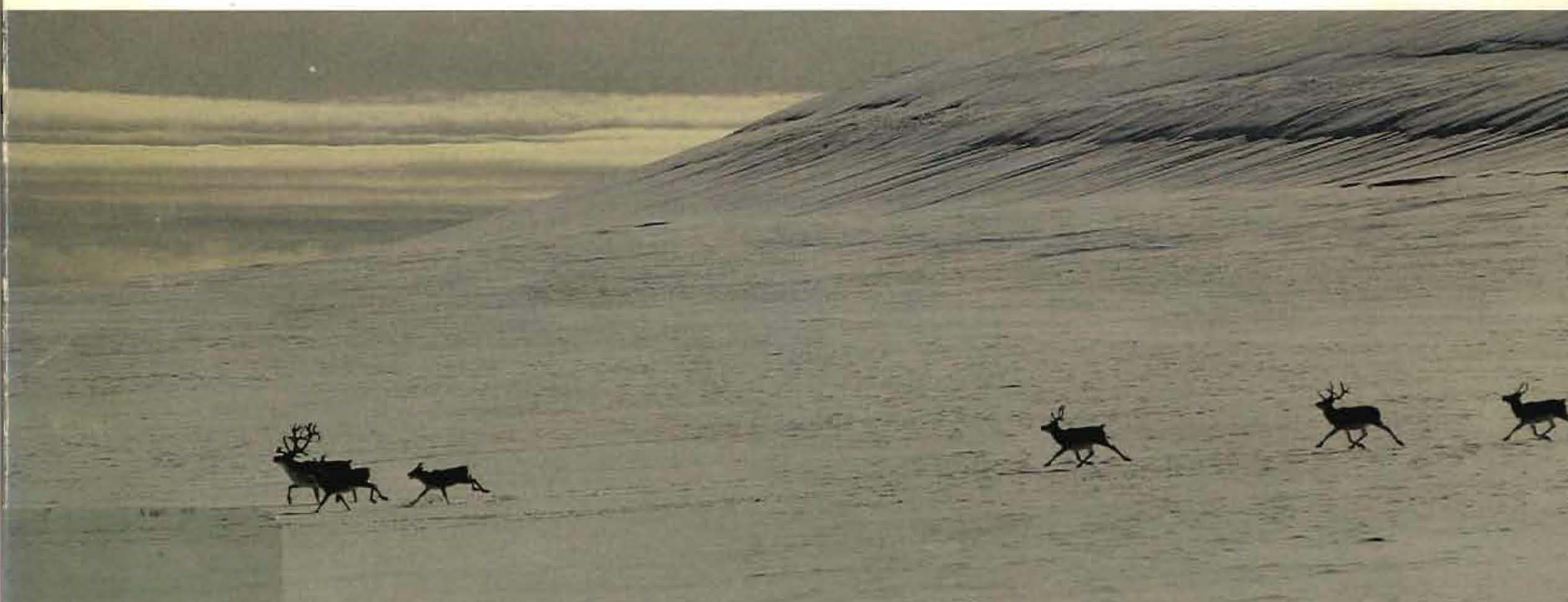
by Frank L. Mille
Richard H. Russe
and Anne Gunn

Peary caribou and muskoxen on western Queen Elizabeth Islands, NWT 1972-74



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Distributions, movements and numbers of Peary caribou and muskoxen on western Queen Elizabeth Islands, Northwest Territories, 1972–74

by Frank L. Miller, Richard H. Russell and Anne Gunn

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Top: Muskoxen crossing polar desert.
Photo by F. L. Miller

Bottom: Caribou herd. Photo by H. Kiliaan

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Perspective

The western Queen Elizabeth Islands were discovered in 1819 by W. E. Parry, but were only occasionally visited by explorers before the mid 20th century. The lack of exploration on the islands explains the paucity of early information about Peary caribou and muskoxen. Exploratory accounts of the late 19th and early 20th centuries have frequent but brief references to both species. Most of the references are in the context of "deer" or "reindeer' and muskox meat as being a sought-after supply of fresh meat. The first systematic survey of caribou and muskoxen on the Queen Elizabeth Islands was in the summer of 1961 (Tener 1961, 1963). The survey was needed to gain baseline information on the wildlife resources because numbers of wildlife in southern regions, which supported a traditional way of life for Inuit, were decreasing. A second reason for the survey was the increasing human activities in the High Arctic and their potential for damaging the environment (Tener 1963). This consideration is significant in view of the probable construction of a natural gas pipeline on Queen Elizabeth Islands.

As a result of requests by the Northwest Territories Game Management Service, late winter and summer surveys were flown over western Queen Elizabeth Islands in 1972, 1973 and 1974. Standard "transect census" strip surveys were used to estimate numbers of Peary caribou and muskoxen. In March 1974 caribou on Prince Patrick and Eglinton islands were dye-marked by use of an aerial spray technique.

The estimated number of Peary caribou on the western Queen Elizabeth Islands declined markedly from 1961 to 1973, while the number of muskoxen rose significantly. In 1974 as a result of the severe winter of 1973–74, however, both Peary caribou and muskox numbers declined drastically from their 1973 levels. Later observations of marked animals on Prince Patrick, Eglinton, Melville confirmed inter-island movement of Peary caribou.

Abstract

We flew three late winter and three summer standard "transect census," 1.6 km wide strip surveys for Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) on the western Queen Elizabeth Islands 1972–74. Technical and weather delays prevented uniform coverage of the survey area. The results are comparable with a previous survey in 1961 for Peary caribou but not for muskoxen. Since 1961 Peary caribou have decreased between 87% and 100% on all islands surveyed in 1972–74. There appears to have been an increase in numbers of muskoxen between 1961 and 1973 with recolonization of Prince Patrick Island. In winter 1973–74 there was high mortality of muskoxen with an overall loss of 35%. Eastern Melville Island, especially the Dundas Peninsula, is the heartland for caribou, some of which move to Prince Patrick to winter. We used aerial dye-spraying to mark the animals and noted their subsequent locations to document the inter-island movements. Southwestern Melville Island, especially Bailey Point area, is the heartland for muskoxen. In summer 1974 more than 25% of all Peary caribou and muskoxen estimated were on the Dundas Peninsula and Bailey Point, which are 6% and 1% of the landmass of the western Queen Elizabeth Islands respectively.

On large islands caribou moved to high, dry sites on coastal areas in early spring and late summer; in the interior they preferred drier sites intermediate in elevation. All year muskoxen preferred well-vegetated sedge (*Carex* spp.) meadows and willow (*Salix* spp.) slopes on coastal sites at low elevations. Summer movements to the interior were usually restricted to shores of watercourses and adjacent drainage slopes. Caribou group sizes were influenced by forage availability: relatively large aggregations form in summer with favourable forage conditions but break up into small groups and singles in winter. For muskoxen under average conditions the pattern of group sizes is opposite of that observed for caribou, but under severe nutritional stress the large winter groups split up. Most single muskoxen occur during the summer.

The marked decreases in numbers are attributed to a combination of high winter mortality in some years and an overall low rate of births and recruitments between 1961 and 1974 for caribou, and at least 1972–74 for muskoxen. We believe a series of years with unfavourable snow and ice conditions made forage unavailable and restricted, and thus caused the decreases in numbers of both species. Currently numbers of both Peary caribou and muskoxen are dangerously low on the western Queen Elizabeth Islands — their conservation and preservation must be considered.

Résumé

Trois années d'affilée, nous avons effectué, à la fin de l'hiver et en été, par échantillonnage en bandes intersectées de 1.6 km chacune, un inventaire démographique du caribou de Peary (*Rangifer tarandus pearyi*) et du boeuf musqué (*Ovibos moschatus*) dans l'ouest de l'archipel Reine-Elisabeth. Les populations de caribous de Peary et de boeufs musqués étaient l'objet de nos études. Conditions météorologiques défavorables et difficultés techniques nous ont empêchés de traiter dans son entier la zone du relevé. Les résultats obtenus se comparent à ceux d'une étude antérieure (1961) dans le cas du caribou de Peary, mais non dans celui du boeuf musqué. Depuis 1961, la population du caribou a diminué de 87 à 100% sur toutes les îles étudiées, 1972–1974. Par contre, l'effectif du boeuf musqué a augmenté entre 1961 et 1973, période marquée par le repeuplement de l'île du Prince-Patrice. La mortalité du boeuf musqué a été élevée l'hiver 1973–1974, donnant lieu à une chute démographique de 35%. L'est de l'île Melville, plus précisément la péninsule Dundas, est l'aire de prédilection des caribous dont un bon nombre vont hiverner sur l'île du Prince-Patrice. Nous avons marqué des animaux à l'aide d'une teinture pulvérisée du haut des airs et relevé ensuite leur position pour en documenter les déplacements d'une île à l'autre. Dans le cas du boeuf musqué, c'est le sud-ouest de l'île Melville, plus précisément la région de la Pointe Bailey, qui est son aire de prédilection. Il ressort de l'extrapolation faite à partir du sondage de l'été 1974 que plus du quart des caribous de Peary et des boeufs musqués se retrouvaient à la péninsule Dundas et à la Pointe Bailey, qui constituent respectivement six et un pour cent de la surface du territoire émergé des îles de l'ouest de l'archipel Reine-Elisabeth.

Sur les grandes îles, les caribous se mettaient, au début du printemps et à la fin de l'été, en quête de hauteurs à sec dans les régions côtières; à l'intérieur, ils cherchaient les sites plus secs quoique moins élevés. Par contre, les boeufs musqués manifestaient, l'année durant, une préférence pour les prés où abondait la laîche (*Carex*), et pour les pentes peu élevées des régions côtières, recouvertes d'arbrisseaux, tels le saule (*Salix*).

Les déplacements estivaux vers l'intérieur se limitaient habituellement aux rives des cours d'eau et aux pentes alluviales adjacentes. La taille des troupeaux de caribous était fonction de la quantité de fourrage disponible; l'été, lorsque le fourrage est abondant, les animaux se réunissent en groupes assez nombreux qui l'hiver se morcellent en petits groupes épars, laissant certains caribous seuls. En temps normal la taille des troupeaux de boeufs musqués suit le modèle inverse de celui des caribous; cependant en temps de famine, les grands troupeaux d'hiver se divisent. C'est surtout l'été qu'on rencontre des boeufs musqués solitaires.

Le taux élevé de mortalité enregistré certains hivers, joint à la faiblesse de la natalité et des autres apports démographiques entre 1961 et 1974 pour ce qui est du caribou, et entre 1972 et 1974 pour le boeuf musqué, expliquent la baisse marquée de la population des deux espèces. C'est à notre avis le fait de mauvaises conditions d'enneigement et de glaciation qui plusieurs années de suite ont rendu le fourrage rare et difficile d'accès. L'effectif actuel du caribou de Peary et du boeuf musqué est à un point critique dans l'ouest des îles Reine-Elisabeth; c'est pourquoi leur préservation commande une attention immédiate.

Резюме

За три последних зимы и лета (1972-74 г.г.) в западной части островов королевы Елизаветы на полосе шириной в 1,6 км мы провели подсчет с воздуха поголовья карибу Пири (Rangifer tarandus pearyi) и мускусных быков (Ovibos moschatus). Технические проблемы и неблагоприятные погодные условия препятствовали проведению равномерного наблюдения за всей территорией. Полученные результаты можно сравнить с данными предыдущего подсчета, проводившегося в 1961 году. Однако следует заметить, что вышеуказанные результаты подсчета можно сравнивать лишь с данными о карибу Пири, но не с данными о мускусных быках. С 1961 года число поголовья карибу Пири колеблется в пределах 87-100% на всех островах, обследованных в 1972-74 г.г. Что же касается мускусных быков, то оказалось, что за период 1961-1973 г.г. их поголовье увеличилось в результате реколонизации острова принца Патрика. Зимой 1973-74 г.г. у мускусных быков наблюдался большой процент смертности с общей потерей в 35%. Восточная часть острова Мельвиль, в особенности полуостров Дундас, является местом скопления карибу, некоторые из которых зимой перебираются на остров принца Патрика. С целью метки животных для последующего документирования их межостровных передвижений и определения их дальнейшего местопребывания мы использовали опрыскивание краской с самолета. Местом скопления мускусных быков является юго-западная часть острова Мельвиль, в особенности мыс Бейли. Летом 1974 года более 25% всего подсчитанного поголовья карибу Пири и мускусных быков находились в районах полуострова Дундас и мыса Бейли. Эти два района составляют соответственно 6% и 1% площади западной части островов королевы Елизаветы.

На больших островах ранней весной и поздним летом карибу перебирались на высокие сухие места прибрежных районов; во внутренних же районах они оказывали предпочтение более сухим местам, расположенным на средней высоте. Мускусные же быки на протяжении всего года оказывали предпочтение лугам, густо поросшим осокой (Carex spp.), а также прибрежным невысоким склонам, поросшим ивой (Salix spp.). Летние передвижения во внутренние районы обычно ограничивались берегами рек и ручьев, а также находившимися по соседству с ними склонами. Размеры групп карибу зависят от наличия кормовых растений: относительно большие группы формируются летом при благоприятных кормовых условиях; зимой же они разбиваются на мелкие группы и одиночек. Что касается мускусных быков, то при средних условиях размеры групп противоположны наблюдающимся у карибу; однако при сильной нехватке кормов большие зимние группы распадаются. Мускусные быки-одиночки встречаются большей частью летом.

Заметное сокращение поголовья вызывается сочетанием высокой смертности в зимнее время, наблюдающейся в определенные годы, и общим низким уровнем рождаемости и физического состояния, наблюдавшихся в период 1961-1974 г.г. у карибу, и, по крайней мере, в 1972-74 г.г. — у мускусных быков. Мы полагаем, что в течение целого ряда лет неблагоприятные снеговые и ледовые условия способствовали исчезновению или же заметному сокращению количества кормовых растений и, таким образом, вызвали сокращение поголовья обоих видов. В настоящее время в западных районах островов королевы Елизаветы число поголовья как карибу Пири, так и мускусных быков, катастрофически низко; вследствие чего следует принять все необходимые меры для консервации и сохранения поголовья обоих видов.

Introduction

Top: The classic muskox defense circle. Note the characteristic positioning of the herd bull, slightly removed from the group — at the left of the photo. Photo by R. H. Russell

Bottom: Bull Peary caribou foraging in summer. Photo by A. Gunn

Until the 1960s Peary caribou and muskoxen on the western Queen Elizabeth Islands had remained in relative isolation from the impact of human activities. In other parts of their ranges, native and white hunters have exploited the populations and in some areas substantially reduced numbers, especially of muskoxen.

Prior to the 20th century there was only sporadic human activity on the western Queen Elizabeth Islands. The islands have never been permanently settled by Inuit, so there was nothing to attract traders or missionaries. Not until the wave of exploration to find the Northwest Passage were the western Queen Elizabeth Islands described by Europeans. W. E. Parry was the first explorer to visit them and he named Melville, Byam Martin and Bathurst (Parry 1821). Forty years later the western Queen Elizabeth Islands were further explored by parties searching for Franklin's expedition. Belcher (1855), M'Dougall (1857) and M'Clintock (1861) all described Melville and adjacent islands during the courses of their sea and sledge journeys.

In the early 20th century two expeditions travelled to the western islands, Bernier (1910) in 1908–1909 and Stefansson (1921) in 1915–1917. The western Queen Elizabeth Islands were described and surveyed by geologists in the 1950s. Tener (1958) reviewed the limited information on muskoxen on the Arctic Islands. Macpherson (1961) compiled the sightings of mammals by the geologists, and that compilation represented the first effort to estimate the numbers of Peary caribou and muskoxen on the western Queen Elizabeth Islands.

Melville Island was the focus of activities for several expeditions including three that overwintered on the south coast. There was considerable hunting not only to supplement rations but for the supposedly anti-scorbutic properties of fresh meat. The first expedition to reach Melville was that of Parry in September 1819. Parry's sightings of two "deer" near Griffiths Point and eight muskoxen near Cape Hearne are the first recorded sightings of Peary caribou and muskoxen on the western Queen Elizabeth Islands (Parry 1821:67, 78). The expedition overwintered at Winter Harbour where "deer" and muskoxen were numerous until the middle of October. The disappearance of the game at that time led Parry (1821:110) to assume that they had migrated south to the mainland. Parry's hunters apparently procured only four muskoxen and 11 "deer" during the year they were on Melville (Parry 1821). In 1851 M'Clintock sledged from Austin's party, wintering between Cornwallis and Griffiths islands, as far west as Cape James Ross on Melville before returning via Winter Harbour. The next expedition had a greater impact on the wildlife of Melville. Capt. Kellett with two ships spent the winter of 1852–53 at Dealey Island. Capt. Kellett (*in* Belcher 1855:138) noted, "This country, it may be said, teems with animal life from the middle of May to the middle of October: ...the animals soon become shy and scarce." On May 18, 1853 Hamilton (*in* Belcher 1855:199) found no muskoxen at Dealey Island and said "Not withstanding my local knowledge of the hunting ground of Melville Island...I should have had great difficulty in supporting my small party of one man and five dogs on the much-talked-of 'resources of the country'." However, "the resources of the country" did provide 114 muskoxen and 94 caribou for fresh meat at Dealey Island 1852–53 (Belcher 1855). M'Dougall (1857:147) noted that of sledging parties sent out to Liddon Gulf (where Parry, 1821:201, had commented on as a feeding place for "deer", muskoxen and hares), Hecla and Griper Bay, Cape Providence and Cape Beechey, "They each and all saw numerous herds of deer and muskoxen...Melville Island, which we most certainly have found to abound in animal life." M'Dougall (1857: 277) further reitcrates the abundance of game on Melville in preference to the lands of Cornwallis, Bathurst and North Devon, but he cautions that game would only sustain life for a limited time.

About 50 years elapsed before another expedition reached and overwintered on Melville. Bernier and his crew stayed August 1908 to August 1909 at Winter Harbour (Bernier 1910). Bernier (1910:44) described the ruminating animals as being unaccustomed to man and easily approached. The crew killed 55 muskoxen and 75 "deer" at Winter Harbour, ample evidence for Bernier's statement that Winter Harbour "Affords great opportunities for laying in supplies of fresh meat" (Bernier 1910:143).

Between 1915 and 1917 Stefansson and his party travelled and hunted over Melville. Stefansson (1921:344) comments that the great number of muskoxen on Melville is not due to its fertility but that it has not been hunted by Eskimos. Caribou are not numerous as the land is "exceptionally infertile". It seems from his accounts that Stefansson's parties killed at least 70 caribou from 1915 to 1917. Storkerson, a member of Stefansson's party, estimated that in 1917 there were 4000 muskoxen, and about 400 had been killed for meat (*in* Macpherson 1961:15). Macpherson (1961: 15) points out that from the estimates of 566 from Thorsteinsson and Tozer in 1958, there appeared to have been a marked decline in the numbers of muskoxen between 1917 and 1958. In 1958 from the geologists' observations (*in* Macpherson 1961:8) 3024 caribou were estimated for Melville.

Bathurst Island was first described by Parry (1821) although he did not land there. In October 1850 M'Clintock, leading a sledging party from ships wintering in the ice between Cornwallis and Griffiths islands, was apparently the first European on Bathurst (Taylor 1955). He left depots for future sledging parties on the south and west coasts but did not explore further. The north coast of Bathurst and adjacent islands were explored by sledging parties from Belcher's expedition in April 1853 (Taylor 1955). One of the first mentions of game on the island was in May 1854 when a sledging party saw "deer" footprints on shore near Allison Inlet (M'Dougall 1857: 387). Bernier (1910:251) noted numbers of "deer" horns seen along the shore near Key Point, August 1909.

In 1953 Inuit were moved to Resolute Bay, Cornwallis Island and began hunting on Bathurst. Records of caribou killed were kept from 1958 by the RCMP (Bissett 1968), and are the only records of caribou on the western Queen Elizabeth Islands that have been harvested. In summer 1959 McNair (*in* Macpherson 1961:13, 16) estimated 300 caribou and 300 muskoxen on Bathurst. The previous year on 24 June 1958, Thorsteinsson saw 149 muskoxen during a flight through the valley formed by Bracebridge–Goodsir inlets (*in* Macpherson 1961:16). In that broad valley the National Museum of Natural Sciences has a High Arctic field station and has studied muskoxen behaviour since 1968 (Gray 1973).

On 4 April 1853, Mecham left Kellett's party overwintering at Dealey Island off eastern Melville Island, sledged west and discovered Eglinton and Prince Patrick islands (Taylor 1955). M'Clintock also sledging from Dealey Island reached Prince Patrick on 14 May 1853 (Taylor 1955). On Prince Patrick, Mecham killed three "reindeer" between 7 May and 6 June 1853 (*in* M'Dougall 1857:298). Stefansson, who travelled along the west coast of Prince Patrick in June 1915, noted that he agreed with Mecham's opinion of absence of game (Stefansson 1921:301). Stefansson (1921: 322) quotes M'Clintock as securing five caribou and three muskoxen in 1853 in May–June on the east and north coasts of Prince Patrick.

In 1949 MacDonald (1954) noted that caribou were quite common around Mould Bay where he saw 171, but numbers had appeared to drop in 1952 when he was able to count only 68 caribou in the Mould Bay area (MacDonald 1954:220). He regularly observed muskoxen feeding on meadows and vegetated slopes of Mould Bay Peninsula in March through September 1952. Between 2 and 56 muskoxen were seen in each day's travel. In 1949 Dyer had counted 149 muskoxen while surveying southeast Prince Patrick for a weather station site (*in* Macpherson 1961:15). In summer 1954 neither Macpherson nor Tozer was able to find live muskoxen but carcasses were common, and one small group of carcasses was seen on the sea-ice near Eglinton Island. Harington (1961:252) suggested that deep crusted snow conditions of winter 1953–54 led to the die-off. The recovery of the muskoxen was slow: in 1958 only three were seen during an extensive geological survey by helicopter (Tener 1965:16–17). From the observations made by geologists in 1958 Macpherson (1961:15) estimated 34 muskoxen for the eastern uplands and 1342 caribou for the same area (Macpherson 1961:8).

Few exploratory parties travelled west of Melville Island in the late 19th and early 20th centuries. Mecham (*in* M'Dougall 1857) was the first European to describe Eglinton Island, but he made no mention of game there during May–June 1853.

The first European to visit Byam Martin was Parry (1821) who landed a boat at Cape Gillman on 27 August 1819. Captain Sabine described remains of deserted Inuit habitations and noted recent traces of "reindeer" and muskoxen in many places (Parry 1821:61). The island was visited by one of M'Dougall's parties in June 1853, two muskoxen were shot and deer were observed (M'Dougall 1857:266). Bernier (1910:217) also noted traces of "deer" and muskoxen on Byam Martin in 1909. McMillan (*in* Bernier 1910:387) described muskoxen feeding on the shores of the island, including a herd of at least eight. Munn (*in* Hone 1934:17) testified that muskoxen were plentiful on Byam Martin Island.

The first aerial survey specifically designed to estimate the numbers of large mammals was in summer 1961 (Tener 1961, 1963). No other intensive or extensive surveys of ungulates were carried out on the western Queen Elizabeth Islands until March 1972.

In 1972 the Northwest Territories Game Management Service (NWT GMS)[1] evaluated the potential effect of the plan to allow Inuit hunters to harvest Peary caribou on Melville Island. The resulting survey in March–April 1972 showed that harvesting would be impractical as there were few caribou and in scattered groups. As the NWT GMS required information on the ecology of Peary caribou and muskoxen to guide management and harvest of both species on Banks Island, they requested CWS to continue the study. Increasing exploratory activity on the western Queen Elizabeth Islands is also a potential threat to wildlife and their habitats. The probable construction of a natural gas pipeline on Melville and adjacent islands gives added significance to the need for information on the ecology of Peary caribou and muskoxen. Concern over the effect of industrial exploratory activities on the western Queen Elizabeth Islands has already been expressed by Inuit from Resolute Bay, Cornwallis Island. They have blamed seismic activities for the decline in number of Peary caribou which they traditionally hunt on Bathurst Island (Freeman 1974).

Baseline data for Peary caribou and muskox populations are essential to evaluate complaints such as this one and to provide guidelines for harvesting by native peoples and industrial constraints. This paper is a report of our observations made during six aerial surveys from March 1972 to August 1974.

[1]Now known as the NWT Fish and Wildlife Service.

Survey area

1. Islands

The Queen Elizabeth Islands surveyed lie between latitudes 74° and 78° North and longitudes 95° and 124° West (Fig. 1). We stratified the three largest islands for survey purposes; there are 13 survey strata on Melville and three each on Bathurst and on Prince Patrick. Total landmass of the islands surveyed is over 91 000 km². The survey area, except western Melville, is low-lying and mainly below 150 m elevation.

1.1. Melville Island (75°40′N, 111°30′W)

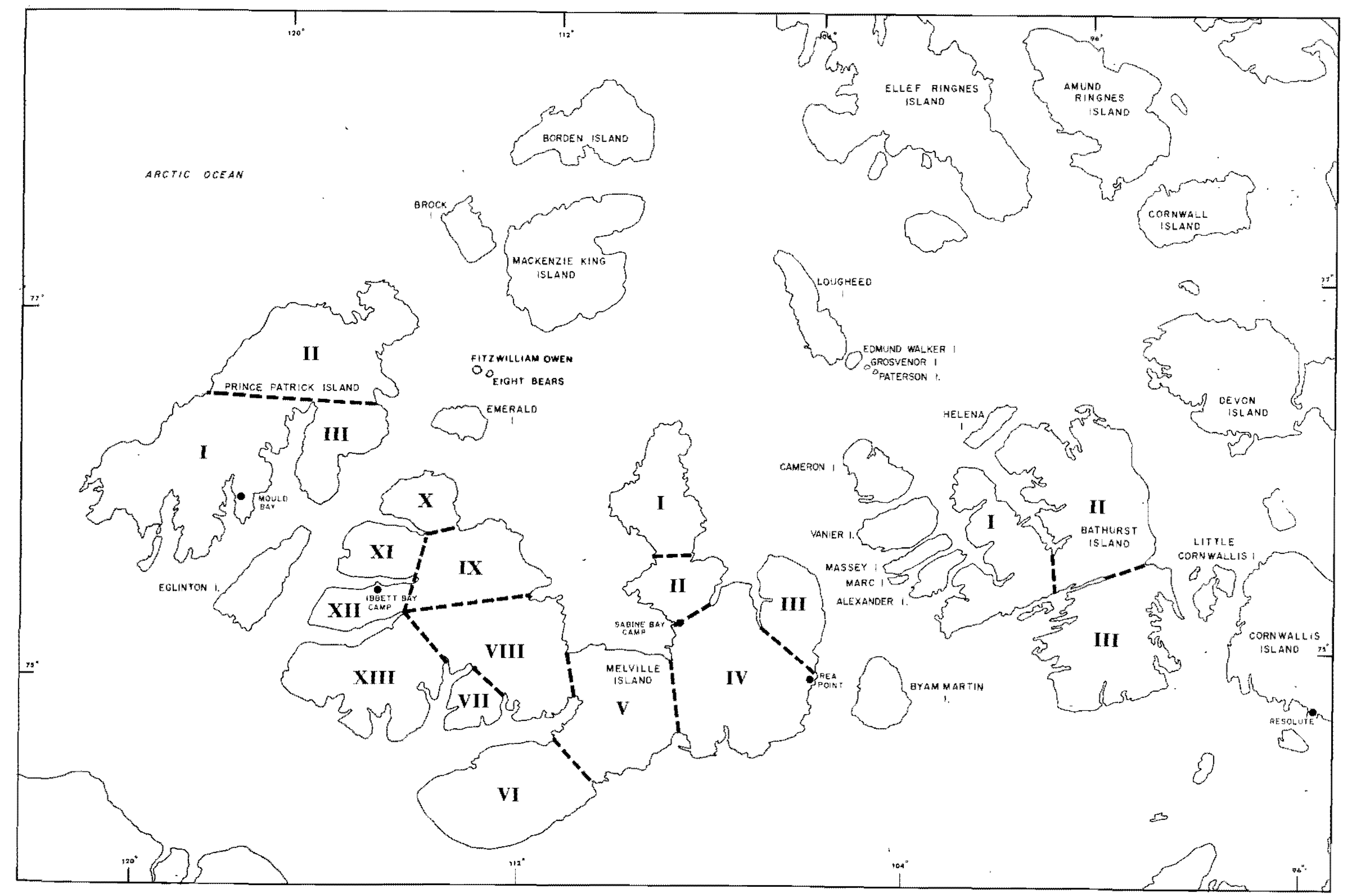
Melville is the largest (42 220 km²) and most rugged of the western islands in the Queen Elizabeth group (Fig. 1). It is the most southerly of the western Queen Elizabeth Islands and is irregular in shape with deep inlets dividing the island into a series of peninsulas.

Eastern (strata III, 1940 km² and IV, 7260 km²), central (stratum V, 4560 km²) and northwestern Melville (strata VIII, 5100 km²; IX, 3330 km²; XI, 1670 km²; and XII, 1400 km²) are a series of ridges and plateaus developed on folded Palaeozoic rocks (Thorsteinsson and Tozer 1960, Tozer and Thorsteinsson 1964). The area is varied but in general the eastern part is lower although more intensely folded than the western uplands (Dunbar and Greenaway 1956). The Blue Mountains on the west coast (stratum XIII, 4770 km²) reach the maximum elevation on Melville of about 1000 m above sea level (elevation measurements recorded for western Melville on 1:250,000 topographical maps, Canada Department of Energy, Mines and Resources are in error). The western uplands have four permanent snowfields totalling 335 km² in area (Bird 1967). The flat-topped ridges of the western uplands are most notably developed in the Canrobert Hills (stratum XI) reaching an elevation of 594 m, and forming steep sea cliffs with a fiord-type coast (Bird 1967).

High seacliffs also border part of southwestern Melville (strata XIII and VII,

Figure 1
Western Queen Elizabeth Islands, NWT, surveyed by air between March 1972 and August 1974.

Figure 1



1030 km²), an area of high plateau country with many deep narrow ravines. To the south, across Liddon Gulf, is the Dundas Peninsula (stratum VI, 5100 km²), an area of dissected plateau (Tozer and Thorsteinsson 1964).

Northwestern (stratum X, 1390 km²) and northeastern (strata I, 2940 km² and II, 1730 km²) Melville are areas of lowland. The lowlands are not featureless, however; strata dip forming several prominent steep faced hills in both areas, and the central part of the Sabine Peninsula (strata I and II) is an island plateau.

1.2. Bathurst Island (75°50′N, 99°30′W)

Bathurst (16 090 km²), which lies on the eastern edge of the survey area (Fig. 1), has a distinctive pattern of inlets and intervening ridges and headlands which reflect the underlying geology (Fortier *et al.* 1963). Most of the coast is sharply sloping, and rugged, but with few cliffs. Because of the long inlets, 25% of the land surface is within 2.5 km of the coast.

The northern three-quarters of the island is dominated by east–northeast folds of bedrock, which form a ridged upland. Erosion has caused regular and continuous ridges with gentle to moderately steep slopes. The drainages either follow the main valleys or cut across ridges forming a trellis pattern. Most of the land (62%) is below 150 m in elevation, the greatest relief is on the northwest, where bluffs reach 412 m.

The southern quarter of the island is mainly a gently undulating plateau mostly below 60 m with few well-defined features. The land is less well-drained than the upland ridges to the north. To the southwest the plateau surface is more dissected with many small ponds.

About 24% of Bathurst lies below 60 m. Ground elevations vary considerably between the three survey strata. Most of the terrain below 60 m occurs in stratum III (5360 km²). Stratum II (6650 km²) has about 75% more intermediate and high ground than stratum I (4080 km²) or III.

Percentage distribution of the landmass of Bathurst by distances from the seacoast is given by stratum in Miller and Russell (1976:App.45).

1.3. Prince Patrick Island
(76°50'N, 119°00'W)

Prince Patrick is large (15 830 km²) and elongated along a northeast–southwest axis (Fig. 1). West and central Prince Patrick (strata I, 7740 km² and II, 5980 km²) are within the Arctic Coastal Plain region which is underlain by the Beaufort Formation (Tozer and Thorsteinsson 1964). The plain slopes gently from the centre of the island to the low-lying west coast; on the southeast the relief is more pronounced where the plain ends in an escarpment. Eastern Prince Patrick (stratum III, 2110 km²) is a dissected plateau with sandstone bluffs and sea cliffs. The south of the island (stratum I) also has pronounced relief with escarpments and cliffs reaching the maximum elevation of 279 m above sea level on the island, about 3% (535 km²) of the land is between 151–279 m. The sandstones vary in the vegetative cover that they support, but the Beaufort Formation (63% of the island, Tener 1963) underlying the Arctic Coastal Plain is uniform in its sparse vegetative cover (Tozer and Thorsteinsson 1964).

1.4. Mackenzie King Island
(77°40'N, 111°30'W)

Mackenzie King is the largest (5100 km²) of a group of three islands, called the Prime Minister group, which are some of the most remote of the Arctic islands (Fig. 1). Mackenzie King is a low-lying but not featureless plain developed on Jurassic to Lower Cretaceous sandstones. The highest of the rounded hills and cuestas are the Leffingwell Crags reaching 140 m above sea level. The Isachsen Formation underlying these landmarks has a sparse vegetative cover (Tozer and Thorsteinsson 1964). West of the Isachsen Formation the vegetation is relatively good (Tener 1963).

1.5. Borden Island
(78°30'N, 111°00'W)

Borden is a dome-shaped, low-lying island, 2790 km² in area (Fig. 1). Like Brock the northwest of the island is on the Arctic Coastal Plain. The southeast is an undulating plain developed on Triassic and Jurassic sandstones which support a relatively good vegetation cover (Tozer and Thorsteinsson 1964). The coastline is low and featureless except in the southeast where the land rises steeply to 80 m above sea level.

1.6. Eglinton Island
(75°50'N, 118°30'W)

Eglinton (1550 km²) is an eroded peneplain with flat-topped hills especially well developed in the central and south portions of the island. About 66% of the total area is below 60 m and only about 4% is above 150 m with a maximum elevation of 240 m above sea level. The northern end is low-lying except for some cliffs reaching 114 m above sea level on the northeast corner.

The badlands of the northern part are underlain by the Isachsen Formation which supports little vegetation. The Cretaceous shales of the south and central portion of the island are more favourable to vegetation cover (Tozer and Thorsteinsson 1964).

1.7. Lougheed Island
(77°30'N, 105°20'W)

The Findley group, Lougheed, Edmund Walker, Grosvenor, Paterson and Stupart islands, is relatively isolated (Fig. 1).

Lougheed is the largest (1300 km²), and like the other islands in the group, is less than 150 m in elevation. The many small rolling hills and ridges are more developed on the north where they reach 137 m above sea level. The land slopes to a low flat coastal plain except on the southwest of the island.

The other four islands form a chain extending southeast off Lougheed. Edmund Walker is the second largest (69 km²). The dissected surface rises to 134 m and drops to a low flat coast.

Grosvenor (8 km²) and Paterson (5 km²) are both low islands. Stupart is a small (2 km²) flat island lying in the narrow and shallow channel between Edmund Walker and Lougheed.

The vegetation of Lougheed has attracted comment from explorers and geologists. Although Savile (1961) suggested that the flora is poor, his conclusion was based on a brief visit to one study site. Stefansson (1921) noted "abundant vegetation". Tener (1963:31) commented that the south central portion of the island was "richly vegetated and dotted with many small ponds." Fortier *et al.* (1963:574) who described the geology of the island, noted that, "The vegetation is generally more dense than on any other of the Arctic Islands" they visited. Tozer and Thorsteinsson (1964) observed that extent of vegetation in the Arctic islands is largely controlled by type of bedrock, and that siltstones are one of the formations that commonly support a good cover of vegetation. Fortier *et al.* (1963) found siltstones outcropping on most of southern Lougheed.

1.8. Byam Martin Island
(75°10'N, 104°20'W)

Byam Martin, 1160 km², is a continuation of the anticlinal area of east central Melville, eroded to an almost fea-

Aerial view of muskox herd in the late winter. Note the craters in the snow formed by muskoxen scraping snow away to expose forage. Photo by F. L. Miller

tureless peneplain, less than 150 m in elevation. The coast is low except for two hills on the east coast and one hill on the south coast that reach about 100 m above sea level.

No comparisons can be made with previous surveys. No aerial survey of Byam Martin was carried out in 1961 (Tener 1963).

1.9. Ile Vanier
(76°10'N, 103°30'W)

Vanier is the largest (1130 km²) of the group of islands known as the Governor General group (Fig. 1). Like northern Bathurst and the other islands in the group, the topography is dominated by folded upland, with ridges and hills running east–northeast. About one-third (348 km²) of Vanier is between 150 m and 259 m in elevation. The higher land includes the central Adam Range with a maximum elevation of 259 m above sea level. The shoreline is relatively steep with well marked coastal terraces and a narrow coastal plain.

1.10. Cameron Island
(76°30'N, 103°50'W)

The folded upland that dominates the topography of the islands in the Governor General group is only evident on the southeast of Cameron (1060 km²), where only 0.6% of the area is above 150 m and reaches a maximum height of 193 m. North and west across the island is a sloped and scarped lowland.

1.11. Brock Island
(77°50'N, 114°10'W)

Brock is a small (790 km²) almost rectangular island with a flat mainly featureless surface. The low north-trending escarpments on the east coast rise to 67 m above sea level, otherwise the coast is low and flat. The northwest of the island is Arctic Coastal Plain underlain by the Beaufort Formation (Tozer and Thorsteinsson 1964).

1.12. Emerald Island
(76°50'N, 114°10'W)

Emerald is a small (550 km²) dome-shaped island with a gently undulating plain rising to a maximum elevation of 90 m. Occasional cliffs of 60–70 m interrupt the otherwise flat coast.

1.13. Alexander Island
(75°50'N, 102°40'W)

Alexander is similar in size (490 km²) to Massey but lower in elevation. The 2% of land (11 km²) above 150 m is mostly in the east where the land rises to 198 m above sea level.

1.14. Massey Island
(76°00'N, 103°10'W)

Less than half the size (440 km²) of and lower in elevation than Vanier, Massey is similar in relief and geological structure. Only 12% (55 km²) of the land is above 150 m with a maximum elevation of 210 m above sea level.

1.15. Little Cornwallis Island
(75°30'N, 96°20'W)

Little Cornwallis is a small (410 km²) irregularly shaped island and is divided into two parts by a low narrow isthmus. The coast is low; inland are about 15 lakes separated by low knobby hills, the highest of which is 137 m above sea level.

1.16. Helena Island
(76°40'N, 101°10'W)

The Berkley group of islands lie about 10 km north of Bathurst (Fig. 1). The largest island is Helena with an area of 220 km² of which 40% (132 km²) is above 150 m. The land rises steeply from the south coast to a maximum of 282 m above sea level and slopes gently to the north.

1.17. Edmund Walker Island
(77°10'N, 104°10'W)

Edmund Walker is the second largest island of the Findley group. It is discussed in the section for Lougheed.

1.18. Ile Marc
(75°50'N, 103°40'W)

Marc is a small (56 km²), flat featureless island, below 150 m in elevation.

1.19. Fitzwilliam Owen Island
(77°10'N, 113°50'W)

Fitzwilliam Owen and Eight Bears are a pair of small isolated islands about 25 km north of Emerald, 40 km east of Prince Patrick and 40 km south of Mackenzie King (Fig. 1). Fitzwilliam Owen has an area of 34 km² and reaches 45 m above sea level. It is a disc-shaped island with a rolling landscape that is mostly bare ground. The vegetation is moss with vascular plants dominating few communities such as on south-facing slopes and coastal saline tundra (Kuc 1970).

1.20. Eight Bears Island (77°10′N, 113°20′W)

The island is small (18 km²) and low, with the gently rolling land reaching a maximum of 48 m above sea level. Eight Bears lies about 6 km east of Fitzwilliam Owen and about 25 km north of Emerald (Fig. 1).

2. Weather

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

An east–west gradient of weather across the western Queen Elizabeth Islands is evident from our observations and the weather records collected at Mould Bay, Prince Patrick Island and Resolute Bay, Cornwallis Island. Unfortunately the absence of long-term weather records from Melville allows only an extrapolation of weather from Mould Bay and Resolute Bay to describe weather on Melville. Subjective observations suggest the weather of eastern Melville is most similar to that recorded at Resolute Bay. Thompson (1971) compared 1 year's weather data from the National Museums of Science research station on central Bathurst Island to data from Resolute Bay. Her results suggested that the differences in the weather between the two locations were the result of the research station's inland site and local topographical effects. Mould Bay tends to have cooler, drier and less stormy weather than Resolute Bay (Miller and Russell 1976: Table 1). Of particular interest to interpretation of our aerial survey results is the differences between snow course data collected at the two weather stations (Miller and Russell 1976: Table 2). In early winter, when much of the snow falls, the two stations tend to have similar snow depths but the second, though smaller, peak of snowfall in spring shows marked differences. At Mould Bay there is usually shallow snow cover during June, but at Resolute Bay there is either no snow or relatively deep snow in June. The pattern of deep snow cover lingering into early July on the eastern part of the survey area was repeated in the spring of 1974 when snow cover was exceptionally deep. In 1972–73 snow cover was relatively shallow and melted early on the eastern part of the survey area, whereas snow cover was relatively deep on the western part but the snow also melted early.

The amount and duration of snow cover, especially in spring, are critical to arctic ungulates, but also critical are the types of snow cover and incidences of freezing rain. Wind removes the snow from exposed slopes and redeposits it as shallow but hard compacted cover and drifts in more sheltered and relatively well-vegetated sites. Freezing rain in autumn, early winter or spring which results in ground-fast ice before snow cover accumulates, ice layering in the snow, and crusting of the snow compounds the stress of forage unavailability on arctic ungulates. Unfortunately neither the type of snow cover nor the incidence of ground-fast ice or ice layering is available for the western Queen Elizabeth Islands.

Information on weather conditions during 1972, 1973 and 1974 were obtained from the following.

1. Atmospheric Environmental Service monthly summary records for Isachsen, Ellef Ringnes Island; Mould Bay, Prince Patrick Island; and Resolute Bay, Cornwallis Island.

2. Weather records for the National Museum of Natural Sciences, High Arctic Research Station, Bathurst Island.

3. Weather records for Rea Point, Melville Island (Panarctic Oils Ltd.).

4. Personal communications with S. MacKinley, Supervisor, Panarctic Oils Ltd., Rea Point, Melville Island; D. A. Gill and D. R. Gray, National Museum of Canada, Bathurst Island; and D. C. Thomas, CWS.

5. Our own empirical observations.

Methods

The survey aircraft, a Helo Courier, returns to Mould Bay, Prince Patrick Island, NWT. Photo by R. H. Russell

1. Aerial surveys

The islands were surveyed by a standard "transect census" strip survey method. Surveys were flown in March–April 1972, 1973 and 1974, August 1972, and July–August 1973 and 1974. Percentage coverage of each aerial survey and flight dates by island and stratum are given in Miller and Russell (1976: Tables 3, 4 and 5). Parallel flight lines were drawn on 1:250,000 scale, topographical maps. In 1972 flight paths were at 6.4 km intervals over the large islands, at 12.8 km intervals on Mackenzie King, Borden, and Brock islands and 3.2 km apart on Eglinton and Byam Martin islands. Melville, Bathurst and Prince Patrick islands were divided into major land units, which provided convenient strata for surveying. The flight lines on Melville were oriented either east–west or north–south in each stratum to provide maximum contact with the coast for accurate navigation. Flight lines were oriented east–west on all other islands although on Byam Martin and Eglinton islands, north–south surveys were added to provide double coverage in March–April 1973, then changed to all east–west lines for remaining surveys. A Helio Courier fixed wing aircraft was used for all surveys, except in August 1972 when a Bell 206 turbo-helicopter was used.

A 1.6 km strip was surveyed. The 0.8 km strips on each side of the aircraft were divided into 0.4 km strips to determine the efficiency of observing within the 1.6 km strip. Wildlife sightings were recorded as being within one of the four, 0.4 km strips or outside the 1.6 km strip (off transect).

To mark the boundaries of each strip on the Helio Courier, wires were strung from an eye-bolt on the wing to one on the fuselage. Lines marked on each observer's window were aligned with corresponding tabs on the wires. At an altitude 150 m above ground, those tabs were checked against fuel drums located at 0.4 and 0.8 km intervals from a reference point on the ground. Allowance was made for the blind spot beneath the aircraft, so that a 0.8 km strip was visible on each side of the aircraft.

All survey flights were flown about 150 m above ground level except on western Melville where broken terrain necessitated higher altitudes. Speeds ranged from 110 to 190 kmph, depending on the number of animals encountered. Observations were located on survey maps and recorded on tape. At the end of each day the sightings were transcribed and located on a second map.

During survey periods we stayed at the Atmospheric Environmental Service weather station, Mould Bay, Prince Patrick Island; Panarctic Oils Limited camp, Rea Point, Melville Island; and at CWS camps near Sabine and Ibbett bays, Melville Island (Fig. 1).

For all surveys on all islands and strata we calculated the estimated numbers and densities together with their respective standard errors using the formulae shown in Scheme 1.

Any discrepancies in the estimates with previously published material are caused by slight variations in the computer program used for the final analyses of the observed data. Estimates given in text are all based on the 1.6 km census strip transects, as the greatest coverages were obtained from the 1.6 km strip counts.

Percentage distributions on the landmass of Melville, Bathurst and Prince Patrick islands for established elevational zones (<60, 60–150, 151–300 and >300 m) and zonal distances from the seacoast (<2.5, 2.5–5.0, 5.1–10.0, 10.1–15.0, and >15.0 km) were determined from 1:250,000 topographical maps. We used an index derived from observed number of animals within a unit divided by the expected number of animals for that unit. The expectation of the number of animals is based on the simple assumption that, if the animals were not selecting habitat, they would occur in proportion to the available landmass. For example, one would expect to find or estimate 10% of the animals on an area that was 10% of the landmass.

Preference infers a selection with the animals having experienced the alternatives. It is likely, however, that the animals in question have learned their so-called preference through their maternal–filial bonds and group affinities, without ever having experienced the unsuitable or less favourable alternatives. A choice was made some time in the past, so we use the term preference to connote the impression of an active continuing choice for the apparently preferred areas, as we consider many sites within those areas critical to the species survival. We do not use the term "avoidance"

Scheme 1
Formulae used to calculate estimated numbers and densities of animals

Let x_{ij} = no. animals (one species) on transect j, stratum i
n_{ij} = area (length × width) transect j, stratum i
A_{ij} = area, stratum i
a_i = area surveyed, stratum i

Then density for stratum i is $\bar{x}_i = \dfrac{\sum_j x_{ij}}{\sum_j n_{ij}}$

The variance of $\bar{x}_i$ is $s^2(\bar{x}_i) = \dfrac{A-a}{A} \cdot \dfrac{m}{m-1} \cdot \dfrac{1}{(\sum_j n_{ij})^2} \left[\sum_j x^2_{ij} + \left(\dfrac{\sum_j x_{ij}}{\sum_j n_{ij}} \right)^2 \sum_j n^2_{ij} - 2 \left(\dfrac{\sum_j x_{ij}}{\sum_j n_{ij}} \right) \sum_j x_{ij} \cdot n_{ij} \right]$

Standard error of $\bar{x}_i = S(\bar{x}_i)$ = square root of $S^2(\bar{x}_i)$

Total estimate for a given stratum is $X_i = \dfrac{A_i}{a_i} \sum_j x_{ij}$

and its standard error is $S(X_i) = \dfrac{A_i}{a_i} \sum_j n_{ij} S(\bar{x}_i)$

For groups of strata, the total is estimated by $X = \Sigma X_i$

and its standard error by $S(X) = \sqrt{\sum_i S^2(X_i)}$

with regard to the units where animals occurred at lower rates than expected, because it is unlikely that many of the animals would have actually been on those areas and left them for more favourable sites. It is also unlikely that those low occurrence sites are currently critical to the species well-being or maintenance of the populations. The discussions of caribou and muskoxen by elevation and distances from the seacoast are, therefore, restricted to consideration of statistical preferences.

To test for the possible presence of interspecific competition between Peary caribou and muskoxen, based on our aerial survey results, we divided our transect strips into 8.0 km lengths. This division resulted in 1.6 × 8.0 km cells, equalling 12.8 km². We then tabulated for each island and by stratum for the larger islands the total number of cells, the number of cells with caribou only, the number of cells with muskoxen only and the number of cells with both caribou and muskoxen on them. A coefficient of association, derived as described below, was calculated for these presence/absence data.

		Species A Present	Absent	Totals
Species B	Present	h	b − h	b
	Absent	a − h	n − a − b + h	n − b
		a	n − a	n

The aerial survey in March–April was assumed to give mainly an estimate of distribution of caribou at that time. We have also assumed that the differences between March–April and July–August 1973 estimates gave an approximation of possible uniform observational error in late winter due to poor contrast between bleached pelages and backgrounds of snow. Originally, the observational error was estimated at about 15%, but subsequent computer analyses of the same data now place the

Results and discussion

error at about 12% (3153/3590, 1973 estimate/1974 estimate minus newborn calves on Melville, Prince Patrick, Eglinton and Byam Martin islands). Readers may wish to consider this possible error; they should also note that the following values are not meant to stand as absolute but as estimates.

2. Aerial dye-spray marking

An aerial dye-spraying technique developed by Simmons (1971) was used to mark Peary caribou on Prince Patrick and Eglinton islands in April 1974. One group of muskoxen was also marked on Eglinton. Results of our dye-marking of caribou, subsequent sightings of dye-marked animals and related evidence for inter-island movements and migrations of caribou are given in detail in Miller *et al.* (1977).

1. Aerial surveys

1.1. Melville Island

1.1.1. Caribou distributions

Distributions of Peary caribou for the island (Table 1) and by stratum varied with the survey (Table 2, Miller and Russell 1976:App. 3–7) as did preferences shown for each stratum (Table 3). Distributions of caribou were not random, however, and preferences were restricted primarily to only two and overall to four of the 13 established strata on Melville. The only marked deviation from observed preferences was in March–April 1972 when 75% of the caribou were seen on strata I and II of the Sabine Peninsula (Table 2). The relatively high number of caribou on the Sabine Peninsula at that time was seemingly in response to deep snow cover on the Dundas Peninsula and other more southerly areas of eastern Melville. We did not survey eastern Melville in March–April 1974, which was another period of deep snow cover. However, observations made by D. C. Thomas, CWS (pers. comm.) during flights over eastern Melville on 1 and 4 April 1974, indicated that many caribou were again on the Sabine Peninsula. The observed caribou appeared to be travelling northward on both of those days.

Our observations indicate that strata IV and VI (Dundas Peninsula) were consistently the important areas for caribou in late winter and summer, but caribou are mobile and showed preferences at times for all other strata on eastern Melville, except stratum V (Table 3). Caribou showed no preferences for strata VII–XIII of western Melville, except in July–August 1974, when they showed preference for stratum X (Table 3).

The results of our three summer surveys on strata I–VI (Tables 2 and 3) show the same general pattern of preferences by caribou for land areas as found by Tener in July 1961. The July 1961 pattern was also similar to the late winter distribution in March–April 1973, but varied from the observed distribution in March–April 1972 (Tables 1 and 3).

In general Peary caribou on Melville move to coastal areas mainly of the Dundas Peninsula and eastern Melville at and or shortly after calving in late May or early June. They remain for the most part on coastal sites until late July or early August in some years. Coastal affinities appear to be tied to the phenology of the vegetation: greening occurring earlier on lower coastal sites than on higher inland areas. As the summer thaw advances and vegetation has freshened on the higher interior plateaus the caribou move inland in mid summer. In mid to late August many caribou begin moving back to coastal areas in marked waves that suggest pre-rut staging movements. Movement to the coast may be range related, but we do not know if Peary caribou have an affinity for traditional coastal areas during the rut, although the preponderance of cast male antlers on several coastal sites suggests that they either rut there or frequent those areas shortly after the rut. We do suggest that movement to the coast for rutting would facilitate contact between the sexes by concentrating most potential breeders, reduce energy expenditures associated with searching efforts and help maximize the number of breedings. Most caribou apparently winter on the more exposed sites of interior plateaus: again moving to coastal areas in late spring.

Tener's 1961 survey did not show a coastal influence on the distribution of caribou on Melville. He suggested (Tener 1963) that either differences in terrain or the 2- to 4-week time lapse between his survey of Bathurst and the subsequent survey of Melville was possibly responsible for this pattern. We believe that the timing is indeed the critical factor in the pattern of observed summer distributions of caribou.

The overall distributions of caribou by elevational zones and zonal distances from the seacoast are given for the entire island (strata I–XIII) in Fig. 2a–f.

In late winter 1972 caribou showed an apparent overall preference for low ground (<60 m) on the entire island (Fig. 2a), although the actual preferences were restricted to strata I and II, and no caribou were seen on the low ground of western Melville. The only preferences for intermediate ground (60–150 m) were also on strata I and II, and on the latter stratum the caribou showed a preference for high ground (>150 m) (Miller and Russell 1976: Table 10).

In summer 1972 the overall preference by caribou was for intermediate ground of the area surveyed (Miller and Russell 1976). That apparent overall preference was caused by the high occurrence of caribou on the intermediate ground of stratum IV. The only preference for high ground was on stratum VI.

In the following late winter survey in 1973 the caribou occurred at a low rate on the low and intermediate ground (Fig. 2b). The overall preference for high ground (Fig. 2b) was caused by preferences for high ground on strata IV and VI.

The overall preference shifted to low ground in summer 1973 (Fig. 2b). The actual preferences were for strata III–VI and IX. There were also high occurrences of caribou on the intermediate and high ground of stratum VI, and the highest ground of stratum III.

No caribou showed any overall preference in summer 1974 (Fig. 2c), apparently because of the high mortality among caribou during the winter of 1973–74. There were, however, preferences for the low ground of strata IV, VI and X. Preferences were also shown for the intermediate ground of stratum V and the intermediate and high ground of Dundas Peninsula.

The overall distributions of caribou by elevational zones and zonal distances from the seacoast showed expected similarities, as elevation and distances from the seacoast are often directly related. The overall distributions of caribou by zonal distances from the seacoast are given in Miller and Russell (1976:Table 11; Figs. 13, 16 and 19; and App. 13–17). For the whole island in late winter 1972 there was no overall preference for any zonal distance

Table 1
Observed and estimated densities and numbers of Peary caribou on Melville Island, Northwest Territories, obtained from aerial surveys

Date	Caribou seen on and off transect	Transect width km	Caribou seen on transect	Caribou/100 km² Mean	± SE	Estimated caribou Estimate	± SE
Mar–Apr 1972	210	0.8	96	1.8	0.6	783	238
		1.6	171	1.7	0.4	705	159
Aug 1972[1]	1414	0.8	—	—	—	—	—
		1.6	643	6.0	1.7	2551	724
Mar–Apr 1973	573	0.8	201	3.8	0.6	1598	240
		1.6	415	3.9	0.4	1648	181
Jul–Aug 1973	2194	0.8	387	7.3	1.8	3065	770
		1.6	864	8.1	1.5	3425	618
Jul–Aug 1974[2]	886	0.8	147	4.2	1.3	1161	357
		1.6	356	4.7	1.2	1408	374

[1]Only strata I–VI were surveyed in Aug. 1972 and no 0.8 km strip was estimated because a helicopter was used to do the survey.
[2]Strata VII, VIII and IX were not surveyed during Jul.–Aug. 1974; extrapolated value for the entire island equals 1679.

Table 2
Percentage distributions of Peary caribou by stratum on Melville Island, Northwest Territories

Stratum	% area of total	Jul[1] 1961	Mar–Apr 1972	Aug[2] 1972	Mar–Apr 1973	Jul–Aug 1973	Jul–Aug 1974
I	7.0	5.2	26.2	0.6	3.7	0.2	0.0
II	4.1	2.2	49.0	0.0	0.0	1.1	0.0
III	4.6	12.6	1.9	2.7	5.1	20.0	4.4
IV	17.2	24.0	11.0	48.7	33.2	23.7	30.4
V	10.8	7.3	0.5	16.9	9.1	9.2	5.6
VI	12.1	19.8	7.6	31.1	30.7	25.5	38.1
VII	2.4	0.8	1.9	—	0.5	0.5	0.2
VIII	12.1	10.3	1.4	—	8.9	5.7	2.3
IX	7.9	3.4	0.0	—	3.3	3.6	1.4
X	3.3	5.2	0.0	—	3.8	1.7	8.2
XI	3.9	0.8	0.5	—	0.0	0.8	1.9
XII	3.3	<0.1	0.0	—	1.2	1.1	1.1
XIII	11.3	8.3	0.0	—	0.5	6.8	6.4
I–V	43.7	51.4	88.6	—	51.0	54.2	40.5
I–VI	55.8	71.2	96.2	—	81.7	79.7	78.5
VII–IX	22.4	14.5	3.3	—	12.7	9.9	3.9
X–XIII	21.8	14.3	0.5	—	5.6	10.4	17.6
VII–XIII	44.2	28.8	3.8	—	18.3	20.3	21.5

[1]Extrapolated from nnmber of Peary caribon seen on and off transect (Tener 1961).
[2]Only strata I–VI were surveyed in Aug. 1972, so no comparison of percentage distributions for Aug. 1972 can be made with other years. The preference patterns, however, can be compared.

Table 3
Observed to expected Peary caribou index values by stratum for Tener's 1961 survey and our five (1972–74) surveys of Melville Island, Northwest Territories (1.0 = expected)

Stratum	Jul 1961	Mar–Apr 1972	Aug 1972	Mar–Apr 1973	Jul–Aug 1973	Jul–Aug 1974
I	0.8	3.7	0.1	0.5	<0.1	0.0
II	0.5	11.4	0.0	0.0	0.3	0.0
III	2.7	0.4	0.3	1.1	4.3	0.8
IV	1.4	0.7	1.6	1.9	1.4	1.4
V	0.7	<0.1	0.9	0.8	0.8	0.4
VI	1.6	0.6	1.4	2.6	2.1	2.6
VII	0.3	0.8	—	0.2	0.2	—
VIII	0.9	0.1	—	0.7	0.5	—
IX	0.4	0.0	—	0.4	0.5	—
X	1.6	0.0	—	1.2	0.5	2.1
XI	0.2	0.1	—	0.0	0.2	0.4
XII	<0.1	0.0	—	0.4	0.3	0.3
XIII	0.7	0.0	—	0.1	0.6	0.5
I–V	1.2	2.0	0.9	1.2	1.2	0.8
I–VI	1.3	1.7	—	1.5	1.4	1.1
VII–IX	0.6	<0.1	—	0.6	0.4	—
X–XIII	0.7	0.1	—	0.3	0.5	0.7
VII–XIII	0.6	0.1	—	0.4	0.5	—

from the seacoast, but on eastern Melville there were preferences for three of the five zones (Fig. 2d). Within stratum, preferences were shown for sites more than 10 km inland on stratum I, but for sites within 10 km of the seacoast on stratum II. No other within stratum preferences were found.

In summer 1972 the overall preference for areas greater than 15 km from the coast on eastern Melville was the result of preferences shown on strata IV and VI. The observed distribution most likely reflects the lateness of the survey, August 13–24. Comparison with results from other summer surveys suggested that caribou had already moved from early summer coastal areas to late summer interior feeding areas.

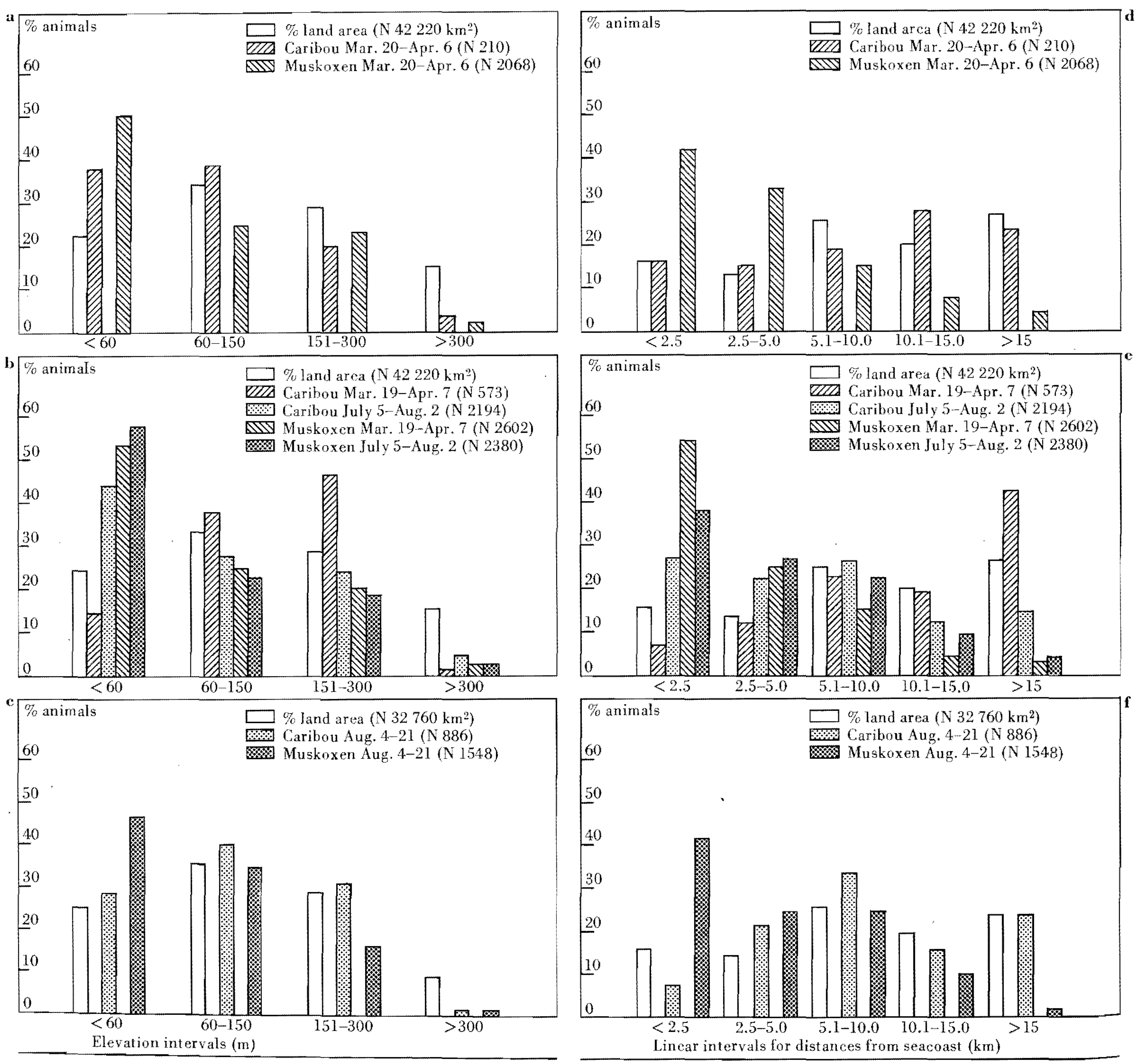
In late winter 1973 the caribou showed an overall preference for the interior sites, except on western Melville (Fig. 2e). The overall preference resulted from the high occurrence of caribou in zones greater than 15 km from the seacoast on strata III, IV and VI. Preferences were shown for the coastal zone of stratum V. Differences in distributions on strata IV and VI, where caribou occurred in high and nearly equal numbers are, however, possibly related to the relative sizes of two strata. Stratum IV is about 42% larger than stratum VI and only held about 8% more caribou. Therefore, we suggest that the wider distribution of caribou on stratum VI reflects winter foraging conditions or wide distributions of available forage or both on stratum VI.

In summer 1973 the overall pattern was reversed and the caribou showed an overall preference for the coastal areas (Fig. 2e). The observed distributions are most likely related to the timing of the survey which was flown between July 5 and August 2. The highest density during all surveys was recorded on stratum III in summer 1973, but the high number most likely represented a movement off stratum IV.

In summer 1974 there was no overall preference for zonal distances from the seacoast for the area surveyed, but pref-

Figure 2
Distribution of Peary caribou and muskoxen on Melville Island, NWT, (a) by elevational zones on strata I–XIII, 1972; (b) by elevational zones on strata I–XIII, 1973; (c) by elevational zones on strata I–VI, X–XIII, 1974; (d) by distance from the seacoast on strata I–XIII, 1972; (e) by distance from the seacoast on strata I–XIII, 1973; (f) by distance from the seacoast on strata I–VI, X–XIII, 1974. Summer 1972 survey, incomplete; no survey March–April 1974.

Figure 2



erences were shown for sites within 2.5–10 km from the seacoast on eastern Melville (Fig. 2f). The spread of preferences for zonal distances from the seacoast again seemingly reflected the relative numbers of caribou occurring on each stratum. Stratum VI had the greatest number of caribou and showed the greatest dispersion of preferences. Caribou on stratum X, western Melville, showed a preference for the 2.5–5.0 km zone.

1.1.2. Caribou recruitment

Variations in caribou calf production on Melville were extreme between 1972 and 1974 (Table 4) reflecting the mild winter of 1972–73 and the severe winter of 1973–74. In summer 1973 overall (strata I–XIII) observed calf production rose to 17.7% of 1489 caribou and dropped to only 1.1% of 895 caribou segregated in summer 1974. Among year variation by stratum (Table 4) reflected the relative severity of the 1972–73 (mild) and 1973–74 (severe) winters. In 1973, 78% of the calves seen were on strata I–VI, but in 1974 no calves were observed on those strata. The 25 calves seen on stratum XIII in 1973 and the 10 calves seen on strata XI–XIII in 1974 were most likely produced by cows that had wintered on Prince Patrick Island and crossed to Melville about calving time. Winter surveys (Table 2, Miller and Russell 1976: App. 3, 5) indicate virtually no caribou on strata XI–XIII.

The importance of each stratum for caribou calf production can not be fully evaluated by the relative percentages of calves because we do not know where producing females wintered or calved due to their migratory behaviour prior to and shortly after calving. Peary caribou calving areas may be traditional, but our summer surveys were flown during post-calving periods, so occurrence of caribou calves by stratum (Table 4) might reflect only a short temporal preference or distribution by maternal cows.

It is likely, however, that the high number of calves seen on stratum VI in summer 1973 (Table 4) indicates the relative importance of stratum VI (Dundas Peninsula) for maternal females and their offspring. We believe that strata III–VI are major areas for summering caribou and, therefore, the areas of primary importance for rearing of caribou calves on Melville Island.

Table 4
Numbers of calves in those groups of Peary caribou in which calves were segregated, and calf crops as percentages of calves to total caribou seen by stratum, Melville Island, Northwest Territories, summer

	No. calves seen			Caribou segregated			Calf crops as % of total caribou segregated by stratum		
Stratum	1972	1973	1974	1972	1973	1974	1972	1973	1974
I	0	1	0	9	4	0	0.0	25.0	0.0
II	0	0	0	0	19	0	0.0	0.0	0.0
III	0	45	0	38	289	41	0.0	15.6	0.0
IV	0	38	0	689	324	280	0.0	11.7	0.0
V	0	36	0	239	146	61	0.0	24.6	0.0
VI	0	86	0	439	319	351	0.0	27.0	0.0
VII	—	4	—	—	11	—	—	36.4	—
VIII	—	17	—	—	126	—	—	13.5	—
IX	—	2	—	—	80	—	—	2.5	—
X	—	7	0	—	38	76	—	18.4	0.0
XI	—	2	5	—	18	17	—	11.1	29.4
XII	—	0	2	—	9	10	—	0.0	20.0
XIII	—	25	3	—	106	59	—	23.6	5.1
Totals	0	263	10	1414	1489	895			

1.1.3. Caribou numbers

The estimated numbers of caribou on Melville showed marked seasonal changes in 1972 and 1973 that could not be accounted for by mortality (Table 1, and by stratum in Miller and Russell 1976:App. 3–7). The decrease between summers 1973 and 1974 (Table 5), however, was most likely caused mainly by mortality.

With the exception of stratum XII, the lowest percentage decrease of caribou between 1961 and 1974 was on stratum VI (Dundas Peninsula), which had the highest percentage (Tables 2 and 5) of caribou by stratum in 1974. Numbers of caribou were greatest on strata IV and VI in 1961 and also greatest, but in reversed order, on those strata in 1974 (Tables 2 and 5). The relative importance of strata IIV and VI to caribou has persisted from, at east, 1961 and 1972–74. On a density basis, stratum VI is the most important of all larger strata (each greater than 5% of the total size of Melville). This persistence suggests that on Melville density independent factors, not range quality, are controlling caribou numbers.

Temporal limitations of our observations during aerial surveys and the seasonal mobility of caribou do not permit detailed analysis of variations in numbers of caribou by stratum presented in Miller and Russell (1976:App. 3–7). Between year changes in numbers sometimes reflect movement between adjacent strata and timing of the surveys, especially in summer. Between year changes in numbers of caribou in late winter by stratum, however, are apparently confounded by annual variations in seasonal movements on and off Melville Island (Table 5). Overall differences in numbers of caribou between winters (Miller and Russell 1976:Tables 4, 13; App. 3, 5) and

Table 5
Estimated caribou in summer by stratum and percentage changes by years, Melville Island, Northwest Territories

Stratum	Estimated caribou				% change			
	1961[1]	Aug 1972	Jul–Aug 1973	Jul–Aug 1974	1961–72	1972–73	1972–74	1973–74
I	516	36	8	0	93.0	−77.8	−100.0	−100.0
II	116	0	50	0	100.0	+	0	−100.0
III	2264	134	583	59	94.1	+235.1	−56.0	−89.9
IV	3114	916	843	408	70.6	−8.0	−55.4	−51.6
V	766	446	321	95	41.8	−28.0	−78.7	−70.4
VI	2114	1020	681	685	51.8	−33.2	−32.8	+0.6
VII	116	—	20	10	—	—	—	−50.0
VIII	1215	—	189	95	—	—	—	−49.7
IX	399	—	115	57	—	—	—	−50.4
X	898	—	130	157	—	—	—	+20.8
XI	148	—	56	8	—	—	—	−85.7
XII	17	—	12	17	—	—	—	+41.7
XIII	1116	—	416	88	—	—	—	−78.8
I–V	6776	1532	1805	562	77.4	+17.8	−63.3	−68.9
I–VI	8890	2552	2485	1247	71.3	−2.6	−51.1	−50.0
VII–IX	1730	—	324	162	—	—	—	−50.0
X–XIII	2179	—	614	270	—	—	—	−56.0
VII–XIII	3909	—	938	432	—	—	—	−53.9
I–XIII	12799	—	3423	1679	—	—	—	−50.9

[1]Extrapolated from Tener 1961.

Table 6
A comparison of grouping statistics from aerial surveys of Peary caribou on Melville Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles Mean	Range
Mar–Apr 1972	100	51	3.2	2–11
Aug 1972[1]	144	4	10.1	2–77
Mar–Apr 1973	144	16	4.4	2–13
Jul–Aug 1973	271	17	8.6	2–60
Jul–Aug 1974[2]	130	7	7.2	2–33

[1]Only strata I–VI were surveyed in Aug. 1972.
[2]Strata VII, VIII and IX were not surveyed in Jul–Aug 1974.

summers (Tables 1, 5, Miller and Russell 1976: App. 4, 6, 7) can often best be explained by migration to and from the island and marked variations in the numbers of animals migrating from year to year (Miller *et al.* 1977).

The similarity of estimates for eastern Melville (strata I–V) and the Dundas Peninsula (stratum VI) suggests little change in caribou numbers from summer 1972 to summer 1973. In summer 1974, however, the estimated number of caribou on eastern Melville dropped 50% and the overall decrease in number of caribou was 50.9% for the entire island (Table 5).

In summer 1974 strata VII–IX were not surveyed due to delays caused by weather and mechanical problems with the aircraft. Also, stratum IV was not surveyed until after the caribou had started a late summer movement, possibly pre-rut, from interior plateaus to coastal areas on other strata. Thus, we recalculated and extrapolated estimated values for those strata. There was no evidence to suggest that the decline in caribou numbers on Melville Island from summer 1973 to summer 1974 was attributable to anything but mortality. Therefore, we made adjustments (Miller and Russell 1976:72–75) that gave an adjusted estimate of 1697 caribou on Melville Island in 1974, or 13.1% of the number of caribou estimated to have been on Melville in summer 1961.

1.1.4. Caribou groups

Percentage distributions of caribou and caribou groups by group size are given in Miller and Russell (1976:Figs. 20–24). No direct relationship between the group size with the highest percentage of total caribou seen and the most frequent group size was evident among caribou on Melville (Table 6, and by stratum in Miller and Russell 1976:App. 19–23). Both the mean group size and range of group sizes are markedly smaller for caribou groups in winter than in summer.

Percentages of solitary caribou among all caribou seen were higher in both late winter surveys than the three summer surveys, and markedly higher in the winter of 1972. The high occurrence of solitary caribou in late winter 1972 suggests those caribou were severely stressed.

We assume that a winter group is composed of a family gathering or sex- and age-related companion animals and that such a group is the closed social unit. We could further assume that the largest winter groups seen reflect the current maximum size of those social units. Therefore, it is likely that the large groups, possibly in excess of 20 individuals, are aggregations of closed social units. In the summers of 1972 and 1973 the ranges of group sizes were similar but in summer of 1974 there were more small groups and no comparably large groups. Although large groups were not seen in summer 1974, the average group size was only slightly lower than the previous summers. This persistence of similar mean group sizes can be explained by the retention of social units in forming summer aggregations even after severe winter mortality. Fewer caribou were present in summer 1974 but they still formed aggregations.

Again the distributions of groups in late winter 1972 and 1973 reflect the relative severity of those winters (Figs. 3a and 3c). In March–April 1972, 57% of all

Figure 3

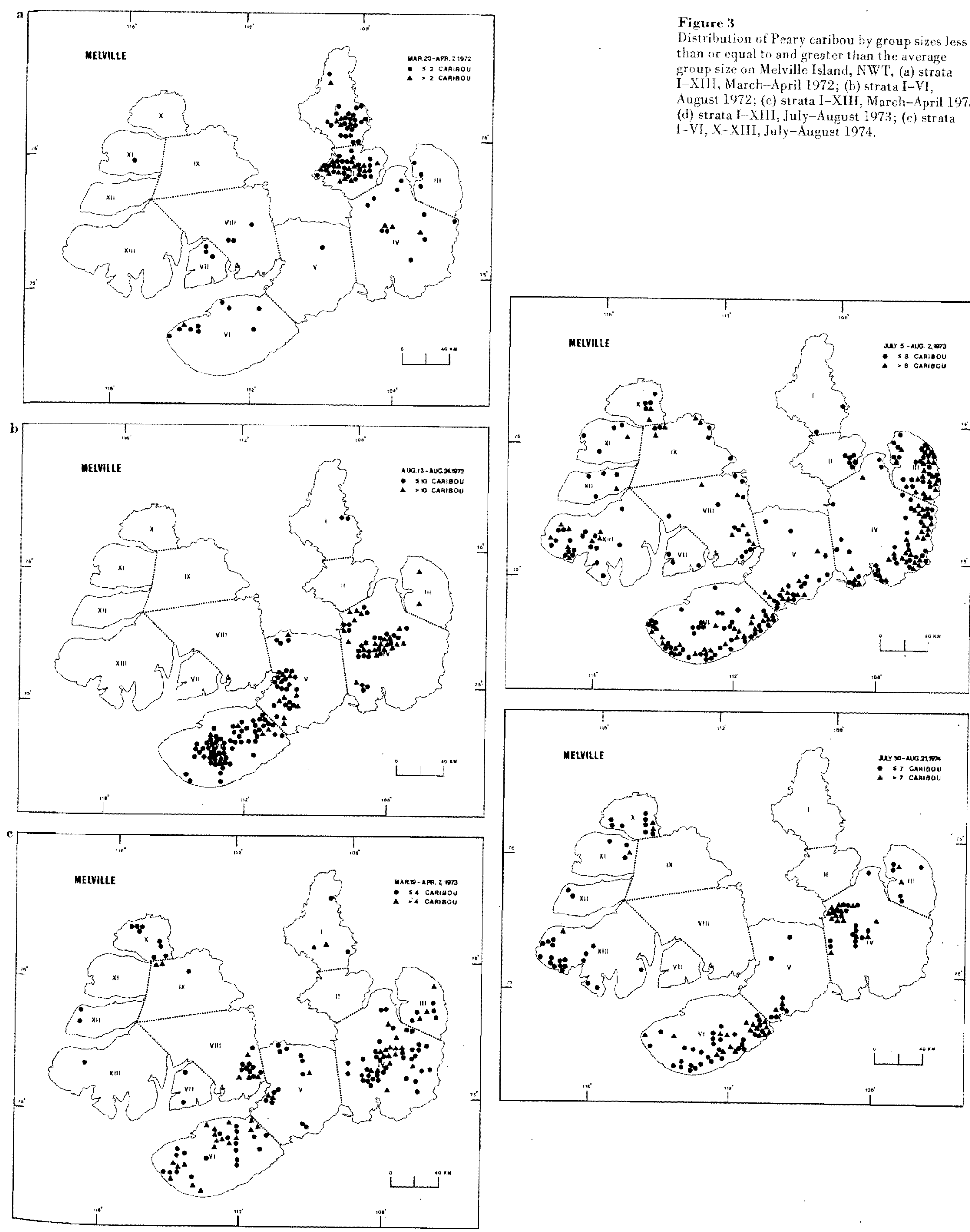


Figure 3
Distribution of Peary caribou by group sizes less than or equal to and greater than the average group size on Melville Island, NWT, (a) strata I–XIII, March–April 1972; (b) strata I–VI, August 1972; (c) strata I–XIII, March–April 1973; (d) strata I–XIII, July–August 1973; (e) strata I–VI, X–XIII, July–August 1974.

groups were clumped on the Sabine Peninsula (strata I and II), but in March–April 1973 only 3% of all groups seen were located there. In late winter 1972 only 12% of the groups not seen on the Sabine Peninsula exceeded the mean group size. In March–April 1973, 90% of the groups seen off the Sabine Peninsula exceeded the mean group size. In late winter 1973 the number of groups on western Melville increased from 7% in March–April 1972 to 20%; and on Dundas Peninsula (stratum VI) from 10% to 26%. A major distribution, 77% of all groups seen, was along a northeast–southwest axis on eastern Melville and Dundas Peninsula, where 82% of the groups were larger than average.

Incomplete surveys in summers 1972 and 1974 prohibit a detailed analysis of grouping over the entire island during the summer (Fig. 3b, d, e). On Eastern Melville (strata I–V) and Dundas Peninsula (stratum VI), however, the distribution of groupings exceeding the mean group size is a further measure of preferences. The numbers of groups exceeding the mean group size for each summer remained surprisingly stable among summers 1972, 1973 and 1974 (30, 29 and 26 respectively) despite apparent extreme variation in environmental stress. This condition suggests some affinity by closed social units for certain aggregations — the existence of clans. If this assumption is correct it would explain the retention of the number of aggregations with reduced overall sizes in summer 1974. Mortality appeared widespread in 1973–74 and all or most closed social units would have experienced mortality. Therefore, their subsequent gathering into aggregations composed of a more or less fixed number of closed social units would result in overall smaller aggregations.

In summer 1972, 70% of all groups on stratum VI exceeded the mean group size, 53% in 1973, and 87% in 1974. Those data suggest that strata IV and VI were preferred summering areas for most of the larger aggregations of caribou. Preference for strata IV and VI persisted after the high mortality of winter 1973–74, indicating that surviving caribou moved to those strata and or that most of the mortality occurred in other strata.

In mid July 1961 Tener (1963) saw a total of 182 groups of caribou on Melville of which 27 were solitary animals. Mean group size excluding solitary animals was 4.8 and including singles was 4.2 caribou (calculated from Fig. 2, Tener 1963). Several of Tener's (1963) observations of group sizes were distinctly different from those obtained during our three summer surveys.

In summer 1961 mean group size was low, apparently caribou were not forming aggregations at that time. Again, in 1961 the small maximal group size of 20 probably reflects the lack of aggregation. Only 7% of all 182 groups were composed of more than nine caribou in 1961 (Tener 1963). In 1972, 1973 and 1974, however, 33%, 31% and 20% of the groups exceeded nine caribou in size. The percentage of solitary caribou was relatively high in 1961 (14.8%) compared to 1972 (2.8%), 1973 (6.3%) and 1974 (5.4%). Percentages of pairs varied considerably, but higher representation in 1961 could have reflected the high calving success. Highest calving success from 1972 to 1974 was in 1973, and segregation of pairs does not support that assumption: only 25% of the pairs were mother–young groups.

Reasons for the observed differences in grouping statistics from 1961 to 1972–74 are abstruse. Tentatively, we could expect that the higher densities of 1961 would have resulted in larger groups. It is possible, however, that greater intolerances brought on by stress through competitive foraging resulted in group fragmentation. Also the high productivity in summer 1961 may have led to widespread aggression by maternal animals toward companion animals, which would cause greater individual spacings. Observers may have perceived such large spacings as different groups.

1.1.5. Muskox distributions

Distributions of muskoxen by stratum were not random and varied with the survey (Tables 7–8, Miller and Russell 1976: App. 24–28) as did preferences shown for each stratum (Miller and Russell 1976: Table 20). The greatest numbers of muskoxen during each survey, however, were consistently found on strata XIII, VIII and VI, in that order, throughout our surveys (Table 8). The importance of strata XIII and VIII was comparable to 1961 findings. This strong consistent pattern of percentage occurrence also held for all of our five surveys of eastern Melville and the Dundas Peninsula, but was opposed to Tener's (1961) findings (Table 8).

The observed pattern of consistency of the order of occurrence of muskoxen by stratum deteriorated when it was tested for observed to expected muskoxen index values (Miller and Russell 1976:Table 20). Stratum XIII remained the most preferred with the highest densities during all of our surveys, but it had the second highest index value in 1961. At one time or another preferences were shown for only 4 of the 13 strata.

We do not know how the overall distributions of muskoxen on Melville vary with season or phase of annual cycle. Many muskox groups seem to shift locations, especially during group fragmentation and regrouping in the spring and group buildup in autumn. Exchange of muskoxen most likely occurs between, at least, the highly populated strata, especially strata XIII, VIII, VII and VI. Movements onto the Dundas Peninsula (stratum VI) seemingly in response to stress occurred in winter 1973–74. Unfortunately, we could not determine the origin of the movements. Group affinities of muskoxen for specific sites and corridor-type ranges between those preferred sites are possibilities, but have not yet been documented on Melville. Seasonal use of ranges by muskoxen are known to vary greatly on the Bracebridge–Goodsir Inlet area of Bathurst Island (Gray 1973) and the Truelove and Sverdrup lowlands of Devon Island (Hubert 1974). It is likely that comparable movements occur seasonally on Melville Island.

Table 7
Observed and estimated densities and numbers of muskoxen on Melville Island, Northwest Territories, obtained from aerial surveys

Date	Muskoxen seen on and off transect	Transect width km	Muskoxen seen on transect	Muskoxen/100 km² Mean	± SE	Estimated muskoxen Estimate	± SE
Mar–Apr 1972	2068	0.8	267	5.1	1.0	2150	410
		1.6	836	8.0	1.1	3394	478
Aug 1972[1]	578	0.8	—	—	—	—	—
		1.6	249	2.3	0.6	986	264
Mar–Apr 1973	2602	0.8	198	3.7	0.9	1645	386
		1.6	760	7.2	1.1	3025	455
Jul–Aug 1973	2380	0.8	493	9.3	2.2	3919	922
		1.6	798	7.5	1.5	3171	627
Jul–Aug 1974[2]	1548	0.8	251	7.2	2.1	1997	588
		1.6	431	5.8	1.4	1717	412

[1]Only strata I–VI were surveyed in Aug. 1972 and no 0.8 km strip was estimated because a helicopter was used to do the survey.

[2]Strata VII, VIII and IX were not surveyed during Jul.–Aug. 1974; extrapolated value for entire island equals 2390.

Table 8
Percentage distributions of muskoxen by stratum on Melville Island, Northwest Territories

Stratum	% area of total	Jul[1] 1961	Mar–Apr 1972	Aug[2] 1972	Mar–Apr 1973	Jul–Aug 1973	Jul–Aug 1974
I	7.0	5.7	1.9	2.6	1.7	2.4	0.0
II	4.1	6.4	0.2	7.9	3.2	4.5	1.6
III	4.6	0.0	0.6	0.9	0.4	0.7	0.0
IV	17.2	0.4	7.2	23.9	6.4	12.8	4.2
V	10.8	0.0	4.8	17.5	5.0	4.3	2.4
VI	12.1	0.0	12.9	47.2	11.6	15.7	15.9
VII	2.4	9.7	3.2	—	3.6	3.1	4.1
VIII	12.1	27.2	15.3	—	13.4	17.1	17.5
IX	7.9	7.1	2.2	—	4.4	4.7	8.7
X	3.3	7.2	2.7	—	1.7	1.5	1.2
XI	3.9	0.4	6.1	—	5.3	3.7	4.0
XII	3.3	0.2	3.7	—	2.5	2.0	2.4
XIII	11.3	35.6	39.2	—	40.8	27.5	38.0
I–V	43.7	12.6	14.8	—	16.6	24.7	8.2
I–VI	55.8	12.6	27.5	—	28.2	40.4	24.1
VII–IX	22.4	44.0	20.7	—	21.5	24.8	30.3
X–XIII	21.8	43.4	51.7	—	50.3	34.8	45.6
VII–XIII	44.2	87.4	72.4	—	71.8	59.6	75.9

[1]Extrapolated for number of muskoxen seen on and off transect (Tener 1961).
[2]Only strata I–VI were surveyed in Aug. 1972, so no comparison of percentage distribution for Aug. 1972 can be made with other years. The preference patterns, however, can be compared.

In all surveys, 1972–74, muskoxen showed an overall preference for low ground (Fig. 2a–c). In all surveys, except in summer 1973, the preference for low ground on the Dundas Peninsula (stratum VI), however, masked the low occurrence of muskoxen on the low ground of eastern Melville. In summer 1973 the overall preference for low ground of eastern Melville was supported by preferences for strata II and IV as well as stratum VI (Miller and Russell 1976:Table 21). In the two late winter surveys, and the two surveys when all Melville was surveyed in summer, there were consistent preferences for intermediate ground of western Melville especially stratum XIII. There was also a continued preference for high ground on stratum XIII. Dispersion of preferences on stratum XIII most likely reflects the high numbers of muskoxen found there during all surveys.

The overall distributions of muskoxen by zonal distances from the seacoast are, in general, directly related to the observed distributions by elevation (Fig. 2d–f). Overall preference was shown in all surveys for the coastal zone <2.5 km, and the adjacent zone 2.5–5.0 km except for eastern Melville in summer 1974. Distributions by distances from the seacoast were tied directly to major sedge meadow areas and reflected elevational distributions as most sedge meadows are found at low elevations. The within-stratum preferences shown in relation to distances from the seacoast are summarized in Miller and Russell (1976: Table 22). The distributions of muskoxen by elevational zones and zonal distances from the seacoast are given for strata I–VI and strata VII–XIII in Miller and Russell (1976:Figs. 2, 5, 8, 11, 14 and 17; Figs. 3, 6, 9, 12, 15 and 18, respectively).

1.1.6. Muskox recruitment

Muskox calf crops as percentages of the total animals segregated were 9.5% for strata I–VI in 1972, 18.7% for strata I–XIII in 1973, and 9.7% for strata I–VI and X–XIII in 1974. Numbers of calves in those groups in which calves were segre-

Table 9
Numbers of calves in those groups of muskoxen in which calves were segregated, and calf crops as percentages of calves to total muskoxen seen by stratum, Melville Island, Northwest Territories, summer

	No. calves seen			Muskoxen segregated			Calf crops as % of total muskoxen segregated by stratum		
Stratum	1972	1973	1974	1972	1973	1974	1972	1973	1974
I	2	15	0	15	57	0	13.3	26.3	0.0
II	3	26	0	46	107	35	6.5	24.3	0.0
III	0	3	0	5	16	0	0.0	18.8	0.0
IV	7	64	0	105	295	94	6.7	21.7	0.0
V	9	14	1	85	102	53	10.6	13.7	1.9
VI	28	61	20	259	367	354	10.8	16.6	5.6
VII	—	9	—	—	62	—	—	14.5	—
VIII	—	75	—	—	400	—	—	18.8	—
IX	—	12	—	—	112	—	—	10.7	—
X	—	3	2	—	37	27	—	8.1	7.4
XI	—	4	7	—	80	88	—	5.0	8.0
XII	—	11	11	—	48	54	—	22.9	20.4
XIII	—	108	106	—	486	803	—	22.2	13.2
Totals	49	405	147	515	2169	1508			

gated, and percentage calf crops are given by stratum for summers 1972, 1973 and 1974 (Table 9). The among year differences in calf production reflect the variation in severity of the three winters: 1971–72, moderately severe; 1972–73, favourable; and 1973–74, severe to catastrophic. Within year differences among strata most likely reflect variations in group composition and exposure to both recent and then prevailing environmental stresses.

Although overall percentages of calves are comparable between 1972 and 1974, the relative severity of the three winters can best be shown by comparison of calf production on strata I–V (Table 9). Calf production on strata I–V rose from 8.2% in 1972 to 21.1% in 1973 and plummeted to 0.5% in 1974. Even including data from strata VI, where calf production was highest, annual percentages of calves to total muskoxen segregation for strata I–VI still reflect the relative severity of the three winters: in 1972 there were 10.8% calves; 1973, 16.6% calves; and 1974, 5.6% calves.

The number and percentage of muskox calves show marked within year and between year variations by stratum (Table 9). We assume, because we lack knowledge of the sex and age compositions of the groups, that the production of calves by stratum should have been proportional to the percentage of the total muskoxen seen on each stratum. If the assumption is valid, the production of calves was greater than expected on strata I, V and VI in 1972; strata I, II, IV, XII and XIII in 1973; and only strata XII and XIII in 1974.

The number of muskox calves was the greatest on stratum XIII in both 1973 and 1974 (Table 9) and represented 27% and 72%, respectively, of observed calves. In 1973, 60% and 1974, 42% of all the observed calves were on the Bailey Point area of stratum XIII. Southwestern Melville appears to be the heartland for muskoxen on the western Queen Elizabeth Islands.

1.1.7. Muskox numbers

We cannot directly compare changes in overall muskox numbers or numbers by stratum between Tener's (1961) estimates and the estimate from our surveys of Melville in 1972, 1973 and 1974 because Tener's figures were subjective. He did not calculate his estimate from his observations (Tener 1963). We believe that his conservative estimate of 1000 muskoxen was indeed well below the actual number of muskoxen that was on Melville in summer 1961. Extrapolation of his observations would have given over 4000 muskoxen in 1961.

Evaluation of changes in numbers of muskoxen by stratum is complicated by some strata estimates of muskox numbers being lower than the total number of muskoxen observed on those strata. Also, sequential events such as total observed muskoxen on a stratum being nearly equal in two years but resultant estimates being lower than the observed in one year and higher in the other year further complicate considerations of those data by stratum. The sizes of existing standard errors of the estimates (Table 7; Miller and Russell 1976: App. 24–28) and derived 95% confidence intervals ($\simeq$2SE) negate comparisons of the observed to expected values to determine changes in muskox numbers by stratum. We believe, however, that much of the variation in estimated numbers by stratum is confounded by clumping phenomena resulting from seasonal and yearly differences in sizes and numbers of muskox groups encountered.

The overall estimates (1.6 km strip) suggest that muskox numbers declined about 10.9% from late winter 1972 to March–April 1973 (Table 7). Muskoxen then increased about 4.7% in summer 1973 and subsequently dropped 24.6% between summer 1973 and 1974. That is 31.9% of the muskoxen that were on Melville in summer 1973 were lost by summer 1974, but the 1974 calf increment replaced 7.3% of them.

Percentage changes in numbers of muskoxen estimated by stratum are given in Table 10 for late winters 1972 and 1973 and for summers 1972, 1973 and 1974.

Table 10
Estimated muskoxen by stratum and percentage changes by seasons and years, Melville Island, Northwest Territories

	Estimated muskoxen					% change			
						Winter	Summer		
Stratum	Mar–Apr 1972	Aug 1972	Mar–Apr 1973	Jul–Aug 1973	Jul–Aug 1974	1972–73	1972–73	1972–74	1973–74
I	123	60	92	0	0	−25.2	−100.0	−100.0	0
II	19	38	99	118	76	+321.0	+110.5	+100.0	−35.6
III	28	0	39	47	0	+39.2	+	+	−100.0
IV	274	270	266	282	157	−2.9	+4.4	−41.8	−44.3
V	192	137	184	156	12	−4.2	+13.9	−91.2	−92.3
VI	343	480	382	209	488	+11.4	−56.4	+1.6	+133.5
VII	115	—	147	135	92	+27.8	—	—	−31.8
VIII	496	—	201	567	388	−59.4	—	—	−31.6
IX	40	—	131	281	193	+127.5	—	—	−31.3
X	127	—	42	65	27	−66.9	—	—	−58.5
XI	197	—	181	89	36	−8.1	—	—	−59.6
XII	87	—	96	104	96	+10.3	—	—	−7.7
XIII	1353	—	1165	1117	825	−13.9	—	—	−26.1
I–V	636	505	680	603	245	+6.9	+19.4	−51.5	−59.4
I–VI	979	985	1062	812	733	+8.5	−17.6	−25.6	−9.7
VII–IX	651	—	479	983	673	−26.4	—	—	−31.5
X–XIII	1764	—	1484	1375	984	−15.9	—	—	−28.4
VII–XIII	2415	—	1963	2358	1657	−18.7	—	—	−29.7
I–XIII	3394	—	3025	3170	2390	−10.9	—	—	−24.6

Although the estimated increase on eastern Melville (strata I–V) in 1972–73 could possibly be accounted for by calf increment, we do not believe this to be the case, as survival would have had to have been exceptionally high. It is possible that some of the mortality (suggested by the overall decline on Melville, 1972–73) took place on eastern Melville (strata I–V), but was subsequently masked by movements of muskoxen from the west (strata VII–XIII). Unfortunately, only stratum XIII was surveyed in the following late winter of 1974. Therefore, the possibility of movements of muskoxen between eastern and western Melville, that could mask mortality which had occurred on one of those areas, persists. We saw 1038 muskoxen on stratum XIII and estimated 1429 muskoxen on 14 April, 1974. Our calculations suggest a 5.6% increase over winter 1972 and a 22.7% increase over winter 1973. We cannot account for those increases through yearling recruitments. Therefore, we suggest, that our observations of muskoxen on stratum XIII indicated that muskoxen had moved from other areas during winter 1973–74. Most likely the influx was from eastern Melville (strata I–V) to escape the severe winter conditions there. Our observations tentatively indicate that movements of muskoxen do occur between eastern and western Melville in some winters. Variations between total observed and estimated values and the lack of survey information from strata VII–IX in summer 1974 masks possible redistributions of muskoxen by stratum during that time period. But total observations given in Miller and Russell (1976:App. 27 and 28) suggest that most of the mortality occurred on strata I–V (eastern Melville).

We infer on the basis of total on and off transect observations that muskox numbers on strata X–XIII more probably remained about stable from summer 1973 to summer 1974 rather than dropping about 28.4% as suggested by our estimates (Table 10, Miller and Russell 1976:App. 27 and 28). Also, numbers of muskoxen on stratum VI (Dundas Peninsula) more probably remained about stable rather than increasing about 133.5% as suggested by our estimates (Table 10, Miller and Russell 1976:App. 27 and 28). The overall 24.6% decline in muskox numbers on Melville from summer 1973 to summer 1974 is acceptable based on both total observed and estimated numbers.

Strata VII–IX were not surveyed in summer 1974. The numbers of muskoxen on different areas of Melville, as outlined above, varied greatly in summer 1974. Thus, we assumed from past knowledge of distributions and numbers of muskoxen on Melville that the changes on strata X–XIII from 1973 to 1974 most closely approximated the changes on strata VII–IX during the same period. Also, because calf production was extremely low on strata I–VI (3.9%) and relatively high (13.0%) in strata X–XIII in 1974, we judged that the overall percentage of calves to total muskoxen segregated on all strata surveyed in 1974 (9.7%) was the best estimate of calf production on strata VII–IX in 1974.

Therefore, muskoxen supposed to be on strata VII–IX in summer 1974 were extrapolated (Miller and Russell 1976: 87–89).

The adjusted estimate of the number of muskoxen on Melville in summer 1974 is 2390, or 139% increase in number of muskoxen estimated to be on Melville in summer 1961.

1.1.8. Muskox groups

Percentage distributions of muskoxen and muskox groups by group size are given in Miller and Russell (1976:Figs. 30–34). No direct relationship between the highest percentage of total muskoxen seen and the group size representing the highest percentage of observed groups was evident among muskoxen on Melville (Table 11, and by stratum in Miller and Russell 1976: App. 39–43). The mean and range of group

Table 11
A comparison of grouping statistics from aerial surveys of muskoxen on Melville Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles: Mean	Range
Mar–Apr 1972	167	6	12.8	2–77
Aug 1972[1]	78	17	9.2	2–24
Mar–Apr 1973	146	0	17.8	2–110
Jul–Aug 1973	310	80	10.0	2–38
Jul–Aug 1974[2]	247	36	7.2	2–25

[1]Only strata I–VI were surveyed in Aug. 1972.
[2]Strata VII, VIII and IX were not surveyed in Jul.–Aug. 1974.

Table 12
Muskox calf distribution in relation to maternal summer group sizes, Melville Island, Northwest Territories

Annual statistics	Calves per group: 0	1	2	3	4	5	6	7	8	9	1–9
Average group size											
1972	6.4	9.9	13.8	15.0	24.0						12.8
1973	5.5	9.7	9.2	12.6	16.2	22.1	21.4	29.0	28.0	22.0	13.7
1974	5.5	8.4	11.6	13.9	16.0	17.7		21.0			11.9
Range of group sizes											
1972	2–17	5–14	7–24	15–15	24–24						5–24
1973	2–23	5–21	5–16	8–38	10–32	13–27	16–36	29–29	28–28	22–22	5–38
1974	2–19	3–13	6–22	11–25	12–19	12–21		21–21			3–25
% of all groups with calves by calves per group											
1972	—	40.7	40.7	14.8	3.8						
1973	—	10.9	29.7	22.7	20.3	7.8	5.5	0.8	1.5	0.8	
1974	—	31.5	31.5	22.2	7.4	5.5		1.9			

sizes were markedly larger for muskox groups in winter than in summer (Table 11). We suggest that the larger group sizes in winter represent coalescence of several summer groups. Many of those gatherings may have a maternal bloodline as a core, and males of a more or less common stock.

During winter restricted forage availability and greater energy demands cause the smaller summer social units to concentrate on the restricted but more productive sedge meadows; hence, the larger winter groups. Calving takes place while muskoxen are in winter groups and conceivably larger groups could afford more protection against predation by wolves. The muskoxen disperse into smaller closed social units in late spring and early summer with the melting of snow and freshening of vegetation. They remain in smaller groups until the coming of the rut in late summer when they merge with neighbouring groups into larger aggregations.

There was a relatively strong trend for the largest mean group sizes to be associated with the strata that had the most muskoxen, although there were slight variations among the survey periods (Miller and Russell 1976:App. 39–43). The two largest groups seen, 110 and 77 muskoxen, were on stratum XIII which was the stratum with highest numbers and densities. The group of 110 was a temporary aggregation caused by the hunting activities of a pack of nine wolves.

When first observed one wolf was standing in the middle of the loosely grouped muskoxen, and the other eight wolves were all grouped on the eastern periphery of the muskox group. When we returned to the area 5 days later we did not see the wolves, and we observed 109 muskoxen in three groups. Such stress may commonly be the cause of temporary formation of large aggregations of muskoxen.

In summer 1973 mean and maximal group sizes were slightly larger than those in summer 1972 and 1974, possibly because calf production was relatively high in 1973. The smaller mean and range of group size in summer 1974 reflects the high mortality of the spring.

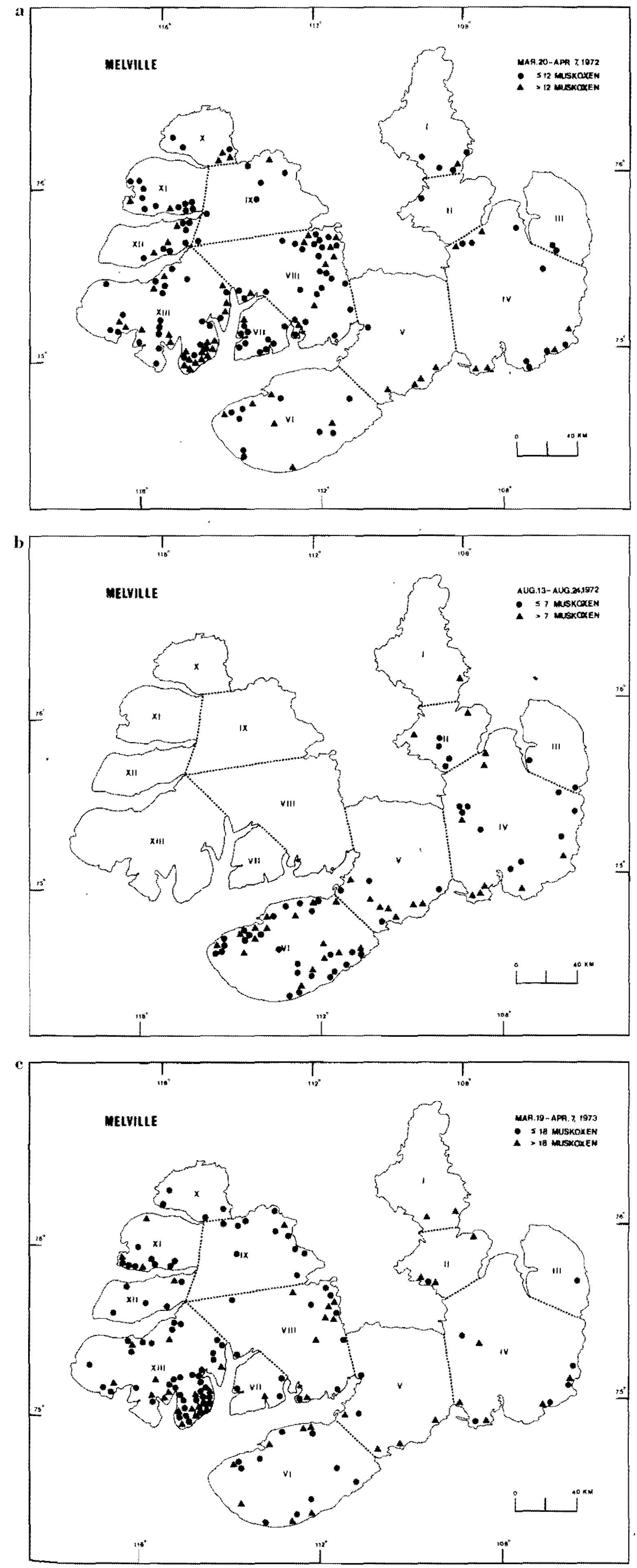
In March–April 1972 and 1973, and July–August 1973, when the island was completely surveyed, the number of groups exceeding the mean group size of each survey period was 36.2%, 33.3% and 32.3%, respectively. Strata XIII, VIII, VI and IV, the first four strata in occurrence of muskoxen, consistently had the largest number of groups exceeding the mean group size and in the same order (Fig. 4). Those observations parallel stratum preferences that we determined by stratum according to muskox distribution (Miller and Russell 1976:App. 24–28).

Tener (1963) reported that the mean group size was 11.9 for muskoxen, excluding five single bulls, in summer 1961. This is higher than mean group sizes we found in summer 1972, 1973 and 1974. We suggest, the relatively small sample size and high calf production in 1961 account for most or all of the differences. This suggestion is, in part, supported by the similarity in group sizes for 1961 and 1973, when percentage calf productions were similar.

Calves as percentages of their maternal groups (groups with calves) varied from 7.1 to 28.6% in summer 1972, 7.9 to 40.9% in summer 1973 and 7.7 to 41.7% in summer 1974. The observed variations in representations of calves by groups led us to suggest that calf mortality is either highly variable among groups or the number of producing females varies greatly from group to group. Although there was considerable overlap in sizes of groups without and with various numbers of calves, on the average, group sizes increased as the number of calves in the group increased (Table 12).

In summers 1972, 1973 and 1974, 44.3%, 55.6% and 25.6% of all groups of two or more muskoxen contained calves. This decrease in 1974 further indicates the severity of winter conditions in 1973–74 and its indirect impact on muskox repro-

Figure 4



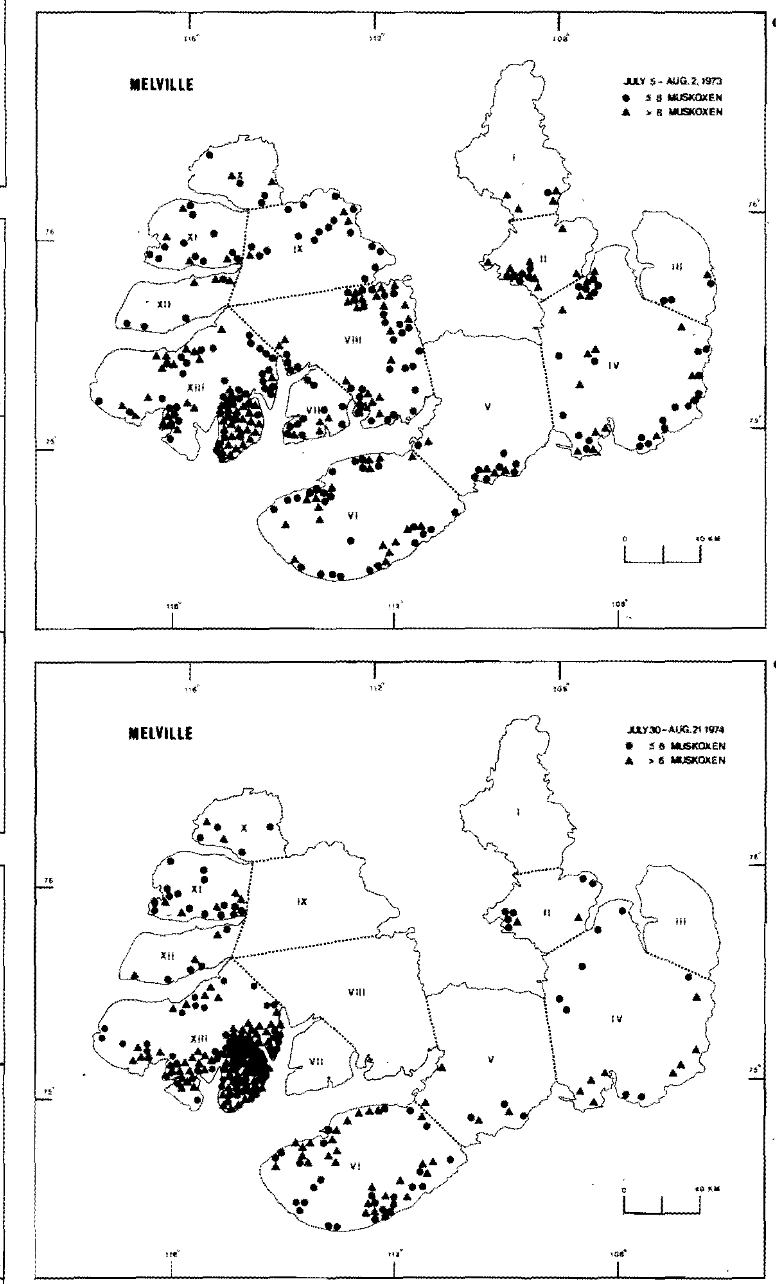
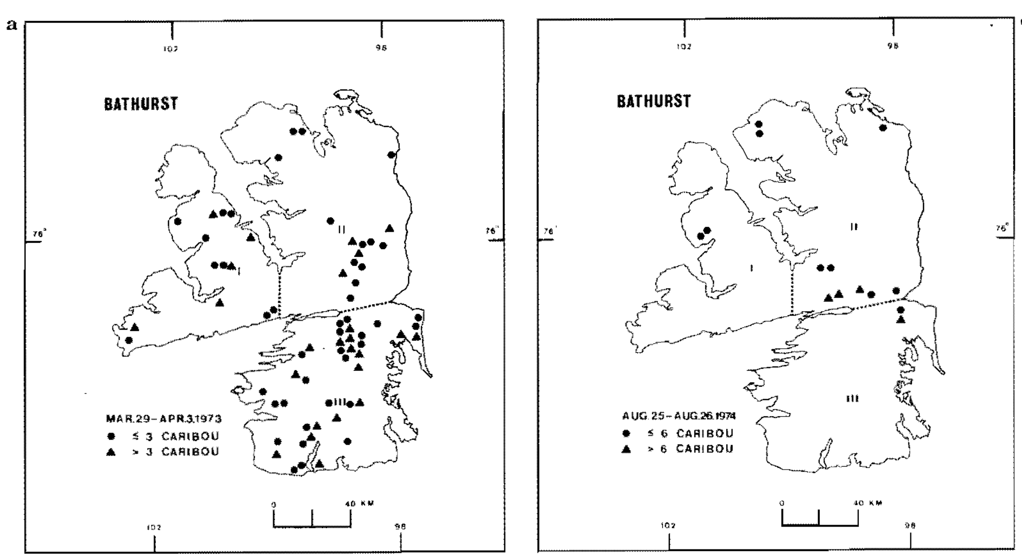
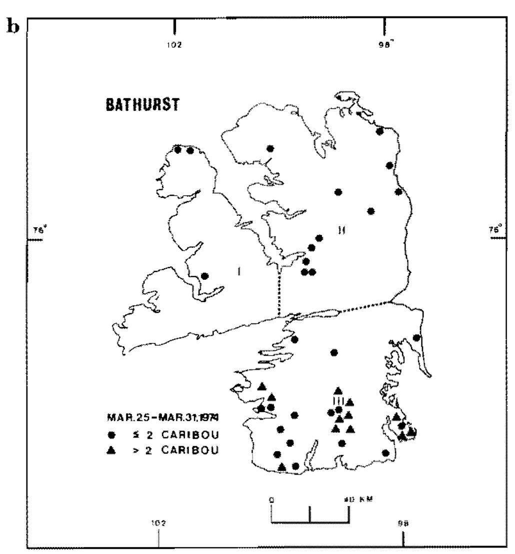


Figure 4
Distribution of muskoxen by group sizes less than or equal to and greater than the average group size on Melville Island, NWT, (a) strata I–XIII, March–April 1972; (b) strata I–VI, August 1972; (c) strata I–XIII, March–April 1973; (d) strata I–XIII, July–August 1973; (e) strata I–VI, X–XIII, July–August 1974.

Figure 5
Distribution of Peary caribou by group sizes less than or equal to and greater than the average group size, Bathurst Island, NWT, (a) March–April 1973; (b) March 1974; (c) August 1974.

Figure 5





duction. Only 1.9% of all groups seen with calves were on eastern Melville (strata I–V). While over 59% of all groups seen with calves were restricted to southwestern Melville (stratum XIII), Bailey Point.

1.2. Bathurst Island

1.2.1. Caribou distributions

In March–April 1973, 60% of the caribou were on stratum III. The remaining caribou were equally distributed between stratum II, 18% and stratum I, 22% (Fig. 5a). Thus, the caribou preferred only stratum III, occurred as expected on stratum I, and were below the expected rate on stratum II.

In March 1974 the distribution of caribou was similar to March–April 1973. Seventy-four percent of the caribou occurred on stratum III, 21% on stratum II, and 5% on stratum I in March 1974. However, actual numbers, both observed and estimated, were dissimilar between years (Table 13). The observed distribution again indicated that caribou preferred only stratum III, but occurrences were lower than expected on both stratum I and stratum II.

In August 1974, the distribution (Fig. 5c) varied considerably from the 1973 and 1974 late winter surveys (Fig. 5a, b). No caribou were seen on transect in stratum III, although 15% of the total caribou observed were off transect on that stratum. Based only on the transect observations 83% of the caribou occurred on stratum II and 17% on stratum I. A preference was shown by animals on and off the transect for stratum II and occurrence on strata I and III was only as expected.

The distribution of caribou in August 1974 was comparable to that observed in June–July 1961 (Tener 1963) and was reversed from the patterns of March–April 1973 and March 1974. In 1961, Tener estimated that over 54% of the caribou were on stratum II, and 45% and 0.4% on stratum I and stratum III, respectively.

The results of both late-winter surveys (Table 13) indicate that the southeastern part of the island (stratum III) is the major wintering area. The distributions of caribou in June–July 1961 and in August 1974 indicate that in summer most caribou on the island range over the northern part. These findings are in agreement with statements by Inuit residents of Resolute Bay (Bissett 1968, Freeman 1974) who believe that the caribou on Bathurst winter in the southeast, move to the northeast to calve, summer in the north, and return south in the autumn.

An index to the preferences shown by caribou for established elevational zones is given by stratum for the three surveys in Miller and Russell (1976:App. 44 and 46). In March–April 1973 caribou showed the greatest preference for areas between 60–300 m in stratum III. This preference is masked in the overall distribution of caribou by elevation (Fig. 6a) because of the relatively low occurrence of caribou within these zones on strata I and II. In March 1974 more of the observed caribou had shifted to lower elevations, but some still showed a preference for the high ground of stratum III (Fig. 6b). In August 1974 the observed caribou had moved to higher ground (Fig. 6b) and showed the strongest preference for the 151–300 m zone in stratum II.

The distributions of caribou by elevation during the three surveys indicate an overall preference for intermediate and high elevational zones. It is our observation that, in summer, caribou on coastal areas usually forage on the higher and drier sites. We assume that the preference shown by caribou for the low ground of stratum III in March 1974 was in response to stresses of the severe winter conditions at that time.

Table 13
Observed and estimated densities and numbers of Peary caribou on Bathurst Island, Northwest Territories, obtained from aerial surveys

Date	Caribou seen on and off transect	Transect width km	Caribou seen on transect	Caribou/100 km²			Estimated caribou		
				Mean	±	SE	Estimate	±	SE
Mar–Apr 1973	203	0.8	83	4.1		0.9	654		143
		1.6	134	3.3		0.5	527		79
Mar 1974	81	0.8	31	1.5		0.5	241		81
		1.6	58	1.4		0.4	226		59
Aug 1974	84	0.8	16	1.2		0.7	187		115
		1.6	41	1.4		0.8	231		130

An index to the preferences shown by caribou for zonal distances from the seacoast is given by stratum for the three surveys in Miller and Russell (1976:App. 45 and 47). The overall occurrence of caribou in relation to the seacoast in March–April 1973 indicates preference for those sites >15.0 km inland, but suggests preferences for sites >10 km inland (Fig. 6c). No overall preferences were clearly determined in March 1974. Weak preferences were suggested however, for the 10.1–15.0 km and >15.0 km zones (Fig. 6d). Within stratum preferences were highly variable in March–April 1973 and March 1974 (Fig. 6c), and no pattern could be discerned. In August 1974 the pattern of distribution in relation to the seacoast changed markedly from those patterns observed in late winter (Fig. 6c, d).

Total absence of caribou on sites within 2.5 km of the seacoast in August 1974 was in contrast with Tener's (1963) observation of a strong coastal affinity by caribou on Bathurst in June–July 1961. This preference may still occur in early summer when they are moving into calving and early summering areas.

1.2.2. Caribou recruitment

We did not identify any short yearling (<1 year of age) caribou during either 1973 or 1974 late winter surveys. No caribou calves were observed during the August 1974 survey, and we conclude that few, if any, calves were born or successfully reared that year.

1.2.3. Caribou numbers

In summer 1973 as delays prevented a survey of Bathurst we have calculated an estimate for caribou numbers. We base our calculations on the previous late winter estimates for that island, an assumed winter average mortality and the average percentage of calves seen on four other islands in summer 1973 (Miller and Russell 1976:100–101). Before calculating the summer estimate, however, the 1973 winter estimate had to be corrected for possible observational error that was probably inherent in all of our late winter surveys of caribou. The error would result from the difficulty of seeing whitish-coated caribou against a snow background causing "lower" winter counts. The late winter counts on Melville, Prince Patrick, Eglinton and Byam Martin islands in 1973 were consistently exceeded by the subsequent summer counts and estimates (exclusive of newborn calves). Using data from those islands we determined the degree of assumed observational error, and corrected our 1973 late winter estimate of caribou on Bathurst accordingly. The calculations gave an estimate of 721 caribou on Bathurst in July–August 1973. Subsequent computer analysis placed the estimate at 712 caribou.

Tener's (1963) estimate of 2723 caribou in summer 1961 and our estimate of 712 in summer 1973 indicate a decline of 73.9% during the 12-year period. The estimated percentage decline of caribou on Melville for the same period was similar, 12,799

Figure 6
Distribution of Peary caribou and muskoxen on Bathurst Island, NWT, (a) by elevational zones, March–April 1973; (b) by elevational zones, 1974; (c) by distance from the seacoast, March–April 1973; (d) by distance from the seacoast, 1974. No survey July–August 1973.

Figure 6

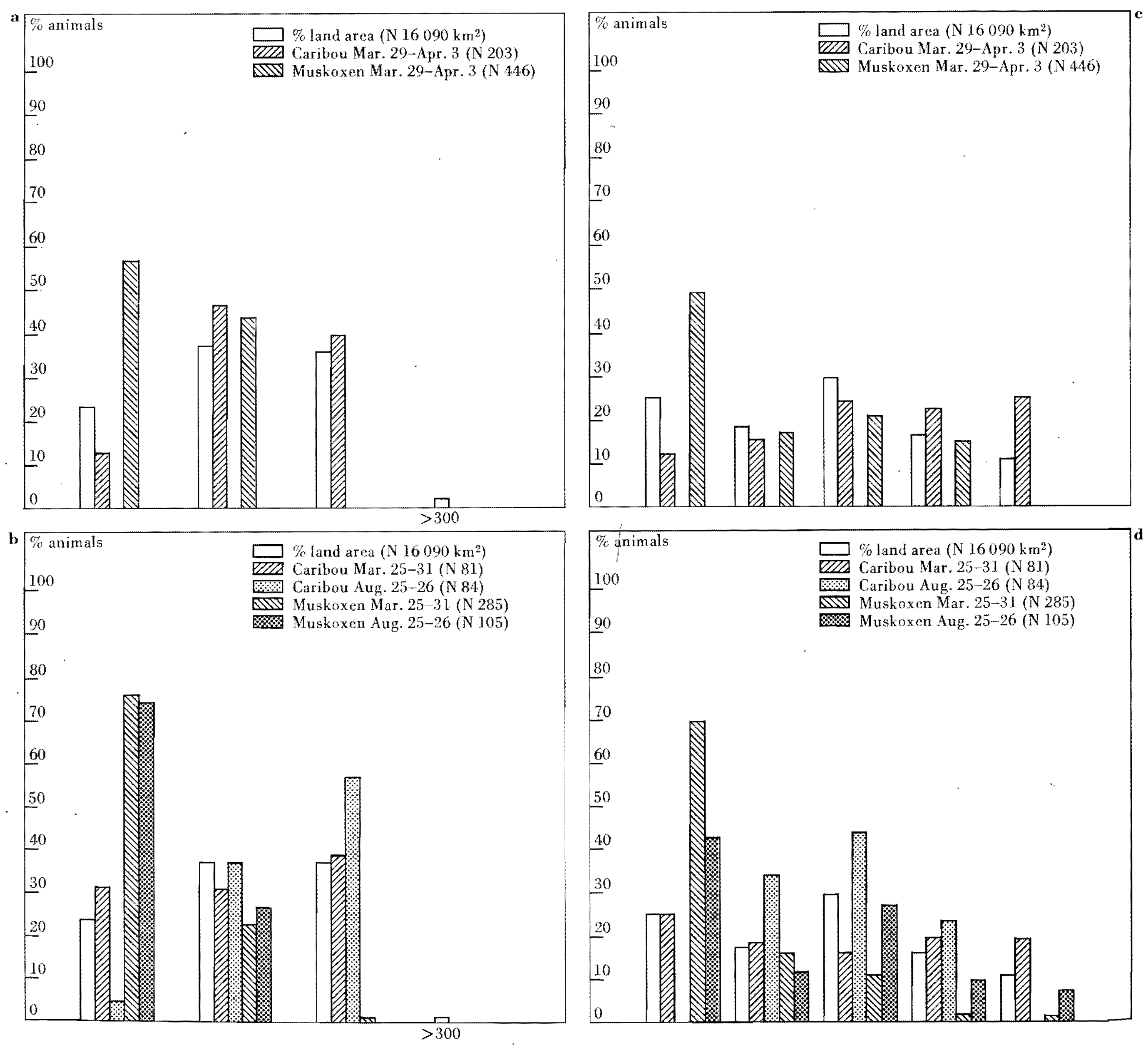


Table 14
A comparison of grouping statistics from aerial surveys of Peary caribou on Bathurst Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles: Mean	Range
Mar–Apr 1973	69	10	3.3	2–6
Mar 1974	41	17	2.7	2–4
Aug 1974	14	1	6.4	2–15

Table 15
Observed and estimated densities and numbers of muskoxen on Bathurst Island, Northwest Territories, obtained from aerial surveys

Date	Muskoxen seen on and off transect	Transect width km	Muskoxen seen on transect	Muskoxen/100 km²: Mean	± SE	Estimated muskoxen: Estimate	± SE
Mar–Apr 1973	446	0.8	77	3.8	1.7	607	273
		1.6	170	4.2	1.2	672	194
Mar 1974	285	0.8	60	2.9	1.0	468	162
		1.6	134	3.2	0.8	522	121
Aug 1974	105	0.8	16	0.8	0.5	136	78
		1.6	37	1.0	0.4	164	70

to 3425, 73.2%; and on Prince Patrick slightly less, 2254 to 807, 64.2%. The marked decrease between summer 1973 and summer 1974 of about 68% accelerated the decline on Bathurst from summer 1961 to 1974 to 91.5%.

If the 1973 adjustment for observational error in winter is applied to the March 1974 estimate of caribou (226) on Bathurst the result (278) is higher but similar to the August 1974 estimate of 231, suggesting that losses after March were about 20%. There is a possibility, however, that some of the mortality that occurred between March and August was offset by the return from Cornwallis of caribou that had moved there in winter.

1.2.4. Caribou harvest

The caribou on Bathurst Island are hunted by the Inuit of Resolute Bay. The kill statistics (Miller and Russell 1976:Table 29) vary according to the source. However, all data show a marked increase in the caribou killed on Cornwallis in the winter of 1973–74. Inuit hunters believe that caribou moved from Bathurst to Little Cornwallis and on to Cornwallis during the winter of 1973–74 (Freeman 1974). The increased kill supports that supposition.

1.2.5. Caribou groups

Average group sizes in August 1974 greatly exceeded those for March–April 1973 and March 1974 although the number of groups seen in August 1974 was reduced by factors of 4.9 and 2.9 from those groups seen during the respective spring surveys (Table 14, and by stratum in Miller and Russell 1976:App. 49). These observations add further support to the expected trend of greater dispersion and smaller group sizes in winter than in summer. The persistence of this pattern in a summer following a severe winter suggests that mortality (unless total) and stress do not strongly influence the subsequent pattern in the following season, and that such behaviour is apparently density independent except in magnitude.

Between 19 June and 7 July 1961 Tener (1963) recorded 79 groups of caribou with average group sizes of 3.7 to 4.7 (22 solitary caribou excluded). Reasons for the higher average group sizes in August 1974 (Table 14) than in June–July 1961 are obscure. Perhaps, the differences were due to the relatively small sample size and the comparative lateness of the survey in 1974. Our impressions, supported by grouping data for Peary caribou on Melville and Prince Patrick islands, are that caribou groups increase in size prior to calving, stabilize or temporarily decrease during calving, then increase during postcalving from late July at least into August. This pattern of summer group formation is comparable, on a smaller scale, to the grouping tendencies of barren-ground caribou on the mainland (Miller 1974). Group sizes become larger when the caribou leave coastal sites and move to inland areas in late July and early August.

Percentage distributions of caribou and caribou groups by group size are given in Miller and Russell (1976:Figs. 44–46). There appears to be no direct relationship between the group size with the greatest percentage of the total caribou seen and the group size that represents the greatest percentage of groups seen. Although data from Table 14 and Miller and Russell (1976:App. 49) indicate no marked influence of mortality and stress on groupings in following seasons, there does appear to be a strong influence causing reduction in group size during the period of stress and mortality. In March–April 1973, groups of more or less than the mean group size were found on all strata (Fig. 5a) but in March 1974 no groups exceeded the mean group size in strata I and II (Fig. 5b). This further supports the belief that mortality and stress are largely responsible for the observed distributions. Only the smaller groups or remnants of large groups remained on strata I and II following the unfavourable winter of 1973–74.

1.2.6. Muskox distributions

The distribution of muskoxen among the three strata of Bathurst did not vary as much, from one survey to another, as did the distribution of caribou, although numbers of muskoxen also declined (Table 15; Fig. 7; Miller and Russell 1976:App. 50). The greatest numbers of muskoxen were found on stratum III during all three surveys: 48% in March–April 1973, 74% in March 1974, and 50% in August 1974. Stratum II contained 24% and 20% of the muskoxen in March–April 1973 and March 1974, respectively, but 48% in August 1974.

Figure 7
Distribution of muskoxen by group sizes less than or equal to and greater than the average group size, Bathurst Island, NWT, (a) March–April 1973; (b) March 1974; (c) August 1974.

Muskoxen on stratum I decreased from 28% of the total in March–April 1973 to 6% in March 1974. No muskoxen were seen on transect on stratum I in August 1974, but 8% of the total muskoxen seen on and off transect were on stratum I. The observed distributions indicated that muskoxen preferred only stratum III. Muskoxen occurred on stratum II at lower rates than expected during March–April 1973 and March 1974, and as expected in August 1974. Muskoxen on stratum I occurred as expected in March–April 1973, then dropped to lower than expected rates of occurrence in March and August 1974.

Tener (1963) also estimated the greatest percentage of muskoxen (46%) on stratum III in June–July 1961, with 36% on stratum I and 18% on stratum II. Findings from 1961 (Tener 1963) and 1973 and 1974 indicate that most muskoxen frequent central and southern Bathurst Island.

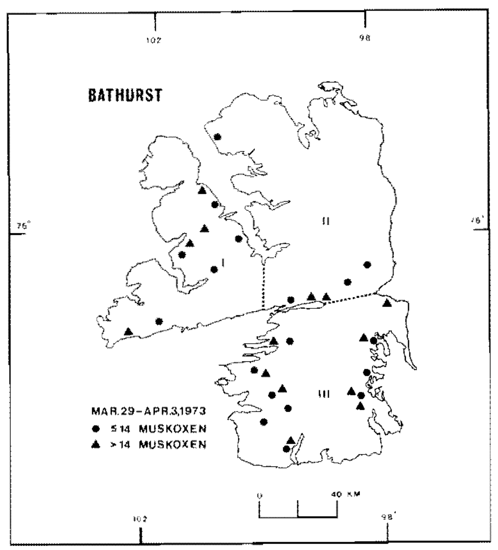
Muskoxen showed strong overall preference for the <60 m zone (Fig. 6a, b) during all three surveys and for the zonal distance within 2.5 km of the seacoast in March–April 1973 and March 1974, with a suggested preference in August 1974 (Fig. 6c, d) (see also, Miller and Russell 1976: App. 51 and 52). Within stratum, preferences were always greatest for the <60 m area of stratum III. We do not know to what degree environmental stresses influenced preferences for inland sites on stratum III. We believe, however, that movement to the interior in summer along water courses is part of the normal pattern. The coastal areas of stratum III and, to a lesser degree the interior, must be considered as critical habitat for muskoxen on Bathurst Island.

1.2.7. Muskox recruitment

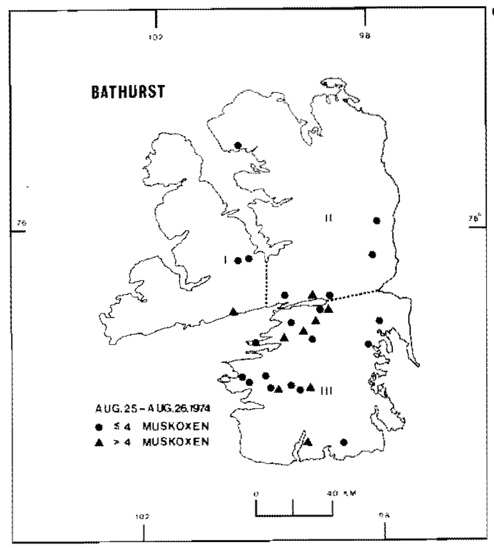
As few muskoxen are born before the first week in April, it is not surprising that no calves were seen in either the March–April 1973 or March 1974 surveys. However, the failure to see any calves in August 1974 is evidence that, as in the case of caribou, few, if any, muskoxen were born or reared successfully on Bathurst in that year.

Figure 7

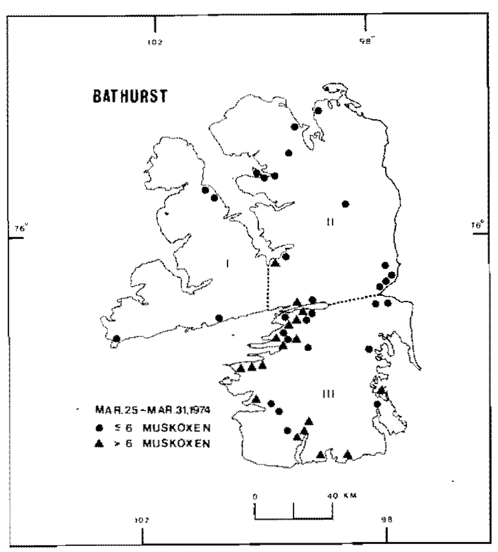
a



c



b



In March–April 1973, 33 (7.4%) of 446 muskoxen seen were short yearlings and in March 1974, 24 (9.2%) of 262 muskoxen observed were short yearlings. However, only 2 (1.9%) of 105 muskoxen seen in August 1974 were yearlings. Although we lack data on numbers of muskoxen that were born in 1973, we can conclude that few of them survived until their second summer.

1.2.8. Muskox numbers

Tener (1963) estimated that there were 1136 muskoxen on Bathurst in the summer of 1961. According to our surveys the number had decreased by 40.8% to 672 by March–April 1973 (Table 15, and by stratum in Miller and Russell 1976:App. 50). The numbers of muskoxen further decreased by 22.3% from April 1973 to March 1974, and between March and July 1974 there was a sharp decrease of 69.6%. The decrease from March–April 1973 to August 1974 was 75.6%. The overall decrease in number of muskoxen on Bathurst between summer 1961 and August 1974 was 85.6%.

1.2.9. Muskoxen groups

In March–April 1973 there were no solitary muskoxen and the average group size was relatively large, as expected for late winter. In March 1974, however, there was an unusually large number of isolated bulls to the number of groups seen and the average group size was small (Table 16, Miller and Russell 1976:App. 53). This atypical winter pattern for muskoxen resulted because snow cover forced the animals to leave their normally preferred feeding sites to seek forage on windblown

Table 16
A comparison of grouping statistics from aerial surveys of muskoxen on Bathurst Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles: Mean	Group size excl. singles: Range
Mar–Apr 1973	32	0	13.9	5–39
Mar 1974	48	8	6.9	2–17
Aug 1974	29	4	4.0	2–10

sparsely-vegetated ridges and knolls. The exposed sites could not support large groups of muskoxen for extended periods. Mortality and behavioural response to stress reduced the group sizes. In addition, intolerance brought on by stress may have led to fragmentation of groups and the unusual occurrence of solitary muskox bulls in late winter. The relatively low number of groups and the small average group sizes observed in August 1974 resulted from the continued loss of muskoxen on Bathurst from March to August 1974. Unlike caribou, the effects of mortality and stress were strongly evident in the grouping pattern of summer 1974.

Distributions between March–April 1973 (Fig. 7a) and March 1974 (Fig. 7b) were similar except for the overall reduction in group sizes and the marked absence of groups larger than the mean on stratum I. In August 1974 (Fig. 7c) there was a marked decrease in number and sizes of groups on stratum II. Although stratum III remained the preferred area, the number of muskoxen noticeably decreased and the proportion of groups below mean group size increased as a result of the spring die-off.

1.2.10. Bracebridge–Goodsir Inlet area

The valley between Bracebridge and Goodsir inlets is about 20 km wide (10 km to either side of a line joining the two inlets) and runs about 60 km from east to west across central Bathurst. It is of special interest because of the long-term biological studies being conducted there by the National Museums of Canada. Therefore, we have compiled separately the total num-

Table 17
Observed and estimated densities and numbers of Peary caribou on Prince Patrick Island, Northwest Territories, obtained from aerial surveys

Date	Caribou seen on and off transect	Transect width km	Caribou seen on transect	Caribou/100 km² Mean	±	SE	Estimated caribou Estimate	±	SE
Apr 1973	549	0.8	192	9.5		2.5	1504		395
		1.6	351	8.7		1.7	1381		269
Jul–Aug 1973	329	0.8	85	4.2		1.7	672		264
		1.6	205	5.1		1.6	807		259
Apr 1974	370	0.8	161	7.9		1.9	1255		296
		1.6	274	6.6		1.3	1049		212
Jul 1974	469	0.8	72	3.5		1.3	559		204
		1.6	163	3.9		1.1	621		177

bers of caribou and muskoxen seen on the area during Tener's (1961) survey in 1961 and ours in 1973 and 1974. Values in parentheses are percentages of total numbers of the species seen both on and off transect during the surveys.

In June–July 1961 only one of the caribou seen by Tener (1961) was on the area. During our surveys more caribou were seen on the area, even though total caribou numbers had decreased: March–April 1973, 18 (9%); March 1974, 2 (2%); and August 1974, 41 (49%).

In 1961 Tener (1961) saw 167 (69%) muskoxen on the Bracebridge–Goodsir lowland. During our surveys there were fewer muskoxen in the valley, both in absolute numbers and as a percentage of the total: 109 (24%) in March–April 1973, 75 (26%) in March 1974, and 20 (19%) in August 1974.

1.3. Prince Patrick Island

1.3.1. Caribou distributions

Distributions of caribou on the island (Table 17, Fig. 8, Miller and Russell 1976:App. 54) were not markedly different between surveys, with the exception of increased occurrence of caribou (26%) on stratum III in July 1974. Percentage frequency of occurrence was always greatest on stratum I: 84%, April 1973; 86%, July–August 1973; 73%, April 1974; and 64%, July 1974. Caribou showed a preference for stratum I during all surveys and for stratum III in July 1974. Caribou occurred at lower rates than expected on stratum II during all surveys, and on stratum III during the first three surveys. In summer, caribou tended to shift to the south and east coastal areas of stratum I, and also stratum III in 1974. Our observed distribution of caribou in July 1974 was similar to Tener's (1961) observed distribution in July 1961: stratum I, 68% in 1961, 64% in 1974; stratum II, 14% in 1961, 11% in 1974; and stratum III, 18% in 1961, 26% in 1974.

Unfavourable weather caused lengthy delays between survey flights in summer 1973. Therefore, movements of caribou from unsurveyed to surveyed areas could have taken place (results indicate that the reverse was not true). The tracks of many caribou leading north from Wilkie Point along the shores of Intrepid Inlet were evidence that such a movement may have preceded our survey of stratum III on 21 August 1973. Caribou were apparently moving inland by that time, and many caribou trails in the light snow cover on stratum III suggested more caribou had summered in the area than were observed.

We believe that stratum I is preferred in both winter and summer with south and east coastal sites being selected more in summer than winter. Stratum III appears to be used only in early summer. Occurrence of caribou on the Beaufort Formation of western Prince Patrick was much greater in 1973 and 1974 (Fig. 8) than in 1961.

An index to the preferences shown by caribou for elevational zones is given by stratum for the four surveys in Miller and Russell (1976:App. 55 and 56). Analysis of caribou distribution by elevation indicated the greatest overall preferences were consistently for intermediate 60–150 m elevational sites (Fig. 9a, b). These overall preferences, however, masked the redistribution of caribou in July 1974 when the greatest preference was shown for the <60 m coastal zone on stratum III. This observed preference most likely reflects the comparatively earlier date of survey in summer 1974 than in 1973. The use of the low ground of stratum III appears to be a temporal preference during early summer which we suggest may be tied to post-calving migratory behaviour.

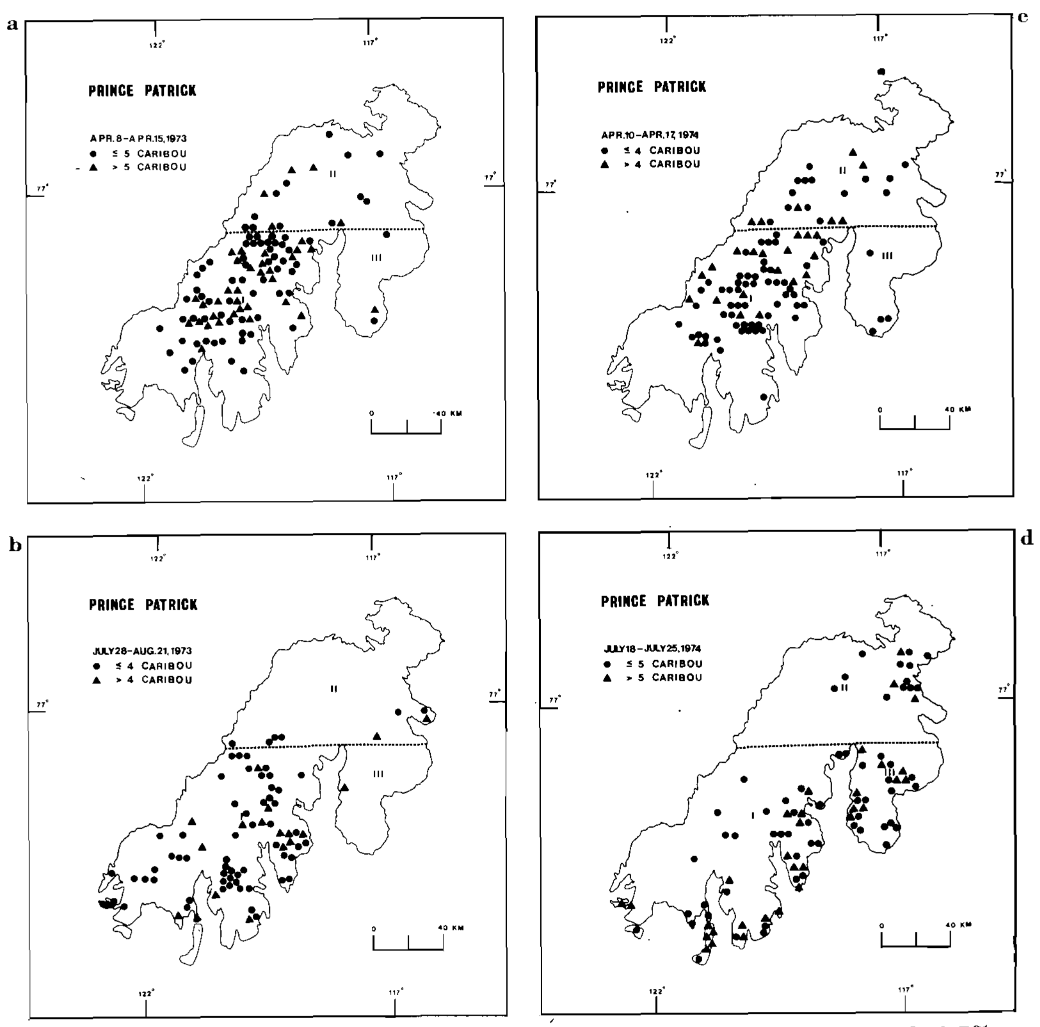
An index to the preferences shown by caribou for established zonal distances from the seacoast is given by stratum for the four surveys in Miller and Russell (1976:App. 57 and 58). The overall occurrences of caribou in relation to the seacoast in both April 1973 and 1974 (Fig. 9c, d) indicate strong preferences only for areas >15 km inland. Strong within stratum preferences were shown only for the >15 km area of stratum I. An overall reversal of late winter distributions relative to the seacoast occurred in both summers (Fig. 9c, d). Although the overall preference was for the <2.5 km zone in summer, the strongest within stratum preference was shown for the >15 km area of stratum I in July–August 1973. Smaller within stratum preferences were also shown for the 10.1–15.0 km zone and were suggested for more coastal areas in July–August 1973. In July 1974 caribou showed the strongest preferences for coastal areas of strata I and III with smaller preferences for zones up to 10 km from the seacoast.

Even though caribou occurred at a lower rate than expected on <60 m sites in July–August 1973 (Fig. 9a), they did show a preference for coastal areas in summer 1973 (Fig. 9c). This apparent contradiction seemingly supports our belief that while caribou often show preferences in early summer for coastal areas they usually seek out higher and drier ground on those sites.

Figure 8

Distribution of Peary caribou by group sizes less than or equal to and greater than the average group size, Prince Patrick Island, NWT, (a) April 1973; (b) July–August 1973; (c) April 1974; (d) July 1974.

Figure 8



1.3.2. Caribou recruitment

No short yearlings were seen in April 1973 or in April 1974. We can not explain their absence on Prince Patrick in those years. The winter of 1972–73 appeared favourable to caribou survival and the winter of 1973–74 appeared only moderately stressful to caribou on Prince Patrick.

Caribou calves represented 10.7% (33) of the caribou segregated in July–August 1973 and 7.0% (33) of the caribou seen in July 1974. The lower percentage of calves in summer 1974 than in summer 1973 indicates that the 1974 calf crop was relatively poor or that substantial mortality occurred before we surveyed in 1974.

In both years most calves were in stratum I. In 1973 all 33 calves were seen among 261 caribou segregated on stratum I (12.6% calves). In 1974, 24 of the 33 calves were seen on stratum I among 63.5% (298) of the total caribou (8.1% calves).

Figure 9

Distribution of Peary caribou and muskoxen on Prince Patrick Island, NWT, (a) by elevational zones, 1973; (b) by elevational zones, 1974; (c) by distance from the seacoast, 1973; (d) by distance from the seacoast, 1974.

Figure 9

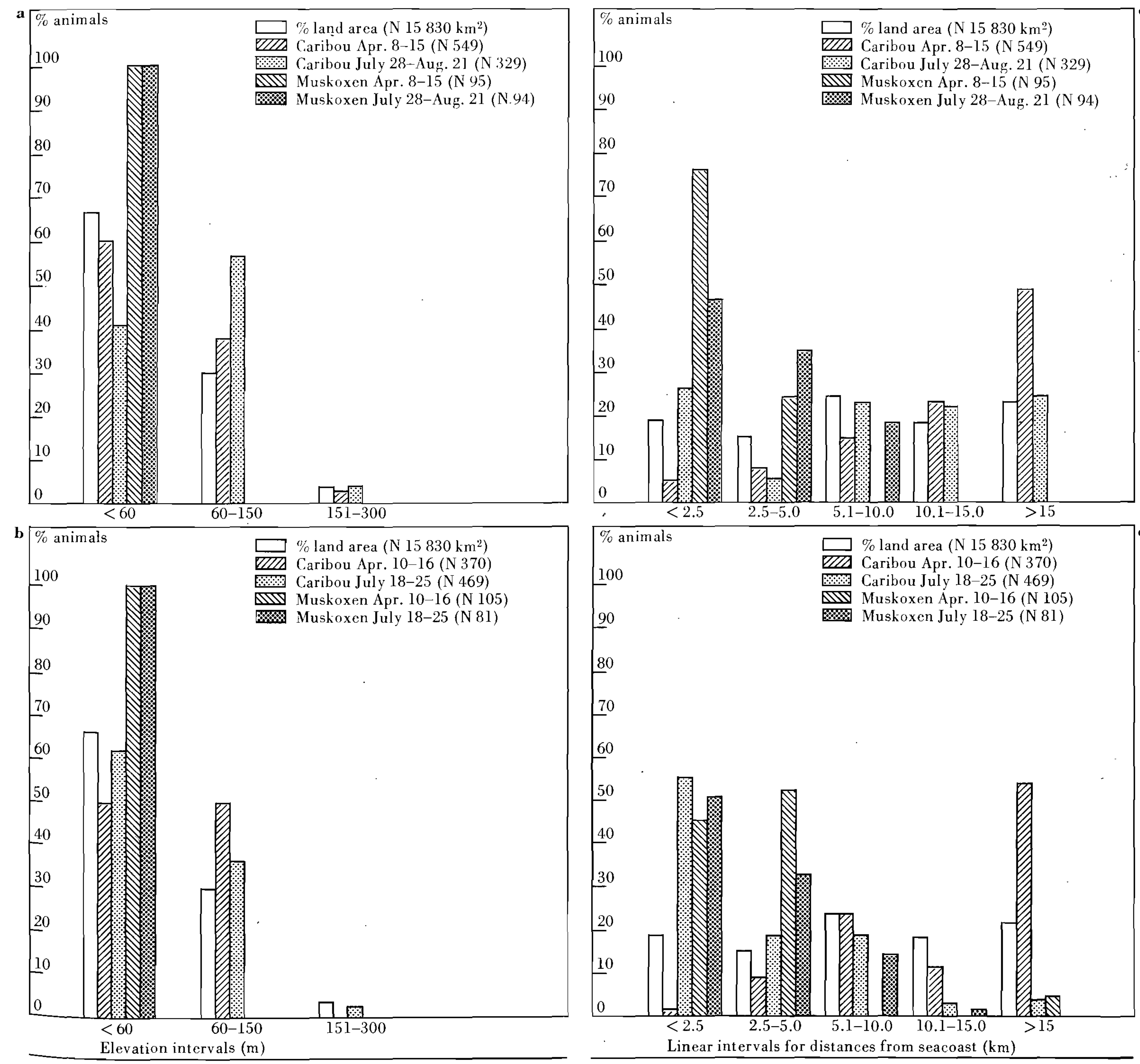


Table 18
A comparison of grouping statistics from aerial surveys of Peary caribou on Prince Patrick Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles Mean	Range
Apr 1973	108	3	5.2	2–18
Jul–Aug 1973	82	19	4.9	1–18
Apr 1974	98	15	4.3	2–16
Jul 1974	91	14	5.9	2–18

1.3.3. Caribou numbers

The estimated numbers of caribou on Prince Patrick showed marked seasonal changes that could not be accounted for by mortality (Table 17, and by stratum in Miller and Russell 1976:App. 54). Caribou numbers decreased from April to August 1973 and from April to July 1974 (Miller *et al.* 1977). This reduction was a reversal of the trend on Melville Island and suggested a spring movement of caribou from Prince Patrick to Melville and a return movement in autumn after freeze up (Miller *et al.* 1977).

Estimated numbers of caribou decreased by 24% between winters 1972–73 and 1973–74 and 23% between summers 1973 and 1974. Estimated numbers of caribou decreased 42% from April 1973 to July 1973, and had risen 30% by April 1974 to subsequently drop 41% by August 1974, for an overall decrease of 55% during the period of surveys.

Tener (1963) estimated that there were 2254 Peary caribou on Prince Patrick in July 1961. Results from our summer surveys indicate that numbers of caribou have declined from 1961 to 1973 by 64% and from 1961 to 1974 by 72%.

1.3.4. Caribou groups

The expected pattern of greater dispersion and smaller groups in winter than in summer is not persistent (Table 18, by stratum in Miller and Russell 1976:App. 59). Smaller group sizes in winter are more evident, albeit, not strongly so by within stratum analysis. Percentage distributions of caribou and caribou group sizes by group size show a weak trend for more large groups during summer. No overall pattern of distribution of caribou by group sizes less than or equal to and greater than average group sizes (Fig. 8) was discerned for within stratum or island comparisons by season. Although the ratios of groups above and below mean group sizes ($\bar{x}$) did not remain constant, the number of groups seen by season (Table 18) and the numbers above and below the means did show a consistent relationship.

	$\leq\bar{x}$	$>\bar{x}$
April 1973	71	37
April 1974	72	26
July–Aug. 1973	62	20
July 1974	59	32

We believe that the deviation from the expected pattern of group sizes of caribou by season was due to the relatively dense concentrations of caribou wintering on restricted areas. Only late winter densities of caribou on stratum I in 1972 and stratum VI in 1973, Melville Island, exceeded the densities on stratum I, Prince Patrick Island. Apparently, patchy availability of winter forage caused clumping of caribou which led to larger groups in winter on Prince Patrick.

The marked spring migrations of caribou to other islands reduced the numbers of caribou summering on Prince Patrick. We could not determine how migration affected summer group sizes. It is likely, however, that if all of the wintering caribou stayed on Prince Patrick each summer, resultant post-calving aggregations would have led to more large groups and or larger average sizes of summer groups.

1.3.5. Muskox distributions

The distributions of muskoxen on Prince Patrick during all surveys were limited to the coastal area east of Mould Bay and the land adjacent to Intrepid Inlet and Jameson Bay, with the exception of one bull muskox seen about 15 km from the west coast of the island (Fig. 10). During three surveys most of the muskoxen were east of Mould Bay on stratum I: 61.1%, April 1973; 54.7%, April 1974; and 84.0%, July 1974. Redistribution occurred in the spring of 1973 and in July–August 1973 most of the muskoxen (58.5%) were on stratum III.

The distributions obtained in Fig. 8a, b (within stratum preferences are given in Miller and Russell 1976:App. 60) and the preference index values indicate a strong affinity for <60 m sites. Within stratum preferences were consistent from April 1973 through April 1974. The shift to stratum I in July 1974 appears to reflect redistribution from strata II and III, but the lower number of muskoxen seen in July than in April 1974 (Miller and Russell 1976:App. 62) suggests either egress or observation error. We saw no evidence of mortality among muskoxen on Prince Patrick at that time which would explain the change in observed numbers.

Within stratum preferences are partially masked in the overall distributions of muskoxen by zonal distances from the seacoast (Fig. 9c, d, preferences by stratum are given in Miller and Russell 1976:App. 61) as indicated by muskox index values. Muskoxen showed the strongest preferences for the sites between 2.5 and 5.0 km from the seacoast in April 1973 and 1974 and July–August 1973. Muskoxen shifted more to coastal sites less than 2.5 km from the seacoast of stratum I in July 1974.

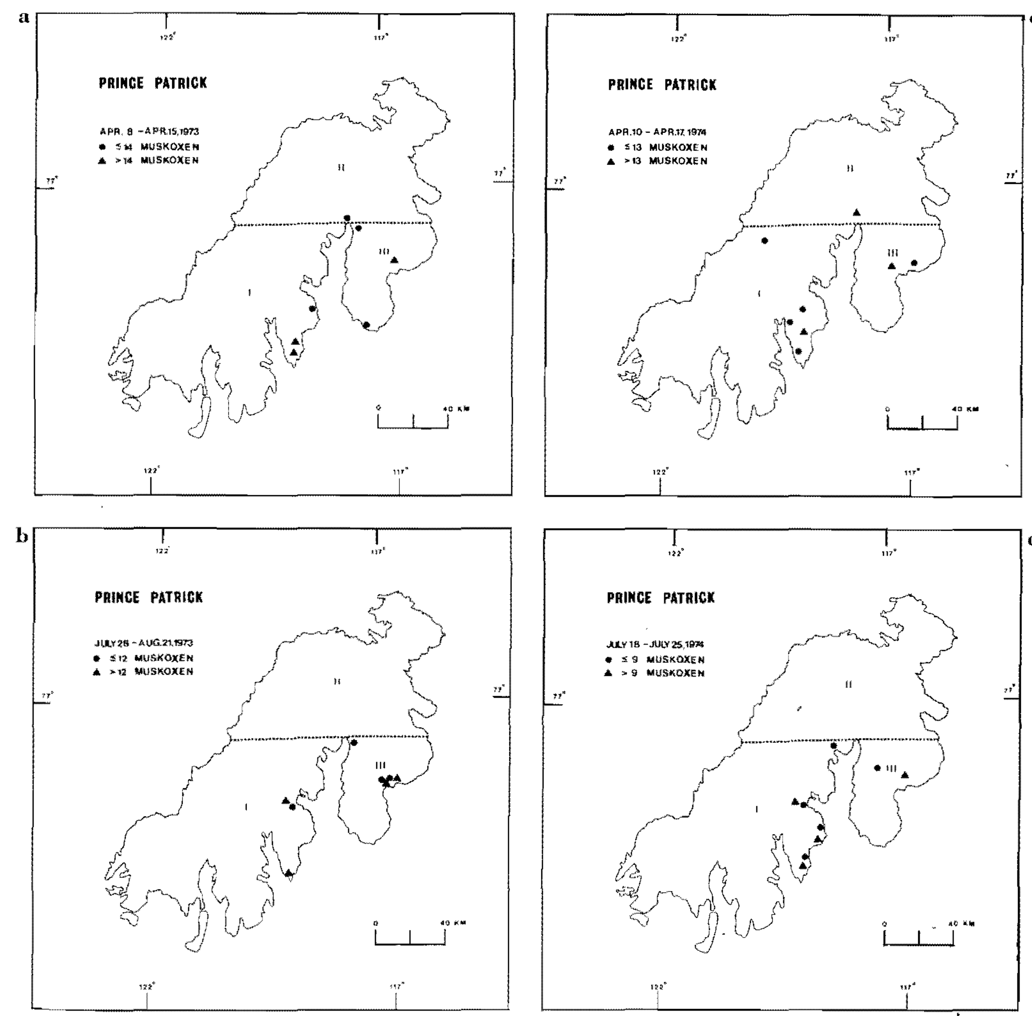
Our observations indicate that currently only the headlands between Mould Bay and Intrepid Inlet and Fitzwilliam Strait are important to muskoxen on Prince Patrick. We suggest from our empirical impressions of the island, that the areas currently occupied by muskoxen represent most of the habitat suitable for them.

1.3.6. Muskox recruitment

In April 1973, 3.2% (3) of the muskoxen seen were short yearlings; we did not see any newborn calves. In July–August 1973, however, we could not identify any

Figure 10
Distribution of muskoxen by group sizes less than or equal to and greater than the average group size on Prince Patrick Island, NWT, (a) April 1973; (b) July–August 1973; (c) April 1974; (d) July 1974.

Figure 10



yearlings, but the calf crop was 16.0% (15) of the observed muskoxen. In April 1974 the short yearlings represented 6.2% (4) of the 65 muskoxen segregated and newborn calves 3.1% (2). Again, in July 1974 we identified no yearlings. The calf crop had risen to 6.2% (5) of the observed muskoxen.

Our observations indicate that yearling survival was nil in 1973 and 1974 even though both winters appeared to be favourable and moderate, respectively, on Prince Patrick. The low number of calves in 1974 suggests that production was poor or a substantial loss occurred prior to our survey. Wolf predation possibly had a strong impact on the limited number of young produced by the few muskoxen on Prince Patrick. Wolves are attracted to the weather station at Mould Bay and there is an active wolf den in the vicinity. These conditions likely result in a higher than normally expected occurrence of wolves on the adjacent muskox areas and subsequently more predation on young muskoxen.

1.3.7. Muskox numbers

Muskoxen were in low numbers (Table 19, Miller and Russell 1976:App. 62) and in restricted distributions (Fig. 10) on Prince Patrick. The occurrence of muskoxen, however, does apparently represent a recolonization, most likely from Melville Island, since 1961. Tener (1963) did not see any muskoxen on Prince Patrick in the summer of 1961, and he concluded that muskoxen probably did not inhabit the island at that time.

The occurrence of low numbers of muskoxen in few groups and their restricted distributions confounded the subsequent estimates (Table 19). Variations in 0.8 and 1.6 km strip estimates most likely reflect error in the technique most likely caused by differences in clumping of muskoxen on the two strips. We suggest the totals of muskoxen seen on and off transects more closely approximate the actual number of muskoxen on Prince Patrick at that time than do the estimates.

1.3.8. Muskox groups

The low number of muskox groups does not allow detailed analysis of grouping data (Table 20, Miller and Russell 1976:App. 63). Although weak, the expected pattern of larger average group sizes in winter than in summer did hold. The small number of groups tended to mask this condition as shown by a comparison of percentage distributions of muskoxen and muskox groups by group size in Miller and Russell (1976: Figs. 68–71). No relationship between the highest percentage of total muskoxen seen and the group size representing the highest percentage of observed groups was evident among muskoxen on Prince Patrick.

In April 1974 the greatest number of muskoxen was seen and the extreme in ranges of group size by survey period was obtained. These conditions suggest ingress during the winter of 1973–74 as it is unlikely that we missed a large group of muskoxen during both previous surveys.

1.4. Mackenzie King Island

On 15 April 1973, we covered 12.5% of the island. On 11 April 1974, we increased the coverage to 25%. In 1973 we saw only three caribou, off transect, on a southwestern site. In 1974 we saw a total of 20 caribou including 15 on transect which gave an estimate of 60. In July 1961 Tener (1963) observed 111 caribou and estimated 2192. Macpherson (1961), in reporting an estimate of 882 caribou by geologists who surveyed the island in summers 1958–59, noted (p. 12) that there was evidence for changes in the number of caribou on Mackenzie King and the neighbouring islands. Macpherson partly based this belief on Stefansson's observations. Stefansson (1921) who discovered the island, described finding tracks in June 1915, which suggested the caribou were more numerous than on Banks Island where he had estimated 2000–3000 caribou. The following year in September, however, Stefansson noted the caribou were "... one tenth as numerous as a year and half before." (Stefansson 1921:476). Although there is evidence for seasonal as well as longer-term changes in caribou numbers, it is not clear how much of the 97% decline from 1961 (Tener 1963) to 1974 can be assigned to inter-island movement and or to a general decline in caribou numbers.

Tener (1963) did not see muskoxen in 1961, nor did we in 1973. We sighted six muskoxen off transect on Mackenzie King in 1974: one group of four on the northwest and a group of two on the eastern part of the island. C. J. Jonkel (pers. comm.) spoke of pilots seeing 12 muskoxen in 1967 or 1968 and two muskoxen in 1969 on Mackenzie King. R. Thorsteinsson and E. T. Tozer found an ancient muskox skull on Leffingwell Crags, Mackenzie King, in 1958 (*in* Macpherson 1961).

1.5. Borden Island

In 1973, on April 14 and 15, we surveyed 12.5% of the island but fog prevented a late-winter survey in 1974. In 1973, we saw only two caribou on a southeastern site. Tener (1963) saw 100 caribou and estimated a population of 1630 on Borden in 1961. The 1973 estimate of 16 caribou suggests the number of caribou has

Table 19
Observed and estimated densities and numbers of muskoxen on Prince Patrick Island, Northwest Territories, obtained from aerial surveys

Date	Muskoxen seen on and off transect	Transect width km	Muskoxen seen on transect	Muskoxen/100 km² Mean	± SE	Estimated muskoxen Estimate	± SE
Apr 1973	95	0.8	13	0.6	0.4	102	62
		1.6	22	0.5	0.3	86	43
Jul–Aug 1973	94	0.8	21	1.0	1.0	163	169
		1.6	39	1.0	0.6	152	101
Apr 1974	105	0.8	0	—	—	—	—
		1.6	23	0.6	0.4	91	57
Jul 1974	81	0.8	30	1.5	0.9	232	138
		1.6	30	0.7	0.4	114	63

declined by about 99% since 1961. In 1958–59 (Macpherson 1961), 1200 caribou were estimated for Borden. Noice (1924:117) suggested that caribou were not numerous on the island in 1916.

In 1973, 1961 and 1958–59 observers saw no muskoxen on Borden. Earlier explorers such as Stefansson (1921) had not observed muskoxen either.

1.6. Eglinton Island

1.6.1. Caribou numbers and distributions

The highest density of caribou obtained during all surveys was on Eglinton (Table 21). The 178 caribou seen on 4 April 1972 were rather uniformly distributed except at the north end of the island where no caribou were seen on the badlands. Only 27 caribou were seen on 10 August 1972, mostly on west central and southern sites. On 8 April 1973, 90 caribou were seen mostly on central and southern sites (Table 25). On 8 August 1973, the caribou count dropped to only seven animals, which were all on relatively well vegetated sites at the southern boundary of the badlands.

Again, in late winter 1974, observed caribou numbers increased markedly to 266 (Table 21). Their distribution was similar to April 1972, but slightly more northerly, with one group occurring on the badlands. On 25 July 1974, the observed caribou numbered only 25; they were distributed along southeastern sites. In summer 1961

Table 20
A comparison of grouping statistics from aerial surveys of muskoxen on Prince Patrick Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles Mean	Range
Apr 1973	7	0	13.6	2–32
Jul–Aug 1973	8	2	15.3	8–22
Apr 1974	8	1	15.0	3–41
Jul 1974	9	1	10.0	2–21

Tener (1963) saw 13 caribou on transect and 38 caribou off transect. Nearly all animals were found on interior sites.

There were considerable reductions in the total numbers of caribou observed in 1973 and estimated in 1973 and 1974 compared to 1972 (Table 21), although the percentage coverage of the island increased by factors of 1.8 and 2.0. We observed no evidence of high mortality on the island to account for the decline in numbers of caribou from winter 1971–72 to winter 1972–73, nor can mortality account for the discrepancies between late winter and summer surveys during the three years. Data indicate that caribou leave Eglinton in late spring and return in varying numbers after the autumn freeze-up. This is probably a regular annual movement but the problem warrants further investigation. Both Prince Patrick and Melville are only 25 km from Eglinton and the ice between is relatively

Table 21
Observed and estimated densities and numbers of Peary caribou on Eglinton Island, Northwest Territories, obtained from aerial surveys

Date	Caribou seen on and off transect	Transect width km	Caribou seen on transect	Caribou/100 km² Mean	± SE	Estimated caribou Estimate	± SE
Apr 1972	178	0.8	82	43.7	11.0	677	171
		1.6	139	37.0	7.9	574	122
Aug 1972[1]	27	0.8	—	—	—	—	—
		1.6	20	5.3	3.8	83	59
Apr 1973	90	0.8	13	3.3	1.3	51	20
		1.6	46	5.8	1.0	90	15
Aug 1973	7	0.8	5	1.3	1.2	20	18
		1.6	6	0.8	0.6	12	9
Apr 1974	266	0.8	101	26.0	7.0	403	108
		1.6	151	19.4	3.8	301	60
Jul 1974	25	0.8	8	2.1	1.4	32	21
		1.6	9	1.2	0.6	18	10

[1]The 0.8 km strip was not estimated in Aug. 1972 because a helicopter was used to do the survey.

Table 22
A comparison of grouping statistics from aerial surveys of Peary caribou on Eglinton Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles Mean	Range
Apr 1972	70	26	3.4	2–9
Aug 1972	3	0	9.0	2–14
Apr 1973	17	0	5.3	2–17
Aug 1973	3	2	5.0	5–5
Apr 1974	75	10	3.9	2–12
Jul 1974	5	0	5.0	3–8

smooth. Therefore, no serious barriers to movements between those islands and Eglinton exist. The large number of caribou observed on stratum XIII on Melville in August 1973, where few had been observed in April 1973, suggests that it is possibly the summering range for caribou wintering on Eglinton.

The distribution of caribou by elevation was random in April 1972, 1974 and July 1974 (Miller and Russell 1976:Table 38, Figs. 76–78). All of the caribou seen on 10 August 1972 had moved to sites above 60 m, but on 8 August 1973 the seven caribou observed were all on sites below 60 m. Only the observed distribution of 8 April 1973, showed the expected late winter preferences for sites above 60 m.

There was a direct relationship between distribution by elevation and distances from the seacoast in August 1972, April and August 1973. In April 1972 and April and July 1974, however, opposite trends occurred with 57.3, 65.0 and 48.0% of the caribou being seen more than 5 km from the seacoast but on sites below 60 m.

1.6.2. Caribou recruitment

No caribou calves were observed on Eglinton during the summers of 1972 and 1973 and only one calf (4.0% of total caribou seen on island) was seen in summer 1974. Tener (1963) saw four calves (31% of caribou seen on transect) on Eglinton in summer 1961.

1.6.3. Caribou groups

The number of groups seen during summer was too small to allow seasonal comparisons (Table 22, and Miller and Russell 1976:Figs. 79–90). The expected pattern of all or most caribou occurring in small winter groups (<10) was obtained in the three late winter surveys (Miller and Russell 1976:Figs. 79, 81, and 83). The largest group of caribou, 17, occurred in summer as expected.

1.6.4. Muskox numbers and distributions

Nearly the same numbers of muskoxen, 24 vs. 20, were tallied in both surveys during 1972 (Table 23) and their distributions were almost identical (Miller and Russell 1976:Figs. 97 and 98). In 1973 almost twice as many (45 and 37) muskoxen and in 1974 more than twice as many (51 and 50) were seen on the surveys as in 1972. Their distribution shifted mostly to the south in 1973, then north and northwest in 1974. It is possible that in the interval 1972–74 one or more groups of muskoxen moved to Eglinton from Melville which is only 25 km to the east. Tener (1963) did not see any muskoxen on Eglinton in July 1961. The island has most likely been recolonized by muskoxen from western Melville.

The low numbers of muskoxen and muskox groups on Eglinton does not allow detailed evaluation of their distributions by elevation and distances from the seacoast. The observed distributions in 1972 and 1973 were most likely a reflection of the expected preferences by muskoxen for sites at low elevations. Distribution by distances from the seacoast, however, possibly reflect more the topography of the island than preferences by muskoxen. Distributions in 1974 were influenced mainly by the severity of the 1973–74 winter and redistribution due to unavailability of forage on preferred sites.

1.6.5. Muskox recruitment

The increment of short yearlings on 4 April 1972 was 4.5% of the muskoxen seen and no newborn calves were present. On 10 August 1972 no yearlings were identified and newborn calves represented 7.1% of the muskoxen seen. The increment of short yearlings was 4.4% on 8 April 1973 and one newborn calf was present. Again on 8 August 1973 no yearlings were identified, but newborn calves represented 13.5% of the observed muskoxen. Even though the increment of short yearlings rose to 11.8% on 11 April 1974, we failed to identify any yearlings during the 25 July 1974 survey. Calving started early in 1974 and we saw six (11.8%) newborn calves on April 11. On July 25, 1974 the calf crop had increased to 18.9% of the total muskoxen observed.

1.6.6. Muskox groups

The number of groups seen was too low to allow seasonal comparisons (Table 24, Miller and Russell 1976:Figs. 91–102). The expected pattern of muskoxen occurring in relatively large groups during late winter and smaller groups in summer did not prevail on Eglinton (Table 24). See section 2.2 (p. 47) for information on the breakup in summer of a winter group of dye-marked muskoxen.

1.7. Lougheed Island

On 3 April 1973 we surveyed 25% of Lougheed and saw a total of 30 caribou in seven groups: five groups on south central sites and two groups on south eastern sites. The 14 caribou we saw on transect gave an estimate of 56 animals. The survey was repeated, again with 25% coverage, on 4 April 1974, and we saw only one caribou. During both surveys we did not see any muskoxen.

Stefansson (1921) who first described the island, estimated 300 caribou. Macpherson (1961) reported that observations by Thorsteinsson in September 1955 gave the same estimate. Tener's (1963) August, 1961, estimate of 1325 caribou was based on 86 caribou seen on transect (6.5% coverage). In addition he saw 146 caribou off transect, most of the sightings were on the south central part of the island. Observations in 1973 suggest that the number of caribou has declined to about 4% of its former size. The sighting of only one caribou in April 1974 suggests that caribou now make little use of the island, at least, in late winter.

Table 23
Observed and estimated densities and numbers of muskoxen on Eglinton Island, Northwest Territories, obtained from aerial surveys

Date	Muskoxen seen on and off transect	Transect width km	Muskoxen seen on transect	Muskoxen/100 km² Mean	± SE	Estimated muskoxen Estimate	± SE
Apr 1972	24	0.8	3	1.6	1.4	25	22
		1.6	3	0.8	0.7	12	10
Aug 1972[1]	20	0.8	—	—	—	—	—
		1.6	1	0.3	0.3	4	4
Apr 1973	45	0.8	11	2.8	2.3	43	35
		1.6	11	1.4	0.9	22	14
Aug 1973	37	0.8	1	0.3	0.2	4	4
		1.6	13	1.7	1.1	26	18
Apr 1974	51	0.8	22	5.7	2.8	88	43
		1.6	22	2.8	1.1	44	18
Jul 1974	50	0.8	7	1.8	1.6	28	25
		1.6	8	1.0	0.7	16	11

[1]The 0.8 km strip was not estimated in Aug. 1972 because a helicopter was used to do the survey.

Stefansson (1921), who was on Lougheed in August 1916, saw no traces of muskoxen. Although Tener (1963) saw no muskoxen in 1961 nor did we in 1973 and 1974 surveys, R. Thorsteinsson found a fresh carcass in 1955 (*in* Macpherson 1961).

On the four smaller islands of the group we saw no caribou or muskoxen in 1973 or 1974 surveys; in 1961 Tener did not survey the islands. Stefansson (1921:541) shot seven of nine "fat" bull caribou seen on Grosvenor on 1 August 1916. He also commented that caribou were able to cross from Edmund Walker to Lougheed by wading across the shallow channel (1921:542).

1.8. Byam Martin Island

1.8.1. Caribou numbers and distributions

We saw only one caribou during the 22 and 23 March 1972 survey (Table 25). We observed no caribou during an intermediate survey flown on 24 May 1972; but on 7 August 1972 we saw 40 on the island.

In 1973 we counted over three times as many caribou (79 vs. 24) on July 15 as on March 27. The caribou were on the south of the island during both sur-

Table 24
A comparison of grouping statistics from aerial surveys of muskoxen on Eglinton Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles Mean	Range
Apr 1972	3	0	8.0	3–13
Aug 1972	3	1	9.5	6–13
Apr 1973	3	0	15.0	11–21
Aug 1973	5	3	17.0	12–22
Apr 1974	5	0	11.4	3–28
Jul 1974	6	2	12.0	3–21

veys, with the exception of four caribou in July. In March, 23 of the 24 caribou were on a 6-km-wide strip between Kay and Langley points. The strip appears as a geologically distinct zone in aerial photographs. In July, 77 of 79 caribou were within 3 km of the south coast near Cape Gillman.

On 1 April 1974 observed caribou numbered three. We again observed only three caribou on the island on 20 August 1974. No signs were evident along the coast to suggest that caribou had come onto and left the island between the two surveys.

Observed numbers of caribou were low, and their distributions by elevation and

Table 25
Observed and estimated densities and numbers of Peary caribou on Byam Martin Island, Northwest Territories, obtained from aerial surveys

Date	Caribou seen on and off transect	Transect width km	Caribou seen on transect	Caribou/100 km² Mean	± SE	Estimated caribou Estimate	± SE
Mar 1972	1	0.8	0	—	—	—	—
		1.6	1	0.4	0.3	4	3
Aug 1972[1]	40	0.8	—	—	—	—	—
		1.6	21	7.4	5.6	86	65
Mar 1973	24	0.8	4	2.7	2.4	31	28
		1.6	17	2.9	1.1	34	13
Jul 1973	79	0.8	11	7.4	6.9	86	80
		1.6	11	3.7	3.1	43	36
Apr 1974	3	0.8	3	1.0	0.5	12	6
		1.6	3	0.5	0.2	6	2
Aug 1974	3	0.8	3	1.0	0.9	12	11
		1.6	3	0.5	0.4	6	4

[1]The 0.8 km strip was not estimated in Aug. 1972 because a helicopter was used to do the survey.

Table 26
A comparison of grouping statistics from aerial surveys of Peary caribou on Byam Martin Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles Mean	Range
Mar 1972	1	1	—	—
Aug 1972	5	0	8.0	2–11
Mar 1973	7	2	4.4	2–7
Jul 1973	8	1	11.1	2–28
Apr 1974	3	3	—	—
Aug 1974	1	0	3.0	3–3

distances from the seacoast were not consistent among all years (Miller and Russell 1976:Tables 46, 47; Figs. 103–105). The overall observed distribution of caribou by elevation during all surveys in relation to available landmass was as expected by chance: 40.6% of the island is below and 59.4% is above 60 m and 41.3 and 58.7% of the caribou were seen on sites below and above 60 m. Deviation from the expected distribution in 1974 may reflect both sample size and severity of the 1973–74 winter.

The variations in numbers of caribou seen between late winter and summer in 1972 and 1973 (Table 25) suggest that most of the caribou summering there were migrants. The low counts during both surveys in 1974 (Table 25), therefore, most likely reflect more the loss of caribou wintering on the other islands than on Byam Martin.

1.8.2. Caribou recruitment

We saw no caribou calves on Byam Martin in the summer of 1972. Calves totalled 11.4% of the caribou seen in summer 1973. No caribou calves were seen in the summer of 1974.

1.8.3. Caribou groups

Information on caribou grouping is fragmentary because of the low numbers of caribou during most surveys. However, the expected pattern of seasonal variation in group size can be discerned (Table 26). Percentage occurrences of caribou groups in relation to total caribou and number of groups seen during each survey and group locations are given in Miller and Russell (1976:Figs. 106–117). Both total caribou and number of groups observed were too few to allow detailed evaluations. The general expected trend in caribou group size from small in winter to large in summer pertains.

1.8.4. Muskox numbers and distributions

We saw 44 muskoxen during the 22 and 23 March 1972 survey (Table 27). During an intermediate survey on 24 May 1972, we observed 52 muskoxen. On 7 August 1972 we saw only 28 muskoxen. The low count probably resulted from our inability to spot muskoxen off transect due to frequent low-lying banks of fog. Muskoxen were distributed in similar patterns during all three surveys, although numbers observed did vary.

In 1973 we observed similar numbers of muskoxen between surveys: 51 on 27 March and 55 on 15 July. The distribution was comparable between surveys but was more westerly than in 1972.

On 1 April 1974 we saw only 26 muskoxen and they were more widely dispersed than in previous years. We saw eight muskoxen carcasses and two of the live muskoxen appeared too weak to stand when we flew over. By 8 August 1974 the observed number of muskoxen had dropped to eight (Table 27).

The strong preference for sites at low elevations and a stronger affinity for coastal areas in late winter than in summer prevailed. Only the occurrence of all eight muskoxen within <2.5 km from the seacoast in August 1974 deviated from the expected summer distribution, but this can be accounted for by the low number of muskoxen seen and all of them in only one group.

The observed numbers of muskoxen in 1972 and 1973 (Table 27) suggest that muskoxen were resident throughout the year and were fluctuating at about 50 head. The rapid reduction in numbers in 1974 (Table 27) reflects winter loss and possibly subsequent emigration by some survivors in the spring.

1.8.5. Muskox recruitment

We saw no short yearlings during either the March or May 1972 surveys, but

7.1% (2) of the muskoxen seen in August 1972 were calves. We observed no short yearlings in March 1973, but calves totalled 23.6% (13) of the muskoxen seen in July 1973. In April and August 1974 we saw no short yearlings or calves.

1.8.6. Muskox groups

Percentage occurrences of muskox groups (Table 28) in relation to total muskoxen and number of groups seen during each survey and group locations are given in Miller and Russell (1976:Figs. 118–129). The number of groups observed during 1972 and 1973 surveys suggests that we probably missed about five small groups in August 1972. The occurrence of 10 groups with reduced numbers in April 1974 most likely reflects winter loss and the stress of forage unavailability.

1.9. Ile Vanier

We covered 25% of Vanier on 4 April 1973 and 1 April 1974. In 1973 we saw five caribou on a west central site. In 1974 we saw four solitary caribou, one on the east coast and three inland to the west. The estimates for 1973 and 1974 were 20 and 15 caribou, respectively.

In the summer of 1961, Tener (1963) gave Vanier 6.5% coverage; he observed 26 caribou and estimated 396. The differences between the surveys of 1961 and 1973–74 indicate a decrease of about 95% of caribou numbers during that period.

In April 1973 we saw a group of six muskoxen on the south central coast. The following year we saw a group of five muskoxen in the same area. Tener (1961) did not see muskoxen in 1961. Interchange of muskoxen between Bathurst and Vanier is likely though it is also possible that muskoxen migrated from eastern Melville.

1.10. Cameron Island

We surveyed 25% of the island on 3 April 1973 and on 4 April 1974. In 1973 we saw six caribou in two groups on east central sites. In 1974 we saw five caribou in two groups, one on an east central site and one on an east coastal site. The 1973 estimate was eight caribou and the 1974 estimate was 20 caribou. Tener (1961) saw 21 caribou and estimated that there were 235 caribou on Cameron in 1961 (Tener 1963). Data suggest a decline of about 92% between 1961 and 1974. The difference between 1973 and 1974 estimates, again, suggests inter-island movement between Bathurst and adjacent islands.

In 1973 we observed one group of five muskoxen on a northeastern coastal site. In 1974 we saw a group of two muskoxen on a north central site and three muskox carcasses. Two of the carcasses were lying side by side in a creek bottom about 5 km southeast of the live animals.

Tener (1963) estimated 25 muskoxen on Cameron, Vanier, Massey and Alexander based on the three muskoxen observed on Cameron in 1961 (Tener 1961). The total estimate for these islands in 1973 was 56 muskoxen and in 1974, 12 muskoxen. The apparent increase in muskox numbers between 1961 and 1973 and the marked decrease in 1974 seemingly reflect inter-island movement and subsequent mortality and or egress.

Table 27
Observed and estimated densities and numbers of muskoxen on Byam Martin Island, Northwest Territories, obtained from aerial surveys

Date	Muskoxen seen on and off transect	Transect width km	Muskoxen seen on transect	Muskoxen/ 100 km²		Estimated muskoxen	
				Mean	± SE	Estimate	± SE
Mar 1972	44	0.8	7	4.7	4.2	55	49
		1.6	37	13.0	11.4	151	132
Aug 1972[1]	28	0.8	—	—	—	—	—
		1.6	15	5.3	5.3	61	61
Mar 1973	51	0.8	0	—	—	—	—
		1.6	4	0.7	0.5	8	6
Jul 1973	55	0.8	16	10.7	11.0	125	128
		1.6	30	10.1	7.2	117	84
Apr 1974	26	0.8	11	3.8	1.7	44	20
		1.6	14	2.4	0.7	28	8
Aug 1974	8	0.8	0	—	—	—	—
		1.6	0	—	—	—	—

[1]The 0.8 km strip was not estimated in Aug. 1972 because a helicopter was used to do the survey.

Table 28
A comparison of grouping statistics from aerial surveys of muskoxen on Byam Martin Island, Northwest Territories

Date	No. groups incl. singles	No. singles	Group size excl. singles	
			Mean	Range
Mar 1972	5	0	8.8	2–28
Aug 1972	5	1	6.8	2–15
Mar 1973	5	0	10.2	4–17
Jul 1973	10	4	8.5	2–15
Apr 1974	10	4	3.7	2–5
Aug 1974	1	0	8.0	8–8

1.11. Brock Island

On 15 April 1973 we surveyed 12.5% of the island. We saw seven caribou in three groups on eastern coastal sites and estimated 24 caribou. Tener (1963) did not complete his survey of Brock in 1961 because of fog, but he estimated that there were 190 caribou. Between 1961 and 1973 there was an apparent 87% decline in caribou. However, geologists saw no caribou in 1958–59 (Macpherson 1961). Numbers of caribou were apparently high in 1915 and 1916 (Stefansson 1921). When the island was revisited in early May 1916, Stefansson (1921:492, 495) noted that there were fewer caribou than the previous spring, but inland from Cape Murray he saw caribou on the rolling hills. As stated for Mackenzie King there appears to be both seasonal changes, involving inter-island movement, and a general decline of caribou numbers.

We saw no muskoxen during the survey in 1973, nor did Tener (1963) in 1961. We know of no evidence for the occurrence of muskoxen on Brock, but interchange among Borden, Mackenzie King and Brock has surely occurred in the past.

1.12. Emerald Island

We covered 25% of the island on 15 April and 30 July 1973 and 17 April 1974. We saw no caribou in April 1973; but we saw 15 caribou in July, 10 on transect which gave an estimate of 39. In April 1974 we saw only three caribou which gave an estimate of 12; we observed no caribou off transect. In summer 1958 geologists surveyed 6% of Emerald and estimated 450 caribou (Macpherson 1961). In July 1961 Tener (1963) surveyed about 8% of Emerald and estimated 161 caribou from 11 caribou on transect; in addition he recorded nine caribou off transect. Differences between 1958 and 1973 summer surveys suggest that less than 10% of the number of caribou previously summering on Emerald now use the island. Differences between 1961 and 1973 summer surveys suggest that only about 25% of the number of caribou that Tener (1963) estimated in 1961 are now summering on the island. Results from the 1973 and 1974 late winter surveys suggest that the occurrence of caribou on the island is seasonal.

In July 1973, 13 of the observed caribou were within 2 km of the coast. Tener (1963) in 1961 also noted the coastal distribution of caribou as 7 of the 11 caribou on transect were within 1.6 km of the coast. In April 1974 the three caribou seen were 6 km from the coast. In 1973 we saw no calves but in 1961 Tener (1963) saw four calves.

Tener (1963) saw no muskoxen in 1961 nor did we in 1973 and 1974 aerial surveys. However, in 1958–59 R. Thorsteinsson found a muskox skull on Emerald (*in* Macpherson 1961).

1.13. Alexander Island

We covered 25% of the island on 4 April 1973 and on 1 April 1974. We did not see caribou in either year, although Tener (1963) had estimated 198 caribou in June–July 1961.

The nine muskoxen that we observed in 1973 on central Alexander were in a large river valley that bisects the south of the island on an east–west course. In 1974 we saw two muskoxen on an east central coastal site. In 1961 Tener (1963) did not see any muskoxen.

1.14. Massey Island

On 4 April 1973 and again on 1 April 1974, we surveyed 25% of the island. We saw 11 caribou in one group on a south central coastal site in April 1973, but we saw no caribou in April 1974. In 1973 we estimated 31 more caribou than Tener (1963) did in 1961. In 1974 the absence of caribou reflects a decline from 1973 and or emigration from the island.

In 1973 and 1974 we did not see muskoxen on Massey. Similarly in 1961 Tener (1961) sighted no muskoxen.

1.15. Little Cornwallis Island

We covered 25% of the island on 1 April 1973 and 23 March and 25 August 1974. In 1973 we saw four caribou: two on a west central site and two on a northwestern coastal site. We estimated eight caribou in 1973. We saw no caribou in March 1974 but we saw a group of three and a group of five on northwestern coastal sites in August 1974. The estimate was 12 caribou in 1974. Tener (1963) did not see caribou on Little Cornwallis in 1961.

In 1973 we saw 10 muskoxen on the east central coast and estimated 40. In March 1974 we saw five muskoxen in two groups on the west coast and estimated 20. In August 1974 we saw three muskoxen in two groups on west central coastal sites and estimated 12. Tener (1963) in 1961 did not see any muskoxen.

1.16. Helena Island

We covered 25% of Helena on 3 April 1973 and on 31 March 1974. We saw no caribou in 1973, but one caribou on a west central site in 1974 which gave an estimate of four. We saw no muskoxen during either survey.

1.17. Edmund Walker Island

Edmund Walker is discussed in the section for Lougheed. No Peary caribou or muskoxen were seen there.

1.18. Ile Marc

On 4 April 1973 and 1 April 1974 we surveyed 100% of the island. In 1973 we saw nine caribou in two groups on north central coastal sites. We saw no caribou in 1974, and Tener (1961) did not survey Marc in 1961. During the two surveys we did not see any muskoxen.

1.19. Fitzwilliam Owen Island

On 14 April 1973 we surveyed 100% of the island and saw one caribou. On 17 April the next year we again surveyed the entire island and saw two caribou. We saw no muskoxen on either survey. Tener (1963) did not survey the island in 1961.

1.20. Eight Bears Island

On 14 April 1973 and again on 17 April 1974, we covered 100% of the island and saw no caribou or muskoxen. Tener (1963) did not survey the island in 1961. Stefansson (1921:342) found an old muskox skull on the island. He wondered how it got there as he had noted that "In our experience they [muskoxen] avoid sea-ice."

2. Species discussion

2.1. Peary caribou

Numbers of Peary caribou decreased markedly from 1961 and 1972 throughout

Table 29
Estimates of and percentage changes in estimated numbers of Peary caribou on western Queen Elizabeth Islands, Northwest Territories

Island	Estimated caribou			Percentage change		
	1961	1973	1974	1961–73	1973–74	1961–74
Melville	12799	3422	1679[1]	−73.3	−50.9	−86.9
Bathurst	2723	712[2]	231	−73.5	−68.0	−91.5
Prince Patrick	2254	807	621	−64.2	−23.0	−72.4
Mackenzie King	2192	0	36[3]	−100.0	+	−98.4
Borden	1630	19[2]	10[3]	−98.8	−47.4	−99.4
Eglinton	204	12	18	−94.1	+50.0	−91.2
Lougheed	1325	66[2]	0	−95.0	−100.0	−100.0
Byam Martin	—	43	6	—	−86.0	—
Vanier	396	24[2]	10[3]	−93.9	−58.3	−97.5
Cameron	235	9[2]	12[3]	−96.2	−33.3	−94.9
Brock	190	28[2]	14[3]	−85.3	−50.0	−92.6
Emerald	161	39	20[4]	−75.8	−48.8	−87.6
Alexander	198	0	0	−100.0	0	−100.0
Massey	13	52[2]	0	+300.0	−100.0	−100.0
Little Cornwallis	0	9[2]	12	+	+33.3	+
Helena	—	0	3[3]	—	+	—
Edmund Walker	—	0	0	—	0	—
Marc	—	0	3[3]	—	−100.0	—
Fitzwilliam Owen	—	1[4]	1[3]	—	0	—
Eight Bears	—	0	0	—	0	—
Totals	24320	5244	2676	−78.4	−49.0	−89.0

[1]Extrapolated value, see text.
[2]Extrapolated from winter 1973 observations and estimate (see text for Bathurst).
[3]Extrapolated from winter 1974 observations and calculated overall decreases (1973–74) on islands surveyed in summer 1974.
[4]Extrapolated from 1973 summer observations and calculated overall decreases (1973–74) on islands surveyed in summer 1974.

the western Queen Elizabeth Islands (Table 29). As Tener did in 1961, we found the highest estimated number of caribou on Melville, although the number was 86.9% less than the 1961 estimate. Caribou on Prince Patrick have suffered the least in terms of an overall percentage loss between 1961 and 1974. Inter-island movements of caribou between Prince Patrick and Melville (Miller *et al.* 1977) complicate the analysis of survival rates on those two islands. It is likely that such movements foster the well-being of caribou, at least when they are at high densities, on one or more of the islands. Prince Patrick appears to serve as a wintering area for many of the caribou that summer on Melville. We assume that the caribou belong to the stock from the island where they calve, and that migrations may involve many or all of the islands when numbers of caribou are high. Based on percentage change, caribou on Bathurst decreased the most among the three islands with the highest numbers of caribou on them in 1961 (Table 29). Tener (1963) estimated that in summer 1961 there were 3565 caribou on Bathurst and its satellite islands, now named Cameron, Vanier, Alexander and Massey. In 1974 we estimated that only 7.1% of that number of caribou were on those five islands.

Decreases of caribou numbers on all of the remaining islands have been as marked or more drastic (Table 29). In 1961 six islands were estimated to have more than 1000 caribou on each of them, in 1974 only one island still had more than 1000 caribou (Table 29).

Eastern Melville, the Dundas Peninsula and south central Prince Patrick support the most caribou and appear as preferred areas for this species. The caribou remaining on Bathurst still winter in the south and move to the north in the summer. Although caribou numbers were high on Eglinton in all winters during the study period, cursory observations by CWS field parties in late winters 1975 and 1976 suggest that very few caribou wintered on Eglinton during those two years. It appears that the mortality of winter 1973–74 was exceptionally high among caribou on Eglinton. Also, there is a possibility that the caribou on Eglinton in winter 1973–74 have responded to and moved to fill vacancies created by mortality among caribou that had wintered on Prince Patrick and or on Melville.

We have determined that caribou show a preference for intermediate elevational zones. Although caribou commonly move to the coast in late winter or early summer, they usually forage on the higher and drier coastal sites.

Calf increments and yearling recruitments have been extremely low or non-existent in some years. All of the data obtained during our surveys indicate that caribou numbers on the western Queen Elizabeth Islands were decreasing. Information on reproductive and physical condition obtained during late winters 1974 (Parker *et al.* 1975), 1975 (Thomas *et al.* 1976) and 1976 (Thomas, pers. comm.) indicate that the decrease is still continuing. It is likely that caribou on Bathurst have reached a critical number and there may be a temporary loss of caribou from the island, if the trend continues for many more years.

Unfortunately, we have no quantitative measures of range condition. But fragmentary weather data and empirical evidence, however, suggests a series of consecutive years with early, deep snow cover; above average snowfalls; late winter, deep snow cover; lingering snow melts and in some years ground-fast ice, ice layering in the snow and heavy crusting of snow all made forage unavailable and restricted. We believe that forage availability and not range quality caused the decreases in numbers of caribou.

Information obtained on grouping dynamics between March 1972 and August 1974 indicate that the sizes of caribou groups are influenced by forage availability. Relatively large aggregations form in summer under favourable foraging conditions. In winter, however, when available forage becomes restricted due to snow cover and icing conditions caribou occur only in small groups. The web of factors that influence grouping is complex and currently obscure but warrants some speculation.

The distribution of Peary caribou is not only forage-related, but should be considered with the socialization of the species. Although seasonal movements and migrations are, at times, likely related to the ability of the range to support the caribou, such activities are maintained by traditions and gregariousness of the species. We consider distributions of caribou to be mainly range-related as a result of activities over long periods which enhanced the survival of individuals who learned to respond spatially and temporally to range differences.

However, such distributions may, also at times, be governed by social demands during different phases of the life cycle (e.g. rutting areas and calving grounds). We consider that group size and structure, seasonal movements, and migrations of a species are controlled by social affinities and defense against predators, and, ultimately, by range. The group characteristics may also reflect the current activities of the animals involved and or the past history of the survival of individuals within the groups.

The cohesiveness of a group on a yearly basis is governed by changes in tolerance of individuals during different phases of the species annual life cycle, the type of bonding maintained with the group, and the form of dominance (hierarchy) exhibited by the species. For caribou, the annual life cycle is: 1) calving 2) post-calving 3) summer 4) pre-rut 5) rut 6) post-rut 7) fall migration 8) winter 9) spring migration and 10) pre-calving. The types of bonding maintained by Peary caribou are most likely the following and a combination thereof: 1) mother – young of the year 2) family 3) mixed or single sex and or age groups.

The sex and age of the dominant individual of a group is apparently governed by the sex and age structure of the group. As with barren-ground caribou, bull groups would be dominated by mature males and cow or cow–juvenile groups by adult females. We have not been able to detect subadult or juvenile groups among Peary caribou during this study. If they occur, most likely the role of dominance would vary between the sexes in mixed groups.

In Peary caribou groups, dominance appears to be of the "straight line" hierarchy type. Co-dominant individuals and the possible occurrence of discrete social subgroups within a group could cause slight alterations to the "straight line" effect.

2.2. Muskoxen

Tener (1963) estimated 7421 muskoxen on the Queen Elizabeth Islands. Only 2161 (29.1%) of those muskoxen were estimated to be on the western islands that we surveyed between 1972 and 1974 (Table 30). No systematic surveys of the central and eastern Queen Elizabeth Islands have been carried out since 1961, so no current estimates of muskoxen are available for those islands. Also, no true comparison of numbers of muskoxen between 1961 and 1973 and 1974 can be made for the western islands because of Tener's (1963) subjective method of evaluating muskox numbers on Melville in 1961 (Table 30).

Using Tener's (1963) estimate of 1000 muskoxen on Melville in summer 1961, we obtain a 91.5% overall increase in muskox numbers and a questionably high 217.1% increase in muskoxen on Melville from 1961 to 1973. At the same time numbers of muskoxen had decreased an estimated 85.6% on Bathurst, and had recolonized Prince Patrick with about 100 head occurring there in 1973. Although those contrasting events are possible, they are currently inexplicable. If muskoxen did indeed make the gains in number on the western Queen Elizabeth Islands as suggested, it would have required an overall average 6% annual increase through recruitment with absolutely no mortality to any animals 1 year of age or older. On Melville the average annual rate of recruitment with no loss of animals after the first year of life would have had to have been over 10%. Especially Melville and Bathurst muskoxen experienced drastic decreases in numbers between 1973 and 1974. The estimated increases from 1961 dropped to 25.1% overall and 139% on Melville. The number of muskoxen on Bathurst in summer 1974 was only 14.4% of the number estimated there in 1961. The effects of the decreases through reduced numbers of producing females will continue to restrict overall increases in muskox numbers for some years to come. Melville, especially the southwest of the island, remains the heartland for muskoxen on the western Queen Elizabeth Islands. In summer 1974 there were an estimated 2390 muskoxen on Melville or 87.4% of all estimated surviving muskoxen on the islands surveyed.

Apparently there are no regular large scale seasonal movements of muskoxen to and from Melville, although some movement between islands must occur for recolonization. On 13 June 1974 the trail of one muskox was seen on the ice between Melville and Prince Patrick. The muskox, probably a solitary bull, had travelled an erratic course over the ice from stratum X of Melville to stratum III of Prince Patrick. In early June 1973 personnel of Panarctic Oils Ltd. reported observing 30 muskoxen on the ice about 25 km southwest of

Lougheed and travelling toward the Sabine Peninsula, Melville Island, which is 100 km from Lougheed (D. Connally, pers. comm.).

We have determined that muskoxen show a preference for well-vegetated sites (sedge meadows and willow slopes) at low elevations. Although muskoxen commonly move inland during summer, they usually restrict such movements to the shores of water courses and drainage slopes. The low ground of southwestern Melville, especially the Bailey Point area, in 1974 supported the highest densities of muskoxen within the survey area.

Muskox increments and recruitments have been negligible or non-existent through the study period. The high increment of 18.7% in 1973 appeared to have been entirely lost in the severe winter of 1973–74. A behavioural study of muskoxen on Bathurst suggests that many muskoxen may have succumbed during the winter of 1967–68 (Gray 1973:35). Subsequent evidence indicates that there were no calves produced during 1968, 1969 or 1970 (Gray 1973:45). The compounded effects of increased mortality of adults and no or minimal calf production during consecutive years have apparently caused the observed decreases in numbers of muskoxen. This mortality has most likely been brought on by a series of winters with unfavourable snow cover and icing conditions restricting and making forage generally unavailable. Hubert (1974) concluded that only density independent factors could cause starvation followed by die-off among muskoxen on native range.

Our information on grouping dynamics indicates that muskoxen form relatively large aggregations in the winter. The winter groupings break up in late spring or early summer. Large groupings begin re-forming with the coming of the rut and persist and often grow throughout the winter. As with caribou the factors influencing group formation by muskoxen are complex and not clear, but now warrant some speculation.

Table 30
Estimates of and percentage changes in estimated numbers of muskoxen on western Queen Elizabeth Islands, Northwest Territories[1]

	Estimated muskoxen			Percentage change		
Island	1961	1973	1974	1961–73	1973–74	1961–74
Melville	1000	3171	2390[2]	+217.1	−24.6	+139
Bathurst	1136	672[3]	164	−40.8	−75.6	−85.6
Prince Patrick	0	152	114	+	−25.0	+
Mackenzie King	0	0	0			
Borden	0	0	0			
Eglinton	0	26	16	+	−38.5	+
Lougheed	0	0	0			
Byam Martin	—	117	0	—	−100.0	—
Vanier	0	0	0			
Cameron	25	0	0	−100.0	0	−100.0
Brock	0	0	0			
Emerald	0	0	0			
Alexander	0	0	0			
Massey	0	0	0			
Little Cornwallis	0	0	20	0	+	0
Helena	—	0	0			
Edmund Walker	—	0	0			
Marc	—	0	0			
Fitzwilliam Owen	—	0	0			
Eight Bears	—	0	0			
Totals	2161	4138	2704	+91.5	−34.7	+25.1

[1]Mackenzie King, Borden, Lougheed, Vanier, Brock, Emerald, Alexander and Massey islands had no muskoxen seen on them when surveyed in 1961, 1973 and 1974. Helena, Edmund Walker, Marc, Fitzwilliam Owen and Eight Bears islands were not surveyed in 1961 and had no muskoxen on them when surveyed in 1973 and 1974.

[2]Extrapolated value, see text.

[3]Winter estimate.

Muskox groups appear complex, that is, difficult to analyse. The group has evolved an advanced form of mutual defense — the defense circle or "ring". Social dominance of muskox groups appears to be restricted to adult males.

The group structure is apparently built around the dominant male of the group. However, most groups contain several other mature males who may hold sway over subgroups at various times and under specific conditions (the summer splitting of winter groups). This belief is supported in general by the fact that groups of females and juvenile muskoxen in this study have not been seen without the dominant male or at least one mature male and most often several mature males within each group. Gray (1973) reported only five herds in which there were no males present between May 1968 and October 1971.

Our observation of the dispersion of a group of 22 muskoxen sprayed with red dye on Eglinton Island offers evidence for the existence of subgroups within muskox groups. When dye-sprayed on 14 April 1974 the group contained 9 bulls, 13 unknowns (adults), 4 yearlings (1973 calves) and 2 newborn calves. When the group was relocated 13 km south of their April site on 8 June 1974, it had been complemented by six newborn calves. The red dye could still be seen on 19 of the adult muskoxen.

Table 31
Dispersion of a group of 28 dye-marked muskoxen[1] between 14 April and 25 July 1974, Eglinton Island, Northwest Territories

Group size			No. dye-marked		
Bulls	Cows and unknwn	Calves	Bulls	Cows and unknwn	Dist. from Apr marking site (km)
4	12	5	2	7	13
3	10	4	3	0	19
2	5	0	1	3	22
1	0	0	1	0	26

[1]Only 19 of the group of 28 muskoxen showed dye markings in June.

Subsequent observations of the dye-marked muskoxen showed that the formation of smaller summer groups may represent either winter subgroups of the original winter group or a combination of individuals of subgroups from two or more winter groups (Table 31). Our observations also indicated that the muskox calf is born within its mother's winter group. The mother–young bond develops rapidly, and newborn calves may serve as common stimuli for group cohesiveness during the prolonged calving period (March–May), thus reinforcing the drive for group defense during the critical period of birth.

The persistence of the mother–young bond in muskoxen has not been determined. The reaction of maternal cows and their juvenile offspring during periods of stress are masked by the contagious behaviour of the group. Offspring seemingly remain, at least until maturity, within their maternal groups. The possibility exists, however unlikely, that a juvenile's well-being only requires social acceptance in any group.

We believe that to maintain the widest distributions and greatest numbers of muskoxen that the range will support, it is important that the heterogeneity of sex and age composition of each herd be maintained. The "normal" heterogeneity of a muskox herd requires a minimal (threshold size, as yet unknown) number of animals in the herd. The best approach to harvesting muskoxen would be the selection of one or a few animals of the desired sex and age from the largest muskox herds in the area being hunted. There is evidence to suggest that solitary muskox bulls are not "surplus animals" and therefore should not be overharvested. Most solitary muskox bulls are not in fact senile or non-breeders, but are often vigorous males that can become dominant members of herds and active breeders. On Bathurst and Devon islands marked solitary bulls were later seen in herds, and marked bulls seen in herds were subsequently seen alone (Jonkel, Gray and Hubert 1975).

Muskox groups stressed by aircraft usually react in one or a combination of three ways: (1) stand their ground, and form a defense circle; (2) flee to surrounding high ground, and form a "ring"; (3) take flight, and continue to run, sometimes, for several kilometers before stopping. Gray (1974) has noted that muskoxen often delay fleeing until the aircraft has passed by, and has suggested that any aircraft disturbance that leads to the formation of a defense circle is potentially harmful. When the group disturbed by aircraft contains newborn calves, a calf often falls behind, if the group responds by flight. Within a few meters travel, however, the maternal cow reverses her course and rushes to her calf. Often simultaneously, or nearly so, other group members also return to the cow and her calf. One would argue that the only feasible defense against wolves during the long calving period for muskoxen is the defense formation or at least remaining in place and closely spaced. It is likely that the response by muskoxen to aircraft harassment as a new form of stress is more intense than their evolved response to encounters with wolves.

At other times of the year, when all members of a group can run at nearly equal speed, escape to high ground could be advantageous for the muskoxen group for the following reasons. 1) Wolves cannot hide in drainages and, consequently, cannot approach the group closely. 2) Wolves cannot ambush on open high ground. 3) Aggressive muskoxen can make quicker charges downgrade at approaching wolves.

2.3. Inter-specific competition

Inter-specific competition for foraging areas has often been suggested by some individuals, although there are no supporting data. Wilkinson, Shank and Penner (1976) found that Peary caribou and muskoxen do not compete, at least in summer, on Banks Island. Their conclusion was based on the observations that the distributions for the two species overlapped only slightly and the preferred habitats and diets were correspondingly different. Gray (1973) observed no evidence of marked reactions by Peary caribou or muskoxen to inter-specific encounters.

To possibly describe the association between Peary caribou and muskoxen, if any, we used the following coefficient or association index:

$$K = (hn - ab) / \sqrt{a \times b \times (n - a) \times (n - b)}$$

We calculated this index using our data from Melville and its major strata groupings and from Bathurst and Prince Patrick islands only; sample sizes from other islands were too small to use.

K is the geometric mean of the coefficient of association proposed by Forbes (1907) with modifications based on a pattern of absences (Miller and Russell 1976). K varies between −1 and +1; 0 shows independence, −1 complete avoidance and +1 complete association.

We used 12.8 km^2 cells as the sample unit because smaller units resulted in too many cells without any animals in them. At that level of examination both weak association and weak disassociation were suggested: of 31 areas, 16 calculations were negative and 15 positive (Table 32). But with the exception of three indices (strata I–V, March–April and August 1972; and I–VI, March–April 1972) the indices also suggest a condition approaching independence (Table 32). Working with 12.8 km^2 cells did not allow evaluation of pos-

Table 32
An analysis of distributions of Peary caribou and muskoxen, seen within 12.8 km^2 (1.6×8 km cells) intervals along transect strips, to measure degree of association or disassociation between the two species on Melville, Bathurst and Prince Patrick Islands, Northwest Territories

Island, strata and survey date	12.8 km^2 cells: Sample size, n	With caribou, a	With muskoxen, b	With both, h	Assoc. index
Melville					
Mar–Apr 1972					
I–V	351	37	16	5	+0.147[1]
I–VI	451	42	23	6	+0.134[1]
VII–IX	185	4	15	0	−0.044
X–XIII	178	1	30	0	−0.034
VII–XIII	363	5	45	0	−0.044
I–XIII	814	47	68	6	+0.039
Aug 1972					
I–V	360	23	15	3	+0.116[1]
I–VI	460	48	32	6	+0.074
Mar–Apr 1973					
I–V	358	48	6	1	+0.012
I–VI	458	70	12	3	+0.044
VII–IX	185	9	9	0	−0.051
X–XIII	178	6	22	0	−0.070
VII–XIII	363	15	31	0	−0.063
I–XIII	821	85	43	3	−0.026
Jul–Aug 1973					
I–V	358	39	17	3	+0.048
I–VI	458	58	26	6	+0.077
VII–IX	185	12	30	1	−0.056
X–XIII	178	22	35	4	−0.014
VII–XIII	363	34	65	5	−0.027
I–XIII	821	92	91	11	+0.010
Jul–Aug 1974					
I–V	358	12	11	0	−0.033
I–VI	458	29	26	3	+0.052
VII–IX	—	—	—	—	
X–XIII	178	17	30	2	−0.044
VII–XIII	—	—	—	—	
I–XIII	636	46	56	5	+0.020
Bathurst					
Mar–Apr 1973	314	37	12	0	−0.073
Mar 1974	314	25	21	3	+0.063
Aug 1974	231	6	8	0	−0.031
Prince Patrick					
Apr 1973	307	56	4	1	+0.020
Jul–Aug 1973	307	41	2	0	−0.032
Apr 1974	311	45	2	0	−0.033
Jul 1974	311	34	4	1	+0.051

[1]Significant at the 0.05 level.

sible competition within each cell. Observed choices of micro-habitat by Peary caribou and muskoxen, however, suggest spatial isolation of the two species within relatively confined areas. That is, where the two species occur together, Peary caribou mostly show preferences for feeding on higher and drier areas while muskoxen usually forage on lower and or wetter sites.

Competition between Peary caribou and muskoxen has not been proven. We believe that such competition is unlikely and if it does occur at all, it is most likely to occur during periods of severe stress. An example was late winter 1973–74 on Bathurst, when muskoxen were observed trying to forage on windswept slopes that appeared to be more favourable habitat for Peary caribou. It is unlikely, however, that even if muskoxen were forced onto caribou foraging areas by prevailing snow cover conditions that the muskoxen could occupy enough area to greatly hinder foraging by Peary caribou.

Further quantitative work is needed to examine possible competition within smaller sample units and the elements of interference, exploitation, non-reciprocal competition and or competitive exclusion (Wilkinson *et al.* 1976). The suggestion that reduction of muskoxen through management efforts, such as was proposed during the late 1960s and early 1970s for Banks Island, will be beneficial and allow increases of formerly co-existing Peary caribou is unfounded. The primary condition of such a premise would be that such inter-specific competition was the most stringent of all limiting factors acting upon the caribou, indeed an unlikely condition. The periodic oscillations of Peary caribou numbers can not be ascribed to inter-specific competition nor can the inevitable lows of such vacillations be prevented by elimination of the supposed inter-specific competition.

2.4. Arctic wolves — the predator

The so-called Melville Island wolf (*Canis lupus arctos* Pocock 1935) is the Canadian High Arctic form of *Canis lupus* that occurs on the Queen Elizabeth Islands. Information on High Arctic wolves is fragmentary, but existing evidence suggests that historically wolves have occurred in low numbers on the Queen Elizabeth Islands, even with relatively high prey populations. High Arctic wolves are mainly dependent for their living on Peary caribou and muskoxen. The future of wolves has now become questionable in the face of the recent crash (1973–74) of both prey species and increasing human contact on western Queen Elizabeth Islands. Details of wolf sightings and impacts are given in Miller and Russell (1976).

Conclusions

1. Numbers of Peary caribou have drastically decreased between 1961 and 1972 and again between 1973 and 1974.
2. Almost the entire population of Peary caribou on Mackenzie King, Borden, Brock, Lougheed, Byam Martin and Emerald islands have been lost and current numbers are below a critical level. This same situation is probably fast developing on Eglinton and Bathurst islands.
3. Eastern Melville and the Dundas Peninsula are still the heartland for Peary caribou on the western Queen Elizabeth Islands, but even there numbers of caribou have dropped drastically from 1961 estimates.
4. As of 1974 Prince Patrick was the second most important island for caribou on the western Queen Elizabeth Islands, and possibly an integral part of the requirements for maintenance of caribou numbers, at least at high densities, on Melville.
5. Peary caribou show an overall preference for sites at intermediate elevational levels (above mean sea level). The preference reflects their choice of foraging habitat — the drier lichen and moss dominated plant communities.
6. In recent years Inuit from Resolute Bay have hunted Peary caribou on Bathurst in winter and spring. In view of the low number of caribou remaining on Bathurst, further hunting there would be unwise until the population recovers. If the caribou now on the island were killed or driven from the island, it might be many years before the island is recolonized, as caribou numbers are at a low throughout the western Queen Elizabeth Islands.
7. The current situation probably demands that the Inuit of Resolute Bay find new caribou hunting grounds, if they are to successfully continue their traditional way of living. A recent survey by Renewable Resources Consultants revealed substantial numbers of caribou on Prince of Wales Island (Renewable Resources 1974).
8. No evaluation of reduction in overall muskox numbers can be made, but marked decreases have occurred between 1961–74 on Bathurst Island and a sharp decrease between 1973–74 on Melville Island.
9. Muskoxen are recolonizing Prince Patrick and Mackenzie King islands.
10. As of 1974 southwestern Melville (stratum XIII), especially the Bailey Point area, was the heartland for muskoxen on the western Queen Elizabeth Islands as was the case in 1961. Stratum XIII will surely serve as a reservoir for future stocking of adjacent areas and islands.
11. Muskoxen show an overall preference for low ground (above mean sea level). The preference reflects their choice and need for well-vegetated sedge meadows and productive willow slopes.
12. We believe that it is unlikely that the periodic oscillations of Peary caribou numbers cannot be ascribed to inter-specific competition, nor can the inevitable lows of such vacillations be prevented by elimination of the supposed inter-specific competition.
13. Snow cover and ground-fast ice are the two principal agents causing forage unavailability which has led to widespread mortality among, and little or no successful reproduction of arctic ungulates, at least, during the study period.
14. We think that Prince Patrick, Eglinton and Melville islands currently form an inter-island complex used seasonally by migratory caribou within the western Queen Elizabeth group. We conclude (*a*) high proportions of caribou seasonally range over two or more islands, (*b*) temporal and spatial aspects of inter-island movement prohibit the evaluation of annual range requirements on an island basis, and (*c*) the inter-island migratory movements are perpetuated by both traditions and responses to environmental stress.
15. Caribou and muskoxen on the western Queen Elizabeth Islands require special care because of their current low numbers. At present there is only a limited harvest of Peary caribou and no harvest of muskoxen. It would not be prudent to increase the harvest of caribou or begin the harvest of muskoxen until surveys indicate that they have increased to a substantially higher

level. If plans are made for harvest of muskoxen from any area, the control should be extended beyond the total numbers of animals killed.

16. The Bailey Point area (850 km^2) of southwestern Melville Island should be set aside as a muskox sanctuary with legal protection such as a National Wildlife Area status. Bailey Point is the core of the heartland for muskoxen, and the continued well-being of muskoxen on Bailey Point may be the key to successful maintenance of the species on the western Queen Elizabeth Islands.

17. The Inuit of Resolute Bay should continue their recent (1975) ban on hunting of Peary caribou on Bathurst Island until surveys indicate that caribou have recovered on that island.

18. Not more than 1% of the estimated 1974 numbers of caribou on Melville and Prince Patrick should be harvested until caribou numbers have recovered.

19. Muskoxen on the western Queen Elizabeth Islands should not be harvested unless the hunt is strictly supervised and results analysed in detail (including all points raised in here). Such a harvest should be restricted to not more than 1% of the estimated 1974 number of muskoxen until increases are determined.

20. Additional surveys of numbers, distributions and movements of caribou on Prince of Wales and Somerset islands should be carried out to determine: 1) the size of harvest the caribou can sustain and 2) if the caribou periodically move into areas hunted by Inuit of Spence Bay.

21. Melville, Prince Patrick, Bathurst and their satellite islands should be resurveyed at 1972–74 coverages between 1978 and 1980.

22. A summer survey should be carried out soon on Mackenzie King, Borden and Brock.

23. Insight should be gained on the magnitude and periodicity of inter-island movements as the construction of pipelines connecting some of the Queen Elizabeth Islands could disrupt or alter the movements of caribou between islands.

24. Any future aerial surveys should cover at least 25% of the land mass, and preferably a larger area for muskoxen. Surveys of muskoxen should include all coastal areas and or all well-vegetated sites, if known. We suggest that a 1.6 km transect strip width be used for both species, but particularly for muskoxen. Surveys for caribou should be flown at about 150 m above ground level, and for muskoxen at about 300 m. If no compositional counts are required, then aerial surveys of muskoxen could be flown between 300–500 m against a background of snow. If a combined survey is required, some average of the points noted is required. Peary caribou should be surveyed for estimated total numbers between the last week of June and first week of August for best results. Surveys during periods of snow cover are subject to considerable observational error: there is no contrast between the light pelage of caribou and the snowy background. Aerial surveys must be flown in winter, however, if winter distributions are desired. Seasonal movements in late spring or early summer and again in late summer could also confound survey results. Aerial surveys of muskoxen should be carried out in late winter (late March and April) or after snow melt in June, if newborn calf counts are desired.

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