An investigation of caribou range on Southampton Island, NWT

by G. R. Parker

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Photo by G. R. Parker.

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Raised beaches and tundra ponds near Native Point, Southampton Island, Northwest Territories.

The author

Gerald R. Parker is a wildlife biologist with the Canadian Wildlife Service (CWS) in Ottawa. He joined CWS in 1966 after receiving degrees (B.Sc., M.Sc.) from Acadia University, Wolfville, Nova Scotia. The results of his study of the Kaminuriak population of barren-ground caribou, from 1966 to 1969, appeared in an earlier report. He continued his study of caribou by conducting a range investigation of Southampton Island, Northwest Territories from 1970 to 1972. Since completing the Southampton Island study he has been studying the feeding habits of muskoxen and Peary caribou on the Queen Elizabeth Islands in the Canadian high Arctic.

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Perspective

By 1955 excessive hunting brought an end to the caribou on Southampton Island in northern Hudson Bay, Northwest Territories. At the request of the Inuit of Coral Harbour, the Northwest Territories Game Management Service and CWS re-established caribou on the island, by air-lifting them from adjacent Coats Island in 1967. It became necessary to evaluate the potential of the island to support a caribou herd. The study was designed to determine optimum caribou densities, based upon lichen standing crop and annual production of vascular plants. This investigation was a baseline study only and as the population reaches manageable levels more specific studies will be required on population dynamics, winter forage availability and seasonal caribou feeding habits.

Abstract

The quantity and quality of forage produced on Southampton Island, Northwest Territories were studied from 1970 to 1972 in order to evaluate the capability of the range to support barren-ground caribou (*Rangifer tarandus groenlandicus*). Using aerial photographs (scale 1:60,000) six moisture regimes were identified. The range was divided into types based on these moisture regimes and on its physiographic features. Vegetation and soil in each range type were sampled, the flora described and the dry weight of the standing crop of lichens and the annual production of sedges, grasses and willows measured. Most herbaceous forage was produced in the limestone Hudson Bay Lowlands while the most productive region for lichens was the crystalline Precambrian Plateau. The most productive caribou range on the island was the South Bay Lowland. The greatest lichen standing crop was approximately 1,000 kilograms per hectare (kg/ha) although restricted alluvial deposits within the South Bay Lowland supported up to 3,000 kg/ha. The standing crop of lichens in the Hudson Bay Lowlands was low: 400 kg/ha was maximum, the average was from 0 to 200 kg/ha. The "reindeer" lichens of the genera *Cladina* and *Cladonia* were insignificant in the total lichen flora of the island; representatives of the genera *Cetraria* and *Alectoria* were the most abundant.

The sedge-willow range type produced the most sedges and willows, averaging 400 kg/ha and 200 kg/ha respectively. The best site for sedge on the island produced approximately 600 kg/ha and the best for willow produced 500 kg/ha.

There was a poor correlation between estimated ground cover and the weight of lichens, sedges, grasses and willows for range types sampled.

The sampling intensity required to provide 80 per cent accuracy at 90 per cent probability for both vegetative cover and forage production varied among range types. The desired accuracy was generally achieved throughout the sampling: on most types over-sampling occurred. There was an inverse correlation between plant cover and sampling intensity required. The intensity of sampling required within any range type depended upon how heterogeneous sample sites were found to be. For most types, a sample of four sites and 60 0.1-sq-m plots provided the acceptable level of accuracy.

The nutritional value of lichens was low. Analyses of sedges and willows, however, showed crude protein levels to be exceptionally high. Quality of forage is not a problem on the island. Based on estimated forage production of range types and estimated caribou requirements, an optimum island population of 40,000 caribou is recommended.

The Coats Island caribou, the population from which the Southampton Island stock originated, were the heaviest recorded specimens of *R. t. groenlandicus* in Canada. Several adult males weighed in 1970 exceeded 180 kg. The relatively unused range on Southampton Island should ensure that the introduced population experiences maximum productivity and reaches 1,000 caribou around 1980. At that time limited hunting is recommended.

Résumé

De 1970 à 1972, on a étudié le volume et la qualité du fourrage produit dans l'île Southampton (Territoires du Nord-Ouest), afin d'évaluer la capacité du territoire à entretenir le caribou des toundras (*Rangifer tarandus groenlandicus*). Les photographies aériennes (échelle de 1:60,000) ont permis d'identifier six régimes hygrométriques. Le territoire a été divisé en sections, selon ces régimes et les caractéristiques physiographiques. On a échantillonné le sol et la végétation de chaque section, décrit la flore et mesuré le poids à sec du peuplement de lichens ainsi que la production annuelle du carex, des graminées et des saules. Les fourrages herbacés poussaient surtout dans les basses-terres calcaires de la baie d'Hudson, tandis que la région la plus propice à la pousse de lichens était le plateau précambrien cristallin. L'aire de caribou la plus productive de l'île était composée des basses-terres de la baie Sud. Le plus important peuplement de lichens représentait environ 1,000 kilogrammes par hectare (kg/ha), mais de petits dépôts alluviaux à l'intérieur des basses-terres de la baie Sud en portaient jusqu'à 3,000 kg/ha. Dans les basses-terres de la baie d'Hudson, le volume des lichens était faible, soit au maximum 400 kg/ha, et en moyenne 0 à 200 kg/ha. Les lichens à caribou des genres *Cladina* et *Cladonia* étaient à peu près absents de la flore de l'île; ce sont les plants des genres *Cetraria* et *Alectoria* qui étaient les plus abondants.

La section de carex et de saules était la plus productive de ces deux essences, dont la masse moyenne respective était de 400 kg/ha et de 200 kg/ha. Le meilleur endroit de l'île pour le carex produisait environ 600 kg/ha et, pour les saules, 500 kg/ha.

On a observé une faible corrélation entre l'importance estimative du tapis végétal et le poids des lichens, carex, graminées et saules pour les sections échantillonnées.

L'intensité de l'échantillonnage nécessaire à l'obtention d'une précision de 80% à un niveau de probabilité de 90% pour ce qui est de la production du tapis végétal et des fourrages variait d'une section à l'autre. On obtenait généralement la précision désirée tout au long du prélèvement de l'échantillonnage; la plupart des sections ont fait l'objet d'un sondage excessif. On a observé une correlation inverse entre l'importance du couvert végétal et l'intensité d'échantillonnage nécessaire. Cette dernière, dans une section donnée, dépendait du caractère hétérogène des emplacements de sondage. Dans la plupart des cas, un échantillon de quatre endroits distincts et 60 parcelles (0.1 mi^2) suffisait à atteindre la précision désirée.

La valeur nutritive des lichens était faible. Des analyses de carex et de saules ont toutefois permis d'observer des niveaux de protéines brutes exceptionnellement élevés. La qualité du fourrage dans l'île ne présente aucun problème. Selon la production approximative de fourrage de chaque section et les exigences estimatives du caribou, la population optimale serait de 40,000 animaux.

Les caribous de l'île Coats, population d'où proviennent les troupeaux de l'île Southampton, ont été les spécimens plus lourds de *R.t. groenlandicus* étudiés au Canada. En 1970, plusieurs adultes mâles pesaient plus de 180 kg. L'aire relativement inutilisée de l'île Southampton devait assurer à la population introduite une productivité maximale et un nombre de 1,000 animaux vers 1980. On recommande pour cette époque une chasse limitée.

Резюме

В период от 1970 до 1972 гг. проводилось обследование количества и качества кормовых растений на острове Саутгемптон в Северо-Западных территориях с целью определить способность местности обеспечить существование карибу бесплодных почв (Rangifer tarandus groenlandicus). При помощи воздушной фотосъемки (масштаб 1:60 000) было определено шесть влажностных режимов. Вся территория была разбита на зоны по признаку этих влажностных режимов и ее физиографических особенностей. Были отобраны образцы растительности и почвы от каждой зоны, была описана ее флора, а также измерялись сухой вес срезанного на корню лишайника и годичный урожай осок, трав и ивняка. Бóльшая часть травяного корма вырастала на известняковых почвах долины Гудзонова залива, а наиболее продуктивным районом для лишайника являлись кристаллические породы докембрийского плоскогорья. Наиболее продуктивной для карибу местностью на острове явилась долина Южного залива. Наибольший урожай лишайника составлял примерно 1000 кг на гектар (кг/га), в то время как отдельные аллювиальные отложения в долине Южного залива давали урожай до 3000 кг/га. Урожай лишайника долины Гудзонова залива был низким; 400 кг/га являлось максимумом, средняя урожайность составляла от 0 до 200 кг/га. Олений мох вида Cladina и Cladonia не составлял значительной доли общего урожая лишайника на острове, в то время как наиболее распространенными являлись представители родов Cetraria и Alectoria.

Местности осочно-ивнякового типа давали большую часть урожая осоки и ивы, в среднем 400 кг/га и 200 кг/га соответственно. Наилучший участок острова по урожаю осины производил примерно 600 кг/га и наилучший участок для ивы — 500 кг/га.

Для типов местностей, подвергавшихся изучению, наблюдалось отсутствие взаимоотношения между предполагаемой толщиной земляного покрова и весом лишайников, осок, трав и ивняка.

Количество проб определялось требованием соблюдения точности в

80% при вероятности 90% как для растительного покрова, так и урожая кормовых растений, по различным типам местностей. Способ отбора образцов в общем удовлетворял требованиям точности, в большинстве случаев наблюдался перебор образцов. Обнаружилось, что существует обратно-пропорциональная зависимость между растительным покровом и необходимым количеством проб. Необходимое количество проб для данного типа местности находилось в зависимости от равномерности ее состояния. Для большинства типов местности пробы с четырех участков и 60 делянок размером в 0,1 м^2 обеспечивали приемлемый уровень точности.

Питательная ценность лишайников была низкой. Однако, анализы осок и ивняков показали исключительно высокие уровни сырых белков. Качество корма на острове не является проблемой. Основываясь на предполагаемой урожайности типов местности и на предполагаемых потребностях карибу, рекомендуется оптимальная цифра популяции карибу в 40 000 голов.

Карибу острова Котс, с которого произошло заселение карибу острова Саутгемптон, являлись наиболее тяжеловесными экземплярами Rangifer tarandus groenlandicus в Канаде. Вес нескольких взрослых самцов, взвешенных в 1970 г., превышал 180 кг. Сравнительно неиспользованные пастбища на острове Саутгемптон обеспечат, надо полагать, что новая популяция достигнет максимальной продуктивности и возрастет до 1000 карибу к 1980 г. К тому времени рекомендуется разрешать охоту в ограниченном масштабе.

Introduction

Prior to the establishment of the Hudson's Bay Company at Coral Harbour in 1924, the Inuit of Southampton Island (Fig. 1a) rarely hunted caribou; they relied extensively upon the sea. The Hudson's Bay Company provided guns and ammunition; its demand for arctic fox pelts prompted the Inuit to establish traplines and travel inland. Thus the caribou population was reduced: by 1930 caribou were already scarce (Sutton, 1932), they were near extermination by 1950 (Bird, 1953), and they probably disappeared from the island altogether around 1955.

The federal government suggested the re-establishment of caribou on Southampton Island as early as 1962 (Brack, 1962). It was not until 1967, however, that CWS and the Game Management Service of the Northwest Territories transferred caribou from Coats Island. The Inuit of Coral Harbour received the caribou transplant enthusiastically and are cooperating by ensuring that no animals are killed until the population reaches a harvestable level.

The need for an appraisal of the caribou range on the island was evident if the Game Management Service was to manage the animals properly. Previous botanical investigations provided no quantitative information on forage abundance and distribution, although the island flora had been well documented.

In 1969, CWS undertook a range appraisal of the island. Field investigations began when CWS established a base camp at Salmon Pond (64°15′N; 84°55′W) from June 2 to August 14, 1970, and continued from a camp near Duke of York Bay (65°02′N; 84°33′W) from July 3 to August 14, 1971. A Cessna 180 aircraft allowed access to much of the island during the last 2 weeks of August 1971. Investigations into the productivity and phenology of vascular plants continued near Coral Harbour from August 1 to August 17, 1972.

The study was designed to provide a base line for management of the caribou of Southampton Island. Specific information is yet required on the population growth of caribou, their seasonal distribution and utilization of forage, and seasonal forage availability.

1. Exploration

On July 29, 1613 Thomas Button became the first European to sight Southampton Island (Barrow, 1818). Other expeditions to sight the island were Bylot and Baffin in 1615 (Barrow, 1818), possibly Foxe in 1631 (Barrow, 1818), Middleton in 1742 (Middleton, 1744), Parry in 1821 (Parry, 1824), Lyon in 1824 (Lyon, 1825), Back in 1836 (Back, 1838), Rae in 1846 (Rae, 1850), and Hall in 1865 (Hall, 1879). Middleton in 1742 first demonstrated, and Parry in 1821 substantiated, that Southampton is an island.

Prior to 1860 no Europeans had been on the island for more than a day or two. Whalers began exploiting these northern waters around 1860 but made only occasional visits to the island and had little contact with the inhabitants.

Captain Comer (1910), a whaler who was in the vicinity of the island between 1893 and 1910, made observations of the Inuit inhabitants and also recorded geographical corrections. A Captain Murray had established a whaling station at Cape Low from 1901 to 1903 (Sutton, 1932). Low (1906), officer-in-charge and geologist of the dominion government expedition to Hudson Bay and the arctic islands in 1903 and 1904, visited the west coast and the Seahorse Point area. From 1916 to 1918, Captain Munn (1919) maintained a whaling station at South Bay. Munn was the first European to make extensive journeys inland; he crossed the island from South Bay to Roes Welcome Sound in February 1918.

By 1920 the general outline of the island was correctly mapped. Contributions to knowledge of the physiography of the interior were made by Mathiassen, Sutton, Manning and Bird. Mathiassen (1931) crossed Frozen Strait to Duke of York Bay, became trapped for the winter of 1922–23 by ice conditions and travelled with the Inuit as far as South Bay. The Hudson's Bay Company established a trading post at Coral Harbour on South Bay in 1924. Sutton (1932) spent the year 1929–30 conducting ornithological investigations near South Bay and added considerably to the general knowledge of the area. Manning (1936; 1942) travelled over the island during 1933 to 1936 and described the interior. The Geographical Branch of the Department of Mines and Technical Suveys in 1950 (Bird, 1953) conducted the most recent extensive study of the island. That study added to knowledge of the physical geography and of the relationship between geographical factors and the location of modern and prehistoric Inuit sites. In the last two decades there have been faunal, geological and archaeological studies on the island.

2. Inuit population

The proto-Dorset culture made little use of the caribou on Southampton Island (Collins, 1957). The later Sadlermiuts, exterminated by disease in 1902–03, also depended almost exclusively on the sea for survival (Bird, 1953). In 1908 Aivilik Eskimos from Repulse Bay repopulated the island.

The Aivilik were joined by the Okomiut, who moved with the Hudson's Bay Company post from Coats Island to Coral Harbour in 1924. The Okomiut had come from south Baffin Island to Coats Island with the establishment of a trading post in 1919 (Sutton, 1932). After 1924 Coral Harbour was the center for the island population.

The Eskimo population was estimated at 138 in 1930 (Sutton, 1932), 160 in 1934 (Manning, 1936), 238 in 1951 (Bird, 1953), 215 in 1959 (Van Stone, 1959) and 209 in 1961 (Brack, 1962). From 1967 to 1970 the Inuit population increased from 260 to 337 (Statistical Information Centre, Indian and Northern Affairs Department, pers. comm.). In 1970 most Inuit lived permanently at Coral Harbour, although several families retained semi-permanent camps at Duke of York Bay.

Some Inuit are employed by the federal Ministry of Transport or the government of the Northwest Territories. Fox trapping and bear hunting are sources of income during winter and fresh meat is obtained by sealing and fishing. A few walrus are killed during the summer months, mainly for dog food, and a quota of approximately 100 caribou is harvested from Coats Island in late summer.

3. The caribou

Caribou were common on Southampton Island in the early 1900s although few records describe their early distribution or abundance.

> Caribou are plentiful on Southampton Island, wintering on the high tablelands, and summering on the low lands near the shores, where the sea breezes gave them relief from the mosquitos (Munn, 1919, p. 54)

Mathiassen (1931:27) reported numerous caribou gathered on the highlands and on Bell Peninsula in winter and scattered over the island in summer. He reported them being exceedingly numerous around Kirchoffer River during winter 1922–23.

Soon after the establishment of the Hudson's Bay Company post in 1924, caribou numbers rapidly declined, probably a result of "an unlimited supply of cartridges to the Aivilingmuit" (Manning, 1942, p. 28).

According to Sutton (1932)

> ... caribou had once been as common as lemmings and unsuspicious as cows ... but they were gone now and the Eskimos were having grave difficulties in finding material for their winter clothing. (p. 80)

> ... At the present time it appears to have disappeared almost altogether from the southern part and to be restricted principally to the region of the high country between East Bay and Duke of York Bay, and to the more or less unknown country inland from the coast and north of Cape Kendall. (p. 79)

In 1935 Manning (1942:29) estimated that no more than 30 caribou remained on the island in the rugged hills along the east coast. In 1938 he noted an increase, but the few small herds which moved down from the hills were promptly shot. By 1950 (Bird, 1953:61) caribou on the island were near extermination, and the last animal probably died prior to 1955. I believe Banfield (1961:53) was wrong when he wrote there were still about 25 animals on the island in 1961.

With the passing of the caribou went the wolves. In 1929–30 Sutton (1932:33) reported wolves, "...formerly a rather common animal...", becoming rare. Manning (1942:20) reported that the last wolf was shot in October 1937.

There is little information on the former caribou population of Coats Island. In 1950 Banfield (1951:8) estimated the total population at 500. Tener (1961) estimated between 500 and 600 caribou on the island in 1961; Harington (1965) estimated 800 caribou in 1965; and Parker (1970) estimated the population at 1,400 to 1,500 caribou in March 1970.

4. Caribou transfer to Southampton Island

In 1962 Brack (1962) discussed the possibility of reintroducing caribou or reindeer to Southampton Island. Such an idea was not new. The Northwest Territories Game Management Service and CWS continued to discuss its feasibility until June 1967 when, finally, the two services transferred caribou to Southampton Island from neighbouring Coats Island (Manning, 1967).

They captured caribou on Coats Island by firing darts from a helicopter, transferred the captured caribou to a holding pen and flew them to Southampton Island by Otter aircraft. They weighed and ear-tagged the caribou before moving them to Southampton Island. Forty-eight caribou were successfully released.

The re-establishment of a caribou population on the island emphasized the need for a range evaluation. The establishment of an animal species in new or formerly occupied range can cause a rapid population increase followed by a crash due to forage over-utilization. Basic to the prevention of such a boom-and-bust phenomenon is an inventory of the existing range.

5. Previous botanical investigations

In August 1821 Parry (1824) landed in the Duke of York Bay region and collected 40 plant species. Although Mathiassen (1931), made no botanical collection he described the dominant vegetation near the Thompson River at Duke of York Bay.

Sutton collected ... "109 species and varieties of vascular plants ... " in 1929 and 1930, most coming from the South Bay region (Raup 1936:17). He also collected algae and fungi (Jennings, 1936a), lichens (Raup, 1936) and bryophytes (Jennings, 1936b).

Polunin (1938;1940;1947a;1947b; 1948) made perhaps the most complete collection of plants and documented the island flora most extensively. In summer 1948 Cody (1951) increased the known vascular flora from 169 species to 178 species, collections being restricted to the Coral Harbour area.

Brown (1954a;1954b) made botanical investigations during the summers of 1951 and 1952 at Bear's Cove Point and Duke of York Bay respectively, increasing the known vascular flora to 187 species. Brown also collected mosses, lichens, algae and fungi during her investigations.

The floral composition of the island has been well documented and plant communities around Coral Harbour (Polunin, 1948), Bear's Cove Point (Brown, 1954a) and Duke of York Bay (Brown, 1954b) well described.

6. Nomenclature

In this report the scientific nomenclature for lichens follows Hale (1970), for mosses Crum, Steere and Anderson (1973) and for vascular plants Porsild (1964). A glossary of technical terms used is provided on page 60. The terminology used to describe recognized plant communities requires further explanation.

The largest recognized and relatively stable major unit of vegetation, being the climax of a region with a particular climate is the *formation* (Ford-Robertson, 1971). Southampton Island is located in the tundra formation. Further subdivisions of the tundra (e. g. high Arctic and low Arctic) are of no practical use in this report. Formations may then be subdivided into classes, orders, alliances and, finally, associations (Poore, 1955).

The *plant association* is the fundamental unit of plant sociology and is a unit of vegetation which exhibits essential uniformity in two respects, namely floral composition and ecologic structure (Cain, 1932). It is the lowest unit into which plant communities are classified and compares to the species in taxonomy (Goodall, 1952). The association projects a certain uniformity of vegetation cover which consists of a repetition of variations (Romell, 1925, cited by Cain, 1932). Species of plants form patches and the patches form a mosaic which constitutes the association (Watt, 1947). I make no attempt to group associations into alliances other than to recognize the *physiographic regions* as described by Bird (1953).

I use the term *range type*, or *type*, analagous to the association, as representing a recognizable land form characterized by one or more dominant plant species, usually having a uniform soil structure and drainage pattern, and incorporating within its boundaries repetitive variations. Where those variations are few in number, are easily recognized and occupy relatively large areas, they are designated as *subtypes*. Otherwise the variations, or basic units (Hopkins, 1957) of an association are designated only as to range type.

Study area

Figure 1a
The location of Southampton Island, Northwest Territories

1. Location

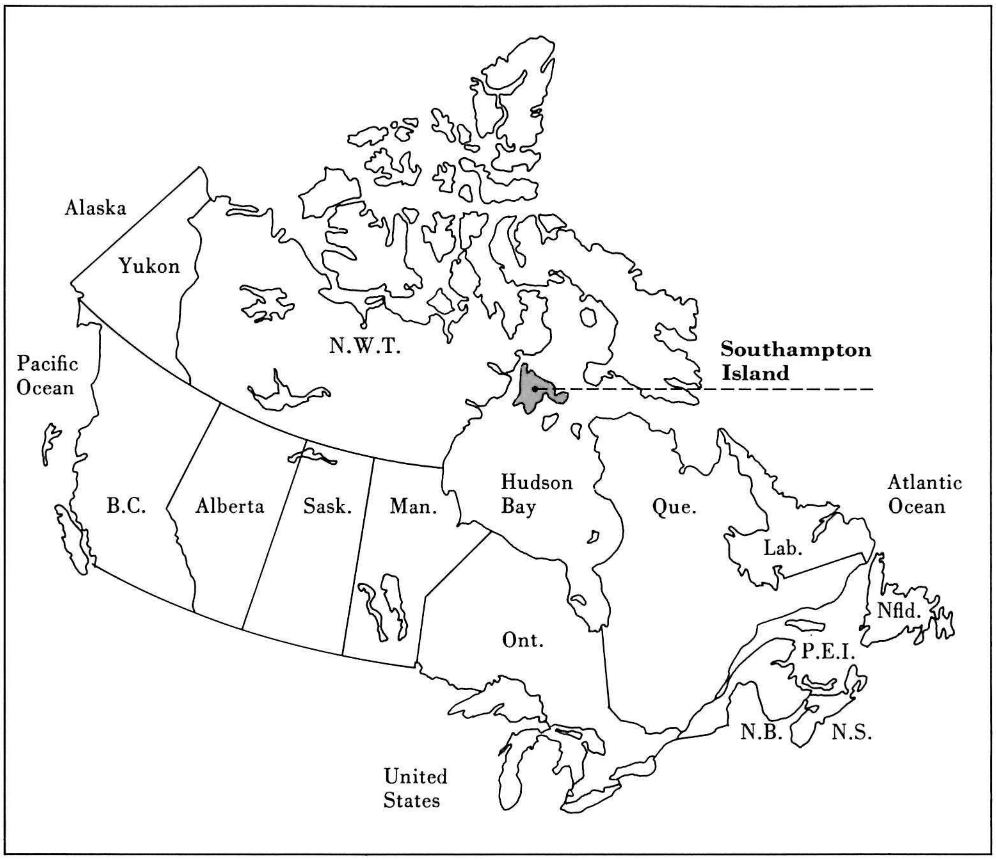
Southampton Island is the largest island in Hudson Bay measuring approximately 43,000 km^2 in area. It is roughly triangular, the apex oriented in a northerly direction. Cape Low, the southernmost tip, lies at 63°06′N and Cape Munn lies 320 km to the north at 65°55′N. Seahorse Point, on Bell Peninsula, is the easternmost point of land at 80°10′W and 350 km west is Cape Kendall at 87°15′W. The island is bordered on the west, and separated from the mainland, by Roes Welcome Sound. To the east and northeast is Foxe Channel and to the south, Coats Island and Hudson Bay (Fig. 1a and 1b).

2. Geology and physiography

Bird (1953:40–48) describes in detail the geology and physical geography of the island. Since his classification forms the basis for my own study I include the following based upon his report.

On a basis of rock structure the fundamental division of the island is between the crystalline rock area, part of the Canadian Shield, and the limestone area, part of the Hudson Bay Lowlands. In the north these two geological formations are separated by an abrupt escarpment while to the south there is a more gradual intergradation of both into the South Bay Lowland. Each of the major formations can be subdivided into the following distinct physiographic regions (Fig. 2).

Figure 1a



2.1. Canadian Shield

A1 *Kirchoffer Upland*–This area is the largest in which the Southampton erosion surface is preserved intact. Drained by the Kirchoffer and Ford rivers, which flow in wide, mature valleys the Kirchoffer upland exhibits little evidence of glaciation. Shattered fragments of the underlying rock form a continuous mantle of debris, and scattered deposits of gravel and sand mark the hillsides and valley floors.

A2 *Cape Welsford Upland*–This region lies to the north of a line from the mouth of Cleveland River in Duke of York Bay to Canyon River on Foxe Channel. The area is criss-crossed by numerous streams, of which those flowing to the east are the largest. The valleys are steep: in some places gorges, in others widening into lake-filled, rock basins carved by glaciers. The most conspicuous feature is the quantity of sand, limestone debris, and gneiss boulders that covers a considerable area.

A3 *Eastern Plateau*–The greatest relief on Southampton Island is in the strip of land, 16 to 32 km wide, extending along the Foxe Channel coast from Canyon River to a short distance north of Liver Creek, meeting the sea in vertical cliffs between 300 m and 450 m high. The plateau is dissected by 10 major fast flowing streams and 10 smaller creeks that enter Foxe Channel. Only Mathiassen Brook has been named. To the west, the plateau blends into the Kirchoffer Upland. The two regions are similar; however, the highest points of the Eastern Plateau are greater, up to 550 m. The surface is gently rolling and virtually featureless; a thick mantle of rock waste covers the bedrock.

A4 *Bell Hills*–A ridge of gneiss rock, about 9.5 km wide, extends for 64 km on the Foxe Channel side of Bell Peninsula from Gore Point to Seahorse Point and is dissected by streams into a number of low hills. The hills are glacially smoothed rock except at the highest levels where there are small areas of shattered rock. The valleys between are partly filled with till and with marine-sorted sediments.

Figure 1b
The major rivers and geographical features of Southampton Island, Northwest Territories

Figure 1b

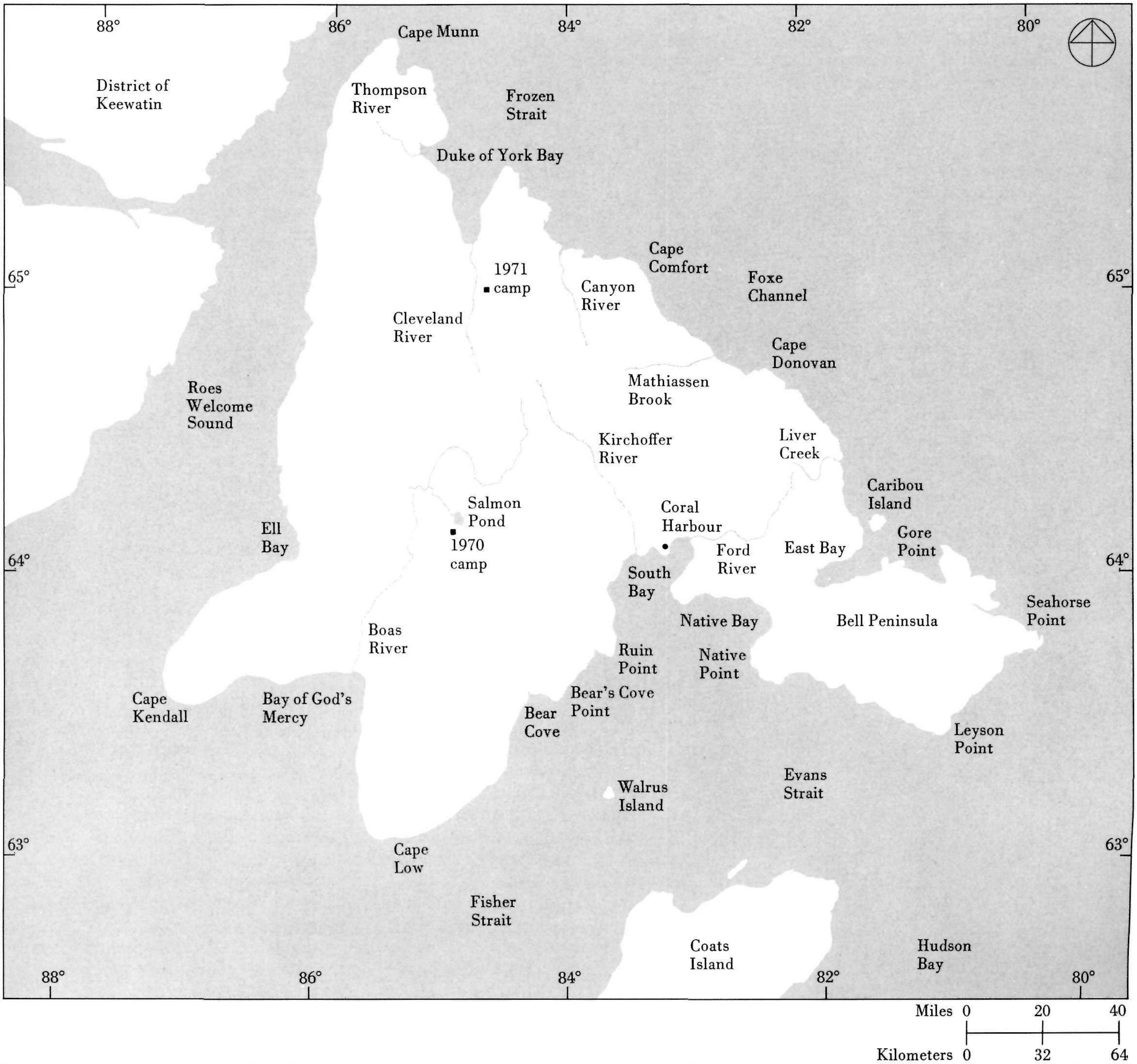
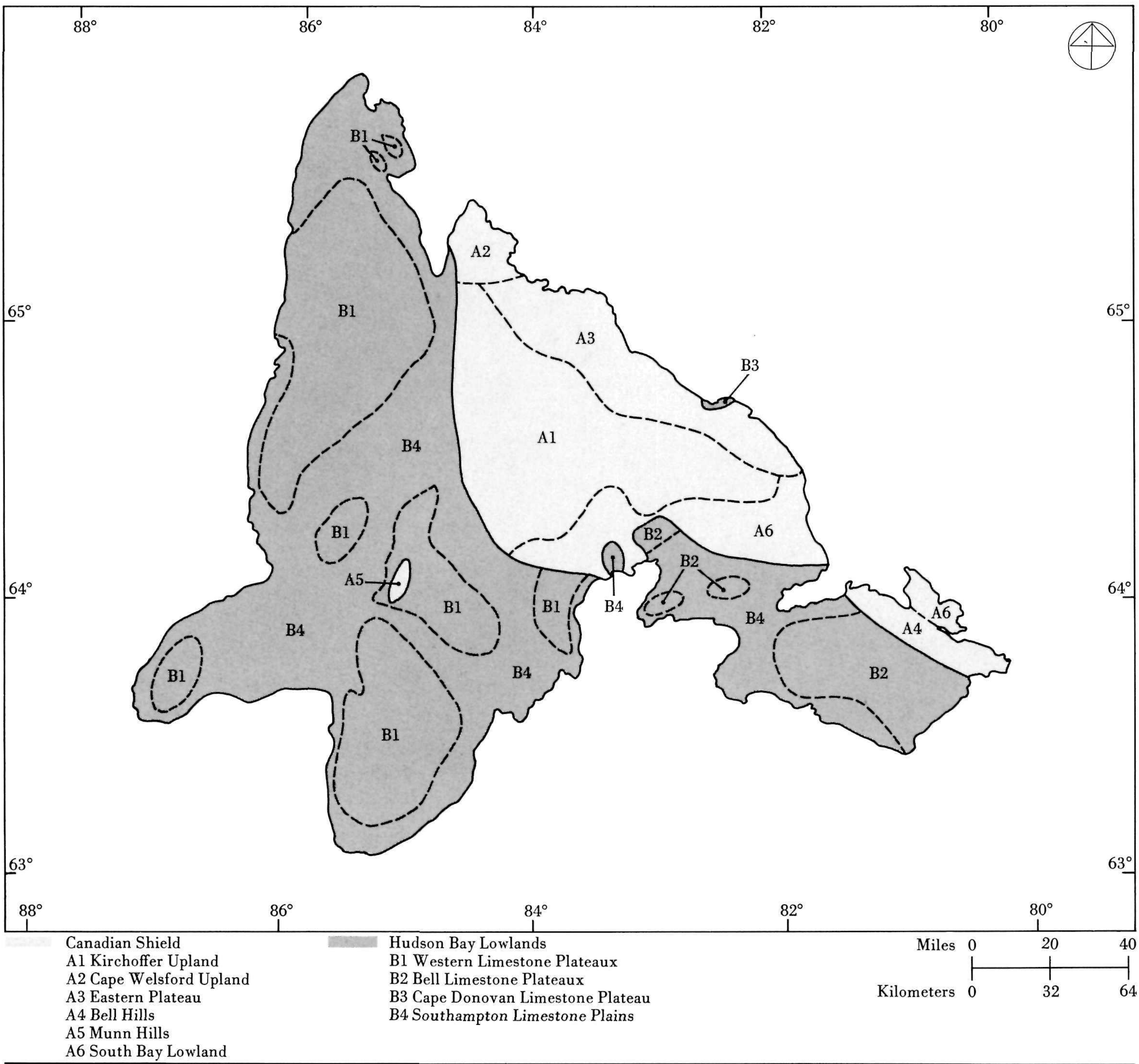


Figure 2
The physiographic regions of Southampton Island as delineated by Bird (1953)

Figure 2



A5 *Munn Hills*–Manning (1942) named these 150-m crystalline gneiss hills, which occupy an oval-shaped area 20 km long, in the southwest of the island. The gneiss is part of the Canadian Shield and is surrounded by limestone plateaux. The hills have been exhumed from under the limestone in the recent geological past. The upper surface is smooth: glacial and post-glacial marine action have swept away rock debris.

A6 *South Bay Lowland*–This is the low-lying granite and gneiss area found south of the crystalline uplands. Although geologically similar to the adjacent Precambrian areas there is little resemblance in the physiography. Small limestone outliers show that the Palaeozoic limestone covered the area in the recent geological past. In the north, the Kirchoffer River enters the region in a shallow gorge, which deepens to 20 to 30 m as the river approaches the sea. The surface is rolling; ridges reach 45 m high with a number of scarps. Rock is exposed on most ridges, but in the hollows, and on all surfaces inland, there are till deposits. The till is covered with hummocky tundra vegetation except in sandy areas associated with former beaches which support heath vegetation. Except for the Kirchoffer and Ford rivers, streams spill over from lake to lake without true valleys.

2.2. Hudson Bay Lowlands

B1 *Western Limestone Plateaux*–Eight plateaux west of Coral Harbour varying from over 3,885 sq km to less than 25 sq km are the remnants of fluvial or marine limestone plains, raised in the late Tertiary by epeirogenic forces. Fluvial erosion subsequently divided the raised plain into a series of plateaux, separated by lowlands. The surfaces of the plateaux are generally flat or very gently undulating and strewn with shattered limestone, ranging from small angular pebbles to plates from 20 to 30 cm in diameter. Vegetation is almost completely lacking except around the small shallow lakes. An integrated drainage system has not developed in the larger plateaux. Small intermittent streams drain into lakes from which there are no obvious outlets. The water flows beneath the frost-shattered limestone on the unbroken bedrock.

B2 *Bell Limestone Plateaux*–The four limestone plateaux on the east side of South Bay are almost identical with those on the west and are only considered separately on the basis of their position in the Bell Peninsula. The plateaux vary from 60 to over 100 m high where the largest merges with the Bell Hills. The upper surfaces are flat and are covered with angular limestone debris.

B3 *Cape Donovan Limestone Plateau*–This 25-sq-km area of Palaeozoic limestone on the northeast coast is much higher than limestone elsewhere on the island. Lakes are lacking except in two of the lowest areas where the underlying Precambrian rock approaches the surface. Elsewhere a thick mantle of frost-shattered limestone fragments buries the bedrock. Seen from the air, the plateau appears to be a rock desert.

B4 *Southampton Limestone Plains*–The limestone plains dissect the Western Limestone Plateaux and the Bell Limestone Plateaux and contain the large rivers of Southampton Island, except the Kirchoffer River. The largest river is the Boas which rises in the Kirchoffer Upland and flows towards Bay of God's Mercy in a broad ill-defined channel between the four limestone plateaux of the southwest of the island. Twenty-five kilometers from the sea it divides into channels, which occupy a strip of land 4.5 to 5.5 km wide. The braided character continues to the sea.

The limestone plains vary considerably in terrain characteristics. Where limestone is close to the surface the terrain is relatively dry. Numerous abandoned beaches are separated by marshland and shallow lagoons. More extensive are the flat featureless plains, poorly drained and with many irregularly shaped shallow lakes. The surface is covered with a layer of sedges, grasses and other arctic water-tolerant plants. Occasionally a low, beach ridge breaks the monotony of the marshland. This second terrain type reaches its maximum development in the southwest of the island and also in the narrow neck of land between East and Native bays.

3. Climate

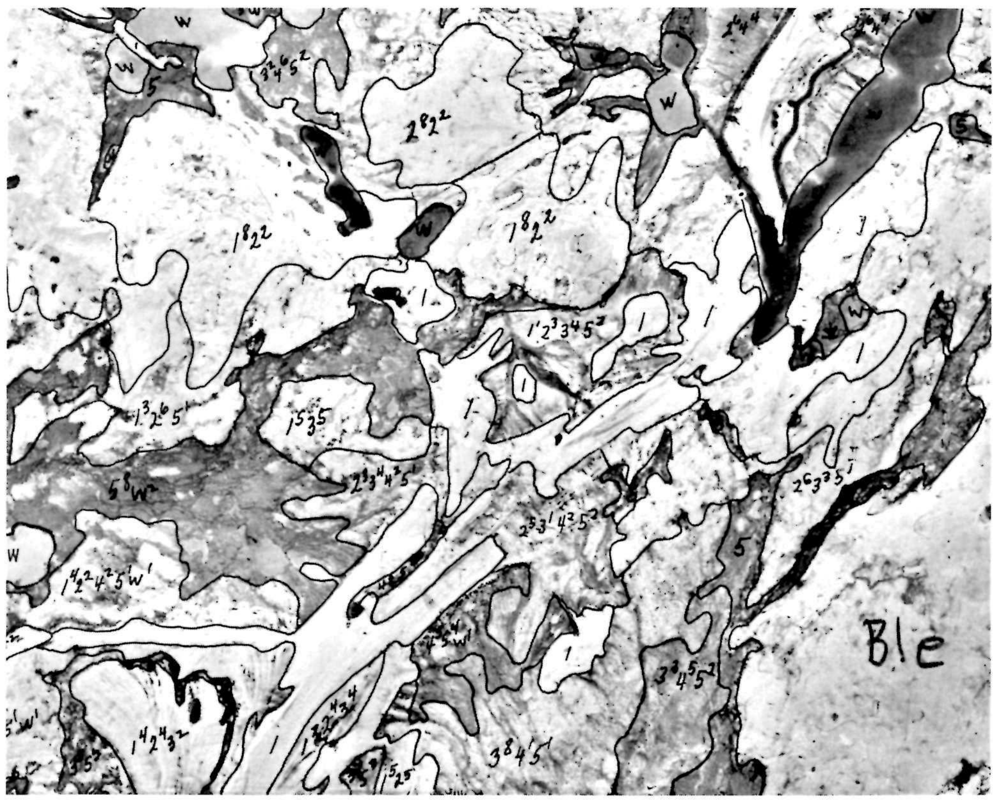
Although Southampton Island is located south of the Arctic Circle, the waters of Hudson Bay create a climate as harsh as that found on most of the higher arctic islands. The average annual wind speed at Coral Harbour (20.1 km per hr) and total precipitation (25.8 cm) are greater than at most of the more northerly stations. Although the annual mean daily temperature (−11.1°C) is comparable to that at Baker Lake (−12.4°C) on the mainland at a similar latitude, the total snowfall is twice the amount (132.7 cm vs 57.2 cm), and nearly four times that at Eureka (37.0 cm) on Ellesmere Island (Thompson, 1967).

Fog and low overcast conditions are prevalent during summer. Above-freezing mean daily temperatures occur during June, July and August, although frost and snow can be expected in all months except July. Appendix 1 gives weather statistics for Coral Harbour, recorded by Atmospheric Environment Service, Department of Environment.

Methods

Figure 3
A portion of an aerial photograph (scale: 1:60,000) used for the preliminary land classification of Southampton Island ($1^8 2^2$ means moisture regime class 1 = 80 per cent; moisture regime class 2 = 20 per cent)

Figure 3



We needed to measure the quantity of forage available in order to estimate stocking rates for caribou on Southampton Island. We sampled range types within Bird's (1953) physiographic regions and extrapolated the results to each region and to the entire island.

During winter 1969–70, Thurlow and Associates, Environmental Control Consultants Ltd., Ottawa, interpreted aerial photographs to provide a workable land classification of Southampton Island. They used black-and-white prints at 1:60,000, which had been taken during summer 1956, to determine the distribution and extent of dominant range types for each physiographic region.

They used soil moisture as the criterion when classifying dominant types within each region. They assumed that vegetation in similar moisture regime classes within a physiographic region would be quite similar.

The moisture regime classification chosen was as follows:

1. Well drained, barren of vegetation;
2. Well drained, light plant cover;
3. Fair drainage, medium vegetational cover;
4. Poorly drained, medium vegetational cover;
5. Poorly drained, good plant cover;
6. Bog;
7. Water.

The consultants delineated each moisture regime on all photographs. Due to the great variation of the moisture regimes and the interspersion of several types within small areas, it was often expedient to classify an area as more than one type.

The classes present in each area were divided to the nearest 10 per cent; e.g. $2^2 3^5 4^3$ = 20 per cent, 50 per cent and 30 per cent of classes 2, 3 and 4 respectively. Figure 3 shows a sample photograph.

They measured the area of each class on the aerial photograph by means of a dot grid and counted the dots in each class within each physiographic region. Using the formula

$$S = \frac{F}{H-h}$$

where S = scale, F = focal length of the camera in feet, H = height of the aircraft above sea level and h = height of the ground, they determined an average scale for each physiographic region. The scale allowed the conversion of the number of dots to square kilometers for that region.

We began in summer 1970 in the field to measure the vegetation within each recognized moisture regime class: to determine standing crop of lichens and annual production of sedges, grasses and willows.

Of the four basic quantitative measurements of a plant community—species dispersion, density, cover and weight—the three measurements chosen for this study were species frequency (dispersion), cover (actual percentage of ground covered by all individuals of a plant species) and above-ground weight (forage yield). Measurements of plant density (number of individuals of a plant species per unit area) appeared both time-consuming and of questionable value. Cover is the most important criterion for determining succession or change (Hanson, 1950; Brown, 1954). We believed that cover values combined with weight were sufficient to determine the potential importance of a species as wildlife forage.

We chose sample sites from aerial photographs. We sampled as many sites as possible within each recognized range type.

The line-plot method was chosen for vegetation sampling. Once the site was selected from a 1:60,000 aerial photograph, a toss of a stone determined the beginning of the transect. Direction of the transect depended upon the configuration of the site and was occasionally altered to remain within the boundaries. Each transect measured 70 m long with 15 plots of 1 sq m at 5 m intervals, all on the right hand side of the tape.

We recorded species occurrence within each square-meter plot. A 20 cm by 50 cm (0.1 sq m) calibrated frame (Daubenmire, 1959) placed in the lower left hand corner of the plot helped estimate cover. We removed lichens at ground level from within the Daubenmire frame on most sites sampled and stored them in paper bags for shipment to Ottawa for dry-weight analysis. We clipped the annual production of grasses, sedges and willows from 0.1-sq-m plots in August 1972 for dry-weight analysis.

In the laboratory, we placed lichen samples in a tray of water and separated them into species. We air-dried each species for 10 to 14 days and weighed it on a Mettler balance in grams to four decimals. We did not separate grasses and sedges before weighing. We weighed willows according to species, although later we grouped species in creeping and ascending growth forms.

J. H. Soper and I. M. Brodo respectively, both of the National Herbarium of Canada, Ottawa identified vascular plants and lichens collected in 1970. W. J. Cody, Biosystematics Research Institute, Department of Agriculture, Ottawa identified vascular plants collected in 1971. G. Brassard, Memorial University, St. John's Newfoundland identified mosses. We deposited all specimens with the respective herbaria.

We collected soil samples from most sites, and described each horizon as to colour (Munsell soil colour charts), width, texture and consistency (The system of soil classification for Canada, 1970). J. H. Day, Soil Research Institute, Department of Agriculture, Ottawa analyzed soil samples. Definitions of terminology used in the descriptions of soil samples can be found in Canada Department of Agriculture (1972).

We analysed samples of the dominant lichen species on the island for total nitrogen, caloric energy and for phosphorus, calcium, magnesium, potassium and sodium and determined total nitrogen using the Micro-Kjeldahl technique. We determined total energy on approximately 1-gram samples in a Gallenkamp Adiabatic Bomb Calorimeter. We determined calcium, sodium, magnesium and potassium values using a Techtron Atomic Absorption Spectrometer (Chapman and Pratt, 1961) and phosphorus values using a Unican SP500 Spectrophotometer (Dickman and Bray, 1940).

We analysed representative samples of vascular plants for total nitrogen, crude fibre, phosphorus and calcium. The crude fibre was the percentage lost when dried residue remaining after digestion of the sample with 1.25 per cent H_2SO_4 and 1.25 per cent NaOH solutions was ignited (Association of Official Agricultural Chemists, 1965).

Results

Table 1
The total area (km²) of the dominant range types within the physiographic regions of Southampton Island, Northwest Territories.

		Hudson Bay Lowlands				Canadian Shield						
Moisture class	Range type	Western Limestone Plateau	Bell Peninsula Plateau	Cape Donovan Limestone Plateau	Southampton Limestone Plains	Kirchoffer Upland	Cape Welsford Upland	Eastern Plateau	Bell Hills	Munn Hills	South Bay Lowland	Totals
1	*Dryas* barrens	1,980.5	264.7	8.5	684.7		28.2					2,966.6
2	Raised lichen–*Dryas* sedge	3,945.0	827.2	25.3	891.1		56.4					5,745.0
3	Patterned ground tundra	2,606.2	561.6	1.5	1,617.0		53.6					4,839.9
4	Sedge–heath transition	1,296.1	334.7	3.6	3,696.6		21.7					5,352.7
5	Sedge–willow meadow	1,477.4	336.5		3,047.1				241.9	41.1	812.9	5,956.9
6	Sedge–willow bog	19.1	0.2		301.5				0.5		5.4	326.7
1–3	Lichen–heath felsenmeer plateau					5,224.8		2,118.9				7,343.7
1–3	Lichen–heath felsenmeer lowland								737.3	73.0	2,978.7	3,789.0
3–6	Plateau meadow					643.5		294.0				937.5
Water		2,034.4	344.8	0.2	2,818.5	49.4	22.0	54.1	59.5	6.2	363.7	5,749.8
Totals*		13,358.7	2,669.7	39.1	13,053.5	5,917.7	181.9	2,467.0	1,039.2	120.3	4,160.7	43,007.8

*Range types not included are alluvial shingle, esker, moss–sedge–lichen meadow and late snow bed. None of these covered extensive areas.

1. Aerial-photo interpretation

The total areas of the most extensive range types (moisture regime classes) in each of the physiographic regions on the island (Fig. 2) are provided in Table 1. Most types were named after the dominant plant species or groups of species as determined by ground sampling; several, however, were best described by including the main physical features (e. g. lichen–heath felsenmeer).

Throughout the Hudson Bay Lowlands aerial-photo interpretation was adequate for recognizing principal range types. Dominant plant species within the same moisture regime in the limestone plateaux varied little; this uniformity continued throughout the limestone plains. Moisture classes 1 to 6 in the Hudson Bay Lowlands as determined from the aerial photographs became the first six range types on Table 1.

Within the Precambrian Plateau of the Canadian Shield attempts to quantify range productivity by determining moisture regime from aerial photographs posed problems. The same criteria were used as for the Hudson Bay Lowlands, although it became obvious that similarly designated areas would not support comparable vegetative cover. For example, in the Western Limestone Plateaux, areas which were designated Class 1 (well drained and barren of vegetation) represented a shattered limestone gravel barrens supporting little or no vegetation. In contrast, within the Canadian Shield a heavily boulder-strewn slope supporting excellent stands of mosses, lichens and heaths might have been designated Class 1 on the photographs. The usefulness of the method was limited by the scale of photography. Limited colour photography (scale = 1:12,000) flown in the summer of 1970 allowed us to compare earlier results from interpretation of black-and-white prints (scale = 1:60,000). As a result, we combined all areas designated as classes 1 to 3 from the black-and-white aerial photography within the Kirchoffer Upland and Eastern Plateau into one type, the lichen-heath felsenmeer plateau (Table 1) and all areas within classes 4 to 6 within the same areas into the plateau heath-sedge meadow (Table 1). The lichen-heath felsenmeer lowland (Table 1) includes the areas designated as classes 1 to 3 within the Bell Hills, Munn Hills and South Bay Lowlands. It is similar to the lichen–heath felsenmeer plateau type. The alluvial shingle, esker, moss–sedge–lichen meadow and late snow bed types were not recognized from aerial photographs but were sampled on the ground. The results are given in the following section.

2. Range types

2.1. Hudson Bay Lowlands

2.1.1. *Dryas* barrens

Here, we found only the most xeric plant species: bare shattered limestone plates and gravel comprised 50 to 90 per cent of the surface (Table 2; Appendix 2).

Table 2
The percentage of ground covered by dominant types of vegetation within the recognized range types on Southampton Island (standard deviation in parentheses)

Range type	0.1 m^2 plots (n)	Sedge & grass	Willow	Forb	Heath	Lichen	Moss	Debris	Rock & bare ground	Water
Hudson Bay Lowlands										
Dryas barrens										
Dryas–sedge–saxifrage	60	7.2(11.8)	0.9(3.6)	2.4(3.0)	16.1(16.2)	1.2(2.0)	1.9(4.6)	2.3(4.3)	84.2(82.9)	
Dryas–lichen–sedge	60	10.0(5.6)	<0.1	5.4(3.5)	19.8(20.6)	12.7(11.5)	0.3(0.5)	4.6(6.5)	57.0(30.9)	
Raised lichen–*Dryas*–sedge	133	25.3(30.5)	1.1(7.5)	5.9(8.0)	31.8(38.0)	32.9(41.0)	2.5(5.1)	6.5(12.0)	21.4(31.7)	
Patterned ground tundra										
Raised sedge–*Dryas*–willow	90	35.7(24.9)	7.9(10.6)	5.3(5.4)	26.7(20.5)	8.4(12.6)	10.5(15.5)	6.2(7.5)	26.2(28.5)	
Flat sedge–willow–*Dryas*	90	27.9(23.3)	11.8(15.7)	5.4(4.8)	10.5(12.7)	1.1(2.9)	7.9(11.7)	10.0(10.7)	50.9(30.7)	
Sedge–heath transition	170	47.9(25.4)	6.0(11.9)	2.1(3.5)	10.3(17.6)	5.2(11.3)	18.6(26.4)	7.6(8.3)	30.0(29.0)	2.4(10.8)
Sedge–willow meadow	146	57.2(28.4)	21.3(26.4)	1.1(2.0)	2.2(9.0)	1.1(4.8)	57.6(30.0)	23.1(20.6)	7.2(17.6)	2.1(11.9)
Sedge–willow bog	55	56.7(27.2)	4.9(10.1)	1.0(2.5)	0.9(5.5)	<0.1	24.2(29.0)	7.4(9.9)	33.3(37.0)	35.4(32.7)
Canadian Shield										
Lichen–heath felsenmeer plateau	90	7.5(8.6)	2.1(4.0)	1.5(2.9)	25.1(21.3)	38.3(26.3)	11.7(17.1)	3.6(3.5)	32.3(29.7)	
Lichen–heath felsenmeer lowland										
Hudson Bay Lowland	105	19.5(17.7)	1.6(4.8)	4.2(3.8)	29.1(18.8)	30.0(18.0)	8.3(14.6)	3.5(4.2)	29.0(27.4)	
South Bay Lowland	45	8.4(6.5)	5.0(7.3)	3.2(4.5)	25.4(25.5)	58.4(25.8)	19.3(23.5)	4.8(7.6)	15.7(17.6)	
Plateau heath–sedge meadow	15	26.1(21.0)	13.8(9.6)	3.9(3.7)	37.1(25.8)	16.8(20.8)	22.3(25.1)	6.6(4.3)	8.0(16.7)	6.2(13.9)
Alluvial shingle	87	9.4(12.2)	1.1(2.8)	1.1(3.6)	24.8(18.1)	87.5(29.9)	8.2(11.6)	3.3(2.0)	1.6(6.3)	
Esker										
North slope	5	4.0(3.7)	1.4(2.1)	0.4(0.5)	36.6(40.5)	27.4(25.2)	42.0(42.6)		9.0(10.8)	
Crest	3	1.6(2.8)			0.6(1.1)	24.6(42.7)	6.0(3.6)		68.3(41.9)	
South slope	7	5.7(3.1)	0.7(1.1)		48.5(15.7)	53.4(29.0)	18.1(21.1)		0.1(0.3)	
Moss–sedge–lichen meadow	15	25.8(10.5)	12.8(16.2)	9.2(9.7)	9.0(14.7)	22.1(19.0)	44.6(32.0)	9.2(9.8)	0.8(2.6)	
Snow bed										
Upper portion	14	12.3(15.1)	3.8(5.4)	5.8(7.6)	54.2(24.6)	26.9(18.6)	9.1(7.2)	3.4(3.1)	13.9(26.4)	
Lower portion	6	9.8(4.0)	10.0(4.4)	8.3(5.7)		2.5(1.6)	31.6(21.6)	39.6(28.0)	7.5(7.7)	

There was an obvious floral gradient from the most barren sites to the lichen–*Dryas*–sedge range type. The most barren sites consisted of 90 per cent or more bare ground, and vegetation was restricted to *Dryas* mats (Fig. 4) scattered in a mosaic over the shattered limestone plates and gravel. Found within the *Dryas* mats, or cushions, were sedges, lichens and forbs, the most dominant of the latter being *Saxifraga oppositifolia*. Between mats we occasionally found solitary specimens of the most xeric species such as *Draba Bellii* and *Lesquerella arctica*.

Based on the proportion of ground cover, the driest site was termed a *Dryas*–sedge–saxifrage subtype. As the proportion of bare surface material decreased, the *Dryas* mats gave way to a more uniform cover of vegetation (Fig. 5). In this *Dryas*–lichen–sedge subtype, *Dryas* remained dominant; lichens became second in dominance followed by sedges and *Saxifraga oppositifolia*. The trend to more cover and finer surface material continued until the next range type was reached.

Dominant sedges included *Carex rupestris* and *C. nardina;* the most important lichens were *Cetraria nivalis*, *Alectoria ochroleuca*, *A. chalybeiformis*, *Thamnolia vermicularis* and *Hypogymnia subobscura*. Willows were scarce but where present were represented by *Salix reticulata*, *S. arctophila*, *S. arctica* and *S. Richardsonii*. Although of minor importance in the total plant cover, common forbs included *Polygonum viviparum*, *Pedicularis lanata*, *Silene acaulis*, *Draba Bellii*, *Oxytropis arctobia* and *Chrysanthemum integrifolium*.

On the sites with a surface of shattered limestone plates, conditions were most xeric and soils were non-existent. Where the surface material was calcareous gravel, we classified the soils as a cryic orthic regosol (Appendix 3). On the latter sites, the surface horizon contained an extremely low proportion of organic matter (1.52 per cent) and was a gravelly loam, both amorphous and friable. All samples were highly basic (Horizon A, pH-8.14; Horizon B, pH-8.23).

Figure 4
The scattered mosaic of *Dryas* mats typical of the *Dryas*–sedge–saxifrage subtype of the *Dryas* barrens range type (TR33)

Figure 5
The more uniformly vegetated *Dryas*–lichen–sedge subtype of the *Dryas* barrens range type (TR38)

2.1.2. Raised lichen–*Dryas* sedge

This is a variable type found predominantly within the Hudson Bay Lowlands. Vegetation was dominated by sedges, *Dryas integrifolia* and lichens (Table 2; Appendix 4). Any one of the three may be dominant at a given site, and they contributed approximately equally to total cover (Fig. 6).

This type was found during field investigation to be within the South Bay Lowland, especially to the north where the lowlands merged with the Kirchoffer Upland. Within the Hudson Bay Lowlands, it was often restricted to Precambrian rock outcroppings and the protected, well drained slopes of calcareous ridges. Species composition and importance on all sites were very similar, although the calcareous ridges probably supported better stands of lichen. Mosses were of minor importance. Approximately 20 per cent, usually gravel and sand, supported no vegetation.

Dominant lichens were *Cetraria nivalis*, *C. cucullata*, *C. islandica*, *Alectoria ochroleuca*, *A. chalybeiformis*, *A. nigricans* and *Thamnolia vermicularis*. Common sedges were *Carex nardina*, *C. rupestris*, *C. misandra*, *C. scirpoidea*, *Kobresia simpliciuscula*, *K. myosuroides* and common grasses were *Poa arctica*, *P. alpigena* and *Arctagrostis latifolia*. The most common willow was the creeping *Salix reticulata* although also present, but only locally common were *Salix arctophila* and *S. Richardsonii*. Common mosses included *Rhacomitrium lanuginosum*, *Hylocomium splendens*, *Thuidium abietinum*, *Mnium hymenophyllum*, *Distichium capillaceum* and *Myurella julacea*. Regularly occurring forbs included *Saxifraga oppositifolia*, *Pedicularis lanata*, *Polygonum viviparum*, *Chrysanthemum integrifolium* and *Oxytropis Maydelliana*. Usually restricted to the less exposed depressions and rock outcroppings were the ericaceous species *Rhododendron lapponicum*, *Cassiope tetragona* and *Vaccinium uliginosum*.

We classified the soil as a cryic orthic regosol (Appendix 5). The surface

Figure 4

Figure 5

Figure 6
A typical site in the raised lichen–*Dryas*–sedge range type (TR31)

Figure 7
An aerial view (150 m) of a sedge–willow–*Dryas* subtype in the patterned ground tundra range type (TR20)

Figure 6

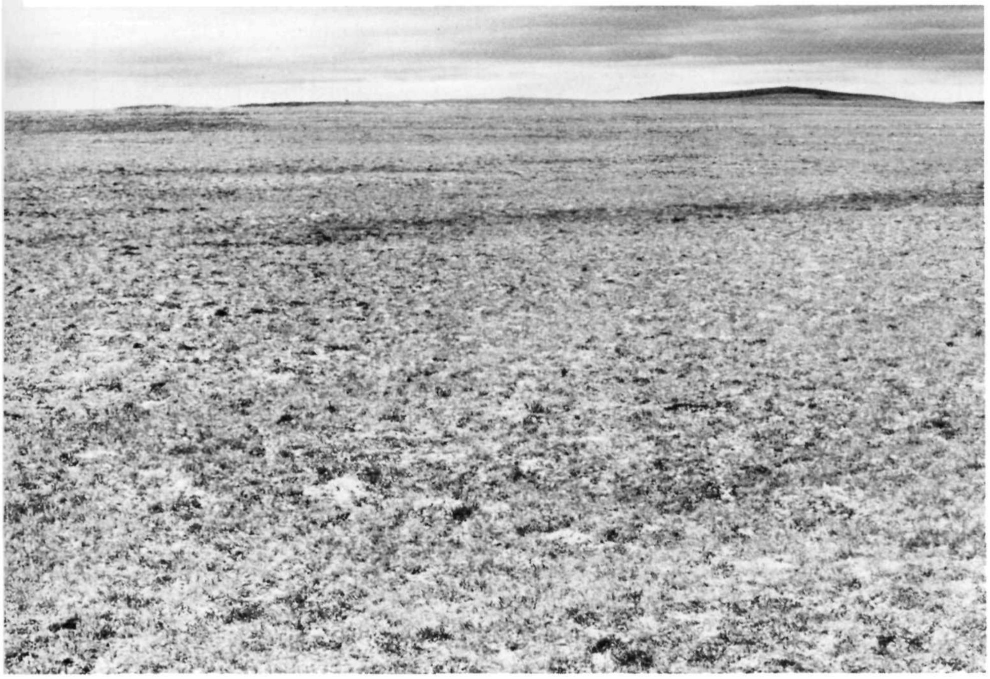


Figure 7

Figure 8
A raised sedge–*Dryas*–willow subtype in the patterned ground tundra range type (TR1)

Figure 9
A flat sedge–willow–*Dryas* subtype of the patterned ground tundra range type (TR30)

Figure 8

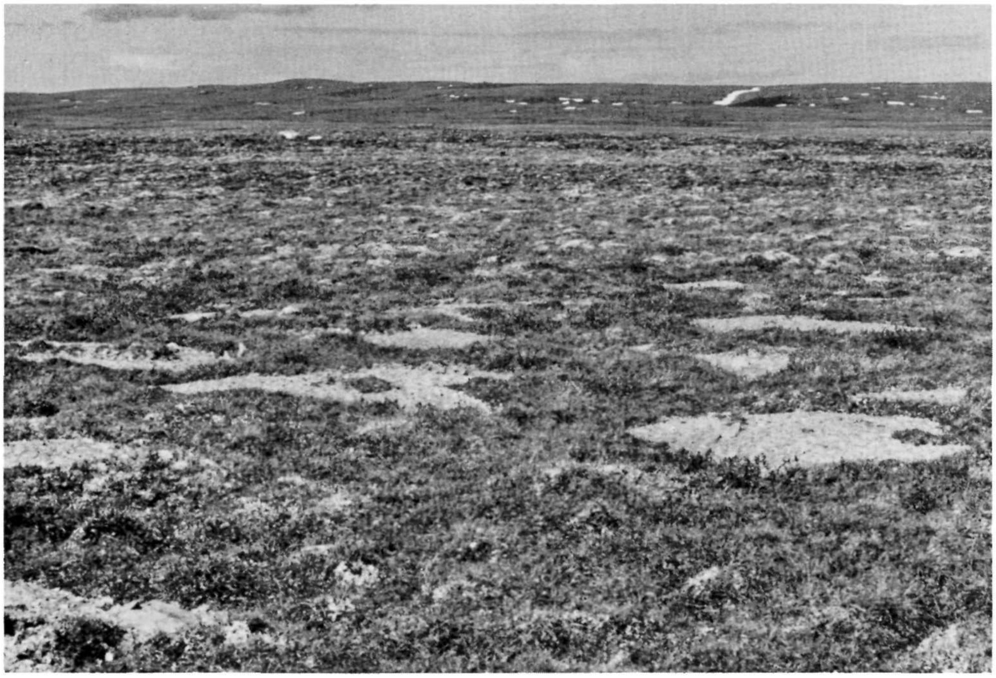


Figure 9

horizon, varying from 5 to 20 cm in depth, contained only 6.71 per cent organic matter and consisted of sand, sandy loam or gravelly loamy sand. Successive horizons contained more gravel. Most soil samples were slightly basic (pH = 6.78–7.89).

2.1.3. Patterned-ground tundra

This type was characterized by extensive patterned ground and restricted to the Hudson Bay Lowlands.

Intensive frost action in the deep soil layer had destroyed distinguishable soil horizons. The surface was characterized by extensive patterned ground (Fig. 7) especially "mud spots" or "frost boils." Soil instability restricted plants to the periphery of the frost boils and the intervening depressions.

Within this type, as recognized by Britton (1957:37), slight variations in topography created differences in soil saturation which influenced plant populations and soil instability. Minor variations in species dominance and composition were common. We identified two subtypes: raised sedge–*Dryas*–willow, and flat sedge–willow–*Dryas* (Table 2; Appendix 6). The former (Fig. 8) occupied the raised and better drained sites, had better developed soils and more complete plant cover than the latter (Fig. 9). Sedges remained dominant within both subtypes, but while *Dryas* was second in dominance on drier sites, willows replaced it on the more poorly drained sites. The percentage of rock and bare ground increased from 25 on drier sites to 50 on wetter sites. The flat sedge–willow–*Dryas* subtype was saturated in early summer but rapidly became dessicated and firm as the season progressed. Within this subtype lichens, forbs and sedges were common on the polygon ridges and willow and sedges in the intervening depressions. Vegetation was more uniformly distributed on the drier sites, except for the unstable polygon center.

Willows were represented by the upright *Salix arctica* and *S. Richardsonii* and

Figure 10
A representative site in the sedge–heath transition range type (TR9)

Figure 11
A well vegetated site in the sedge–heath transition range type (TR28)

Figure 10

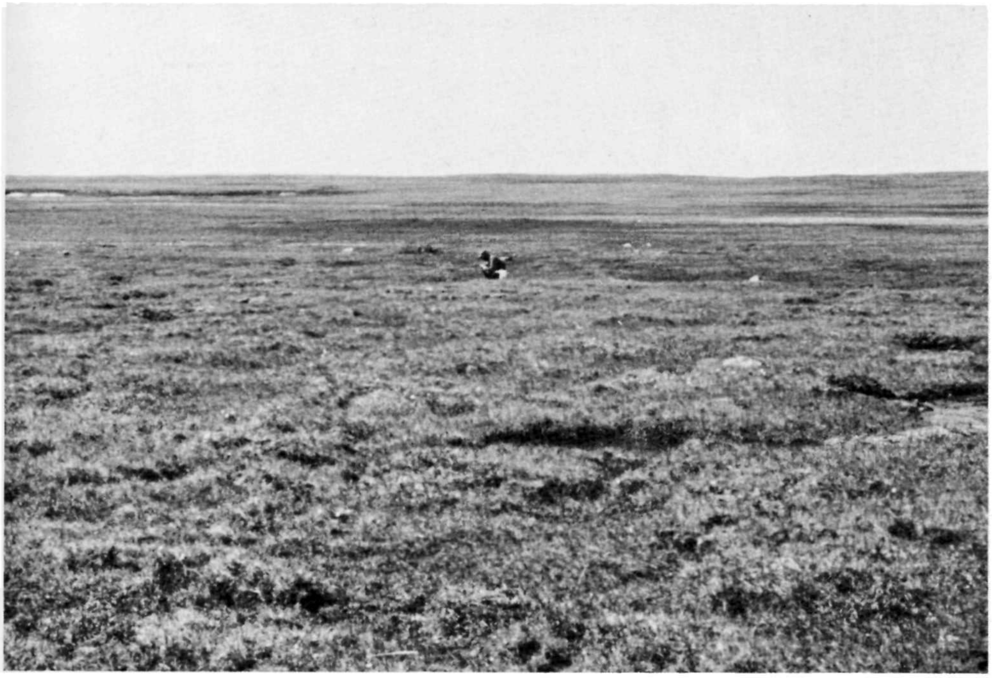


Figure 11

the prostrate *S. arctophila* and *S. reticulata*. Sedges included *Carex rupestris*, *C. scirpoidea*, *C. misandra*, *C. Bigelowii*, *C. rariflora*, *C. atrofusca*, *C. membranacea* and *C. nardina*. Also common were *Eriophorum Scheuchzeri*, *E. triste*, *Juncus albescens*, *Kobresia myosuroides*, *Luzula nivalis* and *Arctagrostis latifolia*. Common mosses included *Ditrichum flexicaule*, *Hypnum bambergeri*, *Tortula ruralis*, *Hypnum revolutum*, *Mnium orthorrhynchum*, *Myruella julacea*, *Rhacomitrium lanuginosum* and *Tortella tortuosa*.

We classified soils as cryic orthic regosol or cryic gleyed orthic regosol (Appendix 7). Horizons were nondistinct or absent. Colour varied from light gray to light brownish gray. The soils consisted of a loam or clay loam containing some gravel and were amorphous, friable and highly calcareous (percentage of lime = 62.80). The typical surface layer was a black sandy loam low in organic matter. All soils were highly basic (pH = 8.23).

2.1.4. Sedge–heath transition

The sedge–heath transition range type includes all land areas of the Hudson Bay Lowlands which were intermediate between the patterned ground tundra and the sedge–willow meadow. It was a varied and disorderly complex, representing a wide range in plant communities and soil types (Fig. 10 and 11). Frost action was not as prevalent as in the patterned ground tundra range type, probably due to the heavy insulating mantle of vegetation and peat. Drainage was poor, and standing water was present at some sites throughout summer although most became free of water as the season progressed. Sedges were the dominant plants while *Dryas integrifolia*, *Salix reticulata* and lichens were restricted to the drier earth hummocks and tussocks. Sedges, *Salix arctica*, *S. Richardsonii* and mosses were the dominant plants on the low lying interstices, although willows contributed a minor part to the total vegetation cover (Table 2; Appendix 8).

Common sedges included *Carex misandra*, *C. scirpoidea*, *C. membranacea* and

Figure 12
A heterogeneous stand of willow (*Salix Richardsonii* and *S. arctica*) and sedges in the sedge–willow meadow range type (TR107)

Figure 13
A water covered sedge–willow bog of the Hudson Bay Lowlands (TR21)

C. rupestris. Also common were *Arctagrostis latifolia*, *Luzula nivalis*, *Juncus albescens*, *Eriophorum triste*, *Kobresia hyperborea* and *K. myosuroides.* Common mosses were *Bryum stenotrichum*, *Ditrichum flexicaule*, *Hypnum bambergeri*, *Myurella julacea*, *Tomenthypnum nitens* and *Tortella arctica.*

Soils varied widely as expected within a transitional vegetation type. Samples included cryic orthic regosol, cryic gleyed eutric brunisol, cryic rego gleysol, cryic rego gleysol (peaty phase) and cryic rego humic gleysol.

The surface horizon usually varied from 5 to 20 cm and consisted of a black or dark gray highly decomposed organic material with fine sand. However, as exemplified by the cryic rego gleysol (peaty phase) sample, there may be only one horizon of dark reddish brown fibrous organic material with an extremely high proportion of carbon (40.70 per cent) and organic matter (70.17 per cent).

The second horizon, when followed by a successive layer, was usually a grayish brown sandy loam with an abrupt and smooth boundary. Where there was no third horizon, gravel replaced the sand although the colour remained a light to dark brownish gray. This horizon was moderately to strongly calcareous. The third horizon was usually an olive gray or grayish brown sandy loam, was moderately to highly calcareous, contained more clay than previous horizons and occasionally contained marine shells. Alkalinity generally increased from the surface horizon down (Appendix 9).

2.1.5. Sedge–willow meadow

Standing water characterized most sites although, as in the previous two range types, much of the land became relatively dry by late summer. Sedge–willow meadow commonly occurred at lake edges, at the bases of slopes adjacent to the escarpment and along streams and flood plains (Fig. 12). Upright willows (*Salix Richardsonii* and *S. arctica*) were prominent, reaching an average of 65 to 75 cm high. Height of the willows above ground depended on

Figure 12

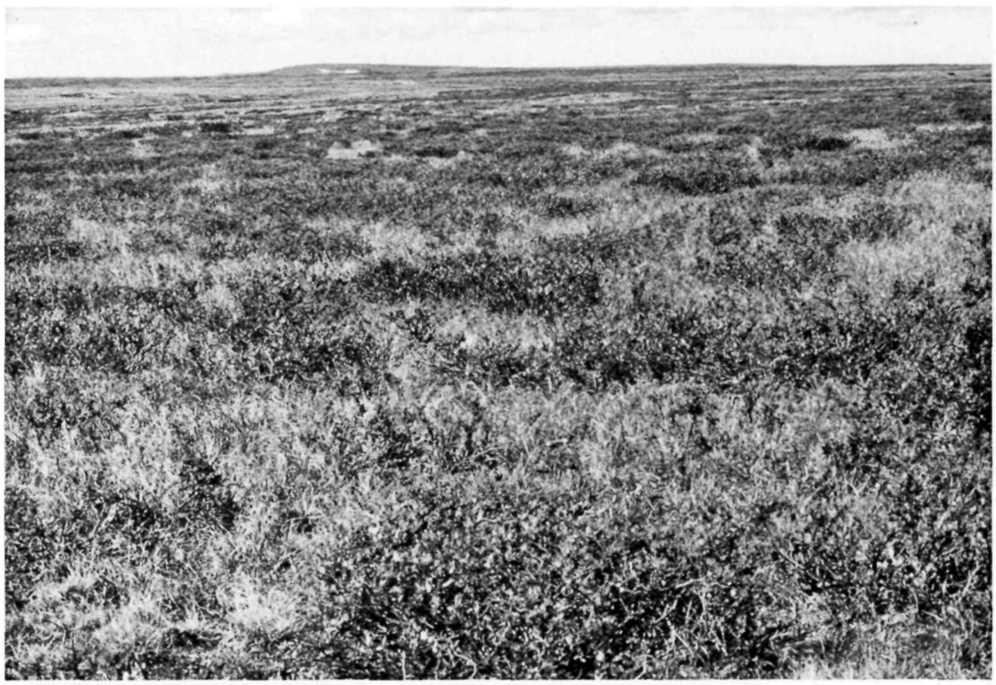


Figure 13

mean annual snow depth. *Salix alaxensis* grew 2 m high and more in the most protected sites. *Salix reticulata* was the most common of the creeping willows. Sedges were abundant, and included *Carex Bigelowii, C. atrofusca, C. misandra, C. membranacea, C. stans, Eriophorum angustifolium, E. Scheuchzeri* and *E. triste*. Also common were *Juncus albescens, Arctagrostis latifolia, Luzula nivalis* and *Alopecurus alpinus*. Mosses comprised over 50 per cent of the ground cover, and dominant species were *Campylium stellatum, Catoscopium nigritum, Drepanocladus lycopodioides, Meesia triquetra, Orthothecium chryseum, Aulacomnium acuminatum, A. palustre, Cinclidium arcticum, Mnium hymenophyllum, Dicranum muehlenbeckii, Ditrichum flexicaule, Tortella arctica, Hypnum bambergeri* and *Tetraplodon* sp. Other plants and their relative importance to total ground cover are shown in Table 2 and Appendix 10.

We collected only two soil samples from this type and both were cryic rego gleysol. Both exhibited two horizons, the upper being a dark reddish brown containing fibrous organic material, sand and some gravel. The upper horizon was slightly calcareous and between 10 and 15 cm in width, and had an abrupt smooth boundary. The lower horizon varied considerably between the two samples both in colour and chemical composition. One sample was a dark grayish brown sand (TR 32) while the other (TR 36) was a light brownish gray, highly calcareous, sandy loam with a few distinct yellowish brown mottles. Alkalinity increased with soil depth (Appendix 11).

2.1.6. Sedge–willow bog

The sedge–willow bog range type was similar to the sedge–willow meadow in terms of dominant species but differed significantly in terms of cover and standing water (Fig. 13). The importance of sedges in total cover was similar (Table 2; Appendix 12) but willows were considerably less important in bogs. Standing water covered 35.4 per cent of the ground compared to only 2.1 per cent in the sedge–willow meadow.

It was often impossible to distinguish between the sedge–willow bog and the sedge–willow meadow.

Many mosses were the same as in the sedge–willow meadow. Common sedges and grasses included *Eriophorum Scheuchzeri, E. angustifolium, Juncus albescens, Carex Bigelowii, C. atrofusca, C. misandra* and *Arctagrostis latifolia*.

2.2. Canadian Shield

2.2.1. Lichen–heath felsenmeer plateau

This type incorporated all the land forms within moisture classes 1 to 3, as delineated from the aerial photography in the Kirchoffer Upland and Eastern Plateau. More detailed classification was not possible because of small-scale photographic coverage and inaccessibility of most of the plateau for ground sampling. As determined from limited ground sampling, aerial reconnaissance and limited colour aerial photography (scale 1:12,000), this seemed the most extensive type throughout the eastern plateau region. Lichens were the dominant plant form and *Cassiope tetragona* and *Dryas integrifolia* were dominant among the dwarf scrub species. Sedges were low in importance. Willows (*Salix reticulata* and *S. arctica*), seldom exceeding 5 cm in height, were also of minor importance. Rock and bare ground, although varying from area to area, averaged one-third the total ground cover (Table 2; Appendix 13; Fig. 14). Sedges, although of minor importance, were represented by *Carex scirpoidea, C. misandra, C. nardina, C. rupestris* and *Luzula nivalis*. Mosses were common and were represented by *Dicranum elongatum, D. groenlandicum, Rhacomitrium lanuginosum, Hypnum bambergeri, Myurella tenerrima, Timmia norvegica, Orthotrichum speciosum* and *Polytrichum juniperinum*. The liverwort *Chandonanthus setiformis* was also collected at one site.

Plateau soils were similar to soils on the gneiss outcroppings in the lowlands and were cryic orthic regosols or lithic orthic regosols. Within the one sample analysed two horizons were distinguishable. Horizon A varied from 10 to 20 cm wide and consisted of a black highly decomposed organic material mixed with gravelly sand. The pH of Horizon A was 7.52, only slightly less than that of Horizon B (7.54) indicating a slightly calcareous substrate. Horizon B varied in colour from yellowish to grayish brown and consisted of coarse sand or gravelly sand with numerous cobbles. Percentage carbon varied from 3.04 in Horizon A to 0.12 in Horizon B.

2.2.2. Plateau heath–sedge meadow

The plateau meadow was sampled only once but results showed a marked contrast to the meadow of the Hudson Bay Lowlands. On the plateau, sedges and grasses formed a smaller proportion of the ground cover, while lichens and heaths (*Cassiope tetragona* and *Dryas integrifolia*) were more important than on the meadows in the Hudson Bay Lowlands.

Willows were represented by *Salix reticulata* and *S. arctophila*. In the stand, but not sampled, were both *S. Richardsonii* and *S. arctica*. The latter two were dwarfed in growth form, less than 20 cm in height.

Mosses were represented by *Ditrichum flexicaule* and *Hylocomium splendens* and also found was the liverwort *Ptilidium ciliare*. Sedges and grasses included *Luzula nivalis, Eriophorum triste, Carex membranacea, C. scirpoidea* and *Arctagrostis latifolia*.

2.2.3. Lichen–heath felsenmeer lowland

This is the dominant type of range within the Bell Hills, Munn Hills and the South Bay Lowland, incorporating areas classified as 1, 2 or 3 from aerial photos. Vegetation composition was similar to that found on the lichen–heath felsenmeer plateau due to similar soils.

This type was dominated by lichens and heaths, the former showing a greater dominance within the South Bay Lowland subtype than the Hudson Bay Lowlands subtype (Table 2; Appendix 14; Fig. 15). Willows were insignificant in the vegetation cover; bare earth and rock occupied approximately 25 per cent of the ground area.

Figure 14
A representative site in the lichen–heath–felsenmeer plateau range type of the Canadian Shield (TR60)

Figure 15
The lichen–heath–felsenmeer lowland range type common in the Bell and Munn hills and the crystalline outcroppings throughout the Hudson Bay Lowlands (TR40)

Figure 14

Figure 15

Common sedges within this type were *Carex scirpoidea*, *C. rupestris*, *C. membranacea*, *C. misandra*, *C. nardina*, *Kobresia myosuroides*, *Luzula confusa* and also *Juncus biglumis*. Mosses were represented by *Rhacomitrium lanuginosum*, *Polytrichum juniperinum*, *Dicranum elongatum*, *Dicranum groenlandicum*, *Ditrichum flexicaule*, *Meesia uliginosa*, *Rhytidium rugosum*, *Drepanocladus uncinatus*, and *Tetraplodon mnioides*.

Soils were cryic orthic regosol or a lithic orthic regosol. Horizon A varied from 10 to 20 cm wide and consisted of a black highly decomposed organic material mixed with fine sand grains and some gravel. Horizon B varied in thickness and often overlay a bedrock base. It usually consisted of yellowish brown gravelly sand with numerous cobbles. The pH of Horizon A had a mean value of 7.32 compared with 8.03 for Horizon B, slightly more basic than the samples from the similar lichen–heath felsenmeer plateau range type (Appendix 15).

2.2.4. Alluvial shingle range type

This range type was most prominent along the drainages of the South Bay Lowland and its soils were of glacial fluvial origin. Although of minor importance in total area, the exceptionally high coverage of lichen made alluvial shingles important as caribou winter range. Although they were most common along the Kirchoffer River, we also found them along the upper Boas and Ford rivers.

Most shingles were slightly higher than surrounding land and occupied several hectares. Frost cracks gave the surface a patterned appearance (Fig. 16).

Cetraria nivalis and *C. cucullata* were dominant on the peripheral slopes where winter snow accumulated; on the elevated and exposed surfaces *Alectoria chalybeiformis* and *A. ochroleuca* were the dominant lichens. The frost crack interstices provided protection for *Cassiope tetragona* and other kinds of heaths (Table 2; Appendix 16; Fig. 17).

Figure 16
Excellent lichen-producing alluvial "shingles" along the lower Kirchoffer River. Note elevated pattern of shingles and restriction of *Cetraria* spp. (light) to lower protected slopes and *Alectoria* spp. (dark) to exposed crests

Figure 17
Good standing crop of lichens on alluvial shingle at Upper Kirchoffer Falls (TR88)

The alluvial soil had no distinguishable horizons and consisted of a coarse, loose, dark grayish sand. The soil was mildly acidic (pH = 5.69) and extremely low in organic matter (0.52 per cent). Total carbon was low at 0.30 per cent. Soils were classified as cryic orthic regosols.

2.2.5. Esker

Eskers were rare and Bird (1953) had recognized only one. It ran southeast through Salmon Pond. Here, we sampled the esker range type. The extremes in microclimate found on the north slope, were accentuated due to the presence of the lake.

We recognized three subtypes (Table 2; Appendix 17). A steep gradient and heavy winter snow cover characterized the northward slope, which was a moss–lichen–*Dryas* subtype. Mosses and *Cassiope tetragona*, characteristic of well protected sites, accounted for over 50 per cent of the ground cover. This subtype had an abrupt upper limit which corresponded to the normal limit of heavy snow cover (Fig. 18).

The ridge crest, having only a light snow cover or none at all throughout the winter, supported a lichen–moss–sedge subtype covering about 30 per cent of the ground: lichens covered approximately 25 per cent, while mosses, sedges and *Dryas integrifolia* accounted for the remainder. Other xeric species commonly found on the esker ridge, but not included in the sample, were *Papaver radicatum*, *Lesquerella artica* and *Draba Bellii*.

The south-facing slope supported a lichen–*Dryas*–moss subtype. Although lichen cover was high (52.2 per cent), the subtype's value as caribou range was restricted by its limited extent on the island.

2.2.6. Moss–sedge–lichen meadow range type

This type was limited in area but had a luxurient flora. The site sampled was well protected at the base of the western escarpment near our 1971 base camp and was part of a flood plain adjacent to a small

Figure 16

Figure 17

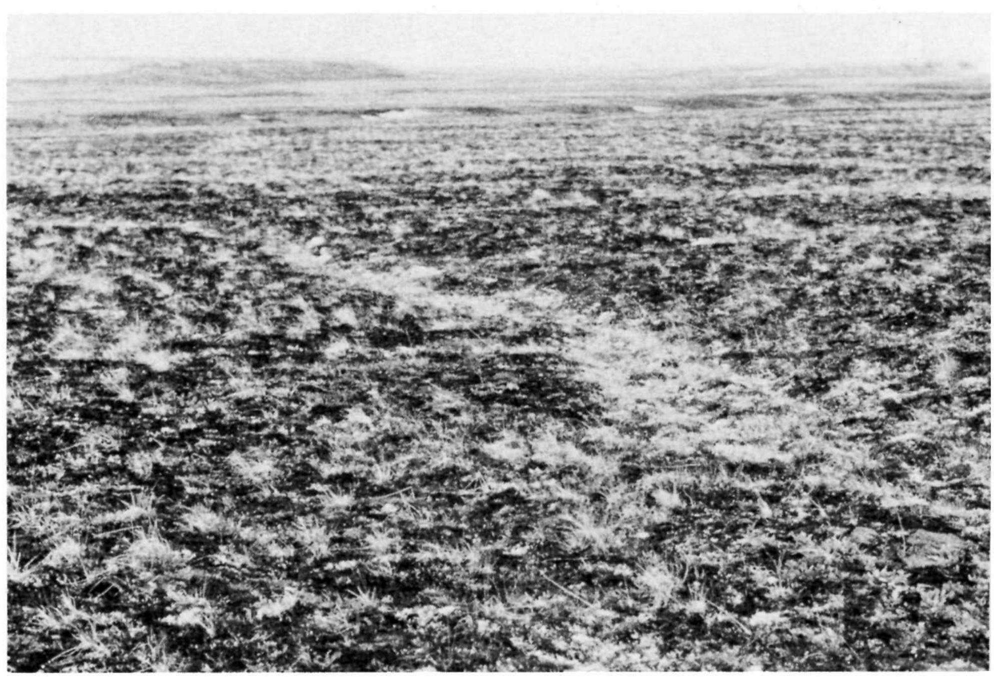


Figure 18
The north-facing slope and crest of an esker at Salmon Pond. Note retreating snow bank and abrupt snow line, separating exposed lichen dominated crest from *Cassiope*–moss dominated slope (TR12)

Figure 19
A well-protected moss–sedge–lichen meadow bordered by high growing willows (*Salix alaxensis* and *S. Richardsonii*) (TR55)

stream (Fig. 19). It was there that *Salix alaxensis* reached 2 m, the maximum height recorded on the island (Fig. 20), although that species was not included in the sample. The species list shows the diversity of plants (Table 2; Appendix 18).

Dominant among the grasses and sedges were *Poa arctica* and *Carex scirpoidea* while mosses were represented by *Dicranum groenlandicum* and *Rhytidium rugosum*.

The luxuriance of the vegetation on this site can be explained by the alluvial origin of the soils, a heavy winter snow cover, the shelter from wind afforded by the escarpment and a unique microclimate enhanced by a very favourable southern exposure.

2.2.7. Late snow bed

The late snow bed range type was common throughout the island, particularly on the Kirchoffer Upland, Eastern Plateau, South Bay Lowland, Munn Hills and Bell Hills where topographical relief is most pronounced. The late snow bed results from a heavy and late covering of snow, the most common indicator species being *Cassiope tetragona*.

Great variability in species composition and cover was found in this range type depending on the extent of snow cover, slope, drainage, and exposure. I have divided the vegetation of a late snowbed area into two subtypes (Table 2; Appendix 18, Fig. 21).

First, I have designated the upper portion, where the snow melted relatively early in the summer season, the *Cassiope*–lichen–*Dryas* subtype. The three dominant kinds of vegetation each covered about 25 per cent of the ground. Sedges and grasses were represented by *Carex scirpoidea*, *C. rupestris*, *C. misandra* and *Poa arctica*. While mosses typically had a low ground cover (9.1 per cent) they were well represented by the following species: *Thuidium abietinum*, *Ditrichum flexicaule*, *Fissidens osmundoides*, *Hypnum bambergeri*, *Myurella tenerrima*, *Tomenthypnum nitens*, *Dicranum muehlenbeckii*, *Hylocomium*

Figure 18

Figure 19

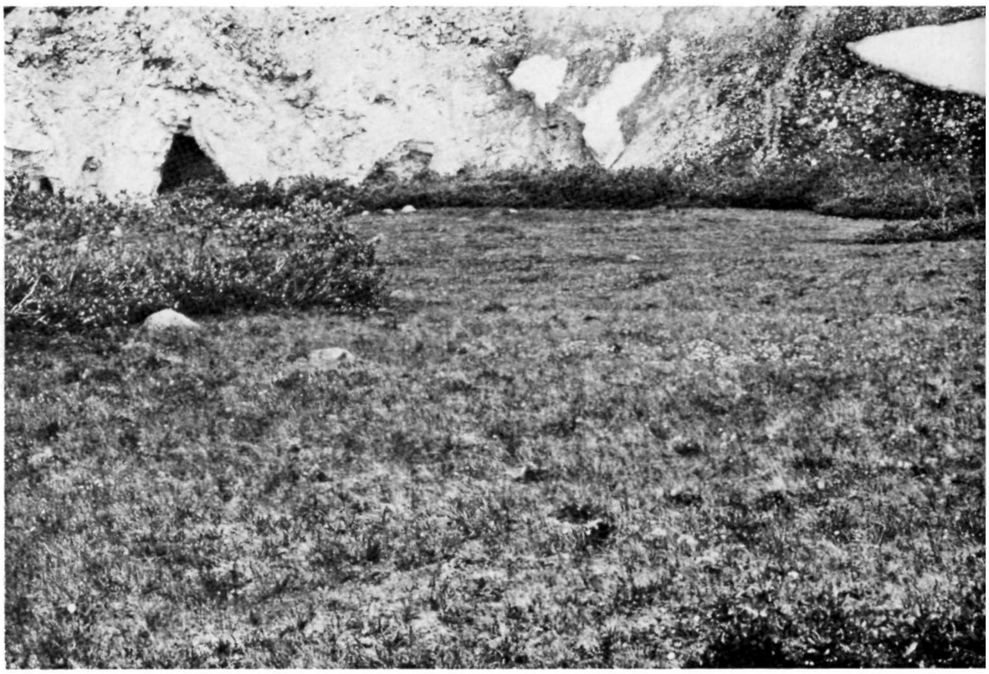


Figure 20
Good growth of *Salix alaxensis* within a moss–sedge–lichen meadow community (TR55)

Figure 21
Contrast in plant cover at site of late snow bed. Heavy snow cover allows formation of upper dark stand of *Cassiope tetragona* while lower area of more persistant snow cover is clearly identified by being nearly devoid of vegetation.

splendens, *Mnium orthorrhynchum*, *Oncophorus virens*, *Rhacomitrium lanuginosum* and *Tortella tortuosa*. Also present was the liverwort *Blepharostoma trichophyllum*.

The snow cover on the lower snowbed subtype in some years did not totally disappear. The vegetational cover was only about 50 per cent, and *Cassiope* and *Dryas* were absent. I call it a moss–willow–sedge subtype. Mosses were abundant, but the species list included only *Fissidens osmundoides*, *Pogonatum alpinum* and *Tortella fragilis*. Willows were represented by both *Salix reticulata* and *S. arctophila;* sedges included *Carex rariflora* and *Luzula nivalis*.

3. Standing crop of lichens

The importance of lichens in the winter diet of reindeer and caribou has long been recognized (Palmer, 1934; Palmer and Rouse, 1945; Semenov-Tyan-Shanskii, 1948; Schaeffer, 1951; Courtright, 1959; Scotter, 1968; Kelsall, 1968; Pegau, 1968; Klein, 1967, 1968; Gaare, 1968; Bergerud, 1970). However, most articles on the winter diet of caribou and reindeer stress the importance of food other than lichens (Palmer, 1934; Semenov-Tyan-Shanskii, 1948; Skunke, 1958, 1969; Skoog, 1968). In parts of northern Russia, wild reindeer are known to subsist on a winter diet all but lacking in lichens (Koshkin, 1937; Alexandrova, 1937; Shastin, 1939; Sdobnikov, 1958; Egorov, 1965; Michurin and Vakhtina, 1968; Kishchinskii, 1971), a situation similar to that reported for caribou on the Alaska Peninsula by Skoog (1968). Lichens are replaced by the brown *mat*, the previous year's production of grasses, sedges, forbs and willow shoots.

There are regional differences in the importance of lichens in the winter diet of caribou and reindeer. Skunke (1969) is correct when he stresses the adaptability of reindeer and caribou. Skoog (1968:354) maintains, "Caribou do not seem to require lichens for the maintenance of populations, as long as adequate amounts of sedge forage are available."

Figure 20

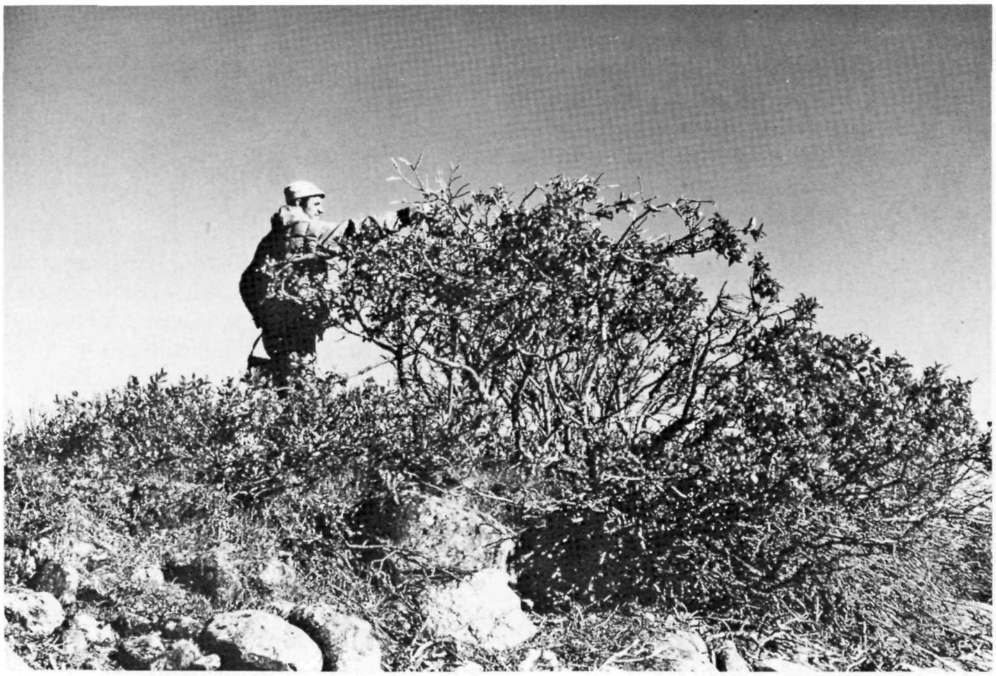
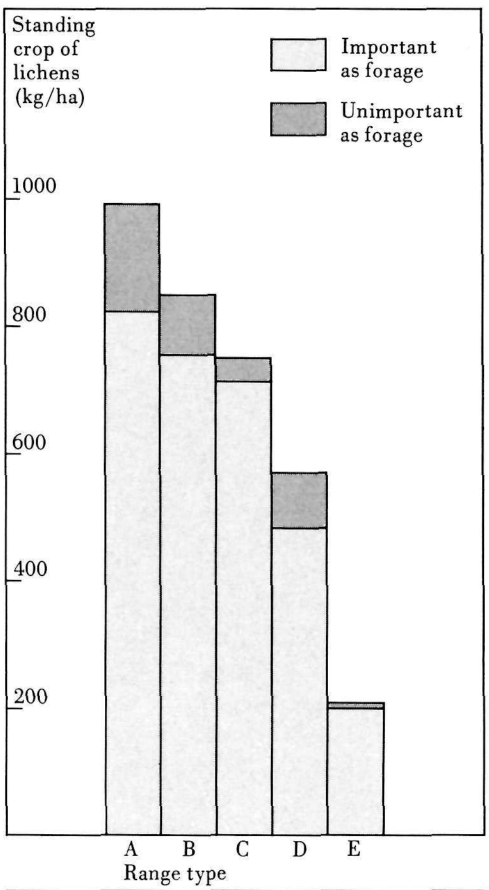


Figure 21

Figure 22
The average standing crop of lichens within five of the most productive range types on Southampton Island (A = lichen–heath felsenmeer lowland; B = lichen–heath felsenmeer plateau; C = raised lichen–*Dryas*–sedge; D = plateau sedge–heath–willow meadow; E = raised patterned ground tundra)

Figure 22



However, a caribou range investigation of an area where lichens exist must incorporate information on lichen species composition and standing crop. As stated by Pegau (1968:255) "Range management practices for reindeer and caribou must be based on principles that incorporate lichen biology."

The Kirchoffer Upland, Eastern Plateau, Bell Hills, Munn Hills and South Bay Lowland, all physiographic regions within the Canadian Shield, were the most productive lichen-producing land forms on the island. The lichen–heath felsenmeer range type on the plateau and the gneiss outcroppings of the Bell and Munn hills and South Bay Lowland support approximately 1,000 kg/ha of lichens, although for what I consider usable lichens (*Cetraria* spp.; *Cladina* spp.; *Cladonia* spp.; *Alectoria* spp.; *Cornicularia* spp.; etc.) that figure drops to 800 kg/ha (Fig. 22). Standing crop values for lichens within the main range types of Southampton Island are shown in Table 3.

On the alluvial shingle range type common along the major rivers draining the uplands and passing through the South Bay Lowland, the standing crop of usable lichens approached 3,000 kg/ha. Although of limited area, those excellent stands of lichen enhance the value of the South Bay Lowland as winter range.

The Hudson Bay Lowlands were poor in lichen production. Only the raised lichen–*Dryas*–sedge range type supported a moderate crop of lichen forage (400 kg/ha) while the raised sedge–*Dryas*–willow subtype of the patterned ground tundra range type supported the smallest crop at approximately 200 kg/ha. The two types account for approximately 20 per cent of the land mass of the Hudson Bay Lowlands. The remaining land area within the Hudson Bay Lowlands had negligible lichen production, the *Dryas* barrens (10 per cent of land mass) being of no value as either winter or summer range. The sedge-heath transition, sedge-willow meadow and bog range types were poor lichen range; only the drier hummocks supported a sparse cover, predominantly of *Cetraria* spp. The value of those types as winter range is dependent upon winter utilization of sedges, grasses and willows by caribou.

We rated the South Bay Lowland excellent winter range due to its high (1,000 kg/ha) standing crop of lichens, the presence of the alluvial shingles along the major drainages and its heterogeneity. It is a mixture of lichen-producing gneiss outcropping and willow- and sedge-producing meadows. The stream valleys provide well sheltered, south-facing slopes where *Betula glandulosa* grows. The slopes along the Kirchoffer River contain the best growth of *Betula glandulosa* on the island. The Kirchoffer Upland, although comparable in lichen production to the South Bay Lowland, lacks the heterogeneity in physiognomy and interspersion of lichen-producing sites and sedge–willow meadows. Extensive boulder fields, containing a reduced standing crop of lichens and higher proportion of bare ground and rock replace rock outcropping in most areas. It is as good winter range as the Bell and Munn hills, and certainly will be used once the population increases and disperses from the South Bay Lowland. The Eastern Plateau is rated as only fair, because greater relief probably makes much of it inaccessible to caribou, and more extensive rock outcropping decreases its productivity.

The Western Limestone Plateaux and Bell Limestone Plateaux of the Hudson Bay Lowlands we rated as fair winter range due to the presence of the raised lichen–*Dryas*–sedge range type. The slightly higher elevation may also create more favourable snow conditions than occur on the remaining limestone plains. The latter region is predominantly poorly drained and supports sedge- and willow-dominated range types. Lichen production was poor and we rated the entire region as poor winter range, except for a narrow coastal area of the Hudson Bay Lowlands which was fair to good winter range. On the raised beaches near the shoreline lichen production was

Table 3
Average standing crop of lichens (kg/ha) in the most important lichen-producing range types on Southampton Island (standard deviations in parentheses)

Species	Raised lichen–*Dryas*–sedge (n = 120)*	Patterned tundra; Sedge–*Dryas*–willow subtype (n = 90)	Lichen–heath felsenmeer plateau (n = 75)	Lichen–heath felsenmeer lowland (n = 75)	Lichen–heath alluvial shingle (n = 44)
Important as forage					
Alectoria chalybeiformis / *Alectoria nigricans*	54.8 (79.7)	5.0 (11.8)	73.5 (52.6)	82.5 (82.5)	272.6 (210.4)
Alectoria ochroleuca	32.7 (62.1)	3.9 (9.3)	79.7 (61.1)	32.9 (13.8)	142.1 (77.8)
Cladina mitis	0.3 (0.8)		13.5 (16.8)	12.3 (6.6)	50.7 (24.4)
Cladina rangiferina			27.7 (31.8)	6.3 (11.6)	8.5 (10.4)
Cladonia amaurocraea	0.3 (0.6)			5.4 (6.7)	20.9 (33.4)
Cladonia deformis			4.7 (4.8)	0.1 (0.3)	37.4 (42.5)
Cladonia ecmocyna			0.4 (0.3)		
Cladonia gracilis	2.7 (5.0)	1.6 (4.0)	20.0 (13.8)	24.4 (21.7)	121.4 (68.9)
Cladonia macrophylla			0.2 (0.3)		0.2 (0.3)
Cladonia phyllophora	0.1 (0.2)		12.2 (15.3)	8.0 (4.5)	9.9 (19.8)
Cladonia subcervicornis	<0.1		1.7 (3.9)	2.1 (3.2)	7.9 (14.4)
Cladonia uncialis			10.0 (13.5)	3.0 (2.5)	30.0 (28.3)
Cetraria nivalis / *Cetraria cucullata* / *Cetraria tilesii*	279.0 (237.8)	143.6 (134.9)	179.7 (86.2)	352.6 (118.0)	553.4 (176.6)
Cetraria delisei	13.6 (36.1)		<0.1	40.4 (56.6)	23.6 (42.2)
Cetraria islandica	18.3 (25.9)	15.3 (21.1)	51.4 (25.3)	68.7 (49.5)	81.6 (48.1)
Cetraria nigricans	1.4 (3.8)		3.8 (7.1)	0.4 (0.7)	31.0 (28.7)
Cornicularia aculeata	4.7 (5.5)	0.2 (0.3)	2.0 (3.6)	12.4 (10.8)	2.1 (4.3)
Cornicularia divergens	11.4 (19.8)	2.9 (6.7)	37.4 (44.7)	39.6 (44.8)	288.7 (122.0)
Dactylina arctica	9.2 (18.3)	2.6 (2.7)	6.6 (9.5)	12.0 (10.8)	23.4 (17.0)
Dactylina ramulosa	<0.1	<0.1	1.8 (2.4)	0.3 (0.8)	1.0 (2.0)
Evernia mesomorpha	<0.1				
Sphaerophorus globosus	9.2 (26.2)		216.6 (238.5)	77.8 (88.7)	1,055.3 (509.6)
Stereocaulon alpinum		1.0 (2.4)			137.8 (150.9)
Thamnolia vermicularis	52.1 (56.0)	27.8 (24.9)	12.4 (11.4)	42.7 (23.3)	13.1 (18.9)
Subtotal	490.1 (436.9)	203.9 (203.6)	755.3 (459.9)	823.9 (311.9)	2,912.6 (608.3)
Unimportant as forage					
Cladonia pyxidata	1.0 (2.0)		1.4 (2.7)	<0.1	2.3 (4.6)
Hypogymnia subobscura / *Parmelia omphalodes*	47.1 (75.1)	0.6 (1.1)	28.7 (14.5)	128.8 (167.1)	90.7 (127.9)
Hypogymnia enteromorpha				8.2 (13.6)	
Ochrolechia frigida	27.3 (50.9)	0.5 (1.3)	38.6 (29.6)	16.5 (11.8)	56.9 (38.1)
Peltigera sp.			0.4 (0.9)		13.1 (17.7)
Others	14.4 (17.8)	2.2 (3.5)	32.8 (35.1)	19.2 (19.9)	281.5 (196.0)
Subtotal	89.8 (97.3)	3.3 (5.0)	101.7 (71.0)	172.7 (180.6)	441.5 (247.8)
Grand total	579.9 (537.8)	207.2 (206.2)	857.0 (527.4)	996.6 (479.6)	3,357.1 (846.2)

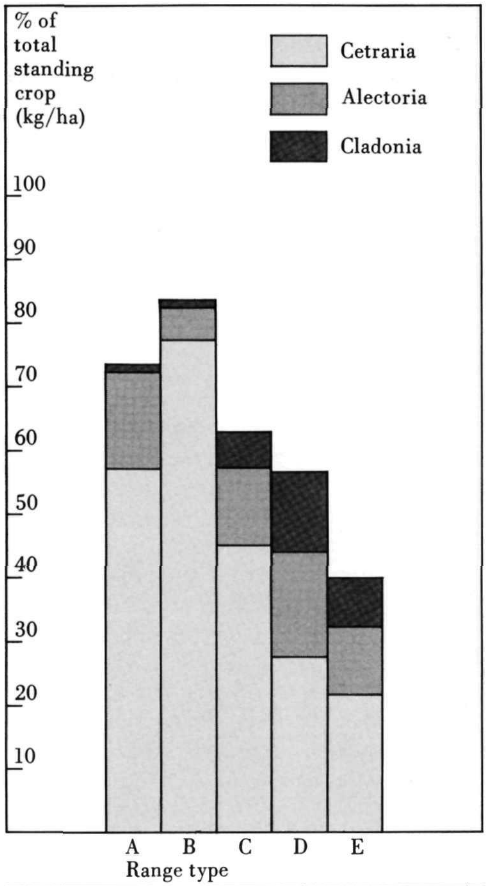
*n = no. of 0.1 m^2 plots.

Figure 23
A stand of *Elymus arenarius* on sand dunes at mouth of Kirchoffer River (August 4, 1972)

Figure 24
The percentage of the three dominant genera of lichens in the total standing crop (kg/ha) of lichens in the five major lichen-producing range types on Southampton Island (A = raised lichen–*Dryas*–sedge; B = patterned ground sedge–*Dryas*–willow subtype; C = lichen–heath felsenmeer lowland; D = lichen–heath felsenmeer plateau; E = alluvial "shingle")

Figure 23

Figure 24



high and there were excellent stands of *Elymus arenarius* (Fig. 23) which could be important to caribou. Aerial winter (March) surveys of caribou on Coats Island in 1961 (Tener, 1961), 1965 (Harington, 1965) and 1970 (Parker, 1970) found most of the population distributed along the coast. Coats Island is comparable to the Hudson Bay Lowlands of Southampton Island.

In all major range types, lichens were dominated by the genus *Cetraria*, particularly the species *C. nivalis*, *C. cucullata*, and *C. islandica*. The traditional reindeer lichens (*Cladina* spp.) were of minor importance in the total lichen flora; species of the genus *Alectoria* (*A. ochroleuca*, *A. chalybeiformis* and *A. nigricans*) made up 5 to 15 per cent of the lichen standing crop (Fig. 24).

4. Annual production of sedges and willows

We measured the annual production of sedges and willows by clipping the current year's growth from 0.1 sq m plots during August 4–15, 1972. We determined frequency and cover of species of vascular plants using the same procedure as for lichens. We clipped all the annual production from 138 plots within a radius of 15 km of Coral Harbour, where possible choosing sites in the sedge–willow meadow range type (n = 70), as sedges and willows are the most important non-lichen forage. We chose a smaller number of plots in the sedge–willow bog (n = 10), the sedge–heath transition (n = 15) and the raised lichen–*Dryas*–sedge (n = 23) range types. Figure 25 shows the linear regression of annual production of estimated ground cover of sedges on plots in the sedge–willow meadow, bog, and transition range types. Similar treatment of data provided the regression lines for annual production and cover of creeping willows (*Salix arctophila* and *S. reticulata*) and ascending willows (*Salix arctica* and *S. Richardsonii*) for plots in the raised lichen–*Dryas*–sedge, transition, sedge–willow meadow and bog range types (Fig. 26 and 27). Except in the case of creeping willows, we found that ground cover was not a precise indicator of annual production. However, in view of the large standard deviations of annual production values, especially for the higher cover estimates, the mean cover values are useful for estimating annual production on large areas such as the range types identified. We used this procedure to estimate grazing capacity on range types and to calculate an optimum caribou population for Southampton Island.

On plots where sedge occupied 90 to 100 per cent of the ground cover, annual production approached 600 kg/ha. Where ascending willows occupied 80 to 90 per cent of the ground cover, annual produc-

Figure 25
Relationship between ground cover (per cent) and annual production of sedges in the sedge–willow meadow, bog and transition range types on Southampton Island

Figure 25

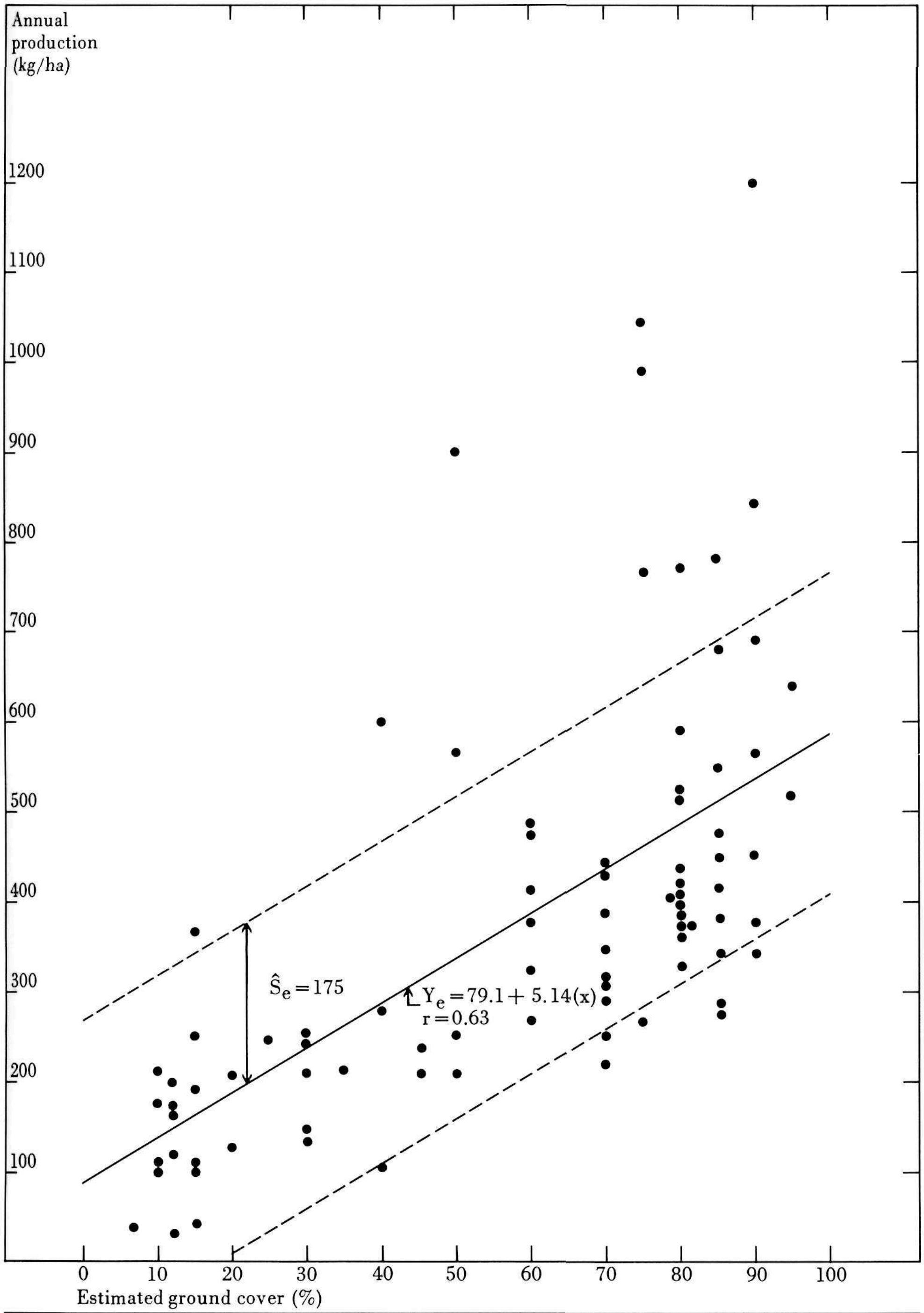


Figure 26
Relationship between ground cover (per cent) and annual production of creeping willows (*Salix reticulata* and *S. arctophila*) in four range types on Southampton Island

Figure 26

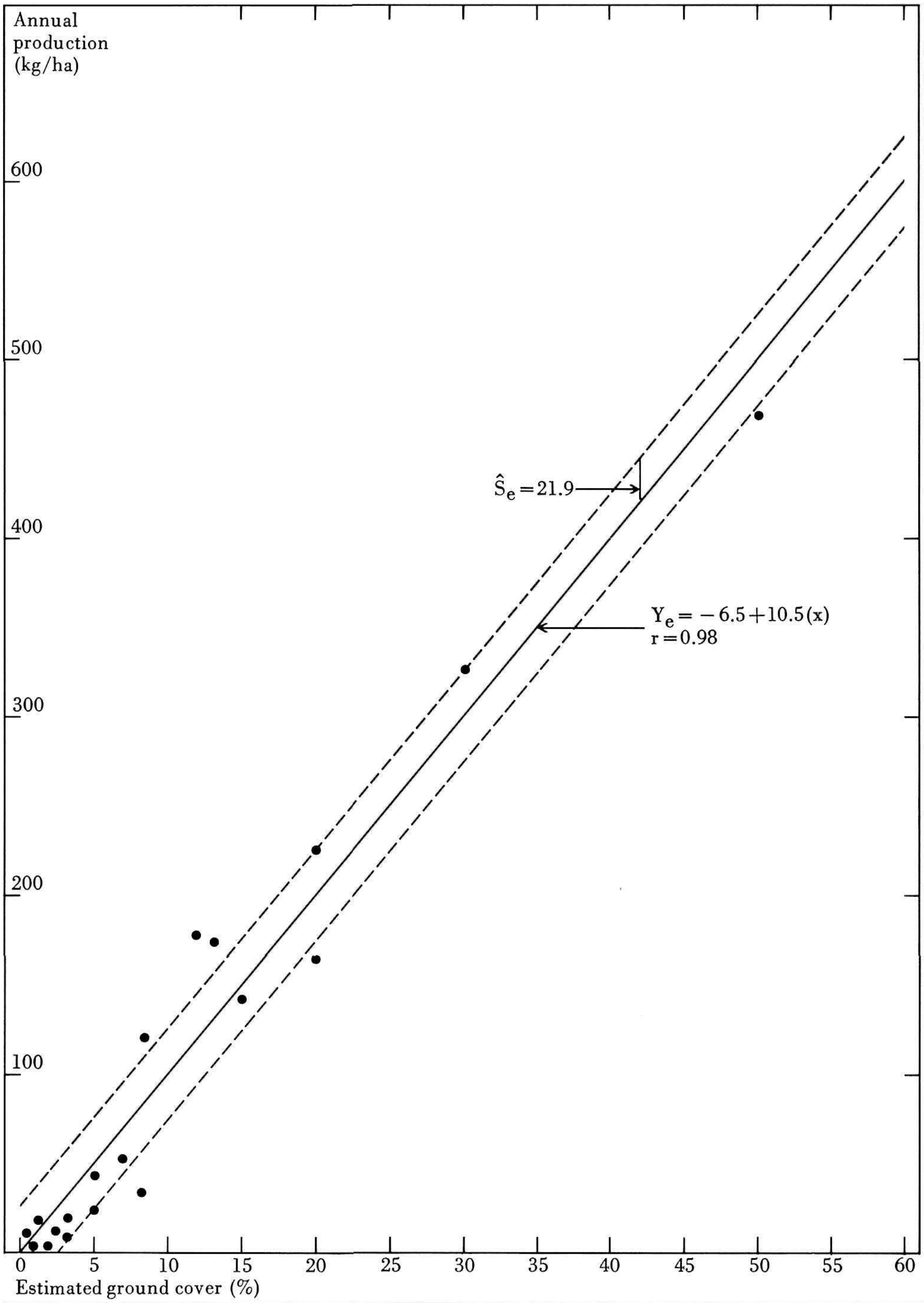


Figure 27
Relationship between ground cover (per cent) and annual production of ascending willows (*Salix arctica* and *S. Richardsonii*) in four range types on Southampton Island

tion approached 500 kg/ha. However, no extensive areas on the island supported such high cover values for those plant species. The mean cover values of sedges, creeping willows and ascending willows in six major vegetation types (Appendices 4,6,8,10,13) were used to estimate annual production values from the regression lines in Figures 25 to 27. Those mean production values are shown in Figure 28.

The range type most productive of sedges and willows was the sedge–willow meadow which produced an average of 400 kg/ha of sedges and 200 kg/ha of willows. The poorest producer of sedges, grasses and willows was the lichen–heath felsenmeer plateau, where sedge production was less than 30 kg/ha and willow less than 10 kg/ha. The sedge–heath transition and the two subtypes within the patterned ground tundra were all fair to good sedge-producing range (230 kg/ha–320 kg/ha). Most sedges and grasses had reached reproductive maturity by early August 1972 when we clipped plots. Growth after mid August would have been slight, so we treat the annual production values as maximum for that year. The new growth of four species of willow was measured at 2-day intervals from August 5 to 16, 1972 (Fig. 29). Growth of plants measured (n = 12) increased during that period, the most rapid growth rate being recorded for the species *S. alaxensis* and the least for *S. reticulata* (Fig. 30). The results emphasize that the annual production values for willows collected in early August are minimal as growth probably continues until frost kills the leaves in September.

5. Chemical analyses

5.1. Lichens

Tables 4 and 5 summarize the results of analyses for minerals, gross energy and protein. We based all analyses upon oven-dried weights. Gross energy of lichen samples from Southampton Island compared favourably with samples from Alaska (Pegau, 1968; Spencer and Krumboltz, 1929) and northern Manitoba (Miller,

Figure 27

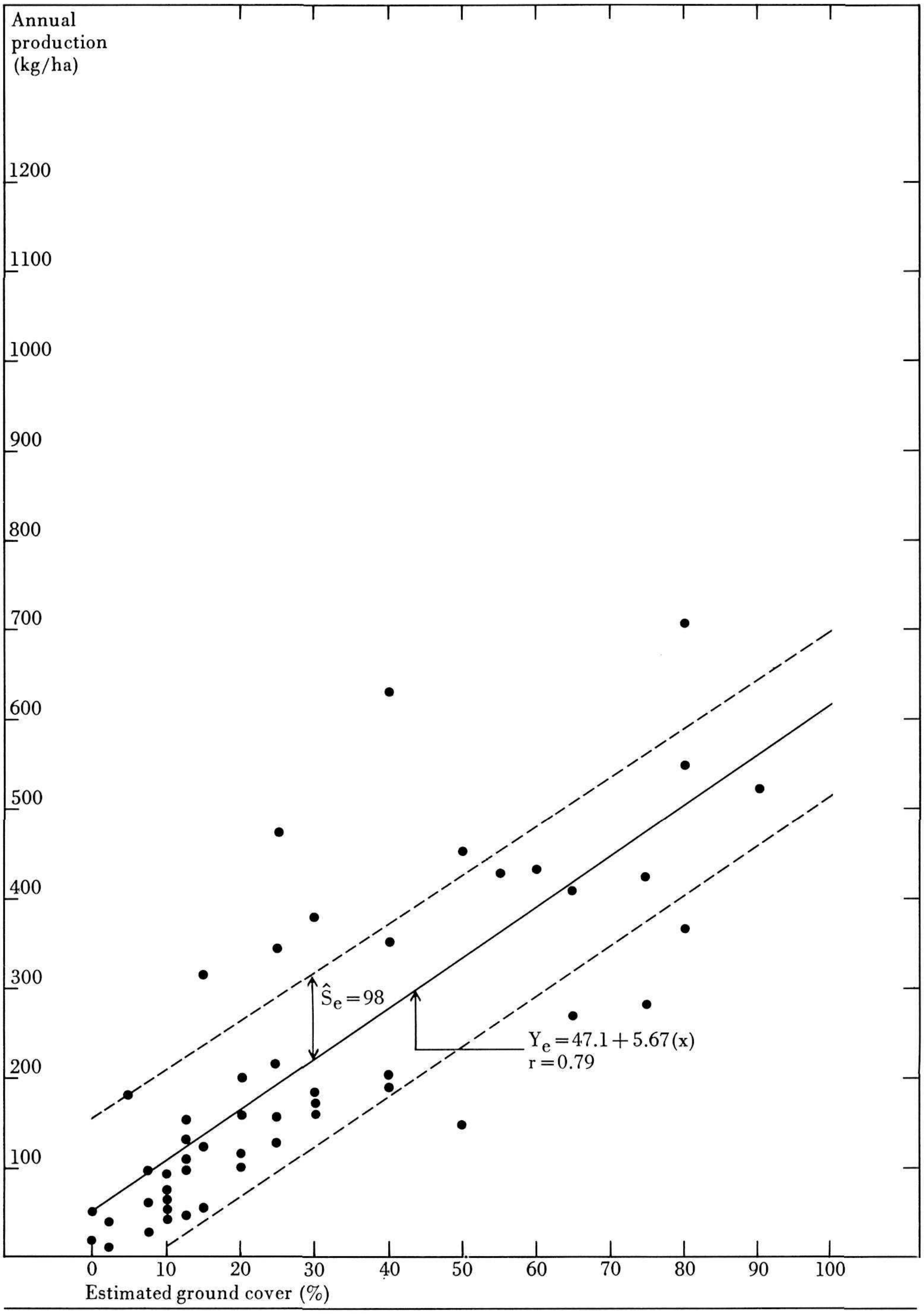


Figure 28
Mean annual production of sedges and willows in six major range types on Southampton Island

Figure 28

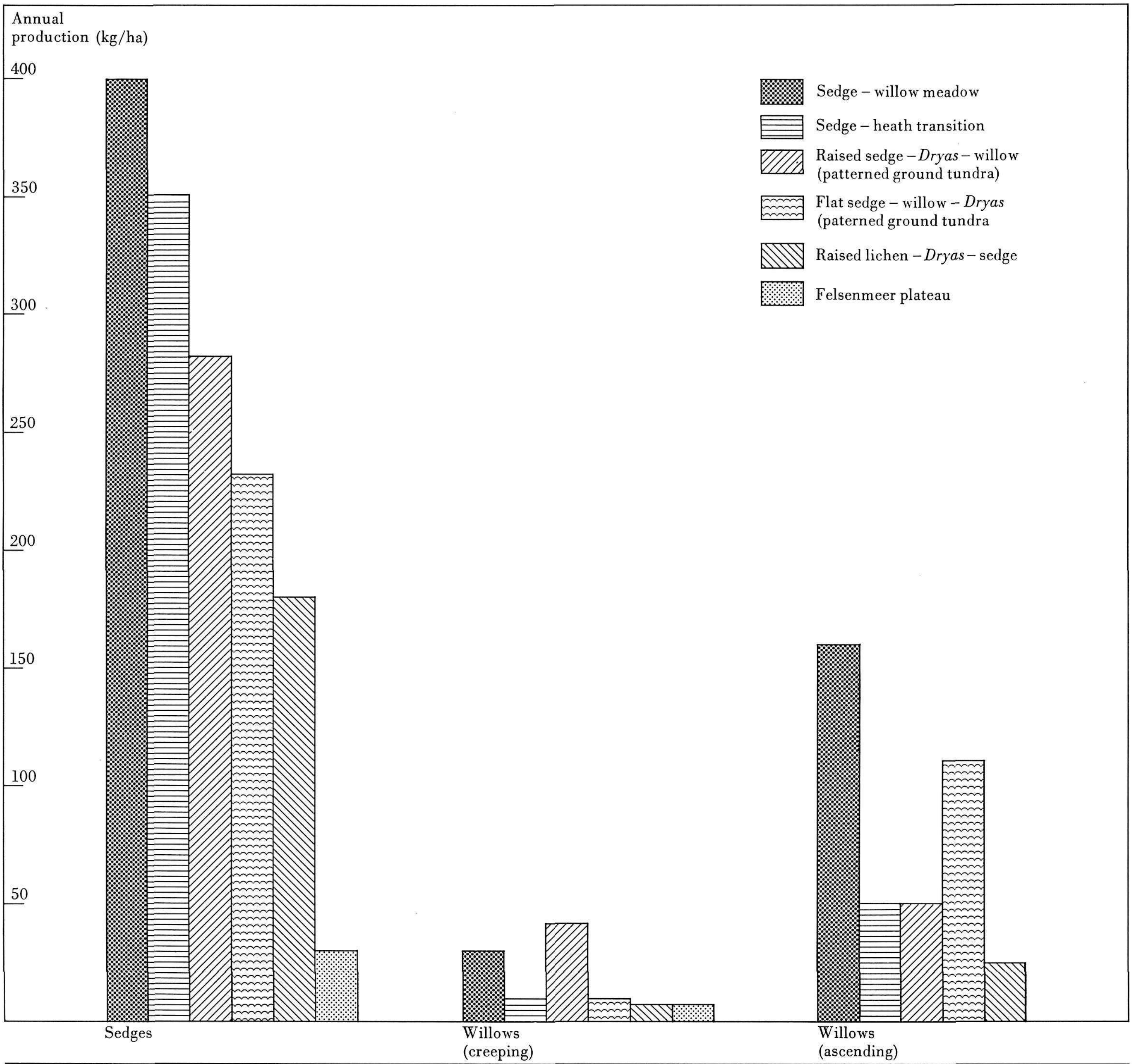


Figure 29
Measuring current year's growth of *Salix Richardsonii* (August 7, 1972)

1970). Energy values from all three areas averaged 400 to 500 Kcal per 100 grams. Mean crude protein percentages were highest for *Cetraria delesii* (5.48 per cent), and *Stereocaulon alpinum* (4.78 per cent). Scotter (1965) and Miller (1970) found percentage protein highest in lichens of the genus *Stereocaulon* in Saskatchewan and Manitoba respectively. Protein percentages of the other lichen species on Southampton Island averaged approximately 2.5 per cent, in agreement with earlier lichen analyses in Alaska, Saskatchewan and Manitoba.

Mineral analyses showed lichens from Southampton Island considerably higher in percentage calcium than lichens from northern Saskatchewan (Scotter, 1965), perhaps because of the extensive limestone substrate on the island. Phosphorus percentages, however, are consistently lower than in samples from Saskatchewan resulting in relatively high calcium: phosphorus ratios.

Figure 29

5.2. Vascular plants

Table 6 shows the percentage crude protein, crude fiber, ash, phosphorus and calcium in representative samples of dominant vascular plants from Southampton Island.

Crude protein values for most specimens were higher than values for similar species from other northern regions. The current year's growth of *Betula glandulosa* and all species of willow except *Salix reticulata* showed crude protein values above 20 per cent. Pegau (1968) found specimens of *Salix pulchra* to approach 25 per cent crude protein in Alaska. In contrast, however, Alexandrova (1940) found specimens of *Betula nana* (18.7 per cent), *Salix glauca* (18.5 per cent) and *S. lapponicum* (14.0 per cent) in parts of northern USSR to be below 20 per cent in crude protein. Larin (1950) also found *Betula nana* in northern USSR to be generally below the 20 per cent crude protein level during the summer period. Kursanov and D'yachkov (1945) and Palmer (1922; 1926) found crude protein for willows in the USSR and Alaska respectively to be far below the 20 per cent level. Those samples from the USSR included plants collected in August, but it is not known when the Alaskan samples were collected.

The two forbs *Pedicularis lanata* and *Oxytropis Maydelliana* were both above 20 per cent in crude protein. Both plants are very common throughout the island and could provide an excellent source of protein during the growing season and possibly into the winter, although nutritive values would be lower then.

Protein levels in samples of the current year's growth of sedges averaged near 18 per cent and in two samples of the previous year's growth of sedges measured 5.5 and 9.8 per cent. Wallace *et al.* (1972) have demonstrated that advanced maturity is characterized by a decrease in protein content and an increase in crude fiber.

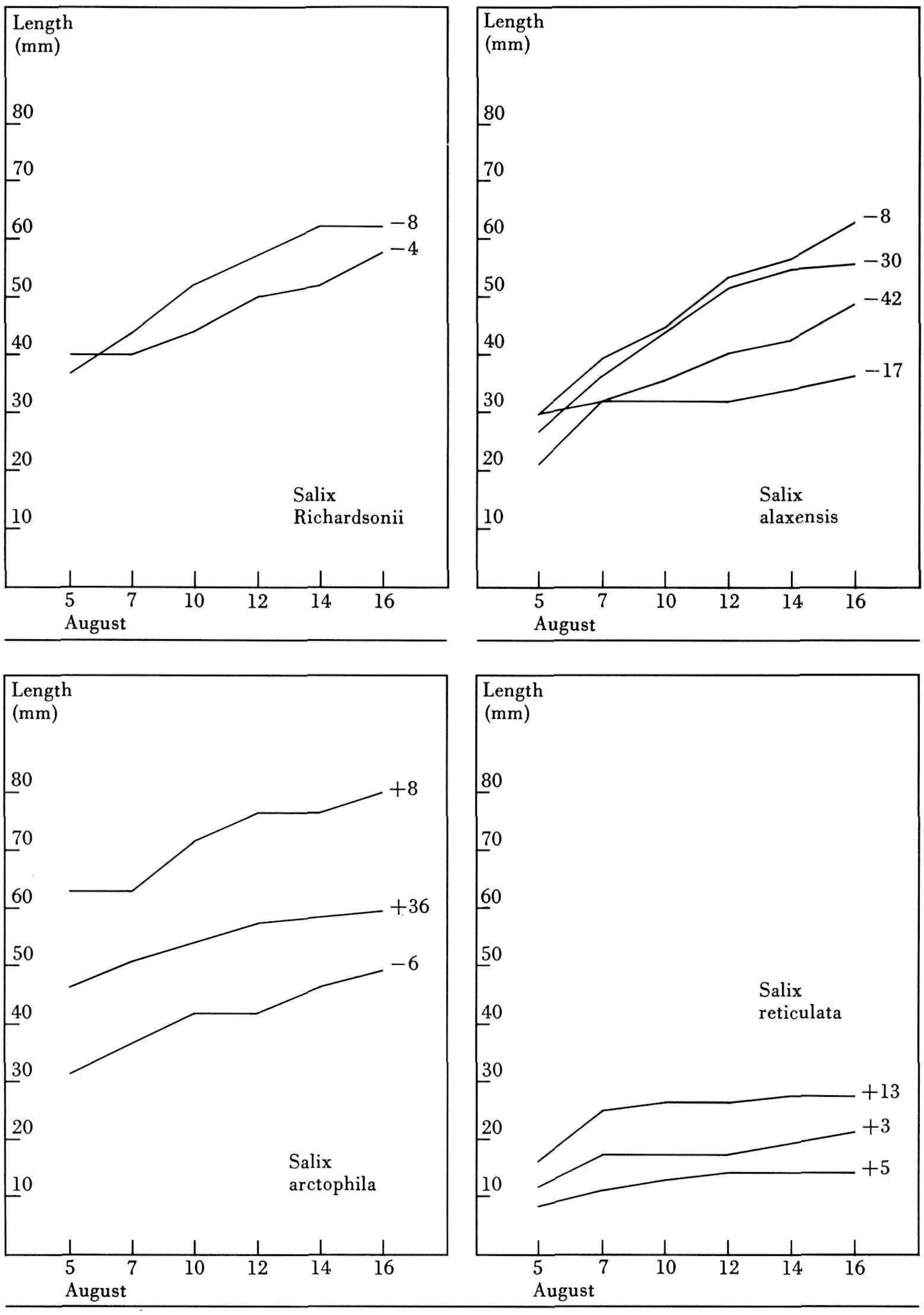
The crude protein levels of two samples of the previous year's growth of sedges were similar to values presented by Florovskaya (1939) for northern Russia and agree with his statement that dead plant material retains approximately one-half to one-third the protein level of green material.

Woody tissue samples (i. e. previous year's growth) of willow showed protein values ranging from 6 to 12 per cent and crude fiber content ranged to a high of 33 per cent. Crude protein content of *Betula glandulosa* decreased from a high of 26 per cent in current year's growth to eight per cent in the previous year's growth, with a corresponding increase in percentage crude fiber.

Analyses of samples from Southampton Island showed calcium levels of lichens and in the new growth of birches and sedges similar, in contrast to the statement by Semenov-Tyan-Shanskii (1948) that calcium values in birches and sedges were

Figure 30
Growth rates of four species of willows on Southampton Island during the period August 5 to 16, 1972.

Figure 30



much greater than those of lichens. The predominantly limestone substrate of the Hudson Bay Lowlands may be responsible for the unexpected high calcium levels in the lichens.

All protein values for new plant growth on Southampton Island surpassed the five per cent crude protein recommended to maintain physical condition in cattle (Campbell *et al.* 1954). The previous year's woody tissue of willows and birch also contained protein levels exceeding five per cent. Caribou have a greater ability than cattle to maintain nitrogen levels by recycling urea (Wales, 1972): caribou therefore need less protein in their diet than cattle.

The quality of forage from vascular plants on Southampton Island is more than adequate to meet the nutritional demands of caribou at all seasons of the year.

6. Sampling intensity

To provide a guide for future studies of tundra range, we estimated the sample size needed for acceptable precision.

6.1. Standing crop of lichens

The precision of the estimate of mean standing crop of lichens is shown for various range types in Table 7. It is given as 90 per cent confidence limits represented as percentage of the mean for cumulative samples of plots. Fourteen plots sampled at one site (TR23) in the lichen–heath felsenmeer lowland produced a precision of ± 36.3 per cent, while 73 plots sampled at 5 sites in the same range type produced a precision of ± 14.5 per cent.

I have chosen a precision of ± 20 per cent at 90 per cent probability as adequate in this range investigation. Sampling intensity was adequate in determining lichen standing crop for the lichen–heath felsenmeer lowland (± 14.5 per cent), lichen–heath felsenmeer plateau (± 18.5 per cent), alluvial shingle (± 6.6 per cent), and raised lichen–*Dryas*–sedge (± 18.7 per cent) types but inadequate for the raised sedge–*Dryas*–willow subtype (± 36.8 per cent). The last-mentioned

Table 4
Mineral analyses (on basis of oven-dried weight) of lichens collected on Southampton Island in 1970 and 1971

Species	No. samples	P, %	Na, %	Ca, %	K, %	Mg, %
Cetraria nivalis	12	.03	.27	1.79	.07	.14
Cetraria cucullata	2	.03	.18	1.62	.03	.06
Cetraria islandica	11	.03	.16	1.59	.04	.05
Dactylina arctica	2	.02	.13	2.85	.04	.07
Thamnolia vermicularis	5	.04	.06	1.57	.05	.02
Sphaerophorus globosus	5	.03	.17	.15	.05	.03
Stereocaulon alpinum	3	.04	.06	.18	.06	.02
Cladina rangiferina	2	.03	.26	.22	.05	.07
Cladina mitis	5	.02	.28	.12	.05	.05
Cladonia gracilis	6	.04	.19	.63	.05	.05
Alectoria ochroleuca	6	.02	.16	.44	.03	.05
Alectoria nigricans	4	.02	.13	.42	.02	.04
Alectoria chalybeiformis	4	.02	.13	.62	.03	.26
Cornicularia divergens	5	.02	.19	.26	.04	.07
Cetraria delesii	2	.04	.06	1.54	.19	.07
Evernia mesomorpha	1	.04	.02	3.39	.11	.08
Cladonia amaurocraea	1	.02	.16	2.32	.04	.03

Table 5
Gross energy and protein analyses (on basis of oven-dried weight) of lichens collected on Southampton Island in 1970 and 1971

Species	No. samples analysed	Gross energy (kcal/g.)			Crude protein (%)		
		Min.	Max.	Mean	Min.	Max.	Mean
Cetraria nivalis	12	3.37	4.34	3.88	1.18	2.48	1.78
Cetraria cucullata	2	3.86	4.50	4.18	1.17	3.45	2.31
Dactylina arctica	2	3.90	4.00	3.95	2.23	2.80	2.51
Thamnolia vermicularis	5	4.20	4.60	4.42	2.38	3.45	2.74
Sphaerophorus globosus	5	4.26	4.87	4.43	1.41	2.12	1.87
Stereocaulon alpinum	3	4.65	4.79	4.72	3.49	6.10	4.78
Cladina rangiferina	2	4.31	4.38	4.35	1.44	2.96	2.20
Cetraria islandica	11	3.77	4.33	4.07	2.05	2.83	2.40
Cladina mitis	5	3.69	4.42	4.24	1.38	1.99	1.61
Cladonia gracilis	6	4.19	4.80	4.53	1.88	3.10	2.41
Alectoria ochroleuca	5	4.34	4.63	4.45	1.23	2.58	1.93
Alectoria nigricans	3	4.17	4.51	4.32	2.11	2.77	2.51
Alectoria chalybeiformis	3	4.23	4.31	4.26	2.25	3.06	2.65
Cornicularia divergens	4	4.28	4.39	4.35	1.52	2.12	1.87
Cetraria delesii	2	3.97	4.37	4.17	4.40	6.58	5.48
Evernia mesomorpha	1	3.49	3.49	3.49	3.05	3.05	3.05
Cladonia amaurocraea	1	4.64	4.64	4.64	1.50	1.50	1.50

Table 6
Chemical analyses of leaves and new stem growth (combined) of representative vascular plants from Southampton Island (August 1972), and analyses of woody tissue of willow and birch and the previous year's growth of sedge

Species	Crude protein, %	Crude fiber, %	Ash, %	P, %	Ca, %
Cassiope tetragona	8.69	16.0	2.41	0.10	0.59
Ledum decumbens	10.13	22.7	2.45	0.12	0.58
Vaccinium Vitis-idaea	7.44	16.3	2.97	0.09	0.68
Arctostaphylos rubra	18.38	10.0	6.21	0.20	1.30
Vaccinium uliginosum (current year)	15.13	22.9	3.53	0.09	0.68
Vaccinium uliginosum (woody tissue)	9.25	34.1	2.06	0.05	0.65
Empetrum nigrum	8.75	15.8	2.35	0.10	0.66
Rhododendron lapponicum	12.50	22.2	3.03	0.10	0.71
Betula glandulosa (current year)	25.69	17.7	4.22	0.40	0.59
Betula glandulosa (woody tissue)	8.13	25.9	1.58	0.09	0.38
Salix arctica (current year)	24.00	15.7	7.34	0.32	1.53
Salix arctica (woody tissue)	6.03	27.0	3.04	0.05	0.95
Salix Richardsonii (current year)	21.81	14.9	8.97	0.23	1.89
Salix Richardsonii (woody tissue)	12.56	26.9	2.45	0.07	0.63
Salix alaxensis (current year)	23.44	20.9	7.51	0.34	1.30
Salix alaxensis (woody tissue)	9.38	33.0	2.54	0.11	0.50
Salix arctophila (current year)	23.25	14.8	6.77	0.24	1.32
Salix arctophila (woody tissue)	7.44	25.1	3.24	0.07	0.86
Salix reticulata (current year)	19.06	17.8	7.38	0.18	1.66
Pedicularis lanata	21.50	16.2	13.00	0.29	3.00
Oxytropis Maydelliana	22.63	22.2	11.29	0.35	2.78
Equisetum variegatum	15.25	16.8	12.29	0.14	1.43
Alopecurus alpinus	14.63	29.1	8.98	0.43	0.43
Eriophorum angustifolium	16.38	22.2	4.81	0.20	0.64
Carex Bigelowii	16.38	23.0	4.25	0.16	0.46
Carex Bigelowii	19.38	23.3	4.84	0.18	0.41
Carex Bigelowii	16.94	24.9	4.97	0.17	0.44
Carex Bigelowii	17.63	26.6	7.04	0.22	0.47
Kobresia simpliciuscula } *Carex misandra* }	18.06	23.2	4.90	0.11	0.64
Carex membranacea } *Carex atrofusca* } *Juncus trifidus* }	19.56	22.3	6.15	0.18	0.67
Carex sp. (previous year)	5.53	31.1	4.34	0.02	0.87
Carex sp. (previous year)	9.81	23.9	10.06	0.04	2.62

Table 7
The precision of standing crop measurements (kg/ha) of usable lichens in the most productive range types on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m²)	Cumulative plots sampled	Kg/ha s	Kg/ha $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Lichen-heath felsenmeer lowland Hudson Bay lowland subtype	1	TR 23	14	14	632.9	758.5	± 36.3	0.83	46.3
	2	TR 29	15	29	495.9	602.9	± 24.9	0.82	45.1
	3	TR 34	14	43	571.2	641.9	± 22.0	0.88	52.0
	4	TR 40	15	58	633.6	808.2	± 16.7	0.78	40.9
	5	TR 56	15	73	640.7	837.4	± 14.5	0.76	38.8
Lichen-heath felsenmeer plateau	1	TR 4	15	15	720.1	1,199.8	± 25.4	0.60	24.2
	2	TR 5	15	30	878.0	1,225.6	± 21.2	0.71	33.8
	3	TR 59	15	45	880.9	869.8	± 24.6	1.01	68.5
	4	TR 60	15	60	808.6	795.1	± 21.3	1.01	68.5
	5	TR 66	15	75	744.2	758.8	± 18.5	0.98	64.5
Patterned ground tundra Raised sedge–*Dryas*–willow subtype	1	TR 1	15	15	676.4	547.0	± 52.0	1.23	101.7
	2	TR 37	15	30	532.7	370.8	± 42.8	1.43	137.4
	3	TR 46	15	45	464.8	253.1	± 44.7	1.83	225.1
	4	TR 51	15	60	423.5	218.6	± 40.8	1.93	250.4
	5	TR 63	15	75	469.3	240.5	± 40.3	2.13	305.0
	6	TR 64	15	90	436.3	204.7	± 36.8	2.13	305.0
Alluvial shingle	1	TR 11	15	15	1,624.3	2,075.7	± 33.0	0.78	40.9
	2	TR 86	15	30	1,531.1	2,580.2	± 17.6	0.59	23.4
	3	TR 87	9	39	1,511.5	2,678.8	± 14.7	0.56	21.0
	4	TR 88	5	44	767.2	2,792.9	± 6.6	0.27	4.9
Raised lichen–*Dryas*–sedge	1	TR 2	15	15	144.0	63.4	± 96.1	2.27	346.4
	2	TR 3	15	30	541.1	410.1	± 39.2	1.31	115.3
	3	TR 16	15	45	477.4	282.6	± 41.0	1.68	189.7
	4	TR 27	15	60	419.6	264.5	± 33.4	1.58	167.8
	5	TR 31	14	74	409.9	324.0	± 24.0	1.26	106.7
	6	TR 35	15	89	510.7	398.9	± 22.2	1.28	110.1
	7	TR 39	14	103	630.0	529.2	± 19.2	1.19	95.2
	8	TR 49	15	118	602.0	483.6	± 18.7	1.24	103.3

*Coefficient of variation $= \frac{s}{\bar{x}}$

†$n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

subtype varied extensively among sites, evident from the steadily increasing value of *V* (coefficient of variation), with increasing numbers of sites (and of plots) included in the sample. To obtain the desired degree of precision, the raised sedge–*Dryas*–willow subtype of the patterned ground range type should receive a greater sampling intensity and/or be divided into a number of more refined subtypes.

6.2. Annual production of sedges, grasses and willows

We required fewer plots to determine the annual production of sedges and grasses (Table 8) than of willows (Table 9) or of the standing crop of lichens (Table 7)

Table 8
The precision of annual production measurements (kg/ha) of sedges and grasses within range types sampled on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m^2)	Cumulative plots sampled	Kg/ha s	Kg/ha $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Dryas barrens	1	TR 108	15	15	10.8	11.5	± 39.3	0.93	58.1
Raised lichen–*Dryas*–sedge	1	TR 101	5	5	21.2	15.9	± 97.5	1.33	118.9
	2	TR 110	8	13	24.3	32.0	± 34.5	0.76	38.8
Sedge-heath transition	1	TR 106	5	5	86.3	329.0	± 19.0	0.26	4.5
Sedge-willow meadow	1	TR 102	10	10	239.8	479.0	± 25.9	0.50	16.8
	2	TR 103	15	25	174.0	418.1	± 13.4	0.41	11.3
	3	TR 104	5	30	188.4	375.4	± 14.9	0.50	16.8
	4	TR 107	15	45	179.0	356.5	± 12.2	0.50	16.8
	5	TR 111	15	60	176.7	316.8	± 11.6	0.55	20.3
	6	TR 112	10	70	200.0	347.8	± 11.1	0.57	21.8
	7	TR 113	13	83	239.3	375.7	± 11.3	0.63	26.6
Sedge-willow bog	1	TR 109	10	10	74.4	160.5	± 23.8	0.46	23.8

*Coefficient of variation $= \frac{s}{\bar{x}}$

† $n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

Table 9
The precision of annual production measurements (kg/ha) of willows within the sedge–willow meadow range type on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Type of willow	Sites sampled	Transect site no.	No. of plots (0.1 m^2)	Cumulative plots sampled	Kg/ha s	Kg/ha $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Creeping (0-5 cm) *S. reticulata* *S. arctophila*	1	TR 102	10	10	12.2	5.0	±127.0	2.44	403.2
	2	TR 103	15	25	27.4	12.5	± 71.4	2.17	319.4
	3	TR 104	5	30	25.3	10.6	± 71.6	2.39	385.0
	4	TR 107	15	45	46.5	18.6	± 61.1	2.49	420.2
	5	TR 111	15	60	163.8	55.3	± 62.7	2.96	589.8
	6	TR 112	10	70	154.8	47.5	± 63.8	3.25	713.4
	7	TR 113	13	83	150.7	46.3	± 58.5	3.25	712.1
Ascending (5 cm +) *S. arctica* *S. Richardsonii*	1	TR 102	10	10	164.0	147.2	± 57.7	1.11	83.4
	2	TR 103	15	25	122.8	78.9	± 51.0	1.55	162.8
	3	TR 104	5	30	115.0	72.5	± 47.5	1.58	169.4
	4	TR 107	15	45	130.5	87.2	± 36.5	1.49	150.5
	5	TR 111	15	60	143.4	97.8	± 31.0	1.46	144.6
	6	TR 112	10	70	138.0	87.2	± 31.0	1.58	168.2
	7	TR 113	13	83	205.1	127.2	± 29.0	1.61	174.7

*Coefficient of variation $= \frac{s}{\bar{x}}$

† $n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

Table 10
The precision of ground cover estimates (per cent) of sedges and grasses in range types sampled on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m²)	Cumulative plots sampled	Kg/ha s	Kg/ha $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Dryas barrens (a) *Dryas*–sedge–saxifrage subtype	1	TR 18	15	15	17.4	17.9	± 41.0	0.97	63.2
	2	TR 19	15	30	13.7	13.9	± 29.3	0.98	64.5
	3	TR 33	15	45	12.9	9.4	± 33.5	1.37	126.2
	4	TR 83	15	60	11.8	7.2	± 34.7	1.63	178.6
(b) *Dryas*–lichen–sedge subtype	1	TR 38	15	15	5.6	12.4	± 19.0	0.45	13.6
	2	TR 45	15	30	4.8	13.1	± 10.7	0.36	8.7
	3	TR 80	15	45	5.1	11.3	± 11.0	0.45	13.6
	4	TR 108	15	60	5.6	10.0	± 11.8	0.56	21.0
Raised lichen–*Dryas*–sedge	1	TR 2	15	15	6.3	15.2	± 17.3	0.41	11.3
	2	TR 3	15	30	9.1	17.5	± 15.5	0.52	18.1
	3	TR 16	15	45	14.5	22.2	± 15.9	0.65	28.4
	4	TR 27	15	60	13.5	23.1	± 12.2	0.58	22.6
	5	TR 31	15	75	12.9	23.3	± 10.4	0.55	20.3
	6	TR 39	15	90	13.3	23.8	± 9.5	0.55	20.3
	7	TR 49	15	105	14.0	23.8	± 9.3	0.58	22.6
	8	TR 98	15	120	16.8	26.8	± 9.2	0.62	25.8
	9	TR 101	5	125	17.1	25.8	± 9.7	0.66	29.2
	10	TR 110	8	133	16.8	25.3	± 9.3	0.66	29.2
Patterned ground tundra (a) Raised sedge–*Dryas*–willow subtype	1	TR 1	15	15	14.2	25.8	± 22.8	0.54	19.6
	2	TR 37	15	30	22.6	40.4	± 16.7	0.56	21.0
	3	TR 46	15	45	22.8	33.1	± 16.8	0.69	32.0
	4	TR 51	15	60	24.3	34.9	± 14.6	0.69	32.0
	5	TR 63	15	75	23.6	31.5	± 14.0	0.74	36.8
	6	TR 64	15	90	24.8	35.7	± 11.9	0.69	32.0
(b) Flat sedge–willow–*Dryas* subtype	1	TR 20	15	15	23.7	26.2	± 38.1	0.90	54.4
	2	TR 24	15	30	20.1	25.8	± 23.3	0.78	40.9
	3	TR 25	15	45	20.0	25.2	± 19.3	0.79	41.9
	4	TR 26	15	60	21.1	25.2	± 17.5	0.83	46.3
	5	TR 30	15	75	23.7	28.3	± 15.7	0.83	46.3
	6	TR 97	15	90	23.3	27.9	± 14.3	0.83	46.3
Sedge-heath transition	1	TR 8	15	15	25.8	50.0	± 21.6	0.51	17.4
	2	TR 9	15	30	23.5	58.9	± 11.9	0.40	10.7
	3	TR 10	15	45	26.7	46.6	± 13.9	0.57	21.8
	4	TR 14	15	60	25.6	48.2	± 11.2	0.53	18.8
	5	TR 28	15	75	24.7	50.7	± 9.0	0.48	15.4
	6	TR 43	15	90	24.8	47.5	± 8.9	0.52	18.1
	7	TR 44	15	105	25.4	48.8	± 8.3	0.52	18.1
	8	TR 48	15	120	25.6	45.7	± 8.3	0.56	21.0
	9	TR 50	15	135	25.3	43.8	± 8.0	0.57	21.8
	10	TR 79	15	150	24.3	43.4	± 7.4	0.56	21.0
	11	TR 84	15	165	25.3	46.4	± 6.8	0.54	19.6
	12	TR 106	5	170	25.3	47.1	± 6.6	0.53	18.8

cont'd

Table 10 cont'd

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m²)	Cumulative plots sampled	Kg/ha s	Kg/ha $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Sedge-willow meadow	1	TR 32	15	15	20.3	62.6	± 13.5	0.32	7.1
	2	TR 36	15	30	21.3	62.8	± 10.1	0.34	7.7
	3	TR 71	15	45	20.4	65.4	± 7.6	0.31	6.5
	4	TR 78	15	60	27.1	55.0	± 10.4	0.49	16.3
	5	TR 102	12	72	26.3	57.7	± 8.8	0.45	13.9
	6	TR 103	15	87	25.3	60.3	± 7.3	0.41	11.8
	7	TR 104	6	93	25.9	58.6	± 7.5	0.44	13.1
	8	TR 107	15	108	26.6	58.2	± 7.2	0.45	14.0
	9	TR 111	15	123	27.6	55.7	± 7.3	0.49	16.5
	10	TR 112	10	133	28.0	57.1	± 6.9	0.48	16.1
	11	TR 113	13	146	28.3	56.4	± 6.8	0.50	16.9
Sedge-willow bog	1	TR 17	15	15	25.6	53.3	± 20.4	0.48	15.5
	2	TR 21	15	30	23.0	58.2	± 11.8	0.39	10.5
	3	TR 47	15	45	26.7	58.6	± 11.1	0.45	13.9
	4	TR 109	10	55	27.1	55.5	± 10.8	0.48	16.0
Lichen-heath felsenmeer lowland (a) Hudson Bay lowland subtype	1	TR 23	15	15	13.1	19.2	± 28.9	0.68	31.5
	2	TR 29	15	30	12.3	18.7	± 19.6	0.65	28.9
	3	TR 34	15	45	19.2	25.0	± 18.7	0.76	39.5
	4	TR 40	15	60	18.7	23.8	± 16.6	0.78	41.5
	5	TR 56	15	75	17.6	21.6	± 15.4	0.81	44.8
	6	TR 81	15	90	17.6	18.4	± 16.5	0.95	61.6
	7	TR 82	15	105	17.8	19.5	± 14.5	0.91	55.8
(b) South Bay lowland subtype	1	TR 92	15	15	6.9	12.1	± 24.2	0.57	22.0
	2	TR 99	15	30	6.2	9.9	± 18.8	0.62	26.5
	3	TR 100	15	45	6.6	8.4	± 19.0	0.78	41.0
Lichen-heath felsenmeer plateau	1	TR 4	15	15	4.4	5.3	± 35.5	0.83	47.3
	2	TR 5	15	30	9.4	7.1	± 39.7	1.32	118.3
	3	TR 59	15	45	8.3	5.8	± 34.6	1.41	135.2
	4	TR 60	15	60	7.5	5.7	± 27.7	1.31	115.2
	5	TR 66	15	75	7.7	5.9	± 24.6	1.30	114.1
	6	TR 96	15	90	8.7	7.5	± 19.8	1.14	88.7

*Coefficient of variation $= \frac{s}{\bar{x}}$

†$n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

because grasses and sedges were uniformly distributed in contrast to the clumped distribution of willows and lichens.

The most sedges and grasses were produced in the sedge-willow meadow and we concentrated on sampling within that range type during 2 weeks in August 1972. Although we sampled seven sites comprising 83 plots, the data indicate that 17 plots would have been adequate for a precision of ± 20 per cent. Twenty-five plots provided a precision of ± 13.4 per cent while an additional 55 plots reduced that span by only ± 2.1 per cent.

We did not adequately sample the other range types except for the sedge–heath transition, but the calculated n_o values suggest that a sample of approximately four sites and 60 plots would have provided 80 per cent accuracy at 90 per cent probability for annual production of sedges and grasses.

6.3. Ground cover

Sampling intensity was adequate to determine cover of sedges and grasses in all range types except the *Dryas*–sedge–

Table 11
The precision of ground cover estimates (per cent) of ascending willows (*Salix arctica* and *S. Richardsonii*) in range types sampled on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m²)	Cumulative plots sampled	Kg/ha: s	Kg/ha: $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Sedge-heath transition	1	TR 8	15	15	5.2	1.5	±145.9	3.44	799.2
	2	TR 9	15	30	4.1	1.5	± 81.8	2.73	502.9
	3	TR 10	15	45	9.4	3.3	± 68.7	2.81	531.4
	4	TR 14	15	60	8.2	2.5	± 69.7	3.29	729.9
	5	TR 28	15	75	7.5	2.1	± 65.6	3.46	808.1
	6	TR 43	15	90	7.5	2.2	± 57.4	3.32	743.7
	7	TR 44	15	105	7.1	2.2	± 51.7	3.23	702.6
	8	TR 48	15	120	10.1	3.1	± 47.8	3.19	688.1
	9	TR 50	15	135	11.8	3.8	± 43.4	3.07	636.8
	10	TR 79	15	150	11.3	3.4	± 43.6	3.26	715.1
	11	TR 84	15	165	10.8	3.1	± 43.8	3.43	793.5
	12	TR 106	5	170	10.6	3.0	± 43.9	3.49	819.6
Sedge-willow meadow	1	TR 32	15	15	30.3	39.0	± 32.9	0.77	40.6
	2	TR 36	15	30	31.4	23.1	± 40.6	1.35	124.1
	3	TR 71	15	45	27.8	15.4	± 44.0	1.80	218.4
	4	TR 78	15	60	26.8	13.7	± 41.3	1.95	256.8
	5	TR 102	12	72	26.0	14.8	± 33.8	1.75	206.8
	6	TR 103	15	87	24.1	13.1	± 32.1	1.83	225.3
	7	TR 104	6	93	23.8	12.9	± 31.2	1.83	227.1
	8	TR 107	15	108	25.2	14.7	± 27.0	1.71	197.2
	9	TR 111	15	123	25.1	15.4	± 24.0	1.62	177.7
	10	TR 112	10	133	24.4	14.4	± 23.9	1.68	191.1
	11	TR 113	13	146	25.2	16.3	± 20.9	1.54	159.8

*Coefficient of variation $= \frac{s}{\bar{x}}$

†$n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

saxifrage subtype of the *Dryas* barrens (Table 10). The paucity of plant cover within that community meant many plots had no cover values. In that subtype the coefficient of variation increased progressively as more sites and plots were added to the sample showing that the sampling method was not appropriate for that type of plant distribution. We obtained the desired 80 per cent accuracy at 90 per cent probability in most range types by sampling two sites including 30 plots. Further sampling, however, confirmed the extent of homogeneity within range types.

In sampling willows to determine ground cover, the extreme variations in cover and the number of plots without willows resulted in a large coefficient of variation and we required a large sample for precision (Tables 11 and 12). Adequate precision was most nearly met in cover estimates of ascending willows in the sedge-willow meadow range type (± 20.9 per cent).

The number of plots used to estimate lichen cover was adequate in range types where it was at least 20 per cent. The greater the lichen cover, the less sampling intensity was required (Table 13). In many range types lichen cover was so sparse that we could not calculate required sampling intensity.

7. The caribou of Coats Island

Coats Island lies approximately 80 km south of Southampton Island across Fisher and Evans straits. It has an area of nearly 5,600 sq km and is geologically similar to Southampton Island. The surface material

Table 12
The precision of ground cover estimates (per cent) of creeping willows (*Salix reticulata* and *S. arctophila*) within range types sampled on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m²)	Cumulative plots sampled	Kg/ha s	Kg/ha x̄	Precision (% of x̄)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Patterned ground tundra (a) Raised sedge–*Dryas*–willow subtype	1	TR 1	15	15	5.7	4.8	± 50.0	1.18	94.0
	2	TR 37	15	30	4.7	5.5	± 25.6	0.85	49.0
	3	TR 46	15	45	5.4	4.6	± 28.4	1.16	91.2
	4	TR 51	15	60	7.4	5.3	± 29.5	1.39	130.7
	5	TR 63	15	75	7.0	5.3	± 24.6	1.30	114.3
	6	TR 64	15	90	7.0	5.8	± 20.9	1.21	98.5
(b) Flat sedge–*Dryas*–willow subtype	1	TR 20	15	15	2.6	2.2	± 50.2	1.18	94.6
	2	TR 24	15	30	2.9	2.6	± 33.6	1.12	85.1
	3	TR 25	15	45	4.0	3.1	± 31.6	1.29	112.6
	4	TR 26	15	60	3.8	2.8	± 28.8	1.36	124.6
	5	TR 30	15	75	4.0	3.0	± 24.8	1.31	115.5
	6	TR 97	15	90	4.1	3.1	± 22.7	1.31	116.5
Sedge-heath transition	1	TR 8	15	15	8.7	5.4	± 67.8	1.60	172.8
	2	TR 9	15	30	6.6	3.8	± 51.8	1.73	201.3
	3	TR 10	15	45	5.7	3.2	± 43.3	1.77	211.8
	4	TR 14	15	60	5.1	2.4	± 45.1	2.13	306.4
	5	TR 28	15	75	4.8	2.2	± 40.7	2.14	310.7
	6	TR 43	15	90	5.3	2.6	± 35.5	2.05	285.1
	7	TR 44	15	105	6.9	3.2	± 34.7	2.17	317.4
	8	TR 48	15	120	6.6	2.9	± 33.6	2.24	339.1
	9	TR 50	15	135	7.0	2.9	± 33.8	2.39	385.8
	10	TR 79	15	150	6.9	3.2	± 28.7	2.14	309.8
	11	TR 84	15	165	6.7	3.0	± 27.8	2.17	319.4
	12	TR 106	5	170	6.6	3.0	± 27.9	2.21	331.2
Sedge-willow meadow	1	TR 32	15	15	2.3	0.6	±164.6	3.88	1,016.6
	2	TR 36	15	30	7.7	3.0	± 75.9	2.53	432.9
	3	TR 71	15	45	14.2	5.1	± 68.2	2.79	524.3
	4	TR 78	15	60	18.1	7.7	± 49.4	2.33	367.3
	5	TR 102	12	72	16.7	6.5	± 49.3	2.55	438.4
	6	TR 103	15	87	15.3	5.8	± 46.1	2.62	463.4
	7	TR 104	6	93	14.9	5.4	± 46.3	2.72	499.8
	8	TR 107	15	108	14.1	5.2	± 42.5	2.69	489.2
	9	TR 111	15	123	13.9	5.2	± 39.0	2.64	469.2
	10	TR 112	10	133	13.4	4.9	± 39.0	2.74	507.6
	11	TR 113	13	146	13.1	4.7	± 37.2	2.74	505.1

*Coefficient of variation $= \frac{s}{\bar{x}}$

† $n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

Table 13
The precision of ground cover estimates (per cent) of usable lichens in range types sampled on Southampton Island, showing effects of increasing sampling intensities (90 per cent probability)

Range type	Sites sampled	Transect site no.	No. of plots (0.1 m²)	Cumulative plots sampled	Kg/ha s	Kg/ha $\bar{x}$	Precision (% of $\bar{x}$)	Coefficient of variation, v*	Required plots for ±20% precision, n_o†
Dryas barrens (a) *Dryas*–lichen sedge subtype	1	TR 38	15	15	8.4	7.1	± 50.1	1.18	94.4
	2	TR 45	15	30	6.5	7.0	± 28.0	0.93	59.1
	3	TR 80	15	45	10.2	9.2	± 26.8	1.09	81.2
	4	TR 108	15	60	9.4	8.3	± 23.9	1.13	86.0
(b) Raised lichen–*Dryas*–sedge subtype	1	TR 2	15	15	8.6	6.2	± 58.7	1.38	129.5
	2	TR 3	15	30	18.9	18.8	± 30.1	1.00	68.2
	3	TR 16	15	45	17.8	13.6	± 31.8	1.30	114.3
	4	TR 27	15	60	15.8	14.0	± 23.9	1.12	85.8
	5	TR 31	15	75	18.8	19.6	± 18.1	0.95	61.6
	6	TR 39	15	90	19.1	22.6	± 14.5	0.84	47.8
	7	TR 49	15	105	18.3	21.0	± 14.0	0.87	51.5
	8	TR 98	15	120	18.6	22.7	± 12.2	0.82	45.3
	9	TR 101	5	125	23.6	25.5	± 13.6	0.92	58.0
	10	TR 110	8	133	24.0	26.8	± 12.7	0.89	53.9
Patterned ground tundra (a) Raised sedge–*Dryas*–willow subtype	1	TR 1	15	15	17.9	18.8	± 40.1	0.94	60.5
	2	TR 37	15	30	15.1	13.0	± 34.8	1.16	90.9
	3	TR 46	15	45	13.4	9.2	± 35.5	1.45	142.0
	4	TR 51	15	60	12.6	8.2	± 32.6	1.54	159.6
	5	TR 63	15	75	13.2	8.7	± 28.7	1.51	154.9
	6	TR 64	15	90	12.4	7.5	± 28.6	1.65	185.0
Lichen-heath felsenmeer lowland (a) Hudson Bay Lowland subtype	1	TR 23	15	15	12.1	21.5	± 23.9	0.56	21.5
	2	TR 29	15	30	10.5	22.4	± 14.0	0.47	14.8
	3	TR 34	15	45	16.0	25.3	± 15.4	0.63	26.8
	4	TR 40	15	60	15.0	26.8	± 11.8	0.56	21.1
	5	TR 56	15	75	15.7	28.0	± 10.6	0.56	21.1
	6	TR 81	15	90	16.0	28.0	± 9.8	0.57	21.9
	7	TR 82	15	105	16.1	25.9	± 9.9	0.62	26.1
(b) South Bay Lowland subtype	1	TR 92	15	15	30.5	57.8	± 22.4	0.52	18.8
	2	TR 99	15	30	28.1	50.3	± 16.7	0.55	21.0
	3	TR 100	15	45	26.3	53.1	± 12.1	0.49	16.5
Lichen-heath felsenmeer plateau	1	TR 4	15	15	27.0	50.7	± 22.5	0.53	19.1
	2	TR 5	15	30	28.1	50.3	± 16.7	0.55	21.0
	3	TR 59	15	45	30.2	37.0	± 19.9	0.81	44.6
	4	TR 60	15	60	27.5	32.9	± 17.6	0.83	46.7
	5	TR 66	15	75	25.4	31.2	± 15.4	0.81	44.8
	6	TR 96	15	90	24.9	33.6	± 12.8	0.74	37.0

*Coefficient of variation $= \frac{s}{\bar{x}}$

†$n_o = \left(\frac{1.64\,v}{20}\right)^2 10^4$

Figure 31
The mean and range of age-specific whole weights for 14 male barren-ground caribou collected on Coats Island, August 17–20, 1970, and comparable data for male caribou collected from the mainland Kaminuriak Population in September from 1966 to 1968 (Dauphiné, 1970)

Figure 32
An adult male barren-ground caribou (*Rangifer tarandus groenlandicus*) shot on Coats Island, Northwest Territories on August 17, 1970 (weight = 183 kg)

Figure 31

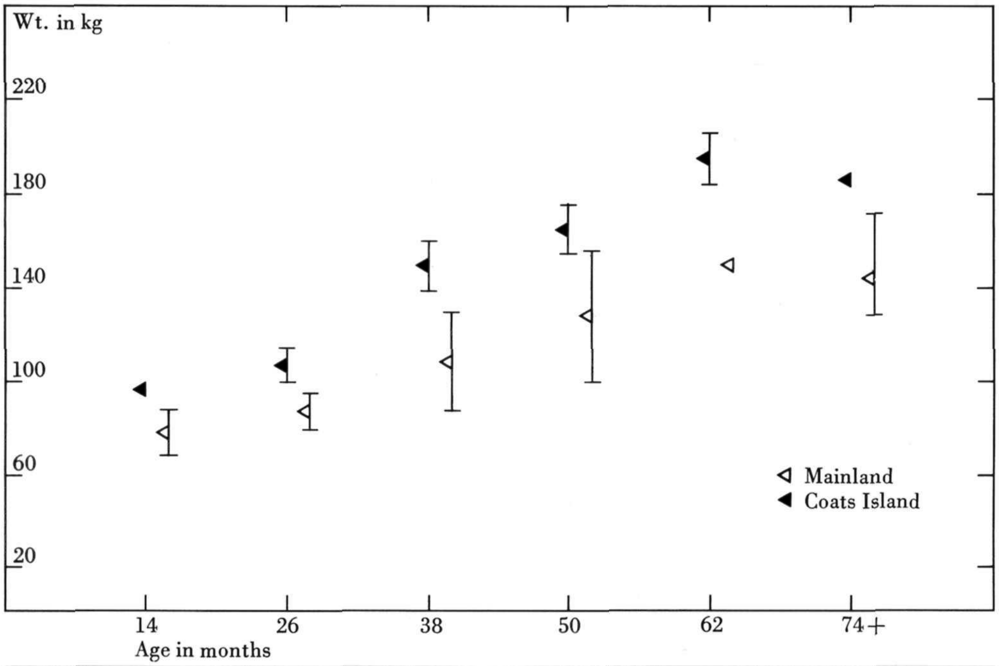


Figure 32

is predominantly limestone except for a small elevated outcropping of Precambrian rock on the extreme northeast coast.

Coats Island has supported barren-ground caribou for over 58 years although information on the animals has been extremely meagre. Polunin (1948:248) reported Captain Henry Toke Munn as stating that the caribou of Coats Island were "... the fattest caribou in the Canadian Arctic". Munn made his observations during his stay on Southampton Island from 1916 to 1918.

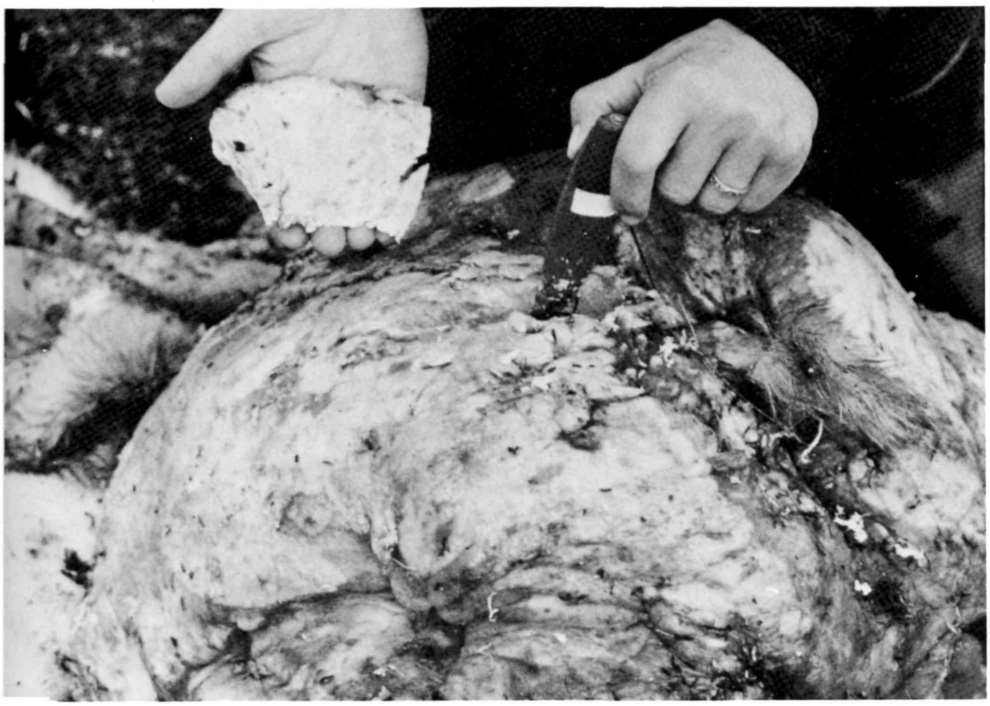
In mid August 1970, Inuit from Coral Harbour killed 60 caribou on Coats Island. CWS collected the mandibles from 55 and biological data from 24 specimens. Appendix 20 shows weights and/or measurements of the 24 specimens. Appendix 21 shows cranial measurements of 18 males.

The cranial measurements are similar to those provided for mainland *R. t. groenlandicus* by Banfield (1961). However, the weights of the males (Fig. 31), are exceptionally high, and far exceed those of caribou of comparable age from the mainland Kaminuriak barren-ground caribou population (Dauphiné, 1970). As caribou on Coats Island were collected one month earlier than those on the mainland (August vs. September) and as adult males put on fat reserves until the rut (October–November) the actual differences between whole weights from the two areas would be greater than indicated. Figure 32 shows a typical adult male barren-ground caribou from Coats Island. Figure 33 shows the exceptional accumulation of back fat on specimen SE-19. Henry Toke Munn was correct in referring to the Coats Island caribou as the heaviest in the Canadian Arctic.

Probable explanations for the exceptional condition of the Coats Island caribou are lack of natural predators, low insect densities during the summer months and the lack of extensive seasonal movements. Reindeer are known to utilize various types of marine plants (Herre, 1956). During an aerial survey of the island in August 1971, caribou were often seen far

Figure 33
Exceptional accumulation of back fat from adult male barren-ground caribou shot on Coats Island, Northwest Territories, on August 18, 1970 (depth of back fat = 93.8 mm)

Figure 33



out on the tidal flats and wading in the water and they may have been utilizing that additional source of forage. A lack of insects at that time eliminates insect harassment as the motivating force behind that behaviour although thermoregulation may have been involved.

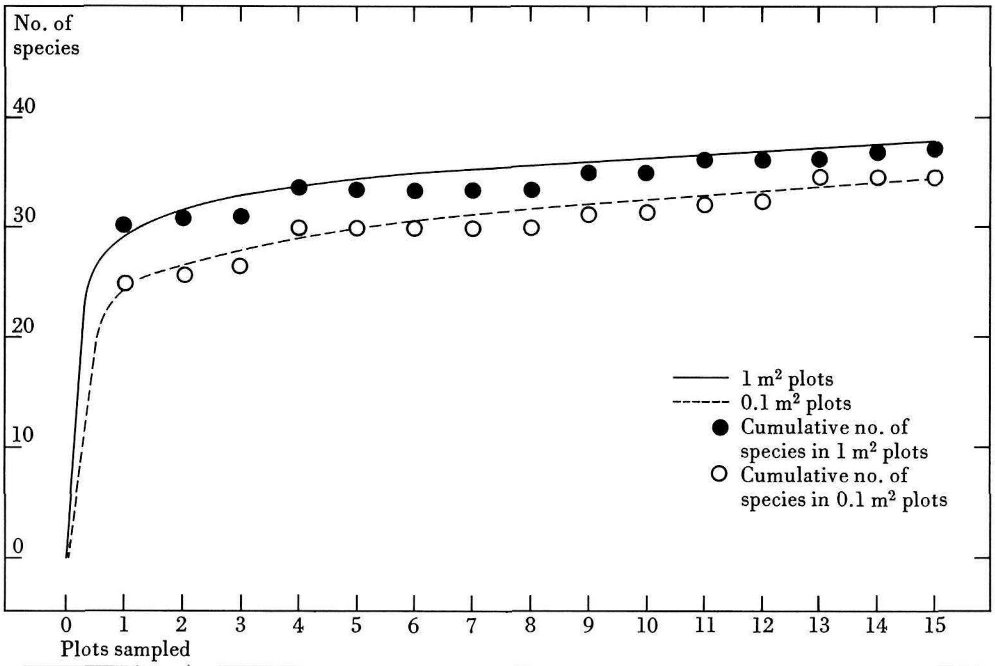
We collected the mandibles of 55 male caribou and determined their ages from tooth eruption and wear. Age class representation was as follows: 14 months–14 per cent; 26 months–33 per cent; 38 months–13 per cent; 50 months–11 per cent; 62 months–16 per cent; 74 months–13 per cent. Eighty-seven per cent of the sample was 5 years of age or younger. The preponderance of young animals and the exceptional condition of all specimens collected suggest that the population has the potential for rapid growth.

Although there has been no range appraisal, cursory aerial examination in August 1971 showed that most of Coats Island is similar to the Hudson Bay Lowlands of Southampton Island. The relatively good, lichen-producing range represented on the Kirchoffer Upland and South Bay Lowland of Southampton Island is absent from Coats Island. Aerial surveys in March, 1970 showed the island population was approaching 2,000 caribou (Parker, 1970), approximately one animal per 2.8 sq km.

Discussion

Figure 34
Species area curves for 15 one-meter-square plots and 15 one-tenth-meter-square plots in the lichen heath felsenmeer plateau range type. Differences in total species occurring in the two sizes of plots are slight. Minimum area of community established at 1 sq m, sampled by plots of 0.1 sq m

Figure 34



We combined aerial photo interpretation and ground sampling to estimate the forage available to caribou on Southampton Island. We were unable to determine seasonal use of range types and food preferences because of the scarcity of caribou on the island. I have turned to other studies for information on which assumptions about this and other factors can be based. Other factors to be considered when estimating the grazing capacity are loss of forage through trampling, physiological stress upon the animal through harassment by predators and insects, and the behaviour of the animal (e. g. mobility, gregariousness).

The difficulties of aerial photo interpretation have been discussed earlier. For a general range inventory of such a large land mass as Southampton Island, we considered adequate land classification from small scale (1:60,000) photography. More detailed interpretation would require larger scale photography.

A basic requirement of plant community analysis is randomness of sample but we selected more or less homogeneous stands with defined characteristics (e. g. sedge–willow meadow). We did this because the aerial photo interpretation had previously classified the land mass into moisture regime classes and we wished to sample those classes to determine plant composition and yield. The spot where sampling began was determined by the toss of a stone, the direction of the transect depended on the size and configuration of the sample area.

I estimated cover values subjectively: visual estimation with the aid of a calibrated Daubenmire Frame. The method can be highly reliable when only one observer estimates cover values (as with this study). The method loses its reliability when more than one estimator is required (Hanson, 1950).

The study exemplified the advantage of small sample plots over larger plots. Cain (1943) stressed this for alpine vegetation and defined the minimal area as that upon which a community can develop its typical composition and structure. From a species/area curve, it is a size where a one-tenth increase in sampling intensity is accompanied by an increase of no more than 10 per cent of the total number of species (Cain, 1938). Figure 34 shows a typical species/area curve for 15 plots of 0.1 sq m and 15 plots of 1.0 sq m from one site within the lichen-heath felsenmeer plateau range type. The difference in total species was small between the two sizes of plots, and I placed the minimum area required to obtain a species list for that community at 1 sq m sampled by 10 plots of 0.1 sq m. Cain (1943) recommended a plot size of 0.1 sq m. He suggested at least 20 plots be used per stand in order to obtain satisfactory frequency percentages and cover averages. I found that sample size adequate for determining frequency percentages for all species but it was only adequate in obtaining cover averages for sedges and grasses. The required sample sizes for cover and production values were high in this study because each site contained a maximum of 15 plots. The cumulative plots within a range type incorporated a number of sites. Floral diversity is greater among sites than within only one.

The study demonstrated certain characteristics of the distribution and abundance of the island flora. Most noticeable was the change in the floral composition between the Hudson Bay Lowlands and the Canadian Shield: the virtual restriction to the Canadian Shield of *Salix herbacea*, *Betula glandulosa*, members of the family *Ericaceae* and the lichens *Cladina rangiferina*, *C. mitis* (reindeer lichens), *Sphaerophorus globosus* and *Stereocaulon alpinum*.

No species was exclusively calciphilous, but among those restricted to the Hudson Bay Lowlands were *Salix alaxensis*, *S. reticulata*, *Saxifraga aizoides*, *Draba Bellii* and *Lesquerella arctica*.

Willows were not abundant on the eastern highlands but were well represented and abundant on the western lowlands. The creeping varieties *Salix reticulata* and *S. arctophila* were very abundant on most sites sampled on the lowlands, while on the wetter and more protected sites the taller *S. arctica* and *S. Richardsonii* were common. On the most protected sites we found *S. alaxensis. Salix Richardsonii* and *S. arctica* were abundant along the base of the western escarpment from the upper Boas River to Duke of York Bay.

Betula glandulosa was restricted in distribution being most common on protected, south-facing sites along the Kirchoffer River drainage.

Plants having the widest distribution on the island included *Dryas integrifolia, Saxifraga oppositifolia, Cassiope tetragona, Pedicularis capitata, Oxytropis Maydelliana, Polygonum viviparum, Silene acaulis, Cetraria nivalis, C. cucullata, C. islandica, Alectoria ochroleuca, A. chalybeiformis, A. nigricans, Thamnolia vermicularis* and *Dactylina arctica*.

Except on the plateau and the limestone barrens, sedges consistently made up one-quarter or more of the ground cover. Lichens were particularly prominent on the alluvial shingle type and were the dominant plant form on the felsenmeer plateau and lowland range types. They were least important on the wet low-lying sites.

Appendix 19 lists plants collected on the island in 1970 and 1971: 68 lichens, 53 bryophytes and 125 vascular plants.

The values for the standing crop of lichens on Southampton Island were lower than most given for other caribou and reindeer ranges. In Alaska, Palmer (1934) generalized that most caribou range supported between 6,000 and 6,500 kg of lichens per hectare and where lichen cover reaches 75 per cent with an average height of 5 cm, standing crop values approach 11,000 kg/ha (Palmer, 1922). The average standing crop value for lichens on the felsenmeer lowlands and eastern plateau of Southampton Island was approximately 1,000 kg/ha and for usable lichens approximately 800 kg/ha. At 75 per cent ground cover, the lichen standing crop would have approached 2,500 kg/ha.

Hustich (1951) stated that lichen woodland in Labrador supported an average of 2,200 kg/ha and that the best locations in northern Norway supported 12,000 to 13,000 kg of lichens per hectare. He also reported that on the lichen heaths of the Russian Yamal the expected standing crop of lichen was 4,545 to 6,363 kg/ha.

Larin (1937) stated that, on an average, on the Russian tundra, where lichens comprise about nine per cent cover, the standing crop approached 1,750 to 2,000 kg/ha. On the best lichen-producing range on Southampton Island a cover value of nine per cent would yield slightly less than 200 kg/ha. Good forested reindeer ranges in Sweden can be expected to support 6,000 to 8,000 kg of lichens per hectare (Skunke, 1969).

In forested barren-ground caribou range in northcentral Canada, Scotter (1968) found maximum standing crops of lichens in upland forest sites to approximate 814 kg/ha. He measured only the living portion of the lichens which probably accounts for the low values for standing crop. Weights of lichens reported here for Southampton Island include both living and dead portions of the podetia. As caribou ingest both living and dead lichen material, it is meaningful to include both in values of standing crop.

Using the standing crop of lichens as the criterion for rating caribou range, Southampton Island must be rated as fair to poor. Standing crop values there were much lower than on caribou and reindeer ranges elsewhere. I did not expect that standing crop values for Southampton Island would compare to the lichen-rich forested range of northern Canada; however, values were much lower even than those determined on tundra ranges in northern Russia.

While "reindeer lichens" (*Cladina* spp.) are limited in both their distribution and abundance on the island, species of the genera *Cetraria* and *Alectoria* are widespread. Although protein and gross energy values for those two genera on Southampton Island are low, as they are in other areas, it has been found elsewhere that both genera are high in fats (Alexandrova, 1940; Kursanov, D'yachkov, 1945; Palmer, 1929).

Annual production values for sedges and grasses per range type showed a negative correction with lichen production values. The relationship is a result of soil moisture content. Sedges grow most profusely on poorly drained soils while lichens occur on well drained and sandy soils.

The low-lying and poorly drained range types of the Hudson Bay Lowlands produced on the average between 200 and 400 kg of sedges and grasses per hectare annually and from 50 to 200 kg of new willow growth. Sedge and willow production on the felsenmeer plateau was poor, on the average less than 40 kg/ha and 20 kg/ha respectively. Production values were low when compared to the average standing crop of herbaceous vegetation in Lapland (68°30′N) of just under 2,500 kg/ha (Pearsall and Newbould, 1957).

These findings explain earlier reports of caribou wintering on the highlands (good lichen production) and summering on the lowlands (good sedge, grass and willow production).

The information acquired on the distribution of range types and their forage production, enabled me to calculate an optimum caribou population for Southampton Island. Because the seasonal food preferences of the island caribou and the availability of forage in winter are still unknown, my estimate of optimum population level is tentative.

Estimates of the carrying capacity of caribou and reindeer range vary: in northern Finland the optimum stocking rate for reindeer has been estimated at 50 ha per animal, on the arctic coast of western Canada 24 ha per animal, in parts of northern Russia about 20 ha per animal and in Labrador about 75 ha per animal (Hustich, 1951).

Palmer (1934) calculated that a caribou requires 1,575 kg of lichen during the 5 winter months in Alaska and on that basis, allowing for a 30-year lichen recovery period, average range could support one animal per 7.6 hectares of productive range. Palmer (unpub.) concluded that a "normal" stocking rate for caribou in Alaska appears to be 10 animals per sq mile (3.8 animals per sq km).

Porsild (1942) mentioned a range allowance of 40 acres (16.1 ha) per reindeer per year under western Canadian tundra conditions. Skunke (1969) recommended a stocking rate of about 12 ha per reindeer per year in the western part of Harjedalen, Sweden.

As tundra range exhibits tremendous variation in the standing crop of lichens and in the annual production of herbaceous forage, it is hazardous to apply stocking rates from one range to another. However, the above suggested rates are useful if forage production values are also considered.

Palmer's estimated stocking rate of 3.8 animals per square kilometer is based on a mean standing crop value of 6,000 to 6,500 kg lichens/ha. That stocking rate is similar to the one suggested by Skunke (1969) using comparable standing crop values. The best lichen-producing range on Southampton Island is within the Canadian Shield formation and supports only 1,000 kg lichens/ha. Suggested stocking rates must therefore be reduced to 0.6 caribou per square kilometer. Lichen-producing range within those land forms has been calculated from aerial photographs to be 11,132 sq km. Those ranges can therefore support about 6,500 to 7,000 caribou.

The only important lichen-producing sites on the Hudson Bay Lowlands are in the raised *Dryas*–sedge range type and the raised sedge–*Dryas*–willow subtype of the patterned ground tundra range type. The former supports approximately 400 kg of lichens per hectare and occupies 5,745 sq km. The latter supports approximately 200 kg of lichen per hectare and occupies 2,420 sq km. Again using the figures suggested by Palmer, those two range types together can support approximately 1,800 to 2,000 caribou. The total carrying capacity of the island in winter, using grazing intensities recommended by Palmer (unpub.) is therefore only 8,000 to 9,000 caribou.

If, however, one used Porsild's (1942) suggested allowance of 40 acres (16.1 ha) per reindeer per year on tundra conditions, carrying capacity would be greatly increased. Assuming all but water and the *Dryas* barrens as tundra range (34,291 sq km) carrying capacity increases to over 200,000 caribou. It becomes obvious that the variables comprising the equation for determining carrying capacity must be altered from region to region and among range types.

Food availability during the winter months is the principal factor responsible for determining maximum population densities of wild ungulates in northern regions. As summarized by Klein (1967: 290) "... range capacity . . . involves two quite different criteria (1) the winter component which governs the upper limit of the population and (2) the summer component which largely determines the physical stature of the individual animals." On Southampton Island it is the limitation of forage during the winter months which limits population growth.

Caribou and reindeer have the ability to maintain nitrogen levels on a low protein diet by recycling urea (Wales, 1972). That ability allows caribou to remain on a high lichen, low protein diet for sustained periods of time, providing the animal receives sufficient minerals and other elements from additional sources of food. The addition of vascular plants to a diet of 80 to 90 per cent lichens would be sufficient for caribou to maintain condition over the winter period.

Igoshina and Florovskaya (1939) state that one reindeer eats 3.0 to 4.5 kg of naturally cured herbaceous forage per day or 5 to 6 kg of lichens per day. Palmer (unpub.) suggests a 250 lb (114 kg) caribou requires 10 lb (4.5 kg) of food per day while Terent'ev (1936) suggests 4 to 6 kg dry matter per day for an adult reindeer.

In my calculations I assumed an adult caribou requires a daily intake of 5 kg of dry forage. In winter this is predominantly lichen, the favoured winter food of caribou, and in summer, grass, sedge, and willow.

Most arctic vascular plants support live organs in the form of buds, shoots and succulent roots in the winter and few plants on the tundra cannot supply green forage for reindeer throughout the year (Terent'ev, 1936; Aksenova, 1937; Temnoev, 1939; Glinka, 1939; Ustinov, Pokrovskii and Bogdanov, 1954; Bonner, 1958; Skunke, 1969). Glinka (1939) reported 65 to 70 per cent of *Festuca ovina* remains green during winter and 20 per cent of *Deschampsia flexuosa*. He stressed the critical importance of grasses and sedges to reindeer live weight and fatness; their importance as a supplement to a lichen-rich winter diet should not be ignored when evaluating grazing capacity. Caribou and reindeer survive in areas where lichens are scarce or absent (Skoog, 1968; Kishchinskii, 1971).

Pegau (1968) calculated a formula for determining reindeer stocking rates in Alaska. I have modified his calculations to estimate a maximum caribou population for Southampton Island and have incorporated the following parameters.

1. Lichen is the staple winter food for caribou. Range types on the Canadian Shield support the greatest standing crop of lichen, and as historical records suggest that region was traditional winter range, the carrying capacity of the island is restricted by the ability of the Canadian Shield to support caribou in the winter.
2. Only 50 per cent of the standing crop of lichen is available for winter use due to snow cover.
3. Caribou remain on the winter range (Canadian Shield) for 8 months (Oct. 1–May 31).
4. Caribou move from the Canadian Shield to the Hudson Bay Lowlands for the summer period (June 1–Sept. 30).

Table 14
Calculations used to estimate winter and summer carrying capacity of range types on Southampton Island (*after* Pegau, 1968)

	Summer range					Winter range	
	Raised lichen *Dryas*–sedge	Patterned ground tundra: Raised	Patterned ground tundra: Flat	Sedge–heath transition	Sedge–willow meadow	Lichen–heath felsenmeer plateau	Lichen–heath felsenmeer lowland
Standing crop of lichen forage (Kg/ha)						755	824
Kg/ha of lichen range available (x0.50) *						377	412
Provision for 4-year rotation (x0.25) †						94	103
Lichen to be consumed under top-cropping (x0.45)						42	46
Kg/ha of new growth of willow‡	10	80	120	60	200		
Kg/ha of new growth of sedges and grasses‡	200	260	230	320	400		
Kg/ha of new growth produced	210	340	350	380	600		
Proportion of new growth potential forage§	0.20	0.20	0.20	0.20	0.20		
Kg/ha of new growth potential forage	42	68	70	76	120		
Daily forage requirements (kg) for an adult caribou‖	÷ 5	÷ 5	÷ 5	÷ 5	÷ 5	÷ 5	÷ 5
Caribou grazing days per hectare	8.4	13.6	14.0	15.2	24.0	8.4	9.2
Days on winter range (Oct. 1 – May 31)						÷240	÷240
Days on summer range (June 1 – Sept. 30)	÷120	÷120	÷120	÷120	÷120		
Caribou/100 ha on summer range	7.0	11.3	11.6	12.6	20.0		
Caribou/100 ha on winter range						3.5	3.8

*50% of potential lichen forage is unavailable due to snow cover.
†Four-year rotation grazing = continuous use at one-quarter animal density.
‡Cover values from Appendices 4, 6, 8 and 10 converted to annual production values from regression lines in Figures 25-27.
§Grazing rate of 20% annual production should not affect plant viability on following year's production (Johnston, 1961).
‖Daily forage requirements of 5 kg as suggested by Igoshina and Florovskaya (1939), Terent'ev (1936) and Palmer (unpub.).

Table 15
The estimated number of caribou Southampton Island would support for the summer (4 months) and winter (8 months) grazing periods (see calculations in Table 14)

	Hudson Bay Lowlands (summer range)					Canadian Shield (winter range)					
Range type	Western Limestone Plateaux	Bell Peninsula Plateaux	Cape Donovan Limestone Plateau	Southampton Limestone Plains	Maximum for summer range	Kirchoffer Upland	Eastern Plateau	Bell Hills	Munn Hills	South Bay Lowland	Maximum for winter range
Raised lichen–*Dryas* sedge	27,615	5,790	177	6,237	39,819						
Patterned ground tundra											
(a) raised	14,702	3,173	8	9,136	27,019						
(b) flat	15,092	3,257	8	9,378	27,735						
Sedge–heath transition	16,330	4,217	45	46,577	67,169						
Sedge–willow meadow	29,548	6,730	0	60,942	97,220						
Lichen–heath felsenmeer plateau						18,286	7,416				25,702
Lichen–heath felsenmeer lowland								2,801	277	11,319	14,397
Total caribou	103,287	23,167	238	132,270	258,962	18,286	7,416	2,801	277	11,319	40,099
Caribou/km²	7.7	8.6	6.0	10.1	8.8	3.0	3.0	2.6	2.3	2.7	2.8

Figure 35
The gradation of Southampton Island into winter and summer caribou range, using lichen standing crop as the criterion for winter range, sedge and willow production for summer range, and incorporating the results of cover mapping from aerial reconnaissance in August 1971 and the physiographic regions shown in Figure 2

Figure 35

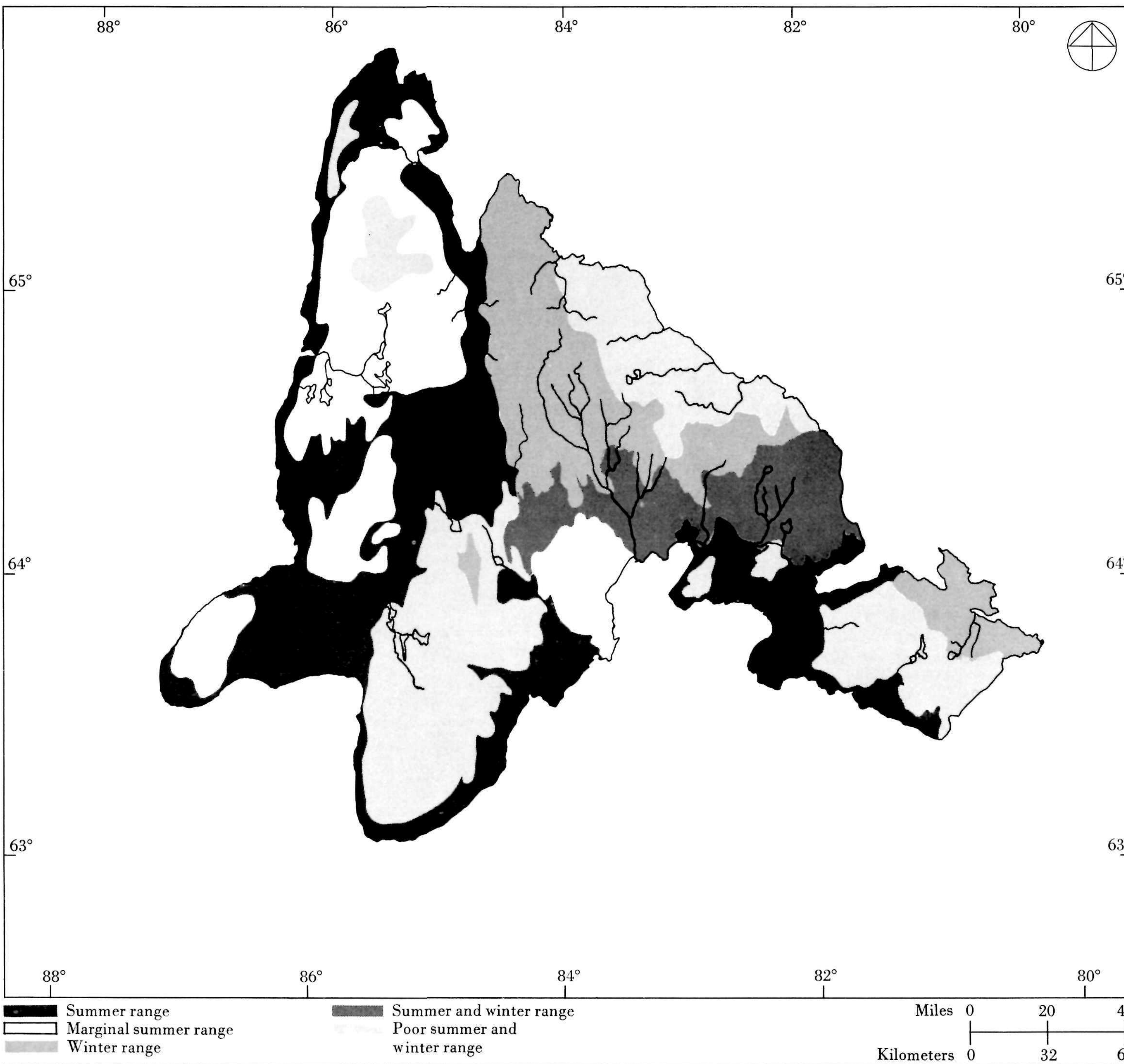


Figure 36
A projected 20-year population growth for the introduced barren-ground caribou population on Southampton Island

5. Summer forage consists of the current year's growth of sedge, grass and willow.
6. The maximum loss of current year's production of sedge, grass and willow from caribou grazing, with no detrimental effect on plant viability or the following year's production, is 20 per cent (Johnston, 1961).
7. An adult caribou requires 5 kg of dry forage daily to maintain condition. This daily requirement consists of lichen in the winter (with the addition of a small supplement of green fodder) and sedge, grass and willow in the summer.
8. Effect on vegetation by rotation grazing at 4-year intervals is similar to continuous use at one-quarter animal density.

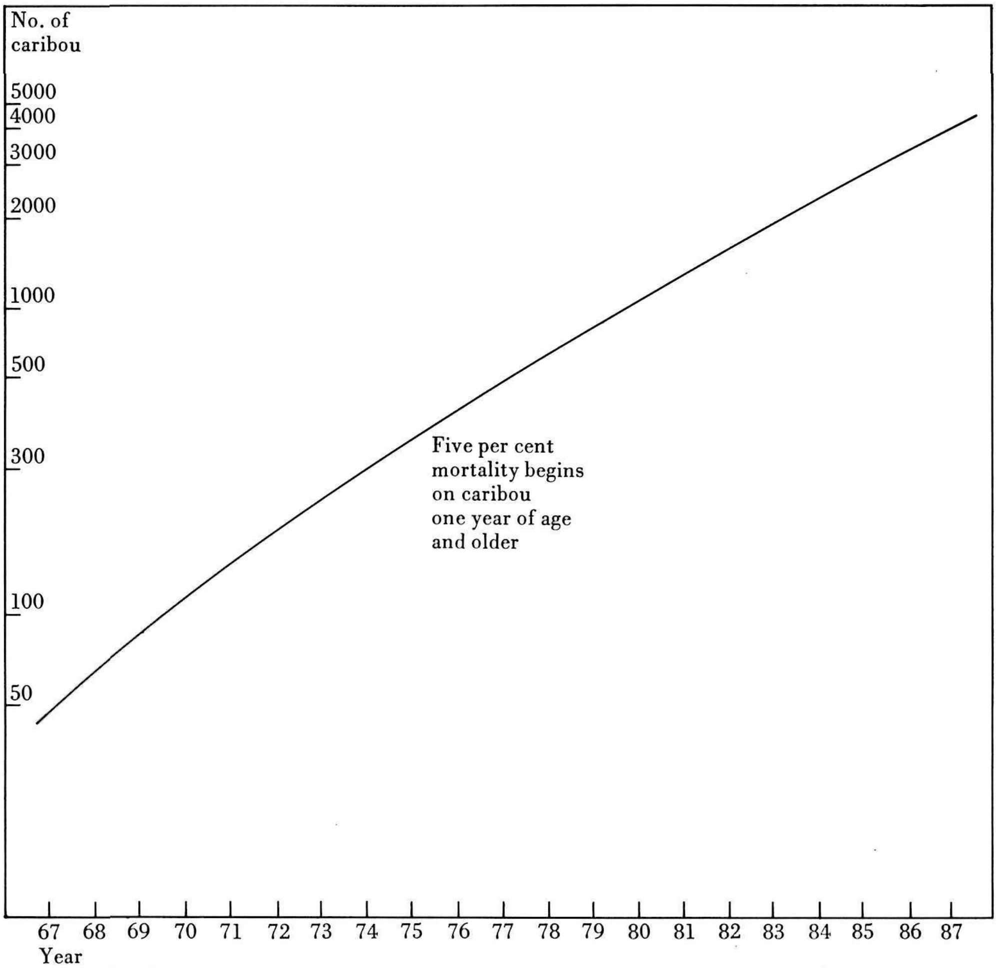
Table 14 shows the calculations for obtaining maximum caribou stocking rates for winter and summer ranges on Southampton Island. The maximum numbers of caribou for range types in physiographic regions on winter and summer range are shown in Table 15.

In Figure 35 I show a gradation of Southampton Island into winter and summer caribou range. This classification uses lichen standing crop as criterion for winter range, sedge and willow production for summer range, and incorporates results of cover mapping from aerial reconnaissance in August, 1971 and the physiographic regions shown in Figure 2.

Andreev (1954) and Pegau (1968) describe "top cropping" as a light grazing by reindeer when only the top one-third of the podetium, or 0.45 of the lichen mass, is utilized. Top cropping allows full recovery of a lichen stand in 3 to 5 years (Andreev, 1954). Both Andreev (1954) and Pegau (1968) suggest a 4-year grazing rotation with reindeer, allowing only light grazing of lichen stands and thus utilizing only approximately one-third the mass. This practice allows a far greater number of reindeer per unit of productive range than intensive use of lichen stands when full recovery may require 30 to 50 years (Andreev, 1954).

In Table 14, I allow for 50 per cent of the lichen range to be unavailable for

Figure 36



winter use due to snow cover. As the distribution of snow cover is relatively uniform from year to year, it is probable that the same areas each winter are unavailable for grazing. The exact amount of unavailable range annually depends upon the amount of snow accumulation.

Whereas reindeer must be herded to ensure that grazing intensity does not exceed the maximum 0.45 of the standing crop, the migratory behaviour of caribou is a natural intrinsic regulatory mechanism. In Table 14 I assume that if caribou densities are maintained at one-quarter those suggested for a 4-year rotation grazing practice for reindeer, the effect upon the standing crop of lichen will be the same. The suggested annual grazing intensity is approximately 11 per cent the total potential and 22 per cent the total available standing crop of lichens.

Although the summer range can theoretically support approximately 250,000 caribou, winter range restricts the population to only 40,000. Densities of caribou on summer range may reach 20 per square kilometer while on winter range densities drop to a maximum of 3.8 per square kilo-

Conclusion

meter. An island population of 40,000 caribou provides a mean density of 2.5 per square mile or approximately one caribou per square kilometer. Prior to the crash of reindeer on St. Mathew Island, Alaska, densities reached 18.7 per square kilometer (Klein, 1968). On St. Paul Island, prior to a crash in the reindeer population in 1939, densities reached 20 animals per square kilometer (Schaeffer, 1951).

Frequent observations of caribou, particularly new calves, following the 1967 transplant suggested that the introduced animals adapted to their new environment and were increasing. Rates of increase were unknown, but lack of natural predators, regulations against hunting and virtually unexploited range suggest that, barring unusual weather they should approach maximum.

Assuming that ten calves survived the transplant, and that the sex ratio of those calves was 1:1, figure 36 shows the potential rate of increase for the 20-year period 1967 to 1987 with the following parameters (breeding rates for females from Dauphiné, 1970):

i. No mortality of calves
ii. No mortality on caribou $\geq$ 1 yr. old from 1967–1975
iii. Five per cent annual mortality on males $\geq$ 1 yr. old (1976–1987)
iv. Five per cent annual mortality on females $\geq$ 1 yr. old (1976–1987)
v. Sex ratio at birth 1:1
vi. Proportion of females breeding 1st year = 0 per cent
vii. Proportion of females breeding 2nd year = 2 per cent
viii. Proportion of females breeding 3rd year = 48 per cent
ix. Proportion of females breeding 4th year and older = 90 per cent

In 1973 the population would reach 240 animals, and by 1980 it would reach 1,068 of which 226 (21 per cent) would be calves. The theoretical population growth projection uses age-specific breeding rates for females determined for the mainland barren-ground caribou population. Those rates could well be higher for a population on relatively unused range. On St. Mathew Island, Alaska, an introduced population of 29 reindeer (*Rangifer tarandus tarandus*) increased to 6,000 during the 19-year period from 1944 to 1963 (Klein, 1968). That population experienced a net increment of 29 per cent in 1957 (Klein, 1968). The annual net increment in the projected population growth for Southampton Island is 27 per cent.

Calf mortality can be highly variable unlike the expected five per cent adult mortality of an unexploited population. On new range with no predation it would be hazardous to assume such an unknown factor. I have excluded calf mortality from my calculations for potential population growth, realizing that the actual rate of growth will be somewhat less. The projected population growth therefore, should be considered maximum, and annual harvests should not be considered until the population has built up to at least 1,000 animals. My calculations indicate that that point will not be reached until 1980.

I found that combining aerial photo interpretation and ground sampling was a reasonable approach to caribou range inventory on Southampton Island. Photography at the scale of 1:60,000 was adequate to delineate land forms and widespread vegetation types on the flat Hudson Bay Lowlands. Photography at that scale could not identify the more varied and intricate vegetation types on the Canadian Shield, where topographic relief created a much greater diversity in microclimate and substrate. The identification of subtypes within the lichen–heath felsenmeer plateau would have been possible through the use of sample colour photography at a scale of 1:12,000.

The patterned-ground tundra, transition and sedge–willow meadow range types in the Hudson Bay Lowlands supported adequate summer forage for barren-ground caribou. Sedges and willows were common throughout those types and were found to be high in important minerals and crude protein. Lichens were not abundant anywhere on the island, but reached their maximum growth and species diversity on the crystalline substrate of the Eastern Plateau and South Bay Lowland.

The "reindeer lichens" of the genera *Cladina* and *Cladonia* were not abundant. Lichens of the genera *Cetraria* and *Alectoria* were the dominant species on the island.

The South Bay Lowland and Kirchoffer Upland were the most important physiographic regions on the island for wintering caribou. Because of the dispersion of vegetation types, we rated the South Bay Lowland as the most important region on the island to caribou.

Based on forage measurements, knowledge of caribou food requirements and assumptions about forage availability in winter, we estimated the carrying capacity of the island at 40,000 caribou. If the assumptions are correct, stabilizing numbers at that level by harvesting should avoid range deterioration and ensure continued productivity of the population.

Recommendations

This investigation provides a baseline for the management of the caribou of Southampton Island. Further studies will be necessary when the population reaches a manageable level.

To detect range deterioration, it would be useful to monitor vegetation in specially constructed enclosures and in comparable unprotected areas. Winter studies of snow cover, food availability and caribou distribution and feeding crater examinations would allow a more precise measure of maximum caribou densities.

I recommend protection from hunting until the population reaches 1,000 caribou. Beginning in 1980 when it should be approaching that number, annual population surveys should be flown. Limited harvesting of males at that stage would not impede population growth. Later more liberal harvests could regulate population growth and sex and age structure. A population of 40,000 caribou should permit a minimum annual harvest of 4,000 animals. Programs to ensure maximum utilization of the resource could incorporate a closely regulated harvest supervised by the Northwest Territories Game Management Service, proper facilities for processing and storage of meat, and collection and analysis of specimen material to monitor population condition and sex and age structure.

Coats Island urgently needs a management program. In 1970 the population was estimated as approaching 2,000 caribou (2.5 per square kilometer). The island is isolated: caribou cannot move to new areas if the grazing capacity is surpassed. Although caribou collected in 1970 were in excellent physical condition, the island cannot support unlimited population growth.

The harvest should approximate the previous year's production and include a greater proportion of adult females.

The caribou population on Coats Island should not be allowed to crash as it is supplying Coral Harbour with fresh meat while the population on Southampton Island increases to harvestable levels.

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Glossary

Alliance–The unit of next higher rank than the association in the *Braun-Blanquet classification* of plant communities (TFS)[1].

Alluvial–Pertaining to deposits formed by finely divided material laid down by running water (DBT)[2].

Annual production–That part of a plant which is produced during one growing season.

Association–The fundamental unit of plant sociology which exhibits essential uniformity in floral composition and ecologic structure (Cain, 1932).

Brunisol–An order of brownish-coloured soils indicative of good to imperfect drainage or of good to moderate oxidizing conditions which have developed under forest, mixed forest and grass, grass and fern, or heath and tundra vegetation associations representative of forest, alpine or tundra communities (TSC)[3].

Bryophyte–Any of the mosses and liverworts (TFS).

Calciphilous–Preferring soils rich in calcium (TFS).

Carrying capacity–The number (or weight) of organisms of a given species and quality that can survive in, without causing deterioration of, a given ecosystem through the least favourable environmental conditions that occur within a stated interval of time (=grazing capacity) (TFS).

Climax community–The culminating stage in plant succession for a given environment, the vegetation being conceived as having reached a highly stable condition (TFS).

Community–Any assembly of organisms living together, no particular ecological status being implied (TFS).

Constancy–That percentage of a given number of plots within which a plant species is found.

Cover–A measure of the importance of a plant species in a community, being the actual percentage of ground covered by all individuals of a plant species in a unit area.

[1] TFS =Ford-Robertson, 1971.
[2] DBT =Henderson and Henderson, 1967.
[3] TSC =The system of soil classification for Canada, 1970.

Cryic–Pertaining to a permanently frozen layer of soil, or a layer in which the temperature is 0°C or lower to a depth of 25 cm 2 months after the summer solstice (August 21). (TSC).

Cryopedologic–Pertaining to disturbances to soils through the intensive action of frost (TEG)[4].

Cryptogam–A plant without apparent reproductive organs reproducing by spores such as ferns and mosses (DBT).

Daubenmire frame–A calibrated quadrat 0.1 sq m in area used to determine the percentage of ground covered by each plant species through ocular estimation.

Density–The number of plants or animals per unit area at a given time (TFS).

Epeirogenic–In geology, a broad, relatively uniform uplift of large areas (TEG).

Ericaceous–Belonging to the family of plants Ericaceae (heath family).

Erosion surface–An area of even surface due to the process of erosion, often covered by an alluvial deposit.

Esker–A mound or ridge of gravel or sand deposited by a stream in association with glacier ice; often elongated and sinuous (TFS).

Felsenmeer–A geological term to describe a land surface characterized by numerous surface boulders; a rock field (TEG).

Flora–The plants peculiar to a country, area, specified environment, or period (DBT).

Fluvial–Pertaining to, found in, or formed by a river.

Forage–The edible vegetation for wildlife.

Forage crop or yield—The edible vegetation for wildlife produced seasonally or annually on a given area (TFS).

Formation–The largest recognized and relatively stable major unit of vegetation, being the climax of an area with a given climate (TFS).

[4] TEG =Fairbridge, 1968.

Frequency–A measure of the importance of a plant species in a community, being the percentage of plots in which a species occurs in a sample area.

Gleysol–An order of soils saturated with water and under reducing conditions continuously or during some period of the year. As a result they have matrix colours of low chroma within 50 cm of the mineral surface. They may have distinct or prominent mottles of high chroma, presumably as a result of localized oxidation of ferrous iron and the deposition of hydrated ferric oxides. They are developed under hydrophytic vegetation and have a thick surface layer of mixed peat or fibrous moss peat (TEG).

Grazing capacity–see "carrying capacity".

Heath–Plants within the family Ericacae. In this report also includes *Dryas integrifolia*.

Horizon–Any layer of soil, roughly parallel to the surface, that may be distinguished from adjacent layers because it differs in physical, chemical or biological characteristics (TFS).

Humus–The most highly decomposed of the organic soil materials, in contrast to the fibric and mesic layers (TSC).

Lithic–Pertaining to a consolidated mineral layer (bedrock) occurring within a depth of between 10 cm and 130 to 160 cm from the surface (TSC).

Mesic–Of sites or habitats conditioned by temperate moist conditions, neither xeric nor hydric (DBT).

Phanerogam–A plant reproducing by flowers and seeds (Porsild, 1964).

Physiognomy–The appearance or obvious physical features of a land unit.

Physiography–In geomorphology and physical geography, the study of the origin and evolution of the structural features of the earth's surface, i.e. of relief (TFS).

Polygon–A multi-sided, more or less symmetrical form, characteristic of ground subject to intensive frost action. Typical of the polar regions and characterized by well-sorted stone borders and a central area which is free from coarser material (TEG).

Range–In ecology, the geographical and altitudinal limits within which a taxon (taxonomic group) occurs. In range management, the grazing land or pasture land of an animal (TFS). In this report, the total territory or land surface used by an animal.

Range management–The art and science of planning and directing range utilization so as to secure sustained maximum production of livestock (or wildlife) (TFS).

Range type–Used in this report to describe a recognizable land form characterized by one or more dominant plant species, usually having a uniform soil structure and drainage pattern and incorporating within its boundaries repetitive variations.

Regosol–An order of soils having well to imperfectly drained mineral soils with good to moderate oxidizing conditions, having horizon development too weak to meet the requirements of soils in any other order (TSC).

Standing crop–The total number or the total weight (biomass) of animals (or plants) present in an area at a given time (TFS). In this report it refers to the total above-ground air-dried weight of lichens.

Subtype–Distinct vegetational variations within a recognized range type.

Transect–In this report, a calibrated straight line in a range type along which sampling units or quadrats are regularly spaced.

Xeric–Of sites or habitats characterized by decidedly dry conditions (TFS).

Appendices

Appendix 1

Weather data for the meteorological station at Coral Harbour, Northwest Territories (Thompson, 1967). Based on 1951 to 1960, except for temperature extremes, records of which go back to 1944.

Month	Air temperature: Mean daily °F	Mean of daily: Max °F	Mean of daily: Min °F	Mean of monthly: Max °F	Mean of monthly: Min °F	Absolute extreme: Highest recorded °F	Absolute extreme: Lowest recorded °F	Precipitation: Rain Mean amt. cm	Precipitation: Snow Mean amt. cm	Total (water) Mean amt. cm	Wind: Most prevalent Direction	Wind: Most prevalent %	Wind: Av speed m.p.h.
Jan.	−21.3	−13.9	−28.6	11	−47	31	−61	0.00	8.50	0.85	NW	35	12.1
Feb.	−20.2	−12.3	−28.1	11	−45	30	−55	0.00	9.75	0.97	N	32	12.3
Mar.	− 9.5	− 0.1	−18.8	21	−39	31	−51	0.00	9.75	0.97	N	37	10.5
Apr.	5.7	14.7	− 3.4	31	−26	40	−39	0.00	12.25	1.22	N	28	13.1
May	22.4	29.6	15.2	42	− 8	48	−36	0.25	18.75	2.12	NW	22	13.2
June	36.6	42.4	30.8	55	19	67	11	1.80	8.00	2.60	N	20	12.3
July	47.6	55.3	39.8	70	33	77	30	3.17	1.25	3.30	N	16	12.2
Aug.	45.9	52.8	39.0	64	31	79	26	3.97	0.12	3.97	N	21	12.9
Sep.	34.3	39.0	29.6	52	18	63	8	2.80	9.00	3.70	N	23	13.3
Oct.	17.2	23.8	10.5	34	− 9	41	−20	0.52	26.75	3.20	NW	28	13.3
Nov.	− 0.2	7.5	− 7.8	28	−28	35	−34	0.05	16.75	1.72	N	35	13.2
Dec.	−14.5	− 7.1	−21.8	18	−40	27	−53	0.00	12.00	1.20	N	34	13.3
Year	12.0	19.3	4.7	71	−51	79	−61	12.57	132.75	25.85			12.6

Appendix 2

Plant composition of the two subtypes within the *Dryas* barrens range type, showing percentage of ground covered by each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%.

	Dryas–sedge–saxifrage subtype						*Dryas*–lichen–sedge subtype						
Site no.	TR 18	TR 19	TR 33	TR 83			TR 38	TR 45	TR 80	TR 108			
m² plots	15	15	15	15		Cover	15	15	15	15		Cover	Total cover
Location	64°15′N 84°53′W	64°15′N 84°53′W	64°24′N 84°44′W	63°52′N 81°05′W	Constancy	(grand mean)	65°02′N 84°33′W	65°02′N 84°33′W	65°02′N 84°33′W	64°15′N 83°16′W	Constancy	(grand mean)	(grand mean)
Sedges and grasses	12.6	9.8	0.6	0.4	V	3.2	12.4	13.2	7.8	6.2	V	10.0	7.5
Salix spp. (0–5 cm)	0.0*	1.7			III	0.5	0.1	0.0	0.0		IV	<0.1	0.2
Tofieldia pusilla										0.0	II	0.0	0.0
Polygonum viviparum	0.4	0.4	<0.1	0.6	V	0.4	<0.1	0.1	0.0	0.0	V	<0.1	0.2
Stellaria longipes		0.0			II	0.0				<0.1	II	<0.1	<0.1
Cerastium alpinum		0.0			II	0.0				0.0	II	0.0	0.0
Arenaria Rossii										<0.1	II	<0.1	<0.1
Silene acaulis							0.6	0.6	0.2		IV	0.3	0.2
Papaver radicatum										0.1	II	<0.1	<0.1
Lesquerella arctica			0.0		II	0.0				0.0	II	0.0	0.0
Draba sp.	0.2	0.0	0.0		IV	<0.1				0.1	II	<0.1	<0.1
Braya purpurascens		0.2		<0.1	III	<0.1							<0.1
Saxifraga aizoides										<0.1	II	<0.1	<0.1
Saxifraga oppositifolia	3.4	2.4	0.8	2.6	V	2.1	3.7	2.1	2.8	4.4	V	3.2	2.7
Dryas integrifolia	18.0	17.8	13.3	24.9	V	18.6	22.3	20.3	22.0	14.6	V	19.8	19.2
Astragalus alpinus							<0.1				II	<0.1	<0.1
Oxytropis Maydelliana									0.0		II	0.0	0.0
Oxytropis arctobia							2.5	2.1	1.4	0.0	V	1.5	0.8
Epilobium latifolium							0.2				II	<0.1	<0.1
Cassiope tetragona	1.0	2.2			III	0.7							0.3
Rhododendron lapponicum		0.0			II	0.0							0.0

Appendix 2 cont'd

Site no.	*Dryas*–sedge–saxifrage subtype TR 18	TR 19	TR 33	TR 83	Con-stancy	Cover (grand mean)	*Dryas*–lichen–sedge subtype TR 38	TR 45	TR 80	TR 108	Con-stancy	Cover (grand mean)	Total cover (grand mean)
m² plots	15	15	15	15			15	15	15	15			
Location	64°15′N 84°53′W	64°15′N 84°53′W	64°24′N 84°44′W	$3°52′N 81°05′W			65°02′N 84°333′W	65°02′N 84°33′W	65°02′N 84°33′W	64°15′N 83°16′W			
Pedicularis lanata	0.0	<0.1	0.0	0.0	V	<0.1	<0.1			<0.1	III	<0.1	<0.1
Chrysanthemum integrifolium	0.0	0.4			III	<0.1				0.0	II	0.0	<0.1
Alectoria ochroleuca							1.1	1.8	1.9	0.0	V	1.2	0.6
Alectoria nigricans							0.4	0.0	0.1	0.4	V	0.2	0.1
Alectoria chalybeiformis							1.8	1.8	5.2	0.2	V	2.2	1.2
Alectoria pubescens								0.6			II	0.1	<0.1
Cetraria nivalis	3.4	0.0	0.2	<0.1	V	0.4	1.7	0.8	4.9	2.0	V	2.5	1.5
Cetraria cucullata			0.1		II	<0.1	0.0	0.2	0.2	0.2	V	0.1	0.1
Cetraria islandica	0.0		0.0		III	0.0	0.2	0.3	<0.1	0.0	V	0.1	<0.1
Cetraria tilesii	0.2				II	<0.1			0.0	0.6	III	0.1	0.1
Cetraria delisei	0.0	0.0			III	0.0				<0.1	II	<0.1	<0.1
Cetraria nigricans							0.2		<0.1		III	<0.1	<0.1
Cladonia pyxidata							0.2		<0.1		III	<0.1	<0.1
Cornicularia divergens							0.0	0.2	0.0	0.0	V	<0.1	<0.1
Dactylina arctica							0.1			0.2	III	<0.1	<0.1
Dactylina ramulosa										0.0	II	0.0	0.0
Evernia mesomorpha							0.2		0.3		III	0.1	<0.1
Hypogymnia subobscura	0.0				II	0.0	1.0	1.0	0.9	0.0	V	0.7	0.4
Ochrolechia frigida	0.2				II	<0.1	<0.1				II	<0.1	<0.1
Parmelia omphalodes								0.3	0.6	0.0	IV	0.2	0.1
Thamnolia vermicularis	0.4	0.0	0.7	0.8	V	0.5	1.2	1.0	1.0	0.9	V	1.0	0.8
Other lichens		0.0	0.2	0.6	IV	0.2	3.0	6.0	4.1		IV	3.3	1.9
Mosses	1.2	2.1	0.4	0.3	V	1.0	0.2		0.6	0.3	IV	0.3	0.6
Debris		2.6		1.2	III	1.1	3.4	2.6	7.6	5.0	V	4.6	3.0
Rock and bare ground	73.0	67.0	86.1	71.4	V	74.6	44.8	57.3	56.8	68.2	V	54.4	65.0

*Present within m² plot but not within 0.1 m² Daubenmire frame.

Appendix 3
Soil analyses for the *Dryas* barrens range type

Site no.	TR 18	TR 19	TR 33	TR 38	TR 45	x̄
Date collected	23/7/70	23/7/70	1/8/70	7/7/71	9/7/71	
Location	64°15′N 84°53′W	64°15′N 84°53′W	64°24′N 84°44′W	65°02′N 84°33′W	65°02′N 84°33′W	
Elevation, meters a.s.l.	90	90	120	120	120	
Land form	plain	plain	crest	crest	crest	
Slope gradient	nil	nil	nil	nil	nil	
Drainage	good	good	good	good	good	
Soil pit depth, cm	40	36	15	50	36	
Root depth, cm	40	36	3–5	35	26	
Chemical analyses						
Horizon A						
Width, cm	20	36	15	15	10	
1:1 pH in H_2O	8.04	8.11	8.23	8.63	7.71	8.14
1:1 pH in 0.01 M $CaCl_2$	7.50	7.52	7.64	7.90	7.37	7.58
Total % C	10.11	10.27	9.16	0.05	2.67	6.45

cont'd

Appendix 3 cont'd

	Site no.					
	TR 18	TR 19	TR 33	TR 38	TR 45	$\bar{x}$
% Lime	75.60	75.50	73.00			73.70
% Dolomite	9.00	9.00	1.60			6.53
% Calcite	66.60	66.50	71.40			68.16
% OM	1.79	2.09	0.69			1.52
Horizon B						
Width, cm	20			35	26	
1:1 pH in H_2O	8.37			8.00	8.33	8.23
1:1 pH in 0.01 M $CaCl_2$	7.64			7.52	7.43	7.53
Total % C	9.45			0.42	0.17	3.34
% Lime	76.80					76.80
% Dolomite	11.60					11.60
% Calcite	65.20					65.20
% OM	0.41					0.41

Appendix 4

Plant composition of the raised lichen–*Dryas*–sedge range type, showing percentage of ground covered for each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%.

Site no.	TR 2	TR 3	TR 16	TR 27	TR 31	TR 39	TR 49	TR 98	TR 101	TR 110		
m^2 plots	15	15	15	15	15	15	15	15	5	8		
Location	64°24′N 84°20′W	64°24′N 84°20′W	64°16′N 84°42′W	64°23′N 84°47′W	64°23′N 84°44′W	65°02′N 84°33′W	65°02′N 84°43′W	64°12′N 83°44′W	64°06′N 83°27′W	64°12′N 83°26′W	Constancy	Cover (grand mean)
Equisetum variegatum			0.3								I	<0.1
Sedges and grasses	15.0	19.8	31.6	25.6	24.4	26.4	23.3	48.0	16.7	3.0	V	25.3
Salix spp. (0-5 cm)		<0.1	0.3			0.4	0.1	0.3	0.4	1.1	IV	0.2
Salix spp. (5-15 cm)			8.3								I	0.9
Tofieldia pusilla						0.2	0.1	0.2	0.0*	0.3	III	<0.1
Oxyria digyna								0.1			I	<0.1
Polygonum viviparum	0.1	1.3	0.6		<0.1	0.4	0.1	0.2	0.0	0.6	V	0.3
Stellaria longipes			0.2							0.0	II	<0.1
Arenaria Rossii							0.2	0.0			II	<0.1
Silene acaulis	0.0			0.1	0.4	0.5		0.0		0.0	IV	0.1
Draba sp.			<0.1	<0.1	<0.1	<0.1					III	<0.1
Braya purpurascens			0.0								I	0.0
Saxifraga aizoides							<0.1				I	<0.1
Saxifraga oppositifolia	7.9	1.7	2.8	2.6	3.2	0.6	5.4	2.2	0.6	2.0	V	3.1
Dryas integrifolia	19.6	22.6	22.6	22.6	35.6	22.6	23.3	56.2	6.2	14.0	V	26.1
Oxytropis Maydelliana	7.4	3.8			0.8	1.8		1.1	0.0	1.6	IV	1.8
Pyrola grandiflora									0.0		I	0.0
Cassiope tetragona			0.3		2.0	9.9	5.2	2.1	10.4	1.6	IV	2.6
Rhododendron lapponicum		0.0			0.3	3.8	2.6		0.4	1.1	IV	0.8
Vaccinium uliginosum					0.5	5.9	0.0	<0.1	23.2	0.0	IV	1.6
Diapensia lapponica			0.0								I	0.0
Pedicularis capitata								0.2	0.0		II	<0.1
Pedicularis lanata	<0.1	0.6	0.1	<0.1	0.2	0.0	0.2			0.5	IV	0.1
Chrysanthemum integrifolium		0.2	0.2	0.0	<0.1		0.2	0.8		0.0	IV	0.2
Alectoria ochroleuca	0.4	1.8			2.2	6.7	0.2	1.2	13.2	8.1	IV	2.4
Alectoria chalybeiformis		5.3				4.7	0.4	0.4	4.4	6.6	IV	1.7
Alectoria nigricans	0.6	2.8		0.2	3.8	1.8	0.0	0.0	2.4	7.1	V	1.5

Appendix 4 cont'd

Site no.	TR 2	TR 3	TR 16	TR 27	TR 31	TR 39	TR 49	TR 98	TR 101	TR 110		
m² plots	15	15	15	15	15	15	15	15	5	8		
Location	64°24′N 84°20′W	64°24′N 84°20′W	64°16′N 84°42′W	64°23′N 84°47′W	64°23′N 84°44′W	65°02′N 84°33′W	65°02′N 84°43′W	64°12′N 83°44′W	64°06′N 83°27′W	64°12′N 83°26′W	Constancy	Cover (grand mean)
Cetraria nivalis	3.6	11.4	2.6	6.4	25.1	8.4	8.1	13.0	29.0	16.8	V	11.0
Cetraria cucullata		3.5			0.6	5.0	0.1	5.8	22.0	2.7	IV	2.6
Cetraria islandica	<0.1	0.8	0.1	0.4	1.0	2.1	0.2	3.6	5.8	1.3	V	1.2
Cetraria delisei			0.1	5.8	0.1	0.0		5.4		0.0	IV	1.3
Cetraria tilesii	0.2		0.1		0.6		0.0	0.9		0.1	IV	0.2
Cetraria nigricans					0.1	0.0	0.0		0.0		III	<0.1
Cladina mitis						0.3					I	<0.1
Cladonia gracilis		<0.1				0.2		0.2	0.0		III	<0.1
Cladonia phyllophora				0.2	0.1		0.0		0.0	0.0	III	<0.1
Cladonia amaurocraea				0.1	0.2				0.0		II	<0.1
Cladonia subcervicornis						<0.1					I	<0.1
Cladonia macrophylla									0.0		I	0.0
Cladonia pleurota									0.0		I	0.0
Cladonia pyxidata							0.0				I	0.0
Cornicularia divergens	0.0	1.0		<0.1	0.8	2.8	0.4	0.4	7.8	1.8	V	1.0
Cornicularia aculeata	0.1	1.2	0.0	<0.1	0.4	0.8	0.1	0.2		0.2	V	0.3
Dactylina arctica	<0.1	0.0	<0.1		0.4	1.7	0.2	0.4	2.6	0.8	V	0.4
Dactylina ramulosa	0.0	0.0			0.0	0.0		0.2	0.0	0.0	IV	<0.1
Evernia mesomorpha						<0.1					I	<0.1
Hypogymnia subobscura	0.2*	2.0				2.3	0.1		0.2	0.2	IV	0.5
Hypogymnia enteromorpha					0.8						I	<0.1
Ochrolechia frigida			<0.1	0.4	3.7	1.0	0.4		0.0		IV	0.6
Parmelia omphalodes	1.0	3.8			0.1	1.4	0.2	0.3	0.4	1.0	IV	0.8
Parmelia centrifuga	0.3	0.1			0.8						II	0.1
Peltigera sp.									0.0		I	0.0
Sphaerophorus globosus						1.4			3.6		II	0.3
Stereocaulon alpinum								0.2			I	<0.1
Thamnolia vermicularis	0.9	3.4	0.2	1.4	6.3	1.4	0.8	2.2	1.6	1.8	V	2.0
Other lichens	8.0	1.4		8.5	7.2	0.6	4.4	3.9			IV	3.8
Mosses	0.2	0.5	6.1	4.0	1.0	2.9	3.4	1.2	4.0	3.6	V	2.5
Debris	†	†	†	†	†	3.0	5.2	2.6	2.8	5.3		
Rock and bare ground	44.6	22.8	25.6	40.6	12.8	4.4	27.2	2.6	0.0	18.0	V	21.4

*Present within m² plot but not within 0.1 m² Daubenmire frame. † No data.

Appendix 5
Soil analyses for the raised lichen–*Dryas*–sedge range type

	Site no.							
	TR 2	TR 3	TR 16	TR 27	TR 31	TR 39	TR 49	x̄
Date collected	5/7/70	6/7/70	21/7/70	30/7/70	1/8/70	7/7/71	12/7/71	
Location	64°24′N 84°20′W	64°24′N 84°20′W	64°16′N 84°42′W	64°18′N 84°47′W	64°23′N 84°44′W	65°02′N 84°33′W	65°02′N 84°43′W	
Elevation, meters a.s.l.	150	150	90	105	120	60	60	
Land form	exposed slope	ridge crest	raised plain	exposed slope	exposed slope	ridge slope	ridge crest	
Slope gradient	5°NW	nil	nil	10°W	10°S	5°W	nil	
Drainage	good	good	good	good	good	good	fair	
Soil pit depth, cm	40	35	30	42	42	42	35	
Root depth, cm	6	22	30+	42	42			

cont'd

Appendix 5 cont'd

	Site no.							
	TR 2	TR 3	TR 16	TR 27	TR 31	TR 39	TR 49	$\bar{x}$
Chemical analyses								
Horizon A								
Width, cm	10			20	20	6	10	
1:1 pH in H_2O	7.93	7.81	7.91	7.77	7.93	5.82	8.37	7.64
1:1 pH in 0.01M $CaCl_2$	7.56	7.18	7.48	7.20	7.54	5.44	7.29	7.09
Total % C	3.83	7.61	8.08	7.03	6.73	4.74	9.90	6.84
% Lime	21.00	3.95	52.20	3.38	34.60			23.02
% Dolomite	21.00	1.25	13.00	2.25	1.10			7.72
% Calcite	0.00	2.70	39.20	1.13	33.50			15.30
% OM	2.26	12.31	3.14	11.41	4.45			6.71
Horizon B								
Width, cm	30+			10	22+	9	25+	
1:1 pH in H_2O	8.30	8.04	8.07	8.41	8.18	6.04	8.25	7.89
1:1 pH in 0.01M $CaCl_2$	7.51	7.53	7.51	7.48	7.75	5.41	7.50	7.24
Total % C	1.49	5.58	8.98	8.90	4.21	0.53	0.34	4.29
% Lime	13.15	40.50	64.60	72.00	30.60			44.17
% Dolomite	12.25	23.50	8.20	10.40	2.00			11.27
% Calcite	0.90	17.00	56.40	61.60	28.60			32.90
% OM	0.00	1.24	2.12	0.45	0.93			0.94
Horizon C								
Width, cm				12+		0–9		
1:1 pH in H_2O				8.40		6.52		7.46
1:1 pH in 0.01M $CaCl_2$				7.50		6.06		6.78
Total % C				9.10		3.80		6.45
% Lime				70.40				70.40
% Dolomite				11.60				11.60
% Calcite				58.80				58.80
% OM				1.12				1.12
Horizon D								
Width, cm						18+		
1:1 pH in H_2O						7.53		7.53
1:1 pH in 0.01M $CaCl_2$						7.00		7.00
Total % C						0.17		0.17
% Lime								
% Dolomite								
Calcite								
% OM								

Appendix 6

Plant composition of the two subtypes of the patterned ground tundra range type, showing percentage of ground covered by each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%

	Raised sedge–*Dryas*–willow subtype								Flat sedge–willow–*Dryas* subtype							
Site no.	TR 1	TR 37	TR 46	TR 51	TR 63	TR 64			TR 20	TR 24	TR 25	TR 26	TR 30	TR 97		
m² plots	15	15	15	15	15	15		Cover	15	15	15	15	15	15		Cover
Location	64°21′N 84°45′W	65°02′N 84°33′W	65°03′N 84°33′W	65°03′N 84°33′W	65°N 84°35′W	65°N 84°35′W	Con-stancy	(grand mean)	64°12′N 84°48′W	64°15′N 84°55′W	64°15′N 84°55′W	64°17′N 85°03′W	64°16′N 84°58′W	64°12′N 83°44′W	Con-stancy	(grand mean)
Equisetum variegatum	0.0*	0.4		<0.1			III	<0.1	0.3	0.3	<0.1	1.2	0.0	0.8	V	0.4
Eriophorum spp.		0.0				0.1	III	<0.1								
Sedges and grasses	25.8	55.0	18.4	40.3	18.1	56.5	V	35.7	25.8	25.0	24.0	23.7	40.8	25.1	V	27.4

Appendix 6 cont'd

	Raised sedge–*Dryas*–willow subtype								Flat sedge–willow–*Dryas* subtype							
Site no.	TR 1	TR 37	TR 46	TR 51	TR 63	TR 64			TR 20	TR 24	TR 26	TR 30	TR 30	TR 97		
m² plots	15	15	15	15	15	15			15	15	15	15	15	15		
Location	64°21′N 84°45′W	65°02′N 84°33′W	65°03′N 84°33′W	65°03′N 84°33′W	65°N 84°35′W	65°N 84°35′W	Constancy	Cover (grand mean)	64°12′N 84°48′W	64°15′N 84°55′W	64°15′N 84°55′W	64°17′N 85°03′W	64°16′N 84°58′W	64°12′N 83°44′W	Constancy	Cover (grand mean)
Salix spp. (0–5 cm)	4.8	6.2	2.8	7.4	5.4	8.0	V	5.8	2.2	3.0	4.0	2.0	4.0	3.4	V	3.1
Salix spp. (5–15 cm)	6.5	0.1	0.3	5.3	0.0	0.5	V	2.1	8.6	6.8	2.7	0.0	10.3	6.8	V	5.9
Salix spp. (15+ cm)										1.3		15.3			III	2.7
Polygonum viviparum		0.3	0.8	0.6	0.7	0.5	V	0.5	0.5	0.7	0.8	1.0	0.8	0.6	V	0.7
Stellaria longipes									<0.1	0.2	0.2	0.1			IV	0.1
Arenaria Rossii					0.0	0.0	III	0.0								
Draba spp.		0.0	0.0	0.0	0.0		IV	0.0	0.0	0.1	<0.1	<0.1			IV	<0.1
Braya purpurascens		0.0		<0.1		0.0	III	<0.1	0.0	0.1	<0.1	0.3		0.2	V	0.1
Saxifraga aizoides				0.0	0.4	4.5	III	0.8						1.3	II	0.2
Saxifraga cernua					0.0		II	0.0								
Saxifraga oppositifolia	0.4	2.2	5.3	3.9	1.3	2.3	V	2.5	3.8	4.0	3.3	2.5	2.9	1.0	V	2.9
Dryas integrifolia	20.6	12.2	27.5	22.8	28.4	27.5	V	23.1	12.6	10.4	14.5	4.5	17.8	3.5	V	10.5
Oxytropis Maydelliana	0.8	0.1	1.2	1.0	3.0		V	1.0								
Oxytropis arctobia				0.0	0.0		III	0.0								
Epilobium latifolium														0.2	II	<0.1
Cassiope tetragona	4.8	4.4	0.2	0.2	4.0		V	2.2								
Rhododendron lapponicum	1.1	0.2			0.3		III	0.2								
Vaccinium uliginosum	3.8	1.7					III	0.9								
Pedicularis capitata		0.6	0.1	0.1	0.6	0.3	V	0.3	0.2	0.2	0.2	0.0	0.4	0.0	V	0.1
Pedicularis lanata					0.2	<0.1	III	<0.1								
Chrysanthemum integrifolium	0.2	0.1	0.5	0.3	0.8	0.5	V	0.4	1.4	1.6	0.7	1.6	0.8	0.6	V	1.1
Alectoria ochroleuca	0.4		<0.1	<0.1	0.2	0.0	V	0.1						0.0	II	0.0
Alectoria nigricans	1.4				<0.1	<0.1	III	0.2						0.0	II	0.0
Alectoria chalybeiformis		0.2	<0.1				III	<0.1								
Cetraria nivalis	9.4	3.7	0.5	3.2	6.8	0.8	V	4.1	0.0	0.0	0.0	0.0	0.0	0.0	V	0.0
Cetraria cucullata	2.0	0.4	0.2	0.4	1.7	<0.1	V	0.8		0.0	0.0	0.0		0.0	IV	0.0
Cetraria islandica	1.5	1.3		0.4	0.6	0.2	V	0.6	0.0	0.0		0.0	0.0	0.1	V	<0.1
Cetraria delisei								0.0						1.5	III	0.2
Cladonia gracilis	0.5						II	<0.1		0.0		0.0	0.0		III	0.0
Cladonia phyllophora					0.0		II	0.0		0.0	0.0	0.0			III	0.0
Cladonia pyxidata					<0.1	<0.1	III	<0.1						0.1	II	<0.1
Cornicularia divergens	0.4	<0.1	0.0	0.1	0.0	0.0	V	0.1						0.0	II	0.0
Cornicularia aculeata	<0.1			<0.1	0.2	<0.1	IV	<0.1								
Dactylina arctica	0.2	0.2		0.4	0.3	0.0	V	0.2		0.0				0.0	III	0.0
Dactylina ramulosa	<0.1	0.0					III	<0.1								
Hypogymnia subobscura	<0.1	0.1		<0.1	0.0		IV	<0.1								
Ochrolechia frigida		0.2					II	<0.1		0.0				0.0	II	0.0
Parmelia omphalodes					<0.1		II	<0.1								
Stereocaulon alpinum	0.5						II	<0.1								
Thamnolia vermicularis	2.2	0.0	0.8	0.6	0.8	0.2	V	0.6	0.0	0.0	0.0	0.0	0.0	0.2	V	<0.1
Other lichens	0.5	0.6	1.2	1.0	0.9	<0.1	V	0.7	1.7	0.0	0.0	0.0	0.0	0.8	V	0.4
Mosses	27.3	12.2	3.4	4.8	4.8	10.6	V	10.5	5.3	10.5	3.5	12.1	6.7	9.1	V	7.9
Debris	1.3	9.2	3.1	7.7	4.8	11.3	V	6.2	10.0	12.2	11.5	5.6	10.0	10.8	V	9.7
Rock and bare ground	4.6	24.1	47.5	36.4	28.4	16.5	V	26.2	55.3	42.0	50.5	59.6	38.6	59.4	V	50.9

*Present within m² plot but not within 0.1 m² Daubenmire frame.

Appendix 7

Soil analyses for the patterned ground tundra range type

	Site no.					
	TR 20	TR 24	TR 25	TR 26	TR 30	$\bar{x}$
Date	24/7/70	28/7/70	28/7/70	30/7/70	31/7/70	
Location	64°12′N 84°48′W	64°15′N 84°55′W	64°15′N 84°55′W	64°17′N 85°03′W	64°16′N 84°58′W	
Elevation meters a.s.l.	105	105	105	105	120	
Land form	flat polygonal mud boils	flat polygonal mud boils	flat polygonal mud boils	flat polygonal mud boils	flat polygonal mud boils	
Slope gradient	nil	nil	nil	nil	nil	
Drainage	fair	fair	fair	fair	fair	
Soil pit depth, cm	55	45	35	46	45	
Root depth, cm	40	20	20	46	45	
Chemical analyses						
Horizon A						
Width, cm	20	45+	35+	46+	45+	
1:1 pH in H_2O	7.69	8.38	8.37	8.41	8.34	8.23
1:1 pH in 0.01M $CaCl_2$	7.02	7.56	7.55	7.60	7.79	7.50
Total % C	8.39	7.08	9.27	8.39	7.96	8.21
% Lime		54.40	64.80	67.00	65.00	62.80
% Dolomite		9.80	13.20	18.00	15.80	14.20
% Calcite		44.60	51.70	49.00	49.20	48.62
% OM	14.46	0.95	2.57	0.60	0.28	3.77
Horizon B						
Width, cm	35+					
1:1 pH in H_2O	8.23					8.23
1:1 pH in 0.01M $CaCl_2$	7.61					7.61
Total % C	9.17					9.17
% Lime	68.50					68.50
% Dolomite	14.98					14.98
% Calcite	53.52					53.52
% OM	1.64					1.64

Appendix 8

Plant composition of the sedge–heath transition range type, showing percentage of ground covered for each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%.

Site no.	TR 8	TR 9	TR 10	TR 14	TR 28	TR 43	TR 44	TR 48	TR 50	TR 79	TR 84	TR 106		
m² plots	15	15	15	15	15	15	15	15	15	15	15	5		
Location	64°24′N 84°20′W	64°24′N 84°20′W	64°21′N 84°45′W	64°13′N 84°55′W	64°17′N 85°13′W	65°02′N 84°33′W	65°02′N 84°33′W	65°02′N 84°43′W	65°02′N 84°43′W	65°03′N 84°33′W	63°52′N 81°05′W	64°13′N 83°15′W	Con- stancy	Cover (grand mean)
Equisetum variegatum	0.2	0.2	1.0	1.0	1.1	0.2	1.7	0.6	0.6	0.4	0.7	1.0	V	0.7
Eriophorum spp.	<0.1	0.4		0.1	0.3	<0.1	0.1			0.0*	0.1	0.0	IV	0.1
Sedges and grasses	50.0	67.3	22.0	53.1	61.0	31.3	56.8	23.5	29.3	39.4	76.6	70.0	V	47.1
Tofieldia pusilla						0.1							I	<0.1
Salix spp. (0–5 cm)	5.4	2.2	2.0		1.5	4.3	6.9	1.0	3.0	5.8	1.6	0.0	V	3.0
Salix spp. (5–15 cm)	1.5	1.5	7.0	0.0	0.6	2.8	1.8	9.8	9.3			0.0	V	3.0
Salix spp. (15+ cm)					0.1								I	<0.1
Polygonum viviparum					0.2	0.5	0.3	0.1	0.0	0.9	0.4		IV	0.2
Stellaria longipes				<0.1									I	<0.1
Arenaria Rossii								<0.1	<0.1				II	<0.1
Melandrium apetalum				0.0									I	0.0

Appendix 8 cont'd

Site no.	TR 8	TR 9	TR 10	TR 14	TR 28	TR 43	TR 44	TR 48	TR 50	TR 79	TR 84	TR 106		
m² plots	15	15	15	15	15	15	15	15	15	15	15	5		Cover
Location	64°24'N 84°20'W	64°24'N 84°20'W	64°21'N 84°45'W	64°13'N 84°55'W	64°17'N 85°13'W	65°02'N 84°33'W	65°02'N 84°33'W	65°02'N 84°43'W	65°02'N 84°43'W	65°03'N 84°33'W	63°52'N 81°05'W	64°13'N 83°15'W	Con-stancy	(grand mean)
Ranunculus spp.					0.0								I	0.0
Eutrema Edwardsii			0.0	0.1									II	<0.1
Draba spp.	0.0		0.0	0.6	<0.1		0.0				<0.1		III	<0.1
Braya purpurascens	0.0						<0.1	0.2	<0.1	0.0	0.0	0.4	V	<0.1
Saxifraga aizoides						0.0	0.0		0.2				II	<0.1
Saxifraga Hirculus											0.1		I	<0.1
Saxifraga oppositifolia	0.1					3.5	1.3	1.5	1.0	2.3	0.0		IV	0.8
Dryas integrifolia	7.7	7.0	14.2	1.3	8.2	23.4	3.6	8.0	13.4	19.3	3.6		V	9.7
Oxytropis Maydelliana			0.4			1.8				0.4			II	0.2
Epilobium latifolium			2.3										I	0.0
Cassiope tetragona			2.5			3.0	0.0		0.6				III	0.5
Rhododendron lapponicum						0.4							I	<0.1
Vaccinium uliginosum			0.3			0.3							II	<0.1
Pedicularis capitata					0.4	0.2	<0.1	0.3	0.1	0.1			III	0.1
Pedicularis sudetica		0.5	0.8	0.0						0.0			III	0.1
Chrysanthemum integrifolium	<0.1		0.3	0.2		0.4	<0.1	0.7	<0.1	0.4			IV	0.2
Alectoria ochroleuca			0.5		0.0	0.0	<0.1		0.1				III	<0.1
Alectoria nigricans				0.0				0.0					II	0.0
Alectoria chalybeiformis			0.8			0.2	<0.1		<0.1				III	0.1
Cetraria nivalis	0.1	0.2	7.7	0.1	0.1	3.4	1.0	3.0	4.2	2.4	0.3		V	2.0
Cetraria cucullata	0.2	<0.1	2.7	0.0	<0.1	0.2	0.0	0.4	0.2	1.6			V	0.4
Cetraria islandica	0.2	<0.1	1.8	0.1	0.3	0.9	0.1	<0.1	1.0	0.1	0.0		V	0.4
Cetraria delisei								0.9	4.0				II	0.4
Cladonia gracilis				0.2	<0.1	0.0	0.0	0.1	0.0		0.0		IV	<0.1
Cladonia phyllophora			0.3	<0.1				0.1	0.2	0.0			III	<0.1
Cladonia uncialis			0.2										I	<0.1
Cladonia pyxidata							0.0	0.7	0.6	0.4			III	0.1
Cornicularia divergens			0.4	0.0	0.0	0.0	0.4						III	<0.1
Cornicularia aculeata						0.0	<0.1	0.0		<0.1			III	<0.1
Dactylina arctica			0.6	<0.1	<0.1	0.2	<0.1	0.0	1.0	<0.1	0.0		IV	0.1
Dactylina ramulosa			0.6			0.0	0.0		0.0				III	<0.1
Hypogymnia subobscura			0.2			0.1	<0.1						II	<0.1
Ochrolechia frigida			0.9			0.1	<0.1	<0.1	0.0	0.0			III	0.1
Parmelia omphalodes			0.2			0.0			0.1				II	<0.1
Thamnolia vermicularis		<0.1	1.4	<0.1	<0.1	0.9		0.6	0.5	0.5			IV	0.4
Other lichens	0.1		1.1	0.0	0.0	2.4	0.0	0.8	1.2	0.2			IV	0.5
Mosses	3.0	10.2	11.6	53.6	15.3	2.5	6.3	6.4	9.3	20.0	69.6	8.0	V	18.6
Debris	8.6	2.6	14.6	13.6	4.0	4.3	7.8	6.6	6.8	8.6	6.4	9.0	V	7.7
Rock and bare ground	34.3	23.6	17.4	4.3	42.6	24.8	38.0	45.5	38.4	30.8	15.5	40.0	V	30.0
Water		5.0			15.4						7.2		II	2.3

*Present within m² plots but not within 0.1 m² Daubenmire frame.

Appendix 9

Soil analyses for the sedge–heath transition range type

	Site no.					
	TR 8	TR 9	TR 10	TR 14	TR 28	$\bar{x}$
Date collected	11/7/70	11/7/70	12/7/70	20/7/70	30/7/70	
Location	64°24′N 84°20′W	64°24′N 84°20′W	64°21′N 84°45′W	64°13′N 84°55′W	64°17′N 85°03′W	
Elevation, meters a.s.l.	120	120	105	120	105	
Land form	flat tundra	flat tundra	hummocky tundra	flat tundra	hummocky tundra	
Slope gradient	nil	nil	nil	nil	nil	
Drainage	poor	poor	poor	poor	poor	
Soil pit depth, cm	31	36	40	32	42	
Root depth, cm	31	26	30	32	42	
Chemical analyses						
Horizon A						
Width, cm	7	5	7	32+	20	
1:1 pH in H_2O	7.02	7.28	7.14	6.81	7.68	7.18
1:1 pH in 0.01M $CaCl_2$	6.69	7.04	6.82	6.52	7.15	6.84
Total % C	15.42	18.64	8.71	40.70	14.30	19.55
% Lime					9.63	9.63
% Dolomite					4.05	4.05
% Calcite					5.58	5.58
% OM	26.58	32.14	15.02	70.17	22.65	33.31
Horizon B						
Width, cm	24+	8	9		22+	
1:1 pH in H_2O	7.56	8.01	8.22		8.30	8.02
1:1 pH in 0.01M $CaCl_2$	7.29	7.42	7.59		7.43	7.43
Total % C	1.94	3.74	2.80		6.38	3.71
% Lime	13.00	24.25	22.00		47.50	26.60
% Dolomite	12.90	22.20	4.15		14.40	13.41
% Calcite	0.10	2.05	17.25		33.10	13.12
% OM	0.66	1.43	0.28		1.17	0.88
Horizon C						
Width, cm		23+	24+			
1:1 pH in H_2O		8.26	8.23			8.24
1:1 pH in 0.01M $CaCl_2$		7.72	7.59			7.65
Total % C		4.99	1.88			3.43
% Lime		36.50	13.50			25.00
% Dolomite		36.50	5.00			20.75
% Calcite		0.00	8.50			4.25
% OM		1.05	0.45			0.75

Appendix 10

Plant composition of the sedge–willow meadow range type, showing percentage of ground covered for each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%

Site no.	TR 32	TR 36	TR 71	TR 78	TR 102	TR 103	TR 104	TR 107	TR 111	TR 112	TR 113		
m^2 plots	15	15	15	15	12	15	6	15	15	10	13		
Location	64°24′N 84°44′W	64°13′N 85°02′W	65°02′N 84°33′W	65°12′N 84°40′W	64°12′N 83°22′W	64°12′N 83°23′W	64°12′N 83°30′W	64°11′N 83°20′W	64°08′N 83°24′W	64°11′N 83°16′W	64°08′N 83°15′W	Constancy	Cover (grand mean)
Equisetum variegatum	0.4	1.0	0.1	0.5	1.0	1.0	1.0	1.0	0.3	0.8	0.6	V	0.7
Eriophorum spp.	0.3	0.0*	0.2	<0.1								III	<0.1
Sedges and grasses	62.6	62.9	70.5	23.6	71.2	72.6	35.0	55.3	38.0	75.0	49.1	V	56.4

Appendix 10 cont'd

Site no.	TR 32	TR 36	TR 71	TR 78	TR 102	TR 103	TR 104	TR 107	TR 111	TR 112	TR 113		
m² plots	15	15	15	15	12	15	6	15	15	10	13		Cover
Location	64°24′N 84°44′W	64°13′N 85°02′W	65°02′N 84°33′W	65°12′N 84°40′W	64°12′N 83°22′W	64°12′N 83°23′W	64°12′N 83°30′W	64°11′N 83°20′W	64°08′N 83°24′W	64°11′N 83°16′W	64°08′N 83°15′W	Constancy	(grand mean)
Tofieldia pusilla				0.0			0.0					II	0.0
Salix spp. (0–5 cm)	0.6	5.5	9.2	15.5	0.9	2.5	0.0	3.6	7.0	0.3	3.5	V	4.9
Salix spp. (5–15 cm)	0.6	1.0		8.6			9.6	25.8				III	4.1
Salix spp. (15 + cm)	38.3	6.3			20.4	5.1			20.4	2.7	35.6	IV	12.2
Polygonum viviparum	0.6	0.2	0.2	0.8	0.0	0.2	0.5	0.2	0.2		0.2	V	0.3
Silene acaulis				0.1								I	<0.1
Melandrium apetalum											0.1	I	<0.1
Eutrema Edwardsii				0.0				<0.1				I	<0.1
Cardamine pratensis											0.0	I	0.0
Draba spp.		0.2	0.2		0.0			<0.1	<0.1			III	<0.1
Braya purpurascens							0.0	0.0				II	0.0
Saxifraga aizoides							0.0					I	0.0
Saxifraga cernua				0.8								I	<0.1
Saxifraga Hirculus			0.4	0.2					0.1	0.0	0.5	III	0.1
Saxifraga oppositifolia	0.0			0.0			0.0					II	0.0
Chrysosplenium tetrandum											0.3	I	<0.1
Dryas integrifolia	0.3	4.4	4.0	4.0		2.1	6.6	0.2	0.4	0.0	4.0	V	2.2
Oxytropis Maydelliana			0.0									I	0.0
Cassiope tetragona				0.0			1.6					II	<0.1
Vaccinium uliginosum							0.0					I	0.0
Pedicularis capitata			0.0	0.0								II	0.0
Pedicularis sudetica		0.1	0.7			1.6		0.4	0.0	1.8	0.0	IV	0.4
Chrysanthemum integrifolium							0.1					I	<0.1
Alectoria ochroleuca			0.0				0.5					II	<0.1
Alectoria nigricans							0.0					I	0.0
Alectoria chalybeiformis									0.0			I	0.0
Cetraria nivalis			0.3	0.2	0.0	<0.1	5.0	0.0			0.0	IV	0.3
Cetraria cucullata			0.0	0.0		<0.1	0.8	<0.1			0.0	IV	<0.1
Cetraria islandica			<0.1	0.1		0.0	0.8					III	<0.1
Cetraria delisei				2.8								I	0.2
Cladina rangiferina							0.0					I	0.0
Cladonia phyllophora							0.0					I	0.0
Cladonia pleurota									0.0			I	0.0
Cladonia pyxidata				0.0			0.5	0.0	0.4		0.7	III	0.1
Cornicularia divergens			0.0				0.3					II	<0.1
Dactylina arctica			0.0	0.1			0.1		0.0			III	<0.1
Hypogymnia subobscura							0.0					I	0.0
Ochrolechia frigida							0.0					I	0.0
Parmelia omphalodes							0.0					I	0.0
Peltigera sp.									0.0			I	0.0
Sphaerophorus globosus							0.1					I	<0.1
Thamnolia vermicularis			<0.1	0.2			0.1					II	<0.1
Other lichens		1.1							0.0			II	0.0
Mosses	57.6	69.6	89.3	70.3	44.1	73.6	11.6	57.3	38.3	24.0	54.6	V	57.6
Debris	33.3	8.6	2.2	15.3	27.6	23.3	14.1	39.6	30.6	30.5	27.3	V	23.1
Rock and bare ground	2.0	7.0		4.6	0.8	0.3	42.4	6.2	8.6	31.5	3.0	V	7.2
Water	5.3		6.4	2.3	0.4				6.6			III	2.1

*Present within m² plots but not within 0.1 m² Daubenmire frame.

Appendix 11

Soil analyses for the sedge–willow meadow range type

	Site no.		
	TR 32	TR 36	$\bar{x}$
Date	1/8/70	8/8/70	
Location	64°24′N 84°44′W	64°13′N 85°02′W	
Elevation meters a.s.l.	105	105	
Land form	flat tundra	flat tundra	
Slope gradient	nil	nil	
Drainage	poor	poor	
Soil pit depth, cm	36	30	
Root length, cm	36+	30+	
Chemical analyses			
Horizon A			
Width, cm	15	10	
1:1 pH in H_2O	6.67	7.23	6.95
1:1 pH in 0.01M $CaCl_2$	6.32	6.87	6.59
Total % C	23.89	29.24	26.56
% Lime			
% Dolomite			
% Calcite			
% OM	41.19	50.41	45.80
Horizon B			
Width, cm	30+	20+	
1:1 pH in H_2O	7.99	8.32	8.15
1:1 pH in 0.01M $CaCl_2$	7.42	7.69	7.55
Total % C	0.91	38.29	19.60
% Lime	5.00	58.60	31.80
% Dolomite	1.50	16.50	9.00
% Calcite	3.50	42.10	22.80
% OM	0.53	53.89	27.21

Appendix 12

Plant composition of the sedge–willow bog range type, showing percentage of ground covered for each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%

Site no.	TR 17	TR 21	TR 47	TR 109		
m^2 plots	15	15	15	10		Cover
Location	64°16′N 84°42′W	64°12′N 84°48′W	65°03′N 84°33′W	64°15′N 83°17′W	Constancy	(grand mean)
Equisetum variegatum	0.4	1.0		0.3	II	0.4
Eriophorum spp.	4.0	1.5	0.1	0.3	V	1.6
Sedges and grasses	51.3	61.6	59.8	41.5	V	54.6
Salix spp. (0–5 cm)	2.2	0.7	9.4	0.0*	V	3.3
Salix spp. (5–15 cm)	0.6	0.7	3.6	1.1	V	1.5
Polygonum viviparum	0.0	0.1	0.4		IV	0.1
Melandrium apetalum			<0.1		II	<0.1
Draba spp.	0.0				II	0.0
Saxifraga aizoides				0.0	II	0.0
Saxifraga oppositifolia			0.1	0.0	III	<0.1
Dryas integrifolia	0.0		3.3		III	0.9
Pedicularis capitata			0.0		II	0.0
Pedicularis sudetica	1.8	0.5	0.1	0.8	V	0.8
Cetraria nivalis			0.0		II	0.0
Cetraria cucullata			<0.1		II	<0.1
Cladonia pyxidata			<0.1		II	<0.1
Mosses	51.3	3.3	30.6	5.5	V	24.2
Debris	15.3		8.5	5.2	IV	7.4
Rock and bare ground	6.0	70.0	1.1	67.5	V	33.3
Water	51.3	42.3	17.8	28.0	V	35.4

*Present within m^2 plots but not within 0.1 m^2 Daubenmire frame.

Appendix 13

Plant composition of the lichen–heath felsenmeer plateau range type, showing percentage of ground covered for each species or group of species. Constancy values: I = 0–15%: II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%

Site no.	TR 4	TR 5	TR 59	TR 60	TR 66	TR 96		
m² plots	15	15	15	15	15	15		
Location	64°25′N 84°25′W	64°25′N 84°25′W	65°02′N 84°37′W	65°02′N 84°37′W	65°02′N 84°36′W	64°32′N 83°25′W	Constancy	Cover (grand mean)
Lycopodium Selago						0.4	II	<0.1
Sedges and grasses	5.3	8.9	5.4	3.3	6.8	15.5	V	7.5
Salix spp. (0–5 cm)		0.2	3.1	2.0	3.3	4.2	V	2.1
Oxyria digyna					<0.1		II	<0.1
Polygonum viviparum			0.5	0.2	0.4		III	0.2
Cerastium alpinum			0.0*	0.0			III	0.0
Arenaria Rossii			0.1	<0.1			III	<0.1
Silene acaulis			0.1	0.5	0.3		III	0.1
Papaver radicatum				0.0			II	0.0
Eutrema Edwardsii					0.0		II	0.0
Saxifraga oppositifolia			2.6	0.6	0.4		III	0.6
Astragalus alpinus			0.4	0.0	<0.1		III	<0.1
Dryas integrifolia			15.8	8.8	18.5		III	7.2
Oxytropis Maydelliana			0.6	0.3	1.2		III	0.3
Oxytropis arctobia					0.1		II	<0.1
Ledum decumbens	2.6	1.3				0.1	III	0.6
Cassiope tetragona	16.4	20.0	3.3	17.3	22.7	15.0	V	15.8
Vaccinium uliginosum					0.2	1.0	III	0.2
Vaccinium Vitis-idaea	4.7	5.0					III	1.6
Pedicularis capitata					0.0		II	0.0
Pedicularis lanata			0.0	0.0			III	0.0
Chrysanthemum integrifolium			0.2				II	<0.1
Alectoria ochroleuca	10.8	9.8	1.3	3.7	2.8	6.3	V	5.8
Alectoria nigricans	2.7	7.8	0.5	1.4	1.2	0.8	V	2.4
Alectoria chalybeiformis	9.2		1.0	0.8	0.6	3.6	V	2.5
Cetraria nivalis	7.8	6.8	3.1	5.2	8.2	5.6	V	6.1
Cetraria cucullata	2.4	<0.1	0.9	1.0	1.4	1.2	V	1.1
Cetraria islandica	0.8	3.4	1.2	1.4	2.3	5.0	V	2.3
Cetraria nigricans	0.6	<0.1			0.0	0.2	IV	0.1
Cetraria delisei			0.1	0.1	0.0	1.0	IV	0.2
Cladina rangiferina	0.0	2.0		0.7	0.6	3.2	V	1.1
Cladina mitis	0.1	0.5	0.0	0.6	0.4	4.8	V	1.1
Cladonia gracilis	0.6	1.0	<0.1	0.6	0.7	0.6	V	0.6

cont'd

Appendix 13 cont'd

	Site no.	TR 4	TR 5	TR 59	TR 60	TR 66	TR 96		
	m² plots	15	15	15	15	15	15		Cover
	Location	64°25′N 84°25′W	64°25′N 84°25′W	65°02′N 84°37′W	65°02′N 84°37′W	65°02′N 84°36′W	64°32′N 83°25′W	Constancy	(grand mean)
Cladonia deformis		0.5	0.6		0.6	0.4	0.6	V	0.4
Cladonia phylliophora		0.3	0.6		<0.1	0.4	0.2	V	0.2
Cladonia subcervicornis		0.2						II	<0.1
Cladonia macrophylla		<0.1	<0.1					III	<0.1
Cladonia uncialis			0.5		0.4	0.1	0.8	IV	0.3
Cladonia pyxidata			0.2	<0.1	0.0			III	<0.1
Cornicularia divergens		4.0	6.3	0.4	0.5	0.6	3.4	V	2.4
Cornicularia aculeata		0.0		0.5	0.4	0.1		IV	0.1
Dactylina arctica		0.3	0.5	0.0	0.6	1.3	1.2	V	0.6
Dactylina ramulosa		0.0	0.5	0.2	0.2	<0.1		V	0.1
Hypogymnia subobscura		0.4	0.1	0.4	0.9	0.4	0.1	V	0.4
Ochrolechia frigida		2.2	0.8	0.5	0.8	0.8		V	0.8
Parmelia omphalodes		1.0	0.8	0.1	0.3	0.6		V	0.4
Peltigera sp.					0.0	<0.1		III	<0.1
Sphaerophorus globosus		8.9	8.7	0.0	1.1	1.4	6.0	V	4.3
Stereocaulon alpinum							0.2	II	<0.1
Thamnolia vermicularis		0.4	0.2	1.0	0.8	0.9	0.6	V	0.6
Other lichens		5.6	1.2	3.4	1.7	1.8	3.1	V	2.8
Mosses		2.2	16.1	3.0	15.2	14.3	19.4	V	11.7
Debris				2.8	3.8	5.4	2.4	IV	2.4
Rock and bare ground		30.6	20.6	61.0	44.0	29.3	9.5	V	32.9

*Present within m² plots but not within 0.1 m² Daubenmire frame.

Appendix 14
Plant composition of the two subtypes within the lichen-heath felsenmeer lowland range type, showing percentage of ground covered for each species or group of species.
Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%

		Hudson Bay Lowlands									South Bay Lowland				
	Site no.	TR 23	TR 29	TR 34	TR 40	TR 56	TR 81	TR 82			TR 92	TR 99	TR 100		
	m² plots	15	15	15	15	15	15	15		Cover	15	15	15		Cover
	Location	64°14′N 84°44′W	64°17′N 84°56′W	64°12′N 84°44′W	65°02′N 84°33′W	65°02′N 84°33′W	65°02′N 84°33′W	63°53′N 81°03′W	Constancy	(grand mean)	64°15′N 82°38′W	64°13′N 83°55′W	64°13′N 83°55′W	Constancy	(grand mean)
Woodsia glabella						0.0*			I	0.0					
Equisetum variegatum		0.1							I	<0.1					
Lycopodium Selago				0.0					I	0.0					
Sedges and grasses		19.2	18.2	37.6	20.2	12.8	26.1	2.5	V	19.5	12.1	7.6	5.6	V	8.4
Tofieldia pusilla						0.1			I	<0.1					
Salix spp. (0–5 cm)		2.1	0.0	2.0	1.0	0.8	1.5	0.0	V	1.0	5.8	4.4	2.1	V	4.1
Salix spp. (5–15 cm)		3.6							I	0.5		2.6		III	0.8
Oxyria digyna				0.3				0.2	II	<0.1		<0.1		III	<0.1
Polygonum viviparum		0.8	0.4	0.7	1.8	1.6	0.6		V	0.8	0.3	0.4	0.2	V	0.3
Stellaria longipes											0.6		0.0	IV	0.2
Silene acaulis		0.4	0.0	0.0	0.1	0.2	0.1	0.0	V	0.1	0.2	0.0		IV	<0.1
Draba spp.		0.1	0.0	0.0				0.0	IV	<0.1					
Braya purpurascens		<0.1		0.1					II	<0.1					
Saxifraga cernua								0.0	I	0.0					
Saxifraga oppositifolia		1.1	2.0	1.8	0.0	0.8	1.3	2.5	V	1.3		0.3	0.0	IV	0.1

Appendix 14 cont'd

	Hudson Bay Lowlands									South Bay Lowland				
Site no.	TR 23	TR 29	TR 34	TR 40	TR 56	TR 81	TR 82			TR 92	TR 99	TR 100		
m² plots	15	15	15	15	15	15	15			15	15	15		
Location	64°14′N 84°44′W	64°17′N 84°56′W	64°12′N 84°44′W	65°02′N 84°33′W	65°02′N 84°33′W	65°02′N 84°33′W	63°53′N 81°03′W	Con-stancy	Cover (grand mean)	64°15′N 82°38′W	64°13′N 83°55′W	64°13′N 83°55′W	Con-stancy	Cover (grand mean)
Saxifraga tricuspidata										<0.1			III	<0.1
Dryas integrifolia	18.8	27.0	21.0	14.1	31.8	22.3	19.6	V	22.0	1.8	31.3	6.2	V	13.1
Astragalus alpinus	0.5		<0.1		0.8	0.0		IV	0.1		0.4		III	0.1
Oxytropis Maydelliana		<0.1	0.6	1.0	3.2	1.7		IV	0.9	4.8	0.6	1.3	V	2.2
Oxytropis arctobia					1.0			I	<0.1					
Epilobium latifolium	0.3		0.2					II	<0.1					
Ledum decumbens	0.0							I	<0.1					
Cassiope tetragona	7.8	8.6	3.6	0.8	1.0	5.7	3.0	V	4.3	1.6	15.0	13.3	V	9.9
Rhododendron lapponicum	0.0	1.9	0.6	0.3		5.6		IV	1.2					
Vaccinium uliginosum	0.6	1.4	2.5	1.6	0.6	1.4		V	1.1	<0.1		1.6	IV	0.5
Vaccinium Vitis-idaea	1.8							I	0.2	3.2	0.4	1.8	V	1.8
Pedicularis capitata	0.4	<0.1	0.2	0.2	0.2	0.1		V	0.1		0.2		III	<0.1
Chrysanthemum integrifolium	0.1	0.1	0.7			0.1	0.0	IV	0.1					
Alectoria ochroleuca	0.8	2.5	1.2	2.1	2.6	3.9	0.7	V	1.9	1.8	6.6	14.1	V	7.5
Alectoria chalybeiformis				4.9	5.4	3.6	0.1	IV	2.0	14.6	0.9	2.9	V	6.1
Alectoria nigricans	0.8	3.8	0.6	1.3	0.6	1.1	0.2	V	1.2	4.0	1.1	2.4	V	2.5
Cetraria nivalis	7.4	8.6	12.8	7.5	11.6	11.6	9.6	V	9.8	8.6	13.4	14.6	V	12.2
Cetraria cucullata	1.0	<0.1	1.6	3.8	2.2	1.0	<0.1	V	1.5	6.6	4.8	6.4	V	5.9
Cetraria islandica	1.9	1.8	2.8	1.2	1.5	1.0	0.4	V	1.5	2.0	3.8	2.4	V	2.7
Cetraria delisei	3.2	0.2	5.5			0.0	0.8	IV	1.3	0.6	2.4	0.0	V	1.0
Cetraria nigricans	<0.1	0.2	0.0	0.0	0.1	0.0		V	<0.1	<0.1		<0.1	IV	<0.1
Cetraria tilesii		0.2	0.2					II	<0.1					
Cladina rangiferina	<0.1	0.1	0.4	0.8	<0.1			IV	0.2	0.0	<0.1	4.0	V	1.3
Cladina mitis	<0.1	0.2	0.2	0.4	0.3	0.0	0.0	V	0.1	0.0	0.6	0.4	V	0.3
Cladonia gracilis	0.5	0.4	0.2	0.4	0.7	0.1		V	0.3	0.5	0.0	0.4	V	0.3
Cladonia uncialis	0.8	0.5	<0.1		0.2			IV	0.2	1.2	<0.1	0.2	V	0.4
Cladonia subcervicornis	<0.1			0.4				II	<0.1					
Cladonia phyllophora	0.6	0.4	0.6	0.0	0.5			IV	0.3					
Cladonia amaurocraea	0.1	0.1	0.4					III	<0.1					
Cladonia pyxidata	<0.1					0.1		II	<0.1		0.0		III	0.0
Cladonia deformis		<0.1	0.0	0.5	0.3			IV	0.1	0.3		0.6	IV	0.3
Cornicularia divergens	0.8	0.4	0.4	2.7	2.1	0.9	0.5	V	1.1	4.2	5.6	6.8	V	5.5
Cornicularia aculeata	0.6	0.3	<0.1	0.7	0.7	0.3	<0.1	V	0.3					
Dactylina arctica	0.7	0.9	1.5	0.6	0.7	1.2	0.0	V	0.8	0.6	0.8	1.1	V	0.8
Dactylina ramulosa	0.0	<0.1	0.0	0.0										
Hypogymnia subobscura	0.0	0.7	0.4	1.6	1.7	0.8		V	0.7	1.1	0.0	0.0	V	0.3
Ochrolechia frigida	0.6	0.9	0.8	0.7	3.7	<0.1	0.4	V	1.0		0.3	<0.1	IV	0.1
Parmelia omphalodes	<0.1	0.4	0.3	2.3	1.6	0.7		V	0.7	2.1			III	0.7
Peltigera sp.					0.0			I	0.0	0.2		0.0	IV	<0.1
Sphaerophorus globosus	0.6	0.4	0.3	2.0	2.0		0.0	V	0.7	10.6	1.0	4.3	V	5.3
Stereocaulon alpinum										0.8		0.1	IV	0.3
Thamnolia vermicularis	0.9	1.6	1.8	1.2	1.0	0.9	0.8	V	1.1	0.9	1.2	0.8	V	0.9
Other lichens	0.3	1.0	1.5	2.8	0.0	3.2	2.2	V	1.5	4.2	2.4	1.7	V	2.7
Mosses	16.0	7.8	10.8	6.6	11.6	2.2	3.1	V	8.3	4.2	13.1	40.3	V	19.2
Debris	7.0		1.9	3.5	2.8	4.0	2.0	V	3.0	8.0	3.6	2.8	V	4.8
Rock and bare ground	22.3	29.9	27.0	25.7	11.9	28.1	57.9	V	28.9	24.1	13.8	9.3	V	15.7
Water	0.5							I	<0.1					

*Present within m² plots but not within 0.1 m² Daubenmire frame.

Appendix 15

Soil analyses for the lichen–heath felsenmeer lowland range type

	Site no.			
	TR 23	TR 29	TR 34	$\bar{x}$
Date	25/7/70	31/7/70	4/8/70	
Location	64°14′N 84°44′W	64°17′N 84°56′W	64°12′N 84°44′W	
Elevation, meters a.s.l.	105	120	120	
Land form	gneiss outcrop	gneiss outcrop	gneiss outcrop	
Slope gradient	5°W	nil	5°W	
Drainage	fair	good	good	
Soil pit depth, cm	36	28	44	
Root length, cm	36	28	25	
Chemical analyses				
Horizon A				
Width, cm	12	28	14	
1:1 pH in H_2O	7.43	7.06	7.47	7.32
1:1 pH in 0.01M $CaCl_2$	7.09	7.04	7.14	7.09
Total % C	8.66	10.34	11.44	10.14
% Lime		10.25		10.25
% Dolomite		2.63		2.63
% Calcite		7.62		7.62
% OM	14.93	15.71	19.72	16.78
Horizon B				
Width, cm	24		30+	
1:1 pH in H_2O	7.58		8.48	8.03
1:1 pH in 0.01M $CaCl_2$	7.36		7.70	7.53
Total % C	4.74		7.35	6.04
% Lime	30.00		60.50	45.25
% Dolomite	9.20		9.80	9.50
% Calcite	20.80		50.70	35.75
% OM	1.97		0.16	1.06

Appendix 16

Plant composition of the lichen–heath alluvial shingle range type, showing percentage of ground covered for each species or group of species. Constancy values: I = 0–15%; II = 16–30%; III = 31–50%; IV = 51–80%; V = 81–100%

	Site no.	TR 11	TR 86	TR 87	TR 88	TR 89	TR 95		
	m² plots	15	15	15	15	12	15		Cover
	Location	64°21′N 84°45′W	64°40′N 84°14′W	64°40′N 84°14′W	64°40′N 84°14′W	64°40′N 84°14′W	64°16′N 82°52′W	Constancy	(grand mean)
Equisetum variegatum							0.0*	II	0.0
Sedges and grasses		3.1	3.6	6.4	15.8	19.2	10.2	V	9.4
Tofieldia pusilla					0.0			II	0.0
Salix spp. (0–5 cm)		0.0	0.5	1.4	3.3	0.0	1.5	V	1.1
Polygonum viviparum					0.3	0.1	0.8	III	0.2
Stellaria longipes						<0.1		II	<0.1
Cerastium alpinum						0.0		II	0.0
Silene acaulis		0.1				<0.1	0.2	III	<0.1
Braya purpurascens			<0.1	0.0				III	<0.1
Saxifraga oppositifolia		2.0					0.1	III	<0.1
Saxifraga tricuspidata					0.0	0.0		III	0.0

Appendix 16 cont'd

Site no.	TR 11	TR 86	TR 87	TR 88	TR 89	TR 95		
m² plots	15	15	15	15	12	15		Cover
Location	64°21′N 84°45′W	64°40′N 84°14′W	64°40′N 84°14′W	64°40′N 84°14′W	64°40′N 84°14′W	64°16′N 82°52′W	Constancy	(Grand mean)
Dryas integrifolia	0.6				3.3	17.8	III	3.6
Oxytropis Maydelliana						1.2	II	0.2
Empetrum nigrum	12.4			1.6	2.0		III	2.7
Ledum decumbens	0.2			0.0			III	<0.1
Cassiope tetragona	9.0	20.9	15.0	3.0	5.5	9.0	V	10.5
Rhododendron lapponicum				0.0	1.4	1.8	III	0.5
Vaccinium uliginosum	0.6	0.4	•	6.0		8.6	IV	2.7
Vaccinium Vitis-idaea	13.6		<0.1	9.8	5.9		IV	4.8
Diapensia lapponica	0.8				0.0		III	0.1
Armeria maritima					0.2	0.0	III	<0.1
Pedicularis lanata						0.1	II	<0.1
Campanula uniflora					<0.1		II	<0.1
Antennaria angustata					0.0		II	0.0
Alectoria ochroleuca	5.9	17.2	11.2	7.8	9.3	5.0	V	9.4
Alectoria chalybeiformis	15.0	24.7	1.6	42.0	24.1	4.9	V	18.5
Alectoria nigricans		1.5	1.0	2.5		2.4	IV	1.2
Cetraria nivalis	10.5	13.3	17.1	9.2	7.8	27.4	V	14.4
Cetraria cucullata	12.8	4.3	6.6	13.4	11.5	10.7	V	9.8
Cetraria islandica	0.8	1.9	3.9	1.0	0.0	2.0	V	1.6
Cetraria nigricans	0.5	0.5	1.2	0.3	<0.1		V	0.4
Cetraria delisei		<0.1	0.7			0.9	III	0.2
Cetraria tilesii						0.0	II	0.0
Cladina rangiferina	0.4	0.2	0.3				III	0.1
Cladina mitis	1.0	1.7	0.7	1.2	2.5	<0.1	V	1.1
Cladonia gracilis	1.9	2.2	1.2	1.2	1.1	0.0	V	1.2
Cladonia uncialis	1.0	0.8	0.2	0.2	2.5	<0.1	V	0.7
Cladonia subcervicornis	0.1	0.7					III	0.1
Cladonia deformis	0.2	1.0	0.6	0.4	0.6		V	0.5
Cladonia macrophylla	<0.1						II	<0.1
Cladonia phyllophora	0.8						II	0.1
Cladonia amaurocraea	0.6	<0.1	<0.1				III	0.1
Cladonia pyxidata				0.8		0.1	II	0.1
Cornicularia divergens	10.6	4.1	14.1	11.0	12.5	4.0	V	9.2
Cornicularia aculeata				0.1		0.4	III	<0.1
Dactylina arctica	1.2	1.2	1.4	0.6	0.2	2.6	V	1.2
Dactylina ramulosa	1.4	<0.1				0.5	III	0.3
Evernia mesomorpha					0.6		II	<0.1
Hypogymnia subobscura	0.6	0.5	0.1	0.4	0.9	1.0	V	0.6
Ochrolechia frigida	0.8	0.8	0.8			<0.1	IV	0.4
Parmelia omphalodes	0.6	0.2			0.3	2.4	IV	0.6
Peltigera sp.		0.4	0.1	0.2			III	0.1
Sphaerophorus globosus	5.2	19.8	17.6	11.0	5.0	1.6	V	10.2
Stereocaulon alpinum	1.0	0.3	2.1	0.4	0.6		V	0.7
Thamnolia vermicularis	1.7	0.2	0.3	1.0	1.1	2.0	V	1.0
Other lichens	0.9	2.4	2.8	1.1	3.2	1.2	V	1.8
Mosses	8.4	6.1	9.2	14.0	6.8	4.4	V	8.2
Debris		2.6	3.2	3.8	3.9		IV	2.2
Rock and bare ground		1.4	4.8		0.6	1.2	IV	1.3

• Present within m² plots but not within 0.1 m² Daubenmire frame.

Appendix 17

Plant composition of an esker, showing percentage of ground covered for each species or group of species

		North slope	Crest	South slope
	Site no.	TR 12	TR 12	TR 12
	m² plots	5	3	7
	Location	64°15′N 84°55′W	64°15′N 84°55′W	64°15′N 84°55′W
Sedges and grasses		4.0	1.6	5.7
Salix spp. (0–5 cm)		1.4		0.7
Saxifraga cernua		0.2		
Dryas integrifolia		25.6	0.6	39.2
Cassiope tetragona		11.0		9.2
Pedicularis capitata		0.2		
Alectoria ochroleuca		1.0		0.4
Alectoria chalybeiformis		3.4	0.6	3.5
Alectoria nigricans		4.0	0.3	1.4
Cetraria nivalis		7.0	20.0	18.5
Cetraria cucullata		1.4		11.1
Cetraria islandica		2.4	0.3	2.8
Cetraria ericetorum				0.1
Cladina rangiferina		0.2		0.1
Cladina mitis				0.1
Cladonia gracilis		0.4		0.2
Cladonia uncialis		0.2		0.2
Cladonia amaurocraea		0.2		
Cladonia phyllophora		0.2		0.1
Cladonia pyxidata		0.2	0.1	0.1
Cornicularia divergens		0.8	0.3	7.5
Cornicularia aculeata		0.2	0.3	0.5
Dactylina arctica		1.6		1.8
Hypogymnia enteromorpha		0.6	0.1	0.5
Hypogymnia subobscura		0.4	0.3	0.7
Nephroma expallidum				0.1
Ochrolechia frigida		0.2	0.1	0.4
Parmelia omphalodes		0.2	0.6	0.8
Sphaerophorus globosus		0.4		
Thamnolia vermicularis		2.2	0.6	1.1
Other lichens		0.2		0.2
Mosses		42.0	6.0	18.1
Rock and bare ground		9.0	68.3	0.1

Appendix 18

Plant composition of a moss-sedge-lichen meadow and a late snow bed, showing percentage of ground covered for each species or group of species

		Moss-sedge-lichen meadow	Late snow bed	
	Vegetation type		Upper portion	Lower portion
	Site no.	TR 55	TR 76	TR 77
	m² plots	15	14	6
	Location	65°02′N 80°40′W	65°03′N 84°40′W	65°03′N 84°40′W
Woodsia glabella			<0.1	
Sedges and grasses		25.8	12.3	9.8
Salix spp. (0–5 cm)		12.8	3.8	10.0

Appendix 18 cont'd

Vegetation type	Moss-sedge-lichen meadow	Late snow bed: Upper portion	Late snow bed: Lower portion
Site no.	TR 55	TR 76	TR 77
m² plots	15	14	6
Location	65°02'N 80°40'W	65°03'N 80°40'W	65°03'N 84°40'W
Oxyria digyna		0.1	5.0
Polygonum viviparum	2.6	0.7	1.6
Stellaria longipes	1.2		
Cerastium alpinum	0.3		
Silene acaulis		0.0*	0.0
Melandrium apetalum	0.0		
Ranunculus pedatifidus	2.8		0.0
Draba spp.	0.2		0.0
Saxifraga cernua	0.0		0.6
Saxifraga oppositifolia		0.1	0.0
Saxifraga tricuspidata	0.0	0.0	
Dryas integrifolia	7.6	23.9	
Astragalus alpinus	0.0	<0.1	
Oxytropis Maydelliana	0.8	3.8	
Oxytropis arctobia		<0.1	
Epilobium latifolium	0.0	0.0	
Cassiope tetragona		29.5	0.0
Arctostaphylos rubra	1.3		
Vaccinium uliginosum		0.7	
Armeria maritima	0.0		
Pedicularis capitata	0.4	0.7	0.8
Pedicularis lanata	0.0		0.0
Campanula uniflora	0.8		0.1
Chrysanthemum integrifolium	0.0		
Taraxacum lacerum	0.0		
Alectoria ochroleuca	0.2	0.0	
Alectoria chalybeiformis	0.1	0.8	
Alectoria nigricans	0.0	0.0	
Cetraria nivalis	0.6	9.2	0.1
Citraria cucullata	5.5	4.7	
Cetraria islandica	4.6	5.4	
Cetraria delisei		0.5	
Cladina mitis		0.3	
Cladonia gracilis		0.2	
Cladonia deformis		0.0	
Cladonia ecmocyna	1.2		
Cladonia phyllophora	0.2	<0.1	
Cladonia pyxidata		0.5	
Cornicularia divergens	0.1	0.3	
Cornicularia aculeata	<0.1	0.4	
Dactylina arctica	0.6	0.3	
Dactylina ramulosa		0.3	
Hypogymnia subobscura	0.1	0.1	
Ochrolechia frigida		0.0	
Parmelia omphalodes	0.4	0.2	
Peltigera sp.	6.5	0.1	

cont'd

Appendix 18 cont'd

Vegetation type	Moss-sedge-lichen meadow	Late snow bed Upper portion	Late snow bed Lower portion
Site no.	TR 55	TR 76	TR 77
m² plots	15	14	6
Location	65°02'N 80°40'W	65°03'N 80°40'W	65°03'N 84°40'W
Sphaerophorus globosus		<0.1	
Stereocaulon alpinum		0.5	
Thamnolia vermicularis	0.6	0.7	0.1
Other lichens	0.2	1.1	1.0
Mosses	44.6	9.1	31.6
Debris	9.2	3.4	39.6
Rock and bare ground	0.8	13.9	.75

* Present within m² plots but not within Daubenmire frame.

Appendix 19

Plants collected on Southampton Island, in 1970 and 1971

Lichens

Cladina rangiferina (L.) Harm.
Cladina mitis (Sandst.) Hale & W. Culb.
Cladonia subcervicornis (Vain.) Kernst.
Cladonia gracilis (L.) Willd.
Cladonia amaurocraea (Flörke) Schaer.
Cladonia phyllophora Hoffm.
Cladonia uncialis (L.) Wigg.
Cladonia deformis (L.) Hoffm.
Cladonia pyxidata (L.) Hoffm.
Cladonia ecmocyna (Ach.) Nyl.
Cladonia pleurota (Flörke) Schaer.
Cladonia squamosa (Scop.) Hoffm.
Cladonia macrophylla (Schaer.) Stenham.
Cetraria nivalis (L.) Ach.
Cetraria tilesii Ach.
Cetraria cucullata (Bell.) Ach.
Cetraria islandica (L.) Ach.
Cetraria delisei (Bory) Th. Fr.
Cetraria andrejevii Oksn.
Cetraria ericetorum Opiz.
Cetraria nigricans (Retz.) Nyl.
Cetraria hepatizon (Ach.) Vain.
Alectoria ochroleuca (Hoffm.) Mass.
Alectoria chalybeiformis (L.) S. Gray
Alectoria pubescens (L.) R. H. Howe
Alectoria nigricans (Ach.) Nyl.
Alectoria minuscula Nyl.
Alectoria nitidula (Th. Fr.) Vain.
Cornicularia divergens Ach.
Cornicularia aculeata (Schreb.) Ach.
Thamnolia vermicularis (Sw.) Ach. *ex* Schaer.
Dactylina arctica (Hook.) Nyl.
Dactylina ramulosa (Hook.) Tuck.
Evernia mesomorpha Nyl.

Lichens cont'd

Hypogymnia subobscura (Vain.) Poelt.
Hypogymnia enteromorpha (Ach.) Nyl.
Stereocaulon alpinum Laur.
Sphaerophorus globosus (Huds.) Vain.
Sphaerophorus fragilis (L.) Pers.
Parmelia omphalodes (L.) Ach.
Parmelia fraudans Nyl.
Parmelia infumata Nyl.
Parmelia saxatilis (L.) Ach.
Parmelia centrifuga (L.) Ach.
Parmelia sulcata Tayl.
Xanthoria elegans (Link) Th. Fr.
Pertusaria dactylina (Ach.) Nyl.
Pertusaria coriacea (Th. Fr.) Th. Fr.
Ochrolechia frigida (Sw.) Lynge
Ochrolechia upsaliensis (L.) Mass.
Physcia caesia (Hoffm.) Hampe.
Physcia subobscura (Nyl.) Nyl.
Lecanora verrucosa Ach.
Lecanora epibryon (Ach.) Ach.
Lecanora crenulata (Dicks.) Nyl.
Peltigera sp.
Umbilicaria hyperborea (Ach.) Ach.
Umbilicaria proboscidea (L.) Schrad.
Solorina crocea (L.) Ach.
Lecidella stigmatea (Ach.) Hert. & Leuck.
Lecidella wulfenii (Hepp) Körb.
Fulgensia bracteata (Hoffm.) Räs.
Nephroma expallidum (Nyl.) Nyl.
Candelariella hudsonica Hak.
Rhizocarpon geographicum (L.) DC.
Rhizocarpon disporum (Naeg.) Müll. Arg.
Sarcogyne sp.
Verrucaria muralis Ach.

Bryophytes

Hypnum bambergeri Schimp.
Hypnum revolutum (Mitt.) Lindb.
Andreaea rupestris Hedw.
Dicranoweisia crispula (Hedw.) Lindb.
Rhacomitrium lanuginosum (Hedw.) Brid.
Polytrichum juniperinum Hedw.
Dicranum elongatum Schleich.
Dicranum groenlandicum Brid.
Dicranum fuscescens Turn.
Dicranum bonjeanii De Not.
Dicranum muehlenbeckii B.S.G.
Aulacomnium acuminatum (Lindb. & Arnell) Kindb.
Aulacomnium turgidum (Wahlenb.) Schwaegr.
Aulacomnium palustre (Hedw.) Schwaegr.
Catoscopium nigritum (Hedw.) Brid.
Myurella julacea (Schwaegr.) B.S.G.
Myurella tenerrima (Brid.) Lindb.
Timmia norvegica Zett.
Timmia austriaca Hedw.
Ditrichum flexicaule (Schwaegr.)
Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb.
Bryum stenotrichum C. Muell.
Tetraplodon mnioides (Hedw.) B.S.G.
Tortella arctica (Arnell) Crundw. & Nyh.
Tortella fragilis (Drumm.) Limpr.
Tortella tortuosa (Hedw.) Limpr.
Orthotrichum speciosum Nees.
Grimmia apocarpa Hedw.
Hylocomium splendens (Hedw.) B.S.G.
Brachythecium turgidum (C. J. Hartm.) Kindb.
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus lycopodioides (Brid.) Warnst.
Saelania glaucescens (Hedw.) Bomanss. & Broth.
Tomenthypnum nitens (Hedw.) Loeske

Appendix 19 cont'd

Bryophytes cont'd

Distichium capillaceum (Hedw.) B.S.G.
Encalypta alpina Sm.
Cinclidium arcticum (B.S.G.) Schimp.
Orthothecium chryseum (Schwaegr.) B.S.G.
Rhytidium rugosum (Hedw.) Kindb.
Fissidens osmundoides Hedw.
Oncophorus virens (Hedw.) Brid.
Oncophorus wahlenbergii Brid.
Meesia uliginosa Hedw.
Meesia triquetra (Richt.) Angstr.
Conostomum tetragonum (Hedw.) Lindb.
Campylium stellatum var. *arcticum* (Williams) Sav.-Ljub.
Thuidium abietinum (Hedw.) B.S.G.
Pogonatum alpinum (Hedw.) Roehl.
Mnium hymenophyllum B.S.G.
Mnium orthorrhynchum Brid.
Chandonanthus setiformis (Ehrh.) Lindb.
Blepharostoma trichophyllum (L.) Dum. ssp. *brevirette* (Bryhn & Kaal.) Schust.
Ptilidium ciliare (L.) Nees.

Vascular plants

Woodsia glabella R. Br.
Cystopteris fragilis (L.) Bernh.
Dryopteris fragrans (L.) Schott.
Equisetum variegatum Schleich.
Equisetum arvense L.
Lycopodium Selago L.
Hierochloe alpina (Sw.) R & S.
Hierochloe pauciflora R. Br.
Alopecurusalpinus L.
Arctagrostis latifolia (R. Br.) Griseb.
Trisetum spicatum (L.) Richt.
Poa alpigena (Fr.) Lindm.
Poa arctica R. Br.
Poa glauca M. Vahl.
Poa alpina L.
Arctophila fulva (Trin.) Rupr.
Dupontia Fisheri R. Br. ssp. *psilosantha* (Rupr.) Hult.
Dupontia Fisheri R. Br.
Festuca baffinensis Polunin.
Elymus arenarius L. ssp. *mollis* (Trin.) Hult.
Eriophorum angustifolium Honck.
Eriophorum Scheuchzeri Hoppe
Eriophorum vaginatum L. ssp. *spissum* (Fern.) Hult.
Eriophorum triste (Th. Fr.) Hadac & Love.
Kobresia myosuroides (Vill.) Fiori & Paol.
Kobresia hyperborea Porsild
Kobresia simpliciuscula (Wahlenb.) Mack.
Carex nardina Fr.
Carex scirpoidea Michx.
Carex rupestris All.
Carex Bigelowii Torr.

Vascular Plants cont'd

Carex stans Drej.
Carex rariflora (Wahlenb.) Sm.
Carex atrofusca Schk.
Carex misandra R. Br.
Carex membranacea Hook.
Juncus castaneus Sm.
Juncus biglumis L.
Juncus albescens (Lge.) Fern.
Juncus trifidus L.
Luzula nivalis (Laest.) Beurl.
Luzula confusa Lindeb.
Tofieldia pusilla (Michx.) Pers.
Salix herbacea L.
Salix Richardsonii Hook.
Salix reticulata L.
Salix alaxensis (Anderss.) Cov.
Salix cordifolia Pursh
Salix arctophila Cockerell
Salix arctica Pall.
Betula glandulosa Michx.
Oxyria digyna (L.) Hill.
Polygonum viviparum L.
Stelaria longipes Goldie s. *monantha* Hult.
Stellaria longipes Goldie *laeta* Richards.
Cerastium alpinum L.
Sagina caespitosa (J. Vahl.) Lge.
Arenaria Rossii R. Br.
Silene acaulis L. var. *exscapa* (All.) DC.
Melandrium apetalum (L.) Fenzl. ssp. *arcticum* (Fr.) Hult.
Melandrium affine (J. Vahl.) Hartm.
Coptis trifolia (L.) Salisb. ssp. *groenlandica* (Oed.) Hult.
Ranunculus nivalis L.
Ranunculus sulphureus Sol.
Ranunculus pedatifidus Sm. var. *leiocarpus* (Trautv.) Fern.
Ranunculus pygmaeus Wahlenb.
Papaver radicatum Rottb.
Cochlearia officinalis L. ssp. *groenlandica* (L.)
Eutrema Edwardsii R. Br.
Cardamine pratensis L. var. *angustifolia* Hook.
Cardamine digitata Richards.
Lesquerella arctica (Wormskj.) Wats.
Draba alpina L.
Draba Bellii Holm.
Draba lactea Adams.
Draba glabella Pursh.
Draba groenlandica El. Ekman
Arabis alpina L.
Arabis arenicola (Richards.) Gel.
Braya purpurascens (R. Br.) Bunge.
Saxifraga aizoides L.
Saxifraga caespitosa L.
Saxifraga cernua L.

Vascular Plants cont'd

Saxifraga Hirculus L. var. *propinqua* (R. Br.) Simm.
Saxifraga oppositifolia L.
Saxifraga tenuis Sm.
Saxifraga tricuspidata Rottb.
Saxifraga rivularis L.
Saxifraga foliolosa R. Br.
Chrysosplenium tetrandrum (Lund) Fries
Potentilla hyparctica Malte.
Potentilla rubricaulis Lehm.
Potentilla Vahliana Lehm.
Dryas integrifolia M. Vahl.
Astragalus alpinus L.
Oxytropis Maydelliana Trautv.
Oxytropis arctobia Bunge
Oxytropis podocarpa Gray
Oxytropis hudsonica (Greene) Fern.
Empetrum nigrum L.
Epilobium latifolium L.
Epilobium arcticum Samuelss.
Hippuris vulgaris L.
Pyrola grandiflora Rad.
Ledum decumbens (Ait.) Lodd.
Cassiope tetragona (L.) D. Don.
Rhododendron lapponicum (L.) Wahlenb.
Arctostaphylos rubra (Rehd. & Wils.) Fern.
Vaccinium uliginosum L. var. *alpinum* Big.
Vaccinium Vitis-idaea L. var. *minus* Lodd.
Diapensia lapponica L.
Armeria maritima (Mill.) Willd. ssp. *labradorica* (Wallr.) Hult.
Mertensia maritima (L.) F. J. Gray.
Pedicularis lapponica L.
Pedicularis capitata Adams.
Pedicularis flammea L.
Pedicularis lanata Cham. & Schlecht.
Pedicularis sudetica Willd.
Campanula uniflora L.
Erigeron unalaschkensis (DC.) Vierh.
Antennaria angustata Greene
Matricaria ambigua (Ledeb.) Kryl.
Chrysanthemum integrifolium Richards.
Senecio congestus (R. Br.) DC.
Taraxacum lacerum Greene.

Appendix 20

Weights (kg) and/or measurements (cm) of 24 barren-ground caribou collected on Coats Island, Northwest Territories, August 17–20, 1970

Specimen no.	Sex	Approx-imate age (mo.)	Whole weight	Total length	Chest girth	Shoulder height	Hind foot	Back fat	Antler length (velvet) R	L
SE- 1	♂	50	152	193	121	113	38/52	56	95	93
SE- 2	♂	62	183	191	138	111	41/57	64	130	134
SE- 3	♂	26	113	173	117	109	39/54	47	62	64
SE- 4	♂						35/49	45		
SE- 5	♂	26					33/46	35		
SE- 6	♂	62	185	196	134	116	38/52	78	95	92
SE- 7	♂	50	174	176	137	99	37/53	71	113	111
SE- 8	♂	50	164	192	125	108	38/52	72	97	101
SE- 9	♂	38	153	188	129	107	38/53	67	78	76
SE-10	♂	26	99	175	123	98	36/48	54	58	54
SE-11	♂	14	96	163	111	97	37/52	28	39	40
SE-12	♂	14		146		91	35/48	23	29	33
SE-13	♀	14		146		79	33/45	31	27	35
SE-14	♂		146	188	131	110	40/54	50		
SE-15	♂	38	157	194	133	117	39/53	70	96	96
SE-19	♂						40/56	94		
SE-20	♂	38					37/53	52	66	67
SE-21	♂	26					35/50	36	55	58
SE-22	♂	38					38/53	61	72	67
SE-23	♂	14					35/49	35	44	46
SE-24	♂	26					37/51	47	60	65
SE-25	♂	62	202	196	139	110	39/56	78	121	125
SE-26	♂	74	186	187	145	108	37/51	80	109	120
SE-27	♂	38	137	186	128	108	37/51	42	83	79

Appendix 21

Mean cranial measurements (mm) of 18 male barren-ground caribou collected on Coats Island, Northwest Territories in August 1970

No. of specimens	Age in months	Basal length	Orbital width	Nasal length	Post nares	Tooth row	Diastema	Occipital height
4	14	274.7	134.0	102.2	32.0	78.7	97.7	75.7
5	26	306.0	153.2	113.2	35.8	94.0	105.8	84.0
4	38	330.3	161.2	126.2	39.3	95.5	120.0	92.2
2	50	345.5	167.0	118.0	38.5	104.5	125.5	90.5
3	62	361.3	167.0	131.3	40.0	98.3	128.6	111.0

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