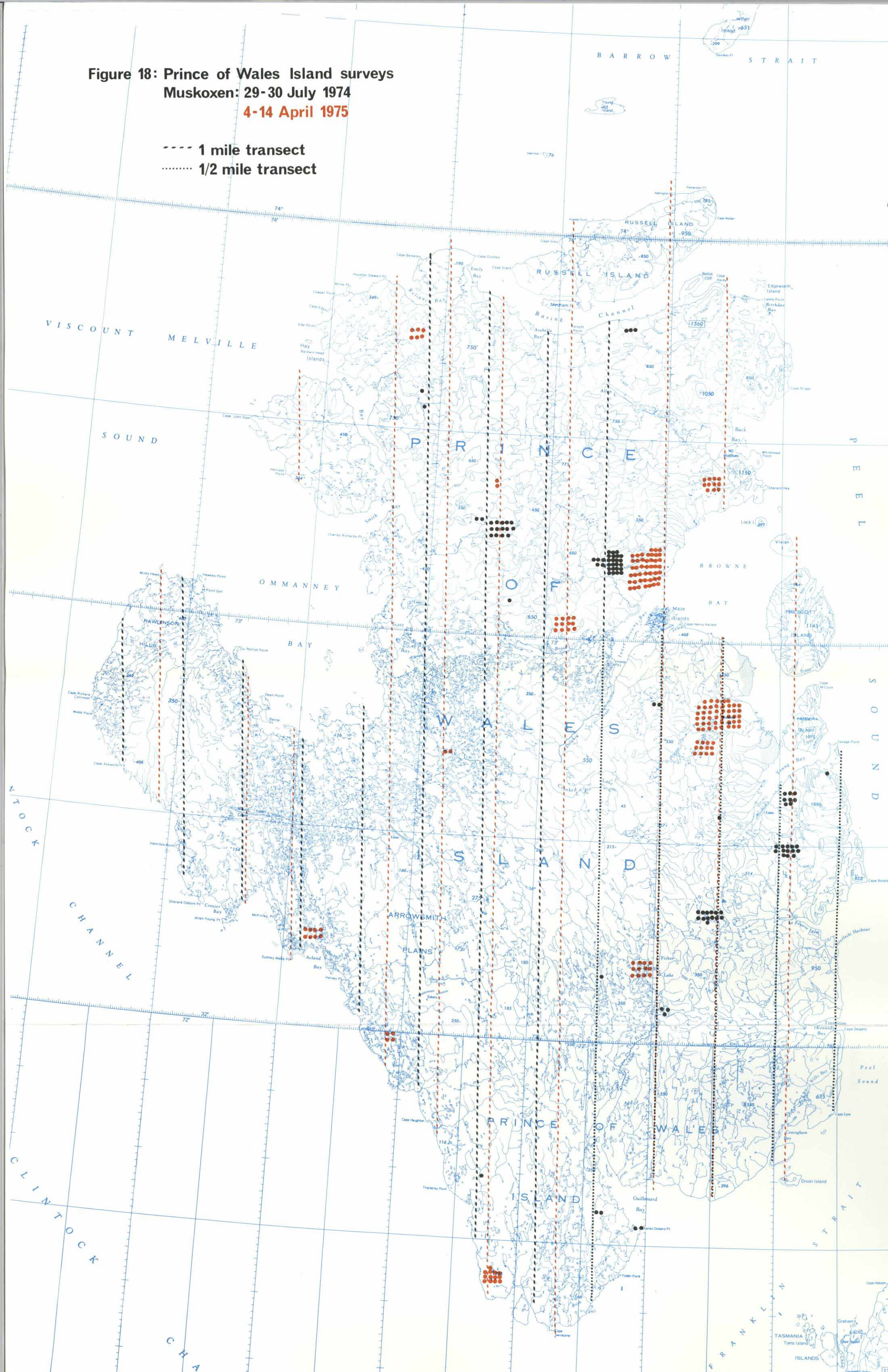


Table 12. Population estimates of caribou on Somerset Island during late winter and summer, 1974 and 1975.

Survey Dates	% Coverage	Number Observed		Population Estimate
		On Transect	Total	
3-9 June 1974	25.3	62	96	245
18-30 March 1975	9.3	60	87	645
23-24 June 1975	9.3	84	132	903

were 87 and 132, respectively.

Distribution of caribou during the March 1975 and early June 1974 surveys appeared similar (Figure 19). Over 80% of the caribou seen during these surveys were north of Stanwell-Fletcher Lake in the rugged uplands on the western coast of the island. Caribou south of Stanwell-Fletcher Lake were located on beach ridges along the western coast of Creswell Bay and on rugged terrain along the western coast of the island.

In late June 1975, over 75% of caribou observed were south of Stanwell-Fletcher Lake (Figure 20). Most of these, particularly in the drier western portion, were cow-calf pairs. Caribou north of Stanwell-Fletcher Lake were widely distributed over the southwestern one-quarter of the island.

Very few cow-calf pairs (9%) were located on Somerset Island north of Stanwell-Fletcher Lake; most (91%) were in the rugged areas to the south (Figure 21). In a transect survey which covered 10% of the island north of Stanwell-Fletcher Lake and Creswell Bay between 27 July and 1 August 1974, only five cow-calf pairs were located (Figure 21). However, seven days earlier on a 20 July spotcheck, 14 cow-calf pairs were observed south of Stanwell-Fletcher Lake in the same general area as those observed in 1975.

Figure 19. Somerset Island survey
Caribou: 3-9 June 1974
18-30 March 1975

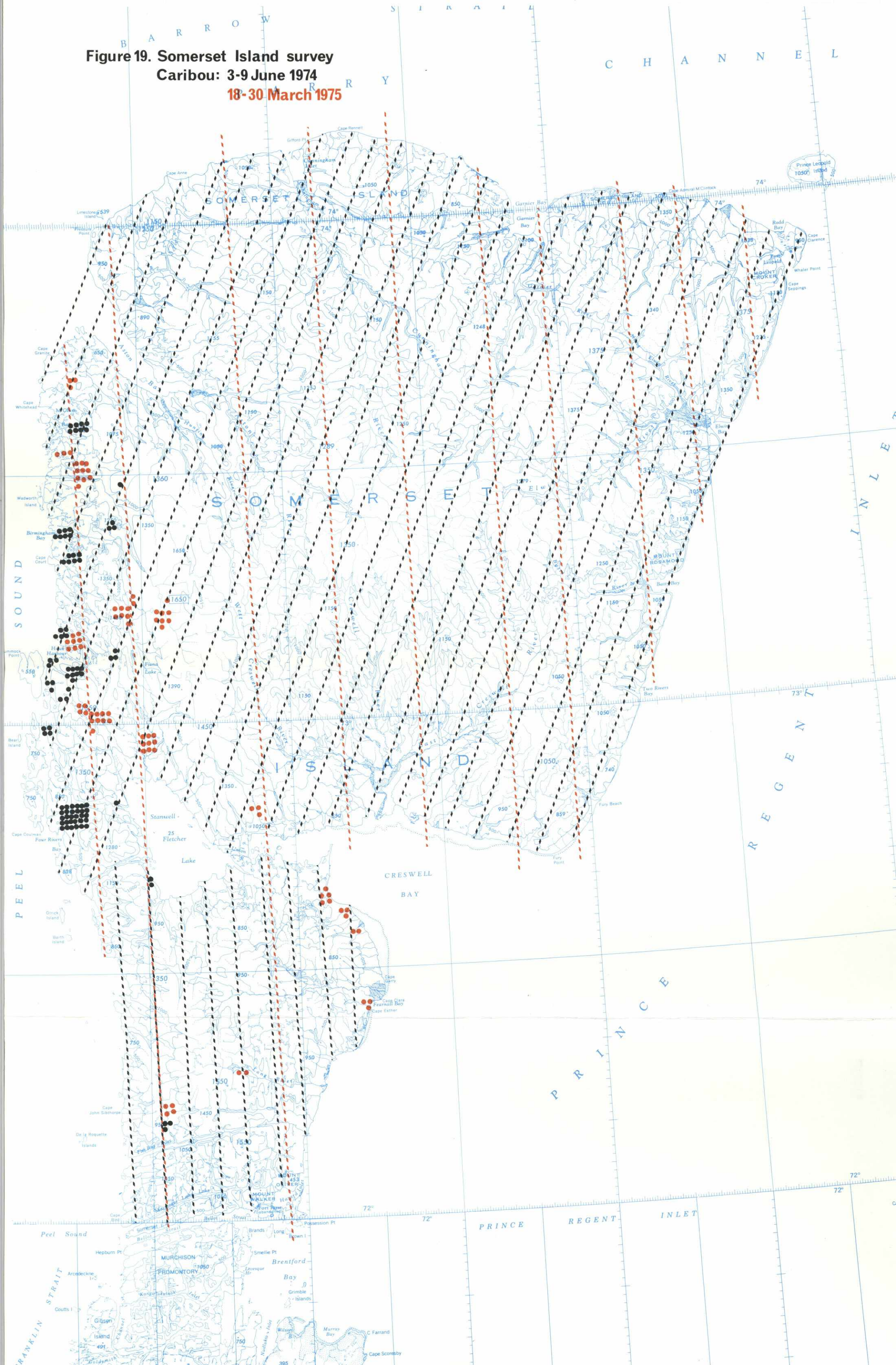


Figure 20. Somerset Island surveys
Caribou: 27 July-1 August 1974
23-24 June 1975

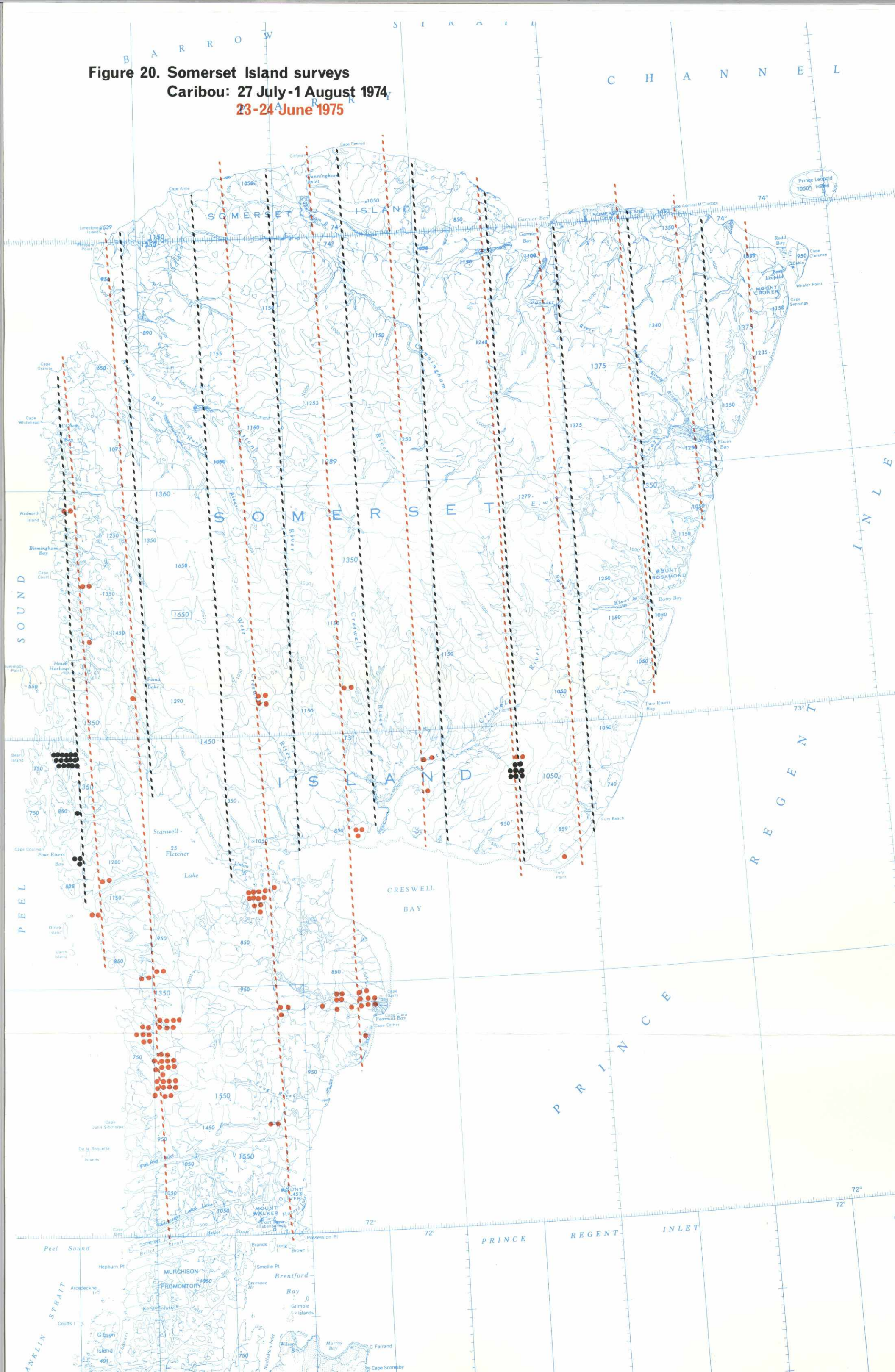
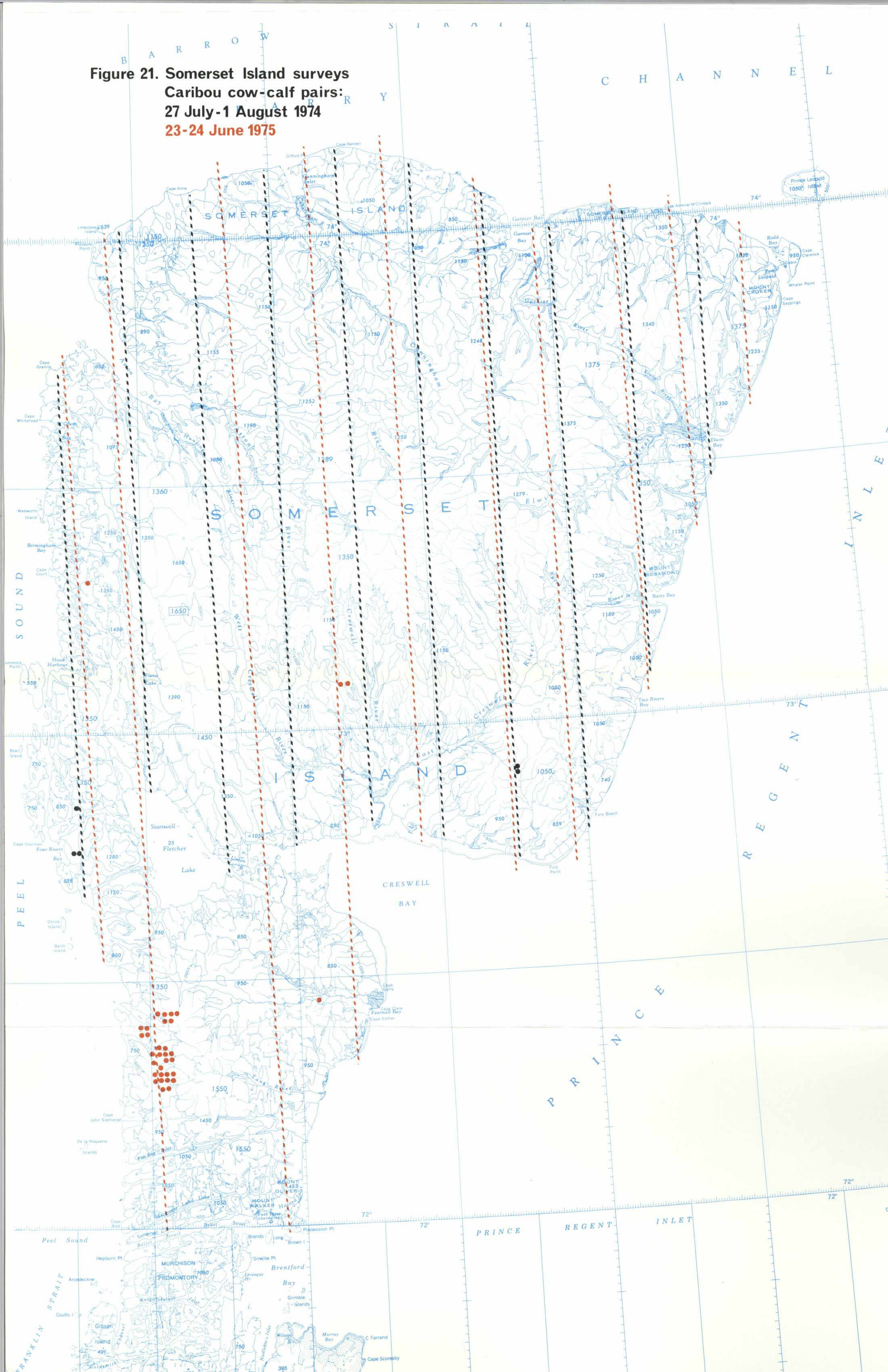


Figure 21. Somerset Island surveys
Caribou cow-calf pairs:
27 July-1 August 1974
23-24 June 1975



Productivity of caribou during both 1974 and 1975 appears to have been good on Somerset Island. During the transect survey of northern Somerset Island in July-August 1974, five calves (28%) were observed in a total of 18 caribou classified (Table 5). Also, during spotchecks of various portions of the island throughout the summer, 26% of the total animals observed were calves. In 1975, 132 caribou were observed during transect surveys, 34 (26%) of these were calves.

Discussion

There is no previously published information regarding caribou numbers on Somerset Island. Estimates of adult population densities (per 100 km^2) during surveys in June 1974 and June 1975 were 1.0 and 2.7. Hence, the caribou population of Somerset Island appears to have increased between the two years. The early June 1974 survey was conducted while much of the ground was still snow-covered; accordingly, this estimate may be slightly low because of the lower visibility of the animals. However, there is also the chance that animals may have immigrated from Boothia Peninsula or Prince of Wales Island. This possibility is commented upon more fully in the discussion on the Prince of Wales Island caribou population.

On the basis of aerial survey results, it appears that the western coast of Somerset Island may be an important wintering area for caribou. Concentrations of cow-calf pairs during early summer along the southwestern coast, particularly south of Stanwell-Fletcher Lake, suggests

this may be a calving area. No caribou were observed in either year on the barren plateau of northeastern Somerset.

Muskoxen

Results

No muskoxen were observed on Somerset Island during aerial surveys in 1974 or 1975.

Discussion

Anderson (1930) recorded Somerset Island as void of muskoxen in the late 1920's, but Tener (1965) estimated the population at 100 individuals based upon observations by Eskimos at Resolute Bay who hunted the island. One herd was reported near Creswell Bay and another on the north end of the island. Muskoxen had been unreported on Somerset Island in recent years until 1975 when a herd of 12 (4 bulls, 5 cows, and 3 calves) was observed near Stanwell-Fletcher Lake in summer (Russell, pers. comm.). Russell thought it was possible the animals had moved onto the island over winter. The area in the vicinity of Stanwell-Fletcher Lake appears to offer suitable habitat for muskoxen.

Boothia Peninsula

During 1974 and 1975, four aerial surveys were completed on Boothia Peninsula. In 1974, surveys covering approximately 25% and 10% of the land surface were conducted between 18 May and 20 June, and 1 and 3 August. The earlier survey was divided into three strata for the purpose of analysis and was based on dates of survey completion within each stratum. In 1975, surveys with a coverage of 9.2% were flown between 18 and 27 March, and 5 and 12 June.

Caribou

Results

During the May-June 1974 survey, a total of 250 caribou were observed and a population estimate of 626 (1.9/100 km^2) caribou was made (Table 13). As portions of this survey were flown during three time periods, some animals may have been missed or others counted more than once because of animal movement. However, the estimate appears reasonable as a minimum of 518 were estimated in Stratum III, the area of greatest concentration. In August 1974, 71 caribou were observed and the population estimate was 561 (1.7/100 km^2). During the March and June 1975 surveys, a total of 146 and 184 caribou were seen. Population estimates of 1,109 (3.4/100 km^2) and 1,739 (5.3/100 km^2) caribou were made. In addition to these surveys of the entire peninsula, a transect survey of the north-

Table 13. Population estimates of caribou on Boothia Peninsula during late winter and summer, 1974 and 1975.

Stratum	Survey Dates	% Coverage	Number Observed		Population Estimate
			On Transect	Total	
I	18-25 May 1974	24.8	11	12	44
II	7-9 June 1974	26.4	17	26	64
III	19-20 June 1974	25.7	133	212	518
				250	626
	1-3 August 1974	9.8	55	71	561
	18-27 March 1975	9.2	102	146	1,109
	5-12 June 1975	9.2	160	184	1,739

western portion of the peninsula was flown between 28 June and 2 July 1975 (Figure 25). Coverage was approximately 16% and, based on previous distribution of animals, we felt that most of the caribou on the peninsula were within the area surveyed. During this survey, a total of 967 caribou were observed; the estimated population was 2,372 animals.

In March 1975, all of the caribou observed were located in the northeastern half of Boothia Peninsula (Figure 22). Most were on the flat, well-vegetated lowlands in the extreme northeastern corner between Brentford Bay and Cape Nordenskiold. The remainder were in the more rugged areas immediately south and west. In May-June 1974 and June 1975, caribou were distributed in the northwest in the rugged terrain between Pasley Bay and Murchison Promontory (Figures 22 and 23). In late June and early July 1975, many caribou were still concentrated in the extreme northwest, but large numbers were also observed in the north-central portion of the peninsula. One group of 352 animals, mostly cow-calf pairs, was observed approximately 45 km southeast of Wrottesley Inlet. In August 1974, caribou were widely distributed over the entire northwestern portion of the island (Figure 24).

The distribution of cow-calf pairs during the summers of 1974 and 1975 was similar (Figures 24 and 25). Concentrations were consistently observed in the northwest between Pasley Bay and Wrottesley Inlet, and in 1975, immediately north of Wrottesley Inlet. In early July 1975, a group of 130 cow-calf pairs was observed approximately 45 km southeast of Wrottesley Inlet in central Boothia.

Figure 22: Boothia Peninsula survey
Caribou: 18 May - 20 June 1974
18-27 March 1975

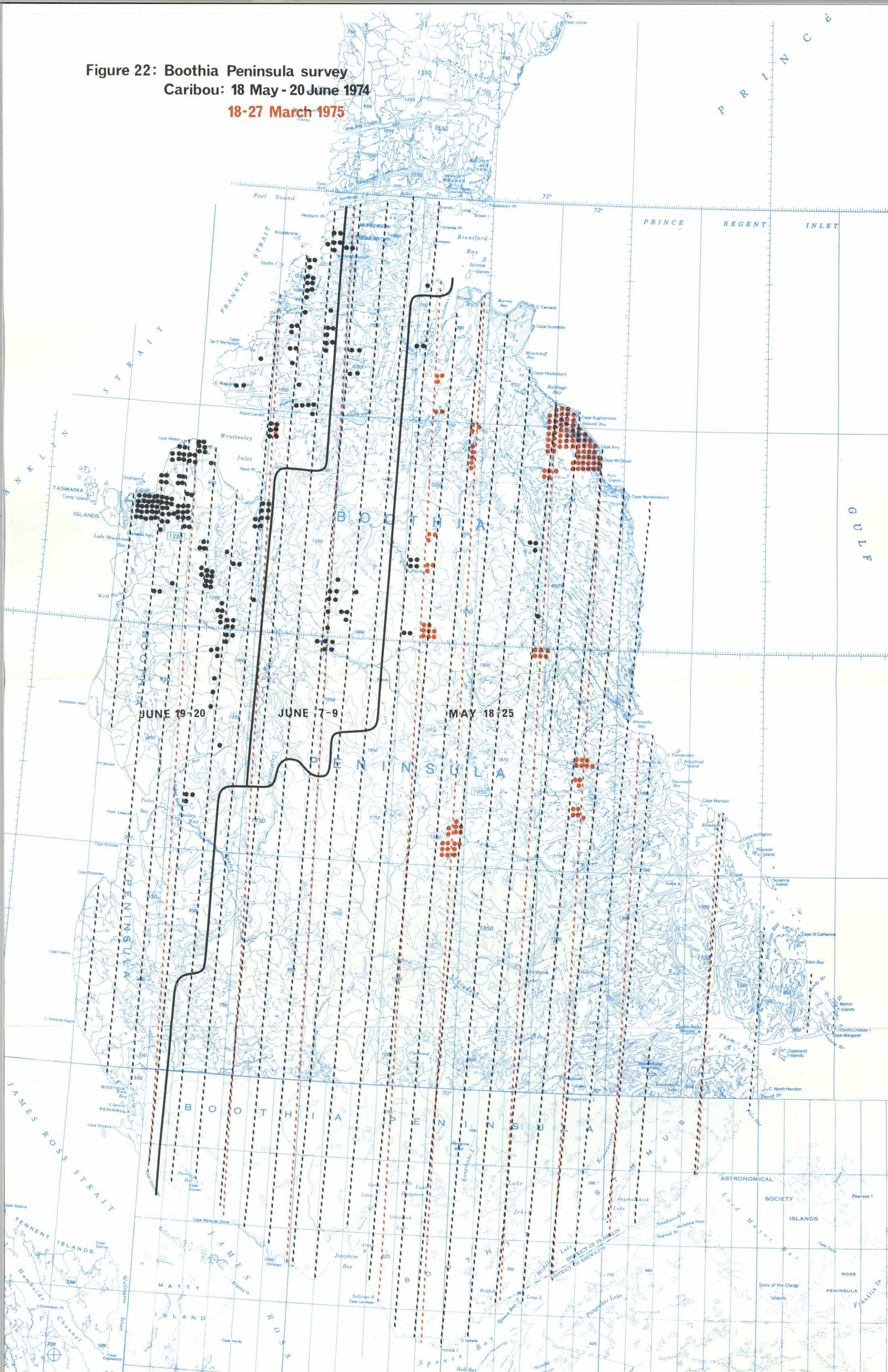


Figure 23: Boothia Peninsula survey
Caribou: 1-3 August 1974
5-12 June 1975

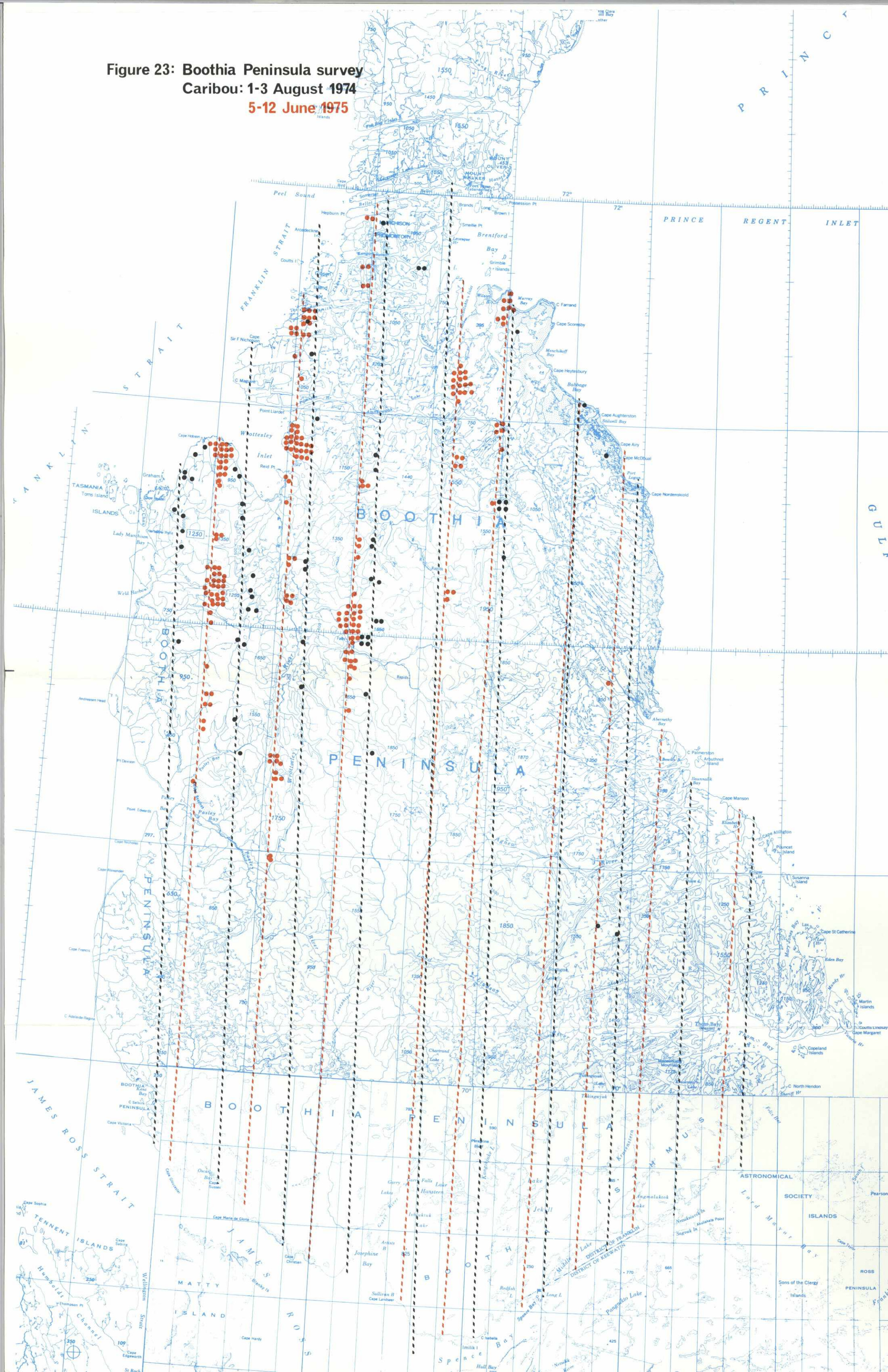
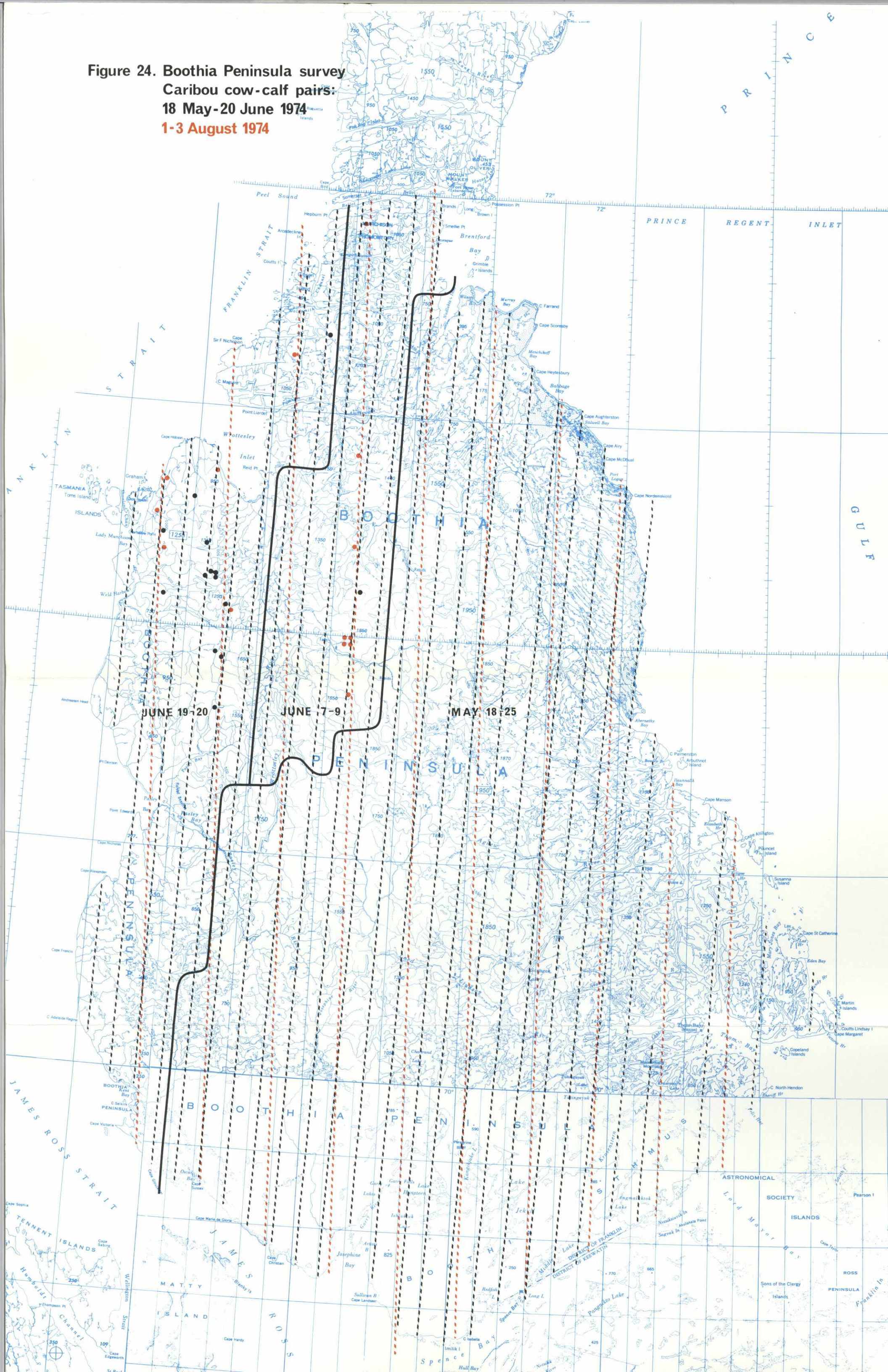


Figure 24. Boothia Peninsula survey
Caribou cow-calf pairs:
18 May-20 June 1974
1-3 August 1974



Caribou productivity on Boothia Peninsula was apparently high in both 1974 and 1975. During transect surveys in summer 1974, 22% of 63 caribou observed were calves (Table 5). In spotcheck surveys throughout the summer, 28% of the total caribou observed were calves. In 1975, 17% of the caribou seen during the 5 to 12 June transect survey were calves. However, this probably underestimated productivity as calving was most likely not complete at the time of the survey. This is substantiated by the 31% calves observed in 967 total caribou during the 28 June to 2 July survey of northwestern Boothia.

Discussion

There is some question at present as to the exact sub-species of caribou inhabiting Boothia Peninsula. Manning (1960) suggests that they may indeed be barren-ground caribou (*R.t. groenlandicus*). Eskimos from Spence Bay and vicinity have traditionally hunted the Boothia caribou population to a large extent. Macpherson (1959) recorded an average kill of 300 animals per year between 1954 and 1958. An estimated 200 caribou were taken in 1973-74 (Green, pers. comm.). Although Banfield (1951) thought the caribou population of Boothia Peninsula to be about 2,000 animals in 1950, there have been no previous aerial surveys to accurately document population numbers.

During surveys in summer 1974, densities of adult caribou appeared to be about 1.4/100 km^2. In summer 1975, adult densities were approximately

4.7/100 km^2. Thus, on the basis of aerial survey results, it appears that caribou densities have increased over three-fold between 1974 and 1975. While it is possible that the discrepancy could be explained by chance alone, we feel it is unlikely because of the agreement between population estimates obtained from each of two surveys in both years. Thus, it appears there has been a movement of approximately 1,000 caribou onto Boothia Peninsula between summer 1974 and summer 1975. Further, because the late winter 1975 population estimate was twice as high as the summer 1974 estimate, animals most likely moved prior to March. Because of an apparent drop in numbers of animals on Prince of Wales Island during the same time period, animals may have emigrated across Peel Sound. This possibility is commented upon more fully in the discussion on the Prince of Wales Island caribou population.

Results of 1974-75 aerial surveys indicate that caribou on Boothia Peninsula may be migratory. Wintering areas appear to be on the east and northeast portions of the peninsula, calving and summering areas in the northwest and north-central portions. From conversations with residents of Spence Bay, it is apparent they also believe these caribou are migratory. They hunt caribou in the southeast (north of Thom Bay to the Abernethy River valley) during winter and in the central portion during fall.

Muskoxen

Results

No muskoxen were observed during aerial surveys in 1974-75.

Discussion

Little information is available regarding muskoxen on Boothia Peninsula. Inuit inhabitants of Boothia Peninsula are said to have travelled to Prince of Wales Island to hunt muskoxen, although isolated animals may have inhabited the peninsula in the Wrottesley valley region in the past (Anderson, 1930).

Spence Bay to Hayes River

One aerial survey, covering 10.3% of the land surface, was flown of the area between Spence Bay and the Hayes River between 31 May and 5 June 1975.

Caribou

Results

Only six caribou were seen during the May-June survey; the estimated population was 58 animals (Table 14). All six caribou observed were

Table 14. Population estimates of caribou between Baker Lake and Spence Bay during late winter and summer, 1975.

Location	Survey Dates	% Coverage	Number Observed		Population Estimate	Estimated Density (per 100 km^2)
			On Transect	Total		
Spence Bay - Hayes River	31 May - 5 June	10.3	6	6	58	0.3
Hayes River - Baker Lake	2-15 March	13.2	305	822	2,311	4.9
	16-29 May	15.7	116	149	739	1.3

[1] Area transected was 46,920 km^2 between 2 and 15 March; 57,370 km^2 between 16 and 29 May.

located in the southern half of the area (Figure 26). One of the observations was of a cow-calf pair; therefore, calving had apparently commenced by the time of the survey. However, because of the early date, it was probably not far advanced. No calves were observed among numerous caribou sighted during the preceding several days immediately south of the Hayes River.

Discussion

Very little previous information is available regarding caribou populations immediately south of Spence Bay. Loughrey (1955) thought that approximately 500 caribou overwintered in the hills along the Murchison River and another 500 in the hilly country at the headwaters of the Hayes River in the early 1950's.

During a spotcheck survey of the area in March 1975, we observed no caribou feeding craters or tracks. Only six caribou were observed in May and June during transect flights. Hence, there was no evidence to indicate that concentrations of caribou were extensively using this area during late winter or spring 1975.

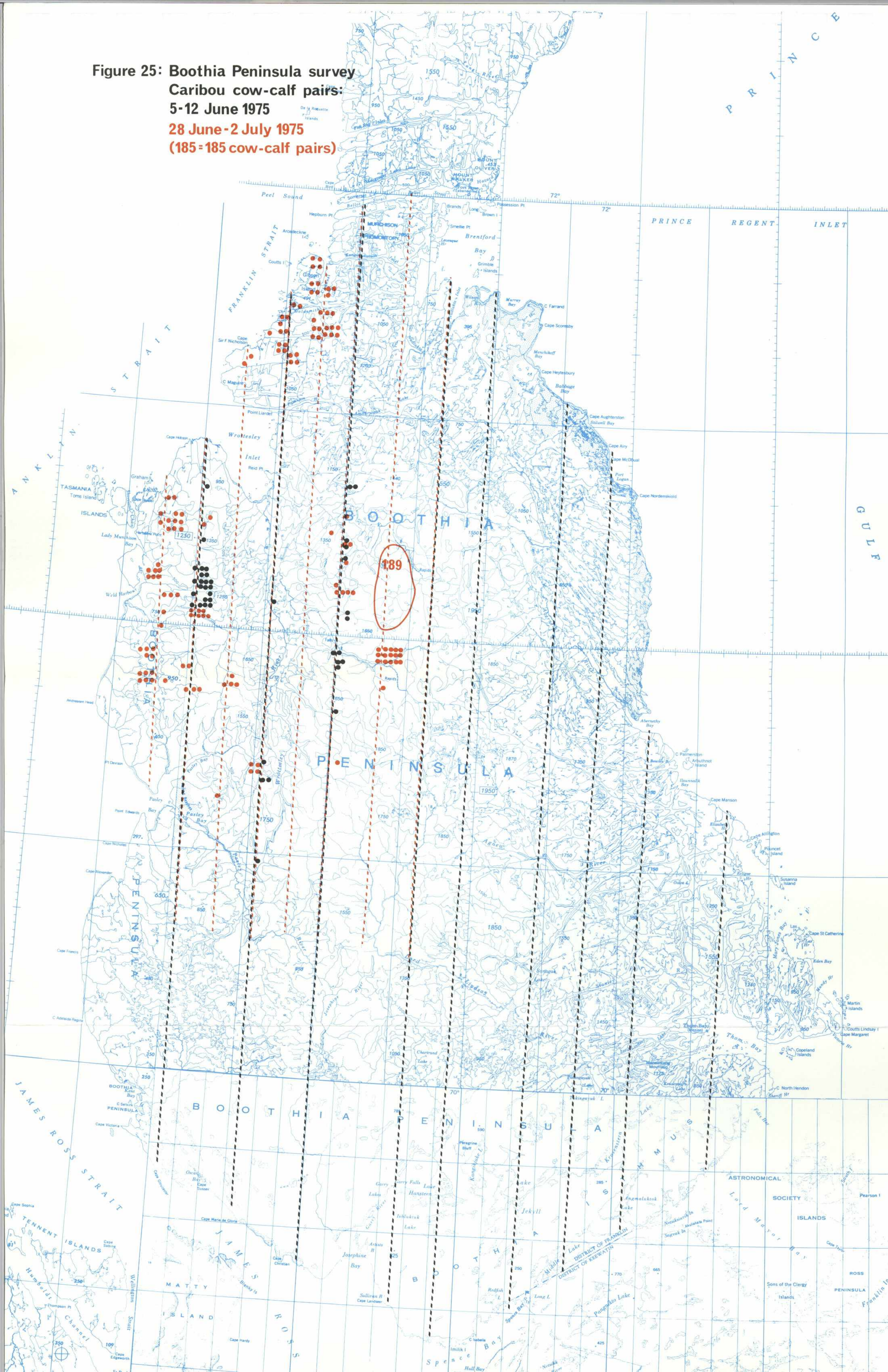
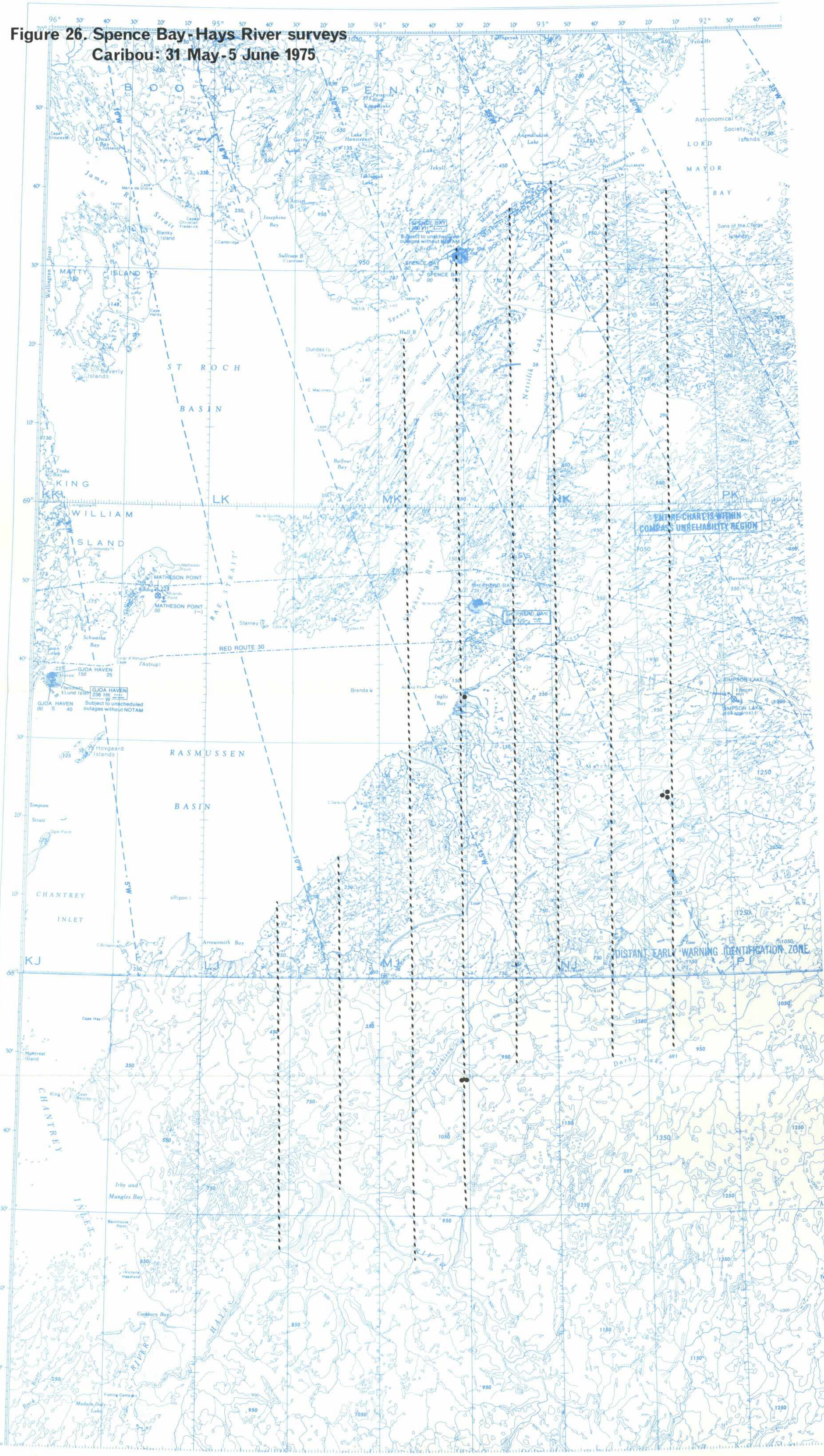


Figure 25: Boothia Peninsula survey
Caribou cow-calf pairs:
5-12 June 1975
28 June - 2 July 1975
(185 = 185 cow-calf pairs)

Figure 26. Spence Bay-Hays River surveys
Caribou: 31 May-5 June 1975



Muskoxen

Results

No muskoxen were observed during aerial surveys between Spence Bay and the Hayes River in 1975.

Discussion

Muskoxen sightings have been made in the past in the vicinity of the Hayes River (Renewable Resources Consulting Services Ltd., 1972). If resident populations are present, densities are likely extremely low. Indeed, muskoxen within this region may be highly transitory.

Hayes River to Baker Lake

Two aerial surveys of the area between the Hayes River and Baker Lake were flown in 1975. A late winter survey, covering 13.2% of land surface, was carried out between 2 and 15 March. In spring, a survey with coverage of 15.7% was conducted between 16 and 29 May. The study area was enlarged from 46,920 km^2 in late winter to 57,370 km^2 in spring to include the area immediately north and west of the Back River (Figure 27).

Caribou

Results

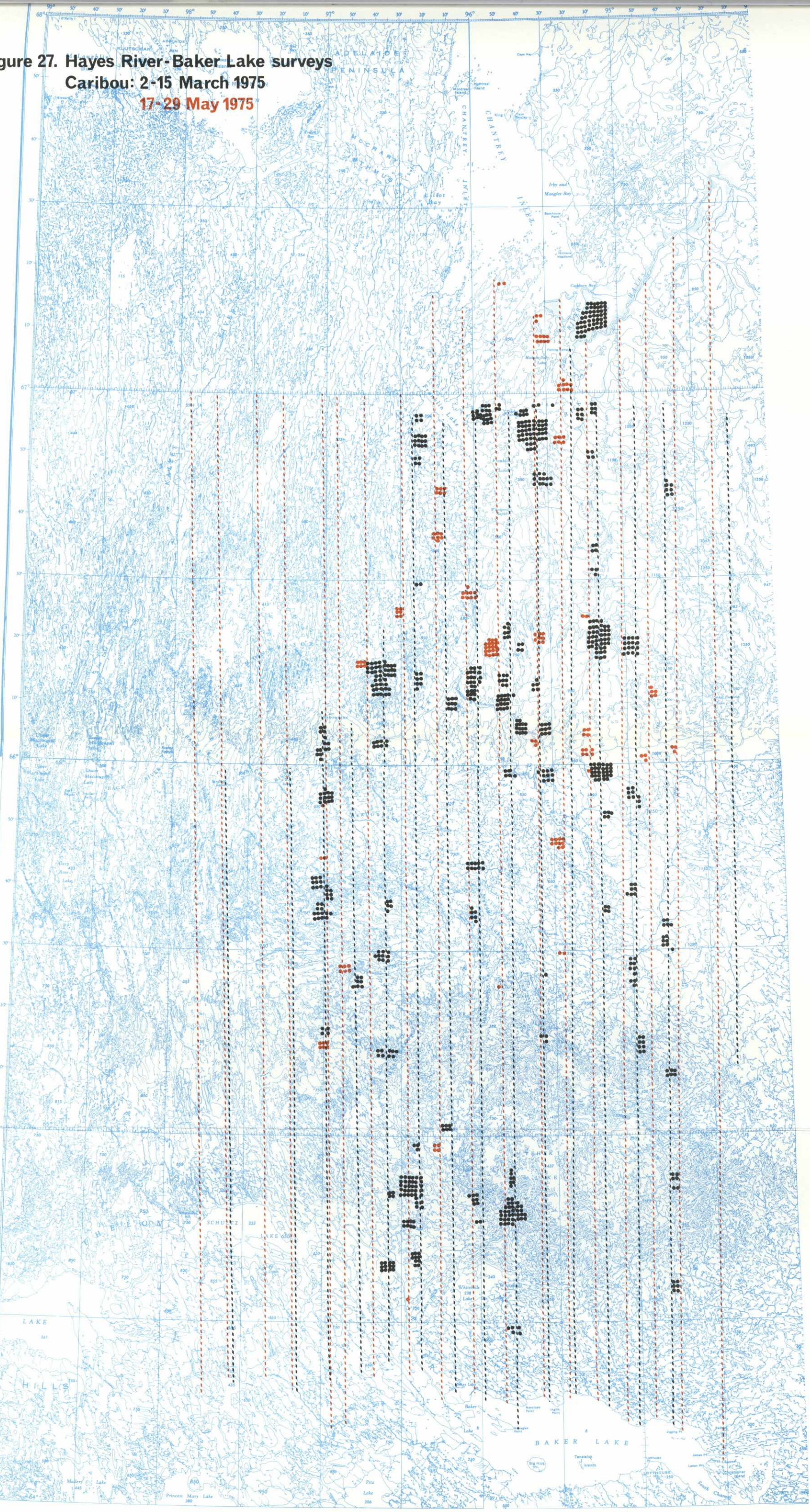
A total of 822 caribou were observed during the March survey between Baker Lake and the Hayes River (Table 14). The population estimate was 2,311. In the May survey, only 149 caribou were observed in an area which was approximately 20% larger than in winter; the estimated population was 739. During the May survey, observation conditions were generally poor with a mottled background of snow and bare ground. Hence, the population estimate for this period is probably low.

In March, caribou were distributed over the entire area (Figure 27). In the south, highest concentrations were found between Schultz Lake and Tehek Lake. In the north, greatest concentrations were along the Back and Hermann river drainages and south of Chantry Inlet. Caribou were generally associated with gently rolling areas where hilltops were blown bare of snow. In May, most caribou were observed in the northern half of the area, again concentrated mostly along the Back and Hermann river drainages. In the south, animals were widely distributed in the central portion of the area.

Discussion

Very little previous information on caribou numbers or distribution is available for the area between Baker Lake and the Hayes River; the available

Figure 27. Hayes River-Baker Lake surveys
Caribou: 2-15 March 1975
17-29 May 1975



information is sketchy. On the basis of a few reconnaissance flights north of Baker Lake in April and May 1955, Loughrey (1955) believed about 500 caribou were in the Hayes River area and about 500 in the area immediately west of Wager Bay. Also, several hundred animals probably winter in the Kellet River and Ellice Hills regions (Loughrey, 1955). Pendergast and Bowden (1973) conducted surveys of the caribou calving ground on Melville Peninsula in 1973 and incidentally observed calving west of Repulse Bay in the vicinity of Pearce Lake and Curtis Lake. The extent of this calving ground is unknown as is the number and movement patterns of these animals. Treude (1975) noted that caribou can be hunted almost year-round near Chantry and Sherman inlets.

Large numbers of barren-ground caribou are traditionally found during summer in the Beverly Lake-Schultz Lake area, west of Baker Lake. The calving ground for these animals, the Beverly caribou herd, is located adjacent to Beverly Lake; extensive post-calving movements occur between there and Schultz Lake (Renewable Resources Consulting Services Ltd., 1972). Thomas (1969) estimated the number of animals in the Beverly herd at 159,000 in 1967.

Information gathered during 1975 indicates that considerable numbers of caribou do winter within the study area. However, knowledge of migration routes and the proximity of calving grounds remains unknown. Considerable numbers of caribou trails observed in snow during the May survey were oriented northeast-southwest, indicating animals may be moving to

calving grounds in extreme northeastern Keewatin. However, future surveys in June will be required to verify locations of calving areas.

Muskoxen

Results

No muskoxen were observed between Baker Lake and the Hayes River during aerial surveys in 1975.

Discussion

Muskoxen have previously been sighted in the area south of Chantry Inlet near Franklin Lake, along the upper Hayes River and in the Ellice Hills region west of Committee Bay (Renewable Resources Consulting Services Ltd., 1972). In summer 1974, five muskoxen were sighted by residents of Baker Lake at the eastern edge of Schultz Lake near the Hayes River. While muskoxen appear to be widely scattered in the region between Baker Lake and Spence Bay, Tener (1965) states that herds totalling 40 to 50 animals have been sighted and suggests possibly 300 muskoxen live in this area. Another estimated 400 muskoxen are found west of Aberdeen Lake in the Thelon Game Sanctuary. The animals in these two localities probably account for nearly one-half of the estimated 1,500 animals on the Canadian mainland.

Habitat Studies

Habitat Description

In devising a habitat classification scheme, plant communities were classified using the IBP method proposed by Fosberg (1967). During data analysis, similar plant communities were then combined to form habitat types. A brief description of the recognized vegetation communities and each habitat type is presented.

Vegetation Communities

The Fosberg method of classifying vegetation was originally devised for use on a world-wide basis. Necessarily, the key is very general and adaptations had to be made for its use in an arctic situation. Additions and changes to this key have been noted in parentheses in the following descriptions.

A total of 19 vegetation communities were identified. Numbers in parentheses, following each community name, indicate the number of vegetation transects located within that community. As sampling of communities was based on location of pellet transects, the number of transects in each community varied. The frequency of occurrence of each plant species within a community was determined from vegetation transects and is presented in Appendix A.

1H14. Open Evergreen Dwarf Shrub with Closed Ground Cover (2)

This dwarf-shrub community is found on hummocky lowlands where frequent frost boils on otherwise level ground presents a variable vegetative pattern. Vegetation covers 81.0% of the ground surface. Hummocks are covered by a mat of dryas (*Dryas integrifolia*), or moss and willow (*Salix arctica*). Willow is almost equally as prevalent as dryas with the frequency of each species being 11.0% and 15.5%, respectively. Patina and crustose lichen are most common between the hummocks. Litter, mostly derived from the shrubs, tends to accumulate at hummock bases. A discontinuous sub-layer of moss is present.

1H21. Open Deciduous Dwarf Shrub with Closed Ground Cover (addition) (38)

This dwarf-shrub community is also characterized by frost-boils, but is generally found on moister areas than the 1H14 community. A moss carpet is present and contributes to the 82.2% plant cover. Willow is found on the hummocks. Sedges and grasses are frequent, as is patina which predominates between the hummocks. Litter again accumulates at hummocks bases.

1M21. Seasonal Orthophyll Meadows (16)

This community is found on flat wet areas adjacent to rivers and fresh-water ponds and lakes. It is dominated by sedges and grasses

with moss comprising a nearly continuous sub-layer. Vegetation covered 82.6% of the ground surface. Litter is common in the community.

1M22. Seasonal Orthophyll Marsh (7)

This community is similar to 1M21 with the exception that it is generally found in depressions, and standing water is present. This condition favors the growth of algae which is common. Sedges are five times more prevalent than grasses with respective frequencies of 27.0% and 5.2%. Moss is dominant within the community, with a frequency of 48.2%. Vegetation covers 92.3% of the ground surface.

1M25. Seasonal Grass Meadow (addition) (1)

This community is found in upland well-drained sites. It presents an overall impression of being herb-dominated although species composition by moss and patina together is 64.0%. The frequency of *Alopecurus alpinus* is 10.0%; *Papaver radicatum*, 2.0%. Total vegetative cover is 86.0%. Litter tends to accumulate in this community.

1012. Moss Meadow (1)

Moss and patina are most prevalent in this vegetation community with frequencies of 65.0% and 24.0%, respectively. The community is found on the lower parts of slopes where snowbeds accumulate over winter and melt slowly over summer. Consequently, the soil is saturated with

water. Ninety-four percent of the ground surface is covered by vegetation.

1022. Lichen Meadow (17)

Species composition of this community is predominantly patina (38.0%) and moss (20.2%). Like 1012, this community is found on lower slopes and level areas below late-lying snowbeds, but patina occurs more frequently than moss. Crustose lichens are frequently observed on the drier sites. Vegetation covers 81.6% of the ground surface.

2C13. Evergreen Narrow Sclerophyll Dwarf Steppe Scrub (24)

Dryas is the dominant shrub within this community; crustose lichen and patina are also common. A sub-layer of vegetation occurs occasionally beneath the shrubs. The community is generally found on level or gently sloping terrain in mesic situations. Vegetation covers 66.1% of the ground surface.

2C21. Deciduous Orthophyll Dwarf Steppe Scrub (addition) (55)

Willow is the dominant shrub in this community with patina, moss, and crustose lichen also present. A broken sub-layer of moss and patina usually occurs beneath the dwarf shrubs. Vegetation covers 68.2% of the ground surface. This vegetation community occurs most frequently on gentle slopes.

2F12. Evergreen Narrow Sclerophyll Dwarf Shrub Steppe Savanna (11)

Dryas is the dominant shrub in this community. The community is similar to 2C13 except that dryas is more infrequent. Patina and crustose lichens are common. Vegetation covers 47.4% of the ground surface. This community is generally found on gently rolling slopes.

2F22. Seasonal Orthophyll Dwarf Shrub Steppe (addition) (60)

Willow is the dominant shrub in this community. The community is similar to 2C21 except there is less willow present. Patina, moss, and crustose lichens are common. A broken sub-layer of vegetation made up mainly of moss is generally present beneath the dwarf shrubs. Vegetation covers 71.5% of the ground surface. This community is most often encountered on gentle lower slopes.

2G23. Perennial Herb Steppe (addition) (4)

This community is dominated by herbaceous vegetation with grasses being more prevalent than forbs. Total plant cover is 72.8%. Moss and patina occur frequently. Litter covers 8.3% of the ground surface in this community.

2H11. Moss Tundra (addition) (7)

This community is similar to 1012 as it is moss dominated and located below late-lying snowbeds, but less vegetation covers the area. Total plant cover is 65.2%. Patina is also common in this community. Moss tundra is generally found on level or gently sloping areas.

2H21. Lichen Tundra (122)

This community is dominated by lichens and patina; respective frequencies of each are 13.2% and 30.9%. Vegetation covers 59.1% of the ground surface. Crustose lichens are most common with some occurrence of fruticose lichens including *Thamnolia vermicularis*, *Cetraria delesi*, *Cetraria telesii*, and *Cetraria cucullata*. This community is characteristic of large expanses of gently-sloping upland terrain.

3B11. Evergreen Sclerophyll Desert Scrub (53)

The dominant shrub in this community is dryas; patina is also present. Rarely is a sub-layer of vegetation present. Only 24.9% of the ground surface is covered by vegetation. This community is generally found on arid upper slopes and rocky windswept ridges.

3B23. Deciduous Orthophyll Desert Scrub (addition) (49)

The dominant shrub in this community is willow. Patina is common with moss, crustose lichens, and purple saxifrage (*Saxifraga oppositifolia*) also frequent. Moss occasionally occurs as a vegetative sub-layer. Thirty percent of the ground surface is plant covered. This community is generally found on middle to lower slopes and on rocky level areas.

3C13. Lichen Tundra Sparse Phases (27)

Vegetation covers 23.9% of the ground surface in this community. Lichens and patina are most common with frequencies of 5.1% and 11.6%, respectively. This community is found mostly on rocky slopes.

3C14. Moss Tundra Sparse Phases (addition) (2)

This vegetation community is similar to 1012 and 2H11 in that it is moss dominated and located below late-lying snowbeds. However, only 26.0% of the ground surface is covered by vegetation. Because of the moist situation, patina is also common.

3C22. Ephemeral (perennial) Herb Desert (67)

Only 17.4% of the ground surface is covered by vegetation in this community. It is dominated by patina and forbs; purple saxifrage is the

dominant forb. Crustose lichens are also present. The community often is found on arid windswept ridges and rocky slopes.

Habitat Types

The 19 vegetation communities were combined into nine habitat types on the basis of similarity in species composition, cover, topographical position, and utilization. A vegetative description of these nine habitat types follows. The frequency of plant species occurring within each habitat type is listed in Table 15. A list of plant species found in the area is given in Appendix B.

Sedge Meadows

This habitat type is a combination of vegetation communities 1M21 and 1M22. Both are sedge communities, the main difference being in the amount of standing water present. Both communities are located in low narrow bands of poorly-drained organic soil next to rivers, streams, lakes, and ponds. Algae thrive in places where water is standing for a major portion of the growing season. Vegetation covers 85.5% of the ground surface. A continuous moss sub-layer is present. Sedges and grasses are the dominant feature of this habitat type; sedges are predominant. *Eriophorum* spp., *Carex stans*, *Carex misandra*, and *Luzula nivalis* are present. Grasses grow on the drier sites with the dominant grass being *Arctagrostis latifolia*. *Alopecurus alpinus*, *Phippsia algida*, and *Festuca brachyphylla* are also present. Litter contributes considerably

Table 15. Frequency of occurrence (%) of plant species within the nine habitat types.

Species	Sedge Meadows (23)[1]	Willow-Sedge Meadows (40)	Open Willow Hummocks (142)	Sparse Willow Slopes (129)	Raised Grasslands (8)	Seepage Slopes (27)	Lichen Uplands (408)	Dryas Plateaus (48)	Dryas-Purple Saxifrage Barrens (435)
				HABITAT TYPES					
Salix arctica	1.8	8.6	7.0	4.6	0.6	0.2	0.2	2.4	0.5
Dryas integrifolia		2.1	0.6	0.4	0.1			13.1	2.1
Total Shrubs	1.8	10.7	7.6	5.0	0.7	0.2	0.2	15.5	2.6
Oxyria digyna		0.3	0.8	0.3	0.6	0.3	0.2	0.2	0.1
Polygonum viviparum		0.2	+[2]	+			+		
Stellaria longipes	0.1	0.1	+	0.1			+		+
Cerastium arcticum		+	+	+			0.1		+
Cerastium Regelii							+		
Caryophyllaceae spp.		+	+			0.5	0.3		0.2
Ranunculus sulphureus	+								
Papaver radicatum		0.1	0.1	0.2	0.4	0.5	0.4	0.1	0.2
Cochlearia officinalis			+				+		+
Draba Bellii	0.1	+	0.1	0.3	0.1	0.5	0.4	+	0.3
Draba lactea				0.1			+		+
Parrya arctica			+	0.1	0.1		0.1		0.1
Parrya nudicaulis							+		
Cruciferae spp.			+	0.2	0.4	0.5	0.1	+	0.2
Saxifraga caespitosa			+	+		0.1	0.1		+
Saxifraga cernua	0.1		+				+	+	+
Saxifraga flagellaris	0.1		+	+	0.1	+			
Saxifraga Hirculus	0.1	+	+				+		+
Saxifraga nivalis			+				+		0.1
Saxifraga oppositifolia		0.9	2.9	2.6	3.5	2.9	2.2	3.0	1.7
Pedicularis arctica	0.1								
Unidentified forb			+	+		0.1	0.1		0.1
Total Forbs	0.6	1.6	3.9	3.9	5.2	5.4	4.0	3.3	3.0
Alopecurus alpinus	0.2	0.1	0.2		1.3	0.3	0.1		
Phippsia algida	0.1					+	+		+
Arctagrostis latifolia	9.4	3.9	0.4	0.1	6.1	2.2	0.1	+	+
Pleuropogon Sabinei				0.3					
Colpodium Vahlianum				0.1	0.1	+	0.2	+	0.1
Festuca brachyphylla	1.5	0.5	+			0.2	+		
Gramineae spp.	0.2	0.4	0.1	0.3	3.0	1.8	0.3	0.1	0.6
Total Grasses	11.4	4.9	0.7	0.8	10.5	4.5	0.7	0.1	0.7
Eriophorum spp.	0.4	1.0	+	+	0.3	0.3	+		
Carex stans	2.0	4.9	0.2	0.1		0.6	0.1	0.1	+
Carex misandra	1.9	1.3	0.3	0.2	1.4	0.1	0.2	0.6	0.1
Carex spp.	17.6	3.1	0.4		0.6	0.2	0.3	0.3	+
Total Sedges	21.9	10.3	0.9	0.3	2.3	1.2	0.6	1.0	0.1
Cetraria cucullata		0.1	0.4	0.1		0.1	1.0	0.5	0.1
Cetraria delisei		0.2	0.7	+	0.4	0.5	2.8	0.5	0.3
Cetraria telesii		0.1	+	+			+	0.1	+
Thamnolia vermicularis		1.1	1.0	1.0	1.5	0.5	1.4	2.6	0.9
Crustose lichen	0.7	6.3	12.6	6.0	5.0	6.3	7.2	11.1	2.6
Total Lichen	0.7	7.8	14.7	7.1	6.9	7.4	12.4	14.8	3.9
Patina	10.3	18.1	32.1	22.0	22.0	31.5	29.2	17.5	8.2
Moss	32.7	27.8	13.5	6.5	23.9	22.4	8.5	3.3	1.7
Algae	6.8	0.6	0.2		1.5	1.8	+		
Litter	9.1	13.4	4.5	2.1	8.3	5.4	2.0	2.2	1.0
Bare Ground and/or rock	5.4	4.5	21.5	52.2	18.8	20.3	41.8	42.1	79.1

[1]number of 100 pt line-transects
[2]+ = present

to total ground cover. Scattered willows occur along the more elevated periphery of Sedge Meadows.

Willow-Sedge Meadows

This habitat type is a combination of vegetation communities 1H14 and 1H21. Vegetation covers 82.1% of the ground surface. Hummocks within this type support willow and dryas. Moss comprises a continuous sub-layer and patina is common. *Arctagrostis latifolia* is the dominant grass with *Alopecurus alpinus* and *Festuca brachyphylla* also present. *Carex* spp. are the most frequent sedges with *Eriophorum* spp. also present. Numerous forbs are present including purple saxifrage, *Oxyria digyna,* and *Polygonum viviparum.* Litter comprises a significant portion of total ground cover.

Open Willow Hummocks

This habitat type is composed of vegetation communities 2C21 and 2F22 where total vegetative cover is greater than 50%. Seventy-four percent of the ground surface is covered with vegetation. Open Willow Hummocks are found on the periphery of lowlands where the terrain begins to rise. The habitat type is generally located on level areas or gentle slopes. Moss consistently forms a sub-layer beneath willow plants. Patina is common between hummocks. The dominant forb is purple saxifrage; *Oxyria digyna* is frequently present. A wide variety of other forbs are also present.

Sparse Willow Slopes

This habitat type is comprised of vegetation communities 2C21, 2F22, and 3B23 where total plant cover is between 5% and 50%. This habitat type is generally located on moderately-drained slopes rising from valley bottoms. Although dryas and willow are often growing in association, willow is the more dominant of the two dwarf shrubs. Patina is common between willow plants. Purple saxifrage is the dominant forb with *Oxyria digyna*, *Draba Bellii*, and *Papaver radicatum* also common. Other forbs occur intermittently. Vegetation covers 45.7% of the ground surface.

Raised Grasslands

Raised Grasslands are found on sheltered valley slopes with well-drained sandy soils. This habitat type, a combination of vegetation communities 1M25 and 2G23, is generally small and localized. Forbs and graminoids are most conspicuous. Vegetation covers 72.9% of the ground surface. The dominant grass is *Arctagrostis latifolia* with *Alopecurus alpinus* and *Colpodium Vahlianum* also present. *Carex misandra*, a sedge of drier sites, is common. Purple saxifrage is the dominant forb with *Oxyria digyna*, *Papaver radicatum*, *Draba Bellii*, *Parrya arctica*, and *Saxifraga flagellaris* also present. Litter covers a significant portion of the ground surface.

Seepage Slopes

This habitat type, comprised of vegetation communities 1012, 1022, 2H11, and 3C14 (cover classes 2 and 3), is found on lower slopes and level areas adjacent to slopes immediately below late-lying snowbeds. The soil is generally saturated and often spongy. The moist situation and shorter growing season occasioned by late-melting snowbeds favor moss and patina. These sites generally are quite small, often less than 10 m by 50 m. Plant cover averages 74.3%, but ranges from 26.0% to 94.0%. In this habitat type, patina is most likely a combination of lichen, moss, and algae which thrive in this moist environment. Vascular plant species include willow, purple saxifrage, and *Arctagrostis latifolia* with a variety of other herbs also occurring.

Lichen Uplands

This habitat type is extensive on upland terrain. It includes vegetation communities 2H21 and 3C13 (cover classes 2 and 3); total plant cover averages 56.2%. Lichen Uplands are most often found on gentle slopes and possess the most diverse species composition. Patina and lichens are dominant. Fruticose lichens include *Cetraria cucullata, Cetraria delisei, Cetraria telesii,* and *Thamnolia vermicularis*. Purple saxifrage is the dominant forb. Other species present in amounts greater than a trace include: *Alopecurus alpinus, Arctagrostis latifolia, Colpodium Vahlianum, Carex stans, Carex misandra, Oxyria digyna, Cerastium arcticum, Papaver radicatum, Draba Bellii, Parrya arctica, Saxifraga*

caespitosa, and willow.

Dryas Plateaus

Dryas Plateaus occur on the upper slopes of raised beaches and level portions of well-drained highlands where patches of snow accumulate during the winter. This type is comprised of vegetation communities 2C13, 2F12, and 3B11 (cover class 3); 55.7% of the ground surface is covered with vegetation. Dryas is found growing in association with willow, but dryas is the more dominant dwarf shrub. Crustose lichens and patina are common. *Thamnolia vermicularis* is the most common fruticose lichen, with *Cetraria cucullata*, *Cetraria delisei*, and *Cetraria telesii* also present. Purple saxifrage is the dominant forb with *Oxyria digyna* and *Papaver radicatum* also occurring. Grass and sedges are not common.

Dryas-Purple Saxifrage Barrens

This habitat type is comprised of vegetation communities 3C22, 3B11 and others falling within vegetation cover class 1. Total plant cover, including patina, is 19.9%. This habitat type occurs on windswept ridge tops where winter snow cover is minimal. The lack of an adequate source of moisture coupled with enhanced desiccation due to winds contribute to the area being nearly void of vegetation. The most exposed ridge tops generally have surfaces composed of shattered limestone. Crowns of purple saxifrage are often greater than 20 cm

in diameter and harbor small mosses and lichens. In sites which are less rigorously windswept, small patches of snow accumulate and contribute sufficient moisture for the growth of dryas. Within the dryas mats, sedges, lichens, and forbs occur. Between these mats of vegetation, solitary specimens of the most xeric species are found. These are generally of the family Cruciferae, with *Draba Bellii* being the most common.

Discussion

Terrestrial plants of arctic regions are small, close to the ground, and often widely separated by bare soil or rock. The predominant life-forms present include mosses, lichens, evergreen and deciduous prostrate shrubs, and short-stemmed herbaceous perennials (grasses, sedges, cushion plants, and rosette plants). Annual plants, when present, are small and quick to flower and set seed.

The availability of water is far more important than temperature in determining the local distribution of different life-forms of tundra vegetation (Billings, 1973). Additionally, the subsoil is permanently frozen (permafrost) with depth of thawing depending on soil texture (the permafrost level is lower in sand and gravel than peaty soils). Drainage, therefore, is often poor in arctic regions.

Where moisture is not limiting, graminoid plants (grasses and sedges) generally dominate. Stemless rosette plants and cushion plants

usually characterize drier sites, i.e. ridges, rocky places, and disturbed areas. Prostrate and cushion-like shrubs range the entire moisture gradient. Among those with evergreen leaves, arctic white heather (*Cassiope tetragona*) dominates where protected by winter snow and supplied with abundant summer melt water; while dryas dominates on well-drained protected areas of windswept ridges or plateaus of polar deserts. Prostrate willows occur in almost all kinds of tundra environments.

Snow accumulations are the major source of moisture. Snow is blown off ridges and accumulates along leeward slopes. Depending on the moisture regime, communities may represent a continuum, grading almost imperceptibly from one to the other, or may show distinct boundaries.

Crustose lichen-covered surfaces better conserve soil moisture than fruticose lichen-covered surfaces and bare soil (Bliss, 1975). Although of no apparent forage value, this may explain the importance of patina. It is a soil holder and moisture accumulator. Organic matter builds up here and other, higher plants, are able to establish a foothold.

Arctic vegetation communities exist on a wide variety of substrate, from rocky fell-fields to deep peaty soils. Many researchers have devised

systems to classify these vegetation communities (Porsild, 1951; Hanson, 1953; Saville, 1961; Barrett and Teeri, 1973; Parker, 1975). However, these systems tend to be either highly specific to the region concerned or extremely general. We chose to use the IBP system (Fosberg, 1967) to classify vegetation in the field. Limitations to this system were encountered. As the key was devised for use throughout the world, its use in this specific arctic situation required adaptations. The initial designation of an area as to closed, open, or sparse vegetative cover was subjective. For example, in many cases vascular plant cover was only 5 to 20%, yet crustose lichens, including patina, could raise the total cover value to greater than 50%. We chose to use all plants in assigning cover values. However, the major advantage to using a standard system was that the same system could be used throughout the Arctic (on the islands and the mainland) and results could be compared to those obtained by other researchers on the Polar Gas environmental program also using the Fosberg system.

In order to meaningfully discuss ungulate use of different areas, the 19 vegetation communities were combined into nine habitat types.

Because of the multitude of streams and small water bodies, the irregular topography, and the influence of permafrost, distinct habitat types are seldom widely continuous, but are distributed depending on elevation, moisture, and quality of soil. The richest areas, in quality and variety of vegetation, are along water margins and in depressions

where organic material has accumulated. The most barren areas are on dry ridges and hilltops, where the substrate may range from clays or silts to rock, seldom containing much organic matter.

In lowlands around rivers and lakes, sedges flourish. Away from the standing water or on raised areas, such as hummocks, willows can gain a foothold. There is a gradual change from sedges along the water courses through lush Willow-Sedge Meadows to the rocky slopes with a few scattered willows. The distinction between Sedge Meadows, Willow-Sedge Meadows, Open Willow Hummocks, and Sparse Willow Slopes is based on total vegetative cover and the amount of willow present. Generally the three former habitat types are in the lowlands near water while Sparse Willow Slopes are on slopes rising out of valleys.

Upland areas are generally well drained. The Lichen Uplands tend to cover vast expanses of the region and are rolling in nature in contrast to other habitat types which are more limited in extent. Due to the undulating terrain, many different physical environments are present, allowing an extremely diverse combination of plant species to occur. Although the Raised Grasslands habitat type occurs infrequently, this type is very obviously distinct. Raised Grasslands are not located in the moist lowland areas and contain very few sedges. Consequently, they were very different from Sedge Meadows.

Dryas Plateaus are generally well drained and occur in areas where, although windswept, pockets of snow can accumulate. Dryas Plateaus,

Sparse Willow Slopes, and Open Willow Hummocks are often adjacent to each other. Often, dryas and willow are found in association and a subjective judgement of dominance had to be made in order to classify the community.

In contrast to most of the high arctic islands, Prince of Wales Island is relatively well vegetated and consists of a mosaic of wet sedge and grass meadows in lowlands and moderately vegetated cushion plant-moss communities of the polar semi-desert type on better drained sites. True polar deserts are a minor feature (Bliss, 1975).

Vegetation communities which were classified on Bathurst, Cornwallis, and Somerset islands were found to be the same as those on Prince of Wales Island. Transect data showed the vegetation communities are composed of generally the same species in similar proportions to those communities on Prince of Wales Island; the only major difference is on Somerset Island where arctic white heather rather than dryas was found to be the dominant evergreen dwarf shrub in several localities. Additional forbs and grasses found on Cornwallis, Bathurst, and Somerset islands are listed in Appendix B.

Habitat Utilization

Two methods were used to examine habitat utilization by caribou and muskoxen. These included counts of summer and winter pellet groups and the more indirect method of examining diet through histological analysis of plant fragments in pellets.

Pellet Group Counts

On Prince of Wales Island, a total of 1,260 transect segments were run during summer 1975. An additional 139 segments were run on Somerset, Cornwallis, and Bathurst islands. As the sample size on the latter three islands is insufficient at this time to reliably determine usage patterns, no attempt has been made to relate these data to those gathered on Prince of Wales Island. However, the data are presented in Appendix C.

Analysis of pellet group distribution on Prince of Wales Island by vegetative cover-class and habitat type showed definite trends for both caribou and muskoxen. Results are presented separately for each species.

Caribou

The relative density of summer and winter caribou pellet groups increased with increasing vegetative cover values (Table 16). The relative density of summer pellet groups found was 0.42 in areas of greater than 75% cover, while it was only 0.01 in areas with less than 5% cover. In winter, the relative density of pellet groups in areas with more than 75% cover was 0.36; in areas with less than 5% cover the relative density was only 0.04.

Table 16. Relative density of caribou pellet groups within vegetative cover-classes.

Cover Class	Transect Segments		Pellet Groups Observed		Pellet Groups/ Hectare		Relative Density (%)	
	Number	%	Summer	Winter	Summer	Winter	Summer	Winter
1 (<5%)	205	16	6	24	3	12	1	4
2 (5-25%)	290	23	11	56	4	19	2	7
3 (25-50%)	287	23	108	150	38	52	22	19
4 (50-75%)	325	26	186	291	57	90	33	34
5 (>75%)	153	12	112	146	73	95	42	36
Total	1,260		423	667				

Table 17. Relative density of caribou pellet groups within habitat types.

Habitat Types	Transect Segments		Pellet Groups Observed		Pellet Groups/ Hectare		Relative Density (%)	
	Number	%	Summer	Winter	Summer	Winter	Summer	Winter
Dryas-Purple Saxifrage Barrens	435	35	10	55	23	13	5	2
Dryas Plateaus	48	4	19	67	40	140	9	20
Lichens Uplands	408	32	173	246	42	60	9	9
Seepage Slopes	27	2	13	11	48	41	10	6
Raised Grasslands	8	1	3	6	38	75	8	11
Sparse Willow Slopes	129	10	30	43	23	33	5	5
Open Willow Hummocks	142	11	114	163	80	115	17	17
Willow-Sedge Meadows	40	3	53	65	133	163	29	24
Sedge Meadows	23	2	8	11	35	48	8	7
Total	1,260		423	667				

Among the habitat types with higher cover-class values, Willow-Sedge Meadows and Open Willow Hummocks had highest relative densities of summer pellet groups, 0.29 and 0.17, respectively (Table 17). Although the Sedge Meadow is also a type with a high cover-class value, relative density of pellet groups was only 0.08. Habitats with the lowest relative densities of pellet groups were Sparse Willow Slopes and Dryas-Purple Saxifrage Barrens with 0.05 each.

The distribution of winter pellet groups was generally similar to summer, with Willow-Sedge Meadows and Open Willow Hummocks having relative densities of 0.24 and 0.17, respectively (Table 17). There was, however, a two-fold increase in the relative density of pellet groups from summer to winter in the Dryas Plateaus, from 0.09 to 0.20. Sedge Meadows again had a low relative density of pellet groups at 0.07. Sparse Willow Slopes and Dryas-Purple Saxifrage Barrens had the lowest relative densities, 0.05 and 0.02.

Muskoxen

The relative density of muskoxen summer and winter pellet groups increased dramatically with increasing vegetative cover-class values (Table 18). Relative densities of pellet groups in areas with greater than 75% cover were 0.80 for summer and 0.89 for winter. The relative density of pellet groups in areas with less than 5% cover was only 0.03 for summer and 0.02 for winter.

Table 18. Relative density of muskoxen pellet groups within vegetative cover-classes.

Cover Class	Transect Segments		Pellet Groups Observed		Pellet Groups/ Hectare		Relative Density (%)	
	Number	%	Summer	Winter	Summer	Winter	Summer	Winter
1 (<5%)	205	16	2	1	2	1	3	2
2 (5-25%)	290	23	3	1	2	0	3	0
3 (25-50%)	287	23	3	5	1	2	2	3
4 (50-75%)	325	26	27	12	8	4	12	6
5 (>75%)	153	12	81	87	53	57	80	89
Total	1,260		116	106				

Among the habitat types with the highest cover-class values, Willow-Sedge Meadows contained the highest relative density of muskoxen pellet groups (Table 19). The relative density of summer pellet groups within this habitat type was 0.77 compared to only 0.02 for Sedge Meadows and 0.09 for Dryas Plateaus. No summer pellet groups were found on either Dryas-Purple Saxifrage Barrens or Seepage Slopes.

The relative density of winter pellet groups was 0.84 in Willow-Sedge Meadows while it was only 0.03 in Sedge Meadows and 0.05 in Raised Grasslands. No winter pellet groups were found on Dryas-Purple Saxifrage Barrens or Seepage Slopes. Between summer and winter, the relative use of each habitat type changed only slightly.

Discussion

Counts of ungulate pellet groups have successfully been employed by many researchers as an index of relative use between areas (Bennett *et al.*, 1940; Rogers *et al.*, 1950; Eberhardt and Van Etten, 1956; Robinette *et al.*, 1958; Neff, 1968). Pellet groups provide a persisting record of animal presence, whereas visual or track counts depend on current activity of the animal and thus may be affected by the presence of the observer and weather conditions. It has been shown that muskoxen and caribou generally lie down after a feeding period and defecate soon after standing up and before moving far (Kelsall, 1968; Bliss, 1975). Consequently, it can be assumed that pellets do indeed provide an index to relative use of areas by ungulates.

Table 19. Relative density of muskoxen pellet groups within habitat types.

Habitat Types	Transect Segments		Pellet Groups Observed		Pellet Groups/ Hectare		Relative Density (%)	
	Number	%	Summer	Winter	Summer	Winter	Summer	Winter
Dryas-Purple Saxifrage Barrens	435	35	2	2	0	0	0	0
Dryas Plateaus	48	4	11	3	23	6	9	3
Lichen Uplands	408	32	7	10	2	2	1	1
Seepage Slopes	27	2	0	0	0	0	0	0
Raised Grasslands	8	1	1	1	12	12	5	5
Sparse Willow Slopes	129	10	2	2	2	2	1	1
Open Willow Hummocks	142	11	17	8	12	6	5	3
Willow-Sedge Meadows	40	3	75	78	188	195	77	84
Sedge Meadows	23	2	1	2	4	9	2	3
Total	1,260		116	106				

Pellet-group counts have been used as an ungulate censusing method on winter and summer ranges (Bennett *et al.*, 1940; Neff, 1968). However, because we were unable to obtain accurate information on critical variables (i.e. age of pellet groups and rate of defecation), the use of pellet-group counts for anything other than a relative index of utilization was precluded.

Due to the arctic environment, decomposition of pellet groups is very slow. Bliss (1975) estimated the rate of decomposition of muskoxen dung based on decomposition-accumulation comparisions and carbon-loss studies. He found pellets on raised beaches lasted 8 to 20 yr while in meadows they lasted only 3 to 5 yr. For this reason, pellet densities may underestimate actual ungulate use of moister habitat types, i.e. Sedge Meadows and Seepage Slopes.

In the field, we initially attempted to distinguish between old pellets and those deposited within the last year but found it to be very difficult. Depending on the place of deposition, the weathering rate of pellet groups varied. Additionally, animal diet apparently affected pellet coloration with shades ranging from black to gray when initially deposited. For these reasons, numbers of old and fresh pellets were combined during analysis. Due to the wandering habits of caribou, and to a lesser extent muskoxen, animals may use a particular area and not return for a few years. Therefore, by counting all pellets, old and fresh, a total land use index is obtained and not simply an index of use in a specific year.

Caribou

To our knowledge, no previous in-depth studies of habitat utilization have been conducted on Peary caribou. Habitat studies have been done on barren-ground caribou and reindeer (Kelsall, 1960, 1968; Lent, 1966; Pegau, 1968; Zhigunov, 1961; Curatolo, 1974; Parker, 1975; Skogland, 1975). Although these studies were carried out in the Low Arctic where generally continuous vegetative cover and different habitat types exist, many similarities to the High Arctic situation are evident.

Caribou range widely and feed over most High Arctic habitat types but do show a preference for areas where vegetative cover is most complete. Additionally, if the difference in relative density of pellet groups found in Willow-Sedge Meadows and Sedge Meadows reflects actual use patterns, forage preferences may influence selection of habitat types. These two habitat types have similar vegetative cover values (Table 15), but differ in species composition. There is a much higher percentage of shrubs in the Willow-Sedge Meadows. Lichens are also present in this habitat type. Additionally, Willow-Sedge Meadows are not immediately adjacent to ponds and streams as are Sedge Meadows; consequently, the ground is more firm and not covered with standing water. Caribou also appear to use other habitat types in the summer but to a lesser degree than those types in low-lying areas containing willow.

In Alaska, White *et al.* (1975) found that barren-ground caribou near Prudhoe Bay displayed a preference for *Dryas* heath/*Salix rotundifolia*

snowbed and *Dupontia* brook meadow communities in early and late summer, respectively. The former community is characterized by sedges, willows, dryas, purple saxifrage and lichens; the latter by a rich variety of herbaceous plants and willows. Caribou also exhibited a lack of preference for the wetter *Carex aquatilis* marsh. This may have been due to high mosquito densities, high water levels or low forage availability in the marsh.

Skogland (1975), in southern Norway, found that willow and herb-dominated snowbeds received 95% of wild reindeer use in early and late summer. Grazing succession was related to phenology, with selection for the early growth stages of plants within different vegetation types. Pegau (1968) found that reindeer began to use newly green sedges in early June but as soon as shrubs began to green-up they moved into shrub-sedge meadows. Kelsall (1968) observed that following the period of rapid plant growth in spring and early summer, caribou became less particular in their feeding habits and consequently wandered through more habitat types seeking new green growth. Except when extremely dry, caribou utilized lichens wherever they could be found.

It appears from our results that Peary caribou also wander during summer to seek new green vegetation. Besides containing the highest percentage of the palatable dwarf shrub willow, Willow-Sedge Meadows are close to water causing them to become green sooner and remain green longer, thereby attracting the majority of use.

During winter, snow conditions undoubtedly influence habitat types chosen by caribou. Both snow depth and snow structure have an important influence on the grazing ungulates and their choice of habitat types during winter. The compactness and depth of the snow, the thickness of the ice crust, and the length of time these persist must be considered in estimating the grazing potential of an area.

Pruitt (1959) and Henshaw (1965) found that caribou avoided areas with deep, wind-packed snow. Stardom (1972), studying woodland caribou, observed that as soon as the first high winds of winter created wind-drift crusts in open areas the animals immediately shifted from lowland bogs to ridge tops. The open bogs had 50 to 55 cm of snow at an average hardness of 164 gm/cm^2 and a mean density of 0.19, while the ridge-top snow was approximately 35 cm deep but had a conglomerate of various sized hard patches of snow in a soft-snow matrix.

Henshaw (1965) described the threshold of sensitivity to snow depth for barren-ground caribou at 60 cm. However, snow hardness, especially crusting conditions at a level higher than 25 cm from the substrate, had the greatest effect on caribou activity (Stardom, 1972). Caribou preferred to enter areas of deeper snow rather than be subjected to vesicular ice or snow crusts of hardness greater than 400 gm/cm^2.

During late winter (March-April) 1975 aerial surveys in Regions I and II, 84% of the 209 caribou we observed were on windswept areas.

In pellet group counts, we noted an increase in the use of Dryas Plateaus during winter. These higher, windswept areas are most likely kept relatively free of snow and consequently are being utilized to a greater extent during winter.

In these upland windswept areas (Dryas Plateaus and Lichen Uplands), we recorded the highest frequency of non-crustose lichens. This high carbohydrate, high energy food has been reported to be the main constituent of the winter diet of barren-ground caribou (Kelsall, 1960, 1968; Zhigunov, 1961; Lent, 1966; Pegau, 1968; Stardom, 1972; Skogland, 1975; Inglis, 1975). But lichens alone probably cannot supply caribou with all necessary dietary requirements as they contain little protein and negligible amounts of minerals (Zhigunov, 1961). Consequently, caribou supplement their diet with remnants of green vegetation (Zhigunov, 1961; Kelsall, 1960). Our results indeed demonstrated a high relative use by caribou of low-lying Willow-Sedge Meadows in winter.

Muskoxen

Although muskoxen are less mobile than caribou, they too move throughout the seasons. In summer, muskoxen move along river systems and occasionally between drainages (Bos, 1967). Bos found muskoxen commonly moving 4 km per day during summer on Nunivak Island. In winter, mobility of muskoxen is much lower with herds often remaining in the same area for several days or even longer (Bos, 1967).

Despite their mobility, muskoxen are still highly site specific as demonstrated by the results of pellet-group counts. They not only preferred areas with a high percentage of vegetative cover, but specifically selected the Willow-Sedge Meadow habitat type during both summer and winter.

In Alaska, Bos (1967) showed that the most important summer range type for muskoxen was the Grass-Browse type. The most important forage species was *Salix pulchra*; wet tundra sedges (primarily *Carex stans*) were also important. During winter, muskoxen selected areas along the coast which were exposed to winds. Wet Tundra and Beach Grass-Forb types were used almost exclusively. Sedges and grasses were the dominant plant groups in both types with some willows in the Wet Tundra type.

Tener (1965) studied the Fosheim Peninsula, Ellesmere Island, and parts of the Thelon Game Sanctuary to determine range types available to muskoxen. He found the availability of willows and sedges to be a determining factor in the abundance of muskoxen during both seasons. These plant species were found in lowland regions around streams and lakes. On Ellesmere Island, a large amount of summer dung was found in the lowland where willow, dryas, and grasses were prevalent. Muskoxen were also observed feeding in lowland areas. Most of the winter pellets were found in sedge areas. Very few winter pellets were found in the willow-dryas site, although examination of winter-killed muskoxen revealed willow, grasses, moss, and some dryas in the rumens.

On Bathurst Island, Gray (1973) found that muskoxen used the valley floors where vegetation was comparatively lush during both winter and summer. Although there was a deeper snow layer here in winter than on the exposed windswept slopes, the vegetation beneath the snow was usually in an air space and possibly easier to utilize than vegetation frozen into a thin layer of compacted snow on a windswept ridge.

Diet Analysis

Samples from a total of 208 caribou pellet groups and 106 muskoxen pellet groups were collected for histological analysis (Table 20). Locations where pellet-group collections were made are presented with the results for each species. At each of these locations, pellets were collected over an estimated area of 7 to 14 km^2.

The plant remains contained within the fecal material were identified to genus and species whenever possible during analysis. To facilitate presentation of results, some of the identified material has been grouped. The Cyperaceae genera of *Carex* and *Eriophorum* and other unidentified genera have been grouped and listed as sedges. The Juncaceae *Luzula* has also been included with the sedges. The graminoid genera of *Alopecurus, Colopodium, Dupontia, Festuca, Arctagrostis,* and some unidentified genera have been grouped. Two evergreen shrubs were grouped, *Dryas integrifolia* and *Cassiope tetragona*. Forbs represent a grouping of the genera *Papaver, Draba, Cerastium, Stellaria, Ranunculus, Oxyria,*

Table 20. Number of caribou and muskoxen pellet groups from which samples were collected for dietary analysis.

	Summer	Intermediate	Winter
CARIBOU			
Prince of Wales Island			
Allen Lake	37	12	25
Baring Channel	17	22	6
Marnie Lake	16	21	27
Seismic Camp	25	0	0
	95	55	58
Somerset Island			
Union River	0	0	20
MUSKOXEN			
Prince of Wales Island			
Seismic Camp and Marnie Lake	58	20	28

Saxifraga, and other unidentified forbs. Only one genus of lichen, *Cetraria*, was separable from the others; this has been grouped with the unidentified genera. Mosses were not identified beyond the familial level.

Caribou

The percent relative density of plant species or species groups in the diet of caribou on Prince of Wales and Somerset islands is presented in Table 21.

Summer

Summer caribou pellets were analyzed from four localities on Prince of Wales Island: Allen Lake, Baring Channel, Marnie Lake, and Seismic Camp (Figure 2). There was some variation in caribou diet between these localities.

When summer dietary items were ranked in order of preference, the first position in all localities was occupied by willow (Figure 28). In all localities except Baring Channel, moss ranked second. Moss was third at Baring Channel, following forbs. At Allen and Marnie lakes, forbs were ranked third and lichens fourth. At the Seismic Camp, lichens ranked third and forbs fourth.

Table 21. Percent relative density of discerned plant fragments in caribou fecal samples deposited in summer, winter, and the intermediate seasons of spring and fall. Localities are Allen Lake (1), Baring Channel (2), Marnie Lake (3), Seismic Camp (4), and Union River (5).

	SUMMER				INTERMEDIATE			WINTER			
	1	2	3	4	1	2	3	1	2	3	5
Mosses	30.02	16.72	14.29	4.02	40.39	35.92	51.41	67.22	40.55	60.68	57.28
Cetraria spp.	4.65	5.21	3.83	.48	9.56	16.04	3.38	6.22	17.92	3.31	2.01
Unidentified Lichens	1.47	8.28	.24	1.30	14.42	5.23	8.56	14.58	12.49	12.53	11.32
Salix arctica	48.23	48.00	70.53	93.41	12.22	1.63	9.44	2.49	6.01	7.10	6.14
Saxifraga spp.	2.78	10.10	5.18	.13	11.92	23.13	19.35	6.79	17.67	8.47	
Draba Bellii	1.32	1.23	.54	.03	4.09	3.65	2.55	1.13	1.90	1.96	
Papaver radicatum	10.10	9.61	3.90	.17	3.25	11.49	.18	.21	1.49	.23	
Cerastium arcticum	.36	.50	.42	.03	2.76	2.12	1.96	.64	1.27	2.59	.27
Cerastium Regelii						.06					
Stellaria longipes		.05				.45	.24	.26	.54	.06	
Oxyria digyna	.36										
Ranunculus	.14						.06			.06	
Unidentified forbs		.20	.18		.18			.05	.11	.06	.47
Cassiope tetragona											4.82
Dryas integrifolia	.14		.06	.13	.18		.18			.34	9.07
Carex spp.		.10		.13	.43		1.11	.05		2.15	8.15
Eriophorum spp.											
Luzula nivalis							.30	.05			
Unidentified Cyperaceae			.36				.24				
Alopecurus alpinus			.06		.30		.74	.16		.34	.07
Colpodium Vahlianum			.12	.10	.12	.17	.18	.05		.06	.13
Dupontia Fisheri										.06	
Festuca spp.											
Arctagrostis latifolia								.10			
Unidentified grasses	.43		.29	.07	.18	.11	.12		.05		.27

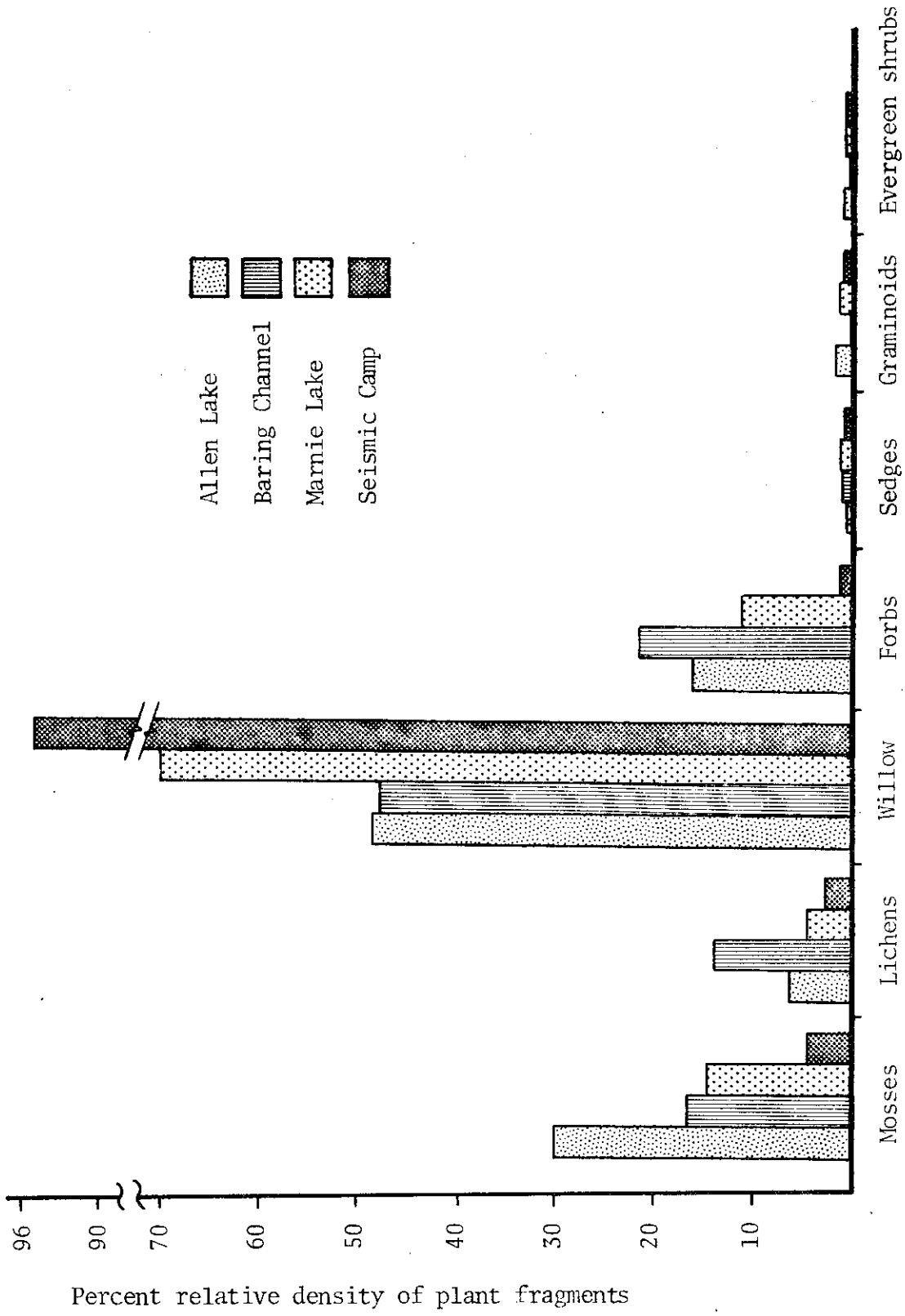


Figure 28. Diet of Peary Caribou during summer.

In all four localities there was a predominance of willow in the summer diet. At Allen Lake and Baring Channel, willow comprised approximately 48% of the estimated dry-weight composition of the diet. The highest estimated dry-weight value of willow was recorded in the Seismic Camp sample, a value of 93%. Mosses and lichens also figured prominently in the summer diet with dry-weight percentages ranging from 6% to 36%. Forbs, particularly Arctic poppy (*Papaver radicatum*) and saxifrage, also were readily consumed. Sedges, graminoids, and evergreen shrubs were very minor constituents of the summer diet; no one group contributed greater than 0.5% of the estimated dry-weight composition of the diet.

Winter

Winter pellets were collected from three localities on Prince of Wales Island and from one locality on Somerset Island, Union River.

When the winter dietary items from the three Prince of Wales localities were ranked in order of preference, changes emerged which are distinct compared to the rank order of summer items. Mosses were seemingly the most preferred items, lichens were second, forbs the third, and willow the fourth (Figure 29). This rank order was consistent for the three localities. The winter diet of caribou at Union River on Somerset Island was slightly different from the Prince of Wales Island localities. The ranked order of preference was: mosses, lichens, evergreen shrubs, sedges, and willows.

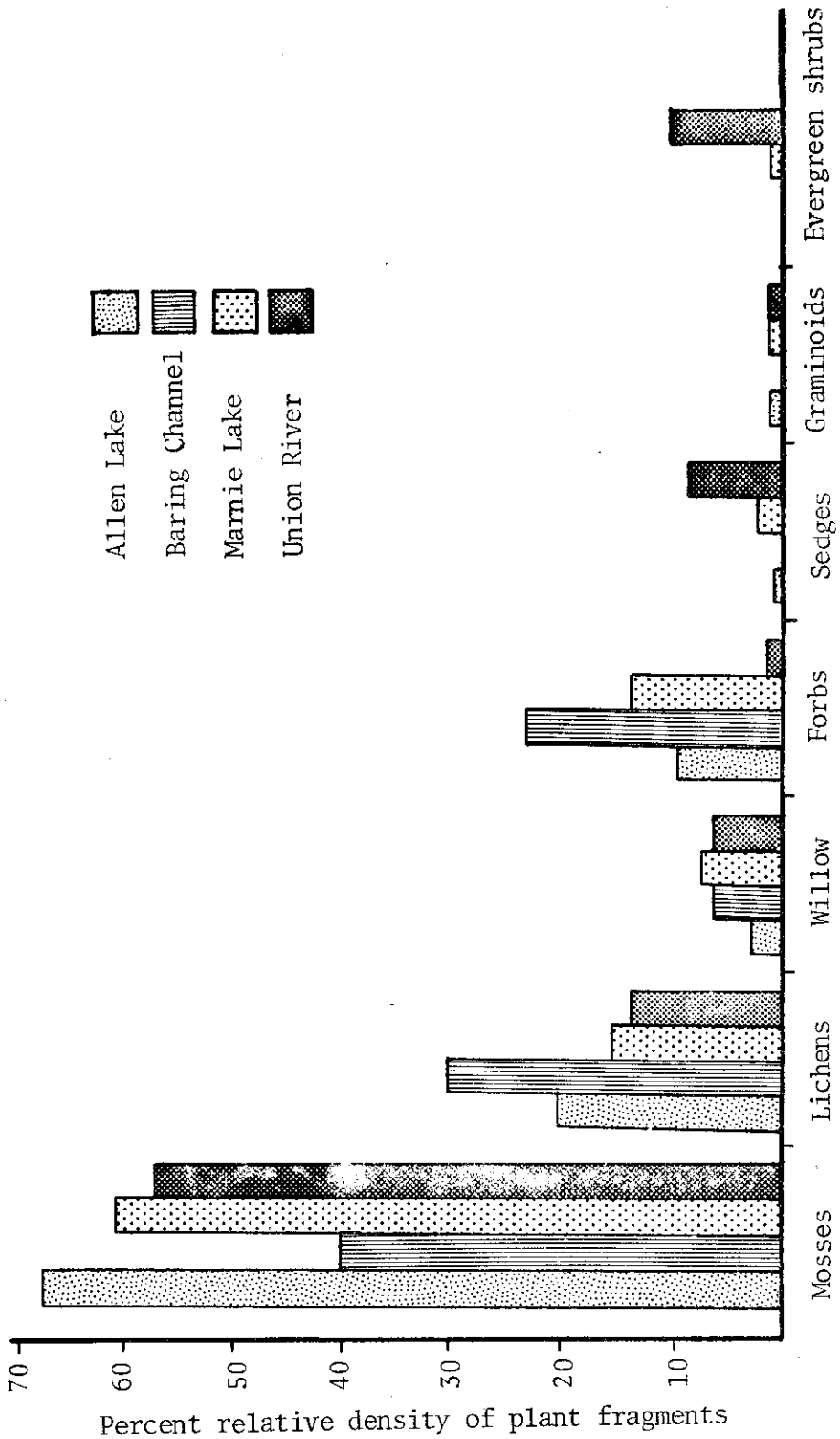


Figure 29. Diet of Peary Caribou during winter.

On Prince of Wales Island, the dry-weight percentage of mosses in the winter diet ranged from 40% to 68%. Lichens comprised from 16% to 30% of the diet; forbs (mainly *Saxifraga*) ranged from 9% to 23%. Sedges, graminoids, and evergreen shrubs were lowest in relative density, with no one group comprising more than 2% of the estimated dry-weight.

Intermediate Seasons

Intermediate season pellet groups were collected from three localities on Prince of Wales Island: Allen Lake, Baring Channel, and Marnie Lake.

There was some variation in the order of preference of dietary items between locations in the intermediate seasons. Mosses were the first preference at Allen Lake and Marnie Lake, and second at Baring Channel (Figure 30). Lichens and forbs were second and third at Allen Lake; this order was reversed at Marnie Lake. At Baring Channel, forbs and lichens were first and third, respectively. Willow was fourth at all three localities.

Mosses comprised the largest portion of the intermediate season diet, with the percent relative density ranging from 36% to 51%. Forbs comprised 22% to 41% of the diet; lichens ranged from 12% to 24%. Willow made up only 2% to 12% of the diet. All other plant groups at each location comprised no more than 3% of the relative density.

Figure 30. Diet of Peary Caribou during intermediate seasons (spring and fall).

Seasonal Variation

When the results of the fecal analysis from the various localities on Prince of Wales Island were averaged for each season, a general diet for Peary caribou was obtained which emphasizes seasonal aspects.

There was a general agreement in the relative amounts of items consumed between diets of winter and intermediate seasons (Figure 31). The most noticeable difference occurred during intermediate seasons when greater amounts of forbs were consumed. Mosses contributed the largest amount to the total estimated dry-weight content of the diet in winter and in the intermediate seasons. In winter, moss was recorded as four times more prevalent than the second most important category, lichens. During the intermediate seasons, the seeming dependency on mosses was reduced to where it was only twice as prevalent as the second most preferred item, forbs. Clearly, mosses were a very important dietary constituent during these seasons. Their use, however, is open to interpretation.

There was a distinct shift in species consumed by Peary caribou in summer. Willow was heavily used; it was four times more prominent in the diet than mosses, which were the second most prominent item. Forbs and lichens constituted a small portion of the summer diet.

In all three diet groupings (summer, winter, and the intermediate seasons), sedges, graminoids, and evergreen shrubs composed a minor part

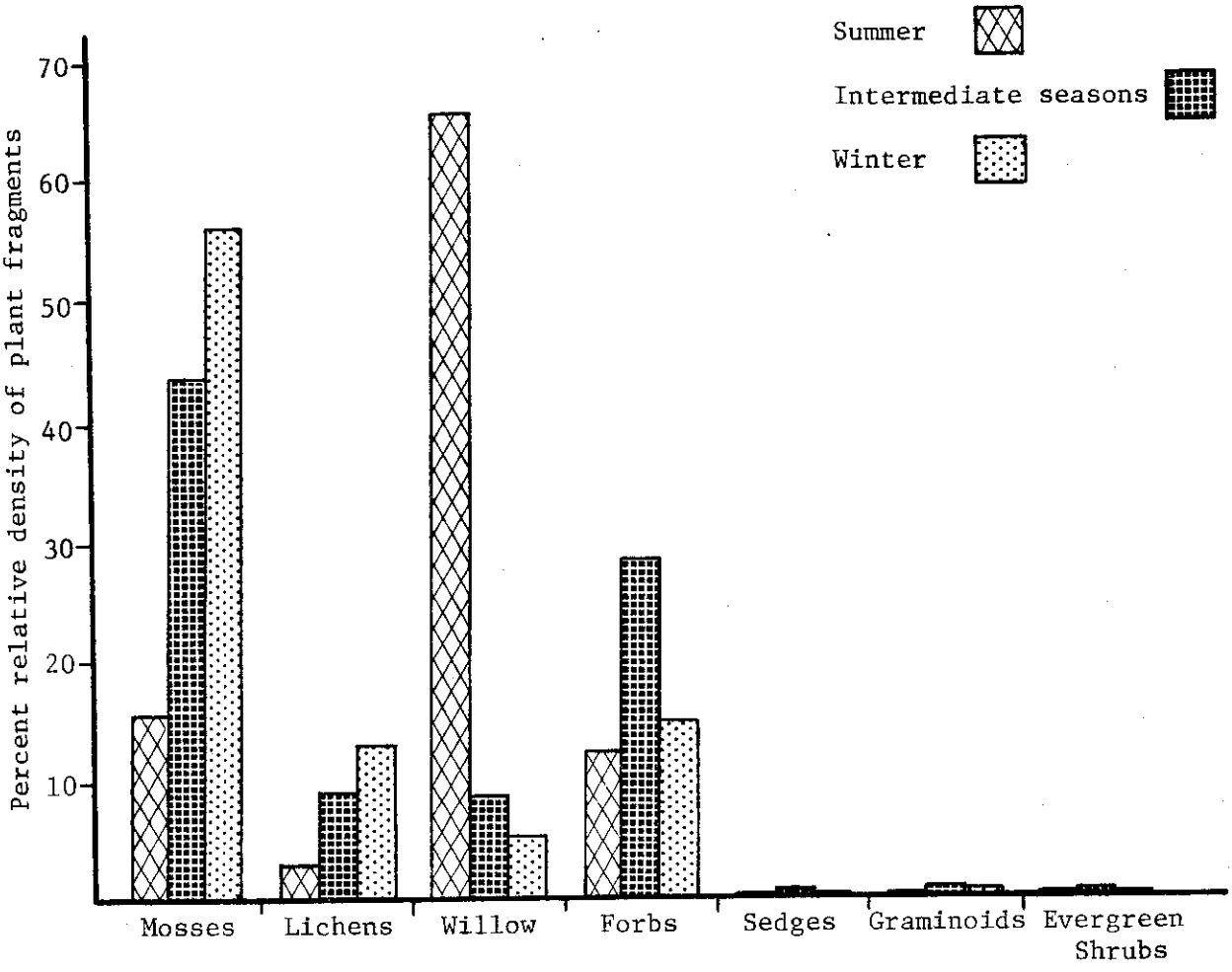


Figure 31. Seasonal diet of Peary Caribou combining all Prince of Wales Island localities.

in the diet of the caribou on northeastern Prince of Wales Island.

Muskoxen

Muskoxen pellets were collected from two localities on Prince of Wales Island: Marnie Lake and Seismic Camp (Figure 2). Pellets from these two localities were combined prior to analysis. The sample sizes for the summer, winter, and intermediate seasons and percent relative density of food items in the diet are presented in Tables 20 and 22, respectively. The identified plant remains were grouped into the seven categories indicated in the results of the caribou diet analysis.

Summer

The summer diet of muskoxen was restricted almost exclusively (99%) to three groups: willows, sedges, and mosses (Figure 32). The relative density of willow was highest at 51%, with sedges (mainly *Carex* spp.) and mosses composing 38% and 10% of the diet, respectively. There was virtually no use (<2%) of forbs, lichens, graminoids, or evergreen shrubs.

Winter

The winter diet of muskoxen was restricted to the same three groups as in summer: mosses, sedges, and willow (Figure 33). However, mosses comprised 52% of the diet in winter, compared with 36% for sedges (*Carex* spp.) and 11% for willow. Again, there was little use (<2%) of forbs,

Table 22. Percent relative density of discerned plant fragments in muskoxen fecal samples deposited in summer, winter, and the intermediate seasons of spring and fall. Collection localities were Marnie Lake and Seismic Camp.

	Summer	Intermediate	Winter
Mosses	9.82	25.51	51.75
Cetraria spp.		.13	
Unidentified Lichens	.06		
Salix arctica	50.98	9.51	11.34
Saxifraga spp.	.83	.08	.07
Draba Bellii			
Papaver radicatum			
Cerastium arcticum	.06	.08	.45
Cerastium Regelii			
Stellaria longipes			
Oxyria digyna			
Ranunculus			
Unidentified forbs	.06	.08	.06
Cassiope tetragona			
Dryas integrifolia	.06		.22
Carex spp.	37.62	64.58	35.50
Eriophorum spp.	.38		
Luzula nivalis		.08	
Unidentified Cyperaceae			
Alopecurus alpinus			
Colpodium Vahlianum		.08	
Dupontia Fisheri			
Festuca spp.			.07
Arctagrostis latifolia			
Unidentified grasses			

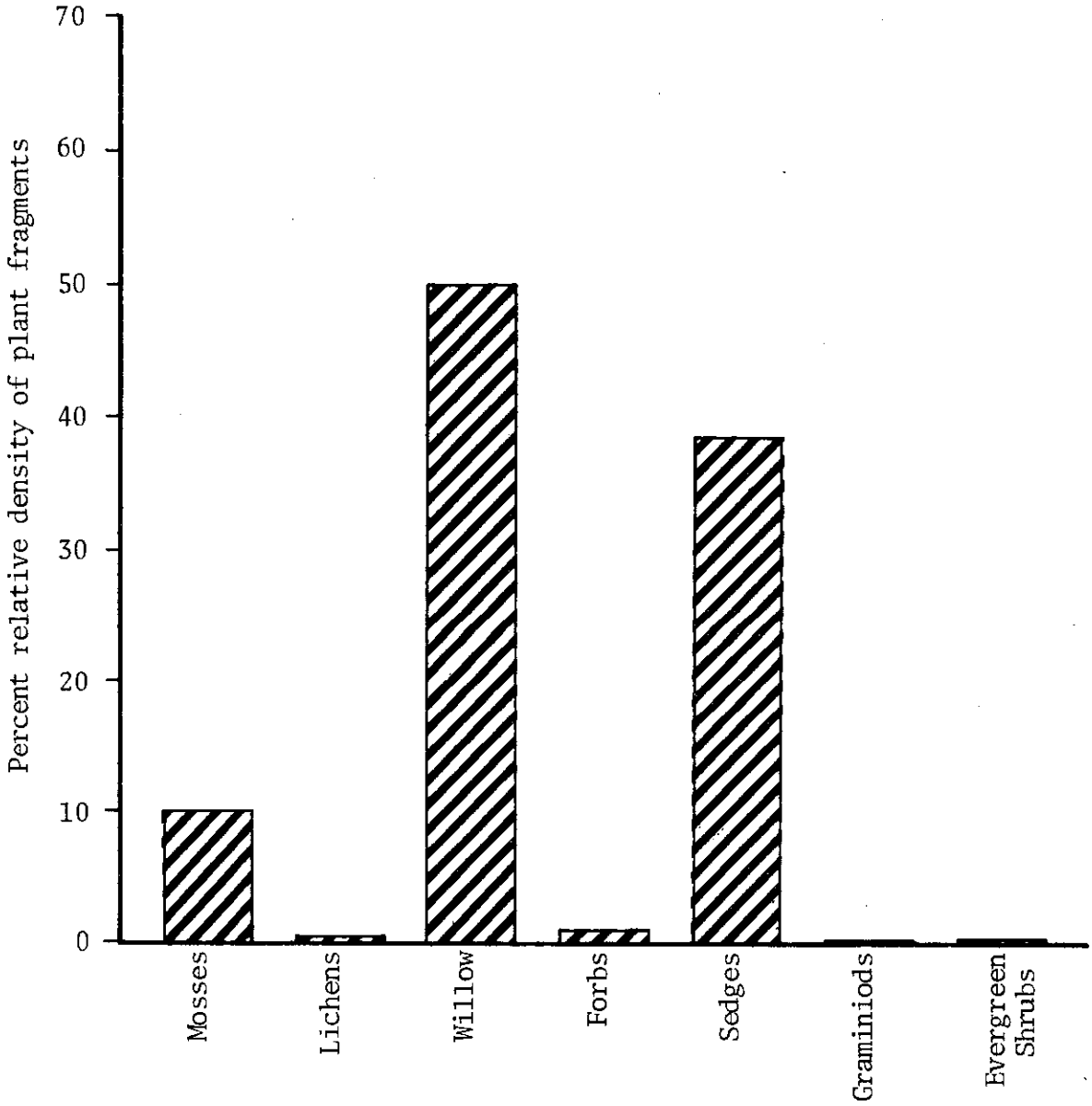


Figure 32. Summer diet of muskoxen at Marnie Lake and Seismic Camp.

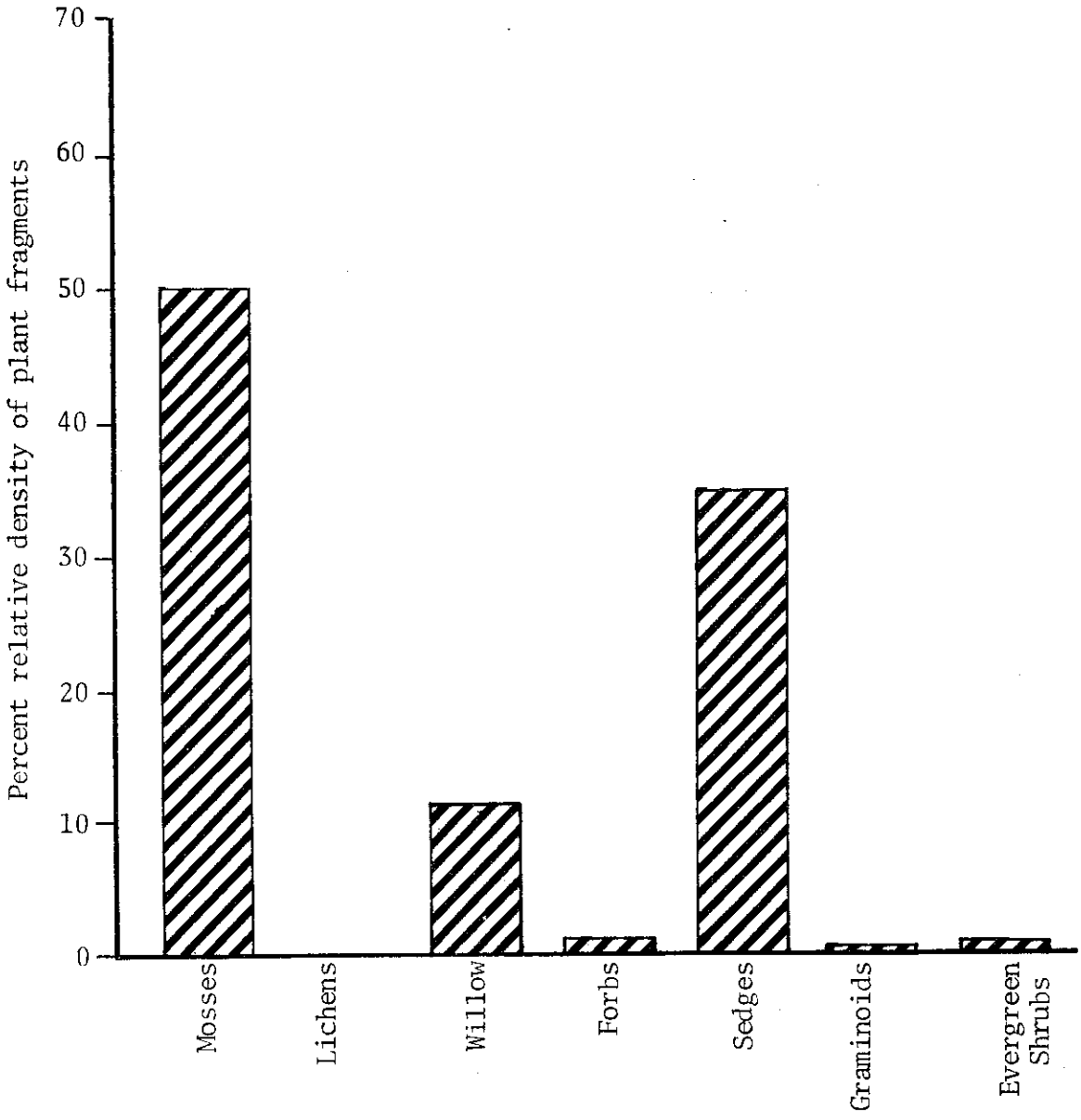


Figure 33. Winter diet of muskoxen at Marnie Lake and Seismic Camp.

lichens, graminoids, or evergreen shrubs.

Intermediate Seasons

The three groups of vegetation which were most prominent in the diet of muskoxen during summer and winter were sedges, mosses, and willows. These three groups were also the most common in the diet during the intermediate seasons (Figure 34). Sedges were the most prominent item with a relative density of 65%. They were over two times more frequent than mosses, the second most prominent item. Willows played a lesser role in the intermediate season diet with a relative density of 10%.

Seasonal Variation

In all seasons, muskoxen consumed three plant groups almost to the exclusion of others. Sedges, mosses, and willows were the most heavily-used plant species. The only seasonal dietary change was a shift in the relative proportions in which these three forms were ingested. In summer, sedges and willow totalled 88% of the estimated dry weight of the diet. In the intermediate seasons, these two forms totalled 74%, they decreased to 46% in winter. Almost all of the remainder of the diet in all seasons consisted of moss. Mosses varied from 9% to 49% of the dry weight of the diet in summer and winter, respectively.

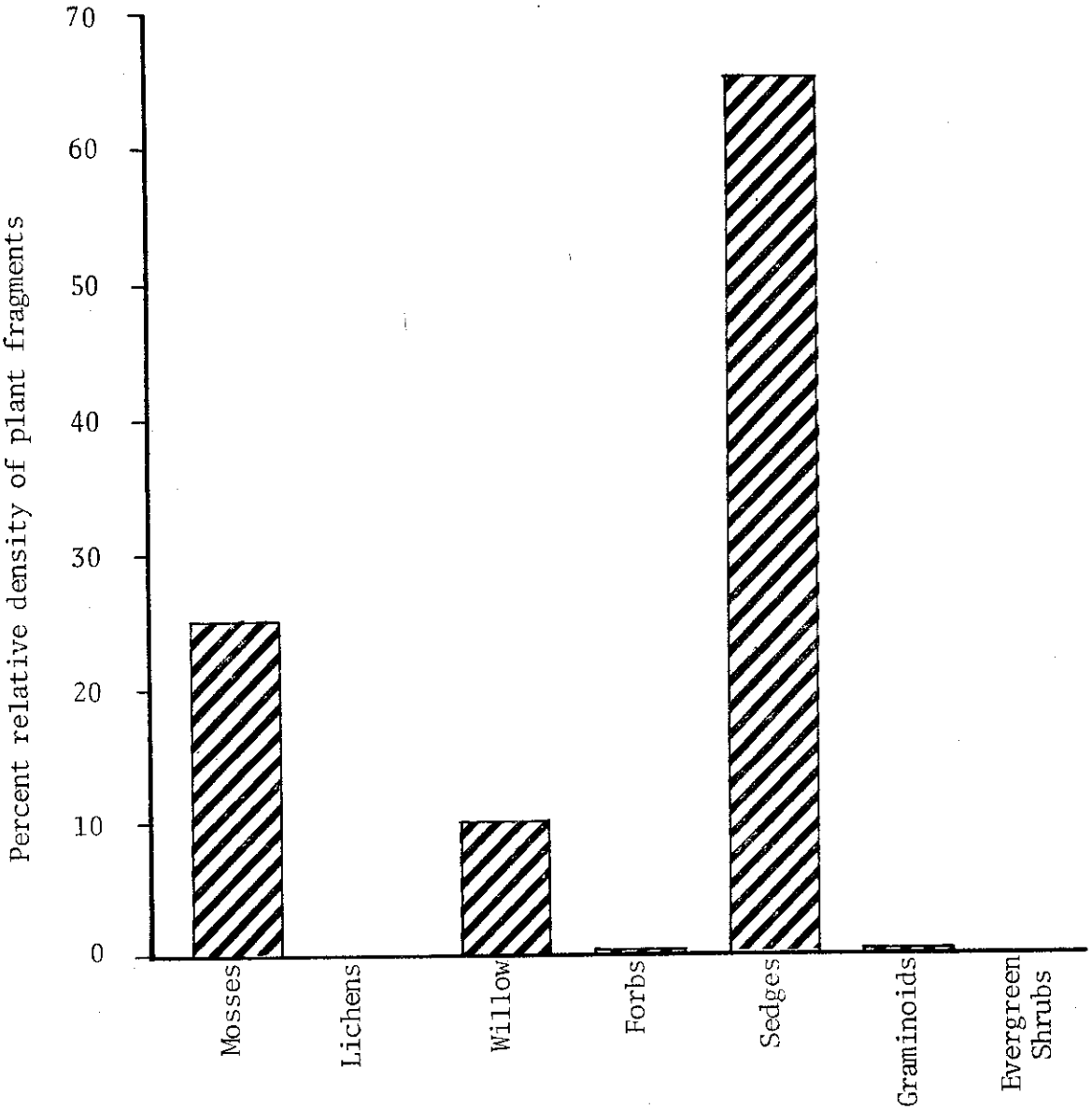


Figure 34. Diet of muskoxen during intermediate seasons (spring and fall) at Marnie Lake and Seismic Camp.

Another feature of the diet of muskoxen was the almost total absence of forbs, lichens, graminoids, and evergreen shrubs in all seasons. Unlike the caribou, which had a broader-based diet, muskoxen restricted their food selection to three groups.

Discussion

In the diets of both caribou and muskoxen in all seasons, one unexpected feature was the high occurrence of mosses. The high incidence may be a function of three variables: intentional ingestion, accidental ingestion, or a result of the analytical technique. A cumulative effect from all three variables is a likely possibility.

Intentional ingestion of more than minimal amounts of moss is contrary to current knowledge of barren-ground caribou diet (Scotter, 1968; Kelsall, 1960; Edwards and Ritcey, 1960) and muskoxen diet (Tener, 1965). It is also contrary to the literature concerning the importance of moss in the diets of vertebrates in general; it is seldom listed in any reports on dietary composition.

On the basis of the high relative densities encountered, it seems unlikely that mosses were only an accidentally ingested item. Caribou have long been regarded as fastidious eaters, easily capable of selecting portions of a plant and sorting out desired items even in snow craters (Kelsall, 1968; Palmer, 1964; Skoog, 1956). Accidental ingestion of between 16% and 56% (dry weight) mosses for caribou and 10% and 51% mosses for

muskoxen seems unlikely.

The third factor likely contributing to the high estimated dry-weight proportion of moss concerns the relative digestibility of moss. The percent relative densities of discerned plant fragments is used to estimate the dry-weight contribution of each food item on a 1:1 basis. This ratio is supported by the work of Sparks and Malechek (1968) who tested animals by feeding them grasses, forbs, and grass-forb mixtures. However, mosses, which are characterized by a thick cuticle, may resist digestion more than other plant species (White *et al.*, 1975). Hence, their remnants would be more prevalent in the fecal material. Consequently, mosses would tend to be over-estimated in their relative contribution to the dry-weight diet composition.

Some variations may have been introduced into the results because of misclassification of pellets within the three seasonal categories. Winter pellets of both species were easily distinguished. The summer pellet groups, each of which was essentially a cohesive mass of what in winter would have been separate pellets, show a very high proportion of willow. In effect, the inclusion of willow may be one of the causative features of the amorphorus summer pellet. Although unlikely, it is possible some pellets grouped as the intermediate season could have been deposited concurrently with the summer pellets and yet lack the "typical" morphological characteristics due to a low content of willow.

Caribou

To date, no data have been published on the diet of Peary caribou. These caribou inhabit the tundra year-round, and although some seasonal movements occur, the animals frequent similar plant communities and have similar diets between years. There was some variation in the diet of Peary caribou between localities on northeast Prince of Wales and Somerset islands. However, the variation between localities was considerably less than the variation exhibited between seasons.

The diet of Peary caribou has a pronounced seasonal character. From approximately early September to late May, their sustenance consists of non-growing vegetation found primarily under a blanket of snow. Green vegetation is available for only the short period between early June and mid-August. It is during this interval that caribou deposit the fat necessary to ensure survival over the coming winter.

Diet analyses demonstrated that caribou were feeding heavily on willow during the summer; forbs and lichens were used to a much lesser extent. The highest frequency of willows was found in Willow-Sedge Meadows and Open Willow Hummocks habitat types. Pellet-group counts indicated these two habitat types were used heaviest in summer. Hence, it appears caribou are selecting areas with a high frequency of willow because of forage preferences for this species in summer.

From summer to winter, there was a 9 to 24-fold decrease (depending

on locality) in the use of willows. Lichens, forbs, and mosses were the most prominent winter dietary items. Fruticose lichens were found to be most prevalent in Dryas Plateaus and Lichen Upland habitat types. Arctic poppy and saxifrage, the most heavily used forbs, were present to a similar degree in all upland habitat types. Pellet-group counts indicated a two-fold increase in the use of the upland Dryas Plateaus from summer to winter; the use of willow habitat types dropped slightly between summer and winter. Therefore, it seems caribou are selecting upland areas in winter because of the higher frequency of lichens in these locations.

Diet analyses indicated that during the intermediate seasons caribou were foraging mainly on forbs, lichens, and mosses. It is probable the majority of pellets attributed to the intermediate seasons of spring and fall were actually spring pellets. *A priori* reasoning places emphasis on spring because this period of change from winter to summer plant material is of much longer duration than the fall. In spring, as the snow melts and temperatures rise, different species of plants develop new growth at various rates. In the fall, however, frost typically kills all the green vegetation within a few days. Accordingly, the spring diet may be envisioned as a relatively gradual incorporation of green material, while the fall diet may be viewed as a somewhat abrupt shift back to dead or dormant material. The emphasis on spring as the most prominent component of the intermediate season is also supported by the results of the pellet analysis which showed that forbs played a salient role in the diet. Members of the genus *Saxifraga* were the most

frequently consumed forb. The most common and widespread species of this genus is purple saxifrage, a species which blooms by mid-June, long before most of the forbs show any new growth. The Arctic poppy, the second most prominent forb in the intermediate seasons diet, also shows considerable vegetative growth prior to other forbs in the spring. Willows, on the other hand, generally have only flowered by mid-June, their leaves not fully developing until later. Willow played a correspondingly lesser role in the diet of caribou in the intermediate seasons.

Muskoxen

There appeared to be considerable seasonal change in the diet of muskoxen. In summer, willow comprised the major portion of the diet, while the consumption of sedges was slightly less. In winter, mosses were the most important dietary constituent with the use of sedges about equal to summer usage. Willows represented a minor part of the winter diet. In the intermediate seasons, sedges were primarily consumed; willow and mosses were consumed also, but to a lesser degree.

The heavy and consistent use of willows and sedges by muskoxen has been documented by others (Tener, 1954, 1965; Bos, 1967). Other researchers have also recorded the frequent use of grasses (Bruggeman, 1953, 1954; summarized *in* Tener, 1965). Reportedly, forbs are eaten occasionally with mountain sorrel (*Oxyria digyna*) and bladder campion (*Melandrium triflorum*) being two species utilized (Tener, 1965).

Some authors have recorded the consumption of moss by muskoxen (Bos, 1967; Hearne, 1795; Sabine, 1824). The observations of these three authors agree with the results of this study: mosses are most frequently consumed in winter.

The results of pellet-group counts on Prince of Wales Island indicate that muskoxen primarily were using the Willow-Sedge Meadow habitat type in all seasons. This habitat has a high frequency of sedges and willows. While the Sedge Meadows also had a high frequency of sedges, pellet-group counts suggested they were used to a much lesser extent. A higher rate of pellet decomposition in this wetter habitat may have caused an underestimation of the relative use of this type. However, it is apparent muskoxen are selecting lowland habitat types year-round because of the high frequency of occurrence of sedges and willows in these areas.

Animal Behavior

Caribou Activity Patterns

Results

During summer 1975, 254 caribou-hours of observation were made. Activity of adults over the entire period was 49% grazing, 39% lying, 2% standing, 9% walking, and 1% trotting or running.

A composite pattern of daily foraging and resting activity of caribou was compiled using these observations (Figure 35). For approximately 83% of a 24 hr period, there were more caribou foraging than resting. Only from 0100 to 0400 hr did resting activity predominate over foraging. After this period of more frequent resting, foraging activity increased rapidly in the early morning, reached its highest peak from 0600 to 1000 hr and then decreased to where approximately only 50% of the animals were foraging by 1200 hr. Foraging activity then gradually increased again in the afternoon and peaked by about 1800 hr before tapering off slowly during the evening. The second peak was both more gradually reached and longer lasting than the early morning bout of foraging activity. Foraging activity continued to decrease through the evening and night until it became less frequent than resting behavior. However, foraging did not cease. Even from 0100 to 0400 hr approximately 45% of the individuals were foraging.

Upon completion of a foraging period, caribou typically bedded down to rest and ruminate. Rest periods were variable in duration but were generally between 0.5 and 0.75 hr in length. Occasionally during resting bouts, animals would rise, forage slightly, and then bed down again a short distance away from the original bedding site.

Upon completion of a resting period, animals typically resumed foraging. For the most part, foraging involved a leisurely walk during

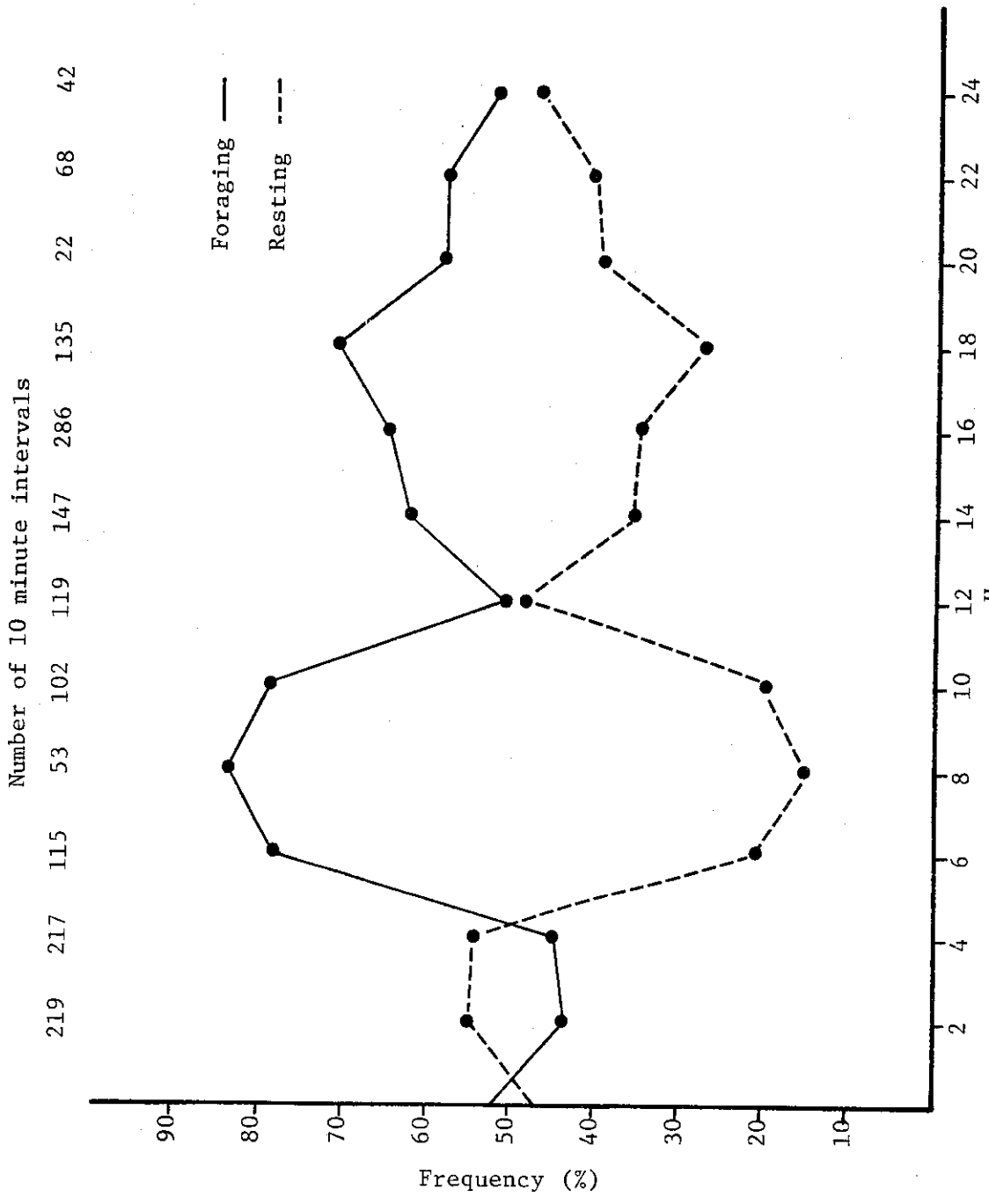


Figure 35. Daily foraging and resting patterns of caribou during summer, adjusted to standard time. Sample sizes are indicated on upper portion of graph.

which time vegetation was consumed. The duration of foraging bouts was longer than resting bouts, generally between 1 and 1.5 hr in length. Upon cessation of foraging, caribou typically bedded down again.

There appeared to be considerable synchronization of activity within groups of caribou. Animals within a group tended to perform certain activities, such as foraging and resting, in unison. A change in activity of the group was generally initiated by one animal, with the others following. Accordingly, if one animal within a group bedded down, the majority of the remaining animals within the group soon did likewise.

Discussion

White *et al.* (1975) found that in summer at Prudhoe Bay, Alaska, adult barren-ground caribou spent an average of 48% of their time eating, 28% lying, 4% standing, 14% walking, and 6% trotting or running. The proportion of time engaged in eating was similar to our figure of 49% for adult Peary caribou. However, the percentage of time spent lying down was considerably lower for caribou at Prudhoe Bay (28%) than on Prince of Wales Island (39%). The proportion of time engaged in walking, trotting, or running was consequently higher for caribou at Prudhoe Bay (20%) than on Prince of Wales Island (10%). White *et al.* (1975) noted considerable insect harassment of caribou at Prudhoe Bay over the summer. We found insect densities on Prince of Wales Island during summer 1975

to be insufficient to cause appreciable harassment of animals. Hence, it is likely that greater insect disturbance of caribou at Prudhoe Bay caused a significant increase in caribou movement.

Peary caribou on Prince of Wales Island demonstrated an average activity cycle of about 2 hr. Approximately one-third of this time was spent bedded down, the remaining two-thirds in foraging activity. Caribou foraged at all times of the day, with peaks in mid-morning and late afternoon.

The occurrence of foraging at all times of the day is not unexpected due to the occurrence of 24 hr of daylight and the need to build up fat reserves over the brief arctic summer. There is general agreement between the foraging activity of Peary caribou and the more southern barren-ground caribou. The latter species forages primarily in the forenoon and evening, interrupted by a mid-afternoon lowering of activity (Banfield, 1951). Barren-ground caribou may be relatively inactive at night, however (Banfield, 1951). Harper (1955) suggests that, during migration, barren-ground caribou are most active from 1000 to 1100 hr and from 1430 to 1700 hr. De Vos's (1960) observations agree with those of Harper's. De Vos observed that when herds discontinued movement, calves would bed down rapidly and within about 45 min all of the adults were generally lying also. Rest periods would persist for approximately 2 hr, thereafter, the herd would become active again and move off within about 15 min.

Ungulate Group Sizes

Caribou

In the analysis of caribou group-size distribution, observations from aerial surveys of eastern Melville, Bathurst, Cornwallis, and Somerset islands were combined because of the low number of groups observed on these islands. Group-size distributions and mean group sizes appeared similar for each island. Observations from Prince of Wales Island, Boothia Peninsula, and the District of Keewatin between Baker Lake and Spence Bay are treated individually.

Results

During March-April surveys, the mean group size for caribou observed on Somerset, Cornwallis, Bathurst, and eastern Melville islands was 4.2 (Table 23). Mean group sizes for Prince of Wales Island and Boothia Peninsula were similar, 3.4 and 4.5, respectively (Tables 24 and 25). However, the mean size of caribou groups observed between Baker Lake and Spence Bay was 7.2 (Table 26). The frequency distribution of group sizes observed between Baker Lake and Spence Bay was significantly different from the distribution at each of the other locations (Table 27). Between Baker Lake and Spence Bay, 54% of the caribou observed were in groups of nine or larger, whereas at the other locations, 56% of the caribou were in groups of five or smaller.

Table 23. Group-size distribution of caribou observed during 1975 aerial surveys of Somerset, Cornwallis, Bathurst and eastern Melville islands.

	1 March - 30 April		1-27 June		28 June - 9 July	
Group Size	Number	% of Total Caribou	Number	% of Total Caribou	Number	% of Total Caribou
1	2	1.7	15	10.4	4	2.5
2	5	8.5	21	29.2	8	10.1
3	7	17.9	3	6.3	3	5.7
4	5	17.1	9	25.0	3	7.6
5	1	4.3	1	3.5	1	3.2
6	2	10.3	2	8.3	3	11.4
7	3	17.9	2	9.7	3	13.3
8	1	6.8				
9	2	15.4				
11			1	7.6		
12					2	15.2
14					1	8.7
16					1	10.1
19					1	12.0
Total Caribou	117		144		158	
Mean Group Size	4.2		2.7		5.3	

Table 24. Group-size distribution of caribou observed during 1975 aerial surveys of Prince of Wales and Russell islands.

Group Size	1 March - 30 April		1-27 June		28 June - 9 July	
	Number	% of Total Caribou	Number	% of Total Caribou	Number	% of Total Caribou
1	8	4.8	111	12.3	14	1.8
2	15	18.0	119	26.3	25	6.6
3	9	16.2	22	7.3	14	5.5
4	5	12.0	28	12.4	7	3.7
5	6	18.0	19	10.5	6	4.0
6	2	7.2	14	9.3	5	4.0
7			7	5.4	4	3.7
8	1	4.8	4	3.5	6	6.3
9	1	5.4	1	1.0	3	3.6
10	1	6.0	1	1.1	5	6.6
11					4	5.8
12			3	4.0	3	4.8
13	1	7.8	1	1.4		
14			1	1.5		
15			1	1.7		
16					2	4.2
17					2	4.5
19					2	5.0
20			1	2.2	1	2.6
26					1	3.4
33					2	8.7
48					1	6.3
66					1	8.7
Total Caribou	167		904		757	
Mean Group Size	3.4		2.7		8.0	

Table 25. Group-size distribution of caribou observed during 1975 aerial surveys of Boothia Peninsula.

Group Size	1 March - 30 April		1-27 June		28 June - 9 July	
	Number	% of Total Caribou	Number	% of Total Caribou	Number	% of Total Caribou
1	3	1.2	26	10.9	18	1.8
2	12	9.9	21	17.6	14	2.8
3	11	13.6	7	8.8	4	1.2
4	7	11.5	9	15.1	16	6.4
5	7	14.4	3	6.3	6	3.0
6	4	9.9	3	7.5	6	3.6
7	4	11.5	1	2.9	3	2.1
8	1	3.3	1	3.3	3	2.4
9	2	7.4	2	7.5	1	0.9
10	1	4.1	1	4.2	5	5.0
11	1	4.5	1	4.6	2	2.2
12			1	5.0	1	1.2
13					2	2.6
14					1	1.4
15			1	6.3	2	3.0
16						
17					1	1.7
18						
19						
20						
21	1	8.6				
22					1	2.2
26					1	2.6
28					1	2.8
40					1	4.0
121					1	12.1
352					1	35.1
Total Caribou	243		239		1002	
Mean Group Size	4.5		3.1		11.0	

Table 26. Group-size distribution of caribou observed during 1975 aerial surveys of Baker Lake - Spence Bay.

Group Size	1 March - 30 April		1-30 May	
	Number	% of Total Caribou	Number	% of Total Caribou
1	4	0.5	5	3.3
2	10	2.4	5	6.6
3	15	5.4	4	7.9
4	14	6.7	2	5.3
5	9	5.4	1	3.3
6	10	7.2	7	27.6
7	11	9.3	1	4.6
8	8	7.7	2	10.5
9	11	11.9	2	11.8
10	5	6.0	1	6.6
11	1	1.3		
12	4	5.8		
13	1	1.6		
14	2	3.4		
15	1	1.8		
16	1	1.9		
17	2	4.1		
18	1	2.2		
19			1	12.5
20	3	7.2		
28	1	3.4		
31	1	3.7		
Total Caribou	830		152	
Mean Group Size	7.2		4.9	

Table 27. Results of Kolmogorov-Smirnov two-sample test for differences in caribou group size distribution between time periods and locations.

Survey Dates	Location[1]	Dmax[2]	Dcrit
1 Mar - 30 Apr	1 vs 4	.305*	.287
	2 vs 4	.418*	.237
	3 vs 4	.289*	.224
28 June - 9 July	1 vs 2	.163	.286
	1 vs 3	.104	.286
	2 vs 3	.099	.202
1 Mar - 30 Apr vs 1-27 June	1	.417*	.317
1 Mar - 30 Apr vs 28 June - 9 July		.166	.357
1-27 June vs 28 June - 9 July		.290	.310
1 Mar - 30 Apr vs 1-27 June	2	.221*	.208
1 Mar - 30 Apr vs 28 June - 9 July		.268*	.234
1-27 June vs 28 June - 9 July		.330*	.151
1 Mar - 30 Apr vs 1-27 June	3	.332*	.241
1 Mar - 30 Apr vs 28 June - 9 July		.164	.234
1-27 June vs 28 June - 9 July		.305*	.211
1 Mar - 30 Apr vs 1-30 May	4	.235	.275

[1] Location 1 = Somerset, Cornwallis, Bathurst, and eastern Melville islands

Location 2 = Prince of Wales and Russell islands

Location 3 = Boothia Peninsula

Location 4 = Baker Lake to Spence Bay

[2] * Denotes a significant difference at the .05 level

During the period between 1 and 30 May, observations of caribou were made between Baker Lake and Spence Bay only. The mean group size was 4.9, 32% lower than in March-April.

Between 1 and 27 June, the mean group size on Somerset, Cornwallis, Bathurst, and eastern Melville islands was 2.7. Group sizes on Prince of Wales Island and Boothia Peninsula during this period were similar, 2.7 and 3.1, respectively. Hence, mean group sizes decreased by an average of 29% between March-April and 1 to 27 June. The frequency distributions of group sizes at all locations were significantly different from the distributions during March-April.

The mean group size of caribou observed on Somerset, Cornwallis, Bathurst, and eastern Melville islands between 28 June and 9 July was 5.3. During this same period, the mean group size was 8.0 on Prince of Wales Island and 11.0 on Boothia Peninsula. The frequency distributions of group sizes between these locations were not significantly different; the major discrepancy between mean herd sizes was a result of a few large herds which were sighted on Prince of Wales Island and Boothia Peninsula. However, between 28 June and 9 July, mean herd sizes were consistently larger (by an average of 180%) than between 1 and 27 June. The frequency distributions of group sizes for these two periods was significantly different on Prince of Wales Island and Boothia Peninsula. Indeed, 47% of all caribou observed on Prince of Wales, Somerset, Cornwallis, Bathurst, and eastern Melville islands were in groups of 12 or

more animals. On Boothia Peninsula, 51% of the animals were in groups of 40 or more.

Discussion

Mean group sizes of caribou observed on the arctic islands during 1975 were generally similar to those observed in previous years by other researchers. Miller *et al.* (1973) found a mean group size of 2.2 for caribou on Melville Island during March and April 1972, and a mean group size of 9.1 in August. On Bathurst Island, Tener (1963) observed a mean group size of 3.6 in June and July 1961; Miller and Russell (1975) found mean group sizes of 2.9 and 1.9 during March and April 1973 and 1974, and 5.3 in August 1974.

During aerial surveys of the Queen Elizabeth Islands in 1961, Tener (1963) noted that groups of Peary caribou generally consisted of fewer individuals than the more southern barren-ground caribou. We also noted this difference between barren-ground caribou in the District of Keewatin and Peary caribou on the arctic islands during March and April. Mean group size of barren-ground caribou observed was almost twice as large as the mean group size for Peary caribou. Tener (1963) suggested this is probably a response to the more limited availability of forage in the High Arctic.

We also observed considerable variation in mean group sizes of caribou between seasons. Between Baker Lake and Spence Bay, the mean

group size declined from 7.2 in March and April to 4.9 in May. The reduction in mean group size is probably a response to the pattern of snow cover. At the time of the survey, much of the ground surface was still snow covered; however, it was mottled with numerous patches of bare ground on exposed hilltops. Caribou were consistently observed on these small patches of bare ground.

Between March-April and 1 to 27 June, there was also a reduction in the mean group size of caribou on the arctic islands and Boothia Peninsula; this reduction was consistent between locations, and is most likely a result of the increased dispersion of animals (primarily adult females) during the calving period. Kelsall (1968) noted a similar reduction in band size of barren-ground caribou during calving.

Mean group sizes of caribou observed between 28 June and 9 July on the arctic islands and Boothia Peninsula were consistently higher at all locations than during either March-April or 1 to 27 June. Miller *et al.* (1973) noted a similar trend on Melville Island in 1972 and suggested the quantity of forage is not as restrictive in summer; hence, caribou are able to congregate in larger groups. The results of our habitat studies on Prince of Wales Island indicate there is indeed a shift in habitat use between winter and summer. Greater use is made of extensive upland areas in winter, while lowland willow areas are used more intensively in summer. As these lowland areas are limited in areal extent, caribou may be responding to a geographically limited resource by congregating in the better vegetated areas during summer.

Muskoxen

During 1975 aerial surveys, muskoxen were observed on eastern Melville, Bathurst, Cornwallis, and Prince of Wales islands. Because of the low number of groups observed on individual islands, all islands were combined in analysis of group sizes.

Results

During March and April surveys, a total of 385 muskoxen were observed in group sizes ranging from 1 to 45 (Table 28). The mean group size was 10.1; however, 49% of the total muskoxen seen were in groups of 13 or larger. Two groups of 45 muskoxen (23.4%) were observed; only one solitary animal (0.3%) was seen.

During surveys in June and July, group sizes ranged from 1 to 40; a total of 294 muskoxen were observed. The mean group size was 6.5; however, over 51% of the total muskoxen seen were in groups of 14 or larger. Seven solitary animals (2.4%) were observed; the largest group size was 40 (13.6%)

Discussion

Between late winter (March-April) and early summer (June-July) the mean group size of muskoxen decreased from 10.1 to 6.5. The frequency distributions of group sizes for these two periods were significantly

Table 28. Group-size distribution of muskoxen observed during 1975 aerial surveys of eastern Melville, Bathurst, Cornwallis and Prince of Wales islands.

Group Size	March - April		June - July	
	Number	% of Total Muskoxen	Number	% of Total Muskoxen
1	1	0.3	7	2.4
2	4	2.1	13	8.8
3	2	1.6	5	5.1
4	1	1.0	1	1.4
5	3	3.9	1	1.7
6	8	12.5	3	6.1
7	1	1.8		
8	2	4.2	1	2.7
9	1	2.3	3	9.2
10			1	3.4
11	3	8.6	1	3.7
12	4	12.5	1	4.1
13	1	3.4		
14	2	7.3	1	4.8
15	1	3.9	3	15.3
16			2	10.9
19	1	4.9		
20			1	6.8
25	1	6.5		
40			1	13.6
45	2	23.4		
Total Muskoxen	385		294	
Mean Group Size	10.1		6.5	

different ($P<.05$; Dmax = .311, Dcrit = .310); 16% of the total muskoxen observed were in groups of three or less in early summer; only 4% in late winter.

Miller *et al.* (1973) noted a drop from 13.6 to 7.8 in the mean group size of muskoxen on Melville Island in 1972 between March-April and August. They also noted a significant increase in the number of lone bulls between late winter and summer. In addition, similar findings were reported from Bathurst Island by Gray (1973) and Miller and Russell (1975).

Tener (1965) suggests larger herd sizes and fewer solitary animals in winter may be a behavioral adaption resulting in better survival, particularly as it relates to predation by wolves. Defence against these large carnivores is more effective in a large group.

The results of our pellet-group counts on Prince of Wales Island indicate muskoxen are extremely restrictive in habitat use during all seasons of the year. However, it appears that habitat use is slightly more diversified in summer than in winter. Hence, smaller group sizes in summer may be a result of increased dispersion of animals in response to a slight increase in diversification of habitat use.

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APPENDICES

Appendix A. Frequency of occurrence (%) of t

Species	1H14	1H2	B11	3B23	3C13	3C14	3C22
Salix arctica	11.0	8	1.2	3.1			0.7
Dryas integrifolia	15.5	1	6.7	0.4			
Total Shrubs	26.5	9.4		3.5			0.7
Oxyria digyna		0	0.1	0.1	0.3		+[1]
Polygonum viviparum		0					
Stellaria longipes		0		0.1			
Cerastium arcticum		+		+			+
Cerastium Regelii							
Caryophyllaceae spp.		+			0.4		0.2
Ranunculus sulphureus							
Papaver radicatum		0		0.2	0.3		0.2
Cochlearia officinalis						0.5	
Draba Bellii		+	+	0.3	0.3		0.3
Draba lactea				0.2			
Parrya arctica		+		0.1	0.3		0.1
Cruciferae spp.		+		0.2			0.2
Saxifraga caespitosa				+	0.1		+
Saxifraga cernua		+			+		+
Saxifraga flagellaris				+		0.5	
Saxifraga Hirculus		+					0.2
Saxifraga nivalis							0.2
Saxifraga oppositifolia	2.0	0	1.7	2.3	1.6		1.5
Pedicularis arctica							
Unidentified forb					0.1		0.1
Total Forbs	2.0	1.5		3.5	3.4	1.0	3.0
Alopecurus alpinus		0		+	+		
Phippsia algida				+			
Arctagrostis latifolia		4					
Pleuropogon Sabinei			0.2	0.1		0.5	+
Colpodium Vahianum							
Festuca brachyphylla	0.5	0	+	0.1	0.2		1.0
Gramineae spp.		0					
Total Grasses	0.5	5.3		0.2	0.2	0.5	1.0
Eriophorum spp.		1	+	+			+
Carex stans		5	0.1	0.1	+		0.4
Carex misandra		1	+				
Carex spp.	3.0						
Total Sedges	3.0	10.8		0.1			0.4
Cetraria cucullata		(	0.1	+	0.6		+
Cetraria delisei	0.5	(	0.1		1.5		0.1
Cetraria telesii		(	+	+	+		+
Thamnolia vermicularis	2.5	1	1.7	1.0	0.3		0.4
Crustose lichen	11.5		4.6	3.9	2.7	3.5	2.3
Total Lichen	14.5	7.2		4.9	5.1	3.5	2.8
Patina	21.0	17.8		13.3	11.6	13.5	8.6
Moss	13.5	28.9		4.1	3.1	7.5	1.6
Algae		0.7		+			
Litter	13.5	13.4		1.2	1.1		0.7
Bare Ground and/or Rock	5.5	4.4		68.8	75.0	74.0	81.9

[1] + = present

Appendix B. List of plant species collected on Prince of Wales and other arctic islands (in parentheses)

Grasses

Alopecurus alpinus
Phippsia algida
Arctagrostis latifolia
Trisetum spicatum
Poa alpigena
Poa arctica spp. *caespitans*
Pleuropogon Sabinei
Colpodium Vahlianum
Dupontia Fisheri
Puccinellia Bruggemanni (Cornwallis)
Festuca brachyphylla

Sedges

Eriophorum angustifolium
Eriophorum triste
Eriophorum vaginatum
Carex stans
Carex misandra
Luzula nivalis
Luzula confusa

Dicots

Salix arctica
Oxyria digyna
Polygonum viviparum
Stelleria longipes
Cerastium arcticum
Cerastium Regelii
Arenaria Rossii (Cornwallis)
Melandrium apetalum ssp. *arcticum*
Ranunculus sulphureus
Papaver radicatum
Cochlearia officinalis
Cardamine pratensis var. *angustifolia* (Somerset)
Draba Bellii
Draba lactea
Braya purpurascens
Parrya arctica
Parrya nudicaulis
Saxifraga caespitosa
Saxifraga cernua
Saxifraga flagellaris ssp. *platysepala*
Saxifraga foliolosa (Somerset)
Saxifraga Hirculus var. *propinqua*
Saxifraga nivalis
Saxifraga oppositifolia
Saxifraga tricuspidata
Chrysosplenium tetrandrum (Somerset)
Potentilla rubricaulis
Dryas integrifolia
Cassiope tetragona
Pedicularis arctica
Chrysanthemum integrifolium (Somerset)
Taraxacum lacerum

Pteridophytes

Equisetum variegatum

Lichens

Alectoria ochroleuca
Cetraria cucullata
Cetraria delisei
Cetraria icelandica
Cetraria telesii
Lecanora epibryon
Lecidea ramulosa
Pertusaria corniaceae
Thamnolia vermicularis

Mosses

Aulocomnum turgidum
Drepanocladus sp.
Rhacometrium sp.
Tomenthypnum nitens

Appendix C. Numbers of caribou and muskoxen pellet groups counted on pellet transects on Somerset, Cornwallis and Bathurst islands.

Habitat Type	Transect Segments	Caribou		Muskoxen	
		Summer	Winter	Summer	Winter
Dryas-Purple Saxifrage Barrens	103	1	8	3	1
Dryas Plateaus	7		36		1
Lichen Uplands	17		2	1	
Seepage Slopes	3			1	
Raised Grasslands	1		1		
Sparse Willow Slopes	1				
Open Willow Hummocks	0				
Willow-Sedge Meadows	5		21		
Sedge Meadows	2			1	
Total	139	1	68	6	2