THE BARREN-GROUND CARIBOU

BY

A.W.F. BANFIELD

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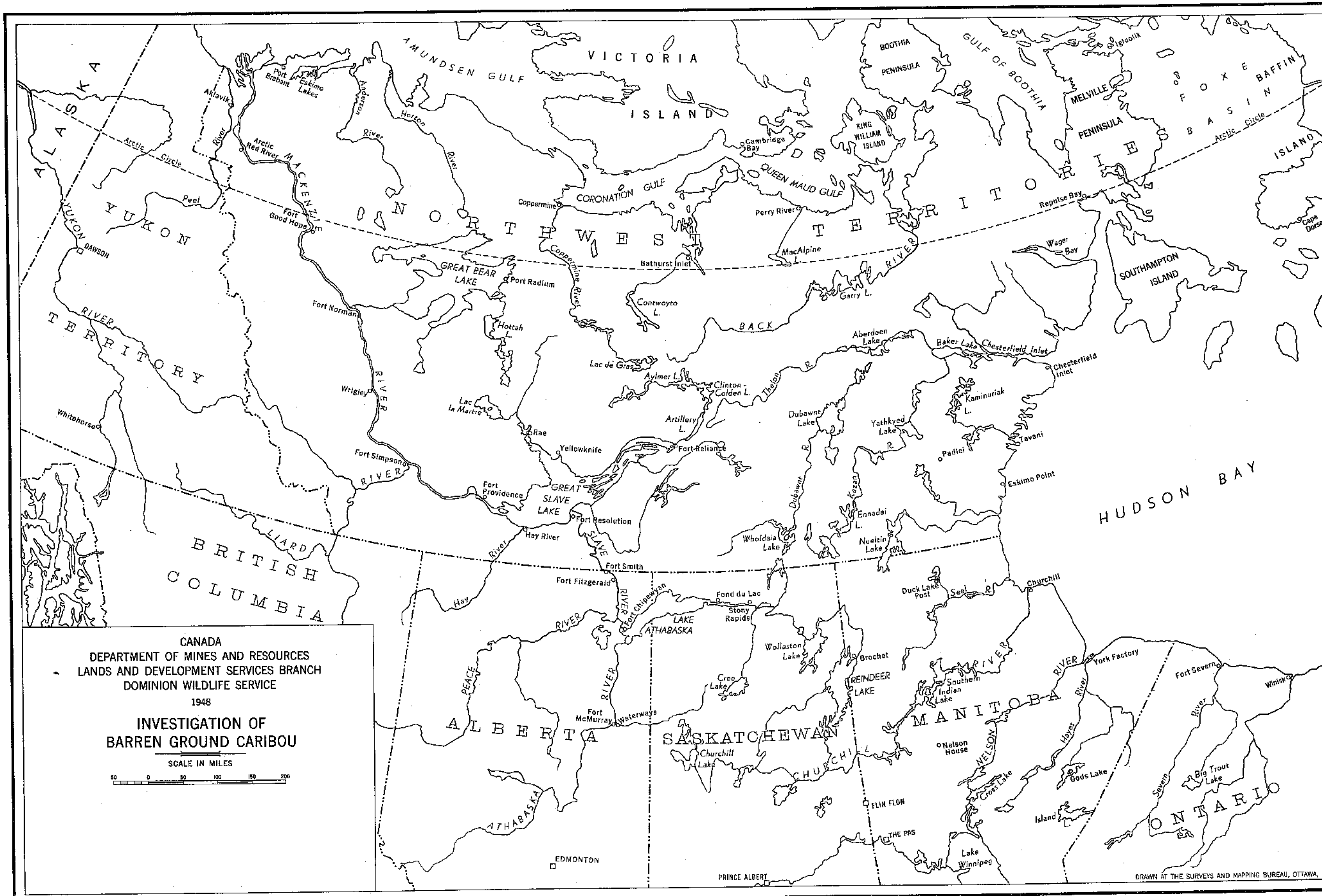
CANADA
DEPARTMENT OF MINES AND RESOURCES
LANDS AND DEVELOPMENT SERVICES BRANCH
DOMINION WILDLIFE SERVICE
1948
INVESTIGATION OF
BARREN GROUND CARIBOU
SCALE IN MILES
50 0 50 100 150 200
DRAWN AT THE SURVEYS AND MAPPING BUREAU, OTTAWA, 1948
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
VICTORIA ISLAND
AMUNDSEN GULF
CORONATION GULF
QUEEN MAUD GULF
GULF OF BOOTHIA
BOOTHIA PENINSULA
MELVILLE PENINSULA
KING WILLIAM ISLAND
FOXE BASIN
BAFFIN ISLAND
SOUTHAMPTON ISLAND
HUDSON BAY
Arctic Circle
Aklavik
Port Brabant
Eskimo Lakes
Arctic Red River
MACKENZIE RIVER
Fort Good Hope
Fort Norman
Wrigley
Fort Simpson
Fort Providence
Peel
Dawson
Whitehorse
Anderson River
Horton River
Coppermine
Coppermine River
GREAT BEAR LAKE
Port Radium
Hottah L.
Lac la Martre
Rae
Yellowknife
GREAT SLAVE LAKE
Fort Resolution
Fort Reliance
Hay River
Fort Smith
Fort Fitzgerald
SLAVE RIVER
LIARD
Cambridge Bay
Perry River
Bathurst Inlet
MacAlpine L.
Contwoyto L.
Lac de Gras
Aylmer L.
Clinton-Colden L.
Artillery L.
BACK RIVER
Garry L.
Thelon R.
Aberdeen Lake
Baker Lake
Chesterfield Inlet
Kaminuriak L.
Yathkyed Lake
Dubawnt Lake
Dubawnt R.
Kazan R.
Ennadai L.
Nueltin Lake
Wholdaia Lake
Padlei
Tavani
Eskimo Point
Repulse Bay
Wager Bay
Igloolik
Cape Dorset
Churchill
Seal R.
Duck Lake Post
Fond du Lac
Stony Rapids
LAKE ATHABASKA
Fort Chipewyan
Wollaston Lake
Cree Lake
Fort McMurray
Waterways
PEACE RIVER
ATHABASKA
EDMONTON
PRINCE ALBERT
Churchill Lake
CHURCHILL
REINDEER LAKE
Brochet
Southern Indian Lake
Nelson House
NELSON
FLIN FLON
THE PAS
Lake Winnipeg
Cross Lake
Island L.
Gods Lake
Hayes River
York Factory
Fort Severn
Severn River
Big Trout Lake
Winisk

INTRODUCTION

The first explorers to visit the extensive arctic tundra of northern Canada reported innumerable herds of barren-ground caribou (Rangifer arcticus) which provided food, clothing and shelter for the nomadic bands of Indians and Eskimos who inhabited arctic and subarctic Canada. The writings of Hearne, Franklin, Richardson, Back, Rae and others contain many colourful accounts of the dependence of northern natives and explorers on this important natural resource.

The caribou is still a vital factor in the economy of more than twenty-five thousand residents of northern Canada, including Eskimos, Indians and European settlers living in the Yukon and Northwest Territories, and the northern parts of Alberta, Saskatchewan, Manitoba, Quebec and Labrador. These regions are remote from a supply of domestic meat and therefore caribou meat plays an important role in the diet of these Canadians. Furthermore, the hides of these animals supply winter clothing which has not yet been surpassed for warmth and lightness by any type of manufactured fabric. The antlers, fat and sinews are also fully utilized for domestic purposes.

In some regions, such as the Ungava peninsula of Quebec, Labrador, and Baffin Island, reduction in the number of caribou in recent years has brought grave hardships to the native population. With the recent increased development in Canada's arctic and subarctic regions, fears have been expressed regarding the present status of this important big game species. The loss of this natural resource would have grave consequences affecting the maintenance of a human population in large areas of northern Canada.

The vast herds of caribou which roamed the arctic prairies during the exploratory period were frequently compared in numbers to the bison of the great plains. When the prairies of central North America were first explored, great herds of bison were encountered. These animals also formed the cornerstone of the economy of nomadic tribes of Indians. By 1890, with the advance of agriculture, ranching and the transcontinental railways, the bison had been reduced from millions to the verge of extinction. The bison has been extirpated from its plains habitat with the exception of a few herds in National Parks, but the barren-ground caribou still roams the arctic tundra in numbers comparable to those present under primitive conditions, largely because its domain has not yet been fully exploited by civilization.

Because of the nomadic habits of the barren-ground caribou, the vast area of its domain which is still largely unexplored, and the scattered human population, there has always been a paucity of accurate information concerning the population and life history of the species. Many legends have sprung up concerning the habits and movements of the caribou which find firm supporters even to-day among the isolated northern trappers and hunters.

There have been previous investigations of the population of this species in the arctic steppes and subarctic forests of northern Canada. Mr. W.H.B. Hoare was commissioned by the Northwest Territories Administration, Department of the Interior to undertake a caribou survey during the years 1925-1927, which was duly reported in mimeographed form.

Dr. C.H.D. Clarke paid particular attention to the status of barren-ground caribou as well as musk-oxen during his investigation of the Thelon Game Sanctuary in 1936-37. These former investigations were handicapped by the geographical magnitude of the problem. The investigators were limited to single parties using the time-honoured means of northern travel: canoe in summer and dog-team in winter.

Cognizant of the urgent need of an intensive investigation of this important natural resource, the Eleventh Conference of Provincial and Dominion Wildlife officials, meeting in Ottawa in February, 1947, passed a resolution recommending that a thorough investigation into the present status and utilization of the barren-ground caribou between Hudson Bay and the Mackenzie River valley, be commenced. It was recognized that the investigation must be a co-operative project, as it involved the interests of several provinces as well as those of the Federal Government.

Present Investigation

As a response to this resolution the present investigation was undertaken by the Canadian Wildlife Service of the Department of Resources and Development. Although sponsored by this Department, the project had the full co-operation of the Game Departments of the provinces of Alberta, Manitoba and Saskatchewan.

The author was instructed to undertake the planning and direction of the field investigations. A scientific advisory committee was appointed, composed of Dr. H.F. Lewis, Chief of the Canadian Wildlife Service (Chairman), Dr. C.H.D. Clarke, Assistant Chief, Fish and Wildlife Division, Ontario Department of Lands and Forests, Dr. I. McT. Cowan, Professor of Zoology, University of British Columbia, and Mr. A. E. Porsild, Chief Botanist, National Museum of Canada. It was intended that these eminent Canadian biologists, each an expert in his field, would give guidance in the interpretation of the data and the presentation of recommendations concerning the future management of this natural resource.

Because of the geographical and historical magnitude of the problem, one of the first steps was to define the scope of the investigation. The present classification of caribou (Rangifer) in North America is generally considered unsatisfactory because of the scarcity of representative specimens. The most generally accepted classifications are those of Anderson (1946) and Murie (1935). They in turn have accepted the work of Jacobi (1931). Within arctic and subarctic Canada there are three recognized species, one of which (arcticus) is divided into six subspecies. The majority of these forms are economically important over their ranges. To study the whole group in a reasonable length of time would not be practicable. The area of study therefore was limited to the mainland of Canada west of Hudson Bay as far as the Athabaska, Slave and Mackenzie Rivers, and from the Arctic Ocean south to the northern portions of the three prairie provinces. This area very closely approximates the present range ascribed to the barren-ground caribou (Rangifer arcticus arcticus). This subspecies was known to be under heavy utilization and was thought still to exist in fair numbers. On the other hand, the caribou populations of Baffin Island and the Ungava peninsula were known to be so reduced that the management policy of increased protection from hunting seemed clearly indicated. The caribou of the high Arctic Islands are still largely unutilized and theoretically unaffected by human agencies. The caribou of the Yukon had already received the attention of a biologist (Murie, 1935). These geographical boundaries therefore appeared most practical.

It was decided that no taxonomic work on the geographic subspecies ascribed to this region would be undertaken at this time. Although specimens were collected, they are insufficient for study of geographic variation of the animal over the whole geographic study area.

Although the process of gathering original information about any species of animal is an unending one, it was decided, for practical reasons, to limit this preliminary investigation to the years 1948-50. It was thought that by the latter date, sufficient fundamental data would have accrued to form the basis for initiation of a management program for the subspecies.

The objects of the investigation may be divided under the two general headings: those of basic research and those of practical consideration. The main objectives were as follows:

(a) To ascertain the present status, distribution and movements of the subspecies or race.

(b) To determine the current population trend.

(c) To investigate the life history of the race and its ecological relations to the environment.

(d) To analyse the human utilization of the resource.

(e) To present a program for the future management of the race.

There was on hand a considerable amount of information dealing with the race, which had accumulated over a period of almost two hundred years of exploration in arctic Canada. This information, largely dealing with occurrence and life history, was available in the exploration literature. Further information of a continuous kind was available in the files of the Department of Resources and Development. Since 1934 mimeographed Caribou Questionnaires have been distributed annually to northern traders, trappers, travellers and police in the Northwest Territories. These questionnaires, which were available for analysis, refer to localities and seek information concerning the dates of occurrence of caribou, change in abundance, migration direction, diseases and utilization. Since 1934 Native Game Returns have been distributed to the Royal Canadian Mounted Police detachments in the Northwest Territories. On these forms the numbers of furs traded and big game killed are reported for each native. The information is collected by direct questioning and consultation with the local traders. These forms were also available for analysis.

Besides these data there were also on hand many individual reports dealing with local caribou conditions. These included regular game reports of the Royal Canadian Mounted Police northern detachments and the wardens of the Forest and Wildlife Service of the Northwest Territories Administration.

Through the co-operation of the Game Officials of the provinces of Alberta, Manitoba and Saskatchewan, reports were received from their field staffs.

Plans for the field investigations were drawn up during the winter of 1947-48. It was decided that both extensive and intensive methods of investigation were required.

It was evident that because of the immensity of the area to be investigated, aircraft would have to be used extensively as a means of transportation as well as a means of observation. The extensive field work was accomplished

Figure 1. A large herd of caribou resting on Ghost Lake, Northwest Territories, during spring migration.

Figure 2. Aerial photography of caribou bands.

by aerial reconnaissance and photography. From this type of observation, data concerning distribution, migration routes, abundance, herd segregation and effect of predators could be obtained. Aerial reconnaissance was found to be a particularly useful means of studying the barren-ground caribou. During the months of April and May one may expect long spells of clear cool weather. With the lengthening days these formed ideal northern flying conditions. At this season of the year the caribou were concentrated and in migration. They were easily observed against the snow-covered landscape of the treeless tundra regions. In the forested regions caribou usually frequent during the migration period the chains of frozen lakes and bogs, where they were equally well discernible (see figure 1).

It was found that the type of aircraft best suited for work of this kind has the following characteristics: long range, high-wing monoplane, ski equipment, good visibility from the ports, ports which open for photography, generally a low speed, good manoeuverability and take-off performance. The Norseman was the most suitable aircraft, although the Beaver was also fairly well adapted for this type of work.

The technique employed was to fly at an altitude of 500 feet above the ground on irregular courses over territory expected to contain caribou. Two observers were employed (one might be the pilot). The investigator carried a map on a clipboard on which the course was plotted. Care was taken to observe and plot distant objects to the side of flight course at a distance as far as caribou could be observed. This was important in order to obtain the width of the transect covered by the flight. If frequent ground checks were made of distant caribou bands the altitude of the aircraft was not needed in calculating the transect width. When a caribou herd was sighted the course was altered to follow a large circle in order to ascertain the length and width of the movement. When caribou herds were observed, the location and approximate number were plotted on the map. If a herd was large, an aerial photograph was taken to check the estimated number. The number of the photograph was recorded beside the record of the herd. The direction of movement, as well as tracks, was also reported.

Aerial photographs were taken with a Fairchild K 20 4x5 inch semiautomatic camera. This is a hand-held instrument which takes a roll of 50 pictures. It has a trigger release and the film and shutter are rewound with a single crank. On clear days over the snow most pictures were taken on Super XX film, at f-8.0, 1/500 sec. with K 2 filter. If the caribou were to be counted alone, the picture could be taken at altitudes up to 1,000 feet. If it was intended to classify the herd the altitude could not be much greater than 300 feet (see figure 2.).

Aerial assistance was rendered by the Royal Canadian Air Force and the Manitoba and Saskatchewan Government Air Services. Pilots of the Royal Canadian Air Force on northern duty turned in numerous valuable observations concerning the movements of caribou. The greater part of the flying, however, was done by the private charter of local air services in northern Manitoba and the Northwest Territories.

Besides these extensive observations, intensive research was undertaken at a series of ground stations throughout the caribou range at various seasons in order to integrate the extensive observations, also to obtain as complete as possible an understanding of the various seasonal aspects of the problem. At the ground stations particular emphasis was placed on studies dealing with life history, ecology, pathology, food requirements, predation, sociology and human utilization.

Information also was gathered by means of frequent interviews with interested parties, by questionnaires and by co-operative action with other agencies.

Valuable assistance in connection with the field investigations was given by the following personnel: A. H. Lawrie, A. L. Wilk, D. Peterson and F.M. Mowat. The other Mammalogists of the Wildlife Service also undertook special projects in connection with this investigation. These were W. A. Fuller, Fort Smith, N.W.T., W. E. Stevens, Aklavik, N.W.T., and J. P. Kelsall.

Before the field work commenced detailed plans were drawn up. These provided for standardization of data collected by the field parties. Standard caribou observation cards and post-mortem cards were designed. On these cards were recorded data extracted from all literature references. Standardized instructions were also issued for range studies and collection of parasites and various types of specimens.

Itinerary

During July and August, 1946, the author travelled down the Mackenzie River to the delta region. Although he was engaged in other wildlife investigations at the time, many opportunities arose to make observations concerning barren-ground caribou distribution, both past and present. The Government reindeer herd was also inspected on Richards Island.

W.E. Stevens obtained data on caribou during a flight from Aklavik to Fort Good Hope and then eastward across the Anderson and Horton Rivers, during October, 1948. The same winter W.A. Fuller was able to observe wintering caribou herds between Great Slave and Athabaska Lakes.

On April 13, 1948, the writer flew from Ottawa to Churchill, Manitoba, and from then until May 24th carried out aerial reconnaissance of the northward migration of caribou in northern Manitoba and southern Keewatin District. Routes, dates and manner of migration were recorded, as well as data on sex and age classification, predation and pathology of specimens examined.

On May 21, A.H. Lawrie and F.M. Mowat arrived from Ottawa. After arranging their kit, they were flown to Nueltin Lake, Keewatin, where they established their base camp. During June they collected information on wolf predation. On July 20, they were flown to a summer camp on Angikuni Lake. From here they travelled by canoe westward to Kamilikuak Lake and returned to Angikuni on August 6th. They were able to gather pathological and life history information on the fore-runners of the summer migration of caribou observed along the route. On August 15th the party returned to Nueltin Lake, where the southward-moving caribou were again met.

On June 25 the author left Ottawa and after being joined by A.L. Wilk in Edmonton proceeded to Fort Smith, N.W.T., by air. After packing the kit the party was flown to Fort Reliance and finally established a base camp at Lake Clinton - Colden on July 6. During July a canoe trip was made northward to Musk-ox Lake on the Back River. In August, upon our return to Lake Clinton - Colden, a trip was made eastward, down the Hanbury River to Sifton Lake. The party was picked up on September 2 and flown to Fort Smith. Abundant information concerning caribou summer food requirements and available range forage was collected. Data on pathology and predation were also collected.

During the autumn period of 1948, Mowat observed the southward migration of caribou from October 13 to the end of December at Brochet, Manitoba. Lawrie remained at Nueltin Lake until December 15 and collected information on Eskimo hunting techniques and caribou rutting behaviour.

From November 3 to 20, Lawrie accompanied a group of Eskimos by dog-team to Cognac River and back to Nueltin Lake. He made valuable first-hand observations on Eskimo hunting methods and caribou utilization along the route.

From November 13 to December 13, 1948, through the co-operation of the Manitoba Department of Lands and Mines, the writer observed the southward migration of caribou along the Hudson Bay Railway. A base camp was established at Ilford, Manitoba, and frequent trips were made along the line as far as Churchill by gas-car. D. Peterson joined the field staff at this point and remained at Ilford, collecting observations and making field patrols. From January to April, 1949, Lawrie and Peterson operated from Ilford, carrying out both ground surveys and aerial reconnaissance through the co-operation of the Manitoba Air Service, covering the winter range of caribou in Manitoba and visiting many northern settlements.

The period January 20 to February 10, 1949, the author spent in carrying out reconnaissance flights over northern Saskatchewan through the co-operation of the Saskatchewan Department of Natural Resources and the Saskatchewan Government Air Service. Much useful information in caribou pathology, movements and utilization was gathered.

During the period March 20-23, Mr. W.A. Fuller carried out three reconnaissance flights in northern Alberta and Saskatchewan, as well as in southern Mackenzie District, in the area north and east of Lake Athabaska, and observed caribou movements. Extensive aerial survey of the Mackenzie District caribou herds was undertaken by the writer during the period April 16 to May 6, 1949, from bases at Yellowknife and Fort Reliance. Long reconnaissance flights were made north and east of Great Slave Lake. Large numbers of migratory caribou were observed and information was gathered on migration routes, wolf predation, calf survival, and caribou behaviour patterns.

After a short stay at Churchill, Manitoba, Lawrie and Peterson proceeded northward to Baker Lake on May 16, 1949, by air. On June 1, they were transported westward to Beverley Lake, where they established a camp and observed caribou on their summer range. On August 2nd they were flown south to Nueltin Lake, where they completed range studies and Eskimo utilization observations. Their field studies were concluded at Churchill on September 1, 1949.

On June 18, 1949, the writer and A.L. Wilk again arrived at Fort Smith. Due to the late season, we were delayed in reaching the caribou on their summer range. The period June 25-July 11 was spent in carrying out vegetation studies on the winter range in the vicinity of Fort Reliance and the Lockhart River. On July 11, we were transported northward by air to Bathurst Inlet. Much valuable information was gathered here concerning Eskimo utilization of caribou, as well as data concerning caribou on the grounds. Through the co-operation of the United States Fish and Wildlife Service during the latter part of July, the opportunity arose to observe caribou concentrations north to Arctic Sound, as well as on a reconnaissance flight eastward to the Perry River. The period August 1-20 was spent at Contwoyto Lake. Here interesting data dealing with Eskimo hunting techniques and caribou tilization during the summer migration were collected. The field investigation was concluded at Fort Smith on August 23, 1949.

The routes travelled during the investigation, including reconnaissance flights and canoe trips, as well as the ground stations established, where intensive research was carried out, all are indicated in Figure 3.

General Description of the Physical Environment

The present distribution of the barren-ground caribou is confined to the Northwest Territories and the northern parts of Alberta, Saskatchewan, Manitoba and Ontario. In the Mackenzie District it occurs east of the Mackenzie River, in Franklin District it occurs on Boothia peninsula and on Victoria, Baffin, Southampton and Coates Islands and throughout Keewatin District.

On the mainland the range is fairly well delineated by the limits of the Precambrian Shield. Caribou are common on the Archean acid rocks, composed of granite, granite-gneiss and granitized sedimentary rocks. They occur less commonly on Proterozoic sedimentary rocks. They occur infrequently on volcanic metamorphosed rocks, such as occur in the immediate vicinity of Flin Flon, Manitoba, and Yellowknife, Mackenzie District. Occasionally during the winter months, caribou bands reach areas underlain by early Palaeozoic rocks beyond the Precambrian shield in the Mackenzie District.

This vast area of Northern Canada is generally of low relief. There is a gradual slope to the north. Numerous areas of low wet prairies interspersed by rock outcroppings occur. There are some regions of rugged mountainous terrain,

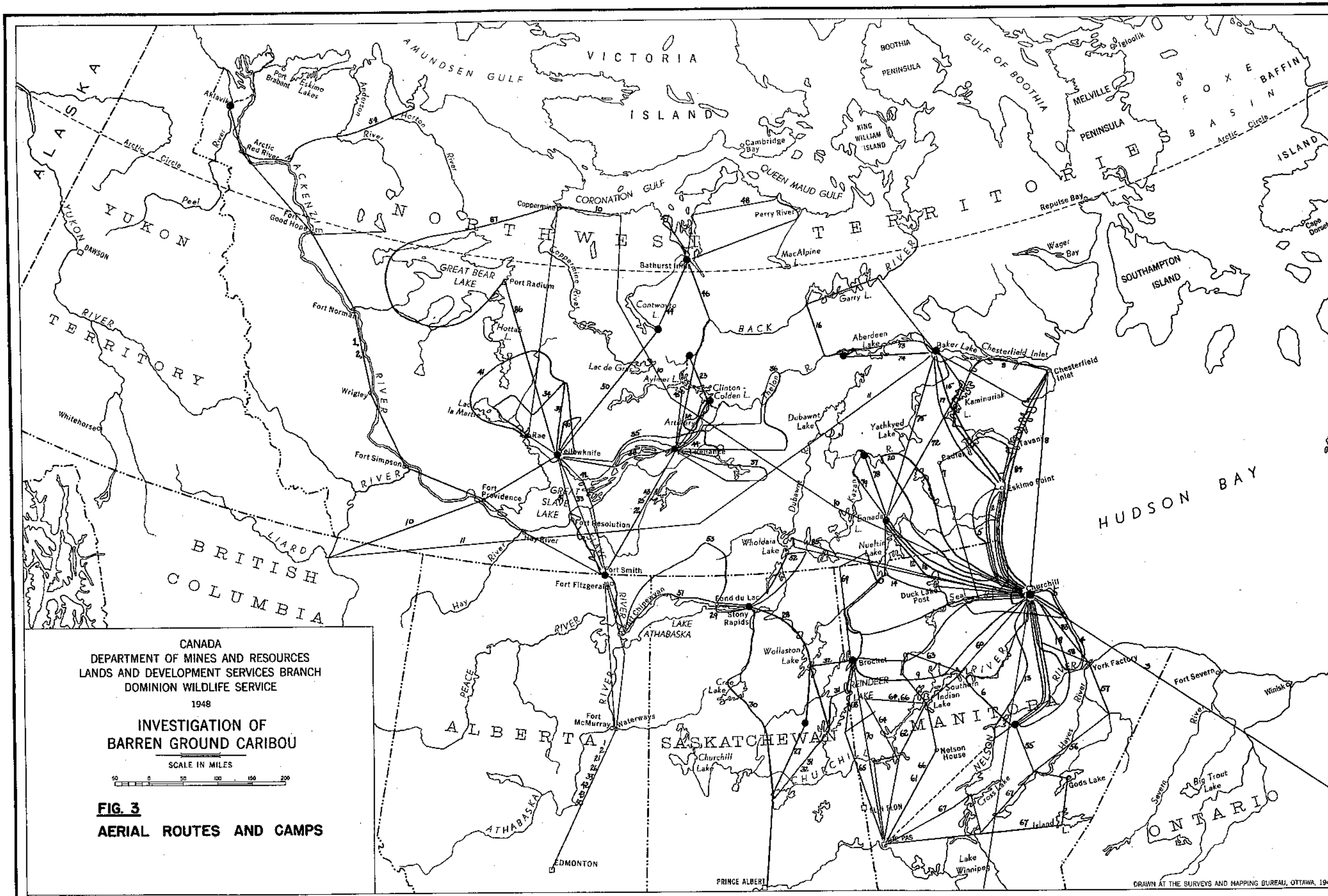

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FIG. 3
AERIAL ROUTES AND CAMPS

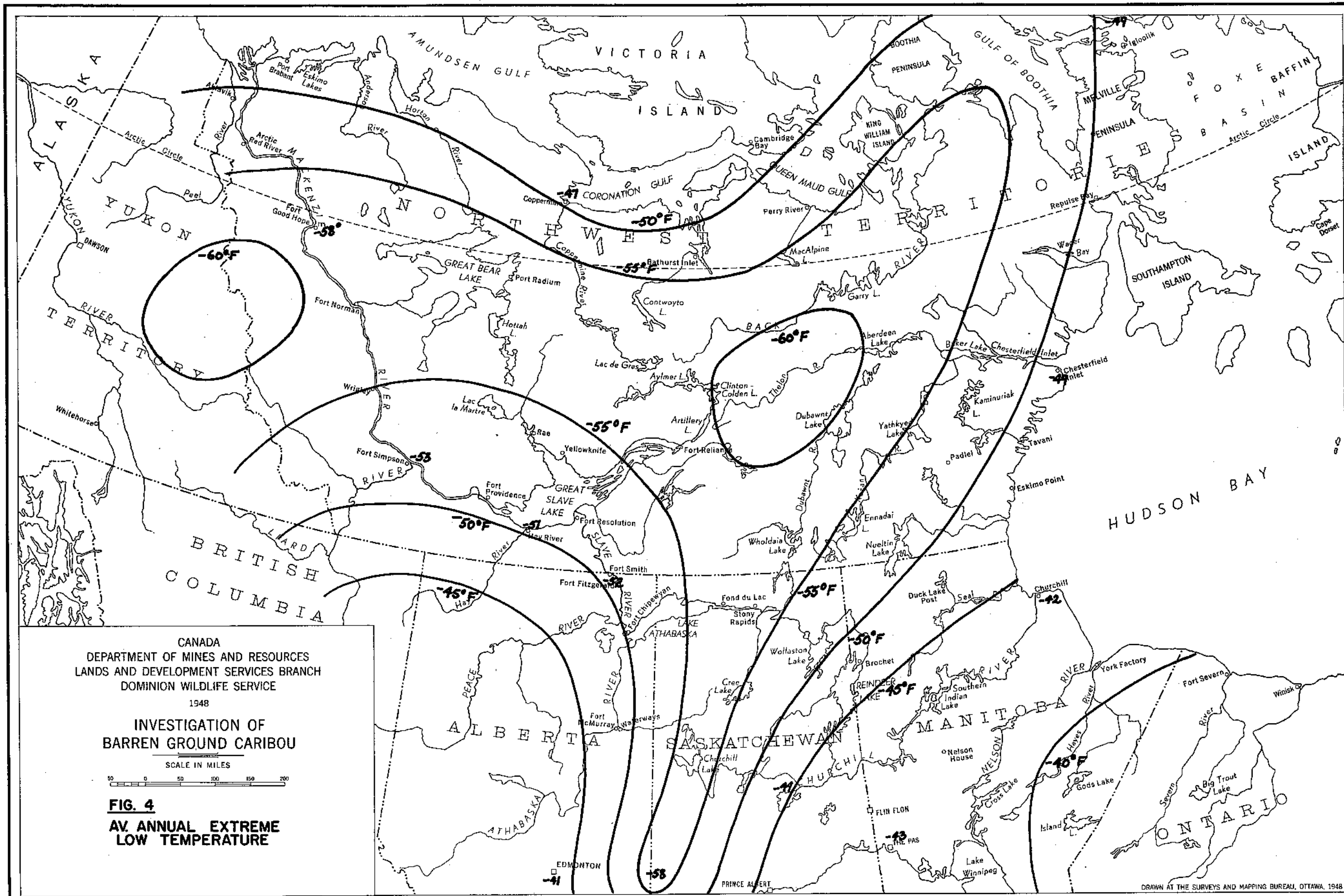
with elevations up to 2,500 feet, and still other regions of rolling terrain. Lakes are exceedingly numerous and account for a large proportion of the total area. The land is criss-crossed by eskars of sand and gravel and many old beach lines are found. The soils are, in general, poor. Over the Pre-cambrian Shield the soil layer is shallow or lacking entirely. In other areas it is primitive in nature, being composed of poorly differentiated rock materials. Humus is generally shallow and acid in reaction in association with the coniferous forests. There are numerous bogs because of the underlying permafrost or rocky substratum.

The climate of the area is characterized by long rigorous winters, with extremely low temperatures and moderate to light snow-fall. The vegetative growing season is confined to the short summer period, which is moderately warm and dry. Frosts and snow may be expected during any month of the year. Since the extremes of the climate and not the average conditions determine the distribution of organisms, these extreme conditions have been examined and recorded in connection with the caribou distribution. The average annual extreme low temperatures for northern stations have been plotted in Figure 4. and isotherms have been drawn. The average extreme annual low temperature over the caribou winter range was found to vary from - 60°F. to - 45°F. There is a tendency for caribou to desert during the winter the central tundra, around which the - 60°F. isotherm is drawn. Small bands, in the winter, occur along the coasts in the region of the - 55°F. isotherm.

The average annual extreme high temperature isotherms are indicated on Figure 5. During the early summer when this temperature may be reached the majority of caribou are north of the +80°F. isotherm. The range of temperature tolerance for this species is, therefore, at least 140°F.

The average yearly rainfall is indicated in Figure 6. During the period when rain falls the caribou are generally to be found north of the line indicating an average rainfall of 6 inches. The summer range is characterized by light rainfall, 5 inches or less.

The average annual snowfall is indicated in Figure 7. During the winter months the snow-fall is heavier on the central tundra than on the coasts or in the forested belt. At this period the bulk of the caribou are to be found in the forested regions. These winter ranges are characterized by an average snow-fall of 45 to 55 inches.



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50 0 50 100 150 200

FIG. 4

AV. ANNUAL EXTREME LOW TEMPERATURE

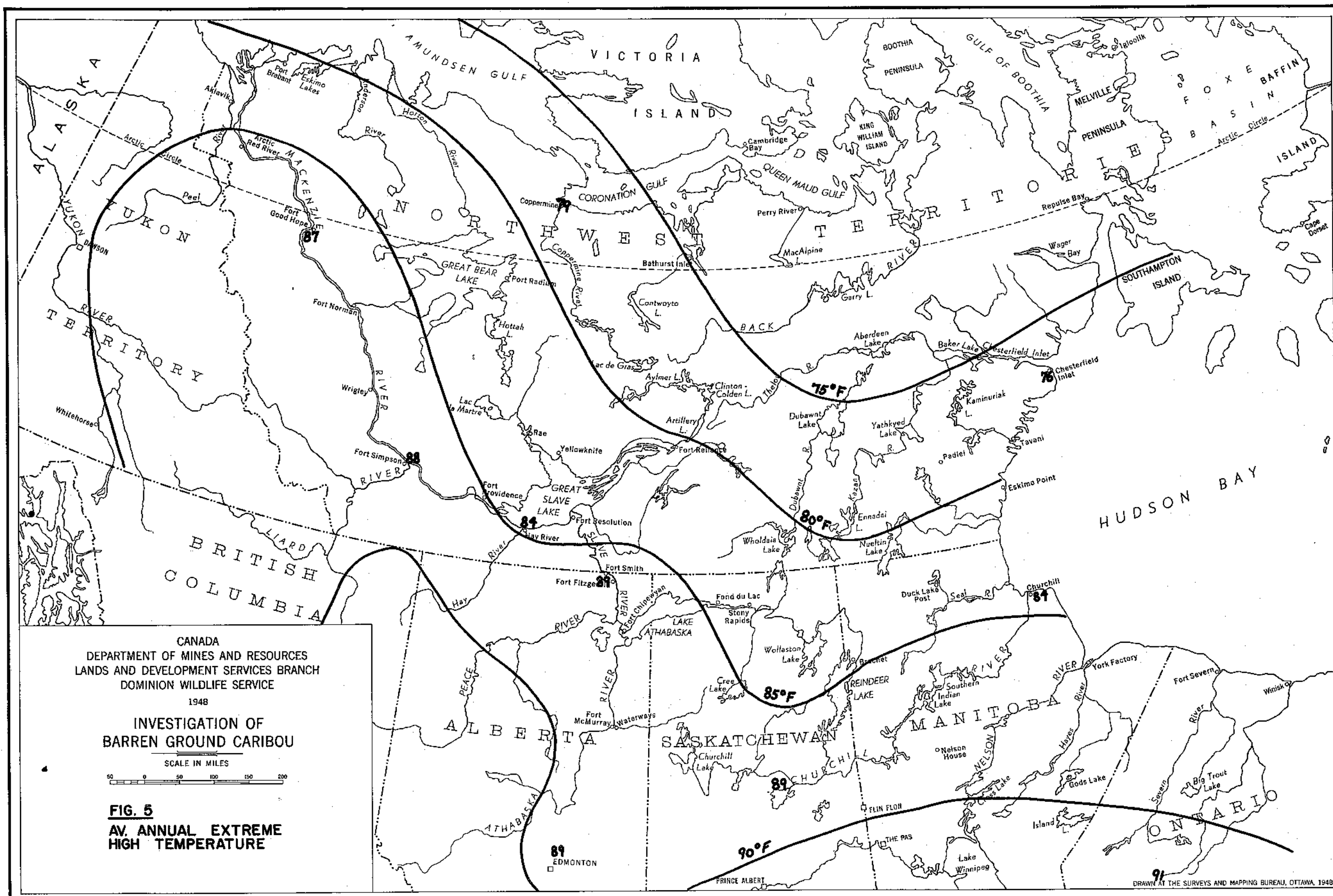
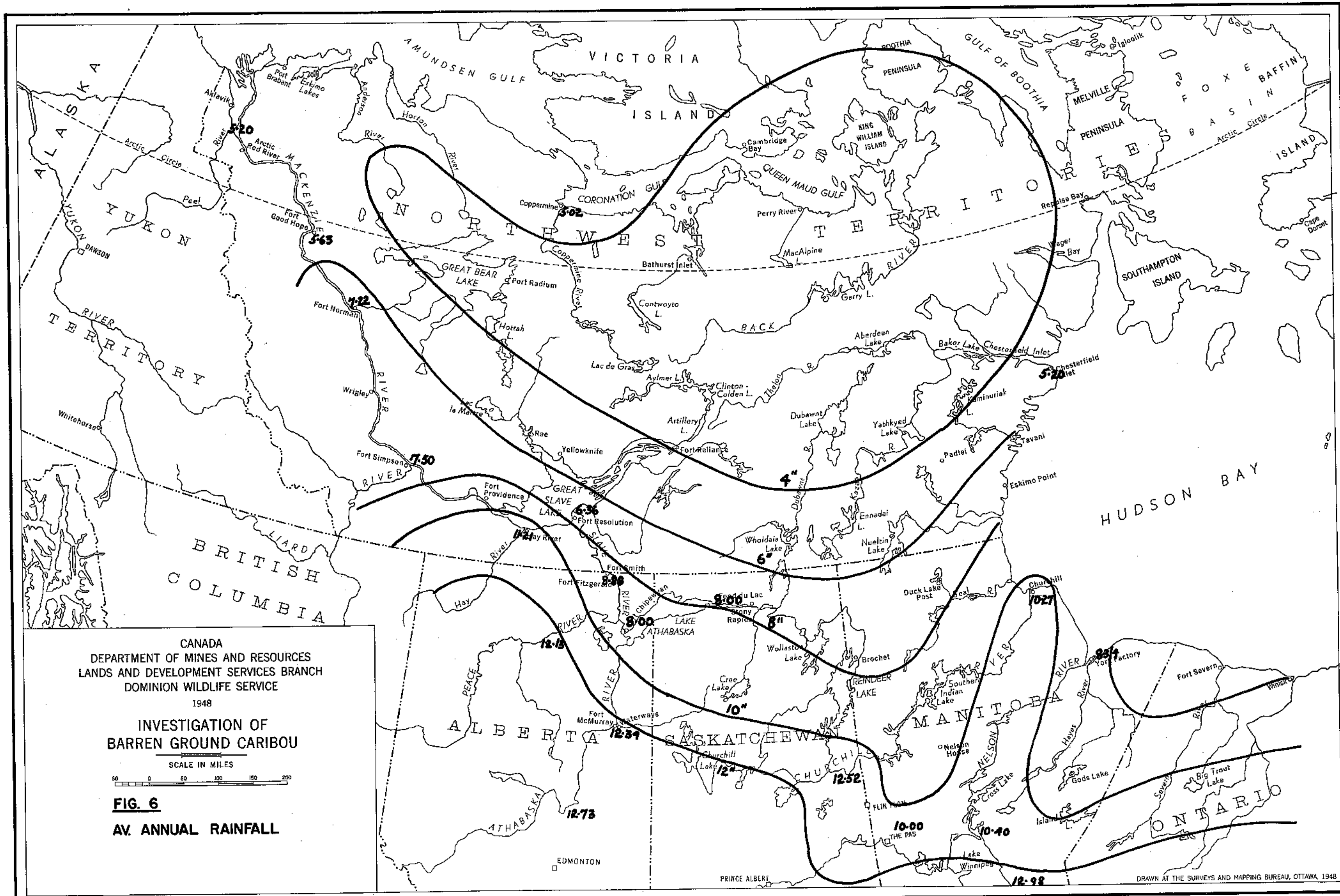


FIG. 5
AV. ANNUAL EXTREME HIGH TEMPERATURE



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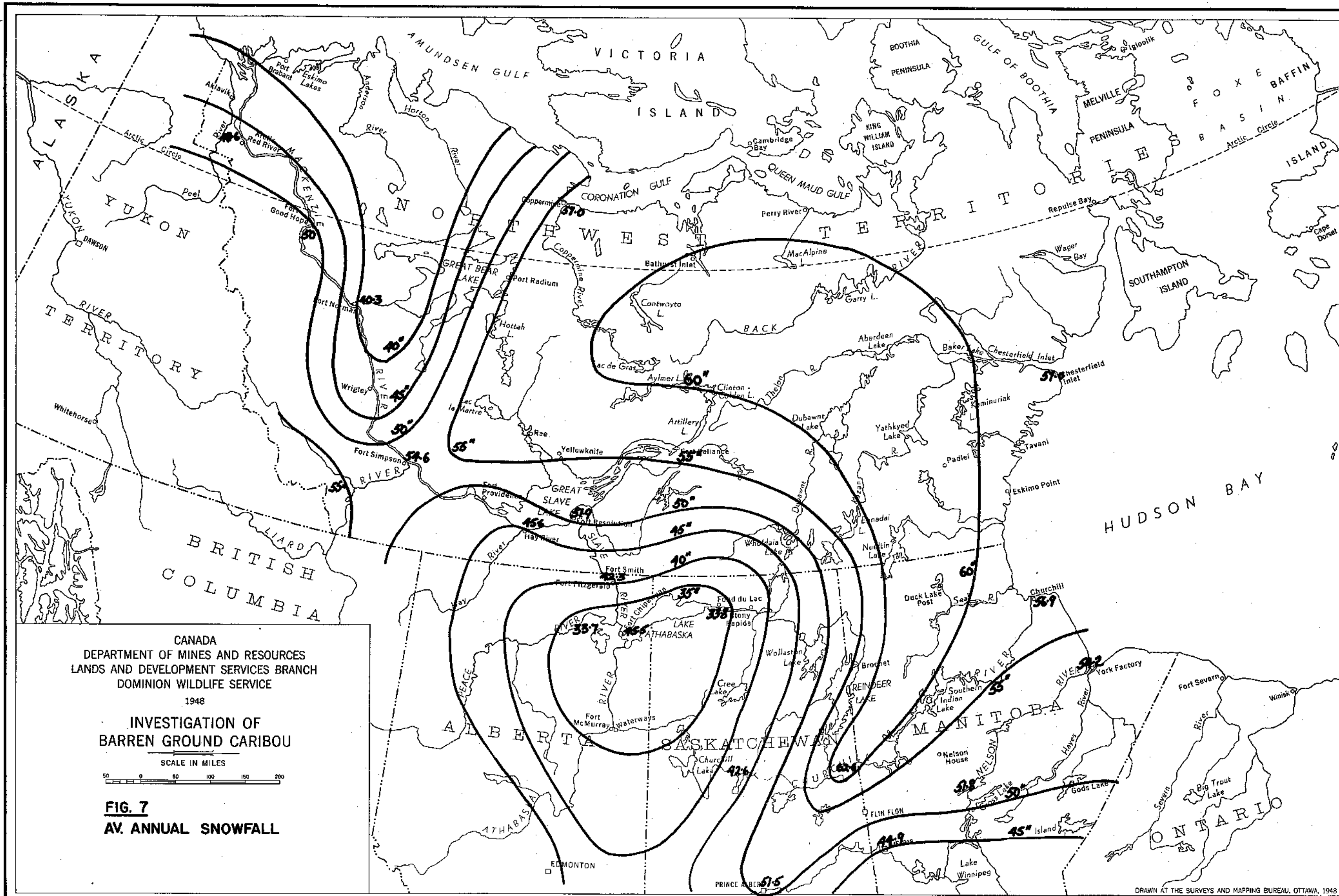
50 0 50 100 150 200

FIG. 6

AV. ANNUAL RAINFALL



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SCALE IN MILES

FIG. 7
AV. ANNUAL SNOWFALL

The whole distributional range is cut by timberline which indicates a fundamental difference in the environment. The timber line roughly approximates the permafrost line. Beyond the treeline the vegetation is characterized by lichens, shrubs and herbaceous plants. To the south of the timberline lies the continental spruce forest.

When the ecologic associations of the barren-ground caribou are considered, it is found that the form is not confined to any one major biotic formation. Bands of caribou may be found in different biotic units depending on season, particular year, or caribou herd under consideration. It cannot be used as an indicator-species of any biotic unit unless the conditions are carefully defined. Since it is an exceeding mobile species it transcends the boundaries of several ecological units.

According to Merriam's Life Zone concept this sub-species must be considered as a member of both the Arctic and the Hudsonian Life Zones. Occasionally during winter incursions it may even penetrate the Canadian Life Zone, as indicated on the map presented by Anderson (1937).

If we adopt Shelford's biome concept, the species is a transient member of the Tundra and Taiga Biomes.

Tundra is the ecologically correct term applied to the zone north of timberline. It is of Siberian origin and is synonymous with the North American popular term, barren-grounds. Taiga is similarly of Siberian origin and refers to the coniferous forest belt adjacent to the tundra on the south (Alee, W.C. et al, 1949). More particularly it is a transient member of the spruce - fir association of Shelford and Olson (1935), of the taiga biome.

If we follow the nomenclature of Dice (1943), the barren-ground caribou is a member of both faunas of the Eskimoian and Hudsonian Biotic Provinces. The seasonal aspects of this problem will be treated elsewhere under distribution.

Historical Records of Barren-ground Caribou

The first reference to the barren-ground caribou was probably that of Martin Frobisher in 1576, as recorded by Purchas (1625). Speaking of Frobisher Bay, Baffin Island Purchas writes, "Having entered three-score leagues, hee went on shore and was encountered with mighty Deere, which ran at him with danger of his life". Other early popular accounts of the species were given by Dobbs (1744) and Pennant (1784).

The earliest detailed account of the life history, migrations and utilization of the race was given by Hearne (1795) describing his trip across land from Fort Prince of Wales (Churchill) to the Coppermine River. The subspecies was first described for science by Richardson in 1829. He based his description on data gathered during the First Franklin Expedition. The type locality chosen was Fort Enterprise, at the headwaters of the Snare River, north of Great Slave Lake. He also presented much information on the life history and native utilization of the species, which formed a basis of our knowledge of this animal and to which little was added for more than 100 years.

During the nineteenth century the journals of the explorers of Northern Canada contained numerous references to the species. These references are usually in the form of casual locality records and observations. Some of the more important observations are contained in the writings of Franklin (1823 and 1828), Back (1836), Richardson (1829 and 1851), Anderson (1857) Lyon (1824), Rae (1850, 1852 and 1855), Anderson and Stewart (1856), Gilder (1881), Tyrrell (1896, 1898 and 1902), Parry (1824), Simpson (1843), McClintock (1859), Ross (1835) and Collinson (1885).

During the latter part of the nineteenth century there appeared several popular accounts of the arctic fauna which were written by naturalist hunters and which contained caribou observations. Some of the more important of these are: Schwatka (1885), Warburton Pike (1892), Hanbury (1904), Tyrrell (1908), Russell (1898), Seton (1907), Munn (1932), Critchell-Bullock (1930) and Whitney (1896).

In the early years of the present century biological investigations of Northern Canada were carried out by trained observers. Their reports contain much valuable information on caribou distribution and movements. Under this heading are such publications as: Stone (1900), Preble (1902 and 1908), Anderson (1913), Stefansson (1913), MacFarlane (1905). Recently there have been several reports by scientists on expeditions supported by the Canadian Government which have presented caribou data, such as: Jenness (1922), Hoare (1930), Porsild (1929), Blanchet (1930), Burwash (1931), Clarke (1940), (1942), Porsild (1945).

From these and numerous other reports it is possible to obtain a fairly complete picture of the distribution and movements of the barren-ground caribou in northern Canada at the time of the first visits of Europeans to the area. These observations are discussed from a geographical point of view in the following paragraphs:

Former Summer Range:

On Richards Island, at the mouth of the Mackenzie River and about the Eskimo Lakes to the eastward, caribou were once abundant during the summer months (Franklin 1828). Porsild (1929) interviewed in 1927 an old Eskimo who stated that he hunted caribou in the Eskimo Lakes area when he was first married. Porsild noted the species to be fairly numerous in the area and observed deeply worn trails indicating a larger population in the past. MacFarlane (1905) recorded that large numbers of caribou spent the summer on the tundra around the mouth of the Anderson River about 1858. Caribou bands were reported as reaching the Arctic coast in May at Franklin Bay by Stone (1900). They were reported from Liverpool and Darnley Bays during August, 1848, by Richardson (1851). Stefansson (1913) reported scattered bands during the summer of 1911 on the tundra bordering the Horton River. There is a gap in the observations from Pearce Point (Stefansson 1913) to Dolphin and Union Straits in the Bernard Harbour region. Here Stefansson records numerous bands crossing the straits to Victoria Island on May 1, 1911. This annual movement was also observed by Hoare (1927) from 1915 to 1919 and he estimated the herds to number in the millions.

According to Preble (1908) small bands of caribou were reported to spend the summer months in the vicinity of Great Bear Lake. Bell (1901) recorded the summer ranges as extending from the Coppermine River to sixty miles west of Fort Confidence on Dease Arm. Porsild (1929) reported caribou as fairly numerous in the Dismal Lakes region in May, 1928. Preble also reported a few on Leith Point during the summer months but the main range at this season was on the tundra to the east of Great Bear Lake. The Coppermine River drainage was first reported as the summer home of large herds of caribou by Hearne (1795). Franklin (1823) also reported herds in this area during his first expedition. During July and August of 1821, his party also observed numerous bands of caribou along the south shore of Coronation Gulf from the Tree River to Cape Turnagain on Kent Peninsula, including Detention Harbour, Arctic Sound, Hood River, Western River and Melville Sound. They also observed caribou on the islands in Bathurst Inlet. Hanbury (1904) also reported observing frequent small groups on Kent Peninsula on May 30, 1901.

From Kent Peninsula large herds crossed the ice to Victoria Island during the early summer. Collinson (1885) reported large herds in the vicinity of Cambridge Bay during October, 1852, awaiting the freezing of the straits. Stefansson recounted how he travelled amid numerous small bands of caribou across Dolphin and Union Straits in the spring of 1911 and on May 12, while south of Prince Albert Sound, Victoria Island, was still in the midst of moving herds. During the spring of 1901, Hanbury (1904) travelled north from Aberdeen Lake to Ogden Bay, Queen Maud Gulf, amid northward moving caribou. On May 11 he reached the coast and observed scattered bands. Proceeding west, he encountered other bands.

Inland in eastern Mackenzie District, Back (1836) observed large concentrations of caribou along the Back River in the early summer of 1834, especially in the vicinity of Lake Beechey. Franklin (1823) reported caribou on the upper Yellowknife River in August, 1820. Munn (1932) observed a concentration of many thousands of caribou on the shores of Artillery Lake in late July, 1892. Lakes Aylmer and Clinton-Colden were reported as summer range by Anderson and Stewart (1856). Large numbers of caribou were reported along the Hanbury and Thelon Rivers during July by Tyrrell (1902), Hoare (1930), Critchell-Bullock (1930-31) and Clarke (1940). The last-named observed a movement of an estimated 100,000-200,000 animals at Hanbury Lake.

In central Keewatin District, Tyrrell (1898) encountered a herd estimated at 100,000-200,000 animals on the shores of Carey Lake of the Dubawnt River system on July 29, 1893. On August 14, 1894, he encountered a large herd at Ennadai Lake, Kazan River. Further north, near Yathkyed Lake, he noted a caribou crossing point where the natives speared them. Porsild (MS.1930) reported scattered bands of caribou along the Kazan River in summer. Downes (1943) reported them from Nueltin Lake. Further north, on the lower Thelon River, caribou were reported as plentiful in the summer by Hanbury (1904) near Aberdeen, Beverley and Baker Lakes. On the lower Back river caribou were recorded by Back (1836) and Schwatka (1885). The latter explorer also observed small groups in the Wager Bay district in the spring of 1879.

On the Arctic coast of Keewatin, Adelaide Peninsula was recorded as summer range by Anderson and Stewart (1856). Schwatka (1885) observed large herds on King William Island during the summer of 1879. During the autumn herds numbering several thousand were observed crossing Simpson's Straits to the south on the first solid ice. The Eskimos told him that there was usually a second movement from Boothia peninsula. On that peninsula Ross (1835) recorded great numbers, which arrived from the south in April and May. MacFarlane (1905), writing of the period about 1857, reported that the barren-ground caribou crossed Bellot Strait to spend the summer on Somerset Island, where they were recorded by Ross (1826). The summer movement of caribou on to Melville peninsula was recorded by Rae (1850) at Repulse Bay and also as far north as Frazer Bay on the west side of the peninsula. Along the north-western coast of Hudson Bay these animals were recorded in summer from Chesterfield Inlet to Igloolik by Lyon (1824) and also by Parry (1824).

Along the western shore of Hudson Bay caribou were reported in summer at Wager Bay and Winchester Inlet by Schwatka (1885), at Chesterfield Inlet by Lyon (1824), at Rankin Inlet by Hanbury (1904), at Eskimo Point by Preble (1902). A few caribou were reported to remain on the tundra east of Churchill, Manitoba, during the summer months by both Preble (1902) and Hanbury (1904).

Hearne (1795) stated that the southern limit of the barren-ground caribou was the Churchill River. He spoke of large herds of "woodland caribou" which spent the winter months in the vicinity of the Nelson River. These herds travelled east in spring crossing the Nelson and Severn Rivers in May to spend the summers on the low shores of Hudson Bay east of Fort Severn. In the autumn they returned inland and migrated northwest, crossing the Hayes River about forty miles above York Factory. Preble (1902) also gave the same account and gave Cape Churchill as the northern "fringe" of bands which migrate to the Hudson Bay coast in spring, crossing the Nelson and Hayes Rivers.

On the other hand Tyrrell (1908), giving an account of a trip by dog-team from Churchill to the Nelson River in

November, 1893, wrote of observing bands of barren-ground caribou along the route. Tyrrell (1913) during his exploration of northern Patricia District, Ontario, in 1912, reported that barren-ground caribou spent the summer on the Hudson Bay shore west of Severn River and migrated west to the Hayes River, Manitoba, in the autumn. He quotes David Thompson as observing a herd of barren-ground caribou crossing the Hayes River eastward in May, 1802.

Mr. H. Conn of the Indian Affairs Branch, Department of Citizenship and Immigration, has informed me that the older Indian hunters at Fort Severn and Winisk, Ontario, remember hunting migratory barren-ground caribou in the autumn as they migrated southwest from the narrow tundra strip along the southern coast of Hudson Bay. Mr. Robert Smith, U.S. Fish and Wildlife Service, Klamath Falls, Oregon, informed me that during a waterfowl survey of the west coast of James Bay in 1944 he discovered antlers of the barren-ground type at Cape Henrietta Maria.

At present it is generally believed that woodland caribou (Rangifer caribou) do not undertake wide-ranging migratory movements, such as are characteristic of the barren-ground caribou. It therefore seems probable that the range of the barren-ground caribou formerly extended eastwart along the south shore of Hudson Bay as far as Cape Henrietta Maria and that Hearne and Preble erroneously believed these to be woodland caribou.

Individual caribou were sometimes reported during the summer in areas usually considered winter range and were considered as stragglers. The few caribou observed on the coast of Hudson Bay east of Churchill, Manitoba, may be considered in this classification. Tyrrell (1896) reported killing a barren-ground caribou on the north shore of Cree Lake in Saskatchewan in July, 1892. Clarke (1940) gives several summer records for the species between Great Slave and Athabaska Lakes north of Goldfields, Saskatchewan, and at Hill Island Lake, Mackenzie District.

Former Winter Range.

Summer was the period in which the early explorers did most of their travelling. There are, therefore, relatively few winter accounts of caribou in the arctic and subarctic regions of Canada.

The timbered areas on the eastern bank of the Mackenzie River north of Arctic Red River were described as former winter range by Porsild (1929). Caribou were reported to winter in large numbers in the upper Anderson River valley by MacFarlane (1905). In the Great Bear Lake Region, Stefansson (1913) reported large numbers spending the winter in the vicinity of Dease Arm, Franklin (1828) reported herds in winter in the vicinity of Fort Franklin, Stefansson (1913) also reported that about 50 years previous to 1908 herds of caribou used to migrate in winter as far west as the Mackenzie River in the vicinity of Fort Norman.

Large herds were reported by Russell (1898) to have migrated westward through Fort Rae in 1877 to spend the winter west of the north arm of Great Slave Lake. Preble (1908) also reported herds wintering in the vicinity of Fort Rae and that the area west of the Camsell River was a winter range of the species. Small numbers of caribou were reported by Franklin (1823) as spending the winter on the lower Yellowknife River. During the winter 1833-34, when Back wintered at Fort Reliance, Great Slave Lake caribou were so scarce as to cause extreme hardship to Indians and Europeans. He received reports, however, that they were fairly common near timberline north of MacLeod Bay and also along the upper Thelon River, far to the southeast.

Preble (1908) reported that herds spent the winter of 1900 about a day's journey east of Fort Smith. Harper (1932) reported that the caribou regularly frequented the Talston River valley in the winters up to 1911 but not subsequently, because the timber had been burnt off. He also stated that every ten years or so caribou crossed Lake Athabaska near Burntwood and Bustard Islands, to winter on the south side of the lake. Preble (op. cit.) reported that Indians told him that the species used to reach Fort McMurray, Alberta, in winter. Mr. Tyrrell (1896) stated that the winter range extended as far south as the southern tip of Reindeer Lake, and west to the Mudjatick and Foster Rivers and Cree Lake in Saskatchewan.

Hearne (1795) reported that in Manitoba herds of barren-ground caribou occurred along the Churchill River in the winter months. The winter occurrence of herds of caribou in the Nelson River drainage was also described by Hearne (op. cit.) and Pennant (1784). Tyrrell (1908) told of hunting wintering herds of caribou between Churchill and York Factory during November, 1893. Preble (1908) gave the dates of appearance of the migrating caribou at Lac du Brochet, Reindeer Lake, as recorded by Joseph Hourston from 1873 to 1890.

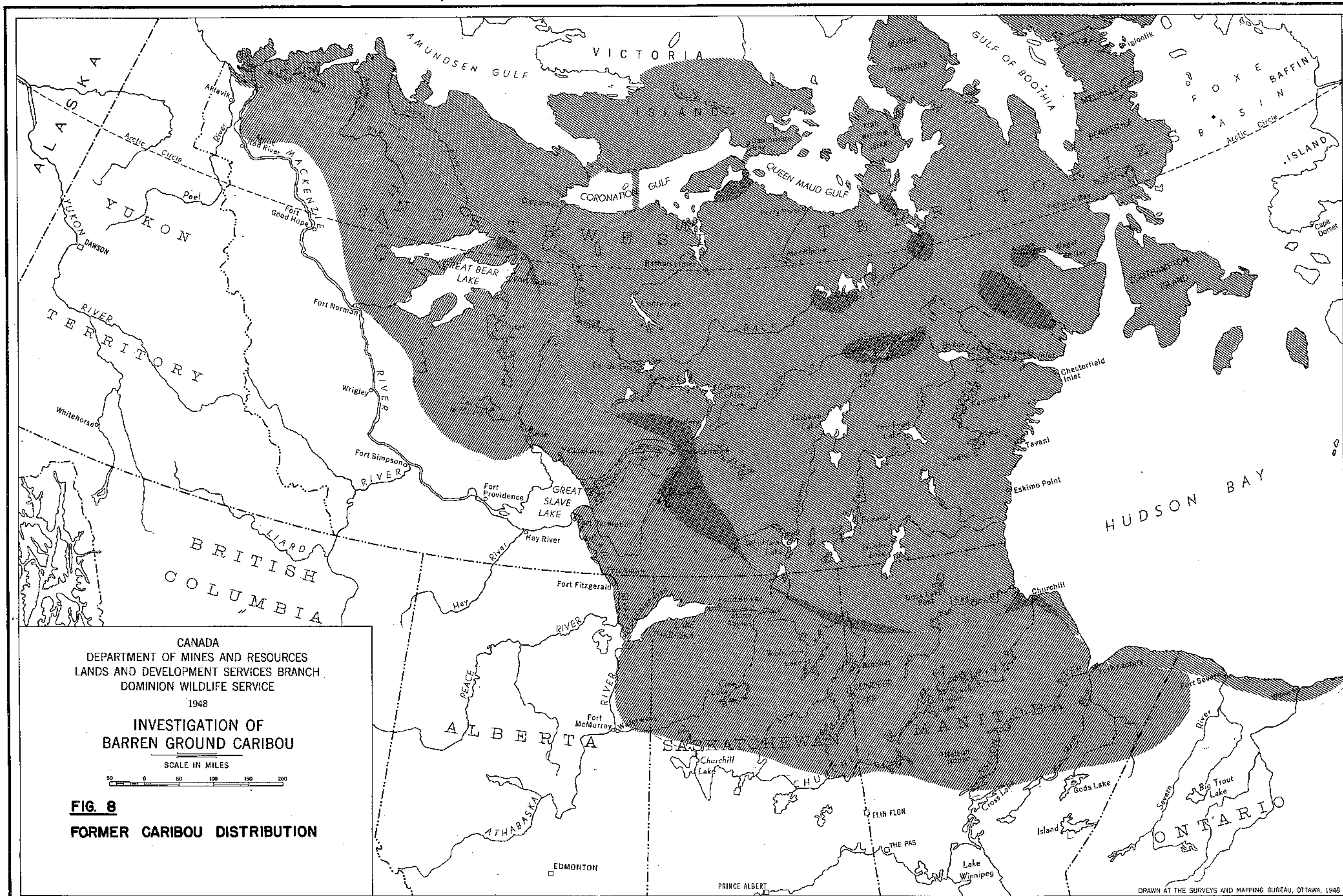
Hoare (1930) reported that herds carried out nomadic counter-clockwise movements in the vicinity of the timberline between Artillery Lake, McKay Lake, Snowdrift, Eileen Lake and Fort Reliance, Mackenzie District, during the winter of 1928-29. Critchell-Bullock (1930-31) reported winter movements in the Ptarmigan River area.

Although it seems that the majority of the caribou crossed the timberline and entered the spruce forests for the winter, small groups of caribou were reported by the early explorers on the barren grounds during the winter months. Schwatka (1885) observed scattered groups during his winter crossings from Winchester Inlet, Hudson Bay, to the mouth of the Back River in the years 1879 to 1880. He also reported that scattered groups were regularly in winter along the Hudson Bay coast from Chesterfield Inlet north to Wager Bay. Hanbury (1904) reported herds of caribou in the vicinity of Schultz and Aberdeen Lakes on the Thelon River during the winter.

On the Arctic coast, wintering bands of caribou were recorded on the Kent peninsula by Tyrrell (1902). The natives told him that none wintered between Cape Barrow and the Coppermine River or eastward from Kent peninsula to Ogden Bay.

The whereabouts of major migration crossing points was of great importance to natives and European explorers who relied on the barren-ground caribou for their existence on the tundra and in the subarctic forests. These favourite crossing points have been recorded in the writings of explorers and naturalists alike. Some of the more important of these migrations were as follows: Anderson River (MacFarlane, 1905), the upper Dease River (Stefansson, 1913), Dolphin and Union Straits (Stefansson, 1913), Kent peninsula - Cambridge Bay (Collinson 1889), Bathurst Inlet (Hoare, 1927). Contwoyto Lake (Hearne, 1795), Fort Rae (Russell, 1898), Point Lake (Hearne, 1795), Athabaska Lake (Harper, 1932), Fond-du-lac (Tyrrell, 1896), Dubawnt River (Tyrrell, 1898), Kazan River (Hearne, 1795), Lac-du-Brochet (Preble, 1908), Camsell River (Preble, 1908), Churchill River (Hearne, 1795), Nelson River (Hearne, 1795), Repulse Bay (Parry, 1824), Isthmus of Boothia (Ross, 1835), Simpson Straits (Schwatka, 1885), Bellot Straits (MacFarlane, 1905).

Many of the earlier naturalists estimated the total number of barren-ground caribou in the area under the present investigation. One of the most popular estimates was made by Seton (1929), who estimated a population of thirty million caribou in the central barren grounds of northern Canada in 1907. Most writers have grossly over-estimated the herds of



CANADA
DEPARTMENT OF MINES AND RESOURCES
LANDS AND DEVELOPMENT SERVICES BRANCH
DOMINION WILDLIFE SERVICE
1948

INVESTIGATION OF
BARREN GROUND CARIBOU

SCALE IN MILES

FIG. 8

FORMER CARIBOU DISTRIBUTION

caribou observed during a massed migration. They introduced a second error into their calculations by assuming an equally dense concentration of caribou beyond their field of view.

The most reliable estimation of the primitive caribou population was that of Anderson (1938) who based his calculations upon the carrying capacity of the arctic tundra and his knowledge of the total caribou range. Dr. Anderson estimated a total population of approximately two and one-half million animals on the continental barren-grounds west of Hudson Bay. Clarke (1940) accepted this estimate as a result of his investigations of the Thelon Game Sanctuary. From an analysis of the available literature and a comparison with present conditions it seems that this is the best possible estimate of the caribou population during the period 1850-1900, the period of the beginnings of the exploitation of Arctic Canada by Europeans.

The former summer and winter distribution, as well as major migration routes as gleaned from published reports and interviews with old residents, have been indicated in Figure 8.

Present Distribution

During the past decade several papers containing caribou distribution records made during expeditions in that period have appeared. These publications of Clarke (1942), Soper (1942), Porsild (1945), Manning (1943 and 1948), Harper (1949), Gavin (1945) and Croft and Gunn (1946) have been used in the preparation of the present distribution analysis. To these published data have been added the information available on the caribou questionnaires since 1940, as well as the records obtained during the present investigation from the observations of the field staff and from interviews with northern residents and travellers. The exposition of the present distribution has been based on the movements of caribou during the decade 1940 - 1950. The present distribution will be discussed under several headings, including winter range, summer range, population, migration routes and changes in status.

<u>Winter Ranges</u>

The first writers, Hearne (1795) and Richardson (1829), described the movement of the caribou herds to the taiga belt as if all herds undertook this movement. Later explorers, such as Schwatka (1885) and Hanbury (1904), noted the winter occurrence of bands of caribou on the tundra, where they sustained the inland Eskimo groups. It is now known that although the majority of caribou generally spend the period November to April annually within the taiga or at timberline, yet other lesser herds and scattered bands remain all winter on the tundra. These bands are usually found on the Arctic Sea and Hudson Bay coasts or on the shores of large lakes, such as Baker and Clinton-Colden Lakes. These tundra wintering grounds are usually found to be undulating areas with slopes that are frequently blown free of snow.

Aside from these bands, in the winter the majority of caribou are found distributed in the transcontinental taiga belt from the Mackenzie delta to extreme eastern Manitoba or rarely to the northwestern Ontario boundary. Generally the caribou are confined to the northern spruce - fir association (Shelford and Olson, 1935) of the larger taiga biome, or the Hudsonian Zone of Anderson (1937) and others. Locally the more southerly taiga associations, or the Canadian Zone (Anderson, op cit.) of the Mackenzie - Athabaska valley and central Saskatchewan and Manitoba, may be invaded during certain winters. During mild seasons the herds often congregate in the vicinity of timberline. During mild spells they may retrace their paths to the tundra, only to re-enter the forested belt on the return of severe winter conditions.

The climate of the winter range has previously been discussed in the account of general environmental conditions. The rock formations underlying the winter range are mostly archean igneous rocks and metamorphased protozoic rocks. Occasionally the herds invade areas underlain by early Palaeozoic formations.

The herds do not return each winter to the same areas. The usual pattern exhibited is for the animals to return for several seasons to the same general locality, then they will abandon this area and spend several winters in an area fifty to several hundred miles away. The reasons for these actions are not clearly understood. Factors such as weather and forest fires must be considered. It is probable, however, that the failure of the food supply upon the frequented winter ranges necessitates a movement to other areas.

The present winter distribution of caribou is shown in Figure 9. The areas currently supporting heavy winter populations are indicated by cross hatching, surrounded by other areas frequented by scattered bands or areas only irregularly invaded by caribou herds.

In the Mackenzie District the regular taiga winter range extends from the forks of the Anderson River in the extreme northwest and includes Coville Lake, the north shore of Great Bear Lake, including Dease and Smith Arms, the Dease River basin, Fort Franklin district and the Bear River, Hottah Lake, the Camsell River valley, Lake Grandin, Lac la Martre, the lower Snare River, the northeast and southeast shores of Great Slave Lake, including the Wecho, Yellowknife and Beaulieu River systems, Nonacho Lake and the Talston River system and eastward to the upper Dubawnt River, Wholdaia and Selwyn Lakes.

In Alberta, the winter range lies along the eastern bank of the Slave River from Fort Fitzgerald to Fort Chipewyan. Rarely it extends west of the Slave River and to the south shore of Lake Athabaska, east of Athabaska River. In Saskatchewan, the range extends from the northern shore of Lake Athabaska southward, including Black and Wollaston Lakes, to the southern tip of Reindeer Lake, the Foster Lakes, Cree Lake and the upper Clearwater River. In Manitoba, the winter range extends eastward from the Cochrane River and Reindeer Lake, including the Upper Seal River drainage, the Churchill River system, Nelson House and the Nelson river as far as Cross Lake, east to the Hayes River, Gods Lake and the Ontario boundary.

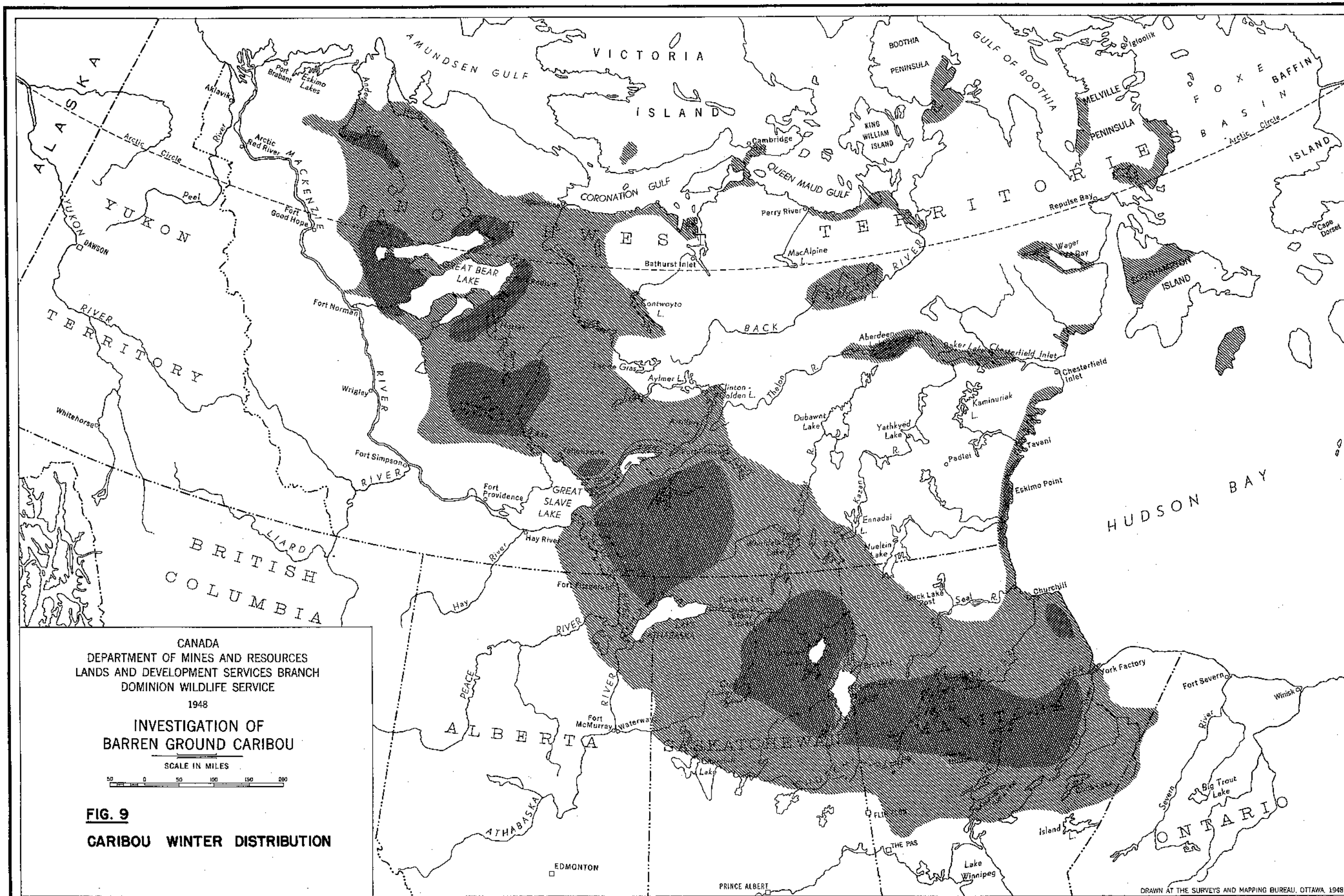


FIG. 9

CARIBOU WINTER DISTRIBUTION

During the winter months scattered bands of caribou occur on the timberline in the vicinity of the Horton River, Coppermine River, Lockhart River, upper Thelon River, Dubawnt River, Kazan River and Nueltin Lake.

The extreme distances that the caribou have penetrated the taiga belt in recent years are as follows: 30 miles east of Fort Good Hope (1946-7), the Mackenzie River crossed in the vicinity of Norman Wells (1945-6), ten miles east of Fort Norman (1946-7), Johnny Hoe River (1938-9), Willow Lake River, 40 miles north of Fort Simpson (1949), Yellowknife (1941), Wood Buffalo Park (1939-40), Lake Clair (1938-39), Embarras Portage (1942-43), Clearwater River (1936-37), Churchill River, Saskatchewan (1943-44), Stanley, Saskatchewan (1946-47), The Pas, Manitoba (1946-47), Cross Lake (1945-46), Island Lake (1943-44), Little Sachigo Lake, Ontario (1947).

The tundra regions frequented by caribou during the winter months are as follows: in Mackenzie District, the upper Horton River, Coronation gulf coast, the islands in Bathurst Inlet, the upper Thelon River; in Keewatin District, the mouth of the Back River, the base of Boothia peninsula, the western and eastern coasts of the Melville peninsula (Manning, 1943), Wager Bay, Winchester Inlet, the lower Thelon from Aberdeen Lake to the eastern end of Baker Lake, the western coast of Hudson Bay from Rankin Inlet south to Nunella.

The area delineated on Figure 7 which may be considered the normal winter range has a total area of approximately 295,000 square miles.

Summer Ranges

During late winter, in April and May, with the lengthening of the daylight hours and the fine weather which generally occurs at that season in the arctic and subarctic areas, there is a general movement of caribou towards the tundra. During the "summer" months of June, July, August and September, with few exceptions the entire population of barren-ground caribou inhabits the tundra belt, beyond the tree-line, in Mackenzie, Keewatin and Franklin Districts of the Northwest Territories and in Manitoba.

Throughout these months the herds are generally in movement. In June and early July the movement is away from the timberline. In late July or early August this direction is reversed and there is a drift towards the tree-line again. By the first of September, the majority of caribou are in the vicinity of the tree-line. Some bands may penetrate the taiga belt a short distance at this time. This late summer movement appears to be in the nature of a backwash of the spring movement. With the approach of the rutting season in autumn there is a second movement out on to the tundra.

Although this late summer movement of the caribou has been well known to residents in the caribou range, it seems to have been overlooked by the early explorers and writers. It was first correctly described by Clarke (1940). This movement will be considered in more detail in a later section.

As in the case of winter ranges, the same summer ranges are not frequented annually. For several years a major herd may spend the early summer in a certain area only to desert it in subsequent seasons. Again it seems that forage requirements necessitate the utilization of different ranges.

The areas which generally support large concentrations of caribou during the summer months are indicated in Figure 8, along with marginal areas which are inhabited by scattered groups, or which only occasionally are frequented by large numbers of caribou. The summer climate of this area has been discussed in general previously.

Not all the caribou, however, reach the tundra in the summer. Tyrrell (1896) reported killing a barren-ground caribou just north of Cree Lake during the summer of 1892. Mr. W. Macdonald, of Yellowknife, reported observing a small group of caribou on the southeast shore of Lake Athabaska during the summer of 1935. The same summer caribou were reported to Clarke (1940) from the Fort Fitzgerald area and north of Goldfields. Small groups of caribou regularly spend the summer months upon the tundra east of Churchill to Point Churchill, Manitoba. Saskatchewan residents reported to the author that occassionally small groups of caribou spend the summer on the islands in Wollaston and Reindeer Lakes. The most logical explanation of these facts is that these individual animals were stragglers in the spring movement and became isolated behind large bodies of water at the time of the spring break-up.

In Mackenzie District the tundra summer range extends from the Eskimo Lakes in the extreme northwest along the Arctic coast to Liverpool and Darnley Bays, thence inland to the Horton River basin, Richardson River, and the Coppermine River valley; again on the Arctic coast from the Tree River to the Western River, with adjacent inland areas, including the Hood and Burnside River valleys. To the eastward scattered bands occur in the vicinity of the Ellice and Perry Rivers. In southern Mackenzie District, caribou range during the summer months in the valleys of the Lackhart, Thelon and Back Rivers. They reach the headwaters of the Snowdrift River in late summer.

In Keewatin District the greatest summer concentrations are in the lower Thelon, Dubawnt, Kazan and Ferguson River systems. To the northward lesser bands frequent the Arctic coast in the vicinity of Queen Maud Gulf, Sherman Inlet, Adelaide peninsula, the lower Back River, the southeast coast of Boothia peninsula, Committee Bay, the east central and west central coasts of Melville peninsula and Wager Bay. In southern Keewatin large concentrations occur in late summer from Kaminuriak Lake south to Nueltin Lake and on the coast southward to Nunalla.

During late summer, bands of caribou may occasionally reach extreme northeastern Saskatchewan in their southward drift.

The most southerly regular summer range of the race is on the narrow coastal strip of tundra east of Churchill, Manitoba, to Cape Churchill and south to the mouth of the Owl

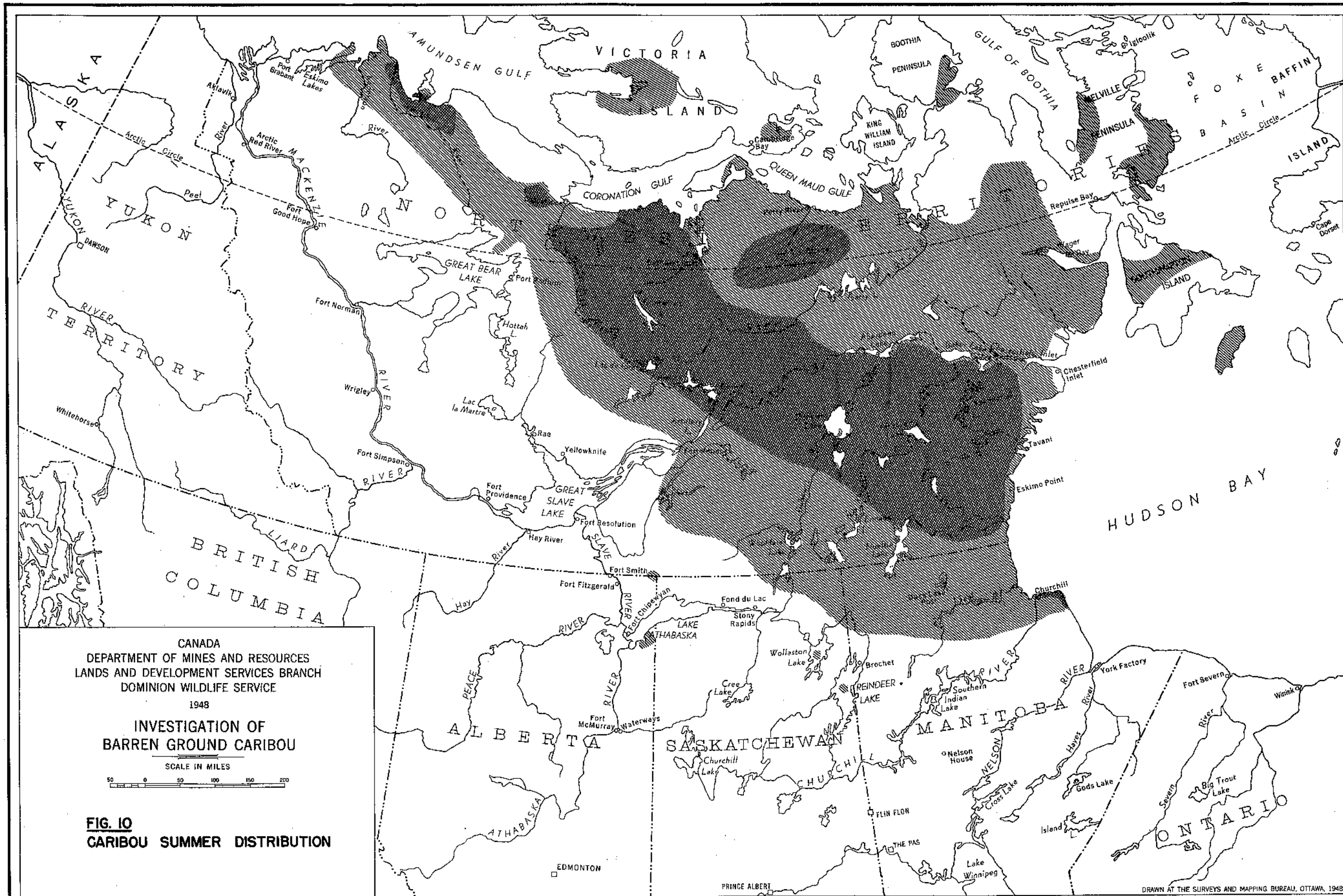


FIG. 10
CARIBOU SUMMER DISTRIBUTION

River. During late summer bands of caribou may travel down the western coast of Hudson Bay as far as the Churchill River.

From Figure 10 the total area of the normal summer range has been calculated to be about 300,000 square miles. It seems that the area occupied during the summer is of approximately the same size as that occupied during the winter.

Present Status

Barren-ground caribou are not evenly distributed over these vast areas in summer and in winter. One may fly long distances over the tundra in summer or the taiga in winter without observing caribou. Or in the space of a short flight many thousands may be observed. The greater number of caribou occur in large herds, which may include anywhere from several thousand to a hundred thousand or more individuals. These herds have general areas in which they carry out their annual movements. The exact ranges and routes may vary from year to year within limits. All the individuals in the herd carry out the same general pattern of movements, although the herd may be compact or attenuated. These large herds seem to be population entities and further investigation may prove that certain herds are of geographic subspecific rank. These major herds may independently thrive or be decimated by human utilization. Occasionally two of these large herds may approach each other's summer range and there may then be an exchange of peripheral bands.

Between these major herds are smaller bands of caribou which are more or less independent of the larger groups. At times these bands may be increased by other stragglers, or they may join a nearby herd. The greater part of the total range of the race is inhabited by such scattered bands of caribou, whose annual movements are less regular than those of the main herds. These facts are best explained by considering the food requirements of a herd of ten thousand animals compared with those of a band of twenty-five animals, on similar ranges where the forage production is limited. It is evident that the larger herd would be forced to keep in motion in order to obtain food for all, while the small band could obtain its forage requirements with minimum local movements.

It has been the general experience during the past century that where herds of caribou have decreased drastically in numbers from over-utilization, the remaining scattered groups cease regular obvious movements and instead carry out local wanderings.

Before discussing the migration routes it will be necessary to outline the major herds and their summer, winter and rutting areas. Utilizing all available information the writer has distinguished the main herds and their ranges as shown in table 1. This herd analysis agrees fairly well with that of Clarke (1940).

Table 1. Record of present caribou herds - 1950.

#	Name	Winter Range	Summer Range	Population
1	Colville Lake	Colville L. area	Liverpool - Darnley Bay	5,000
2	Great Bear	Ft. Franklin - Dease Bay	Richardson and Coppermine R.	30,000
3	Radium	Hottah Lake	Tree River	5,000
4	Rae	Lac la Martre	Bathurst Inlet	210,000
5	Yellowknife	N. Shore Great Slave Lake	Upper Back R.	4,000
6	Hanbury	Talston River	Lake Beechey	175,000
7	Athabaska	Lake Athabaska	Thelon Lakes	75,000
8	Saskatchewan	Wollaston Lake	Kazan River	25,000
9	Brochet	Reindeer Lake	Baker Lake	40,000
10	Duck Lake	Nelson House	Baker Lake	25,000
11	Churchill	Nelson River	Baker Lake	55,000
12	Melville Pen.	Melville Pen.	Melville Pen.	3,000
13	Boothia Pen.	Boothia Pen.	Boothia Pen.	2,000
14	Victoria Is.	Victoria Is.	Victoria Is.	1,000
15	Southampton Is.	Southampton Is.	Southampton Is.	500
16	Coates Is.	Coates Is.	Coates Is.	500
17	Aberdeen Lake	Aberdeen Lake	Perry River	10,000
18	Hudson Bay	H.B. coast, Daly Bay.	Mouth of Back R.	3,500
19	Adelaide Pen.	Back River	Adelaide & Sherman Gulfs	500
				670,000

By means of flying transects over the migrating caribou herds, as previously described in this report, population estimates for the main herds were calculated. Strip census figures were obtained from counts and photographs of large concentrations. The areas covered by the herds were then delineated by aerial reconnaissance and after the assumption of an equal concentration in the areas not covered, the total population estimate was calculated.

On a couple of occasions, exceptional coverage of the Rae herd was obtained when the herd was observed concentrated in a narrow corridor and a particularly complete count was obtained as shown in plate 1. (aerial view of caribou herd).

The population information derived from all the flights carried out during the investigation is listed in table 2. The flights are numbered consecutively as indicated in figure I, where the routes are shown in detail. Also given in table 2 are the date, destination and length of each flight, the length of the flight over the corridors of migrating caribou, the average width of the field of vision (which varied with altitude, type of vegetative cover, terrain etc.), the transect area, the number of caribou observed (from which the number of caribou per square mile was calculated) and the number of wolves observed during each flight.

The population estimates of the various herds were not made directly from these data. The flight data were plotted on large-scale maps. The boundaries of the migration

TABLE 2.

AERIAL RECONNAISSANCE FLIGHTS

Flight Number	Date	Route	Mileage	Mileage in Caribou Herd	Width of Strip mi.	Area sq. mi.	Caribou	Caribou / sq. mile	Wolves
1	15 July '46	Edmonton - Aklavik	1350	0	0	0	0	0	0
2	17 Aug. '46	Aklavik - Edmonton	1350	0	0	0	0	0	0
3	13 Apr. '48	Ottawa - Churchill	1250	0	0	0	0	0	0
4	16 " "	Ch. - Port Nelson	388	116	4	546	3825	7.00	6
5	17 " "	" - Eskimo Point	404	124	5	620	1700	2.75	3
6	19 " "	" - Split Lake	548	92	4	368	2600	7.06	5
7	20 " "	" - Padlei	692	228	4.5	1080	905	0.84	1
8	21 " "	" - Chesterfield	812	96	5	480	965	2.01	0
9	24 " "	" - Brochet	632	219	3	657	430	0.65	0
10	4 May "	" - Coppermine	1725	214	4	852	1400	1.65	1
11	5 " "	Ft.Smith - Churchill	1628	208	4	832	1200	1.45	0
12	6 " "	Ch. - Nueltin Lake	528	262	3.5	944	2630	2.79	1
13	7 " "	" - Nelson River	612	368	3.5	1196	1820	1.54	9
14	8 " "	" - Cochrane River	792	310	2.5	812	877	1.08	2
15	11 " "	" - Baker Lake	464	118	5	590	8750	14.8	0
16	12 " "	Baker Lake - Back R.	532	232	4	928	470	0.51	0

Flight Number	Date	Route	Mileage	Mileage in Caribou Herd	Width of Strip mi.	Area sq. mi.	Caribou	Caribou / sq. mile	Wolves
17	13 May, '48	Baker Lake - Ch.	475	216	5	1080	4260	3.95	0
18	14 " "	Ch. - Nueltin Lake	530	314	2.5	824	1400	1.70	0
19	15 " "	Ch. - Ilford	572	146	3.	404	880	2.18	1
20	17 " "	Ch. - Kazan R.	740	274	4.	1058	1815	1.73	2
21	2 July "	Ft.Smith - Ft.Reliance	228	0	0	0	0	0	0
22	6 " "	Reliance - Muskox Lake	244	0	0	0	0	0	1
23	2 Aug. "	Clinton-Colden - Walmsley	120	120	4	480	35	0.73	0
24	2 Sept. "	Clinton-Colden - Reliance	96	25	4	100	10	0.10	0
25	3 " "	Ft. Reliance - Ft.Smith	228	0	0	0	0	0	0
26	27 Jan. '49	Prince Albert - Missi L.	286	28	3	84.	105	1.25	0
27	28 " "	Missi L.-Stoney Rapid	258	156	3	468	1224	2.62	0
28	29 " "	Stoney-Fond-du-lac	148	8	3	24	16	0.67	0
29	31 " "	" Prince Albert	462	56	3	168	41	0.25	0
30	2 Feb. "	" " "	462	120	3	360	164	0.46	0
31	4 " "	P.A. - Brochet	394	16	3	48	12	0.25	0
32	5 " "	Brochet - P. A.	482	136	3	308	163	0.53	0
33	21 Apr. "	Edmonton-Yellowknife	650	0	0	0	0	0	0

Flight Number	Date	Route	Mileage	Mileage in Caribou Herd	Width of Strip mi.	Area sq. mi.	Caribou	Caribou / sq. mi.	Wolves
34	24 Apr. '49	Yk. - Ghost Lake	444	88	4	352	100,000	283.	20
35	25 " "	" - Reliance	376	12	3	36	20	0.6	3
36	26 " "	Reliance - Thelon	512	192	8	1536	36,750	20.7	4
37	27 " "	" - Sid Lake	374	152	8	1216	10,067	8.25	8
38	27 " "	" - Yellowknife	176	20	3	60	85	1.4	0
39	28 " "	Yk. - Ghost Lake	256	40	4	160	40,000	250.	6
40	29 " "	" - Yellowknife R.	136	0	0	0	0	0	0
41	29 " "	" - Lac la Martre	428	48	4	192	467	2.43	0
42	1 May "	" - Fort Smith	200	0	0	0	0	0	0
43	25 June "	Ft.Smith - Ft.Reliance	228	0	0	0	0	0	0
44	1 July "	Ft.Reliance - Artillery L.	52	0	0	0	0	0	0
45	3 " "	" " - Aylmer L.	188	52	4	224	219	1.00	0
46	11 " "	" " - Bathurst Inlet.	300	172	6	1032	5,140	3.90	0
47	24 " "	Bathurst - Arctic Sound	232	232	8	1856	126,795	68.4	1
48	26 " "	" - Perry R.	416	14	4	56	211	3.78	0
49	1 Aug. "	" - Contwoyto L.	125	10	8	80	20	0.25	0
50	19 " "	Contwoyto L. - Ft.Smith	448	40	8	320	350	1.09	0
51	21 March "	Smith - Fond du Lac	264	8	3	24	17	0.71	0
52	22 " "	Fond-du-lac - Snowbird	384	96	3	288	500	1.74	0
53	23 " "	" " " - Chipewyan	312	192	3	576	120	0.29	0
54	25-27 Aug. '48	Aklavik - Paulutuk	880	0	4	0	0	0	0
55	28 Jan. '49	Ilford - Oxford House	80	44	2	88	36	0.41	0
56	29 " "	Oxford House - Shamattawa	138	0	-	-	0	0	0

Flight Number	Date	Route	Mileage	Mileage in Caribou Herd	Width of Strip mi.	Area sq.mi.	Caribou	Caribou / sq. mi.	Wolves
57	31 Jan. '49	Shamattawa - York Factory.	96	18	2	36	33	0.92	0
58	1 Feb. "	York Factory - Ch.	176	0	-	-	0	-	0
59	4 " "	Ch. - Duck Lake	288	0	-	-	0	-	0
60	5 " "	" - South Indian L.	234	92	2	184	177	0.96	0
61	6 " "	South Indian - The Pas	250	0	-	-	0	-	0
62	12 " "	The Pas - South Indian	260	0	-	-	0	-	0
63	13 " "	South Indian - Big Sand	254	198	2	396	261	.66	0
64	16 " "	South Indian - The Pas	336	80	2	160	28	.18	0
65	17 " "	Lynn Lake - The Pas	344	18	2	36	2	.06	0
66	18 " "	Nelson House - Barrington L.	220	8	2	16	7	.44	
67	28 " "	The Pas - Cross Lake, Island L.	672	0	-		0		0
68	28 " "	The Pas - Brochet	224	28	2	56	32	0.58	0
69	29 " "	Brochet - Putahow L. N.W.T.	416	-	-	-	7	-	0
70	30 " "	" - The Pas	318	52	2	104	72	0.76	4
71	16 May "	Ch. - Nueltin Lake	264	36	2	72	50	0.76	0
72	17 " "	Nueltin Lake - Baker Lake	324	36	4	144	750	5.22	0
73	1 June "	Baker Lake - Beverley Lake	164	22	4	88	3000	34.0	0

Flight Number	Date	Route	Mileage	Mileage in Caribou Herd	Width of Strip Mi.	Area sq. mi.	Caribou	Caribou / sq. mi.	Wolves
74	1 Aug. '49	Beverley Lake - Baker Lake	152	0	-	-	0	-	0
75	2 " "	Baker Lake - Nueltin Lake	298	0	-	-	0	-	0
76	27 " "	Nueltin Lake - Churchill	265	-	-	-	7	-	0
77	23 May '48	Churchill - Nueltin Lake	265	-	-	-	2	-	0
78	20 July "	Nueltin Lake - Angikuni Lake	136	-	-	-	0	-	0
79	15 Aug. "	Angikuni Lake - Nueltin Lake	136	-	-	-	8	-	-
80	13 Oct. "	Nueltin Lake - Brochet	240	-	-	-	-	-	-
81	10 Dec. "	Nueltin Lake - Churchill	265	-	-	-	0	-	0
82	9 Feb. '50	Churchill - Duck Lake	278	0	-	-	0	-	0
83	10 " "	Churchill - York Factory	308	96	1	96	825	8.59	3
84	13 " "	Churchill - Chesterfield Inlet	372	84	2	168	338	2.05	0
85	20-23 Feb."	Churchill - Snowbird Lake	810	0	-	-	0	-	0
86	22-23 Apr."	Yellowknife - Radium	290	0	-	-	0	-	0
87	24 " "	Radium - Franklin - Coppermine	610	0	-	-	0	-	0
		Totals	35,896			24,963	358,593		82

corridors were drawn and the positions of the head and tail of each moving herd were fixed. The flight data obtained during this migration period were then re-arranged to show the transects across the corridors and the caribou observed. By means of a planimeter the corridor area was found. Finally a total population estimate was made using the transect caribou density figures.

In the case of several herds many flights had been made over the migration routes and so several sets of data were available on various sections of the route. The most complete data available were those obtained for the Manitoba herds during April and May, 1948. The complete routes were divided into seven sections and independent estimates were made for each section. These routes are indicated on a later spring migration figure. The population analysis for the Manitoba herds is shown in Appendix 1, where the calculations for the population estimates of the other herds also appear. These estimates tend to be minimal. The major source of error is in the herd boundaries. In each case these have been drawn conservatively, based on the terminal animals or fresh tracks observed. The areas frequented by animals may have been larger. Another source of error is the fact that most estimates were made during the spring migration period and it is probable that straggling herds may have remained undetected on the winter range. On the open tundra, the transect counts may be relied upon as being fairly accurate. In the taiga belt, however, it is likely that some groups were not enumerated because they were hidden among the trees. The width of each transect was adjusted, in flight, to compensate for this error and advantage was taken of the caribou's habit of lying on the frozen lakes in the afternoon.

The figures obtained in Appendix 1 have been adjusted by the addition of 1000 - 2000, to allow for missed groups and to bring the estimate to the nearest even five thousand. The estimated populations of the various herds are stated in Table 1 and are based primarily on aerial counts. Some of the herds, however, were not observed to the best advantage from the air. For these herds the counts of dependable observers have been used. The field investigators have also had opportunities to estimate the numbers of several herds on the ground at crossing points. All these data have been used in the total estimate.

The total population of barren-ground caribou on the mainland is estimated to be approximately 670,000. This figure is probably a minimal estimate, since there might be bands not enumerated. This estimate is probably accurate within 20 per cent. This gives an estimated average concentrations of 2.27 caribou per square mile of winter range, and 2.24 caribou per square mile of summer range.

It is noted from table 2, that during migrations the density of caribou may be as high as 283 animals per square mile. On a crowded summer range at Bathurst Inlet the observed density of caribou was 68 per square mile. The average observed density on the winter range in Saskatchewan was 1.18

animals per square mile. Lawrie estimated 2 animals per square mile on the Manitoba winter range.

Migration Routes

The word migration has come to have so many specialized meanings that it is considered expedient to define its use in this report. Migration is here used to describe the extensive wanderings or movements of caribou bands. It is not meant to imply that these movements are necessarily comparable to bird migration, for instance.

The caribou herds travel from summer ranges to winter ranges over distinct migration routes. These routes are marked by deep parallel trails which cross great areas of tundra and adjoining taiga. These trails are a characteristic feature of the tundra and are clearly observed from aircraft. They usually follow the line of least physical resistance, extending up long draws, through natural defiles along rock faults and beside lake shores, and leading to river and lake crossings at fords, rapids and narrows (see plates 11 and 12). Such trails are useful to the hunter and traveller, as they are paths on which walking is easy.

The trails are generally 6 - 12 inches wide, clear of vegetation, sometimes worn as much as 4 inches deep through the hummocks and surface debris by constant use of herds over a period of many years. There are usually parallel trails, 1 to 3 feet apart. As many as 12 parallel trails have been counted on one route.

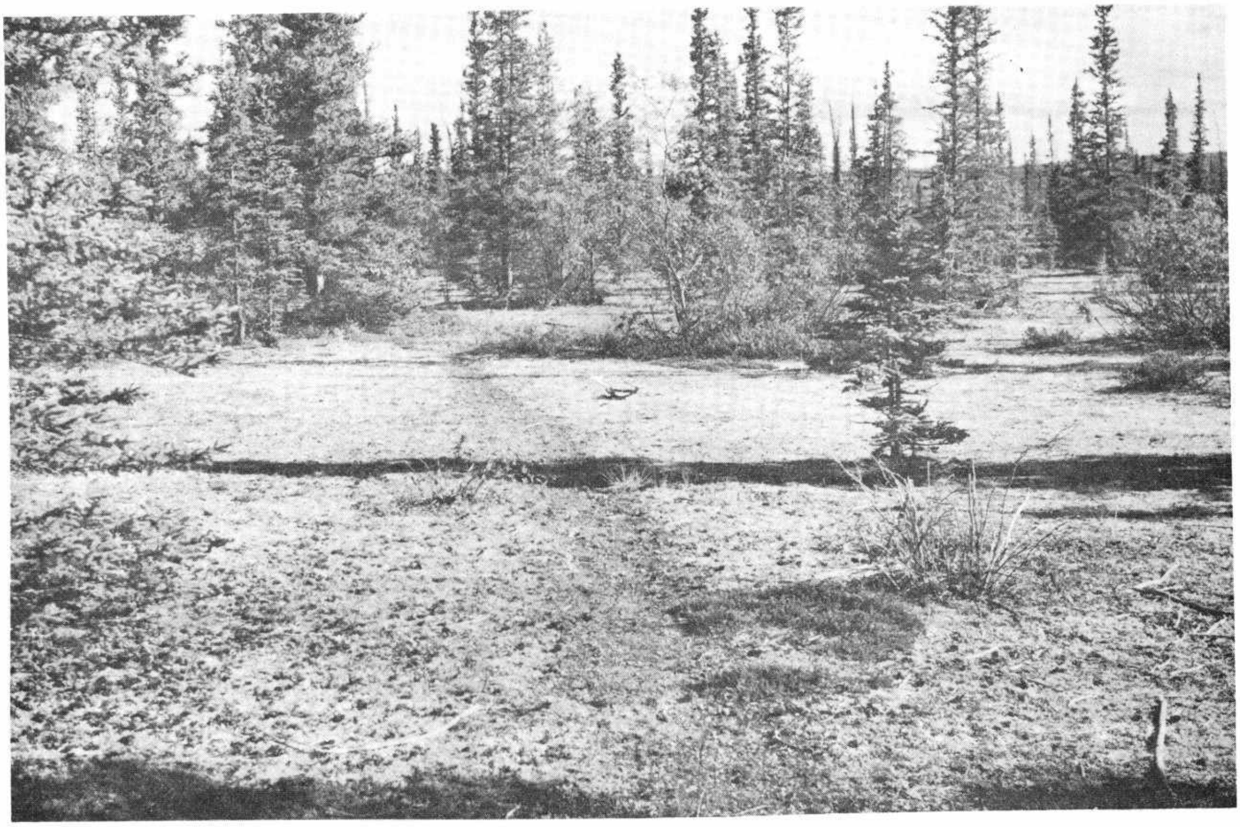


Figure 11. Caribou trail through taiga near Fort Reliance, N.W.T.

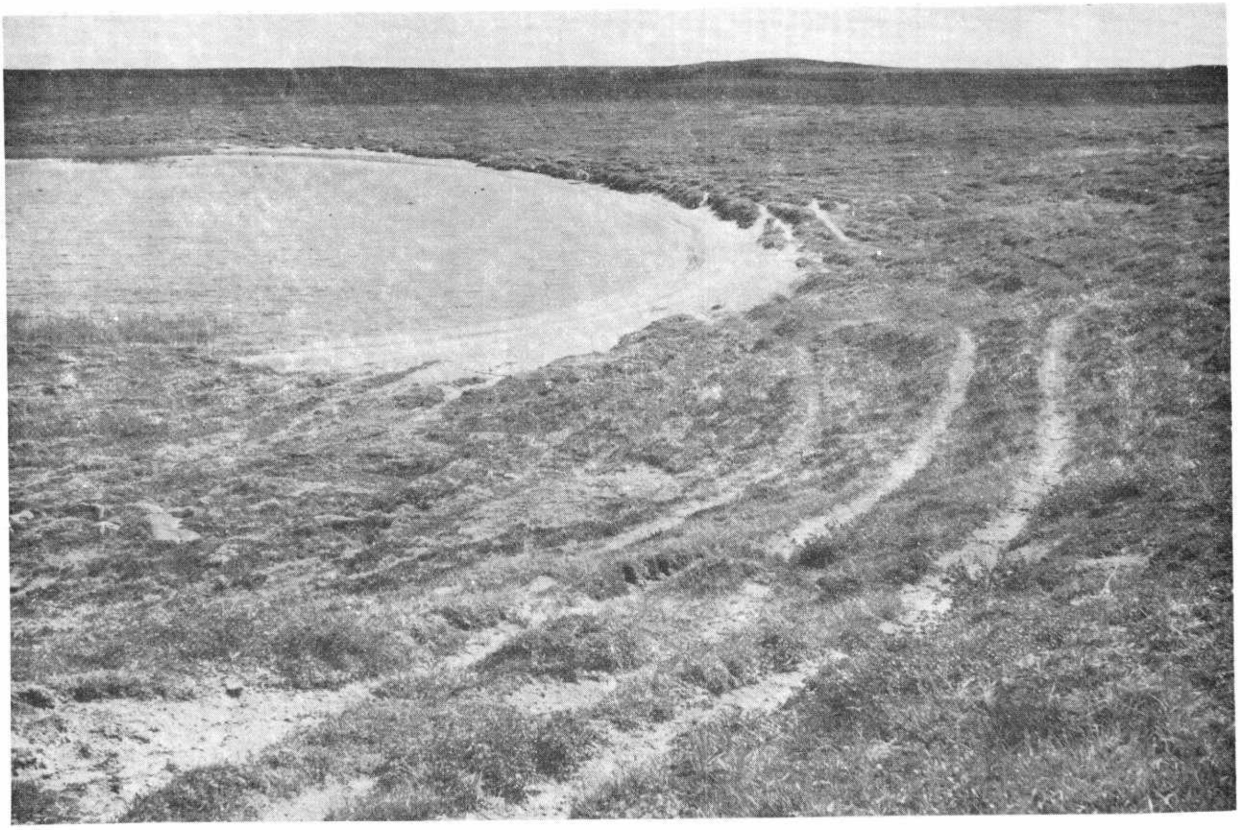


Figure 12. Caribou trails on the tundra at Contwoyto Lake, N.W.T.

The exact route taken by the herds during seasonal migrations depends upon several factors, the most important of which are the location of the range which the animals are leaving and the location of the range to which they are proceeding. If a new winter range was reached during the winter the spring migration route will probably be different from previous ones, since the animals will travel towards the summer range from the new location. Other factors, such as local topography, areas burnt by forest fires, overgrazed or unproductive areas and excessive hunting, will have a part in determining which route is taken.

During the spring migrations the routes lie along frozen watersheds the axes of which are in the direction of migration. The caribou herds migrate upon the frozen lakes and rivers. During summer and autumn migrations the animals tend to follow heights of land and to cross the watersheds. The different directions of travel cause much criss-crossing of the caribou trails.

The natives and European trappers of the caribou range have become familiar with the routes generally used by caribou during migration periods. The hunters congregate at well known lake crossings or defiles in order to secure their needed supplies of meats and hides. They are unable to forecast with certainty the appearance of the herds and if for any reason the caribou fail to use the favourite migration route, the hunters may suffer dire consequences, as Back did in 1833-34. Unless the hunters happen across the new route they are likely to conclude that the caribou herds have been decimated. With the increased amount of air travel in northern Canada to-day, the residents are often advised by pilots of the whereabouts of migrating caribou.

Spring Migration

During April and May there is a general migration of the large herds from the winter ranges on the northern fringes of the taiga towards the tundra summer range. The usual routes followed by the herds during this migration period are indicated in figure 13. This information has been derived from personal observation and the reports of police and wardens, as well as from questionnaires and interviews with trappers. The routes shown were those used during the seasons of 1948 and 1949. As explained previously, deviations from these routes will occur from time to time. The routes used by the individual herds will be considered in detail.

Colville Lake Herd

From the area about Colville Lake the route leads northeast to the headwaters of the Anderson River. It then turns north, following the route of the Anderson River valley as far as timberline at latitude 69° degrees. Here the route divides and the larger bands turn eastward and cross the tundra towards the mouth of the Horton River. The migration may extend eastward along the Arctic coast as far as Cape Lyon, east

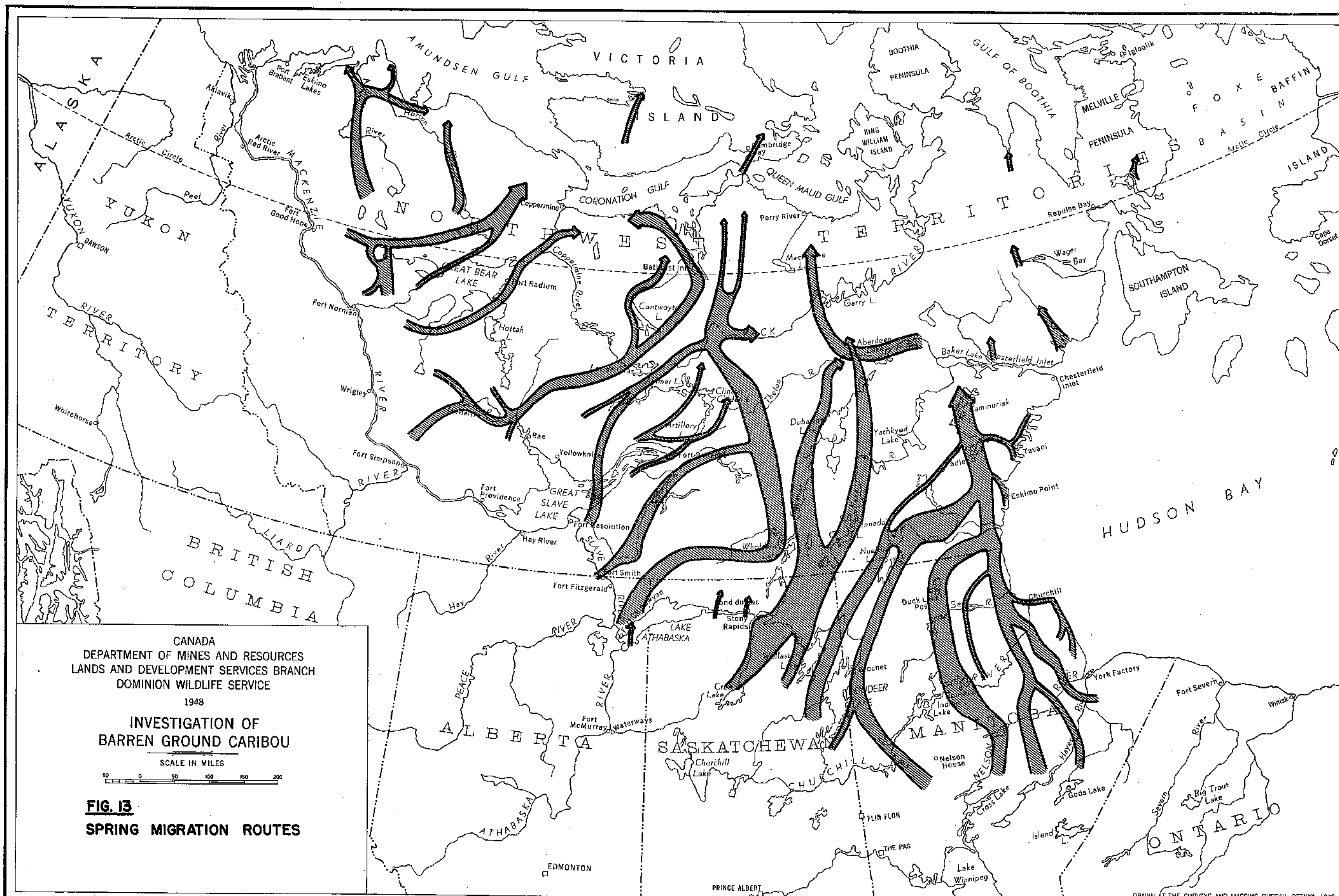


FIG. 13

SPRING MIGRATION ROUTES

of Darnley Bay. From the Anderson River small bands may swing northwest and reach the Arctic coast in the vicinity of Liverpool Bay or as far west as the Eskimo Lakes.

Great Bear Herd

From winter ranges in the vicinity of Fort Franklin, Great Bear River and Brackett Lake the spring migration route leads northward to Smith Arm, Great Bear Lake, which may be crossed or circumpassed. The route then turns eastward along the north shore of Great Bear Lake to Dease Arm. A second route from Fort Franklin leads northwest along the western shore of Keith Arm and across Deerpass Bay. The lake is crossed from Etacha Point to MacDonnel Point and Dease Arm so reached. From Dease Arm the route turns north, the headwaters of the Horton River are crossed and the caribou bands reach the tundra. The movement usually extends northeast to the headwaters of the Richardson and Rae Rivers and the Dismal Lakes area. From Dease Arm bands may ascend the Dease River to the tundra.

Radium Herd

Smaller herds of caribou spend the winter on the eastern shore of McTavish Arm, Great Bear Lake. The range may extend as far as Hottah Lake or the Johnny Hoe River. In spring these herds travel northeast along the eastern shore of Great Bear Lake to Hornby Bay, then turn eastward, ascending rivers such as the Sloan, and reach the Coppermine River. The movement generally extends eastward onto the tundra east of the Coppermine in the vicinity of the September Mountains.

Rae Herd

From winter ranges west of Lac la Martre, in the regions of Lakes Tache and Grandin and Willowlake River, the routes converge east to the southern end of Lac la Martre. Here the route turns northeast and ascends the Emile and Snare Rivers to Ghost Lake, where it turns easterly up the Ghost River towards timberline in the vicinity of Jolly Lake and Winter Lake. The Yellowknife River is crossed in the vicinity of Lake Providence. The route extends northeast from here, past Yamba and Ajax Lakes to the southern end of Contwoyto Lake and continues northeast to the headwaters of the Western River and the tip of Bathurst Inlet. After reaching the Arctic coast at Bathurst Inlet the route turns northwest along the western shore of the Inlet and continues across the Burnside and Hood Rivers. The greater part of the herds find summer pasturage in the vicinity of Arctic Sound but some movement may continue west as far as Gray Bay and the mouth of the Tree River. From Contwoyto Lake, the herds may reach the coast by a second route leading down the Burnside River.

Yellowknife Herd

From winter ranges along the northeast shore of Great Slave Lake, spring migration routes lead northeast via the river valleys of the Wecho, Yellowknife and Beaulieu Rivers towards the headwaters of the Lockhart River, near Courageous and MacKay Lakes. Frequently there is a northward movement of caribou across Great Slave Lake from Rocher River to Gros Cap via the Simpson Islands and up the Beaulieu River. On the tundra these herds continue their northeast direction towards Muskox Lake and the upper Back River as far as Lake Beechey. The Back River may first be reached at Sussex, Muskox or Regan Lakes. Occasionally bands of caribou may use winter ranges north of McLeod Bay, Great Slave Lake. The spring migration route of these bands is directly east, crossing Artillery Lake, until the Hanbury River is reached. Then they turn north towards the Back River.

Hanbury Herd

From winter ranges between Great Slave and Athabaska Lakes, in the drainages of the Talston, Tazin and Snowdrift Rivers, spring migration routes lead northeast, ascending the Talston and Snowdrift Rivers, across Nonacho, Eileen and Whitefish Lakes. On the tundra east of Whitefish Lake, the route turns north to the Hanbury River, which is crossed between Sifton Lake and Dickson Canyon. The route continues northward, passing to the east of the rocky terrain north of Lake Clinton-Colden. The Back River is reached in the vicinity of Malley Rapids and is followed northward to Beechey Lake. Here the route swings to the eastward and may continue down the middle reaches of the Back River or across it and northward into the unexplored region east of Bathurst Inlet. Smaller bands may occasionally reach the headwaters of the Ellice River and Melville Sound.

Athabaska Herd

A spring migration route extends northeast along the northern shore of Lake Athabaska from Fort Chipewyan. North of the 60th parallel of latitude the route turns eastward across Scott and Selwyn Lakes, then turns north, descending the Dubawnt River, which is crossed from east to west in the vicinity of Carey and Barlow Lakes. The route then turns north and follows the western shore of the Dubawnt River, around Lake Dubawnt until the lakes on the lower Thelon River are reached. The herds may spend the early summer here or continue north into the region beyond the lakes.

Occasionally bands from south of Athabaska Lake may cross at Fond-du-lac and Stoney Rapids and continue northward to the upper Dubawnt River.

Saskatchewan Herd

From winter ranges in the vicinity of Cree and Foster Lakes, the spring route leads northeast down the Cree and Geikie Rivers and crosses the Fond-du-lac River between Wollaston and Black Lakes. The route continues northeast, ascending the Cochrane and Porcupine Rivers and reaching the tundra in the vicinity of the headwaters of the Kazan River, which is descended as far as Angikuni Lake. Thence they go northward to the area surrounding the junction of the Dubawnt and Thelon Rivers. Smaller herds may cross Beverley and Aberdeen Lakes and continue north of these lakes.

In Saskatchewan a second route extends northeast between Wollaston and Reindeer Lakes, across the Cochrane

River, and north along the Brochet - Nueltin Lake portage. The route continues along the western shore of Nueltin Lake, across Windy Bay, and gradually turns northeast, crossing North Henik Lake and continuing towards the Ferguson River area.

Brochet Herd

The spring migration route of this herd leads north from wintering grounds east of Reindeer Lake, sometimes extending as far south as the Churchill River and east to Granville Lake. The route lies along the east shore of Reindeer Lake past Lac du Brochet, ascending the Cochrane River and then turning north-east to Nueltin Lake. It continues along the eastern shore of that lake, crossing the Thlewiaza River between it and Edehon Lake. The route then turns abruptly east, passes south of South Henik Lake and reaches the main coastal migration route about 50 miles inland from Eskimo Point. Here the herds turn northward and join with other herds migrating towards Chesterfield Inlet.

Duck Lake Herd

From winter ranges in the vicinity of Nelson House and the upper Nelson River in central Manitoba and South Indian Lake, the spring migration route leads north to the Seal River. The Seal River is descended to the junction with the Wolverine River, which in turn is ascended, past Duck Lake post. North of Nejanilini Lake the route turns eastward and the Hudson Bay migration route is met inland from Nunalla.

Churchill Herd

The main body of this herd frequents winter ranges in the valleys of the Nelson and Hayes Rivers as far southeast as Gods Lake. The spring migration routes lead north, crossing the Hayes and Nelson Rivers. The Hudson Bay railway is crossed between Ilford and Gillam and also between McClintock and Lamprey. The Churchill River is crossed between the Canyon and Long Island. The route then turns northwest and crosses the Knife and Seal Rivers near the coast. From this point it continues northward, parallel to the Hudson Bay coast but at a distance of about 25 miles inland, until the Maguse River is reached north of Eskimo Point. In the meantime the coast herds have generally been augmented by herds of caribou which have followed the Brochet and Duck Lake migration routes. The caribou herds turn north-west and ascend the Maguse River, cross Kaminak and Kaminuriak Lakes, then turn westward to reach the lower Kazan River in the vicinity of Thirty-Mile Lake. There is a smaller herd of caribou which regularly spends the winter in the marginal taiga southeast of Churchill, Manitoba, and north of the Nelson River. During the spring migration these bands travel eastward to the Hudson Bay coast in the vicinity of the Owl River. They then turn north and follow the coast-line north to Cape Churchill, then west, passing Churchill along the shore ice. They cross the mouth of the Churchill River and Button Bay on the bay ice. Then they turn inland at the mouth of the North Knife River.

Aberdeen Lake

The largest herd which regularly spends the winter on the tundra frequents the immediate vicinity of the large lakes on the lower Thelon River, from Aberdeen Lake to Baker Lake. In spring there is a northwestern migration from this drainage system towards the Back River, which is crossed in the vicinity of the Buchanan River junction. The route continues northward toward the upper drainage system of the Perry River and a large unnamed river to the west. Frequently the movement reaches the Arctic coast in the Queen Maud Sea area. It may even extend to the numerous offshore islands.

Hudson Bay Coast Bands

Along the Hudson Bay coast there are scattered bands of caribou during the winter months at such locations as Nunalla, Eskimo Point, Maguse River, Tavanni, Rankin Inlet, Winchester Inlet and Wager Bay. In spring these bands move northwest and travel inland. Those bands south of Chesterfield join the herds migrating north along the Hudson Bay coast. Those north of Chesterfield Inlet also move northwest. The movement sometimes extends as far as the Arctic Coast in the area about Pelly Bay and the mouth of the Back River.

The movements of the other scattered bands of caribou on the tundra are too irregular to describe in such detail. There is some northward drift of animals in Adelaide, Boothia and Melville peninsulas.

Both the time and the duration of the spring migration depend on a number of factors, the most important of which are: the severity of the preceding winter, the spring weather and the depth to which the herds penetrated the taiga during their winter migrations. The effect of weather upon the movements of caribou will be covered in a later section. It is sufficient to state at this point that the earlier the season the earlier will be the spring migration and the later the spring season, the more the migration will be delayed.

From many observations of the investigators and the analysis of the Caribou Questionnaires and literature references, the average periods of spring migration through certain northern communities have been indicated in Appendix 3. The localities refer to the general hunting and trapping areas about the posts. The dotted lines indicate the periods when caribou have been known to be present. The heavy lines indicate the average dates when the animals occur locally and the relative thickness indicates relative numbers.

Midsummer Migration

Clarke (1940) was the first author to describe the regular midsummer movements of the caribou. He referred to this migration as a "backwash" from the spring migration. Previously this return towards timberline was thought to be an early autumn migration to the wintering grounds. It is not surprising that the early explorers failed to note the regularity of this movement, since their observations were limited by primitive transportation means. The use of aircraft has made it possible to obtain extensive simultaneous observations of caribou movements.

The impetus of the spring migration seems to be spent by the middle of July and the animals have reached the limit of their travels upon the tundra. As has been shown, this takes many bands to the Arctic coast of America or even to the coastal islands a short distance offshore, as is the case in Bathurst Inlet and Queen Maud Gulf (Gavin, 1945). Other large groups do not reach the sea and reach their maximum penetration of the tundra in the Richardson, Back and Thelon river systems.

By late July or early August there is a general retracing of the routes towards timberline. This movement is indulged in by all the herds from the Eskimo Lakes to Hudson Bay. The cause of this general movement will be discussed later under the heading of Migration Behaviour. In this section the routes alone will be described. This movement also loses its impetus during late August, when the herds are on the southern limits of the tundra region, in the vicinity of timberline. At this time the population is more diffuse than previously, small bands of loitering caribou are frequently met, and some regularly penetrate the taiga belt for a considerable distance. The herds are complete, with the total number of cows and bulls together.

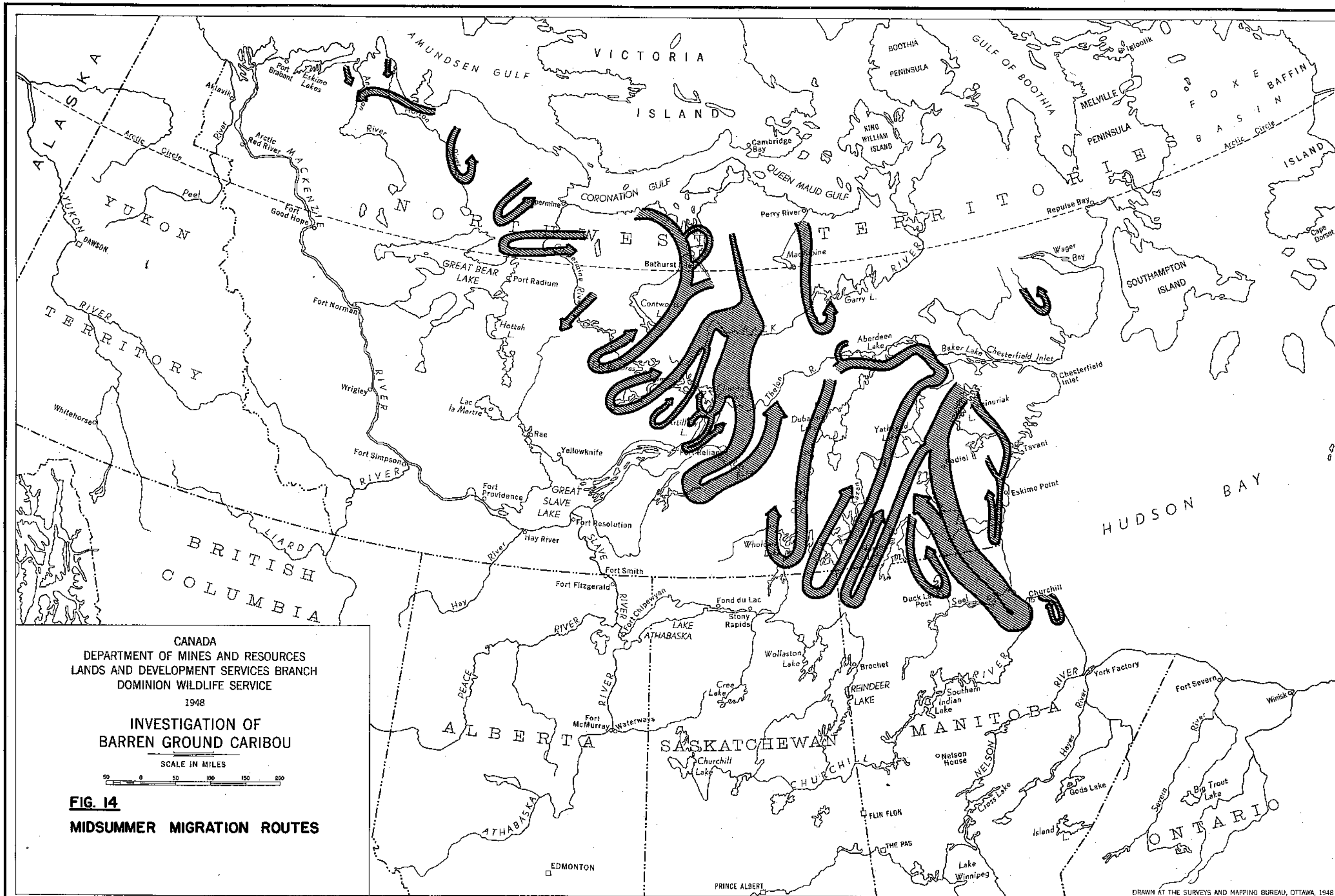
During September, a general movement of the herds away from the timberline again takes place and the herds retrace their spring migration routes onto the tundra. This time, however, the movement does not extend so far and the herds do not reach the extreme penetration of July. The rut occurs upon the tundra after the impetus of this movement has been lost. This cycle of migration is brought to a close in October or early November. The winter has set in with the first severe snowstorms. The current mid-summer migration routes are indicated in figure 14.

Colville Lake Herd

During the mid-summer migration there is a western drift of caribou bands from Darnley and Franklin Bays towards timberline on the Anderson and Horton Rivers. The backwash takes the herds again to the tundra on the hills beyond the river valleys.

Great Bear Herd

There is a general southwest movement towards the headwaters of the Dease River. Stragglers generally reach Dease Arm and Hornby Bay of Great Bear Lake. The backwash takes the herds to the vicinity of the Dismal Lakes and Coppermine River.



CANADA
DEPARTMENT OF MINES AND RESOURCES
LANDS AND DEVELOPMENT SERVICES BRANCH
DOMINION WILDLIFE SERVICE
1948

INVESTIGATION OF
BARREN GROUND CARIBOU

SCALE IN MILES

FIG. 14

MIDSUMMER MIGRATION ROUTES

DRAWN AT THE SURVEYS AND MAPPING BUREAU, OTTAWA, 1948

Radium Herd

During this period, herds move westward into the taiga east of Great Bear Lake. Later the movement is reversed and the animals drift eastward to the Coppermine River Valley.

Rae Herd

In late summer the herds move southward down the western coast of Bathurst Inlet. Opposite Burnside Harbour they turn inland, crossing rough terrain until the east branch of the Burnside River is reached. This river is ascended and then the herds turn westward and pass around the south end of Contwoyto Lake. The route continues southwest until the Coppermine River is crossed in the vicinity of Lake Providence. The movement loses its impetus in the vicinity of the headwaters of the Snare River. The backwash carries bands of caribou northeast as far as Contwoyto Lake.

Yellowknife Herd

In late July the movement of caribou follows up the Back River, crossing in the Muakox Lake area or at the Back River portage. The bands continue southward past Aylmer Lake and turn southwest, crossing the Lockhard River. The limit of movement is near timberline in the McKay Lake region. The reverse migration takes the animals north to Aylmer and Muskox Lakes.

Hanbury Herd

The movement during this period is at first southward from the Back River, passing to the east of lakes Aylmer and Clinton-Colden. The western edge of the herds crossing the Hanbury River crosses at Deville Lake. Some bands turn southwest, travelling along the shores of Lakes Ptarmigan and Artillery and reaching Great Slave Lake at the mouth of the Lockhart River. The main herd continues south from the Hanbury River to Lynx Lake and finally reaches timberline southeast of Nonacho Lake. The return movement later takes caribou bands northward to Aylmer Lake and the Thelon and Hanbury Rivers.

Athabaska Herd

The movements of this herd are probably similar to those above. Their greatest penetration of the taiga is probably in the vicinity of the upper Dubawnt River.

Saskatchewan Herd

During midsummer large herds of caribou move southward, ascending the Dubawnt River. The limit of their southward drift is Selwyn Lake, in northern Saskatchewan. In autumn the drift is reversed and bands move northward to the tundra beyond the timberline in the Dubawnt River valley.

Kazan Herd

In midsummer there is a large-scale eastern movement of caribou in the region of the large lakes on the lower Thelon River. Large herds reach the western end of Baker lake and pass southeastward along its south shore. The Kazan River is reached in the vicinity of Thirty-Mile Lake. Here the majority seem to follow the shoreline to the southwest and ascend the Kazan on the western side of Ennadai Lake. This movement may continue as far south as Sunrise Lake, Saskatchewan. The northward drift in September takes the bands north at least to Ennadai Lake.

Brochet, Duck Lake, Churchill Herds

From summer ranges south of Baker Lake and east of the Kazan River the herds drift south in the Kaminuriak-Ferguson River regions. The route leads past Maguse Lake and Padlei. At this point the routes diverge. The Brochet herds trend more to the southwest, passing down the western shore of Nueltin Lake and continuing south until the leaders reach the big bend in the Cochrane River.

The Duck Lake herds continue southward, crossing the Tha-anne and Thlewiaza Rivers, and reach their maximum penetration of the taiga at this season in the Nejanilini Lake region.

From the Kaminak Lake area the Churchill herds drift southeast towards the coast. They pass southward inland from Eskimo Point and cross the Thlewiaza River near the coast. The stragglers on the left flank of this movement are on the Hudson Bay coast. The movement continues south, crosses the timberline, and enters the taiga in the lower Seal River drainage. Before the impetus of the movement is spent the leading bands may reach the vicinity of the Churchill River about the first of September. During the month of September the backward drift commences and the herds retrace their paths northward to the timberline region about Nueltin Lake. Thlewiaza River, Henik Lakes and the Hudson Bay coast.

The location of the northern autumn ranges may often be ascertained by the number of southbound autumn migrations. At Baker Lake and Padlei there is only one southward migration. At Nueltin Lake there are two. This places the autumn range between Nueltin Lake and Padlei. Similarly at Bathurst Inlet there is usually a single early autumn movement while on the upper Coppermine there are two movements, which places the autumn range somewhere in the vicinity of Contwoyto Lake.

For the remaining herds the midsummer movements are less well known. It is known that in late July there is a southward drift of bands of caribou from the Queen Maud Gulf area. This movement continues southeast through the region of the large lakes on the lower Back River. Whether there is a later reversal of this drift in the area north of Aberdeen Lake is not known.

Similarly for the Hudson Bay bands there is a midsummer drift from the regions of their maximum northwest penetration towards the Wager Bay and Winchester Inlet areas.

These midsummer movements as described are not characterized by the concentrated movements of large herd groups but rather by the movements of small bands or herds of 500-2000 animals. Nor do all the individual caribou take part in the migrations. As a result, by late summer and early autumn small bands of caribou are dispersed widely from the northern fringes of the taiga to the Arctic Ocean. It was during these southward movements that the greatest slaughters were carried out by natives at crossings of the Burnside, Coppermine, Hanbury, Thelon, Kazan, Thlewiaza and Seal Rivers.

Autumn Migrations

During late autumn, associated with the termination of the rut and the first severe blizzards on the tundra, the major herd groups commence the annual migration towards the winter ranges in the taiga or near timberline. This movement usually commences in late October or in November. Occasionally, during unusually mild winters, the migration may be delayed until December.

The migration is first characterized by a withdrawal of the scattered herds from the extreme summer range near the Arctic coast or the tundra ranges of the Back and Thelon Rivers. As the bands congregate upon the tundra, the movement becomes precipitate and finally the herds migrate down well-worn trails in dense masses towards timberline. It is at this season that the most spectacular migrations have been observed by northern trappers and a few explorers, such as Russell (1898) at Fort Rae and Stefansson (1913) at the headwaters of the Horton River.

If the weather remains rigorous the great columns of caribou continue swiftly towards their winter ranges. If, the weather moderates the pace slows down and the herds will be delayed in reaching the wintering grounds. The winter ranges are usually reached in December, but occasionally the migration does not conclude until January. The current autumn migration routes are indicated in figure 15.

Colville Herd

During the autumn migration bands travel eastward from the Eskimo Lakes and westward from Franklin and Darnley Bays to meet near timberline on the Anderson River. The Anderson River is ascended to the winter quarters. The western limit of the route is at the junction of the Anderson and Wolverine Rivers. A second route of migration ascends the Horton River and turns southwest across the middle reaches of the river.

Great Bear Herd

From the Dismal Lakes area the movement is southwest in autumn, leading down the Dease River drainage system to Dease Arm of Great Bear Lake. The route then follows the

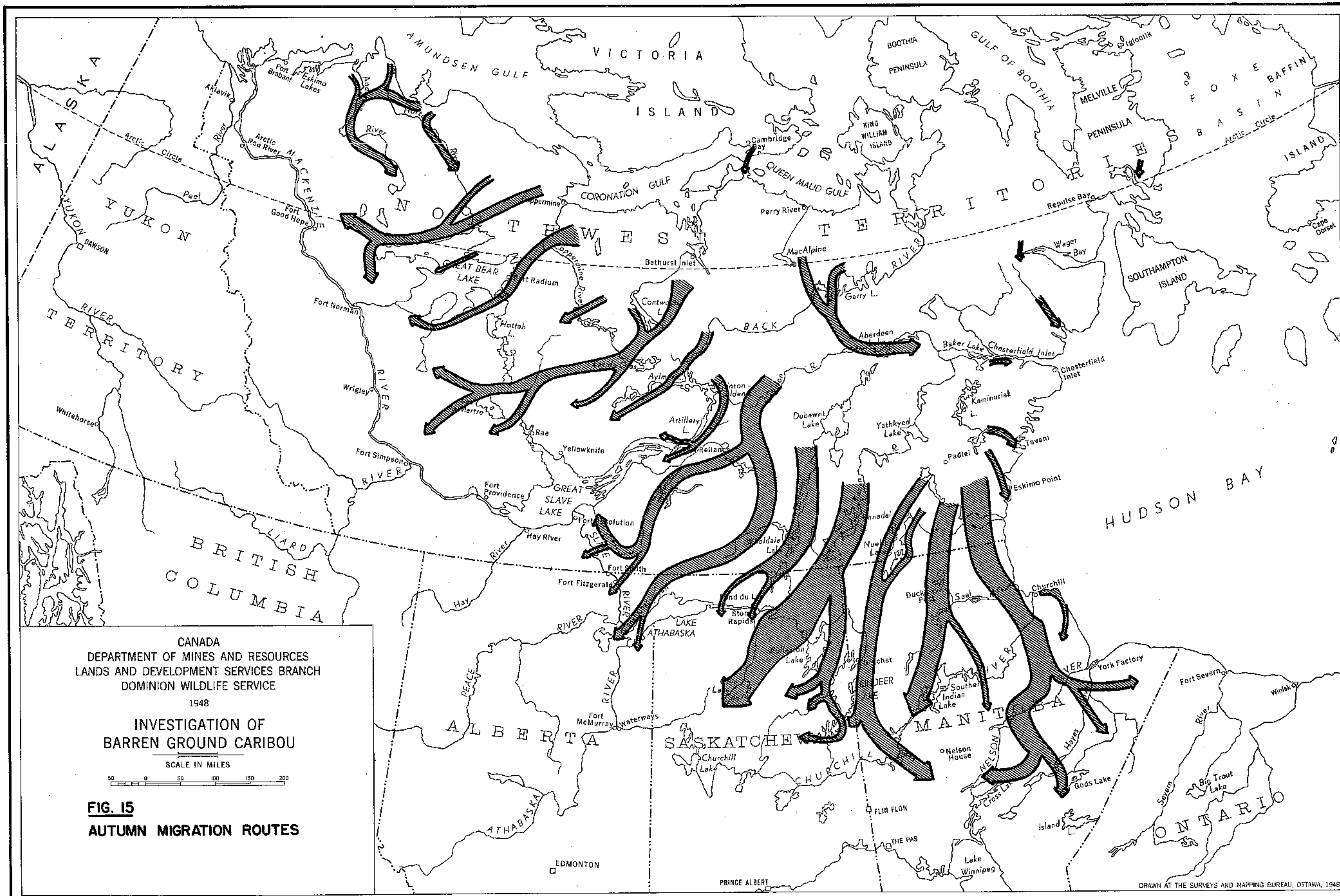


FIG. 15

AUTUMN MIGRATION ROUTES

north shore of the Lake to Smith Arm. Here the general route divides. Occasionally the herds turn northwest towards Colville Lake or towards Fort Good Hope on the Mackenzie River. More commonly the herds turn southward around Smith Arm and reach the Great Bear River. The westerly limit of the movement is usually in the Brackett Lake area.

Other bands from the Coppermine River travelling west will reach the southern shore of Dease Arm and cross the Lake from MacDonnel Cape to Etacho Point, if the migration is late enough to find the lake frozen. The bands then continue southwest, crossing Deerpass Bay and reaching the Fort Franklin vicinity.

Radium Herd

From the timberline on the Coppermine River bands of caribou travel westward in autumn to McTavish Arm. Here the route follows the eastern shore southwest to the lower Camsell River and Hottah Lake. It may continue as far as Johnny Hoe River.

Rae Herd

From the tundra about Contwoyto Lake massed herds travel southwest in autumn and cross the Coppermine River south of Point Lake. The route continues west to the headwaters of the Snare River, which is generally descended in a southwest direction. The route continues across the Emile River and around Lac-la-Martre, either to the north or to south

Beyond these points bands may turn northwest to Lake Grandin or southwest towards Willow Lake.

Yellowknife Herd

In autumn from the tundra about the upper Back River and Aylmer Lake, caribou herds migrate southwest towards treeline in the vicinity of Courageous Lake on the upper Lockhart River. Continuing southwest, the headwaters of the Yellowknife, Wecho, Beaulieu Rivers are reached. Scattered bands usually reach Gordon Lake.

Occasionally a different route is used. The Lockhart River is crossed at Thanakoie Narrows between Aylmer and Clinton-Colden Lakes. The trails lead southwest, west of Artillery Lake. Reaching McLeod Bay, Great Slave Lake, the bands turn west along the shore to the Beaulieu River.

Hanbury Herd

Within the past several years this herd has followed several distinct migration routes. Originating upon the tundra between the Back and Thelon Rivers, the migration route leads southward. Some herds travel towards the southwest, passing Clinton-Colden, Ptarmigan and Artillery Lakes and reaching Great Slave Lake at the mouth of the Lockhart River. The route follows the southeast shore of the lake towards Snowdrift. A second route leads west from the upper Thelon River, crossing Whitefish Lake, and continuing to the headwaters of the Talston River. The river valley is descended as far as Rocher River. In autumn, in the area east of Fort Smith, the direction of migration is northward.

During the winter of 1948-9, the majority of herds continued directly south from the Hanbury River, continued east of Lynx Lake, crossed the upper Thelon and spent the winter months near timberline in the vicinity of the headwaters of the Talston and Dubawnt Rivers.

Athabaska Herd.

In the autumn, from the main migration route described above, certain herds continue southwest, ascending the upper Dubawnt River valley towards Tazin Lake. The route continues southwest along the north shore of Lake Athabaska to the immediate area of Fort Chipewyan. Occasionally the lake is crossed via Burntwood and Bustard Islands and bands reach the Athabaska River region. In other years the herds continue west of the Slave River, reaching Lake Claire and the lower Peace River.

A second route from Wholdaia Lake continues directly south, past Selwyn Lake, and reaches the eastern end of Athabaska Lake at Stoney Rapids and Fond-du-lac. These were formerly much-used crossing points. The bands continued south to Black Lake and the Cree River region.

Saskatchewan Herd

In autumn there is a well marked migration of caribou up the upper Kazan River, past Ennadai Lake, to the northeast corner of Saskatchewan. In this area the route divides. Large herds turn southwest, descending the Porkupine River valley, and cross the Fond-du-lac River between Black and Wollaston Rivers. The winter range extends from this region southwest to Cree Lake.

From the northeast corner of Saskatchewan other herds continue south, ascending the Cochrane River to Wollaston Lake. The route continues down the eastern shore of this lake and turns southwest, ascending the Geikie and Wathaman Rivers towards Foster Lakes. Occasionally this movement may continue southwest as far as the Churchill River, near Stanley and Snake Lake.

Brochet Herd

From the vicinity of the Henik Lakes, Keewatin District, the autumn migration route of this herd extends southward across Windy Bay of Nueltin Lake and along the western shore of the lake, across the portage and down the Cochrane River to Reindeer Lake. The route then continues south along the eastern shore of that lake to the wintering areas near South End. Frequently the migration continues southward down the Reindeer River to the Churchill River valley. Or midway down the lake, the herds may turn southeast and reach Lynn Lake.

Duck Lake Herd

In autumn herds move south, crossing the Tha-anne and Thlewiaza Rivers of Keewatin District. The route of travel continues south through north-central Manitoba, passing Duck Lake, crossing the Seal River and reaching the Churchill River in the vicinity of Southern Indian Lake. The winter range extends from here south to the vicinity of Nelson House. Occasionally the herds continue southwest towards Herb Lake and Cross Lake on the Nelson River.

Churchill Herd

From southern Keewatin District herds of caribou travel rapidly south in the autumn, generally a short distance inland from the Hudson Bay coast. The movement passes inland from Eskimo Point and crosses the Thlewiaza, Seal and Knife Rivers. The route then generally turns southeast and crosses the Churchill River above the head of navigation. The direction is continued until the Hudson Bay Railway is reached near Lamprey and Back. The caribou bands frequently appear reluctant to cross the track and continue south along its western side for some distance. The route then divides, some herds cross the track and continue southeast towards the lower Nelson River, the Hayes River and Shamattawa. Other bands continue south and cross the tracks and the Nelson River near Gillam. Still other bands, upon reaching the Nelson River, which may still be open in early December, turn west and cross the river at Split Lake. These bands then continue south to winter quarters in the upper Nelson and Hayes River valleys and the vicinity of Oxford House. Since 1945 the herds have penetrated as far south as Knee Lake and Gods Lake, Manitoba.

The autumn movements of the other herds are not well known. The scattered bands of the Hudson Bay group migrate southeast towards the Hudson Bay coast of Keewatin. The Aberdeen Lake herd moves southeast from the Back River region to the lower Thelon. There is a general southward trend in the scattered groups on the northern peninsulas. The Boothia bands move towards the isthmus. The Adelaide bands move towards the mouth of the Back River. In Melville peninsula there is also probably a southern movement towards the coastal districts about Lyon Inlet and Committee Bay.

The autumn migration routes which have been generally used during recent years are indicated in figure 11.

Man has exerted an influence upon the migration routes used by the caribou. Hoare (1927) observed the establishment of trading posts eastward along the Arctic coast in the Coronation Gulf region during the period 1910-1920. Associated with the introduction of firearms and the fur trade among the Eskimos of the region, he also observed the gradual diminution of the caribou migration from the continent to Victoria Island. The locale of the spring crossing of Coronation Gulf also moved eastward. Hoare reported that the last large-scale crossing of Dolphin and Union Straits from Bernard Harbour took place in the spring of 1917, a small crossing of Coronation Gulf from the Tree River region occurred in the spring of 1920, and the spring crossing from Kent Peninsula was discontinued soon after 1920. He speculated that the coal smoke from the stoves of the new posts discouraged the caribou. The advent of firearms and the fur industry would seem to be a more practical consideration, for it is frequently observed that caribou often completely ignore human habitation during their migrations. Russell (1898) reported a migration through Fort Rae when the animals passed between the buildings. Caribou bands have also migrated through Fort Chipewyan and Fond-du-lac on several occasions. During the spring migration of 1948 caribou bands migrated through Fort Churchill camp and through the outskirts of Churchill village on April 24th and 25th. On May 5th we were delayed in landing on the airstrip because of caribou bands migrating across it.

Instances were reported where several hunters camped at a favourite crossing point had turned a migration from its route by excessive hunting. A former crossing of the east end of Baker Lake was cited as an example.

It seems likely that excessive hunting also influences the movement of caribou when herds are decimated to the point where they need no longer travel great distances in search of fresh fodder.

The most important influence exerted by man upon the movements of caribou is the destruction of forage through forest fires. The lichens, upon which the caribou heavily rely for winter forage, are exceedingly slow-growing plants. It has been ascertained from investigations in Alaska by Palmer (1926) that it may take a burnt-over lichen area as long as 25 years to regenerate.

If the humus is destroyed the loss is for all practical purposes, permanent. Lichens must be considered as a long-term crop, comparable to the trees themselves. Fires under sub-arctic conditions are even more damaging than at lower latitudes, since the restoration growth is extremely slow because of the rigorous climatic conditions. Harper (1932) and Clarke (1940) have previously pointed out the serious role of forest fires in reducing the number of caribou that can be supported on the taiga winter ranges.

During the present investigation factual information which would indicate an actual desertion of a burned area by the caribou was sought. Such evidence was obtained in abundance from the aerial reconnaissance flights.

It was observed everywhere that caribou and their tracks were absent from the recently burned areas, while their tracks were abundant in the adjacent "green" areas. Occasionally the winter distribution of caribou was observed to be delineated by the boundaries of "green" taiga. In figure 16 the observations made on flights in northern Saskatchewan during January, 1949, are shown. From the figure one can note the presence of caribou bands in the unburned areas and their

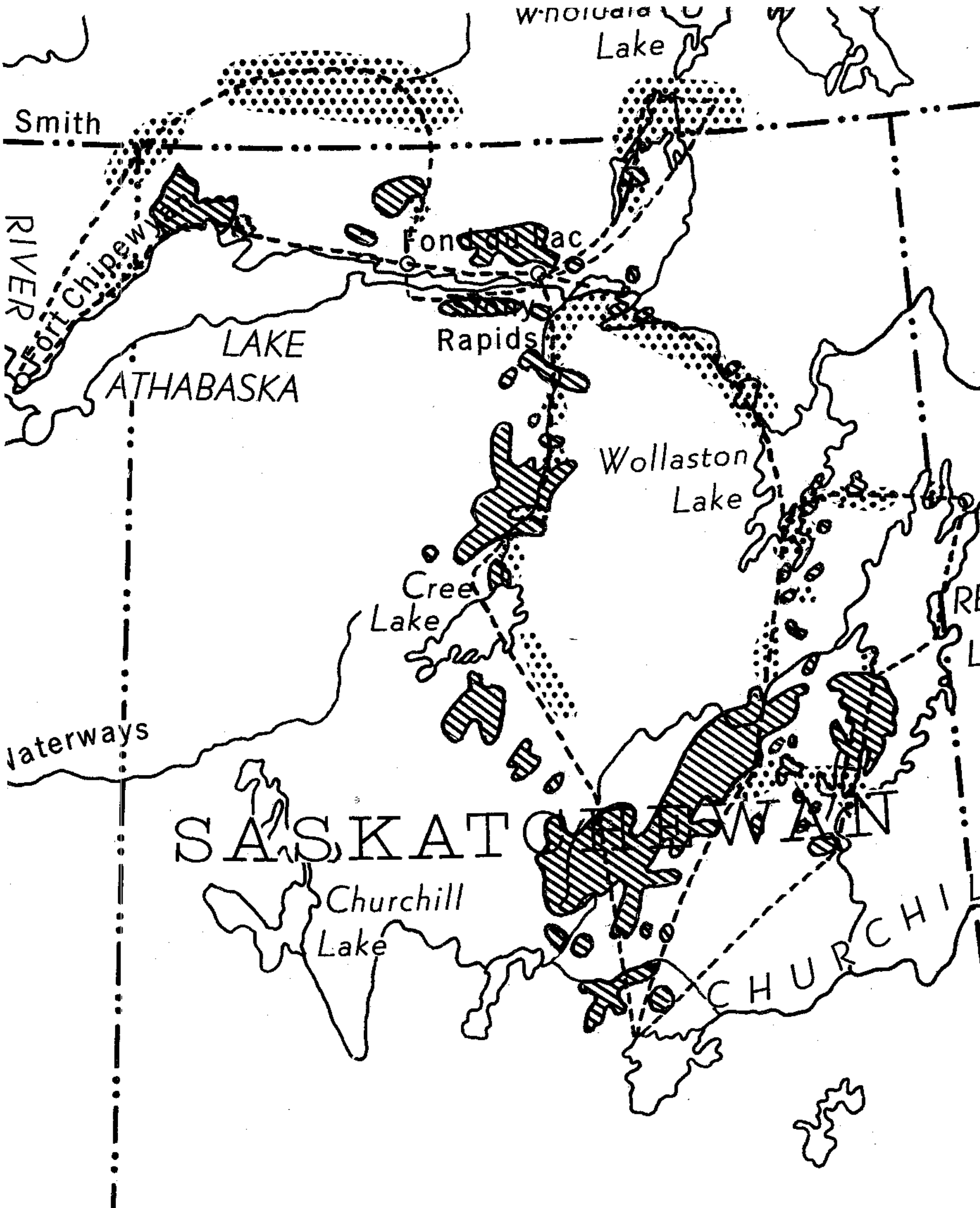


FIG. 16. LOCATIONS OF BURNS AND CARIBOU IN SASKATCHEWAN.

BURNS. CARIBOU.

absence from the burned areas. This type of observation was repeated on several flights in Manitoba, Saskatchewan and the Mackenzie District, Northwest Territories.

During migration periods it was observed that the routes travelled by the animals lay in "green" corridors between burned areas. Such was the case at Ghost Lake, Mackenzie District on April 24, 1949, where the route lay eastward along a narrow "green" corridor between two extensive burns at Mattberry Lake and south of Ghost Lake. Large burned areas were practically devoid of winter caribou tracks in the snow. Small burns were occasionally crossed by single trails but there was no evidence of feeding.

The tundra and the northern fringe of the taiga are largely unaffected by fires. There have been many large destructive fires in the heart of the taiga winter caribou range.

In the Mackenzie District, there are large burned areas in the Mattberry - Indin Lakes region. The usefulness of a large area east and northeast from Yellowknife as caribou range has been largely destroyed by the destruction of the vegetation by numerous recent fires. There are also large burns in the lower Talston River region. The winter range south of Fort Reliance is still largely intact. The recent numerous burns along the Mackenzie River valley have little influence upon the species as it seldom reaches that region.

There have been damaging fires about Tazin Lake and Camsell Portage, Saskatchewan. Large areas of former caribou winter range in central northern Saskatchewan, south of Wollaston Lake and west of Reindeer Lake, have been destroyed (see figure 17). Throughout this area no caribou were observed during reconnaissance flights in January and February, 1949. Large burns immediately north of Fond-du-lac and Stoney Rapids have probably deflected migration routes away from these crossing points. From reconnaissance flights in which the burns were mapped it is estimated that 30 per cent of the winter range in Saskatchewan has been ruined for many years.

Similarly in northern Manitoba there have been large burns recently in the caribou winter range. Large areas north and west of Southern Indian Lake have been destroyed, as well as other areas in the Angling River drainage, south of the Nelson River. It seems probable that the recent destruction of winter forage in the Southern Indian Lake region may have been a contributing cause of the recent southward movement of caribou herds into central Manitoba in winter.

It is known that the destruction of the winter lichen forage by fire means the abandonment of the area by caribou for many years, possibly 25 years. It is difficult to assess the full effect of recent burns upon the population

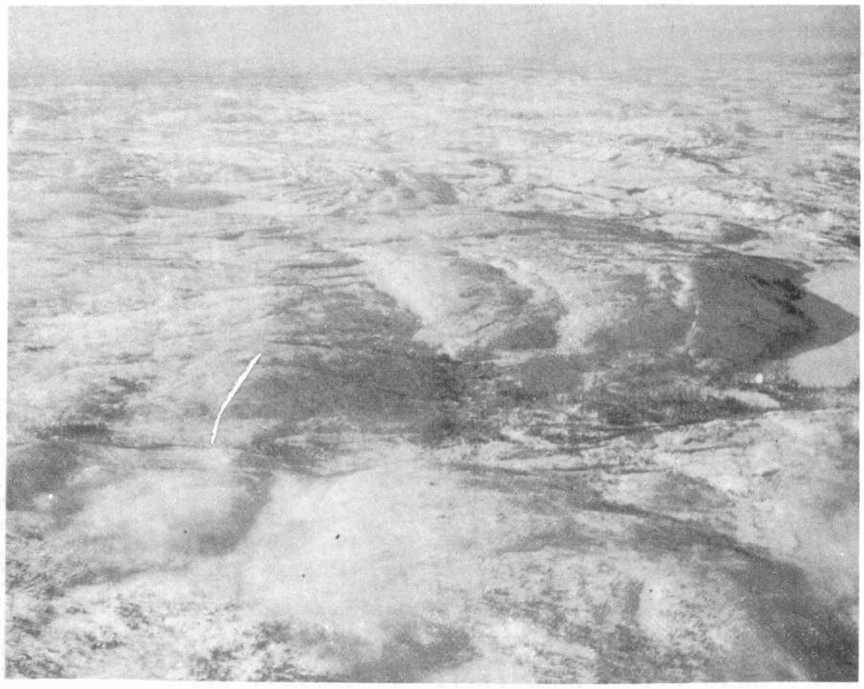


Figure 17. A large burned area near Cree Lake, Saskatchewan.

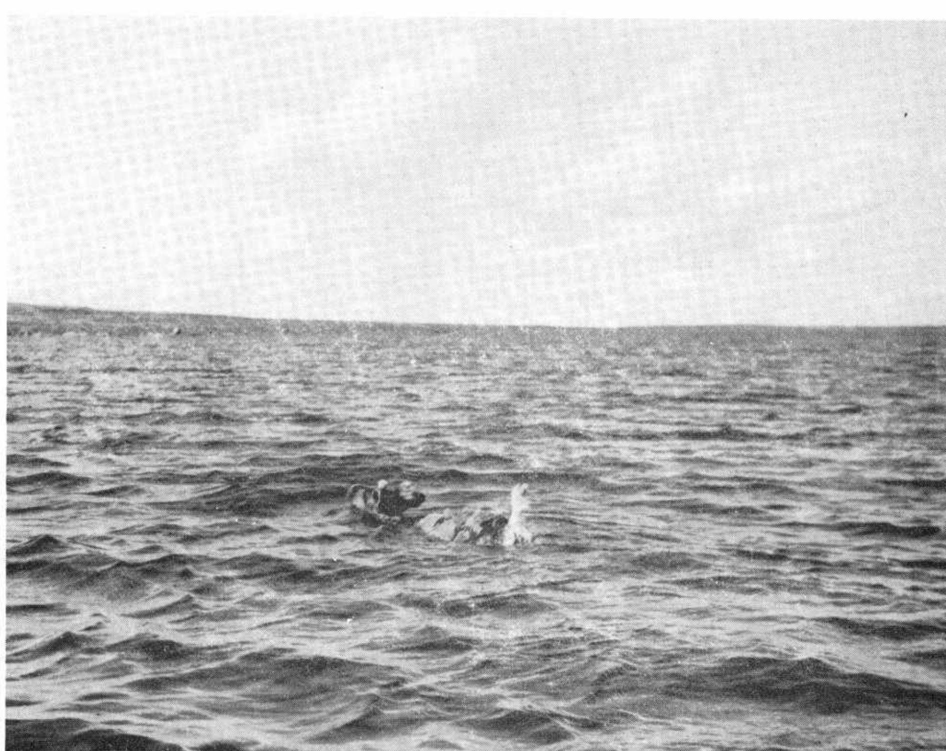


Figure 21. An adult cow swimming across a narrow tundra lake.

of the species. Hitherto it has meant a shift of the caribou herds to other areas, which have usually been available. It is probable that were the larger part of the winter range eventually destroyed by fire, the total population of caribou would be drastically reduced by starvation.

Until recently, the entire caribou range has not been invaded by transportation routes such as roads or railroads, with the exception of the Hudson Bay Railway, built in the period 1925-30. This railroad invades the winter range of the Churchill herds and lies across the migration routes of the Churchill and Duck Lake herds. Annually approximately 75,000 caribou cross the railroad tracks in migration. The railroad has not caused the dire effects on the survival of the Manitoba herds that were forecast.

The herds cross the tracks during the months of November, December, April and May. During these periods some mortality is caused by trains, but it does not seem to be large. The engineers of the two trains per week drive with caution at the favourite crossing points during the months mentioned. While investigations were being carried out along the route in November and December, 1948, only three animals were reported as being killed. A trip from Ilford to Churchill and return in December by gas car failed to produce any signs of excessive mortality along the track. It was reported that previously 6 animals had been killed by a train on a trestle.

The track does influence the behaviour of the migrating bands. They parallel the track for some distance before stringing across it in single file and striking off in the direction of travel. Usually a few individuals may be observed walking down the roadbed. The chief influence of the railway has been the result of the presence of work crews, stationed along the route, and of the increased accessibility of the herds to hunters. It also provides, however, a good means for warden patrols.

Changes in Caribou Range and Status

In previous sections, the former distribution, as revealed by historical records, and the present distribution, as shown by information gathered during the investigation, have been fully described. In the present section, it is intended to discuss the changes in range and populations that have occurred. A serious problem arises in consequence of the fact that the historical accounts cover a period of approximately 140 years, from 1780 to 1920. In order to facilitate matters, the historical data will be considered to apply to conditions about 1900. It is unlikely that European culture had greatly affected the caribou range at the beginning of the present century. It is true that the fur trade was in full swing along the main waterways in northern Canada, including the Mackenzie River, but the vast tundra and timberline areas to the east were still unexploited, as was the Arctic coast.

The Eskimos were still largely without firearms. During the period about the beginning of the present century several excellent exploratory accounts, which give a good picture of caribou distribution under relatively primitive conditions, were published.

The present status applies to the year 1950, so that there is span of 50 years which includes the major changes in caribou population. This was also a period of rapid exploration and exploitation of this northern region.

The summer range will be considered first. There has been a great shrinkage in the range and reduction in population from the Mackenzie delta east to Coppermine. The large herds reported from the delta by Franklin (1828) and Simpson (1943) have been absent for many years (Porsild, 1929). The writings of Richardson (1851), MacFarlane (1905) and Stefansson (1913) also indicated a large population along the Arctic coast eastward to Coppermine. At present small groups of caribou remain in this region.

From Coppermine east to Kent peninsula, present conditions seem little changed from those described by Franklin (1828) and Simpson (1843). In recent years few caribou have reached the Arctic coast in the region of Queen Maud Gulf, although according to Gavin (1945), fair numbers do so in certain years. Aerial observations indicate in general that there are far fewer animals south of Queen Maud Gulf than were encountered there by Hanbury in 1901 (1904).

Simpson (1843) observed great herds of caribou in summer along the Arctic coast from Sherman Inlet to Boothia peninsula and on King William Island, as did Schwatka (1885). At present there are indications that caribou are either extirpated or reduced to low numbers on this island, while on the adjacent mainland they occur in very small groups.

Along the Gulf of Boothia and on Melville peninsula caribou were reported in large herds by Rae (1850) and Lyon (1824), The Melville herds were migratory, leaving the peninsula in winter. Caribou now occur only in small bands on the east and west coasts of the peninsula. Inland from Winchester Sound, Schwatka (1885) encountered many herds of caribou. At present only small scattered groups occur in the region. Along the Hudson Bay coast from Chesterfield Inlet to York Factory, caribou occur in numbers comparable to those described by early explorers, although there probably has been a diminution.

Upon the central tundra summer range there seems to have been less change in numbers. The observations of Franklin (1825) on the Coppermine River, Hearne (1795) at Contwoyto Lake and on the Kazan, Back (1836) on the Back River, Tyrrell (1902) on the Thelon and Tyrrell (1898) on the Dubawnt River; these observations of massed caribou can be generally duplicated today in the same areas.

Turning to migration routes, the great autumn migration of caribou across the upper Horton River, described by Stefansson (1913), has no counterpart today nor have the herds which ascended the Anderson River (MacFarlane, 1905). The caribou have largely forsaken the crossing point at Fort Rae described by Russell (1898). At Fond-du-lac and Stoney Rapids, Saskatchewan, the migrations are reported to be much smaller of late. Lac du Brochet, Manitoba, is situated at a major crossing point. Father Eganoff, who has been stationed there for 40 years, reported that he has noted a steady decline in the numbers of migrating caribou. Caribou still cross the Churchill and Nelson Rivers as described by Hearne (1795), Tyrrell (1912) and Hanbury (1904), but the present numbers are reported by oldtime trappers to be fewer.

The present areas occupied as winter range are generally the same as those mentioned in records of exploration. During recent years there has been a tendency for caribou bands to inhabit areas near the limits of the range for the subspecies. In some of these areas they had been absent for several decades.

Caribou no longer inhabit the east bank of the lower Mackenzie River. In recent years they have penetrated to within 30 miles east of Fort Good Hope. However, they regularly occur in winter along the Bear River east of Fort Norman. According to Stefansson (1913), they had been absent from the west side of Great Bear Lake for many years. They seem to be less common at present south of the lake in the vicinity of the Camsell River than was reported by Preble (1908). The situation about Great Slave Lake seems to have changed little from that recorded by early explorers. In winter herds frequently penetrate to the Fort Smith vicinity, where, according to Preble (op. cit.), they seem to have been met rarely in the early years of this century. Several years ago bands reached the Clearwater River region of Alberta, an area to which Preble reported they once reached fifty years prior to his investigation. In northern Saskatchewan, the range seems to have changed little from that described by Tyrrell (1896). The recent southward extension of the winter range in central Manitoba seems to be unprecedented in the period under consideration. Old Cree hunters state that it has been 75 years since the caribou occurred in their country.

It is difficult now to estimate the number of caribou which existed upon the arrival of the first explorers. Their descriptions lead one to conclude that there were larger herds then than inhabit the area today. Discarding the obvious over-estimates of some writers, we are left with Anderson's (1937) estimate of 2,500,000 animals for the entire range of the species. This estimate was based on the carrying capacity of the range, without reference to losses due to human utilization or predation. It must therefore be considered to be a maximum estimate of the population.

It has been previously determined that the present population is approximately 670,000 animals. This estimate therefore indicates a probable reduction to 25 per cent of the primitive numbers. This reduction in animals has apparently resulted from the decimation of certain herds and the lesser reduction of other herds. The herds which have been reduced to small bands are those which formerly occurred from the Mackenzie Delta east to Coppermine, including herds which formerly migrated annually to Victoria Island; also herds which formerly inhabited Kent peninsula, Adelaide peninsula, King William Island, Boothia peninsula, Somerset Island, Melville Peninsula, Southampton Island, and the Hudson Bay coast from Winchester Inlet to Repulse Bay and finally the tundra along the Ontario Hudson Bay coastline.

It is to be noted that these areas are along the present extreme range of the species. This fact suggests that these herds might have been inhabiting marginal territory and that reductions in population near the centre of the range might have caused a withdrawal of herds from this marginal range. This theory is of a speculative nature and is difficult to refute or support at present. In the meantime, other historical factors, bearing upon the population decrease, will be discussed.

The area along the Arctic coast, east to Dolphin and Union Straits, where the caribou were greatly reduced in numbers, is known to parallel very closely the range of the baleen whales in western Arctic waters. During the closing years of the last century and the early years of the present century there was a concentration of the whaling industry in these waters. Many ships spent the winter frozen in at Arctic ports. The crews of these ships depended largely upon the caribou for a supply of meat. The local natives were provided with firearms and paid in trade goods to secure meat. The number of caribou killed for whaling ships was tremendous in comparison with the resources of the Arctic. Some idea of this slaughter may be obtained from the report of Stone (1900): "The large whaling fleets in Bering Straits, and as far north as Point Barrow, have created a demand for the flesh of the caribou and they are slaughtered by the thousands for the purpose of barter; now this demand has been extended by this fleet of whalers, along the Arctic coast as far as Cape Parry.

One winter fifteen vessels wintered at Herschel Island and I am reliably informed that these vessels each used from 10,000 pounds to 20,000 pounds of caribou meat an aggregate of over 300,000 pounds in one winter, principally the saddles; at the head of Franklin Bay, in the winter of 1897-98, four ships used of the same kind of meat about 90,000 pounds, and at Cape Bathurst, in 1898-99, one vessel used in the neighbourhood of 40,000 pounds."

It is therefore concluded that the annual take of the whaling fleet at the commencement of this century was a primary factor in the decimation of these herds along the western Arctic coast.

Along the eastern Arctic coast from Adelaide peninsula to Melville peninsula and south to Winchester Inlet, one cannot attribute the decimation of the caribou herds to the action of whaling fleets. There was a certain amount of whaling in eastern waters but this influence probably affected only the Hudson Bay coast. Nor can one easily conceive that the reduction in caribou was here due primarily to European explorers and traders, since the region was infrequently visited. The native populations of these coasts seem to be the only human agents that might have caused the decline.

During the years under consideration there was a great change in the economy of the natives. Under the influence of the fur trade, the native Eskimos and Indians were persuaded to make long journeys into the central tundra seeking furs. They received firearms which enormously increased their killing power; they were encouraged to trade caribou meat and tongues, as well as furs, for the maintenance of the trading posts; and in order to undertake these necessary new travels, the natives increased the size of the dog teams, which were fed caribou meat. All these facts point to a conclusion that this changed native economy caused a great increase in the killing of caribou which led to a gradual diminution in the population in the interior.

Since 1934 the distribution of the Departmental "Caribou Questionnaire" to northern residents has permitted a study of the recent trend in the population from a second source. The questionnaire asks correspondents to report whether the caribou have increased, decreased, or remained the same in their region, during the current season. The changes in population reported by the observers have been plotted on a series of annual maps which are provided on figures to appendix 2.

From an inspection of these maps it is noted that there is no clear-cut evidence of a major decline in population over the period 1934-1949. The majority of correspondents indicate in their observations that there has been a gradual irregular decline in numbers in recent years. The maps do indicate annual local shifts in populations. In any season caribou may be reported as decreasing in one or more areas while in contiguous areas they are reported as increasing. This phenomenon occurs annually and is caused by the unpredictable nomadic movements of the caribou as they seek fresh ranges.

In recent years the increase in the European population in the Mackenzie valley and the northern parts of the prairie provinces has led to an increased take of caribou by this group.

Physical Description

The barren-ground caribou is classed as a typical Arctic mammal because of its extreme northern range. The closely related Polar caribou (Rangifer pearyii) inhabits the most northerly land--the northern tips of Ellesmere Island and Greenland. The centre of the range of the subject form is on the continental tundra. Since the barren-ground caribou inhabits both the taiga and the tundra, seasonally, it may not be considered an indicator species for either community. The caribou possesses, nevertheless, a variety of physical adaptations which enable it to cope with its Arctic environment. The hoofs are large, broad and concave. The large size of the hoofs assists in supporting the weight of the animal on crusted snow. The concavity of the sole of the hoof makes the animal more sure-footed on ice. On wind-packed snow or on ice, caribou leave only the outline of the outer edge of the hoof as tracks. The appendages, such as ears, tail and muzzle, are short and well furred, which protects these parts from frost-bite. The pelage is long, dense and light, providing insulation against low temperatures. In late winter and early spring the pelage is greyish-white as a result of bleaching and wearing and provides some camouflage against the snow. The polar caribou is largely white throughout the year.

These adaptations better fit the animal for the rigorous Arctic climate, as is emphasized by a unique observation made by Stefansson (1913). During the extreme low temperatures of mid-winter, his party learned to look for small clouds of condensed vapour, forming trails above the stunted spruce of timberline, for these indicated the presence of bands of caribou among the scattered trees below.

Measurements

The measurements taken from specimens and carcasses examined during the present investigation are given in table 3. All measurements are in millimetres. From the table it is noted that the adult bulls are about seven per cent larger than adult cows, although there is little difference in hind foot length or shoulder height. Some indication of the growth of the young animals is given by the measurements of the younger age classes. The animals reach almost adult stature at about three years of age. Because of the difficulties of Arctic field work, few opportunities to weigh caribou carcasses arose. Eight adult bulls averaged 222 pounds in weight (178-264). Four adult cows averaged 149 pounds in weight (130-165) and four yearlings averaged 113 pounds (105-125).

Pelage

The coat of the caribou is dense and relatively long for a species of deer. There is one annual moult, occurring during July. The individual hairs of the new coat continue to grow in length and diameter during autumn and early winter. This causes a change in the position of the hairs. Whereas in late summer the hairs are depressed and lie parallel to the hide, by winter, in consequence of the continued growth, the hairs stand erect and form an exceedingly thick, long pelage. In late winter and spring, the coat wears a great deal. The hair becomes brittle and the tips break off easily. This causes the white bases of the hair to show more prominently and results in the animal appearing whitish. There is also much individual variation in pelage colour and wear.

This annual cycle makes the description of the pelage a difficult project. It also makes it useless to compare two hides in a taxanomic study unless the hides were taken at the same season.

In its new coat in late August, an adult bull is rich clove-brown dorsally and on the flanks. The colouration is darker on the mid-dorsal line and on the crown of the head and the face. It may be almost black around the eyes, base of the muzzle and lips. The broad muzzle is covered with short white hairs. The chest and legs are also of a darker tone, almost black. Sprinkled among the dark hairs are a few reddish brown ones. The area around each foot immediately above the hooves, the inside of the thighs, the rump and the ventral surface of the tail are white. The dorsal surface of the tail has a narrow clove-brown strip. On the side of the neck is a broad area of light grey which extends posteriorly onto the shoulder and extends further onto the flank in a narrow strip. The extent of this pale grey strip depends upon the individual bull. It seems that the older animals have more extensive light flank strips.

TABLE 3. MEASUREMENTS OF CARIBOU SPECIMENS EXAMINED

Class	Number Examined	Average Total Length	Range	Average Shoulder Height	Range	Hind Foot	Range	Tail
Adult Bull	9	1809	1890-1725	1051	1170-875	521	540-457	127
Adult Cow	9	1663	1780-1590	1049	1140-980	511	540-485	125
2-3 yr. Bull	8	1708	1780-1640	1101	1195-1050	511	450-497	---
2-3 yr. Cow	3	1611	1650-1585	1030	1030-1030	540	550-530	---
Yearlings	2	1390	1390-1390	910	930-890	470	480-460	---
Calf	3	1023	1070-1000	687	750-650	370	390-335	---
TOTAL -	34							

Note. All measurements are in millimeters.

In autumn, before the rut commences, the pelage has increased in length. The hairs that form a fringe along the mid-ventral line of the neck increase to a length of about six inches, giving the animal a ventral "mane". The pale grey neck patch turns white. This band extends posteriorly across the shoulder and along the flank. Below this white band is a clove-brown band.

The new coat of the adult cow is similar to that of the bull in general pattern. The general colour is again clove-brown, without the tendency to blackish colouration on face and limbs. The leg colour is generally reddish-brown. The cows also have the greyish-white neck patches, but their area is less extensive and they are more greyish than on the bull. On the backs of all classes on animals one frequently finds small circular areas of brownish fur. These spots are caused by the presence of warble fly scars on the hide underneath.

Yearlings in new coat are very dark in colouration. The pelage is a rich, dark seal-brown dorsally and on face, chest and limbs. There is little tendency towards the grey neck patches in the second autumn. Only the belly and rump are clear white.

As the winter progresses, all classes seem to become lighter in colour, until by late winter they seem to be salt-and pepper coloured. Since the tips of the hairs alone are clove-brown and the bases are white, the continued growth of the fur, accompanied by breakage of the tips, causes this change. There may be some bleaching. By late spring the majority of adults appear whitish at a distance. By early summer the fur becomes loosened at the base and starts to fall off in patches. It seems to wear off first on the face and around the eyes, where the new dark brown pelage showing through gives the appearance of black eye-rings. It soon wears off the legs and flanks and remains longest on the back and rump.

There is a tremendous amount of hair shed by the caribou annually in June and July on the tundra. Clarke (1940) remarked on the amount of caribou hair along the Hanbury River. In August, 1948, the upper Hanbury River was visited by the author. Here along the banks for many miles below favourite crossing points was, at the spring high-water mark, a wide swath of matted caribou hair which looked like stranded flood debris.

Although the moult generally commences in July there is a wide variation in the times when the different age and sex classes assume the new clean autumn pelage. The yearlings are generally the first to complete the moult. About the same time the young mature bulls also complete the change, followed by old bulls then barren cows. Finally, the bulk of the adult cows which bore fawns that spring moult much later than the other animals. Even in early September one often sees in ragged moulting pelage cows that are followed by calves. It seems that the bearing of young delays the period of moult.

During the period August 15-18, 1949, at Contwoyto Lake, a sample count of caribou was made to indicate the relative progress of the moult. This is shown in table 4.

Table 4. Procedure of Moult

Adult Bulls		Adult Cows		Yearlings		
New Coat	Old Coat	New Coat	Old Coat	New Coat	Old Coat	Total
65 84%	13 16%	25 52%	23 48%	14 93%	1 7%	141

At birth the calves are reddish-brown above with white underparts, a black muzzle, and grayish legs. They keep this pelage from birth in June until about the middle of August, when they moult into their first winter pelage. Their natal coat continues to grow during the summer and by late July it may be long and curly. The texture of this coat is very fine. By this time, as a result of fading, the pelage is rather pale brown.

In mid-August or later, depending upon the date of their birth, they assume a new coat. This is chocolate brown above, with grey flanks, ears, and neck. The belly, rump, and ventral tail surface are white. A dark slate band extends between the fore and hind limbs on the flank and above it is a greyish band. The crown may remain rusty, the muzzle is black. This coat continues to grow as does the adult coat. By spring it is generally paler than the adult pelage.

Albinism seems to be rare among caribou. During the investigation, three albinos were observed among about 200,000 animals. One was an adult bull shot by an Eskimo at Contwoyto Lake. The hides of albinos are eagerly sought by natives for the manufacture of fancy parkas.

Antler Development

The barren-ground caribou carries an impressive set of antlers. The average length of the beam of adult bulls is greater than their average shoulder height. Besides their great size, the antlers are also characterized by their great individual variation. No two sets of antlers are exactly the same. Indeed the right antler is probably never the mirror image of the left. In the subspecies under discussion, the bulls carry the larger antlers. Cows generally carry antlers, but these are much smaller, more simple in development, often unsymetrical (sometimes only one antler is developed), and a few cows never develop antlers.

Despite the great individual variation in the antlers of adult bulls, there is a characteristic pattern on which the variations are super-imposed. From a rugose burr the main beam of the antler extends upwards for a very short distance and then turns posteriorly and laterally for about one half its total length and finally turns upwards for the remainder of its length. Above the burr, the beam is somewhat compressed in cross-section, beyond this portion however it is generally oval or round in cross-section until the terminal portion is reached. The antlers of females and of senile bulls occasionally have compressed beams.

The possession of this long, round or oval beam is one of the characteristics which distinguishes this species from the woodland caribou, which has flattened beams.

A short distance above the burr a main branch extends forward and down over the frontal and nasal region of the face. This is the brow tine. A short distance further along the beam, a second branch, the bezel tine, is given off. It extends forward and curves in towards the mid-line, as does the brow tine, but it remains approximately horizontal and does not descend. After giving off these two branches close to the burr, the beam continues laterally backward. At the position where the beam turns upward, a single posterior tine generally branches off and points posteriorly. Along the ascending ramus of the beam, several terminal tines are found. These arise on the posterior surface of the beam and turn in towards the mid-line.

The individual variation is found in the length of the beam, the presence or absence of a posterior tine, the structure of the brow, bezel and terminal tines, the relative development of the left and right brow tines and the spread of the antlers. The brow tine is generally widely palmate, with numerous terminal short buttons, but it may be forked or simply flattened at the tip. Generally one brow tine is dominant and extends vertically over the facial region while the opposite member is reduced or even absent. In 35 sets of antlers of adult bulls, 69 per cent had the left brow tine dominant, 23 per cent the right and in 8 per cent both were equally developed, lying parallel along the mid-line about an inch apart. The bezel tines may be simple, flattened, forked or palmate, with numerous buttons. The terminal tines may be distinct or the whole terminal portion of the beam may be palmate with fused terminal tines, in which case they appear as fingerlike processes. Generally the bezel tine and the terminal tines are simultaneously palmate or distinct. This allows a classification of the antlers as either digitate or palmate. Of 35 antler sets examined, 54 per cent were digitate and 46 per cent palmate. There is also considerable variation in the spread of the two beams. In a few younger animals the set may be very high and narrow with the beams parallel and close together. In a few cases one observes exceedingly wide-spreading antlers.

In North American Big Game (1939) the record set for the subspecies came from the Hudson Bay coast and measured 63 inches along the outside curve of the beam from burr to tip. During the present study the longest antler found by the author measured 54 inches along the beam. The measurements and pattern of antlers examined during the investigation are given in table 5. The average length and spread are approximately 43.5 inches and 30 inches respectively.

The antlers of an adult cow are much smaller than those of a bull. They are basically similar in pattern but simpler in development. From a much smaller burr than that on the bull a beam of smaller diameter leads upwards then curves posteriorly and laterally. There is great variation in the antler development. Both brow and bezel tines may be absent or represented by short buttons or tines, either simple or forked, or small flattened plates. The terminal tines, if present, are generally simple. Large palmations other than the brow tine are rarely found. The short beam is generally simple, with one or two short tines. There are many irregularities in antler development among this sex. Some cows have no antlers; others only one; many carry only simple spikes. Others carry small replicas of the racks on the bulls. It is possible to confuse the antlers of a two-year-old bull with those of a cow with a well-developed set.

Development of Antlers with Age.

Small bony nobs may be palpated on the frontal bones, under the skin, of a two-month-old calf. These continue to grow during the first summer and by early autumn all the calves are carrying small "spike" antlers in velvet. The velvet is tardy in rubbing off these spikes, but by late winter young male fawns have spikes about 10 inches long, while the females' spikes are about 6 inches long. A few precocious males may have forked antlers the first season.

During the second season there is considerable development in antler growth. The young bulls generally have a miniature rack, with brow, bezel and beam formation. The young cows may have long spikes, 18 inches or so, forked antlers or curving beams with small brow and bezel units. By the third season the antlers are generally adult in form, although the maximum development for bulls probably has not yet been reached.

Table 5. MEASUREMENTS OF ANTLERS

Class	No.	Average Length of beam	Range	Av. Spread of Antlers	Range	Av. Diam	Range	Percentage with			Dominant Brow %		
								Spike	+Brow	+Brow +Bezel	R.	L.	Both
Adult bull	44	1087	1350--690	741	1025-500	53.2	70.0-42.0	0	1	99	23	69	8
Adult cow	23	346	550--75	278	400-200	24.7	32.0-18.0	17	62	17			
R2 bull	5	599	780--345	498	700-323	40.4	40.4	0	20	80			
Yearling	7	151	325--25	150	150	----	-----	100	0	0			
	79												

Note. All measurements are in millimeters.

With the increase in years there comes a recession in antler development. The maximum development is probably during the years from the fourth to the seventh. With senility and increasing bodily debility, the antler growth is less. Old bulls tend to have reduced numbers of tines and simple, long, curved beams. With cows the maximum development may terminate even earlier. Annual pregnancies seem to cause a physical drain and old pregnant cows are frequently found to have dwarfed, asymmetrical antlers or only velvet nobs.

Annual Growth of Antlers.

At the time of the rut, late October, both sexes possess antlers. Those of the bulls are clean and polished. Those of many cows still have velvet strips hanging from them. Soon after the termination of the rut, by the early part of November, the adult bulls shed their antlers, the oldest males dropping antlers first. By mid-December only the two-and-three-year-old bulls still retain their antlers. By February all bulls with the exception of the rising yearling class and a few rising two-year-olds, have usually shed their antlers. By March the first velvet growths appear on the older bulls. These antlers in velvet grow rapidly from May; so that by July the adult bulls have antlers two to three feet in length, with the main tines showing beneath the velvet. The growth of the antlers of the younger animals is delayed until late spring. The calves do not drop their spikes until early summer.

By August the bulls have large, cumbersome antlers in velvet. These appear to be completely developed but probably some terminal growth occurs later. The bony cores are remarkably flexible. When a large bull trots by, the great velvet rack may be observed to spring in and out with each step. At this time the antlers seem to be very sensitive and tender. The bulls frequently turn the head to the side and scratch the antlers carefully with a rear hoof. Insects alighting on the rack are shaken off. The head is handled carefully when the rack is lowered into a shrub when feeding.

By mid-September the antlers have hardened and the velvet is rubbed off. Lawrie reported seeing the first rubbed antlers on September 7, 1948. By September 20, the majority of bulls had bloody antlers with hanging velvet. The bulls often rub their antlers against small spruce saplings to remove the velvet. On the Lockhart River, in June, 1949, several such spruce were found. The branches and strips of bark had been stripped off by the rubbing of caribou antlers. At this time the velvet may hang in long strips from the antlers. The stripping of the velvet may leave the antlers streaked with blood at first. By October the antlers are polished clean and smooth.

The annual growth of the antlers on the cows is about six months out of phase with that of the adult bulls. This fact greatly facilitated the identification of the sexes from aerial photographs, during the investigation. The velvet is rubbed off the cows' antlers during late October. They then carry their antlers until April or May. The older animals shed their antlers earlier in April, while the younger animals retain theirs until late May or early June. The new antlers develop in the velvet during the early summer, and further growth continues during late summer.

Considering the large antler development on bulls and the great individual variation, one would expect to meet many abnormalities. The only pathological condition observed was on a set from a bull shot by an Eskimo hunter at Contwoyto Lake. In this set two extremely long terminal tines, one from each antler, crossed on the mid-line over the shoulders. The friction from the rubbing of the two crossed tines had rubbed off the velvet, with some superficial bleeding. At the point of meeting the bony cores were enlarged.

<u>Dentition</u>

The dentition of the caribou may be classified as buno-selenodont, which indicates that they are mainly browsers in food habits. As is typical with all deer, they do not show the highest selenodont modifications reached by the bovids, which are practically completely grazing animals. The normal dental formula for the species is $I.\frac{0}{3}: C.\frac{1}{1}: P.\frac{3}{3}: M.\frac{3}{3}: = 34$. The three lower incisors are loosely set in their alveoli and are flexible. This may be of some significance in their feeding habits. These teeth wear unevenly; the greatest wear occurs on the central pair (I.1). Because of this the incisors of older animals are notched in the median line. The upper canines are vestigial and normally are not cut. They may be lacking altogether in some females. Since they seldom appear, the replacement of the deciduous canines by the permanent canines is problematical. In one bull skull examined, there were two canines in the one alveolus, probably the deciduous tooth and the permanent tooth. It seems likely that the development and replacement of these teeth are highly irregular in this species.

During the field work, an effort was made to examine as many skulls as possible, in order to determine the eruption of the teeth and if possible, use the tooth wear as a method of age determination. Three hundred and two skulls were examined and single mandibles were collected from specimens, hunters' kills and carcasses found on the tundra and in the taiga.

It was found that the species exhibited some variation from the normal condition. In two specimens examined, the lower pair of permanent incisiform canines were absent. In several specimens the upper canines were absent. One yearling specimen examined had a single small deciduous premolar in front of the row of cheek teeth. This was a relict first premolar which in most caribou is lost in the normal dentition.

As a basis for describing the normal growth and replacement of the teeth, 143 mandibles of caribou between the ages of one month prior to birth and about three years old were used.

Of these specimens the approximate age was known for 36 mandibles. These were from specimens and hunters' kills, consisting of 23 fawns, 8 yearlings, 2 two-year-olds and 2 three-year-olds. The age of these specimens was determined by date of death, measurements, antler development and location. Since collections were made on both summer and winter ranges, it was possible to assign approximate ages to many of the other specimens of younger caribou as they were either at the whole year or the half, depending on whether they were summer or winter kills. These 107 mandibles were fitted into the series by study of comparative eruption and wear of the teeth. A further check was provided by comparison with 12 mandibles of reindeer (Rangifer arcticus asiaticus) of known age from the Departmental herd at the Reindeer Station, Mackenzie District. It was found that the eruption and wear of the reindeer teeth was almost the same as that of the dated caribou teeth.

Following the work of Severinghaus (1949), measurements were made on the lingual side of the tooth row from gum line vertically to the highest point of the tooth crown. In the case of the molars where there are two lingual cusps, the measurements were made on the anterior one. The gum line is indicated by a line of heavy pigmentation. It does not always correspond to the enamel line. In addition, the wear on each tooth was noted and the relative width between the dentine and the enamel on the lingual crest of the anterior cusp of the first molar. It was found that the eruption and wear on the posterior cusp on the third molar was also noteworthy because it was the last part of the dentition to be worn.

It was found that the wear was generally similar on all the check teeth. There was also fair similarity in the eruption and wear of teeth on specimens of comparable age. A few cases of irregular heavy wear and broken teeth were noted. Some of these cases were associated with infections of Actinomycosis. Three complete skulls of young animals were examined and it was found that the replacement of upper and lower teeth was similar.

For convenience, the date of birth for all calves was considered as June first. An analysis of the 143 specimens examined in this study is presented in table 6. Here the average measurements and observations on teeth eruption and wear are given for each age class. The data have also been presented in graph form in figure 18, where the dates of eruption and wear on the teeth until the age of 38 months may be more easily observed. A series of mandibles from animals of different ages is shown in figure 19.

It is likely that at birth the deciduous incisors are in the process of eruption. The deciduous premolars are erupted in the first couple of weeks. At the age of 2-3 weeks the fawns already have a complete set of deciduous teeth. The first wear on the deciduous premolars is at the age of about a month and a half, when the fawns first start to feed on vegetation. The first permanent molar is erupted in the third month, the second in the tenth month and the third in the seventeenth month. There were an insufficient number of critical specimens

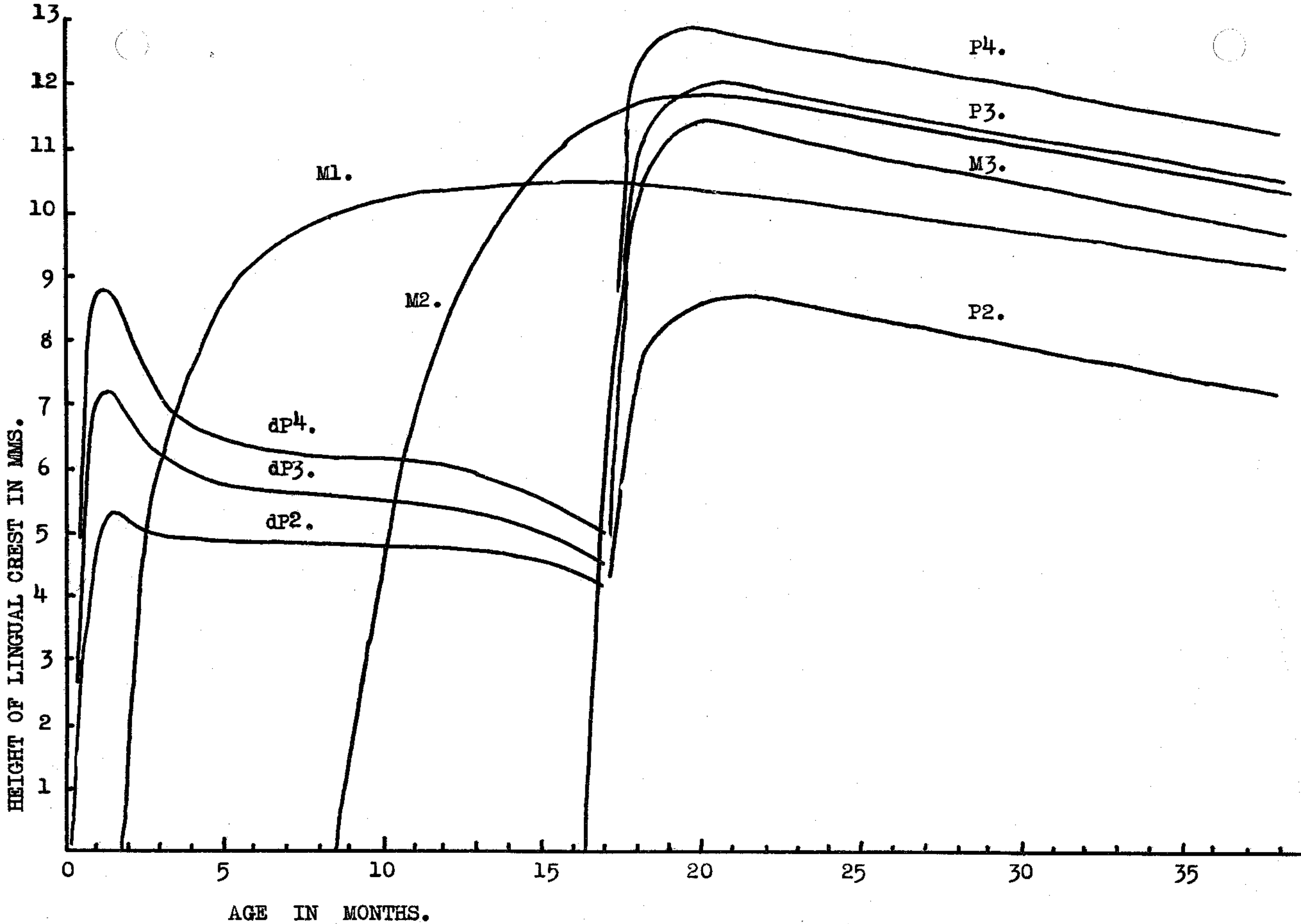


FIGURE 18. DIAGRAM OF TOOTH ERUPTION AND WEAR.

Table 6. Eruption and Wear of Teeth

Age	No.	I1	P2.	P3.	P4.	M1.	M2.	M3.	D/E	Eruption	Wear
0	1	-	0	0	0	0	0	0	-	dI's	-
½ mo.	2	-	d3.0	d5.3	8.0	0	0	0	-	dP's	-
1	8	d5.4	5.1	6.8	8.0	0	0	0	-	-	-
1½	5	7.2	5.1	7.1	8.8	0	0	0	-	-	dP3 light.
2½	7	-	4.8	6.5	7.8	p3.8	0	0	0	pM1	dP3,4. light.
3	4	4.9	4.9	6.4	7.0	6.2	0	0	0	"	dP2 light P3, 4. Mod.
5	7	-	4.8	5.2	5.7	8.7	0	0	0	-	dP's moderate
8	4	-	4.8	5.8	6.3	9.9	0	0	½	-	" "
10	4	p7.3	4.8	5.5	6.7	9.7	p4.1	0	½	pI1,2, M2.	" heavy
12	2	-	4.0	4.4	4.6	8.6	8.3	0	1	pI3,C, M2.	" "
14	4	7.1	4.7	4.9	5.2	10.4	9.5	0	1	-	" "
16	4	-	4.2	4.6	5.7	10.4	11.0	0	1	-	" "
17	6	7.0	5.0	4.4	5.0	10.3	12.1	p6.1	1	pP's M3	pM1 light
18	7	-	p7.8	p11.2	p12.2	10.6	11.3	9.3	1	M3	" "
20	7	-	8.1	11.4	12.9	10.5	12.0	11.7	1	-	" "
22	8	6.5	8.9	11.6	12.4	10.2	11.0	12.2	1	M3pc	P3,4,M1,2 light.
24	10	-	8.4	11.7	12.0	10.1	11.6	10.8	1	"	P3,4,M1,2 3 light.
26	9	6.0	6.8	11.3	12.5	10.0	11.3	10.5	1½	-	M3 pc.light.
29	14	6.4	8.0	11.2	12.2	9.8	10.8	10.9	1½	-	" " "
33	14	6.1	8.4	10.8	10.9	9.4	10.6	10.7	2	-	P2,3,4,M1,2, 3 pc. mod.
36	12	5.5	7.3	11.0	11.2	9.3	10.7	9.6	2	-	" "
38	5	5.7	7.1	10.2	11.7	9.2	10.3	9.4	2½	-	" "
Total 143											

Note. All measurements are in millimeters.

to indicate the replacement sequence of the permanent incisors. The replacement occurs rapidly between the 10th and 12th month from incisor 1 to 3 and the lower canines follow suit. The early stages of the eruption of the permanent premolars are not well documented, as they are fully erupted at an earlier date than shown, but carry thin caps of the deciduous premolars on their crowns. The deciduous caps are finally shed and the permanent premolars come into wear in the eighteenth month.

The first wear on the permanent dentition occurs on the first molar at an approximate age of twelve months. The last portion to show wear is the posterior cusp of the third molar. This cusp shows first signs of wear at approximately 26 months.

From the 20th to the 38th month the even wear on the cheek teeth is noteworthy. The rate of wear for M1. has been calculated to be about 1.4 mm. for 20 months. The most heavily worn mandible of 302 specimens examined had M1 with a height of 3.6 mm., or 7 mm. less than the maximum at 18 months. If the tooth wear were continuous at the same rate as indicated by these data, the age of this specimen would have been about 9.8 years at death. From data concerning the longevity of reindeer, this is a reasonable calculation for the approximate limit of longevity of the species.

From the data presented above it is possible to list the following changes in the dental formula at various ages.

At birth	$\frac{0.}{3d}$	$\frac{0.}{1d}$	$\frac{0.}{0}$	$\frac{0}{0}$	== 8 total
At 1 week	$\frac{0.}{3d}$	$\frac{0.}{1d}$	$\frac{3d.}{3d}$	$\frac{0}{0}$	== 20
At 10 weeks	$\frac{0.}{3d}$	$\frac{0.}{1d}$	$\frac{3d.}{3d}$	$\frac{1}{1}$	== 24
At 10 months	$\frac{0.}{3pd.}$	$\frac{0.}{1d}$	$\frac{3d.}{3d}$	$\frac{2}{2}$	== 28
At 16 months	$\frac{0.}{3}$	$\frac{0.}{1}$	$\frac{3dp.}{3dp}$	$\frac{2}{2}$	== 28
At 18 months	$\frac{0.}{3}$	$\frac{1}{1}$ (?)	$\frac{3.}{3}$	$\frac{3}{3}$	== 34

From these observations it is noted that the eruption of teeth of the subject species closely follows that of the white-tailed deer (Odocoileus virginianus) as presented by Severinghaus. The eruption of the permanent incisors is quite different from that of the wapiti (Cervus canadensis), which erupts one pair of incisors annually, starting with the second summer. It appears that in the eruption of the dentition young caribou are more precocious than young white-tailed deer.

During the summer months the barren-ground caribou is a rangy animal in body proportions. The body seems slim and the legs relatively long. The legs are relatively longer than those of the reindeer, which allows them to be easily picked out of a herd of reindeer, which seem thick-bodied and short-legged in comparison. During late autumn, because of lengthening pelage and fat storage, the caribou appear more sturdy.

As is characteristic of the deer family, the caribou possess several prominent glands. The infraorbital gland on the face is well developed. There are also a pair of interdigital glands between digits 3 and 4 of each forelimb. The use of these glands is not known. The glands which are prominently situated on the metacarpals of white-tailed deer are absent on the caribou.

A characteristic sound associated with the passage of a herd of caribou is the loud clicking of their foot bones. This clicking has been attributed to the interplay of carpal bones or sesmoid bones in the foot when the weight of the animal is placed on that foot. This peculiar noise may be of some social significance, helping to keep the herd together when moving.

The wide hoofs have previously been described. The single foot-print made upon firm snow, sand or mud consists of the imprint of the four hoofs, because the dew claws are low on the foot and carry some of the body weight. The anterior hoofs on each foot are pointed at the anterior tip and rounded behind. They leave wide crescent marks with the two points facing in towards the mid-line. The dew claws leave two crescentic marks close behind the anterior hoofs. A large bull leaves a foot-print approximately 185 mm. long and 125 mm. wide. The foot-print of a cow is approximately 145 mm. in length and 90 mm. in width.

The foot-print of a calf in summer generally lacks the impression of the dew claws and measures about 60 mm. in length and 65 mm. in width.

The trail of a trotting caribou consists of three foot-prints in a straight line about 36 inches apart and a fourth print displaced to the right and about 20 inches from the last print. The series is then repeated.

Storage of Fat.

Part of the stocky appearance of caribou in autumn, at the onset of the rut, is caused by fat storage. Some fat is stored in the coelom in the greater omentum, mesenteries and around the rectum, but more important is the deposition of a layer of fat over the saddle and rump, beneath the hide. This layer may reach 3 inches in thickness and weigh up to thirty pounds. It was referred to as the depouille (spoils) by the early Canadian voyagers and is often mentioned by early writers as an important dietary factor.

There is a different cycle of fat storage in the two sexes. The adult bulls commence building a layer of back fat in late summer. This deposition grows during September and October until the rutting period is reached. During the rut, bulls rarely take time to eat and the layer of fat is soon used up, with the result that they generally enter the winter in lean condition. During spring there may be some deposition of fat on omenta and mesenteries, but throughout spring and early summer bulls generally remain lean.

The accumulation of back fat on the cows occurs later in the season than on the bulls. The deposition seldom starts until September and reaches its maximum thickness in late autumn or early winter. During late winter and spring the back fat is utilized. By late spring and summer, cows are usually very lean. Those with calves are often in very lean condition and do not commence to accumulate fat until late in the season. On the other hand, barren cows often remain fat throughout the winter and start to accumulate new back fat by mid-August. Calves are universally lean throughout their first winters. In mid-summer yearlings and two-year-olds generally start to accumulate fat deposits. In autumn a fat animal may often be picked out of a group of thinner animals by the stubby appearance of its tail when the animal is running.

The annual cycle of fat deposition outlined above is subject to many variations caused by environmental factors. If the bands spend the winter on rich vegetative ranges, they may retain heavy layers of back fat during the spring migration. Specimens collected at Churchill in April, 1948, were all in excellent condition. Even the pregnant cows had back fat about 20 mm. thick on the rump. The hordes of biting insects upon the tundra have a profound effect upon the accumulation of fat during the summer months. Under the attacks of black flies and mosquitoes caribou feed irregularly and are continually moving. It was noted that soon after the early disappearance of biting flies in 1948, the caribou commenced to store mesenteric fat.

In 1949 the fly season was more prolonged and the caribou taken showed little deposition of fat in late August. Stefansson (1921) noted that the caribou on Banks Island had rich deposits of fat during the summer in comparison with the mainland herds with which he was familiar. He correlated this observation with the lack of mosquitoes on the Banks Island summer range.

Range Vegetation Studies.

In order to obtain quantitative data on the food preferences of the caribou, it was necessary first to carry out studies of forage availability and forage production in the various plant communities which were seasonally frequented by them. Besides providing quantitative data on available food, the observations also give a quantitative picture of some of the plant communities typical of the caribou range.

Observations were made at six stations: two in the taiga biome and four on the tundra biome. These stations were in localities much frequented by caribou. The tundra stations were on typical summer range and the taiga stations on typical winter range. Each station represented a typical plant community. The stations were as follows:

1. Fort Reliance, Mackenzie Dist. - dry wooded hillside community.
2. Fort Reliance, Mackenzie Dist. - damp, low, sphagnum bog community.
3. Bathurst Inlet, Mackenzie Dist. - damp, Arctic Sea Coast tundra community.

4. Contwoyto Lake, Mackenzie Dist. - dry, flat interior tundra community.

5. Lake Clinton-Colden, " " - dry rocky tundra community.

6. Muskox Lake, Mackenzie Dist. - moist snowbank tundra community.

The range studies were carried out at Fort Reliance in June, 1949; Bathurst Inlet, July, 1949; Contwoyto Lake, August, 1949; Muskox Lake, July, 1948; and Lake Clinton-Colden, August, 1948.

The data were obtained by means of a Raunkiaer's circle, using a systematic sampling technique. Random line transects were laid across the plant communities. At each tenth pace, the plants which fell within the circle immediately in front of the observer were tallied. At each stop simultaneous observations were made for the different vegetation strata present: tree, shrub and ground vegetation, and the average height of each stratum was estimated. The data tallied for each "throw" of the Raunkiaer's circle included species present and the approximate coverage of their leaves and stems. For each station between 100 and 300 "throws" of the Raunkiaer's circle were made. For each species information was also recorded concerning the spacing of the individual plants. This was indicated as a figure on a sociability scale as indicated below:

Sociability 5. Plants growing in thick pure stands.

4. Plants growing in large clumps.

3. Plants growing in small groups.

1. Plants occurring singly.

The forage production studies were made only at Lake Clinton-Colden. Here in late August, after the completion of the season's growth, 15 clip - quadrats were laid out systematically across a tundra community being utilized by caribou. The quadrats were one square yard in area. All the new seasonal growth, leaves, berries and twigs, was clipped to within one inch of the ground. The ground lichens were also collected. The forage was segregated by species in paper bags; air-dried for one week and then weighed.

The quantitative data derived from these studies for each community studied, are listed in tables 7-12 . Under frequency index are recorded the number of times each species occurred in a sample "throw". The occurrences are expressed as decimal fractions of the total number of samples. Similarly, under coverage is recorded the total coverage of the species, expressed as a decimal fraction of the total area surveyed.

A pictorial comparison of the total coverages of the various strata in both the taiga and the tundra communities is given in figure 20. From this figure, the absence of trees and tall bushes and the scarcity of shrubs on the tundra is indicated. The lesser total coverage of vegetation in the tundra communities is also noteworthy.

Table 7. Station 1. Dry hillside Fort Reliance. 115 throws

Stratum		Freq. Index.	Coverage	Sociability
Trees 20 ft. +	White spruce (Picea glauca)	.14	.068	5
	White birch (Betula papyrifera)	.16	.093	2
	Aspen (Populus tremuloides)	T	T	2
	Total		.161	
Bushes 10 ft. + -	White spruce (Picea glauca)	.06	.031	5
	White birch (Betula papyrifera)	.03	.015	2
	Willows (Salix sp.)	.07	.030	2
	Alders (Alnus sp.)	.04	.023	2
	Total		.098	
Shrubs 2 ft. + -	Buffalo berry (Sheperdia canadensis)	.08	.038	1
	Willows (Salix sp.)	.10	.030	2
	Glandular birch (Betula glandulosa)	.02	.004	4
	Labrador tea (Ledum decumbens)	.34	.110	5
	Bilberry (Vaccinium uliginosum)	.10	.027	4
	Juniper (Juniperus communis)	.04	.016	1
	Rhododendron (Rhododendron lapponicum)	.03	.008	3
	White spruce (Picea glauca)	.03	.026	5
	Total		.225	
Ground Veg.	Foxberry (Vaccinium Vitis-Idaea)	.60	.150	4
	Crowberry (Empetrum nigrum)	.44	.166	2
	Labrador tea (Ledum decumbens)	.17	.021	5
	Bearberry (Arctostaphylos alpina)	.13	.032	4
	Pyrola (Pyrola sp.)	.07	.041	1
	Bilberry (Vaccinium uliginosum)	.03	.003	1
	Grass (Calamagrostis purpurascens)	.04	.014	5
	Mosses (Musci)	.51	.276	5
	Lichen (Cladonia alpestris var. sylvatica)	.14	.027	2
	Lichen (Cladonia rangiferina)	.05	.011	2
	Lichen (Cetraria nivalis)	.07	.014	2
	Total		.728	

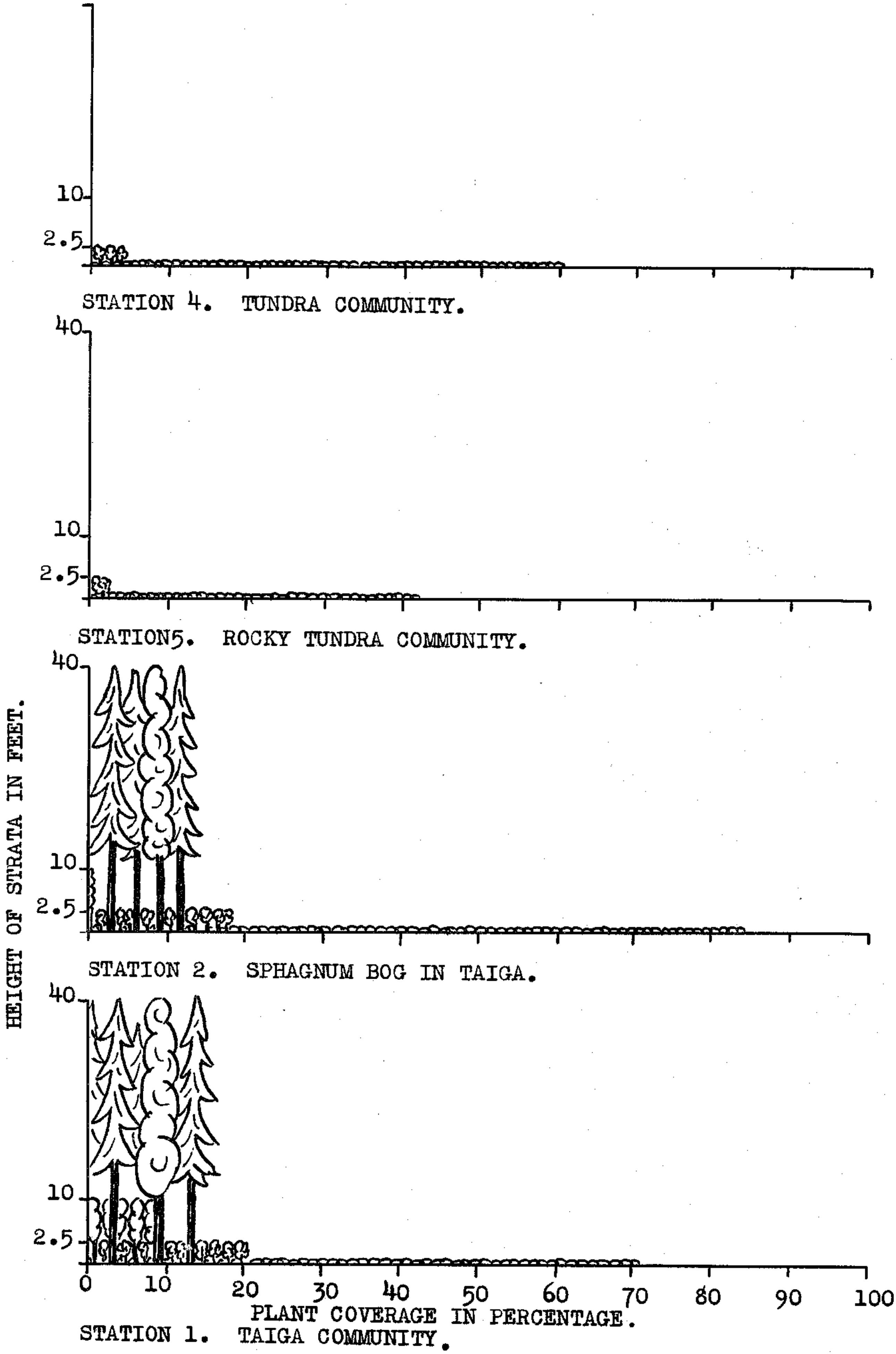


FIG. 20. COMPARISON OF PLANT COVERAGE AT VARIOUS STATIONS.

Table 8. Station 2 Bog Fort Reliance, N.W.T. 100 "throws".

Species		Freq. Index.	Coverage	Sociability
Trees 20 ft.				
Black spruce	(*Picea mariana*)	.21	.092	4
Tamarack	(*Larix laricina*)	.03	.020	1
White birch	(*Betula papyrifera*)	.04	.010	1
Total			.122	
Bushes 10 ft.				
Tamarack	(*Larix laricina*)	.01	.002	1
Willows	(*Salix* sp.)	.03	.006	1
Total			.008	
Shrubs 2 ft.				
Black spruce	(*Picea mariana*)	.09	.034	4
Dwarf birch	(*Betula glandulosa*)	.02	.005	4
Tamarack	(*Larix laricina*)	.02	.006	1
Willows	(*Salix* sp.)	.12	.017	1
Juniper	(*Juniperus communis*)	.01	.006	1
Rhododendron	(*Rhododendron lapponicum*)	.04	.018	3
Labrador tea	(*Ledum decumbens*)	.33	.063	5
Bilberry	(*Vaccinium uliginosum*)	.22	.041	4
Andromeda	(*Andromeda polifolia*)	.01	.004	2
Total			.194	
Ground vegetation				
Crowberry	(*Empetrum nigrum*)	.23	.065	2
Foxberry	(*Vaccinium Vitis-Idaea*)	.42	.067	4
Bearberry	(*Arctostaphylos alpina*)	.14	.029	4
Labrador tea	(*Ledum decumbens*)	.17	.022	5
Mosses	(*Musci*)	.75	.325	5
Lichen	(*Cladonia rangiferina*)	.40	.145	3
Lichen	(*Cetraria nivalis*)	.15	.027	2
Lichen	(*Cladonia alpostris var. sylvatica*)	.28	.055	2
Horsetail	(*Equisetum* sp.)	.07	.007	2
Lycopod	(*Lycopodium* sp.)	.01	.005	2
Sedge	(*Carex Williamsii*)	.03	.014	2
Sedge	(*Carex concolor*)	.05	.013	3
Grass	(*Calamagrostis canadensis*)	.01	.003	5
Andromeda	(*Andromeda polifolia*)	.06	.006	1
Willows	(*Salix* sp.)	.09	.020	2
Cottongrass	(*Eriophorum* sp.)	.04	.019	5
Blueberry	(*Vaccinium uliginosum*)	.02	.008	2
Dryad	(*Dryas integrifolia*)	.01	.004	2
Total			.842	

Table 9. Station 3 Tundra Bathurst Inlet, N.W.T. 125 "throws".

Species		Freq. Index.	Coverage	Sociability
Shrubs 2' 6".				
Willows	(Salix sp.)	.08	.021	2
Alder	(Alnus sp.)	.04	.014	4
Glandular birch	(Betula glandulosa)	.04	.011	4
Total			.047	
Ground vegetation				
Dryad	(Dryas integrifolia)	.10	.014	3
Bilberry	(Vaccinium uliginosum)	.61	.105	4
Mosses	(Musci)	.60	.177	5
Glandular birch	(Betula glandulosa)	.27	.069	4
Foxberry	(Vaccinium Vitis-Idaea)	.09	.007	4
Willows	(Salix sp.)	.43	.060	2
Lichen	(Cetraria nivalis)	.42	.072	3
Lichen	(Alectoria ochroleuca)	.17	.013	3
Crowberry	(Empetrum nigrum)	.23	.034	2
Labrador tea	(Ledum decumbens)	.20	.013	5
Cassiope	(Cassiope tetragona)	.32	.083	1
Lupine	(Lupinus arcticus)	.18	.017	1
Rhododendron	(Rhododendron lapponicum)	.18	.019	3
Lousewort	(Pedicularis labradorica)	.07	.002	1
Lichen	(Stereocaulon Paschale)	.13	.018	2
Lichen	(Thamnolia vermicularis)	.08	.003	2
Lichen	(Cladonia rangiferina)	.12	.014	2
Lichen	(Cetraria islandica)	.09	.006	2
Lichen	(Dactylina arctica)	.04	.001	2
Bearberry	(Arctostaphylos alpina)	.10	.017	4
Andromeda	(Andromeda polifolia)	.03	.001	1
Bluegrass	(Poa glauca)	.01	.002	5
Grass	(Calamagrostis purpurascens)	.02	.003	5
Cottongrass	(Eriophorum sp.)	.02	.008	5
Sedge	(Carex concolor)	.34	.045	3
Sedges	(Carex sp.)	.06	.038	5
Total			.828	

Table 10. Station 4 - Dry Tundra Contwoyto Lake, N.W.T. 125 "throws"

Species		Freq. Index.	Coverage	Sociability
Shrubs 2' 6"				
Glandular birch	(Betula glandulosa)	.07	.050	4
Ground Vegetation				
Glandular birch	(Betula glandulosa)	.32	.083	4
Labrador tea	(Ledum decumbens)	.26	.057	5
Mosses	(Musci)	.32	.067	5
Lichen	(Cetraria nivalis)	.13	.002	3
Foxberry	(Vaccinium Vitis-Idaea)	.18	.026	4
Bilberry	(Vaccinium uliginosum)	.30	.058	4
Bearberry	(Arctostaphylos alpina)	.05	.006	4
Lichen	(Alectoria ochroleuca)	.02	T	3
Sedge	(Carex concolor)	.38	.072	5
Crowberry	(Empetrum nigrum)	.06	.010	2
Willows	(Salix sp.)	.27	.029	2
Cottongrass	(Eriophorum sp.)	.15	.069	5
Iceland Lichen	(Cetraria islandica)	.06	.002	3
Rosemary	(Andromeda polifolia)	.01	T	1
Cloudberry	(Rubus chamaemorus)	.02	.001	1
Sedge	(Carex membranacea)	.01	.002	5
Lichen	(Cladonia rangiferina)	.01	T	2
Sedges	(Carex sp.)	.19	.089	5
Knotweed	(Polygonum sp.)	.02	.001	1
Bluegrass	(Poa sp.)	.02	.003	3
Lousewort	(Pedicularis lapponica)	.02	.002	1
Alpine azalea	(Loiseleuria procumbens)	.02	.002	3
Milk vetch	(Astragalus alpinus)	.02	.001	1
Bluegrass	(Poa glauca)	.04	.009	3
Holy grass	(Hierochloe alpina)	.08	.016	3
Total			.605	

Table 12. Station 6 Tundra Musk-ox Lake, N.W.T. 100 "throws"

Species		Freq. Index	Coverage	Sociability
Shrubs 2'6"				
Willows	(*Salix* sp.)	.07	.008	2
Birch	(*Betula glandulosa*)	.40	.130	4
Total			.138	
Ground Vegetation				
Labrador tea	(*Ledum decumbens*)	.38	.091	5
Bilberry	(*Vaccinium uliginosum*)	.19	.056	4
Foxberry	(*Vaccinium Vitis-Idaea*)	.16	.029	4
Crowberry	(*Empetrum nigrum*)	.12	.047	2
Bearberry	(*Arctostaphylos alpina*)	.10	.019	4
Rosemary	(*Andromeda polifolia*)	.08	.014	1
Cloudberry	(*Rubus Chamaemorus*)	.01	.001	1
Butterwort	(*Pinguicula villosa*)	.01	T	3
Knotweed	(*Polygonum viviparum*)	.02	.004	1
Sedge	(*Carex concolor*)	.16	.032	3
Cottongrass	(*Eriophorum vaginatum*)	.31	.184	5
Bent reed grass	(*Calamagrostis purpurascens*)	.04	.014	5
Holy grass	(*Hierochloe alpina*)	.02	.014	3
Bent grass	(*Agrostis borealis*)	.01	.008	3
Lichen	(*Cetraria nivalis*)	.21	.022	3
Lichen	(*Cetraria islandica*)	.09	.023	3
Sphagnum	(*Sphagnum* sp.)	.08	.039	5
Mosses	(*Musci*)	.12	.024	3
Total			.761	

From a comparison of the plant species found in the tundra communities with those of the taiga communities, it is noted that certain species are confined to one formation or the other. In the taiga communities it is the unique group of tree species which dominate the appearance of the community. On the tundra, however, the numerically dominant species as well as the ones with the dominant growth form are a group of plants which are also the dominant species in the understories of the taiga communities. These plants which were common to all stations are: Ledum decumbens, Empetrum nigrum, Arctostaphylos alpina, Vaccinium uliginosum, Betula glandulosa, Andromeda polifolia and several species of Salix. In some respects the tundra communities seem to be most easily characterized by the description - treeless.

On the white spruce of the taiga several arboreal lichens are found. Two of the more common species are Evernia prunastri and Alectoria jubata. These plants are important sources of winter food for the caribou.

In the taiga where caribou are known to spend the winter, little evidence was noted of utilization aside from light browsing of willow and birch twigs and arboreal lichens. On many of the tundra areas visited, however, there were many signs of heavy utilization. This was particularly evident at Lake Clinton-Colden where the shubby growth of willows and glandular birch was heavily browsed. The lichen growth was also heavily utilized. Over large portions of the central tundra lichen growth is restricted by heavy caribou use. In these areas luxuriant lichens are only found in inaccessible rocky crevasses. These conditions are different from those in the Eskimo Lakes area where the lichen growth is rich. Reports from east of Hudson Bay also indicate a more luxuriant lichen growth. In these areas the caribou population has been severely reduced. In the taiga communities visited there was a heavier lichen growth than on the tundra. It is likely that the caribou are attracted to these areas in winter.

Food Requirements

During the investigation 16 samples of caribou stomach contents were preserved. These came from 14 caribou specimens taken on the tundra in summer and two from winter specimens from taiga localities.

The volumetric analysis of the stomach contents are presented in table 13 along with the availability of the plant species taken from the previous range studies. From these data the preference ratios for the various species has been calculated.

The Barren-ground Caribou

Behaviour

The actions of a caribou at any one moment may be classified under one of three headings: individual, social or ecologic behaviour. The actions that a caribou makes as an individual, such as walking and feeding, are classified as individual behaviour. Any related actions of two or more individuals of mutual benefit, such as mating behaviour, is

TABLE 13 TO BE INSERTED AT THIS POINT WHEN AVAILABLE.

classified as social behaviour. The behaviour patterns exhibited by a caribou in relation with another animal species of the community is considered ecologic behaviour. The reactions of caribou to the attacks of insects and predators also fall under this heading, but will be dealt with under separate sections.

Individual Behaviour

It is difficult to discuss animal behaviour without using words which seem to have an anthropomorphic connotation. When dealing with the higher groups of mammals this is perhaps less reprehensible than generally held. It seems probable that many "human emotions", such as fear, curiosity and playfulness, are really basic mammal emotions. In the following discussion such words are used as descriptive terms. It is intended to describe the actions which we associate with these "emotions".

Locomotion.

The caribou uses a variety of gaits. It appears to be a restless animal by nature. While slowly feeding along a ridge, it may suddenly break into a trot, only to resume a walk again after a few paces. It uses a leisurely walking pace when feeding, browsing a willow shoot here and then grazing on a bunch of blue grass further on. The head is occasionally lifted for a look at the surroundings. When alarmed, or aroused by curiosity, the caribou trots with head held high, the line of the head approximately paralleling the ground, the short tail held stiffy erect and the legs thrown loosely forward and out. This gait can be changed to a fast pace with which the caribou may cover great distances with seemingly little effort. When using the pace the legs are stiffened and the animal progresses with a long springing stride. Both legs on one side are thrown forward together, then the legs of the other side. When hard pressed, the species will break into a laboured rolling gallop, but this gait is never maintained for a long period.

Caribou appear to travel at high speed when pursued with a snowmobile on a frozen lake. It is usually necessary to drive between 45 to 50 mph to overtake them. Because of their devious routes it is difficult to ascertain their speed by comparison. The most reliable estimation of their top speed obtained was made by Messrs. J. Staunton and R. Shewfelt, former Manitoba Game Guardians, in November, 1948, near Gillam, Manitoba. While they were travelling along the Hudson Bay Railway in a gas-car, a small band of caribou tried to cross the track ahead of them. One young bull galloped along the roadbed ahead of the gas-car for about a quarter of a mile before turning off. They were able to adjust their speed to that of the caribou and found it was travelling at a rate of approximately 37 mph.

An excellent opportunity arose to observe the rate of travel during migration in the autumn of 1948, in Manitoba, as the route taken lay southward along the Hudson Bay Railway south of Churchill. During frequent trips by gas-car between Churchill and Ilford, it was possible to note the location of the vanguard of the herds. These observations are given in table 14. The average daily distance advanced was 19.4 miles.

Table 14. Daily distances advanced during migrations

Date	Location of vanguard	Miles per day
Nov. 14, 1948	Churchill River	
" 18, "	Mile 432, HBR	12
" 19, "	Mile 412, HBR	20
" 20, "	Mile 372, HBR	40
" 22, "	Mile 349, HBR	23
" 23, "	Mile 337, HBR	12
" 27, "	Split Lake	16
" 28, "	Moose nose Lake	20
" 29, "	Mile 261, HBR	12
Dec. 1, "	Bigstone River	20
Average		19.4

Forty miles is probably near the maximum distance advanced in one day during migration. Often the rate of travel will be exceedingly slow, and the caribou may travel only during a short period of the day. During a twenty-four hour period on August 4-5, 1948, a caribou herd was followed from Lake Clinton-Colden to Deville Lake, Mackenzie District, a distance of ten miles. During the spring migration of 1949, a very large herd of caribou was observed entering the western end of Ghost Lake, Mackenzie District, on April 24th. On April 28th, the area was revisited and the vanguard of the herd had moved only 12 miles eastward along the frozen lake.

It is difficult to calculate the daily range of caribou because they are in movement practically the whole of the year. The daily distance travelled depends on the season and weather. It is probably a minimum during midwinter and during the month of July, and a maximum during spring and autumn. From August 20 to 25, 1948, three bull caribou remained within an area of about fifty acres, on the shores of Lake Clinton-Colden. In the vicinity of Bathurst Inlet, a herd of about 4,000 caribou was under constant observation from July 11 to 15, 1949. During this period the herd drifted about five miles. The usual observation, however, is to see a small band of feeding caribou drift gradually out of sight a mile or two away, in about two hours.

Caribou are probably the most amphibious of all the deer, notwithstanding the moose's well known summer habit of feeding in the water. They take readily to water as a means of escape from predators and insect pests and in order to cross lakes and rivers in their line of travel. They are strong swimmers. In water they float higher than most mammals, with the tail and head held high and the rump, back and shoulders well above the water. The height at which they float depends on the condition of the pelage, the antlers and the amount of fat stored. During the summer a cow generally floats higher than a bull, which is generally weighted down by heavy antlers in velvet (see figure 21). A group of heavily antlered bulls was observed to hesitate at crossing a small lake along with the rest of a large herd until finally the band trotted around the shore of the lake.

It is commonly believed by northern residents that the hair of the caribou is hollow and that this gives increased buoyancy to a swimming caribou. Caribou hair on being sectioned was found to have a solid cortex filled with large spongy cells similar to those of other deer. There is no doubt, however, that the thick new pelage of late summer does trap some air, which assists in the buoyancy. Calves also readily take to water at a very early age, but they cannot swim as fast as their parents and frequently on reaching land, must run ahead, searching for their mothers.

Rivers and lakes are usually crossed at the narrowest points and so the usual swim is not more than a quarter of a mile. On August 18, 1949, a band of caribou was observed to swim about two miles to an island in Contwoyto Lake when cornered on a point by Eskimo Hunters.

On August 15, 1948, a band of 20 caribou were observed swimming across Caribou Narrows, Lake Clinton-Colden. They swam the distance of 1000 yards in 8 minutes, 25 seconds, or at a speed of 4.0 miles per hour. This speed of 4 mph was attained without special exertion. When pursued by a canoe, they can swim faster for short periods. It is difficult to overtake swimming caribou, even in a light canoe with two strong paddlers. Under these conditions, they can probably attain a speed of approximately 6 miles per hour.

On leaving the water, each caribou lowers the head and shakes the water from its fur in the same manner as a dog does.

Voice. Caribou are usually silent, but this does not mean that they are voiceless. When surprised at close range, or annoyed by insects, both sexes give a loud snort. When in large groups caribou may frequently be heard uttering grunts which resemble the grunts of swine or the sound of a belch. The calves bawl frequently during the first few months of their lives. What with the bawling of calves and the low short belching grunts of the adults, there is a great deal of noise in a large herd of caribou.

During early July, 1949, it was noted that a significant variation in the amount of clamour of a large herd was associated with the daily activity. The peak was reached in the early morning and evening, at the height of the feeding periods. During the afternoon, when most of the caribou were resting, there was little clamour. A migrating herd of caribou is often accompanied by grunts and the creeking of their foot-joints.

Senses. Caribou possess a keen sense of smell and rely largely on this sense for warning of danger. When stalking caribou it is necessary to be sure that the wind is favourable, since caribou react quickly and violently upon catching human scent. If feeding the head is jerked up upon the scent of danger and a shudder is sometimes observed to run down the animal's frame, the head is then turned towards the wind and the nostrils dilated. If the scent is confirmed, the animal will break into a trot. If the animal was lying down, it usually leaps to its feet on catching human scent. This reaction to human scent is also given by calves when they are about two months old. In a herd, if one caribou reacts to the scent of danger, others will become alarmed and trot about, testing the wind with their nostrils. The flight is usually not prolonged and the animals turn to stare towards the location of the danger.

It is difficult to calculate the distance the human scent carries with strength sufficient to alarm the species. On August 5, 1948, at the Hanbury River portage from Ptarmigan Lake the author lay among some boulders to watch an advancing herd of several thousand caribou. The herd was advancing across the wind carrying the human scent. Soon I was surrounded by moving bands, except for a corridor of land directly downwind from my positi n, which was clear of caribou. It was about one mile in length and subtended an angle of about 15 degrees from my position. Any bands attempting to cross this segment were immediately repelled by my scent and made their way around by travelling upwind. These bands often passed within 20 yards to the windward of my position.

The caribou's sense of hearing is good, but not as keen as that or some other species. On being stalked, they often did not pay particular attention to twigs crackling or to soft voices. On August 6, 1948, on stalking a herd of caribou, the author was followed by a screaming herring gull (Larus argentatus). It was noted that the nearest caribou watched the screaming gull and were apprehensive, frequently lifting their heads to watch in my direction. This observation was repeated at other times with ravens (Corvus corax) and gulls. It was decided that the caribou took warning from the cries of these scavangers, which often follow hunting wolves or men.

It seems that the barren-ground caribou has not yet definitely associated a rifle shot with danger. When one fires at a caribou herd, the animals not hit appear startled. They usually peer towards the sound of the shot and then circle to get the scent of the hunter. This behaviour trait makes the species particularly vulnerable to the modern hunting rifle.

The eyesight of caribou may be described as poor compared with that of other species such as the pronghorn antelope (Antilocarpa americana). It is possible to crawl upwind to within 15 yards of a resting caribou by the simple device of moving when the animal's head is turned away and "freezing" when the animal looks your way. It is usually possible to walk unobserved to within about 150 yards of a herd of caribou on the open tundra. Within 100 yards, caribou are quick to notice movements. They then try to circle downwind of the suspicious object. When first alarmed by a scent, they often try to confirm the danger by observation before taking to flight. A hunter usually experiences more difficulty in approaching a herd of caribou on the tundra in winter because of the scarcity of cover. Moving objects are more quickly perceived against the white background of snow.

On April 22, 1948, bands of migrating caribou were observed passing northwest along the shore-ice at Churchill, Manitoba. The ground was covered with heavily crusted snow and the sky was clear, causing severe glare from the surface of the snow. The caribou were observed to be travelling in strings, with their heads down and their eyes closed except for mere slits. It is possible that they suffer from snowblindness during the clear days of early spring.

"Curiosity" The barren-ground caribou is well known for its so-called "curiosity". It is difficult to find a better word to describe its observed actions. It has been the common experience of all who have hunted it that it can be attracted by unusual behaviour of the hunter. The normal reaction when they are suspicious of danger is to circle to a position downwind from the object of suspicion. When alarmed they flee for a short distance, only to pause and look over their shoulders at the intruders. This habit makes the species extremely vulnerable to the modern rifle.

Caribou are generally docile animals which cannot be provoked into making an offensive move. During the rutting season occasionally a wounded or cornered bull will defend himself. At Fort Reliance a wounded bull turned on a pursuing dog and sparred with its antlers. Usually they use their speed to leave a dangerous situation.

The preferred temperature range for the species seems to be lower than the higher summer temperatures reached in the Arctic. At this season, where snowbanks persist on the northern hillsides, large herds may often be observed bedded down on a bank during the summer afternoons as shown in figure 26. It is possible that this may also be an effort to obtain relief from insect pests.

Diel Activity. Because of the difficulty of observing caribou at night, it is impossible to give a complete picture of the diel activity. In the mid-summer period it is possible to obtain information during the hours of the arctic twilight.

From many hours of continuous observation of caribou during the summer months the following generalizations have been made. Caribou feed casually during the entire twenty-four-hour period, but there are peaks in their feeding activity during the forenoon and evening. At other periods feeding is desultory, being interrupted by long rest periods. During mid-afternoon there is a general lowering of activity and long rest periods are taken. From observations made during August, 1949, on the Hanbury River, on the distance travelled between night and early morning, it seems that there may also be a period of relative inactivity at night.

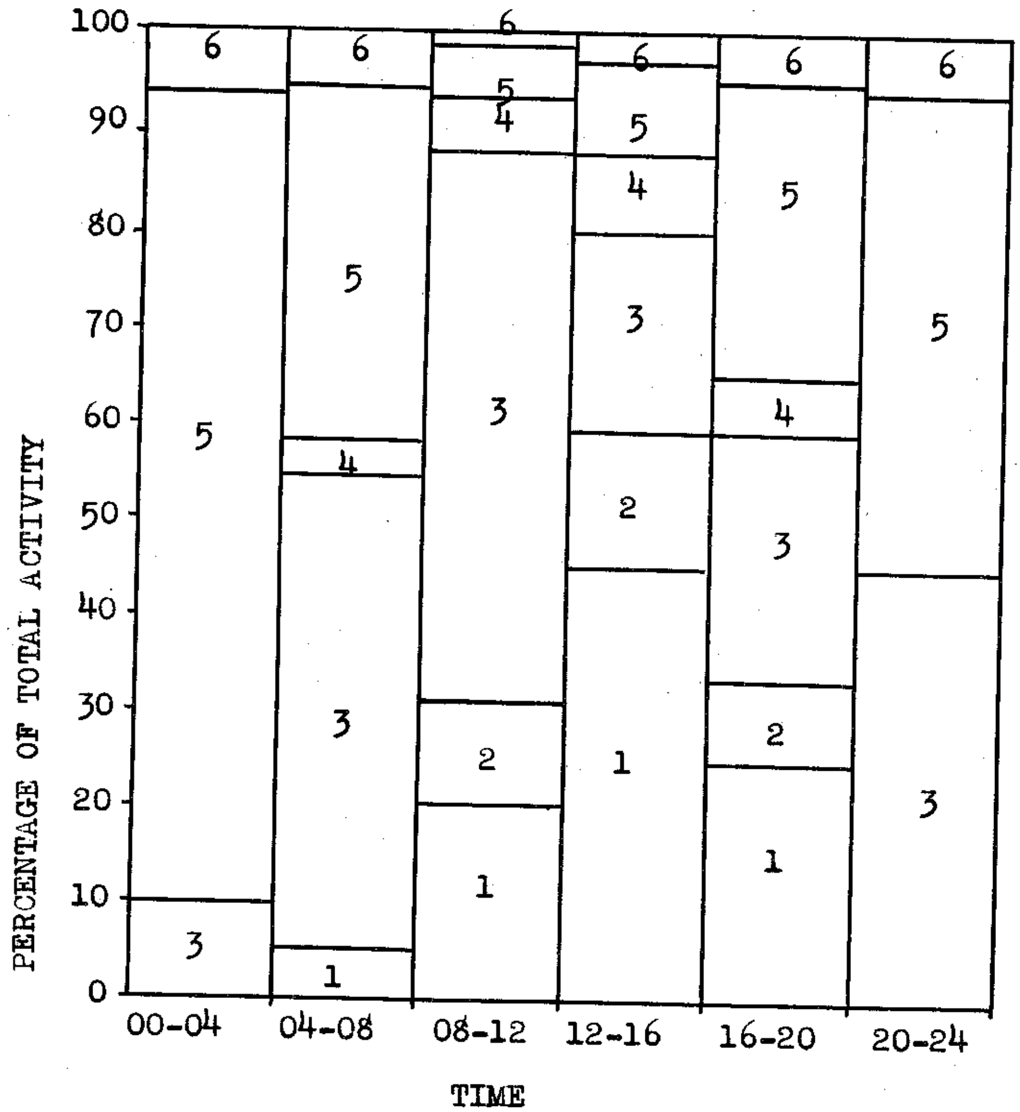
During these rest periods the animals usually lie with their backs to the wind, with the head erect, facing downwind, and the legs either tucked under the body or extended. To sleep, the head is brought around and tucked into the flank. Several cows were observed lying flat, with head on the ground and legs extended. Bulls are unable to take this position in summer because of their growing antlers. During the winter, caribou usually spend the afternoons lying on frozen lakes. While resting, they chew the cud in the same manner as cattle.

When migrating, the movement is usually made at dawn and dusk. At these times very little feeding is done and the herd progresses at a steady walk or with frequent short trots. During the feeding periods there may be a general drift in the direction of travel.

The general periods of maximum feeding, migrating and resting are given in graph form in figure 22. These data are derived from the analysis of 5000 minutes of constant observation of small groups of caribou during various times of day.

Social Behaviour

The barren-ground caribou is a gregarious animal and is usually met in small bands or loose herds. The herd is a social group, consisting of different age and sex groups at different times of the year. The behaviour patterns described



150	210	1360	1250	300	2050

CARIBOU-MINUTES

1. LYING.
2. STANDING.
3. FEEDING.
4. FIGHTING INSECTS.
5. TRAVELLING.
6. RUNNING.

FIG.22. CHART OF DIEL ACTIVITY.

previously have generally been those of the individual. The behaviour described in the following sections is mainly group behaviour.

The observed actions of individual caribou in a herd appear to be governed by a force of attraction analagous to a magnetic force. From the air, the individuals in a large herd of moving caribou are observed to be arranged in parallel strings like iron filings in a magnetic field. When alarmed while feeding, dispersed individuals quickly run together to form a band. In rapid movement, the herds appear to travel with a flowing motion over the well-beaten trails and to funnel through natural defiles.

Bands of caribou consist of about 5 to 100 individuals. A herd is composed of several loosely associated bands, with a total of from 100 to about 2000-3000 animals. Many photographs have been taken of closely packed herds, which are usually composed of one or two thousand caribou. During migratory periods large migrating herds which total between 100,000 and 200,000 animals have been observed, but these large masses are clearly divided into individual herds composed of approximately a thousand animals each. The amount of available forage along the route probably governs the size of the herds.

As a grepariou<s species, the barren-ground caribou has no individual home range. It is possible that the herd to which the individual belongs has a home range. Since the caribou is a nomadic species, the herd home range is many miles in extent. It may extend up to 800 miles in length between the summer and winter ranges.

At the same time there seems to be very little sign of a sense of territoriality in the species. This behaviour pattern is probably limited to the bulls in the rutting season, when they may attempt to intimidate nearby rivals. It is doubtful if there is any spatial relation in this pattern, as the herd may be in movement at the time. Only the proximity of the rival seems intolerable. This same intolerance of certain classes to the proximity of other classes at certain periods was noted among both sexes. On August 7, 1948, a yearling was observed to stab at a calf with a foreleg and then try to hunt it out of the way. Cows were observed to turn half away and lower their heads against calves trying to find their mothers. It is probable that similar actions are used by the cows to drive off the yearlings at the time of the birth of the calves.

During migrations it is usual for caribou to follow well-beaten trails in single file. At times there may be several parallelling files. At other fimes the group may bunch together. Aside from the close association of the cows and their calves there seemed to be no fixed organization to the group. The various small bands might join and then break apart with a different composition. There similarly seemed to be no set leader of each group. Bands were usually led by an adult female, but sometimes by a younger animal; even a calf might temporarily lead the band. In the vanguard of a summer herd one frequently observed a small group of bulls and a group of barren cows, with cows and calves in the rear. The leadership changes to whichever animal moves off first in the direction in which most of the herd want to go.

The route taken by migrating caribou during the winter generally follows strings of lakes, rivers and bogs. During the summer, the route generally lies around large bodies of water and across the narrowest parts of lakes or rivers. The numerous caribou trails generally follows the line of least resistance, where the walking is easiest. Consequently, trails often follow the ridges of eskers, natural passes in rocky country and defiles caused by rock discontinuities.

The caribou trails frequently lead to river crossings at rapids or waterfalls. These locations seem to be favourite crossing points yet they are often associated with considerable risk. This danger will be discussed later under mortality. An observation which was made on migrating caribou helps to explain this habit.

On August 5, 1948, at the Hanbury portage, a large congregation of caribou was under observation on the north shore of a small lake. By late evening the herd had grown to about 4,000 animals. The lake lay across the general line of movement and the bands were gradually moving down several valleys to the shore where several hundred caribou were feeding. Several small groups were at the water's edge and a few animals were standing in the water. Often one would gaze over to the south shore of the lake, about 150 yards away at the narrowest point. At 8.35 p.m. a large band of about 200 animals trotted rapidly down the bank and the leaders plunged into the water, and started to swim in single file towards the south shore. This movement was accompanied by a great deal of splashing, to which was added the clamour of the animals. Other nearby bands now joined the procession and it was soon evident that many bands were racing over the undulating ground towards the crossing point. It seemed as if a signal had been given and the whole herd was soon in movement. The majority of the bands could not see the crossing point because of hills, yet they were drawn there. By 9.50 p.m., 2,760 animals had swum across the narrows. It was evident that the majority of these bands had been stimulated, by hearing the splashing and clamour of the others, to make this crossing.

It is therefore believed that the noise of rushing water at rapids and waterfalls attracts caribou to cross the rivers at those points.

It has been the common observation of many writers that caribou are more wary and difficult to approach when in small bands than when in large herds. Tyrrell (1898) photographed a large herd of caribou at close range on the shores of Cary Lake, Keewatin District, during the summer of 1893. Stefansson (1913) writes of his guides attempting to spear caribou with knives tied to poles, when the caribou were passing in large columns.

During the current investigation it was generally found necessary to employ many precautions in stalking small groups of caribou in order to observe them at close range. On April 24 and 28, 1949, the opportunity arose to observe closely packed columns of migrating caribou on Ghost Lake, Mackenzie District. On these occasions the herds were sighted from the air, and the plane was landed among the herds on the frozen lake. It was found that the caribou were not greatly alarmed by the presence of humans. It was possible to walk up to within 25 yards of large herds (see figure 23). Often when the animals were bedded down, they remained lying on the ice, watching the approach of the observers, until it was evident that the observers would pass through the herd. At this time those in the path would rise and trot off the line of approach. In this way it was possible to walk down cleared corridors among herds of approximately 5,000 animals.

By manoeuvering with four observers, it was possible to herd the caribou past a photographer at a range of 10 yards. At such times individual observers appeared to be in the midst of galloping herds. Eventually a yearling was even lassoed with a piece of mooring rope by the pilot as a herd rushed by his position at a distance of about 5 yards.

It was found that in a galloping herd of several thousand caribou each animal was under perfect co-ordinated control. One could walk across the path of such a herd only to have it divide and pass on each side, leaving a space about 20 yards in diameter about the observer. At one point, the author, by crossing on the snow, obtained excellent photographs when a large herd was so manoeuvered by the other observers as to pass over the spot. The animals, while at full gallop, swerved to pass on each flank. Some passed within a few yards. From the many observations made on these days it was evident that caribou in large herds are less wary and more easily approached than when in small groups. It seems as if the caribou are conscious of the safety in numbers.

It is commonly believed by trappers and natives that caribou invariably feed and migrate into the wind. This dependence upon the wind direction during migrations was repeated by the earlier writers, such as Richardson (1829) and others. Critchell-Bullock (1930) kept meteorological records with his caribou records and gave a table which indicated that the direction of travel was independent of wind direction. His observations were made during the autumn, winter and spring period, in the vicinity of the Hanbury River.

During the present investigation daily meteorological records were kept simultaneously with the caribou observations. It was found that the travelling caribou were moving in a predetermined direction. They were moving towards either the summer, the winter or the rutting range, depending upon the season and irrespective of the wind direction. Quite often this path of movement will lie in the direction from which the wind is blowing. The wind might have a secondary effect on their movements, as it is usually associated with a storm which might cause more rapid movement. During the summer, insect pests would be reduced during and following a storm and this often caused movements of the herds. Winter storms often caused the herds to move more rapidly and to travel more deeply into the forested area.

A total of 210 critical observations were made during the study. The analysis of the correlation between direction of travel and wind direction is given in table 15.

Clarke (1940) writing of his observations on the summer migration of the Hanbury herd, reported that he observed large herds milling. Smaller herds would split off from the large

Figure 23. Unwary migrating herds of caribou, Ghost Lake, N.W.T.

Figure 24. Bands of cows and calves migrating on the tundra in April, 1948.

circling herds and race down to the river bank to ford the river. This is a well known trait with reindeer and is used as a method of controlling the animals when they are being driven to the corral.

Table 15. Relation between Movement & Wind Direction

DIRECTION OF WIND	0 IN FRONT	22.5°	45°	67.5°	90°	112.5°	135°	157.5	180 BEHIND
OBS.	28	14	40	12	42	9	30	11	24
PER CENT	13.3	6.6	19.0	5.7	20.0	4.3	14.3	5.7	11.4

During the present investigation, many large herds were observed both from the ground and from the air and none was observed to mill. With several other observers we tried to force herds to mill on Ghost Lake, without success. Invariably the caribou would break through in strings and stream away in one direction.

Herd Segregation

It has been mentioned previously that the herd varies in composition at different seasons of the year. These differences in composition may be due to changes in tolerance between various sex and age classes at different seasons such as the rejection of yearlings by the cows and the association of bulls and cows during the rutting season.

Starting with the writings of Richardson and Franklin, most scientists and naturalists have described the segregation of the sexes during the migration. It was stated that the bulls trailed the cows north in the spring. The majority of northern trappers also hold this opinion. Hoare (1930) stated that the bulls preceded the cows during migration. As a result of his summer observations on the Hanbury River, Clarke (1940) decided that the sexes travelled together, although they might be segregated into bands of about a thousand animals of one sex or the other.

During the present investigation it was confirmed that the majority of the mature bulls follow the cows and yearlings from the winter ranges to the tundra summer range in the spring. During the aerial investigations carried out in Keewatin and Manitoba during April and May, 1948, 10,548 caribou were photographed. Of these, 2,866 were at such range as to be classifiable by age and sex. The herd was composed of 18.8% adult bulls, 56.4% adult cows, 15.8% calves and 9.0% yearlings. The leading bands were composed of adult cows, yearlings and a few 2-year-and 3-year-old bulls. By May 15 these bands were spread from timberline far out on the tundra (see figure 24). At that date bands of bulls were moving northward in the area between the Nelson and Churchill Rivers (see figure 25). As has been explained before, the difference in antler development at this time made recognition possible.

It was possible that the cows were accompanied by significant groups of bulls which were missed, and therefore another check was desirable. An opportunity arose to check these data when the Hanbury herd was observed moving southward in August, 1949. At that time a classification of 2,753 animals indicated that the herd was composed of 19.1% adult bulls, 54.8% adult cows, 17.2% calves and 8.9% yearlings. This confirms the herd composition figures of the spring count and the accounting of the bulls' location in migration.

Figure 25. Bands of bulls on a taiga lake following cows northward, May, 1948.

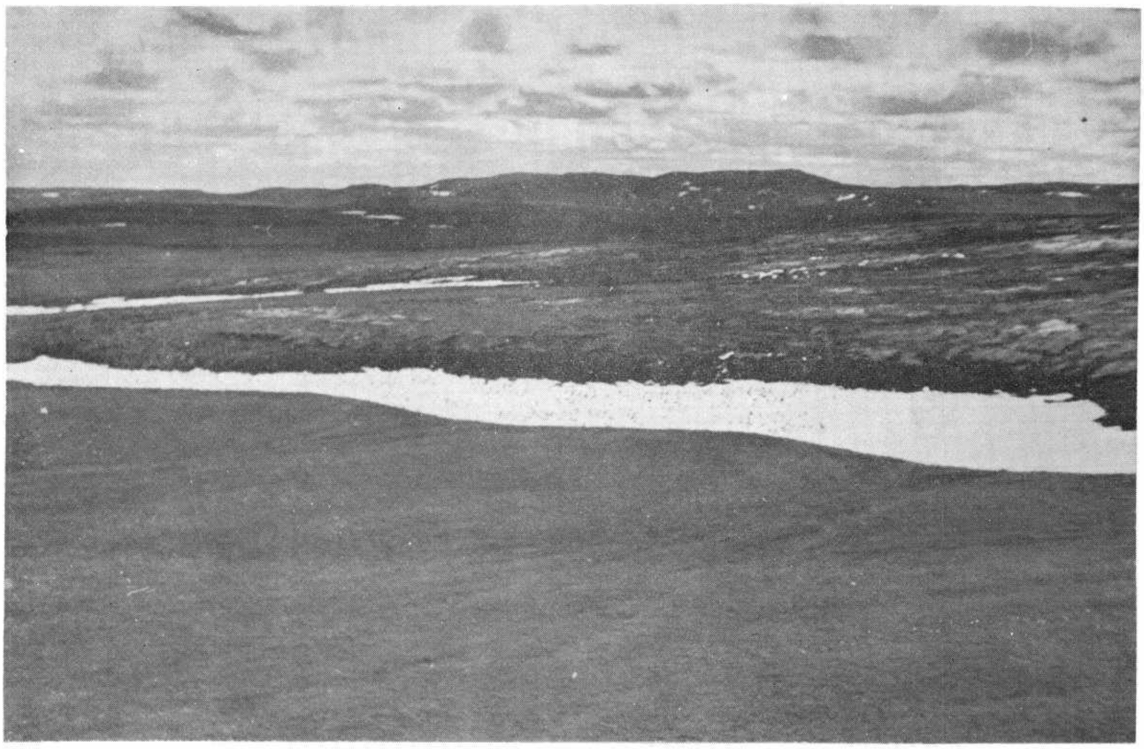


Figure 26. Caribou bands resting on snowbank in summer, Bathurst Inlet, N.W.T.

During April, 1949, additional observations on the Snare River, Mackenzie District, confirmed this fact. At this time large herds composed largely of cows and yearlings were observed in the vicinity of Ghost Lake, while large bands of bulls were observed in the vicinity of Lac la Martre, trailing the large herds of cows and young animals which were ascending the Snare River towards the tundra.

During his investigations in Manitoba in the winter season of 1948-49, Lawrie noted that there was some evidence of a partial sexual segregation on the winter ranges in northern Manitoba. The northward migration in early spring was initiated by a movement of cows and calves in late January and early February. This was not as rapid as a later April movement. He also noted that cows and yearlings first appeared at Nueltin Lake in May, followed by the bulk of the bulls in June.

The majority of adult bull caribou that belong to the herds which spend the winter in the forested part of the range do not travel as far out onto the tundra region in summer as do the cows and young. During late June and July, bands of bulls are frequently observed at or near timberlines. Bands of bulls have been reported by many observers as present in the vicinity of the Coppermine River, east of Great Bear Lake, at this season (Stefansson, 1913). Straggling bulls have similarly been reported from the vicinity of the Lockhart and Hanbury Rivers. On July 1, 1949, during a reconnaissance flight, 219 bulls were observed in small bands between Fletcher Lake and Aylmer Lake. Trappers also report the occurrence of bulls in summer on the upper Thelon River.

Most of the bulls which accompany the herds of cows are young animals, two-or three-year-olds, but there are usually a few old bulls which form small groups on the outskirts of the herd. During a flight to Arctic Sound, Mackenzie District, from Bathurst Inlet on July 24, 1949, several groups of mature bulls were observed northwest of Arctic Sound. Clarke (1942) reported that bulls reached the Arctic coast in the vicinity of Bernard Harbour. It is of interest to note that Stefansson (1913) reported that the herds crossing Dolphin and Union Straits to Victoria Island on May 1, 1911, were composed of cows and yearling bulls.

As the bands of cows and new-born calves move towards timberline in late July or early August they gradually pick up the summering bands of bulls. This causes an initial concentration of caribou on the tundra in mid-summer. Most of the various age and sex classes are present, but there may be some local segregation, resulting in bulls, yearlings or barren cows travelling together in small groups. These groups of bulls, yearlings and a few barren cows seem to move southward during the mid-summer migration at a faster pace than the cows with calves. These move more leisurely and are widespread over the tundra in late summer.

During the late summer at more southerly points, bands of bull caribou usually form the vanguard of the movement towards the timberline. These advance groups of bulls may be a day's distance or more ahead of the main herd. At our camp on Contwoyto Lake, Mackenzie District, in 1949, the first bull caribou was observed on August 10th. A few scattered bulls were observed daily until August

15th, when 200 caribou, many of which were cows, were observed. In September the northern backwash from the mid-summer migration brings all the sex and age classes together before the commencement of the rutting season.

During the winter months it is the bulls which penetrate deepest into the forested parts of the caribou range. The hunting lodge maintained by the Saskatchewan Government Airways at Missi Lake, Saskatchewan, is situated near the normal limit of winter penetration. During the three hunting seasons in which the lodge has been operated, several hundred animals have been taken but only one or two of these were cows. During the winter of 1948-49, caribou penetrated to an area about 45 miles north of Fort Simpson, N.W.T. It was reported that the majority of animals taken here by local residents were bulls. Since the winter of 1945-46, caribou have frequently reached the vicinity of Gods Lake, Manitoba, during the winter. These animals also have been reported to be mostly bulls.

During the months of April and May, yearling caribou closely follow the cows. But by early July the cows have new-born calves and the yearlings are observed to be associating together in small bands on the outskirts of the large summer herds. During July, 1949, long periods were spent in close observation of herds on the summer grounds. It was frequently noticed that the yearlings foraged by themselves singly, in small groups, or in the company of barren cows or bulls. It is concluded that during June, before the birth of the calves, the yearlings are driven off by the cows. Observations in August and September, 1948, at Lake Clinton-Colden, provided some evidence that the yearlings may rejoin the cows. Frequently groups composed of a cow, a calf and a yearling were observed.

During the summer months many observations on herd composition indicated that barren cows associated together on the outskirts of the main herd and often formed the vanguard in movement.

Rutting Behaviour.

The rut occurs during the latter part of October and the first part of November. The peak in activity lasts for about two weeks in late October. During the rutting season the majority of the herds are on the tundra in the vicinity of the timberline. The barren-ground caribou bulls do not segregate and defend harems of cows as has been reported for the Newfoundland caribou (Rangifer caribou terranovae) by Dugmore (1913). In the area studied rutting occurs in large herds or smaller bands containing all age classes of cows and bulls.

Lawrie observed the rut at Nueltin Lake in October, 1948. He reported the first sparring by bulls on October 12. On October 17, he observed a young bull in a group of 3 cows, 1 prime bull and 2 younger bulls, attempt coitus. Later in October he observed that the adult bulls in a herd grazed only intermittently and dashed about, sparring with each other and uttering long belching roars. On one occasion he observed marshalling activities of several adult bulls in a herd. The bulls walked back along the flank of a large herd and made short rushes at grazing groups, hastening them on.

The bulls serve the cows in the herd indiscriminately. Only when bulls come into close proximity with one another do they become antagonistic. The sparring matches are usually of short duration. It is seldom that a bull is injured in one of these tests.

On November 29, 1949, the migrating herds had reached Ilford, Manitoba. A small group composed of two young bulls, a cow and calf were observed at close range crossing a frozen lake. The two bulls sparred with each other and pursued the cow, nuzzling her back. The adult bulls had shed their antlers by that date and were not taking part in these sexual activities.

Calving Behaviour

Because of the poor Arctic travelling conditions during June, when the calves are born, few data have been obtained on calving behaviour. It is known that there are no special calving grounds. The calves are dropped wherever the herd or band happens to be at the appropriate season. This in turn depends upon whether the spring was an early or a late one.

Female caribou are solicitous for their calves and seldom abandon them. On August 14, 1948, a calf was killed by a wolf opposite our camp on Lake Clinton-Colden, at about 8.00 a.m. The cow remained in the vicinity for two days and was observed to peer towards the calf carcass several times.

It seems unlikely that the cows travel very far from the remainder of the band to calve. The young are precocious and are soon able to get about. In a matter of a couple of days they can run as fast as the remainder of the band. The calves are playful during the summer and are frequently seen romping in small groups, chasing each other or prancing about the cows. They suckle at frequent intervals during the first month or six weeks, often bunting the udder vigorously like many other young ungulates. By the end of the first month they are doing some grazing on their own account. There is general harmony among the bands of cows and calves in early summer.

Warning Behaviour

In a herd of caribou, the individual animals take warning from the actions of one of their number. A single cow may become suspicious of a stalking observer and peer towards the intruder. Other caribou will lift their heads and watch the apprehensive one. If the danger is confirmed, by sight or odour, the animal on guard will snort and turn, whereupon the whole band will take flight, following whichever animal takes the lead.

In a large resting herd there are always certain individuals which are awake and watchful. Their action seems to be purely random, since there are always some individuals which awake, stand up, stretch, feed and then lie down and chew the cud while others are asleep. These later sleep while others are watchful.

Ecologic Relations.

By ecologic relations are meant the communal relationships between caribou and other species of animals and plants. The caribou is a herbivorous animal and is therefore dependent primarily upon the vegetation for its existence. The vegetation in turn is dependent upon the soil. The relationship between caribou and plants was discussed under food requirements. The caribou in turn provides the primary source of food for the local carnivorous animals, as is the role of all herbivores in nature. It, therefore, is a central link in some of the more important northern food chains and occupies a central position in the biologic pyramid.

Some of the more important predators of caribou are as follows: wolf (*Canis lupus*), man (*Homo sapiens*), barren-ground grizzly bear (_Ursus richardsoni_, etc.) and golden eagle (_Aquila chrysaetos_), These relationships will be discussed in greater detail later. Animals of this group normally kill caribou for food, although any one of the above species will eat caribou which were killed by some other agency, if it suits its taste or urgency.

Animals of a second group do not normally kill caribou for food but normally eat the meat of caribou found dead. These scavengers are as follows: Arctic fox (_Alopex lagopus_), lynx (_Lynx canadensis_), wolverine (_Gulo luscus_), bald eagle (_Haliacetus leucocephalus_), herring gull (_Larus argentatus_) and raven (_Corvus corax_).

There are other herbivorous mammals which belong to the same communities that might be considered competitors of the caribou if the available vegetation were not sufficient for all. Since the food requirements of the various species are not known in detail, it is not possible to assess the exact degree of competition between these species. A list of possible competitors is as follows: musk-ox (_Ovibos moschatus_), arctic hare (_Lepus arcticus_), collared lemming (_Dichrostonyx groenlandicus_), brown lemming (_Lemmus trimucronatus_), tundra vole (_Microtus operarius_), red-backed vole (_Clethrionomys dawsoni_). Some of the more important food chains involving the larger tundra vertebrates are indicated in figure 27. The central position of the caribou is to be noticed as well as the fundamental position of the vegetation and soil. The chemicals used in the community are ultimately returned to the soil upon the death of the peripheral organisms, such as the wolf and man, by a host of smaller organisms involved in the degenerative processes. From glancing at this diagram one can see the interdependence of the various species of the community.

The actions of caribou are at times detrimental to other species of animals and plants. Since the species is gregarious and equipped with sharp hoofs, it regularly damages much vegetation by trampling when feeding or migrating. The range of the species is criss-crossed by numerous trails along which the caribou travel and so prevent the growth of vegetation. Trampling is probably also harmful to the burrows and runways of the small rodents.

A unique relationship is the one between the caribou and the muskrat (Ondatra zibethica). During the winter months, the caribou invades the range of the muskrat in the timbered areas. In northern Canada during the winter, muskrats build feeding "forms" of submerged vegetation which they pile on the ice and in which they feed. The muskrats chew a hole in the ice in the autumn and keep it open all winter. These are called push-ups by northern trappers. The caribou frequently use frozen lakes for travelling and resting. They habitually seek out the muskrat "push-ups" and paw them up to eat. This often causes the holes to freeze over and the muskrat is unable to reopen them. Caribou trails leading to destroyed "push-ups" were observed near Ilford, Manitoba, in December, 1948.

It was reported that caribou frequently do considerable damage on a winter trapline. On the tundra they seem to be attracted to traps set for arctic fox. These they paw up. Other damage is done by trampling.

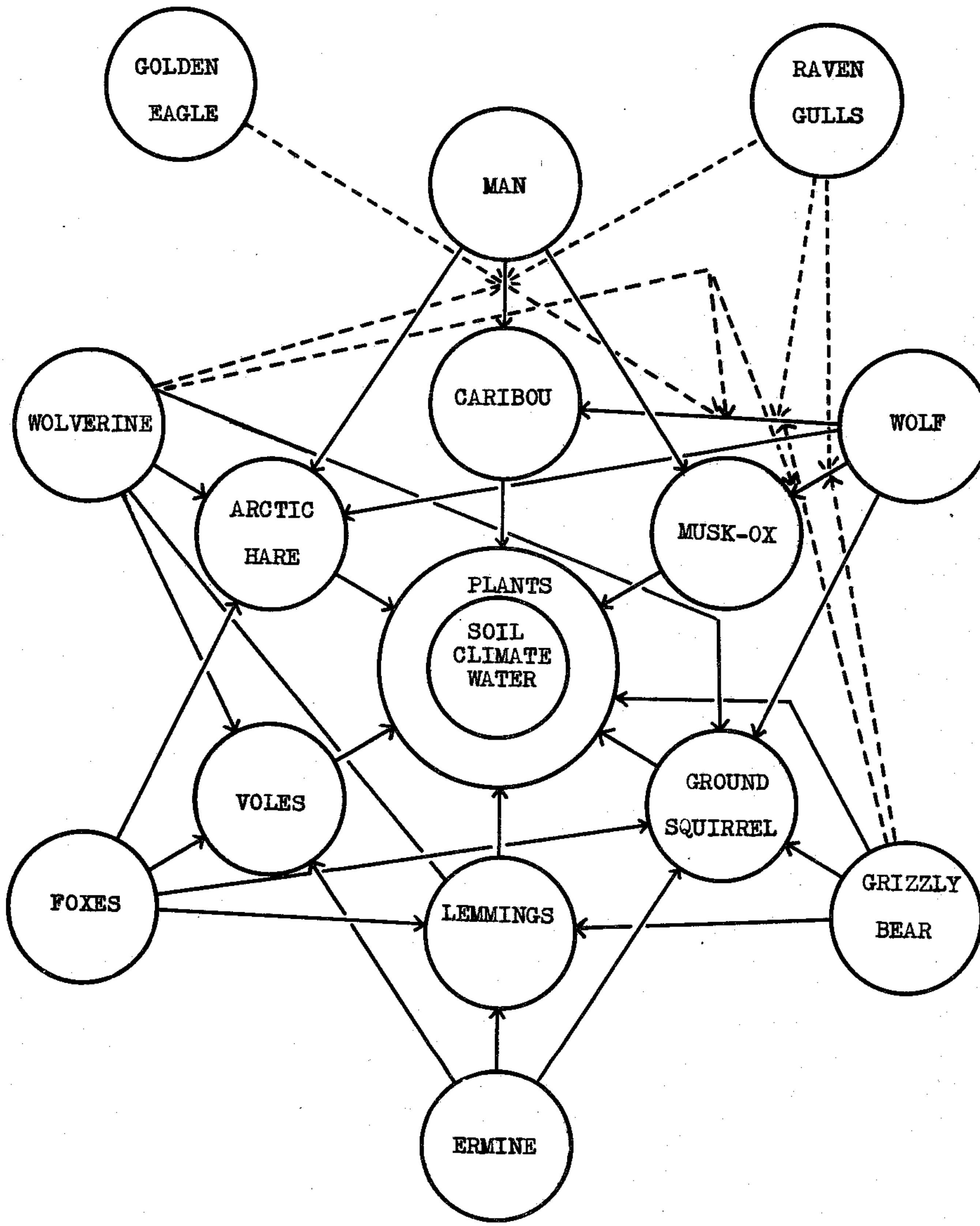


FIGURE 27. SOME VERTEBRATE FOOD CHAINS OF THE TUNDRA.

There are few observations on the behaviour of caribou towards species other than predators. Some observations made during the investigation are of interest in this connection.

On August 14, 1949, at about 8.00 a.m. a band of about 50 caribou were being observed as they fed on the shores of Lake Clinton-Colden. Over the ridge behind them a bull musk-ox suddenly appeared at a distance of about 200 yards. The wind was in favour of the musk-ox. When the caribou saw the slowly approaching musk-ox, they became greatly agitated and circled about. Finally the herd split in two at its close approach and the sections ran over the hill in different directions. The musk-ox leisurely walked down to the water's edge, drank and then turned and retraced its steps over the hill. It does not seem likely that this was the first musk-ox these caribou had ever seen or that this was a normal reaction to the species. It seems probable that the caribou were unable to identify the beast by odour and feared, because of bulk and colour, that it might be a barren-ground grizzly.

On July 24, 1949, a band of 40 musk-oxen were observed northwest of Arctic Sound. There were scattered bands of caribou feeding within a few hundred yards without showing any concern.

On August 31, 1948, while the writer was watching the actions of Arctic fox whelps at the den entrance near Lake Clinton-Colden, a cow and calf caribou were noted feeding across the wind towards the den. They gradually approached to within about 25 feet of the whelps and 50 feet of the observer. When the calf received the scent from the den it was momentarily startled and ran off a few paces, then turned and looked towards the whelps, which made no outcry. Both caribou then continued to feed towards the observer. A few moments later the calf caught my scent and bounded away. The cow after a moment's hesitation followed the calf. It seems that the fox scent did not convey the idea of danger to the caribou, while human scent warned of danger. It was also interesting to note that a calf approximately three months old was aware of the human scent.

On several occasions feeding herds of caribou were observed to flush flocks of willow ptarmigan (Lagopus lagopus). These flew zig-zagging through the herd without causing any observable excitement. It has been reported that these birds feed in winter in the areas pawed up by the caribou in their feeding activities.

The communal relationship between caribou and herring gulls has been mentioned previously under the section dealing with hearing. On April 29, 1949, large numbers of ravens accompanied the large herds on Ghost Lake. It was noted that the caribou occasionally glanced up at a particularly raucous raven flying overhead. The caribou are warned of the approach of predators by the calls of these avian scavangers. Lawrie reported seeing three swimming bulls turn back when they saw three gulls on the water in their path. Unusual incidents easily cause panic among caribou.

It has ~~been~~ already been indicated that there are usually several other species of animals accompanying a herd of caribou during certain seasons. These are the wolves which kill caribou for food and ravens, gulls and eagles which feed on the carrion. As the caribou herd migrates this aggregation of species forms a mobile community. On the tundra during the summer months the land appears particularly lifeless when caribou are absent from the locality.

It was so during the first three weeks of July, 1948, while we were travelling by canoe from Lake Clinton-Colden to Musk-ox Lake on the Back River. The mammals observed were of the smaller kinds, such as the Parry's ground squirrel (<u>Citellus parryii</u>), and few raptorial birds were seen. On July 25, one peregrine (<u>Falco peregrinus</u>), and one golden eagle were observed on Sussex Lake. On July 26, on Aylmer Lake, more ravens were observed than on any day previously and on arising in the morning a fresh wolf track was observed in front of our tent. On July 27, ravens were numerous and the first caribou bands were observed moving southward. The same morning 17 musk-oxen were observed at Thanokoie Narrows. On July 29, the first wolf was observed at the same locality.

On August 1, we returned to our base camp on Lake Clinton-Colden to await the arrival of the caribou. On August 3, several ravens were observed. At 8.45 that evening a wolf was heard howling in the distance. It later appeared and swam across Caribou Narrows, on the exact route that was later used by bands of caribou. At 8.30 p.m., August 4, a herd of approximately 2,600 caribou was sighted on the far side of the narrows where the wolf had appeared the evening before. A second wolf was following the herd.

In the vicinity of the large herd seen on Ghost Lake on April 23, 1949, were also seen about 20 wolves, 100 ravens, one golden eagle and two bald eagles. The herd was in migration at the time. During the winter months groups of these predators and scavengers remain with the caribou herds. Probably unmated individuals, or those which have brought off their young, accompany caribou herds during the early summer months.

The introduction of the domestic reindeer (Rangifer arcticus asiaticus) to the caribou range in northern Canada gives rise to a serious problem. Were the reindeer to hybridize with the caribou the results might be catastrophic. The wild virility of the native stock might be so impaired by dilution as to render it more susceptible to the attacks of predators or other environmental pressure. The introduction of exotic diseases might also have serious effects. At present it is impossible to forecast the final results from such a hybridization, but, observing the present situation in Alaska, it is assumed that the results would be detrimental and could possibly lead to the extermination of the race.

From a scientific point of view the extermination of a native race of mammal by hybridization with an exotic form would be regrettable.

Fortunately such hybridization in Canada is unlikely at present. The Government reindeer herds are situated at the mouth of the Mackenzie and Anderson Rivers, in areas where the native caribou have been exterminated or reduced to very low numbers. In addition these herds are under constant supervision. During the winter of 1948-49, south of the Reindeer

Preserve east of the Mackenzie River, two animals which were tentatively identified as hybrids were shot. This identification cannot be confirmed at present because of the paucity of comparative systematic data.

A second possible location for hybridization was in the vicinity of Fort Smith after 1912. During the summer of that year several Lapland reindeer (Rangifer tarandus tarandus) escaped during barge transportation. There were several local observations of these animals subsequently (Harper, 1932). It was concluded, however, that they soon succumbed in the foreign environment. Since they escaped on the winter range of the native caribou it seems unlikely that they had the opportunity to mate with the native form.

There is some indication that a barrier may exist between the Asiatic reindeer and the barren-ground caribou on a sexual physiological level. The reindeer calves of the government herd at the mouth of the Mackenzie River are born in April while the native caribou calves are born in June. Assuming a similar gestation period, it seems likely that the rutting seasons are also two months apart. This indicates a temporal barrier which would cause the two forms to be sexually isolated.

During the winter months the barren-ground caribou invades the range of the western woodland caribou (Rangifer caribou sylvestris) in Manitoba, Saskatchewan, Alberta and the Mackenzie District, (Banfield, 1949). This introduces the problem of interbreeding between the two forms. It has been previously explained, however, that with the barren-ground caribou, rutting takes place on the tundra or in the vicinity of treeline after a northward movement in autumn. At this time they are therefore several hundred miles from known populations of woodland caribou. The two forms are, therefore, separated by a spatial barrier causing sexual isolation. It is possible that individual barren-ground caribou which have been isolated in the taiga belt during the summer by lake barriers, might transcend this barrier but the survival probability and autumn movements of these individuals are unknown at present.

Migration Behaviour

One of the most obvious habits of the barren-ground caribou, described by many of the early explorers and naturalists, is their seasonal migration. It was noted that the native Eskimos and Indians regulated their annual movements so as to take advantage of the migrations of caribou to obtain food and clothing. These caribou movements were surprisingly regular over a great expanse of Arctic and subarctic Canada. They naturally aroused the interest of writers, who attempted to explain them and state their cause. The reasons given were usually relatively simple and based on single factors.

Murie (1944) has briefly stated some of the more important theories regarding the causes of migration of Alaska-Yukon caribou. These theories are discussed in greater length below with reference to the subject race of caribou.

One of the earliest theories developed was that the caribou migrated north and south with the seasons, seeking the shelter of the southern taiga in winter and migrating north in summer of the tundra. This conception fits well under the "seasonal migration" classification of Heape (1931). Indeed the movements of caribou are discussed by Heape under this heading. This places the emphasis on seasonal changes in weather.

A slight variation of this theory is that the seasonal movements are caused by food requirements. The tundra in winter failed to supply the food requirements of the species. This conception fits into the "alimentary migration" classification of Heape (op. cit.).

A theory which is popularly held among northern residents is that the summer movements are caused by the seasonal occurrence of the hordes of mosquitoes and black flies. It is said that the herds move out of the forest just before the flies become intolerable. They are supposed to move north to the Arctic coast to seek relief from these pests. In late summer they return to the southern tundra regions when the flies are waning.

Other writers maintained that the migrations were instinctive. The modern herds perhaps retrace ancestral routes by which the caribou populated the extreme summer range. It has been pointed out that the caribou bands inhabiting the eastern shore of Foxe Basin, on Baffin Island, migrated northwest in the autumn, towards Fury and Hecla Straits, where it was supposed that their ancestors had crossed from Melville peninsula. It seems that the migrations were considered by these authors to be analagous to bird migration.

Starting with the writings of Hanbury (1904), an increasing amount of factual information which was difficult to explain under these migration conceptions was presented. It was found that several large herds of caribou do not leave the tundra in winter. Few caribou herds migrate on a North-South axis, many travel N.E.--S.W. or even E.-W. during their annual migrations. The majority of caribou do not reach the Arctic coast in summer and herds are widely distributed on the tundra in the height of the fly season. The mid-summer southward migration as described by Clarke (1940) and in this report is difficult to account for by any of the above theories.

It seems unlikely that one factor along determines the migrations. Certain factual considerations which bear upon this problem are presented below.

During the summer months, the diet consists chiefly of the green foliage of willows and birch along with grasses and sedges. In winter there is a change in the diet. Lichens, and the twigs of willows and a certain amount of cured forage are preferred. There is therefore a seasonal change in diet, as was shown in the section on food requirements. Vegetation analysis has indicated that large areas of the central continental tundra produce only a small crop of lichens and shrubby growth. The taiga, on the other hand, has a rich understory of shrubs and a good ground oover of lichens, as well as arboreal lichens. The majority of caribou herds spend the winter in the taiga belt. There are smaller herds which remain on the tundra. They usually congregate in winter in undulating terrain near large bodies of fresh water or on the Arctic or Hudson Bay coast. It is probable that in these areas, there is greater vegetation growth - lichens and willows, due to increased moisture. Also, winds are known to blow the hillsides bare of snow. Food requirements, therefore, play an important role in determining the location of the winter quarters.

It has previously been shown that weather also affects the location and rate of migration. The caribou seldom leave the tundra in late autumn until the advent of the first severe winter storms. During mild winters they often remain near timberline. During early, severe winters the herds tend to migrate deeper into the taiga. Similarly, an early spring will usually be associated with an early spring migration, while during a prolonged winter the spring movement to the tundra is generally delayed.

With reference to important life history periods, both rutting and fawning take place upon the tundra. The rut occurs in autumn after the first frosts. The mid-summer migration carries the majority of caribou to timberline about the time of the first frosts. It is possible that this frost killing of the summer green foliage may be associated with this movement. In the second phase of the mid-summer migration, the herds retrace their paths back to the tundra prior to the rut. It seems reasonable that this later movement is associated with the rut. In this case it could be classified as a "gametic migration of Heape (op. cit.)."

The early spring migration from the taiga to the far tundra summer quarters takes place long before the start of the fly season. On the tundra the flies seldom reach plague proportions until the middle of July. At this time the fawns are about a month old. Towards the end of July, at the height of the black fly season, the herds commence their movement towards timberline. They must pass through a wide belt of tundra swarming with flies before they reach timberline late in August, when the flies have declined in numbers. These summer migrations were observed, during the investigation, both at the height of the density of biting flies and when there were few insect pests on the wing. It was easily observed that the flies had a profound effect on the daily activity of the animals, making them highly agitated. The flies also seemed to increase the speed of their migrations. However, there was no indication that insects were a primary cause in the major cycle of caribou movements.

From an inspection of the figures in which the seasonal migration routes are drawn, it is evident that there is no general north-south axis of seasonal movement. Some herds move northeast in spring, others northwest, some east, others west. The herds parallelling the western shore of Hudson Bay travel north for a considerable distance. Yet, in all these directions there is a rough correlation. It is to be noted that the route is generally at a right angle to the nearest treeline. So the herds between Great Bear and Great Slave Lakes migrate on a general east-west axis, while those in the Thelon-Kazan area migrate more closely north-south. The main river valleys often act as migration routes, especially when frozen.

The foregoing discussion has been based on the assumption that caribou movements may be classified as "migrations" as conceived by Heape. There is another possible conception.

From the previous description of the population and annual movements it is evident that caribou are migrating during the greater part of the year. Even when on summer or winter ranges the bands are continually drifting along. The barren-ground caribou is a gregarious species and characteristically occurs in large herds at all seasons of the year. In order that the individuals in the herd may obtain their food requirements, it is necessary that the herd keep in motion and so it continually changes its feeding range.

Heape (op. cit.), in his discussion of nomadism, gave as examples the movements of whales, other aquatic mammals, wolves and certain tribes of man. He thought of their wanderings as haphazard. It is generally accepted that although the movements in any brief period of time may be at random, yet there are seasonal aspects to the movements of these nomadic mammals. Most of these examples return to chosen habitats for the birth of the young, or return regularly to certain localities in the pursuit of certain kinds of food. So the nomadic tribes of herders take their flocks to fresh winter and summer ranges. In dealing with a nomadic species one may, therefore, expect to note a long-time regularity, with random local movements.

The movements of the barren-ground caribou are best described as nomadic. As a gregarious species, the herds are continually in random movement, seeking an adequate supply of food. Superimposed upon this local system are annual travel requirements. Annual shifts in food preferences and available forage encourage travel. In summer the herds seek the relatively cool, dry tundra, with lush green foliage. In winter the majority of herds seek the taiga, where the snowfall is less, the temperature is less severe, and lichens and twigs are plentiful. The rut and fawning also seem to require a tundra location. Local weather and physiography affect routes and periods of movement.

This conception of the movements of caribou seems to fit the annual movements of the species. It also explains the occasional absence of animals from their usual ranges and migration routes, which has frequently caused hardship for the natives depending on their arrival. As a nomadic species, they are easily caused to deviate from common routes by a variety of environmental factors discussed previously. This view also explains the caribou's habit of suddenly appearing in large numbers in a new area, either in winter or in summer. It has also been noted that where the species has been reduced in numbers to small bands, these make only local movements and cease to perform the long migrations which are characteristic of the large herds.

From the data accumulated in the present study, it seems probable that the barren-ground caribou is fundamentally both gregarious and nomadic in behaviour. Seasonal changes in meteorological factors, food preferences, food production and reproductive requirements cause a superposition of annual cyclic spatial movements over the territories occupied by the herds.

Vital Statistics

The rut occurs upon the tundra or in the vicinity of the timberline during the months of October and November. At this period travel conditions are difficult and it is far from easy to get factual information on rutting behaviour. There is no special location for each herd to rut, since the locality depends upon the progress of the autumn migration. The rut takes place wherever the herds are at the rutting season.

Calving occurs upon the tundra during June. There are no special localities where the cows drop their calves. The locality in any given instance depends upon the progress of the spring migration of the cows and young stock. There are, however, general locations which the herds usually reach during the spring movement in time for the calves to be dropped. The calving of the Hudson Bay coast herds usually takes place around Kaminak and Kaminuriak Lakes, Keewatin District. The upper Back River is frequently the site of calving for the Hanbury and Yellowknife herds. The Rae herd cows frequently drop their calves near Contwoyto Lake.

It was hoped to examine a great number of young calves soon after birth, but unfortunately, due to travelling difficulties in June, the youngest calves observed were three weeks old. Of eleven calves under one month of age observed at close range, seven were males. This small sample gives a sexual ratio of .140 males to .100 females, soon after birth.

From a segregation of more than 4,000 caribou observed during July and early August, 1948 and 1949, on the tundra the annual increment of calves was found to be 40.5 per cent of the mature cows. This annual increment percentage compares favourably with that of other species of cervids in the National Parks. It indicates a healthy "young" herd with a rapid turnover if the population is constant. When the summer herd composition is adjusted to include the normal percentage of stags, the annual increment is found to be approximately 21.1 per cent of the total herd. Calculated on the population estimate of 670,000 caribou, this gives an annual increment of approximately 141,000 calves.

The composition of the herds at various seasons, calculated by means of segregated counts of caribou observed on the gound and from aerial photographs, is given in table 18. Lawrie observed a herd composition of 18 per cent bulls, 48 per cent cows, 25 per cent calves and 9 per cent yearlings during the rutting season. Approximately similar herd compositions were observed in other herds when all classes were accounted for.

The gestation period is thought to be about 32 weeks. Of 9 adult females of which post mortem examinations were made, 6 or a ratio of .667, were pregnant. This small sample gives a ratio which seems a little low. It suggests, however, a mortality of approximately 37 per cent from mid-pregnancy to the age of about one month. Of the six foetuses examined, four were females, a ratio of 50 : 100, males to females. Again, not much faith can be put in such a small sample. There were no instances of twinning observed among autopsied cows, nor were any reported by the trappers interviewed. Two or more calves are frequently observed following a single cow in the summer. This, however, is not a positive indication of twinning, since calves frequently play together and may follow a single cow for a short period. At other times orphaned calves may be "adopted" by cows. Twinning is reported as being rare among the reindeer in the Government herd.

Growth

Five foetuses examined during early May, 1948, when they were about four weeks prior to birth, averaged 516 mm. in total length and 246 mm. hind foot. The slight variation in their measurements suggested that the conceptions occurred within a relatively short period.

Three calves approximately two months old averaged 1025 mm. total length, 687 mm. shoulder height, 373 mm. hind foot. One fawn weighed 26 pounds at an approximate age of three weeks and another 43 pounds at an approximate age of 6 weeks, while a third weighed 75 pounds when about 3 months old.

Caribou calves are precocious. Within a few hours after birth they are able to follow their mothers. In about two days they are strong enough to keep up with the movements of the herd. The cows do not cache the calves, as do white-tailed deer (Odocoileus virginianus). The calves follow the cows while the latter are feeding. The calves spend a good deal of time frolicking together or running around their feeding cows. When young they suckle frequently, usually from the right side. When the flow is slow they bunt vigorously. When about a month old, the calves commence foraging for themselves. They continue to suckle regularly, however, until spring. On April 25, 1948, at Churchill, Manitoba I observed a calf (then almost a yearling) attempt to suckle a cow. It had to bend its carpel joint to get under the cow and when it rose, it lifted the famale's hind legs off the ground. Two female caribou examined in November and December were both lactating. This delayed weaning is probably of assistance in helping the calves to survive their first winter.

From segregated counts, some information was obtained on the survival of calves to the age of 18 months, as indicated in table 18. At an approximate age of one month calves were present in a ratio of .386 to the adult cows. At an approximate age of 10 months the ratio had dropped to approximately .322 to adult cows. By the second summer as yearlings the ratio had dropped to .178 to adult cows. At the close of their second winter, when the animals were approximately 20 months old, this ratio had fallen to .158.

From observations made in November, 1948, at Ilford, Manitoba, it seems likely that bull caribou become sexually mature at the age of 2 or 3 years. It is unlikely that at that age they are successful in servicing many cows.

On April 30, 1948, a post-mortem examination was performed on a young pregnant female at Churchill, Manitoba. From its measurements, eruption of teeth and spike antlers it was determined to be approximately 23 months old. This means that the animal was sexually mature when it was 17 months old. From reports of trappers it seems that yearling cows rut regularly and must be considered sexually mature.

From segregation counts when all the sex and age classes were together it was observed that the ratio of mature bulls to cows was approximately .345.

Pathology

In the previous section we have considered the reproductive rate of the herds. It has been possible to estimate the annual increment of calves and the subsequent reduction in this annual group until the age of about 20 months. In the following sections the factors which cause reductions in caribou population will be considered. Ideally, the numerical effect of each factor should be determined. Unfortunately, under field conditions and with techniques available at present, it is impossible to obtain this information. When considering each reduction factor, some information about the age classes affected can, however, be furnished.

Among the most important reduction factors are diseases and parasites. In order to study the diseases of caribou, post mortem examinations were made on 77 animals. These specimens were obtained in several ways: some were animals killed by hunters, others were carcasses found, or disabled and sick animals killed for examination, or specimens taken for museum purposes. It was found that the caribou population was quite healthy, compared to populations of elk (_Cervus canadensis_) and moose (_Alces americana_) which have been studied in the National Parks.

External Parasites

When dealing with the barren-ground caribou, one of the first pathological features which attracts attention is the absence of typical mammal ectoparasites, such as flees (_Siphonaptera_), ticks (_Acarina_) and lice (_Anoplura_). It seems likely that the external environment is so severe that it prevents the completion of the life cycle of some of these arthropods, which rely on two different mammalian hosts with an intermediate period on the vegetation.

Table 16. Segregation of Caribou from Aerial Photographs

Flight	Date	Herd	Total Photo.	Total Segreg.	Males	Females	R1	R2 F	R2 M
4	16 Apr, 48	Churchill	2,525	382	1	274	79	28	
5	17 " "	"	225	79	0	53	17	9	
6	19 " "	"	1,460	178	0	107	50	21	
7	20 " "	"	301	39	0	29	8	2	
8	21 " "	"	174	135	0	106	12	17	
9	24 " "	Brochet	104	-	-	-	-	-	
10	4 May "	Rae	475	0	23	8	0	-	
11	5 " "	Hanbury	32	-	-	-	-	-	
12	6 " "	Brochet	378	76	0	56	12	8	
13	7 " "	Churchill	700	613	169	330	65	37	12
14	8 " "	Brochet	116	97	49	37	6	4	1
15	11 " "	Churchill	2,634	412	0	276	103	33	
16	12 " "	Aberdeen	82	22	0	17	2	3	
17	13 " "	Duck Lake	403	49	0	37	9	3	
19	15 " "	Churchill	316	277	277	1	1	0	37
20	17 " "	Duck Lake	443	399	44	268	50	29	8
35	24 " 49	Rae	30,459	1,472	37	976	314	145	-
38	27 " "	Hanbury	552	536	5	310	154	67	-
40	28 " "	Rae	1,665	1,665	39	1,093	353	180	-
42	29 " "	Rae	26	26	14	8	1	3	-
48	24 July "	Rae	5,000	-	-	-	-	-	-
	TOTALS		48,070	6.496	658	3,978	1236	589	58

NOTE: R1 refers to the age group rising one year old.

R2 refers to the age group rising two years old.

Table 17. Segregation of Herds on the ground

Date	Herd	Total animals Segregated	Males	Females	R1	R2
August, 1948	Hanbury	2753	525	1506	476	246
July, 1949	Rae	1003	29	625	252	97
August, 1949	Rae	251	135	72	17	27
August, 1948	Kazan	249	77	78	62	32
September "	Nueltin	1650	861	451	247	91
October, "	"	541	98	259	135	49
July, 1949	Kazan	792	243	314	135	100

Table 18. Percentage Composition of Herds

Herd	Season	Total animals segregated	Per cent Males	Per cent Females	Per cent R1	Per cent R2	Ratio R1/F.	Ratio R2/F.
Churchill etc.	Winter	2866	18.8	56.4	15.8	9.0	27.8	9.7
Rae	"	3163	3.0	65.6	21.1	10.4	32.2	15.8
Hanbury	"	536	1.0	57.7	28.8	12.5	50.0	21.6
"	Summer	2753	19.1	54.8	17.2	8.9	31.6	16.3
Rae	"	1254	13.1	55.5	21.5	9.9	38.6	17.8
Kazan	" 1949	792	30.7	43.1	17.1	9.1	43.0	31.9
"	" 1948	249	31.0	31.4	24.9	12.8	79.5	41.0
Nueltin	" 1948	1650	52.3	27.3	15.0	5.6	45.7	20.2
"	Rutting "	541	18.0	47.8	24.8	9.5	52.3	18.9

NOTES:

R1. refers to the age group rising one year old.
R2. refers to the age group rising two years old.
R1/F. indicates the ratio of calves to cows.
R2/F. indicates the ratio of yearlings to cows.

The "external" arthropod parasites of the caribou are situated internally, taking up positions under the hide and in the nasal passages.

The most prevalent parasitic infection of the barren-ground caribou is that of the warble fly (Oedemagena tarandi). It is of common occurrence throughout the entire range of the species, as well as in the reindeer range of Alaska and the Mackenzie Delta. Every trapper and native is familiar with the larvae of this fly, which lie beneath the hide, and the holes which they pierce through the hide. It is of economic importance because of the damage caused to the hides.

The warble fly is a large orange and black hirsute bee-like fly, which, as an adult, is on the wing on the tundra for about three weeks in the months of July and August. The exact period during which it is active depends upon the weather. During 1948, in which there was a warm early summer on the tundra, warble flies were observed on the wing from about July 10 to August 4. After that date no flies were observed among the caribou bands. The summer of 1949 was a delayed and cold season. Warble flies were first observed on August 1 and from then until August 19 they were very common at Contwoyto Lake.

The fly makes a low buzz in flight and progresses in rapid darts, often alighting on rock surfaces. It usually flies at an elevation of 1 - 5 feet from the ground. On August 4, 1948, at Lake Clinton-Colden a female warble fly alighted on the ground about three feet from my position. After extending its ovipostor, it flew up and struck my elbow with enough force to

Figure 28. Caribou herd on the summer range at Bathurst Inlet, N.W.T.

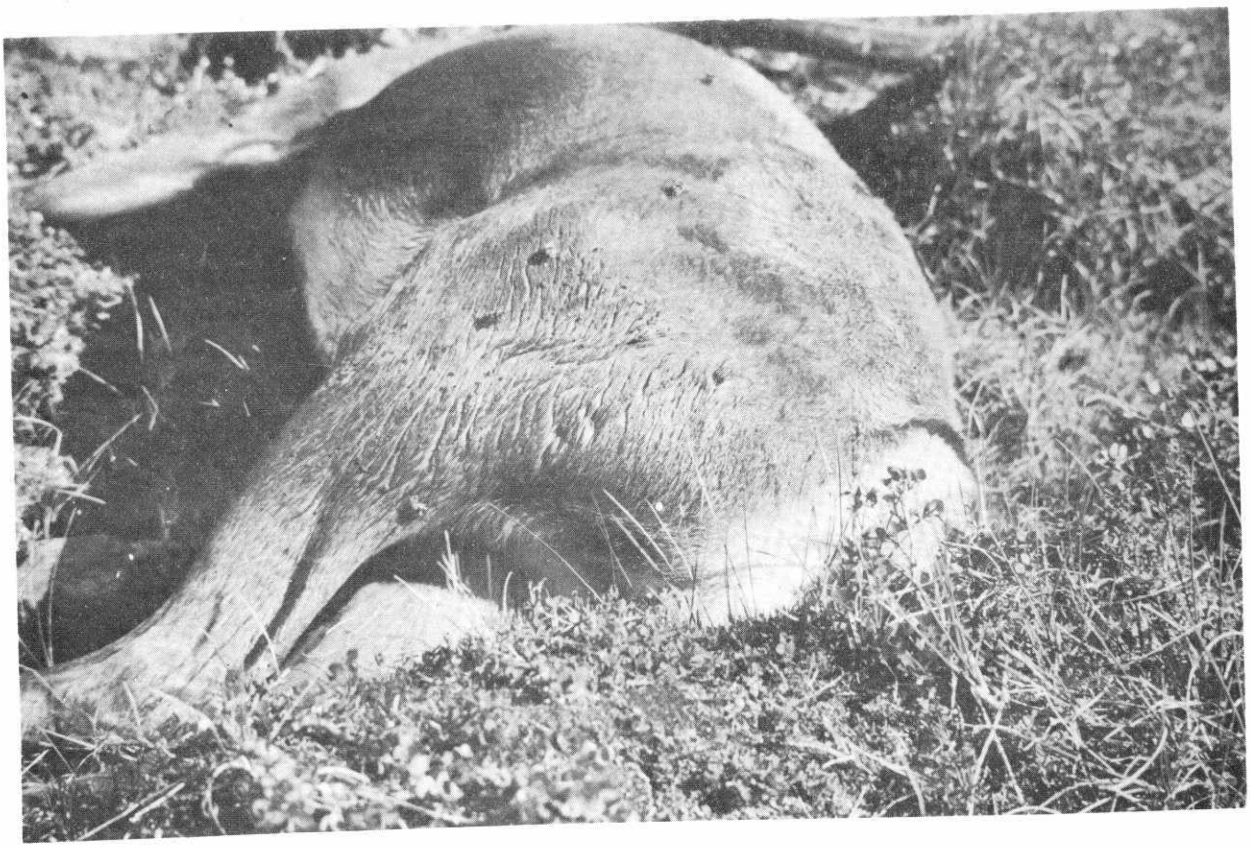


Figure 29. Female warble flies laying eggs on the rump of a caribou.

cause a brief, sharp tingle. It is thought that its buzz and strike are enough to draw the attention of the caribou.

Both males and females are on the wing together. The males were frequently observed and collected from the faces of wounded and freshly killed caribou. It is probable that the sexes meet at the caribou. Copulation was noted on the caribou antlers and on rocks in direct sunlight.

The females alight on the caribou. They were observed on the hocks, rump, flanks, back and antlers. The eggs, which are about 1.5 mm. in length, are deposited in small groups of 2 to 5 on the hair. They are attached in a series near the base of the hair, which is short at this time. Females in the act of depositing eggs are shown on the rump of a wounded animal in figure 29.

Some time later the eggs hatch and the larvae bore through the hide and migrate between the muscle surface and the hide towards the back region. From the work of Dove and Cushing (1933) it seems that the larvae of the caribou warble fly travel directly to the back region under the skin without penetrating the body cavity as does the cattle warble fly (Hypoderma sp.). In our post-mortem examinations we found no internal evidence of larvae during late summer and early autumn.

In carcasses examined in Manitoba during November and December, 1948, the majority of larva were found already attached to the hide, while other small, slender larvae were found burrowing through the fascia under the hide. Even in late January, 1949, in a specimen examined in northern Saskatchewan, 3 small larvae were found still free in the fascia.

Usually by autumn the larvae take up a position lying against the hide and attached to it by the anterior end. A small round hole is bored through the hide to act as a breathing orifice. Because of the irritation caused by the larvae the host tissues deposit a tough integument about each larva, which thus becomes encapsulated. The larvae become attached to the under side of the hide along the back, between the shoulders and the rump, with the exception of the mid-dorsal line, where the dorsal spines of the vertebrae cause friction along the hide (see figure 30).

During winter and spring the larvae grow and gradually take within their capsules a position perpendicular to the hide. The breathing orifice is also enlarged. Until early May the larvae are creamy white in colour. By May, they start to turn brown. Parallel rows of spines are developed on the segments. At this time the larvae are about the size of a man's terminal thumb joint. They are exceedingly active and pulsate within the capsules, probably causing great irritation to the host. In late June, the larvae enlarge the breathing orifices and squirm out, to drop onto the caribou trails, where they pupate. The pupae are dark brown, segmented ovoid chitincus capsules. During August, 1948, three pupal cases were picked up on the caribou trails at Clinton-Colden Lake. Later the adult flies emerge from the pupal cases.

Annually, from about November until June, this parasite causes significant damage to the caribou hides because of the numerous punctures made to provide breathing orifices. During the months of July, August and September, either the caribou are free of the parasites or the larvae are freely moving through the subcutaneous layer of fascia. During this period the punctures from the previous season's larvae heal and become replaced by small round spots of scar tissue.

It is during this period, when the warble scars are of little significance, that the hides are taken by Eskimos and Indians for winter clothing. Late autumn and winter hides are useless as winter clothing because of the density of the hair. The warble punctures which are present at this time are of little importance because these hides are generally used for sleeping robes, beds, igloo insulation, etc. Warble damage to the hides affects human interests significantly only in relation to the Indian production of "buckskin" from the winter hides. It is chiefly during the winter months that the Indians obtain the caribou hides which they tan for use as buckskin. At this time the numerous warble punctures limit the size of clear pieces of hide which can be obtained.

Warble fly infection is universal among the caribou herds. Of 25 specimens examined during the period when the larvae were evident, 100 per cent were found infected to a greater or less degree. The least number of warbles counted was 5, the greatest approximately 300. On one hide it was estimated that there were 40 larvae per 20 square inches of the most heavily infected portion of the hide. On 15 specimens on which the number of warbles was counted or closely estimated the average number was 70 per hide.

The warble scars are permanent and may be counted on a hide. On a mature bull examined, there were approximately 350 scars from shoulders to tail. On another there were 135 scars. On yearling hides there are rarely more than 5 scars. The sexes do not seem to be similarly infested. In general, adult bulls seem to have the heaviest infestation. This is probably accounted for by the migratory habits of the bulls. They usually follow the cows northward in spring and spend the summer further south than the cows. In this way they pick up the warble flies which emerged as larvae from the leading cows.

The calves generally are lightly infected by warbles. They may carry four or five larvae or be free of this parasite the first winter. It seems likely that the flies show a preference for adults.

Usually heavy infestations of warbles have no significance as a mortality factor, unless as one of a series of factors causing general debility of the host. In two specimens examined there had been infection of single larval capsules by pyremic bacteria, with the resulting formation of a pustule. In other cases some of the larvae had died and had been encapsulated. In a couple of old caribou specimens the superficial back muscles were pitted from former bacterial infections of the larval capsules.

When adult warble flies are on the wing the caribou are exceedingly restless and react violently to the attacks of the flies. During the height of the summer fly season much of the behaviour of the animals is in the form of action intended to evade the attacks of flies. At this period it was found possible to creep within 20 yards of animals and see the warble flies through binoculars. Often it was impossible to determine if the evasive action was due to the attacks of warble flies or to those of the hordes of mosquitos and black flies. In general, it seemed that the warble flies were the main causative factors.

Under the attack of these flies, the caribou spend little time in feeding and dash about at random. The animals will collect on promontories, where a slight breeze may keep the insects down. The caribou stand with their rumps to the wind and their heads down. Often the face is held in the shelter of a large rock. At other times animals will stand in wet sedge meadow with the feet deep in the ooze and the head lowered into the sedges.

When a warble fly approaches, the animal stiffens; the muzzle is pointed stiffly down. The head and antlers, as well as the hide, are shaken. The feet are stamped and the head may be quickly turned to bite at a flank. If the attacks become unbearable, the animal will break from the static position and race wildly away. Occasionally a caribou will dash wildly past a human, passing within a few paces, apparently oblivious to everything except the insect tormentors.

Often the caribou seek relief in the ponds and marshes, splashing through the shallow water or swimming into the deeper water. At these times the animals frequently seem exhausted, with drooping head and lolling tongue, drinking frequently, snatching a bite here and there

On August 15, 1949, at Contwoyto Lake, the migrating bands were tormented by warbles and hosts of black flies. I observed a group of about 20 bulls on an esker, where they were grouped in a tight circle, with their heads lowered in the centre. The circle rotated slowly, with the animals moving sideways. Occasionally one would toss its antlers. Animals would suddenly dash away, the circle would close, and other animals would join the formation. At one period there were two such milling bands. Finally the circles were broken as the animals cantered away. In this formation, the caribou probably protected their forequarters and flanks from the attacks of warble flies.

At this season the caribou usually receive some respite during the twilight hours. It is at this time that they migrate and feed.

The barren-ground caribou is also host to a second parasitic fly, the nostril fly (Cephanomyia nasalis). During the present investigation little information about the life history of this fly was obtained. It is known that the adult fly is a large, black, hirsute, bee-like insect. The adults are on the wing during a short period in the summer. These flies are viviparous, the eggs hatching in the oviduct. The female deposits minute larvae in the nostrils of the caribou. These immediately migrate into the nasal passages. In late winter they are attached to the nasal mucosa in the naso-pharynx region. They appear in small clusters in pockets in the mucosa behind the hard palate. By April the larvae are about an inch long and one quarter of an inch in diameter. They are also very active and pulsate in their attached position. When mature the larvae detach themselves and are coughed out by the host. They fall to the ground and pupate. This probably takes place in June. A few weeks later the adults emerge.

Of 25 specimens examined when larvae were evident, 24.0 per cent were infected. The number of individual larvae varied from 10 to 40. Infected animals were observed at Ghost Lake, Mackenzie District; Nueltin Lake, Keewatin District; and Churchill, Manitoba. It seems that the effects of this parasite are local and that the rate of infection may vary from year to year.

Heavy infection of nostril flies causes severe distress. In late spring infected caribou were observed coughing and sneezing. It does not seem likely that this parasite is a direct mortality factor. It may have a secondary effect in relation to predation. During late spring it was noted that when the caribou bands were forced to run, many ran with mouths open and tongues out. Examination showed that some of these animals had their nasal passages almost blocked by these parasites. It seems likely that such animals would be at a physical disadvantage in a long pursuit and that heavy infestations of nasal fly larvae might lead to greater mortality by predation.

No adult flies were found. It is likely that, during the period when they implant their larvae, they harry the caribou in the same way the warble flies do. On July 13, 1949, at Bathurst Inlet, a calf and a young bull were observed to react violently when they independently wandered into a small wet depression. Both animals shook their heads violently, sneezed and raced down wind. The calf stood on its hind legs and pawed at its muzzle with its forelegs. No warbles were observed on the wing at that date. It was thought likely that the animals had been attacked by a nose bot fly.

The hords of mosquotoes (Culex sp. etc.) and black flies (Simulium sp.) which are found upon the tundra during the summer months are well known to everyone through the writings of northern travellers. The torment they inflict upon all warm-blooded creatures is difficult to describe. Lemmings, ground squirrels, nesting birds and caribou are surrounded by a cloud of these insects during still days.

These insects attack the caribou where the fur is thin. Favourite objectives are lips, muzzle, ears, eyes and other parts where the hair may have been rubbed off. Summer specimens examined had the ears swollen with numerous small blood scabs, the eyes and lips were ringed with hundreds of mosquitoes and black flies. In the fur itself were thousands of flies. During July the caribou are moulting and generally have areas bare of hair, which makes them extremely vulnerable to the insects.

The many evasive actions which caribou take to combat the attacks of flies have already been described under the section dealing with the warble fly. The attacks of insects have a profound effect upon the diurnal activity of caribou; affecting its feeding habits, daily movements and resting periods. Caribou bands travel faster and cover more ground during periods when the flies are at their peak. It seems unlikely, however, that the annual migrations are controlled by the presence of insects.

Munn (1932) wrote that he observed that when the caribou migration passed in late summer, the mosquitoes followed the herds, deserting the area behind the caribou. This is an interesting explanation, but in reality he probably experienced the termination of the tundra fly season, as we did on Clinton-Colden Lake on August 4, 1948, just prior to the arrival of the caribou in that area.

On two specimens examined there were large areas of hide devoid of hair and covered by scabby flakes. The areas involved were the brisket and flank. The symptoms suggested a case of sarcoptic mange caused by an infection of mange mites (Sarcopsis scabii). At present, examinations have failed to demonstrate from the specimens the presence of mites.

Internal Parasites

The barren-ground caribou serves as an intermediate host for a series of cestode parasites of native Canidae. Since the wolves and foxes eat caribou, either as predators or as scavengers, opportunity is provided to complete the life cycle of the parasites.

The commonest internal parasitic infection of the caribou is that of the dog tapeworm (Taenia hydatigena). This parasite is in the cysticercus larval stage. It occurs as a creamy, fluid-filled vesicle with a yellow head, encysted in the liver, mesenteries or heart. It has been previously reported under the name Cysticercus tenuicollis in the Newfoundland caribou (R. caribou terranovae) by Dickmans (1932). This is the name under which the intermediate cysticercus was formerly known. The liver may carry a single vesicle or in heavy infections several vesicles may be found. Of 61 animals examined, 44.3 per cent were infected. The average number of larvae was 2.6 per animal. The highest count was 14 in a single liver.

This parasite occurs as an adult tapeworm in the intestines of wolves (Canis lupus), Arctic fox (Alopex lagopus), red fox (Vulpes fulva) and the sleigh dog. The eggs leave the body of the terminal host in its feces. The eggs are extremely resistant and viable for a long period. In the course of weathering the eggs become washed out of the feces and splashed onto the surrounding vegetation. These eggs are then eaten by the caribou as it is grazing on the low vegetation.

The eggs pass through the stomachs and hatch in the intestine. The larvae penetrate the intestinal mucosa and probably enter the venous blood system, by which they are generally carried to the liver through the hepatic portal vein. In the liver they become encysted in the glandular tissue. The larvae continue their development into cysterci, each of which consists of a simple fluid-filled vesicle containing an inverted scolex. The host tissue builds a tough integument about the vesicle, forming a cyst.

The caribou must carry a certain resistance to this parasite, for three examples were found where the cysterci had died and the host had organized the area, leaving a tough white necrotic area on the liver. Light infestations of this parasite probably have little effect upon the general health of the caribou. With heavy infestations, the function of the affected organ is impaired, which leads to general debility of the animal.

If, upon the death of the caribou, the liver, lungs, or entrails are eaten by a wolf, fox or dog, the cysts are digested in the stomach, the vesicle is opened and the scolex is released into the intestines. Here the scolex attaches itself to the intestinal wall and proliferates the series of proglotids that make up the adult tapeworm.

This is a natural cycle in the wolf and caribou populations of northern Canada. Heavy infestations of tapeworms in the wolves also cause debility, which makes them more vulnerable to the effects of other mortality factors.

This parasite is of economic importance as a parasitic disease of northern sleigh dogs. The feeding of sleigh dogs with caribou viscera causes their infection with the dog tapeworm. Heavy tapeworm infestations cause weakness and lassitude in dogs and leave them more vulnerable to other diseases. The natives habitually feed such offal to their dogs. The Eskimo method of caching caribou carcasses with the liver and thoracic viscera intact, as observed at Contwoyto Lake, permits widespread infestation of their dogs.

The caribou also functions as the intermediate host for a second dog tapeworm (Taenia krabbei). The cysterci of this tapeworm appear as small, creamy, fluid-filled vesicles with yellow centres, about 5 mm. in diameter, encysted in somatic muscles and the diaphragm. They are frequently found in the superficial muscles of the rump and shoulder. Of 54 animals critically examined, 28.0 per cent were infected. The life history and economic importance of this tapeworm are similar to those of T. hydatigena.

A specimen of caribou muscle sent from Baffin Island was found to have a multiple infection of Taenia ovis, another of the same group of canine tapeworms.

Of importance was the discovery of two caribou with coenuri of the granular tapeworm (Echinococcus granulosus). One specimen was killed on the Hudson Bay Railway, Manitoba, on November 23, 1948, the other at Nueltin Lake on September 7, 1948. The adult form of this tapeworm is about one-half inch long, composed of a scolex and three segments, and located in the upper small intestine of Canids. It has been reported from wolves and coyotes (Canis latrans) in Canada by Cowan (1949). The life history of this tapeworm is similar to that of the dog tapeworm, with the exception of the location of the cystercus in the intermediate host. Large game mammals such as moose (Alces americana), and elk (Cervus americanus) are the usual intermediate hosts. To this list can now be added the barren-ground caribou. The coenurus is a large, fluid-filled vesicle which may vary in size from that of a walnut to that of a grapefruit. It is generally located in the lungs. It contains many independent scolices and brood capsules. The manner in which the larva reaches the lungs is probably different from that characteristic of the Taenia group.

This parasite naturally completes it life cycle in the barren-ground caribou and the wolf, in the tundra and northern taiga regions of Canada, taking advantage of the predator - prey relationship between these two animals. Under average conditions it probably has little effect upon the individual's general health. With heavy infestations it probably causes general debility.

The importance of this parasite is due to the fact that it is also known as a parasite of man. The form which occurs in man is the coenurus, the same that occurs in the caribou. The location of the vesicle is somewhat different from what it is in game mammals, as it is found in the liver, lungs, kidney, abdominal wall and brain of man. Frequently there is a variation in the life history, with the formation of secondary vesicles, called brood capsules, containing scolices which bud off from the primary vesicle. This parasitic disease is sometimes lethal, especially when the vesicle forms in the brain. The cysts can be removed only by surgery, if and where that is possible. The fluid from the vesicle is highly toxic and the danger of anaphylactic shock is high.

This parasetic disease of man is more common in Canada that is generally believed. There have been about 37 cases reported in Canadian hospitals in the past 15 years (Davies, 1946). Future medical examinations of northern Eskimos and Indians will probably show a much higher incidence of this parasitic disease. A case has already been reported in a young Indian girl from northern Ontario (Bartlett, 1946). Officials of the Indian Affairs Medical Services reported a case of a Northwest Territories Indian in a Vancouver hospital for surgery early in 1949.

Since the coenurus is the parasitic stage found in man, humans become infected by swallowing the eggs that are found in canid feces. It is probable that humans are infected from domestic dogs, which in turn became infected by eating the viscera of caribou. With the general lack of sanitation in northern camps and the close association of natives with their dogs, the way is open for the infection of the adults and children through the fur of the dogs and from the ground in the vicinity of the doglines. Recent medical investigations (Saunders, 1949), (Brown, 1948), (Wherrett, 1945), have indicated that northern groups of natives support a relatively high infection of parasitic diseases. This is correlated with their close association with the natural fauna and their domestic animals and their primitive level of sanitation and food preparation.

Besides the natural cycle of the granular tapeworm in wolves and caribou, there seems to be a secondary domestic cycle developed to a small extent through caribou, sleigh dogs and man.

The Nueltin Lake party reported the finding of an intestinal tapeworm in a caribou specimen. At the time of writing there has been no further determination of this specimen. It is probably a member of the genus Monezia, the species of which are intestinal parasites of ungulates.

Besides the previously mentioned Cestode parasites of caribou, there is a prevelent Nematode infestation. Infestations of hair lungworm (Dictyocaulus viviparus) are widespread in the caribou herds. The adults are thin roundworms, of creamy colour, about one or two inches in length. They may be found in the bronchioli and in terminal portions of the lung lobes. Light infestations are probably of little significance as a mortality factor. Heavy infestations may cause lung hemorrhages and edema. This condition among big game mammals is known as verminous pneumonia.

Of 58 animals critically examined 24.2 per cent were found to carry infestations of adult stages of this nematode. Gross examination of the lungs showed light to moderate infestations of adults. From 5 to 20 adult worms were found. Had microscopic examinations of the lung tissues been made, it is likely that eggs and larvae would have been found in other specimens.

The thread lungworm is a single host parasite which undergoes most of its life cycle within the lung tissues of the host. The animals become infected by eating vegetation which carries the eggs of the nematode. The eggs are splashed onto the vegetation by the coughing and sneezing of heavily infected animals. It is possible that resistant eggs present in the lung tissues might survive the death and subsequent decay of the host's carcass. Heavy infestations of this parasite are usually associated with crowded conditions on the ranges of big game species. The caribou infestations were much lighter than those observed in the elk of certain National Parks. This suggests that the present concentration of caribou, at least in some areas, may be considered to involve crowding.

Hadwen and Palmer (1922) reported the discovery of a protozoan Sarcosporidia infection in one caribou. It produced lesions of "pitting" on the surface of bones and tendons. Hadwen (1922) also reported the discovery of a new nematode, Nematodirus tarandi in the Alaskan reindeer. It is possible that these parasites may also be present in the barren-ground caribou. Lawrie reported finding two infections of nematodes in the alimentary tracts of caribou he examined. These specimens have not yet been identified.

Bacterial Diseases

Attempts were made in the field examination of carcasses to take note of any gross lesions which might point to bacterial infections. About 20 blood smears were obtained, but examination of these specimens has failed to yield any evidence of microparasites. Seven bulk blood samples were also secured. Poor success in keeping the specimens was experienced under aseptic field conditions. All but two of the samples hemolysed before reaching the laboratory. The remaining two blood samples were examined at the Animal Diseases Research Institute, Hull, P.Q. and were pronounced to be negative for Contageous Abortion (Brucellosis).

On January 3, 1949, the warden at Fort Simpson, Northwest Territories, bought from the natives five thighs of caribou which showed tuberculous lesions. A specimen was sent to the Alberta Department of Agriculture Laboratory at Edmonton, Alberta, where it was diagnosed as an infection of bovine tuberculosis. The discovery of this infection of Mycobacterium tuberculosis var. bovis suggests that bovine tuberculosis is endemic in the barren-ground caribou herds of northern Canada, since the spread from domestic stock seems extremely unlikely. The effect on the human population of the region is difficult to assess at this time.

On August 13, 1948, a very lame old bull caribou was observed on the shore of Lake Clinton-Colden, Northwest Territories. The animal limped badly and rose on its hind legs stiffly to turn about. On post mortem examination it was found to have two large pyremic vesicles, one in the right tarsal joint and the other in the right carpal joint. The posterior one was suppurating to the exterior through an orifice. In foals such localization of pyremia is known as joint ill. The pathogenic factors involved are a complex of pyogenic bacteria including _Staphlococcus aurus_ and _Corynebacterium pyogenes_. On a later occasion a limping calf with swollen joints was observed. It is likely that it was suffering from a similar bacterial condition. Caribou affected with joint ill would be increasingly vulnerable to the attacks of predators.

Examination of 380 caribou skulls found during the investigation, as well as of the specimens killed indicated a widespread infection of lumpy jaw (Actinomycosis). Two organisms are involved in the formation of the lesions of this disease; _Actinomyces bovis_ attacks the teeth alveoli and the bony tissues, and _Actinomyces necrophorus_ attacks the soft tissues of the tongue, gums and cheeks. These organisms are universal in distribution. It is believed that they find entry to the tissues through abrasions to the gums and cheeks caused by abrasive vegetable foods. In the case of the caribou the identity of the causative forage plants is unknown.

There is still considerable confusion about this disease. In reality there are two or three closely related diseases. Actinomycosis is a chronic disease of ungulates, such as sheep, cattle, and deer. It is caused by infections of the ray fungus, _Actinomyces bovis_. This organism attacks the bones of the skull, including the maxillae and the mandibles in particular, causing necrosis of the alveoli and exostosis of the mandible. The resulting malocclusion and loss of teeth interfere with normal feeding (see figure 31.).

Necrotic stomatitis is an acute disease of ungulates and man. The causative organism is _Actinomyces necrophorus_, which attacks the soft tissues of the mouth-gums, tongue and cheeks. It causes the formation of ulcers and caseo-necrotic areas. Other focal points for infection may be on the internal alimentary organs. The disease usually pursues a rapid course resulting in death.

A third disease, Actinobacillosis, also known as wooden tongue, is caused by _Actinobacillus lignierisi_ which causes ulcers on lymph modes, skin, muscles and tongue.

Of 65 specimens examined, one exhibited the gross lesions of the cheek typical of an infection of _Actinomyces necrophorus_. Of 380 skulls examined from the caribou range, 8 exhibited typical lesions of necrosis of alveoli and exostosis of the mandibles indicating a ratio of infection of approximately 2.1 per cent of a disease, probably actinomycosis. This infection is low compared to that in National Park ungulates. Lawrie also reported finding lesions in the heart valves of one specimen and a pyremic lesion on the antler of another which seemed to indicate bacterial infections.

It is difficult to give a quantitative assessment of the significance of the above pathological conditions as factors in the mortality of caribou. The animal parasites described probably seldom are the primary cause of death for caribou. Heavy infections, however, by causing general debility, open the way to other lethal factors, such as predation, severe climatic and forage conditions, as well as more serious diseases. It was generally observed that the heaviest parasitic infections were found in old animals. These individuals could often be picked out of a herd by their poor coat, slight antler development and lagging gait.

Bacterial and fungus diseases, such as tuberculosis, and actinomycosis are probably lethal. Occasionally caribou carcasses, which cannot be assigned to causes other than disease, are found on the range. In the present investigation, at least 7 carcasses in which death was assigned to disease were found. These seemed to be the carcasses of old animals.

Accidents

Accidents are the cause of death of many caribou annually. Several trappers reported finding bulls with antler punctures. It is not likely that many bulls succumb from rutting wounds because the sparrings of the bulls are mostly bluff. Sgt. W. Morris of the R.C.C. Signals, Fort Reliance, Northwest Territories, reported that in November, 1948, a young bull caribou was watched crossing the newly formed ice of Great Slave Lake. It fell through a weak spot and spent about three quarters of an hour threshing about in the freezing water. It finally succeeded in clambering out onto the ice. The animal was exhausted and crossed the ice slowly, lying down frequently to rest. Because of the animals' habit of crossing frozen lakes and rivers during migrations it seems likely that some perish by breaking through the ice are so weakened thereby as to fall prey to the attacks of wolves. In November, 1948, Lawrie reported seeing two carcasses frozen in the thin ice of lakes.

An old Indian chief from Split Lake, Manitoba, confided during a discussion that the only caribou he had secured during the autumn of 1948 he had found lying with broken legs, at the foot of a cliff. He said it was not an unusual discovery. Considering the rough nature of much of their range, it seems likely that a few caribou suffer broken limb bones. Seton (1907) reported observing a lone caribou with a broken leg on an island in Lake Clinton-Colden. He speculated that it had sought sanctuary on the island.

Although the above-mentioned accidents probably cause the death of a few caribou annually, observations indicate that the majority of accidental deaths are caused by drowning at rapids and wa-waterfalls. Clarke (1940) reported the finding of more than 500 caribou carcasses at the foot of Helen Falls on the Hanbury River, by an R.C.M.P. patrol. During the present investigation it was found that other large rivers take a significant toll of caribou. In the course of a patrol, on July 5, 1949, up the Lockhart River from the site of old Fort Reliance to Tyrrell Falls, about 10 caribou carcasses were found stranded on gravel bars. Along the shore of the pool at the base of the falls were the skeletal remains of 31 additional caribou. It was concluded that these animals had been carried over the falls to their death, or had perished along the river bank and had been washed down stream (see figure 32.). On July 29, 1949, the fresh carcasses of two adult bulls were observed below the falls at the mouth of the Burnside River.

The attraction of rapids and waterfalls for migrating caribou herds has already been discussed under migratory behaviour. It seems probable that the many large, swift rivers which transect the caribou range take an annual toll of some two thousand caribou. It seems likely that all age and sex classes suffer from this factor.

The weather also plays an important role as a mortality factor for the caribou population. The greatest losses are to newborn calves when exceptionally severe weather conditions occur during the calving season. During June, 1947, there were unseasonable blizzards on the southern tundra. Mr. Turner, of Eskimo Point, Keewatin District, reported finding the tundra about Kaminak Lake littered with the carcasses of newborn calves. He estimated an 80 per cent calf loss in the Keewatin District herds that season. Similar observations havw been made elsewhere.

Severe weather conditions during the rutting season may affect the number of fertilizations. Trappers interviewed, reported finding fewer foetuses some years than others. Severe winter conditions, such as blizzards and crusting of snow, may cause local mortality by making foraging difficult.

Predation

The biotic communities of the tundra and taiga biomes of northern Canada are relatively little influenced by civilized man. The natural increase of the various species is kept below the saturation point of the environment by an array of natural population controls. One of the more obvious of these mechanisms is predation.

This is not the place for a detailed discussion of predation. It is intended to point out only the fundamental aspects of this factor, which are often overlooked. The population of a species cannot increase beyond the natural saturation point of its environment without disastrous results. The population of a species well adapted to its environment probably approaches the saturation point of its

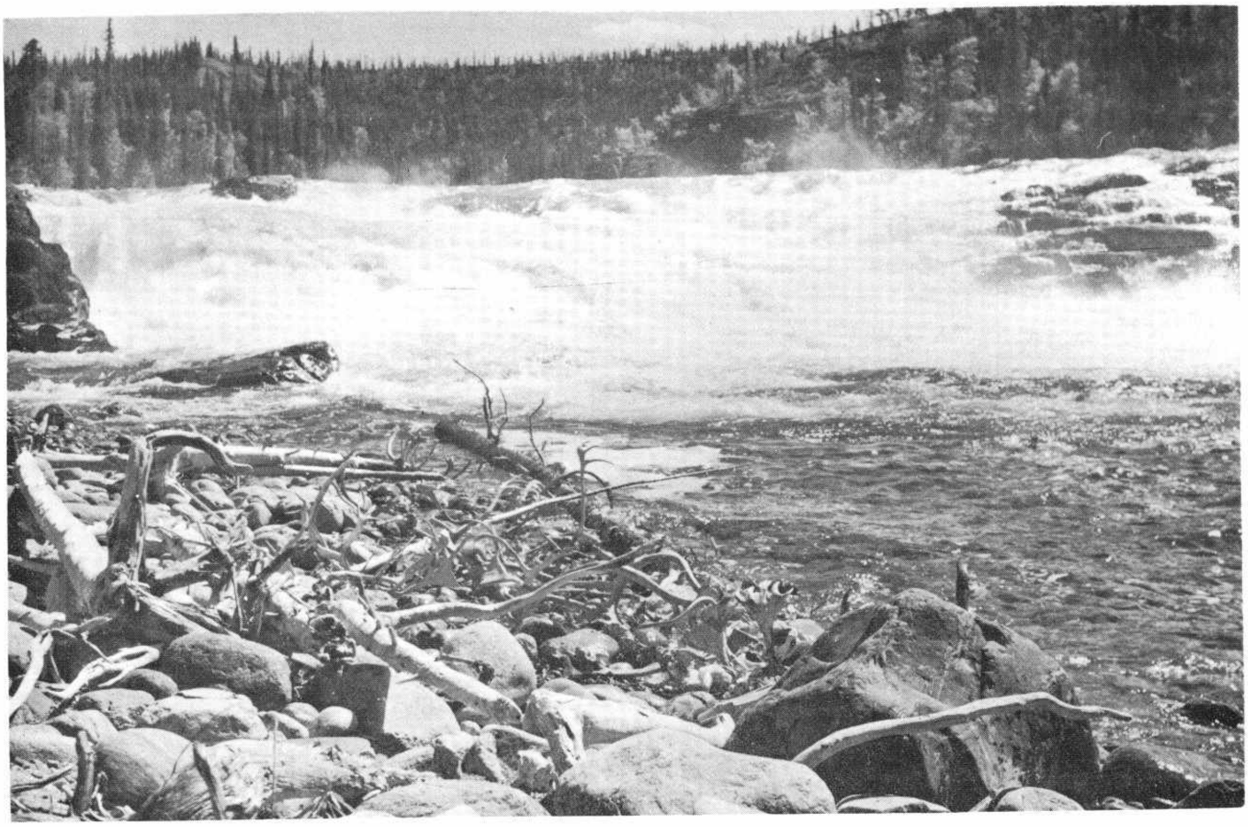


Figure 32. Skulls and bones of caribou washed over Tyrrell Falls, Lockhart River, N.W.T.

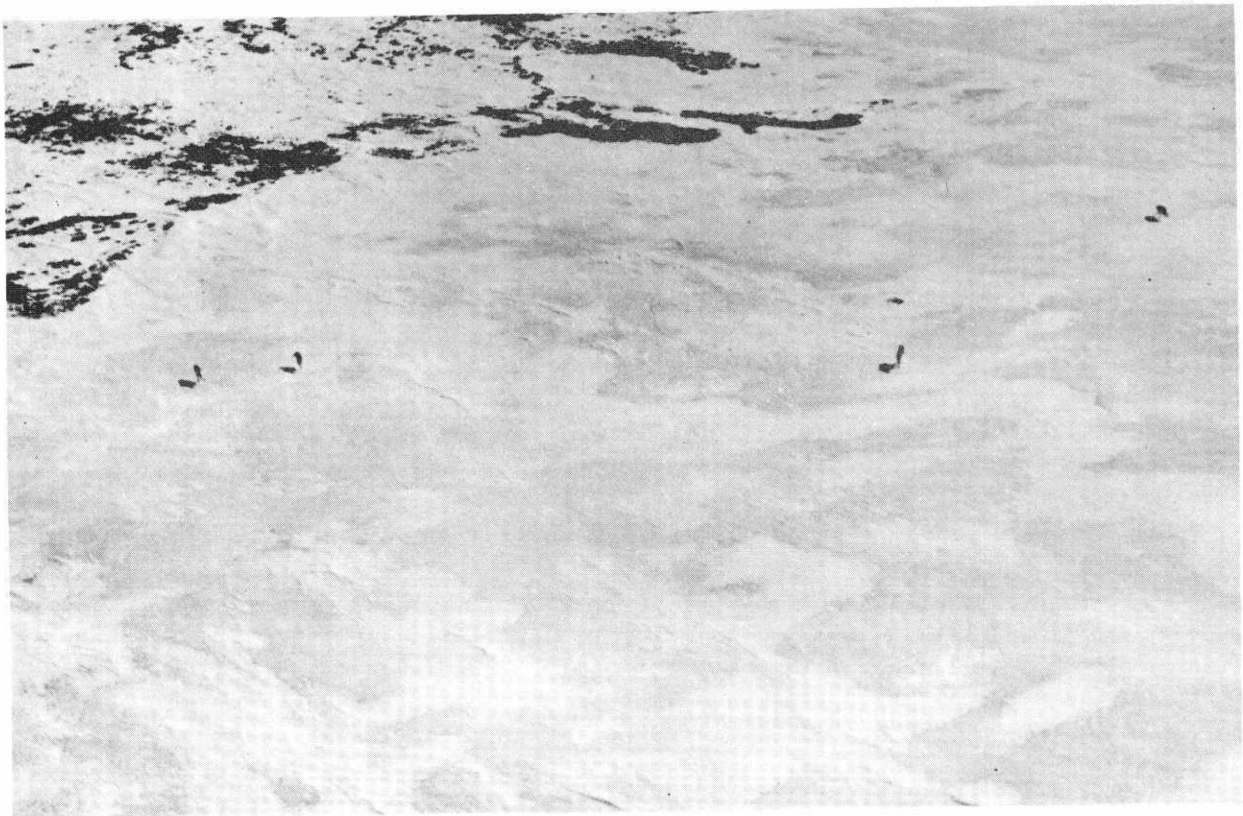


Figure 33. A pack of four wolves crossing a frozen tundra pool.

environment. In order that the population of a species may continue at a constant level, only two offspring per generation of adults may survive. During a lifetime a pair of animals normally produce offspring far in excess of this requirement. These must be removed by mechanisms that regulate populations if the population is to remain constant. Incidentally these offspring provide the raw material to support higher classes in the biologic pyramid, as explained in the section on ecology.

Besides the fundamental effect of predation, predation is generally considered to be secondarily beneficial to the prey species by the removal of the aged, crippled, and diseased individuals. Predators throughout geologic time have probably played an important role in the development of many of the fleet characteristics of the ungulates.

Wolf Predation

The natural predators of the caribou are man and the wolf. The record provided by the Pleistocene drawings from western Europe confirm that these three species have existed together for thousands of years. This is a comment on the productivity and resistance of the caribou. Primitive man was, in the biotic community, a member on the same footing with other members. In arctic and subarctic Canada, the transformation from primitive conditions to civilization is taking place now. The effects of man as a predator will be considered in a later section. The present section will deal with the other animal predators of the caribou.

Next to man, the wolf (*Canis lupus*) is the most important predator of the barren-ground caribou throughout the whole range of the species. The relationship between the wolf and the caribou is a close one. This fundamental association has been discussed previously under ecology. Its consequence has been that the wolves of the caribou range have also developed a nomadic way of life during the greater part of the year.

During the late spring and early summer months, wolves are relatively static. The small family packs are confined to the immediate vicinity of the den, within a day's cruise. By late summer the whelps are old enough to travel and the pack wanders in search of food. During this period the whelps are taught to hunt. For the remainder of the year, autumn, winter and early spring, the majority of the wolves follow the migrating herds of caribou. A few old or outcast individuals may lead a nomadic life all year. During the present investigation practically all of the wolves observed from the air (see table 2 and figure 33) were associated with herds of caribou. It is doubtful if taxonomists have borne in mind the fact that the wolves of northern Canada regularly travel distances up to approximately 500-1400 miles annually when following the caribou herds. This fact has made the subspecific determination of the wolves in the study area a difficult project.

During the early summer months, the wolf population is scattered over the tundra and the northern regions of the taiga. Clarke (1940) thought that the distribution was fairly even over this vast area, and estimated that there were approximately 40,000 wolves in the caribou range. The present investigation has shown that this estimate is far too high. During approximately 360 hours of flying at low altitude over tundra and taiga, during which time approximately 50,000 square miles were surveyed, only 82 wolves were observed. It might be argued that all the local wolves were not seen. In the taiga, it is probable that many animals were missed. Over the tundra, however, few animals passed unobserved. Geese, ducks, ptarmigan, owls, foxes were all observed. It is unlikely that many wolves escaped notice. After all, a wolf is as large as a yearling caribou and more than a quarter of a million caribou were counted.

Over large portions of the northern continental tundra, wolves are exceedingly rare or absent. Our observations and information indicated that east of Bathurst Inlet to Hudson Bay, north of the Back River, and on the Peninsulas, wolves are rare. This fact is confirmed by Manning (1943). On the more southerly portions of the tundra, near timberline, wolves are fairly common. Wolves den commonly in the vicinity of Muskox, Aylmer, Clinton-Colden and Nueltin Lakes, and the Hanbury, Upper Thelon, Dubawnt, and Kazan Rivers.

During the spring migration of caribou, the herds are followed by packs of wolves. On April 24, 1949, about 100,000 caribou were observed on Ghost Lake. Among the caribou herds approximately 20 wolves were observed. These were seen feeding on carcasses and in pursuit of caribou (see figure 34). As the migration continues the wolf packs drop off and seek denning sites to rear their young. In July, this same herd was under close scrutiny for three weeks upon the calving grounds at Bathurst Inlet. During this period, when the herd was watched for many days on the ground and also surveyed from the air, wolf predation was negligible. One wolf and the tracks of a second were all that were observed. At this time there is very little calf mortality caused by wolves. The calf mortality occurs later in the summer, when the herds return towards timberline.

In the summer of 1948 studies were carried out by Mr. F. Mowat at two wolf dens near Nueltin Lake, Keewatin District. This locality is within the northern fringe of the taiga. During the early part of the summer, when the whelps were being raised, there were no caribou present in the area.

One den site was on one of the terminal knolls of a large esker which spilled into Windy Bay. The entrance of the natal den had a diameter of 19 and 15 inches. The burrow sloped down for 14 feet and then turned into a nest cavity which was about 4 feet below the surface. Besides the natal burrow there were three other burrows, one of which had been used in 1947. The two others had caved in. On nearby knolls were fresh "beds". According to Mr. C. Schweder, a trapper whose cabin was approximately three-quarters of a mile away, the location had been used by wolves for at least 10 years.. On another knoll near by there were 12 discarded dens in an area of about 5 acres.

There were three adult wolves, a mated pair and a second young male, as well as four whelps, at the den during the summer of 1948. The territory hunted by the pack during the summer was estimated to be approximately 90 square miles. This territory was bounded on the south by Windy Bay, Nueltin Lake. The den was on the edge of the territory. Across Windy Bay and six miles from the first den, there were, on the same esker, a second den and pack. The hunting area of this pack was estimated to be approximately 84 square miles.

The territory of the first pack was inhabited from May to October. The snow still lay deep on the ground when the wolves arrived in May, The length of the den burrow was increased by a three-

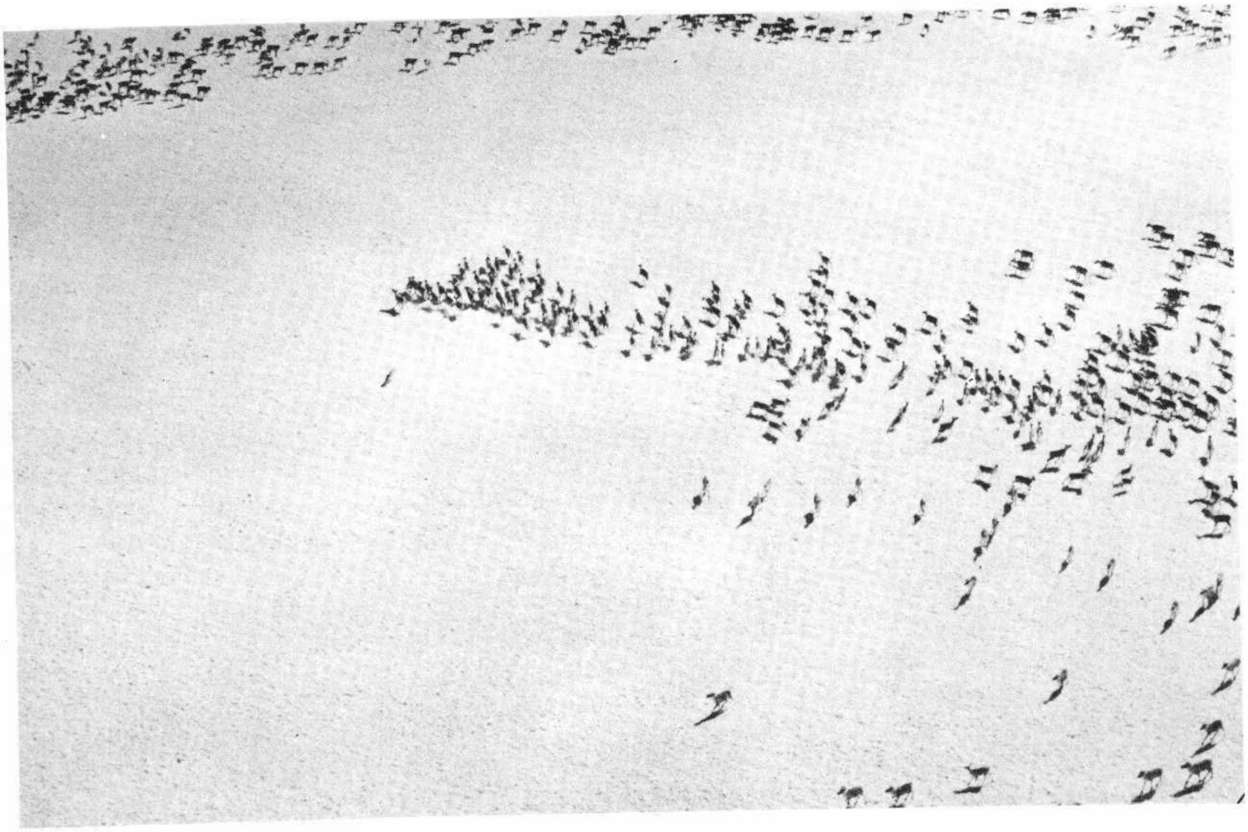


Figure 34. A wolf pursuing a band of caribou, Ghost Lake, N.W.T.

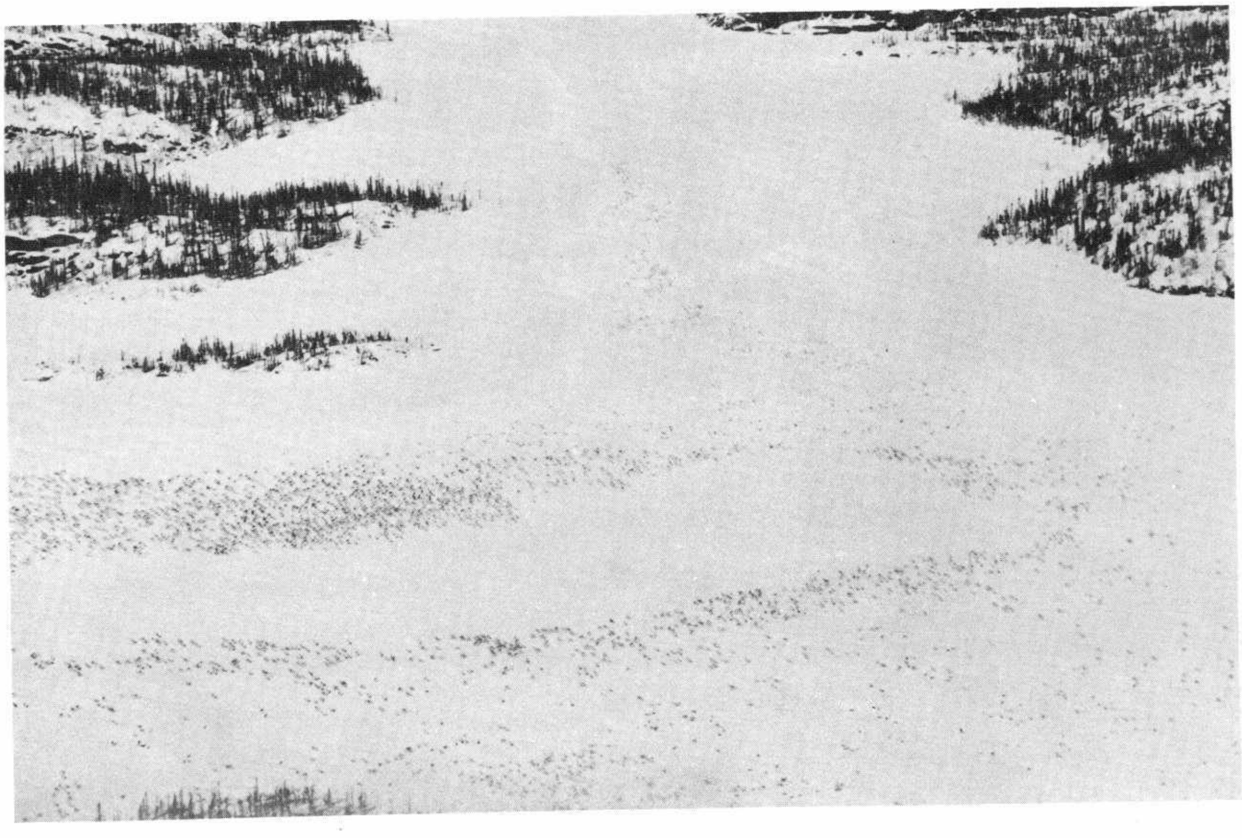


Figure 35. A wolf in the centre of a large herd of caribou, Ghost Lake, N.W.T.

foot burrow through the snow. The den locality was located at a major caribou crossing point, much frequented during migration periods.

Observations at the natal den were commenced on June 13, 1948, On June 23, between 5.00 p.m. and 9.16 p.m., the bitch carried the pups from the natal den to a summer den, three-quarters of a mile away. She carried the first two pups, one at a time, by the scruff of the neck, but on the last trip carried two with difficulty. The summer den was in a rock crevass in a talus slope under a 20-foot rock fault. In the boulder pile were numerous crevasses and small caves.

The author also discovered a den on an esker at Sussex Lake, Mackenzie District, on July 13, 1948. Eskers may contain the majority of tundra dens.

Mowat used a small tent as a blind and made 40 hours of observations of the dens, distributed through the 24-hour day, in the period from June 13 to July 6. A 12-power binocular was used. The blind was in clear view of the den at a distance of approximately three-quarters of a mile. It seemed to have no effect upon the activities of the wolves.

During the early afternoon period, two adult wolves were usually resting at the lookout. They seemed to rest fitfully, frequently raising their heads for a quick glance about the horizon. By late evening there seemed to be an increase in hunting activities. From midnight until morning, one or more wolves were away from the den on extended hunting forages. There was much companionship shown between the different wolves and some frolicking. The pups played together in a small glade near the den. During the observations, on only one occasion was meat thought to have been brought to the den. Generally the wolves hunted individually and fed by themselves away from the dens.

There were very few caribou remains about the dens. There were the fragments of 7 animals about the den. This may have been several years' accumulation. The remains consisted mainly of limb fragments. From June 13 to September 24, nine caribou carcasses were found upon the tundra within the range of the hunting wolves. Some of these also were several years old and some may have died from causes other than wolf predation. All showed utilization by wolves.

From June 17 to August 20 it was known that there were no caribou in the vicinity, as the herds had continued further north. During this period the wolves were observed hunting for lemmings and mice in the swales, eating dead fish found along the lake shore and also a dead herring gull. On a couple of occasions wolves were observed to swim into the lake in pursuit of ducks. The wolves also gnawed the antlers and bones of old caribou carcasses and consumed sections of caribou hide and hair. This is a cause of confusion in the analysis of wolf scats, since the presence of caribou hair may indicate old carcasses rather than fresh kills.

These observations are in direct opposition to the hunting observations made at Ghost Lake, MacKenzie District. They indicate a drastic change in diet between the denning period and the winter nomadic period.

During the investigation, several opportunities to observe the hunting activities of the wolves in the midst of migrating caribou bands during the late summer arose. On August 11, 1948, Lawrie and Mowat observed, across a wide valley, the hunting tactics of a small pack of three wolves at Angikuni Lake, Keewatin District. The wolves were in line abreast and 200-300 yards apart. They were in plain view of eight scattered bulls, which they passed at ranges of 200-600 yards. Those caribou which were further than 300 yards from the wolves ignored them, even though the wind was favourable to them. The nearer caribou snorted, jumped a few paces and watched the passage of the wolves. The wolves later drew together and formed a sociable group, then spread out again. One of the animals explored a small draw and flushed a calf out of a clump of willows at a range of 100 yards. The wolf gave pursuit while its companions sat on their haunches and watched the chase. In the first 50 yards of the chase, a cow and a calf were flushed from the willows and these ran parallel to the wolf on a converging course until about 50 feet from the wolf, which then gave up the pursuit of the first calf and swung towards the second. It seemed likely that the wolf could have overtaken it, but after another 50 yards he quit, after having run only about 100 yards in all.

The first calf had stopped and watched the chase. At this point a second wolf trotted in his direction. When it was about 100 yards away, the calf turned and fled. The second wolf made a quick burst of speed for about 25 yards, but then slackened to a walk and sauntered on. In the meantime the cow and calf circled back and passed within 100 yards of their former pursuer, which ignored their passing. The wolves continued abreast across the swale. One stalked a yearling, which let it approach within 75 yards before fleeing in a circle. The wolf did not follow, but joined its companions.

Similar observations were made by the present writer. At 8.30 p.m. on August 4, 1948, at Lake Clinton-Colden, the migration of several large bands of caribou was being watched. Suddenly a large group was observed to become much agitated. Many caribou peered towards a knoll and others trotted about restlessly. Upon a second glance through the binocular a large white wolf was seen to come out from behind the knoll. The caribou turned and fled in a compact group of about 50 animals. Both wolf and caribou maintained top speed for about 100 yards, during which time the wolf seemed to be losing ground. It quickly gave up the chase. Other bands to the flank ignored the chase.

On other occasions the pursuit may be continued for a much longer period than those recorded above. On August 14, 1950, Wilk observed a calf run past him at Lake Clinton-Colden. The animal was winded, with heaving flanks and open mouth. It passed Wilk at a distance of about 30 yards without paying any attention to him. Wilk watched it gallop down to the shore of the lake, wade into the water, take a drink, then pick its way slowly along the rocky shore. About 5 minutes later a yellowish wolf came over the hill at a fast trot, with its nose close to the ground, following the calf's trail. The observer tried to hide behind a rock but the wolf noticed the movement and, after a brief pause, wheeled and trotted off. From the appearance of the calf, the chase had probably been a lone one. Had the chase not been interrupted, it is likely that the calf would have taken to the water and escaped.

Wolves use two techniques in hunting caribou. The first method is a patrol, by which the wolves flush caribou at close range and then pursue them. The second method is by stalking. When the wind is favourable to the wolf or when it sees a caribou, it will stalk its prey and then rush it.

On August 8, 1948, Wilk was searching for caribou on the Hanbury River. Glancing up, he saw a lone wolf trotting along a ridge which approached Wilk's path at an angle. As Wilk continued on his way and their paths converged, the wolf assumed a stalking position and with crouching legs and with head and tail extended, continued to stalk Wilk. As both were travelling into the wind, the wolf could not catch the human scent. Both continued their paths until they were about 100 yards apart. At this point the wolf caught the scent of Wilk's trail. It sniffed at the trail, arose and looked at Wilk and abruptly galloped off -- a case of mistaken identity.

No wolf was actually observed to kill a caribou during the investigation. The actual act barely missed observation in the following instance. At 8.00 a.m. on August 14, 1948, a band of about 20 cows and calves was observed across a narrow bay from our tent on Lake Clinton-Colden. Most of the caribou were feeding, but several animals were lying down. A few minutes later, the band was noted trotting up wind, about 100 yards from the first position. Some were feeding, but several cows were staring behind at the first position. Glancing back, I noticed for the first time a large white wolf crouched over a caribou carcass, tearing strips of meat from it. A lone cow was standing on a small promotory, down wind from the wolf and watching it. At 8.30 a.m. the wolf left the carcass and trotted after the departed band. It paused several times to look at the carcass and the cow near by.

Upon examination of the site, two calf carcasses were found. Short blood trails led about 12 yards from each carcass. From the evidence it seems likely that the wolf stalked the band and caught the calves after a short chase. The calves were probably lying down, asleep.

The first calf had a broken front leg and a slashed shoulder, also a slash on the rump. The second calf on which the wolf was observed feeding was reduced to a skeleton and hide. It appeared that the wolf had run alongside the first calf and had pulled it down by a crushing bite on the shoulder. Wolves are popularly supposed to hamstring their prey. From reports by trappers and observations upon carcasses, it is concluded that this is seldom done. The general method that the wolf uses for killing a caribou is to race alongside of the caribou and pull it down by grasping the flank, shoulder, or throat, with the jaws. Once the animal is down, the wolves usually seize it by the throat. According to trappers' reports, wolves often, during the winter months, band together in large packs, each comprising several family groups, to hunt caribou. The law of diminishing returns probably controls the size of these packs. Wolves thus associated are reported to co-operate in driving caribou bands over promontories onto glazed ice.

When caribou are abundant, wolves often kill in excess of their immediate needs. In the observation cited above, two calves were killed within about 25 yards in one attack. One calf was largely consumed, with the exception of the intestinal viscera, lower limbs, hide and skeletal column. From the other carcass only the tongue and throat were removed. On August 27, the same wolf returned to the kill and ate it. Similarly the wolf which stalked Wilk on the Hanbury River was found, upon later investigation, to be returning to a kill several days old. The Nueltin Lake pack also returned regularly to old kills.

What appears to be excessive killing by wolves seldom goes unutilized in the long run. When caribou are scarce in the district, the wolves return to their old kills. Other scavengers, such as Arctic fox, wolverine, barren-ground grizzly bears and raptorial birds, also utilize these wolf kills.

Wolves have been known to cache chunks of meat for later reference (Murie, 1944). Upon the tundra and in the taiga, partially utilized wolf kills must be considered as caches, for the wolves usually return to the kills. During migratory periods the wolves may move on. On these occasions following wolves or other scavengers clean up these carcasses. These wolf caches are probably revisited about as commonly as the natives return to their caches. Unutilized carcasses cached by humans were more frequently than predatory kills.

It is also frequently stated that wolves eat only freshly killed meat. Abundant observations during the present investigations and trappers' observations indicate that wolves will eat from carcasses that have been dead for long periods of time. On several occasions wolves were noted feeding on old kills and on carcasses killed by humans.

Caribou Reaction to Predation

It is popularly supposed that caribou are terrified by the presence of wolves and are unable to carry out their normal feeding routine when wolves are in the area. Also it is commonly stated that caribou are defenseless against predators and fall easy prey upon the onslaught of wolves. Many observations made on wolves and caribou during the present investigation tend to refute these assertions. When caribou sense the approach of wolves, they become alert and watch the predators. If the wolves are not actually in pursuit of the individual caribou in question, the latter will watch the wolves until they are out of sight. Even if the wolves are approaching the caribou they generally do not move until the wolves are about 100 yards away. If the wolves have been scented, the caribou will gallop off down wind, otherwise they will circle to get wind of the wolf.

In large herds, caribou are particularly unruffled by the approach of wolves. They will sometimes remain bedded down while wolves pass through the herd within 50 yards of them. During the winter months caribou seem to become accustomed to the presence of wolves associated with the caribou herd. On April 17, 1948, northwest of Eskimo Point, Keewatin District, a herd of 25 caribou were noted bedded down upon a ridge. As the plane roared overhead, the caribou were watched as they jumped to their feet and raced away. Only then were 2 other animals seen about 150 yards behind the caribou band. As they arose and followed the caribou, it was realized that they were wolves.

Among the many herds of caribou migrating across Ghost Lake, Mackenzie District, on April 24, 1949, several wolves were observed, trotting along the trails behind the caribou. In one case, a second band of caribou were following about 200 yards behind a wolf. On the same day, a herd of about 3,000 caribou were observed on a frozen lake. The herd formation was in the shape of a doughnut (figure 35). On closer inspection from the air it was found that there was a single wolf in the centre of the ring. As the wolf ran in one direction the line of caribou fanned out in front. Those behind stood and watched.

The pursuit of a band of caribou by a single wolf was photographed from the air (see figure 34.). It will be noted in the photograph that the animals immediately in front of the wolf are in full gallop. Others to the flank are trotting. Those behind the chase are standing and watching. Others are still lying down.

When a single animal has been singled out for pursuit, it makes a maximum effort to outdistance the wolf. If the pursuit is continued the caribou will generally make for water. Upon reaching the shore, it will plunge in and swim away. During the early winter, caribou which race onto the glassy ice to escape the wolves, generally find themselves at a disadvantage. Throughout the winter months the caribou persist in seeking safety upon the frozen lakes.

From a study of the wolf hunting techniques and the caribou reaction to pursuit it may be concluded that single animals, sleeping individuals, inexperienced calves, wounded, sick and aged animals would be most likely to succumb to the stalking and flushing type of pursuit. The gregarious habits of the caribou are advantageous to the individual in providing warning and relative safety in numbers from attack.

General Considerations

Murie's work (1944) on the predatory-prey relationship between wolves and Dall sheep (Ovis dalli) indicated that the weak and aged classes suffered the greatest mortality, including wolf mortality.

During the present investigation attempts were made to note the age and physical condition of the carcasses believed to result from wolf predation. Difficulties were met in assigning the cause of death of many of the carcasses observed. Of the kills classified, 6 were adult bulls, 9 adult cows, 13 calves, 7 yearlings, 9 aged bulls, 6 aged cows. Three of the aged animals showed lesions of actinomycosis. Those carcasses showing poor antler development and broken and greatly worn teeth were called aged. This small sample of 50 carcasses shows higher proportions of calves and aged bulls than one would expect in the normal population. These data suggest that these classes receive the heaviest wolf pressure. Of the 698 carcasses discovered, 483 were ascribed to human kills, 174 to wolf kills, 36 to accidental deaths and 5 to natural deaths.

The Nueltin Lake party collected 62 wolf scats, which were analysed. Since the scats were picked up on the tundra, there was no way of knowing their age. Some may have been from a period when caribou were abundant. Of the 70 items recorded in the scats, 41 were caribou remains, 15 were lemmings and voles, 3 were birds, 2 were arctic hares, 2 were fish, and 7 were vegetation (grass and twigs).

The quantitative information gathered during the present investigation is insufficient to give a reliable estimate of the effect of wolf predation upon the caribou population of the area under study. All the observations indicate that the total amount of wolf predation has been greatly overestimated. It has been previously recorded that on April 24, 1949, twenty wolves were observed associated with a herd of approximately 100,000 caribou on Ghost Lake. From that point the migration route was traced back to Lac la Martre. Along the route 113 caribou carcasses were observed on the ice of the lakes. Several wolves were seen feeding upon these carcasses. Probably more were hidden in the timber. From other records it is thought that the herd took about a month to travel this distance. During this period the herd suffered a loss of approximately 0.25 per cent. In the course of a year this predation loss might be in the neighbourhood of 2.5 per cent of the total herd.

During the investigation, it was a common observation to see crippled caribou, many with broken limbs or flesh wounds, trailing the migrating bands. Also a few carcasses of caribou which had not been disturbed by predators were found. These had died from wounds or disease. Two lame caribou which showed symptoms of bacterial infection which rendered speedy movement impossible were collected. Had wolf predation been severe at that time these animals would certainly have succumbed. In southern Keewatin District packs of wolves could probably live through the winter on the caribou killed by hunters and left on the tundra; they would not need to kill for themselves. Trappers and natives report that wolves in this area cause heavy losses of cached meat.

From historical records (MacFarlane, op. cit), we know that the population of wolves varies greatly in the course of years in northern Canada. All reports seem to point to a recent decrease from a peak. The work of Plummer (1948) suggests that rabies may be a control factor. A wolf carcass which had died naturally was found at Sussex Lake.

I can see no reason for thinking that the annual loss from wolf predation is greater than 5 per cent of the total population, even during periods of wolf abundance. In a population of 670,000 caribou this would amount to about 34,000 animals.

Lesser Predators

Seton (1929) gives a record of a wolverine (*Gulo luscus*) killing a caribou in the "north". It is not clear what caribou subspecies was concerned. None of the European trappers or natives interviewed during the present investigation had ever known wolverines to kill a caribou. They all stated that the wolverine affected the caribou only as a scavenger. Under these circumstances, there is no cause to consider the wolverine an important predator of the caribou.

Throughout the range of the barren-ground caribou, the barren-ground grizzly bear (Ursus richardsonii, etc.) is extremely rare. It is likely that bears secure a few new-born calves annually, as bears usually do in the range of other species of deer. This carnivore likewise is of no significance as a predator of caribou.

The golden eagle (Aquila chrysaetos) has been reported by Murie (1944) as killing new-born calves upon the calving grounds in Alaska. One Eskimo hunter at Bathurst Inlet reported that he had seen an eagle kill a caribou calf many years ago. He gave a convincing description of the attack and the fate of the calf. Others interviewed also reported that eagles occasionally capture calves.

On April 24, 1949, in the vicinity of Ghost Lake, two animals were observed on a caribou carcass on a frozen lake. At first glance, the animals appeared to be wolves. Upon circling lower in the plane, it was found that the animals were two golden eagles which flushed from the carcass. It is probable that they were eating at a wolf kill. This observation indicates, however, that some golden eagles follow the caribou herds in winter.

Golden eagles also are too scarce on the caribou range to be significant as predators on the caribou population.

Human Utilization

Just as the great herds of bison on the prairies of central North America once maintained the cultural level of the tribes of plains Indians, so the caribou has formed the cornerstone in the economy of two great peoples -- the Athabaskan Indians and the Eskimos. These two nations who inhabited the subarctic taiga biome and the tundra of the Arctic sea coasts, built much of their culture about this animal.

The Eskimos who inhabit the area under investigation were formerly more of a coastal people. Although the majority lived on the coasts, there were inland tribes who lived in the valleys of the Back, Thelon, Dubawnt and Kazan Rivers. The culture of the coastal tribes was based more on a marine economy and seals and walrus played the more important roles. The inland tribes were more or less dependent upon the caribou. Even the coastal tribes, however, made hunting excursions inland in summer to obtain caribou hides for clothing. The caribou continues to be an important natural resource of food and winter clothing, making large areas of tundra and border taiga habitable for European trappers, prospectors and travellers.

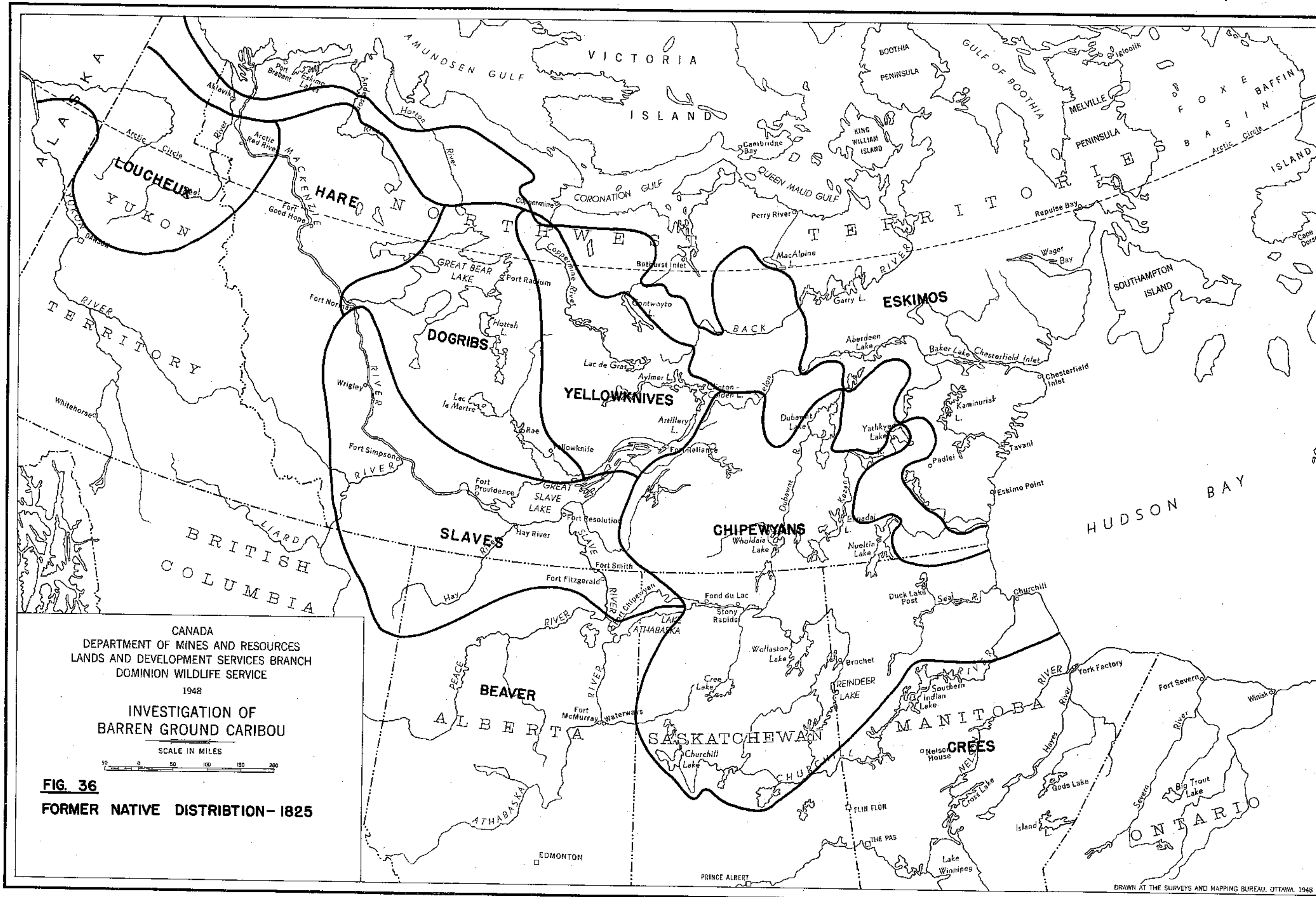
The Athabaskan people were divided into several tribes, the most important of which was the Chipewyan tribe. Although all of these tribes were more less dependent upon the caribou, the Chipewyan culture was based entirely upon this natural resource of their territory and so they gained the name of the "Caribou-eaters". They lived in the northern edge of the taiga from Churchill to Great Bear Lake. During the summer they made long excursions onto the tundra to live upon the caribou and obtain hides for clothing. Frequently during the autumn there was a second tundra hunt for muskox hides.

The approximate distribution of native tribes in the taiga and tundra range of the barren-ground caribou, at the arrival of the first European explorers, about 1825, is indicated in figure 36. This map is based upon the writings of Hearne (1796) Franklin (1825) (1828), Richardson (1829), (1851), Back (1836), Simpson (1893), Pike (1892), Hanbury (1904), and Tyrrell (1898), and is modified from Jenness (1937).

Hunting Methods

The early explorers remarked upon the ingenious primitive hunting methods employed by natives to kill caribou, and many colourful accounts were presented. In general both the Indians and the Eskimos employed similar techniques. The Eskimos, it is true, were denied the use of wood in the construction of their traps, but they made effective use of materials at hand, such as snow blocks. For a complete account of primitive Eskimo hunting techniques consult Jenness (1921). Mason (1902) describes Indian Hunting techniques.

Within the taiga the Indians were able to construct pounds to capture bands of caribou. Hearne (1796) described the pounds used by the Chipewyans in the vicinity of Churchill, Manitoba. These circular pounds were built of brushy trees with a common gate placed upon a well-worn trail. Inside were counter hedges arranged in a maze. At intervals were openings containing thong snares tied to a growing spruce pole. From the gate, where they formed an acute angle, drift fences extended to a lake shore or along a valley border. A family or two would pitch their tents near by and maintain these pounds during the winter months. During good winters it might not be necessary to move camp from such a pound. Varieties of such a pound



CANADA
DEPARTMENT OF MINES AND RESOURCES
LANDS AND DEVELOPMENT SERVICES BRANCH
DOMINION WILDLIFE SERVICE
1948

INVESTIGATION OF
BARREN GROUND CARIBOU

SCALE IN MILES
50 0 50 100 150 200

FIG. 36

FORMER NATIVE DISTRIBTION - 1825

were constructed from Churchill to the Mackenzie delta. I was informed that the remains of a drift fence were still visible on Pike's portage, between Artillery Lake and Great Slave Lake. Often the trap consisted of a brush fence barring a migration route. In the fence were openings with snares attached to trees. Photographs of similar fences used in Alaska were presented in Murie (1935). Stone (1900) presented a diagram of a pound used by the Loucheux Indians of the lower Mackenzie River.

During the winter months small spruce trees in line were frozen into the ice across a lake. The caribou, upon reaching the line of spruce saplings, refused to cross it and followed it to shore, where the hunters were hidden.

The Eskimos employed the same technique to drive caribou, but with the materials which were at hand on the tundra. Long drift fences were constructed of pillars of stones. The pillars were made of two or three stones piled upon each other, or a section of sod was placed upon an upturned columnar stone. These stone columns were placed from 10 to 20 feet apart. The stone fences were sometimes as much as a mile or two in length. They generally crossed well worn trails at right angles and led to a natural defile or lake crossing. Back (1836) reported stone columns at crossings on the Back River.

Several stone fences were examined at the south end of Contwoyto Lake, Mackenzie District, during August, 1949 (see figure 37). These were composed of upturned stones with sod tops. The average height of the pillars was about 24 inches and the average distance between pillars was about 12 feet. One fence was about 400 yards long and another was about a half-mile long. Beside the stone fences were many old skulls and skeletons of caribou.

When operating these drift fences during a caribou migration, several families of Eskimos would hunt together. The women, children and aged would spread themselves along the fence, hiding behind the stone columns. The hunters, armed with bows and spears, would take up their position at the apex of the fence or, if the fence led to a lake, in kyaks at the water's edge. Those on land remained hidden behind large boulders or in shallow trenches with breastworks of stones, such as that shown in figure 38. When a herd of caribou reached the fence, the scattered non-hunters arose, shouted and waved their arms. The caribou mistaking the unfamiliar stone columns for crouching humans, were reluctant to cross the stone fence and so raced along the fence to the defile or lake shore, where the hunters slaughtered them at close quarters by bow, spear and knife.

Such fences are known from the Back, Thelon and Kazan River valleys, as well as from the Keewatin coast. These fences are not used now and have fallen into disrepair. The shallow trenches, however, are frequently used as blinds by Eskimo hunters armed with rifles. Such tranches may be frequently found at favourite caribou crossing points or on summits from which good views of the surrounding territory may be obtained. They are usually about 10 feet in length and about 2 feet in depth. A row of small stones along the front increases concealment.

During the winter months the Eskimos sometimes constructed pitfalls in snow banks to capture caribou. A good description of such a snow trap was given by Hanbury (1904). A pit large enough to hold a caribou was dug in the side of a crusted snowbank and the walls were sometimes strengthened by soaking them

Figure 37. Eskimo stone and sod drift fence.

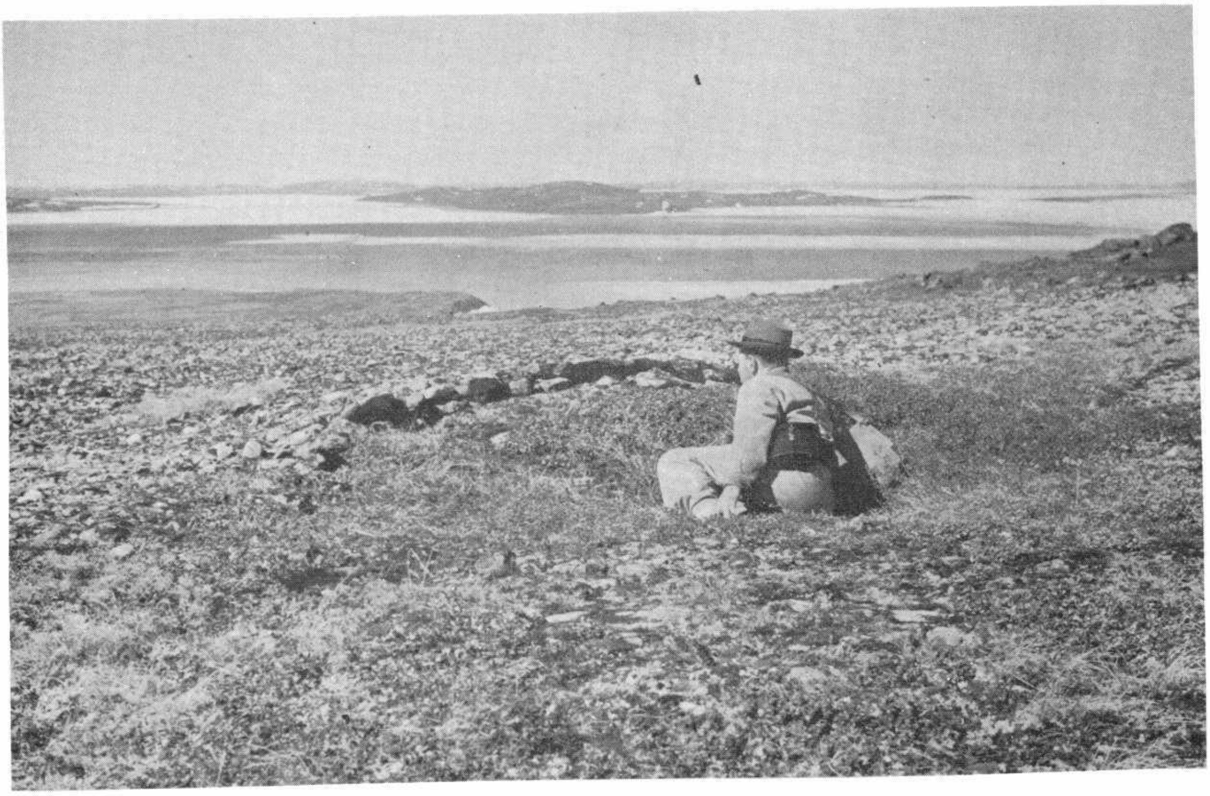


Figure 38. Eskimo hunting trench.

with water, which froze. The pit was roofed with thin sheets of crusted snow and baited with a sprinkling of dog urine or vegetation. One side remained as a sloping ramp. A caribou would walk up the snow ramp to obtain the food or investigate the urine and would fall into the pit. It was necessary to visit the traps frequently in order to dispatch the trapped animals as soon as possible, before they died from their own efforts, which generally caused tainting of the meat.

In the taiga the Indians constructed dead-falls, snares and pitfalls along the game trails. By these caribou as well as moose, sometimes were taken.

The most popular primitive method of securing caribou, used by both Indians and Eskimos, was spearing swimming caribou from canoes and kyaks. This method was similar, whether on the tundra or within timber. The natives congregated at favourite caribou crossing spots, where the animals frequently swan across broad rivers, or at points where they swam across lakes during migrations. These hunts usually took place during late summer and autumn migrations towards timberline. The hunters hid their boats and themselves on the bank opposite that on which the caribou bands were expected to appear. The hunters remained concealed until the migrating caribou band had swum over half the distance across the sheet of water. Then the hunters rushed down to the edge of the water, jumped into their canoes or kyaks and gave pursuit. The swimming caribou turned to try to make the other shore. They were quidkly surrounded and the slaughter commenced. The caribou were rapidly dispatched with thrusts of spears and knives into the back in the kidneys. The dorsal aorta was frequently severed by a sideways motion of the spear.

The spears were constructed of straight spruce saplings about eight feet long, tipped with copper, iron, or bone blades. Now steel blades are used. It is reported that blades fashioned from iron files are used by the Chipewyans in Northern Manitoba.

During these occasions the hunters became greatly excited and great slaughters of caribou took place. Hearne (1796) observed such a slaughter of caribou by his Chipewyan companions at a crossing on the Kazan River near Yathkyed Lake. Other well-known caribou crossings, where they were regularly speared, were on the lower Thelon, Back, Dubawnt and Kazan Rivers. On the Hudson Bay coast of Keewatin speared at the mouths of the Ferguson, Maguse and Thlewiaza Rivers. In Mackenzie District caribou were speared at crossings on the Coppermine and Lockhart Rivers, as well as on the arms of Great Bear Lake and at Fort Rae on Great Slave Lake. In Saskatchewan favourite spearing points were the narrows at Fond-du-lac and Stoney Rapids on Lake Athabaska. In Manitoba caribou were speared at crossings on the Cochrane and Nelson Rivers.

This method of killing caribou is still used by natives in northern Canada. Mr. H. Brown of the Hudson's Bay Company reported that when he visited a crossing point on the lower Kazan River several years ago, there were on the banks piles of caribou skulls and leg bones about four feet high. On this occasion he watched 12 hunters kill about 250 caribou at the crossing.

At crossing points at the southern end of Contwoyto Lake, 170 skulls of caribou were counted about 3 abandoned camp sites.

These were the remains of a few of the animals killed at this crossing point in recent years.

This method is favoured by the natives because no rifle shells are needed. The most important point where Indians spear caribou during the southward migration is at a narrows in Nejanilini Lake, immediately north of Duck Lake Post, Manitoba. Mr. J. Staunton of Ilford, Manitoba, formerly a provincial game guardian, who visited the post during the winter of 1947-1948, reported that many caribou were speared annually while crossing the lake. The bodies floated down the river past the post and were hauled ashore and cached in piles near the camp for winter use.

On August 18, 1948, Mr. A.H. Lawrie of the investigation staff accompanied a group of four Thalmuit Eskimos on a spearing hunt at Nueltin Lake, Keewatin District. Mr. Lawrie describes the incident as follows:

"The canoe was held in readiness on the south shore of the bay where the caribou had a half mile swim to make. As the animals neared the shore after this swim the canoe was urged towards them at the first sign of their turning aside. They were thus faced with an equally long swim back to the north shore and escape. Initially more than a match for four paddles they were overtaken in mid bay and the spearing begun with the canoe driven right among the panic striken animals often with the prow riding up onto one.

The spear consists of a diamond shaped blade two inches long and one and a half wide affixed by a socket to a five foot wooden shaft. The heads were obviously of commercial manufacture but the rusted iron betrayed no trademark: the shafts were cut from native spruce, on the spot. The weapon is held very close to the butt and jabbed single handedly into the small of the caribou's back life an overgrown dagger. The stoke, properly delivered, either severs the dorsal aorta, penetrates the spleen, or opens the chest cavity. In any event death is rapid and efficiently speared animals do not reach shore. However the Eskimo became wildly excited in the process and the spearman laid about him at any animal within reach with the inevitable result that many animals were more or less severly wounded. Many of these lived to reach shore and those which had merely been slashed over the rump went free while the badly wounded either died on the beach or escaped to die in the hills. Twenty caribou were secured in this way including two animals which were tracked down and shot by the writer. There is no doubt that at least as many more were wounded, some of them probably fatally. A single dead caribou, bearing the mark of the spear, was found inland two days later. The Eskimo made no attempt to pursue the wounded and contented themselves with skinning out those which had reached the shore (the writer had insisted that they spear only animals which were prime) and ensuring that those in the water would float to drift ashore. This latter is apparently a common practice designed to save the trouble of towing kills ashore - the head is turned back and dorsally and the antlers hooked under the fore-legs in such a way that the muzzle is held above the surface and the lungs do not fill with water.

To the credit of the Eskimo it must be said that all of these animals were recovered the following day but the fate of the meat and the hides is an excellent illustration of their failings - perhaps, too, of their difficulties. Tongues and marrow bones were taken for immediate use, the balance piled in a heap on the beach. The suggestion that some of this meat should be dried was met with the assurance that it would serve as dog food in the winter. In deference to the writer's plea that it be properly cached a few dead willows were flung over the pile. In the fall the water rose and the whole, long since putrid, was frozen in! The hides were dutifully staked out to dry and totally ruined by a subsequent five day rain which brought no action from the Eskimo. Quite probably they had never seriously intended to use them - it was a long walk home and hides are heavy."

According to residents of Churchill and Eskimo Point, caribou are probably still speared on the lower Kazan River and at the mouths of the Maguse and Thlewiaza Rivers.

The Eskimos at the southern end of Contwoyto Lake were questioned in this regard during August, 1949. Several hunters admitted using this method regularly to obtain caribou when there was a good crossing. One of the hunters had a caribou skin kyak, measuring 20' 4" long with 16" beam, which carried on the deck an armament of two 9' 2" wooden spears with steel blades as shown in figure 39.

On August 16, we accompanied two hunters with kyaks to a crossing point to await the crossing of a band of caribou at a point where the lake was about a quarter of a mile wide. Finally, a small group of three bulls entered the water and swam toward our position. When the animals were more than half way across the strait, the hunters took to their kyaks and gave pursuit. The caribou turned, but the nearest one was overtaken by the swift kyaks. One hunter paddled alongside the swimming animal, seized his spear and despatched the creature with two swift jabs. The carcass was then towed ashore and dragged onto the tundra (figure 40) for butchering.

The Eskimo method of butchering is different from the European way and deserves notice. The head is first disjointed and the neck severed at the atlas. The tongue is excised through the bow of the lower jaw. Next a mid-ventral incision is made through the hide and extended up the inside of each leg (figure 41). The carcass is skinned with little aid from a hunting knife; the hide is pulled off by the hands. The hide is separated from the flesh by repeatedly thrusting the closed fist down the flank. After the hide is removed from one flank, the animal is rolled over on the hide and the other side is skinned out. The abdominal viscera are removed through a transverse out in the groin. The thoracic organs are left intact. On the occasion mentioned the four limbs were disjointed and carried back to camp in a large bag of caribou hide. The remainder of the carcass was covered with the hide to protect the meat from the attacks of blow-flies until it could be carried to camp. On other occasions the vertebral column is disarticulated ahead of the sacrum and the hindquarters are severed from the body. The hindquarters, weighing 40-50 pounds in all, are easily carried on the shoulders, one leg projecting forward over each shoulder of the carrier. Sometimes the disjointed forelimbs are thrown across the projecting hindlegs to balance the load.

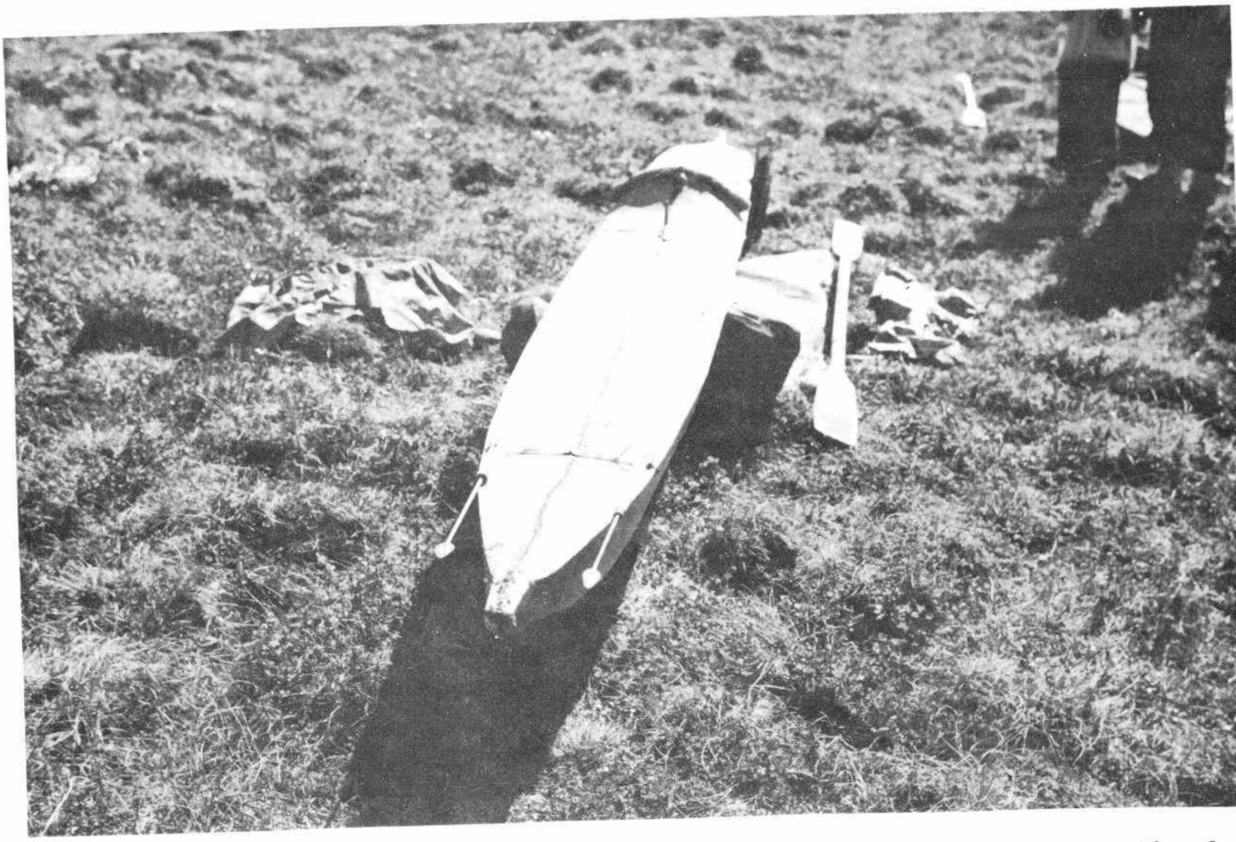


Figure 39. Eskimo kyak of caribou hides with two caribou spears on the deck.

Figure 40. Bull caribou speared from the kyak.

Figure 41. Eskimo skinning caribou.

Figure 42. Eskimo bow of musk-ox horn, caribou hide quiver and copper tipped arrows.

Although there are isolated uses of primitive hunting methods, practically every native hunter in the caribou range -- Eskimo and Indian -- owns one or two rifles, which are the weapons most widely used by Europeans and natives. The rifles used against caribou run the gamut of ancient and modern firearms. The most popular weapon is the .30/30 carbine. Other calibres used are: .22, .300, .303. The various trading posts try to stock a minimum number of the more popular rifle and cartridge styles.

The .30/30 carbine is a weapon well adapted for hunting caribou. The majority of animals are shot at ranges less than 100 yards. The lever action allows several animals to be shot out of a herd. The action seems to act satisfactorily at low temperatures. Finally, the rifle is relatively cheap and the cartridges are universally available.

The .22 rifle is an indispensible weapon of the northern trappers and natives. Among its many uses are: the despatching of trapped animals and the shooting of arctic hares, ptarmigan, waterfowl and ground squirrels. It is light and the ammunition is inexpensive. For these reasons, this is the firearm most frequently carried by a trapper, as well as by women and children. Although the majority of hunters possess rifles of greater caliber, every family possesses at least one or two .22 caliber rifles.

As a result a great deal of caribou hunting by Eskimos and Indians is done with .22 caliber rifles. Some men use those light rifles, while practically all the hunting od caribou done by women and children is done with them. The number of caribou killed or wounded by women and children is worthy of attention. Harper (1949) described the hunting activities of a 10-year-old Eskimo lad

Figure 43. Eskimo hunter with bow.

Figure 44. A bull caribou approaching an Eskimo hunter.

and his 16-year-old half-breed hunting companion at Nueltin Lake, Keewatin District.

On August 16, 1949, at Contowyto Lake, two youthful Eskimo hunters of the approximate ages of 6 and 11 were met returning from a successful hunt, laden down with a caribou hide and a .22 rifle.

I have been informed by several traders that the activities of children are not always so practical or successful. At times they fire into passing caribou herds with .22 rifles in sport without any intention of utilization.

At exceptionally close range, an accurate hit in heart or brain with a bullet from a .22 long cartridge will kill a caribou. These conditions are seldom met. During August, 1949, several of the Eskimos hunting caribou at Contwoyto Lake were using .22 rifles. On two occasions, I watched caribou fall from shots from these rifles. Both animals were shot at ranges less than 10 yards. One fell several minutes after a single hit in the heart. The other after three hits in the chest (figure 44).

These were exceptional cases. Many other caribou were wounded at greater ranges and escaped. Each day from August 10 to 20, while about ten Eskimos were shooting animals for hides, I observed several wounded animals in the bands being hunted. On August 15, there were four wounded animals hobbling about the scene of a slaughter while the Eskimos skinned carcasses without attempting to kill the wounded animals. During the period mentioned I despatched four wounded animals abandoned by the Eskimos. These animals were usually wounded by .22 bullets in rump, abdomen or legs.

Many European traders, trappers and missionaries reported observed instances of excessive wounding of caribou by the use of .22 rifles in the hands of natives, especially children.

Both Eskimos and Indians generally make no effort to conserve caribou when hunting. As many caribou as possible are killed from each band as the opportunity arises. Little or no attempt is made to select suitable animals for hides or for meat. As long as other animals are available, rarely are attempts made to kill wounded animals which escape, or to follow up wounded animals which finally drop far from the scene of the shooting.

Intensive survey of the locations of regular hunts in both the taiga and tundra always resulted in the discovery of the remains of numerous caribou, whose intact condition, frequent hide punctures, or broken bones, indicated that they were unutilized animals killed by gunfire. Such carcasses were found at Churchill, Manitoba, and at Nueltin Lake, Eskimo Point, Fort Reliance, Contwoyto Lake, Muskox Lake, and Bathurst Inlet, Northwest Territories.

A typical example of such hunting wastages was observed by the author on August 15, 1949, at Contwoyto Lake. A band of approximately 20 animals were feeding in a small swale about half a mile from camp. Two Eskimo hunters approached to about 75 yards range before opening fire. Out of eight animals shot, two were wounded and escaped. Later the scene was visited to observe skinning and caching techniques. On the side of the swale the carcass of a large adult stag was found. The pelage was in delayed moult and unsuitable for clothing. The hide and the velvet on the antlers had been slashed by the hunters' knives and the already bloating carcass had been abandoned.

On August 16, a herd of about 125 caribou were observed to swim a narrow part of the lake and reach a long peninsula on which four Eskimo hunters had taken up positions about 25 yards apart. On the report of the first rifle, the leading animals turned and the band hesitated for a few moments. Then the band ran the gauntlet past the hunters, who blazed away at the animals at a range of about 20 yards, knocking many caribou down. The band continued down the point past the Eskimo tents and dog lines. It was a spirited scene, with the dogs howling and jumping on their chains and the women rushing out of the tents searching for rifles.

Two days later we visited the camp and counted more than 75 carcasses lying on the peninsula -- the result of several hunts such as that described above. The majority were within 150 yards of the tents. Some of these had been skinned and eviscerated. I wandered about a mile down the peninsula and observed about 10 unutilized carcasses. Four bloated carcasses were lying in shallow water. No attempt to utilize these animals had been made. Other wounded animals had dropped too far from the hunting scene to be easily located by the Eskimos. There were also two wounded cows hobbling about the scene, ignored by the natives.

Mr. Lawrie also reported on the extravagant use of ammunition by Eskimos when hunting caribou. Between the middle of August, 1948, and the middle of October, 1948, 3000 rounds of 30.30, 500 rounds of .303 and 120 rounds of 44.40 ammunition were issued to the 11 heads of families at Nueltin Lake. On November 5, 1948, five of these families had no ammunition left. The expenditure of this ammunition was probably accompanied by the heavy and wasteful slaughter of caribou. The local trader reported that he found caribou cached everywhere throughout the territory the following winter -- "the hills were full of dead deer".

Such wastages have been reported by many writers during the last century and the early part of the present century. It is regrettable that these conditions still exist. From interviews with wardens, traders, missionaries and trappers in the northern parts of provinces and the Northwest Territories it is known that excessive wastage is widespread throughout the whole range of the caribou and is indulged in by Indians, Eskimos and some European trappers.

At all stations during the investigation it was commonly observed that native Eskimos and Indians killed caribou during every month of the year, regardless of the regulations. Caribou are shot as long as they are readily available.

From the air, Indians and Eskimos were observed hunting caribou in Manitoba and the Northwest Territories in April and May of 1948 and 1949. Often the carcasses, offal, hunters and dog-teams were clearly observed on the frozen lakes. In the Northwest Territories, Eskimos and Roman Catholic priests were observed hunting caribou in July. It is probable that trappers, missionaries and traders in remote areas also hunt caribou regularly throughout the year.

Caches

A variety of methods are used to preserve the meat for future use and protect it from the depredations of large predators. The actual methods used depend largely upon the resources at hand.

Figure 45. Eskimo caching carcass under sods.

Figure 46. Transporting caribou meat by dogs and sled in summer.

On the tundra, the skinned and eviscerated carcasses of animals killed during the late summer by Eskimos are usually cached by being covered with a pile of large rocks, with the antlers or limbs protruding. If no rocks are present where the animals are killed, they are often covered with large sods, as shown in figure 45.

Occasionally elaborate rock caches are constructed. At Bathurst Inlet a group of eight stone caches were examined. They were formed of limestone slabs. The cache cavities were rectangular, with dimensions of approximately 4x2x2 feet. The walls were formed of rocks set on edge. Outside of these were two to three feet of slabs laid on their sides. The caches were covered with exceptionally large slabs. The overall dimensions of the caches were approximately 7 feet square (see figure 47).

In Keewatin District, during the autumn and early winter, the Padleimuit Eskimos cache their caribou by the simple device of turning the head down so that the antlers project upwards. When the carcasses become drifted over with snow in the winter, the antlers will guide the hunters back to their caches. In any event, an Eskimo's supply of meat consists of many groups of carcasses, cached at the point where they were shot -- 5 here, 10 there.

These caches are liable to the depredations of scavengers, such as wolves, arctic foxes, wolverines and barren-ground grizzly bears. These animals consume an appreciable amount of any trapper's or native's meat supply. It is difficult to obtain an estimate of such losses. From discussions with many residents it is estimated that losses from scavengers may be about 10 to 20 per cent of an individual's meat cache. Individual trappers reported losses up to 75 per cent under singular conditions.

During the winter months more secure caches may be made by building a snowhouse around the meat supply and then pouring water over the snowhouse to transform it into an icehouse. A second method is to cut a hole in the ice of a lake and suspend the meat in the water (Pike, 1892). A more satisfactory method is to place the meat in the ice and cover with ice blocks or to pour water over the meat and build up a thick layer of ice. These methods have been used by northern trappers, travellers and natives on the tundra.

Within the taiga, lumber may be used to construct caches. The most popular cache is a wooden platform supported by four poles and reached by a ladder (see figure 48). To protect the meat from the depredations of scavengers the poles are often peeled of bark, wrapped with tin and ringed with cod hooks, facing downward, or with spikes. The platform is usually so located that the snow will not drift too deep around it and is placed in an opening, so that arboreal scavengers cannot drop onto the platform. If the platform overlaps the supports by three feet, it makes it additionally difficult for an animal to climb onto the platform. The Indians also hang meat in trees, or cache it under rocks or in ice houses. Sometimes they construct small storehouses.

The European residents in the caribou territory have utilized all of these methods. In addition, many trappers have oonstructed storehouses or root houses at their base camp. To construct a cellar in an area of permafrost is a difficult task, but it repays the effort by its refrigerating effect in summer.

Much wastage of caribou meat occurs as a result of the native habit of killing caribou and caching them along the trail for future use when travelling on traplines or to the posts during

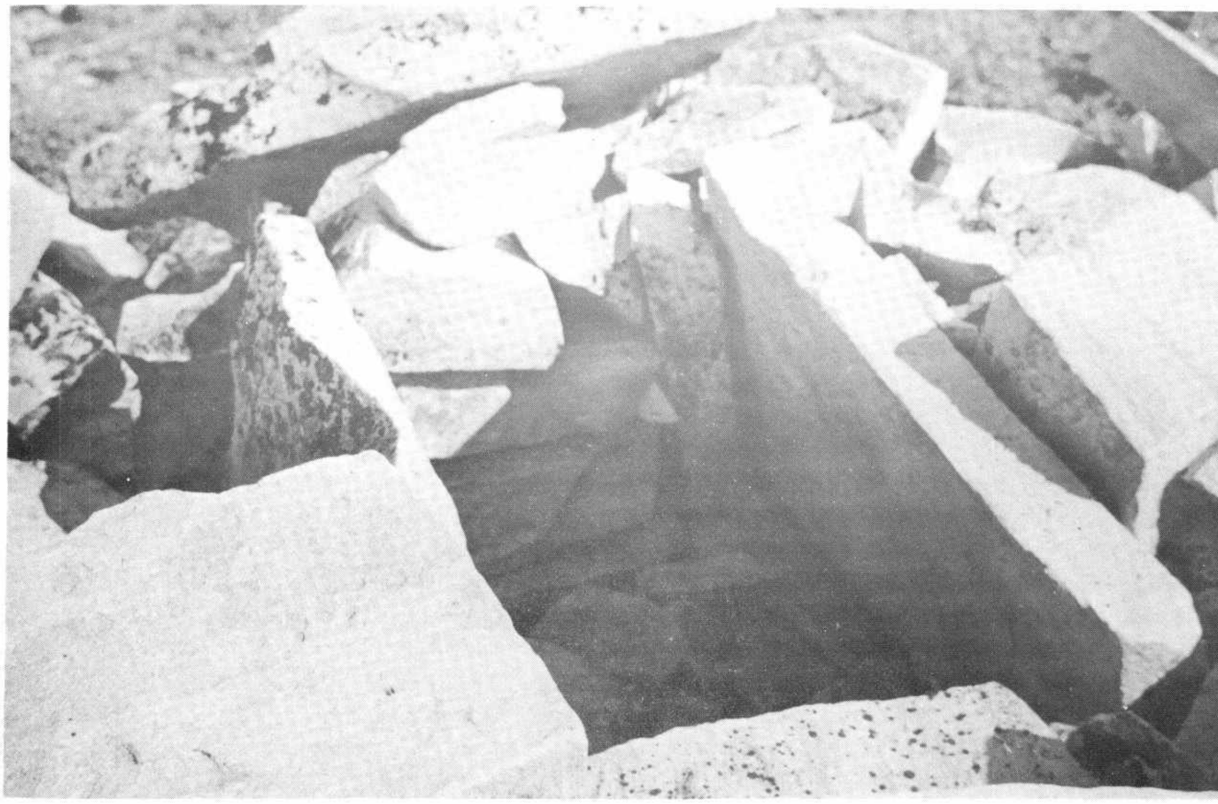


Figure 47. A stone cache on the tundra.

Figure 48. An Indian platform cache, Fort Reliance, N.W.T.

the winter months. Unfortunately, the hunters may never return that way again. Lawrie reports that there were 58 cached carcasses known to his party near their camp on Nueltin Lake during 1948. Of these not more than a dozen were used. Some of these were cached so early in the autumn that the meat putrified.

Uses

The caribou was once the cornerstone of the economy of the native tribes in Arctic and sub-Arctic Canada. It provided these people with all the necessities of life. In modern times, the products of civilization have replaced many of the former products of caribou. In times of emergency, however, the primitive caribou products are still used in remote areas. Even now small groups of Eskimos and Indians are almost completely dependent upon the caribou.

The primary use of caribou is as a vital supply of meat which is of superior quality. There is quite a variation in tastes for meat cuts, as between the natives and Europeans. The white trappers prefer the hind quarters for human consumption. The Eskimos prefer such cuts as the head meat and the rib basket. All are agreed, however, that the tongue is the prime delicacy, and that it is only slightly superior to the liver. The back fat, known to the early explorers as the "depouille", is a valuable addition to the larder. It is an important part of pemmican. It is added to lean meat to provide carbohydrates for energy. Other favourite cuts are from the rump, with about one-half meat and one-half fat. The fat is rendered and used as fuel oil in the small stone lamps of the Eskimos.

Other caribou products which are used are the tips of antlers in velvet, stomach contents ("neerook"), and blood, which is allowed to jell in bags of intestine lining. The marrow in the leg bones is considered a delicacy by natives and Europeans alike. The leg bones are heated over hot stones. When cooked, the bones are split open by pounding with stones. The marrow is scooped out by penknives or eaten directly.

There are three main methods of meat preparation in common use among the natives. With freshly killed caribou, or when there is an abundant fuel supply, the meat is boiled in large portions. During the spring and late summer months, large amounts of meat are dried. For drying, long, thin strips of meat are cut from the flanks and hind quarters. These are hung over long poles. On the tundra, these poles are often supported by the antlered heads of freshly killed stags, as shown in figure 49. Upon drying, the meat becomes black and flakes easily. This food is cached and is also carried by sleigh. It is used during midsummer and early winter if caribou are absent. Lawrie reports that the Kazan Thalmuit dry no caribou meat.

The third method of preparation is freezing. During the winter months cached meat is eaten in the frozen state. Strips of meat are flaked off the frozen carcass with a penknife.

Caribou meat is universally used as dog food by Eskimos and Indians during the winter months throughout the caribou range. Where caribou are available, few natives make the effort needed to obtain a winter's supply of fish. The amount of caribou meat consumed by a hunter's dogs may easily be 50 per cent of his total winter requirements. A team of 10 to 14 dogs can easily dispose of

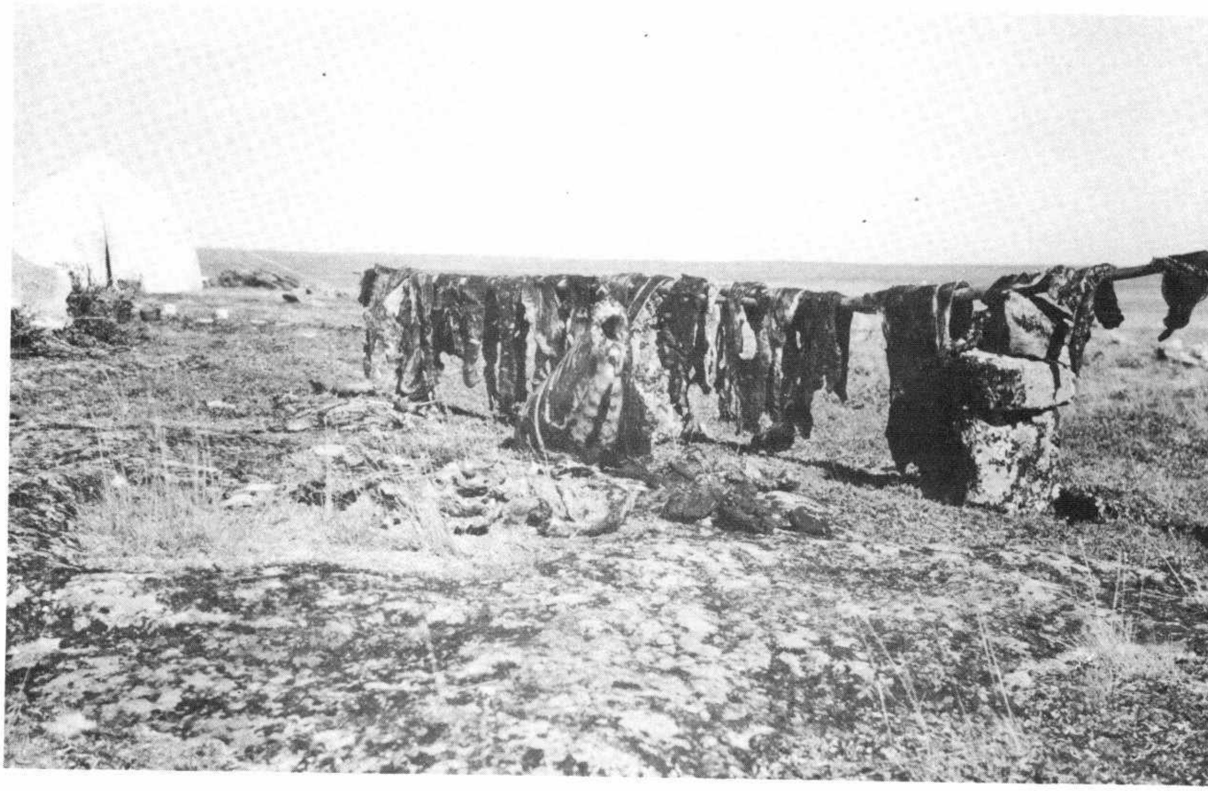


Figure 49. Drying caribou meat on the tundra.

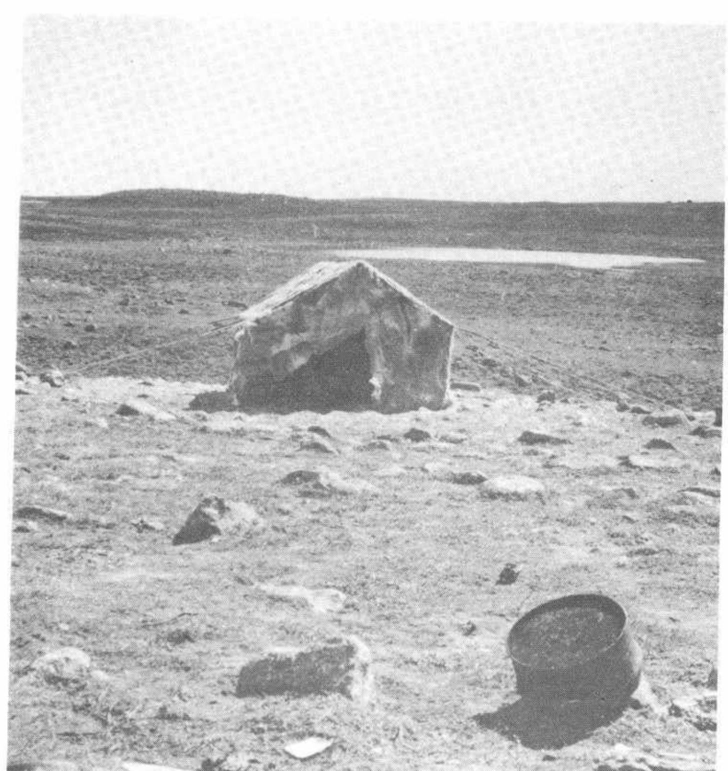


Figure 50. An Eskimo tent of caribou hides, Contwoyto Lake, N.W.T.

a medium-sized carcass each day. Few teams, however, are so fortunate as to receive this allotment. Lawrie estimated that a team of 6 dogs would require about 50 caribou per year.

There are no statistics of the average number of dogs in the caribou country, but it is estimated to be about 8 to 10 dogs per family. The Indians' teams are generally composed of from 4 to 8 animals, while Eskimo teams may number up to 15 dogs.

The early explorers, such as Hearne (1795), spoke of the dogs possessed by both Eskimos and Indians. From their reports it is concluded that the natives had fewer dogs at that time than they have now. Even at the beginning of the present century the Eskimos of the Arctic coast possessed fewer dogs. The average dog team was probably composed of 4 to 5 animals. At that time the Eskimos travelled but little from their coastal haunts. During the present century these poeple were encouraged to make long winter journeys inland to secure the Arctic fox for trade. Without doubt the fur industry has caused a great increase in the dog population by requiring long journeys on winter trap lines and to the trading posts.

A growing number of natives about the posts have been instructed by police, certain traders and missionaries to put up a winter's supply of fish for dog feed. The majority of European trappers also dry fish for dog feed. Away from the centres of population, however, the regulations are generally ignored. Generally many caribou caches made in early autumn are not fit for human consumption by winter because of putrification or the activities of blow flies. These carcasses are generally used for dog feed, as are portions of other carcasses less palatable for humans. Often because of necessity, and sometimes by preference, such putrid carcasses are eaten in winter by Eskimos and dogs alike.

It has been reported that certain individuals, both native and European, leave caribou carcasses along their trap lines to act as fox bait. I do not doubt that many caribou carcasses are utilized in this manner. It is difficult, however, to obtain a clear-cut picture of this use, since many carcasses are present on the traplines, some well cached, others lying on the ground unprotected. Undoubtedly Arctic foxes utilize a great many of these carcasses.

The second important product of the caribou is the furred hide, which serves as superior quality winter clothing for Arctic peoples. The hides taken from animals shot during August and September are used for clothing by Eskimos, Indians and Europeans resident in the caribou range.

The Eskimo method of preparing hides for clothing was noted at Contwoyto Lake. The green hides were pegged out upon the tundra with the hair side down. If the weather became damp, care was taken to cover them. The skins are scraped free of excess meat and fat. When dry, the hides are roughly tanned by scraping with a tool called an ulu, while the hide is rolled over a smooth rock. This action breaks down the dermal fibers. When the process is complete, the hide is flexible, white and thin.

A complete Eskimo winter caribou-hide outfit consists of an inner and an outer suit. The inner suit comprises a parka-like garment, worn with the hair inside, inner trousers and stockings. Worn over these are outer garments, and including parka, trousers, high boots and mitts, which are made with the hair facing outward.

This is the ideal outfit. Not every Eskimo is so fitted. Generally the hunters in the family will have complete outfits. Women and children rarely possess both suits. Ideally, this clothing is renewed each summer. In many localities where caribou are uncommon, the Eskimos have to make their caribou clothing last for two or three years. In some localities women and children may be observed in tattered garments years old, in many cases handed down from the men.

Sealskin outer boots are preferred by coastal Eskimos. These are worn over caribou-hide stockings.

In localities where caribou are still plentiful, the Eskimos make extra outfits. These are traded to the Hudson Bay Company for sale in regions where caribou are scarce. Several trading posts, such as Coppermine, Bathurst Inlet, Baker Lake, Eskimo Point and Duck Lake, are referred to as "Caribou posts" by the traders. From these posts raw caribou hides, tanned hides, sinews, babiche, and ready-made caribou outfits are secured from the natives for distribution to other posts, such as Cambridge Bay, King William Island, Spence Bay and Igloolik, where caribou are scarce. At Bathurst Inlet, in July, 1949, there were between 3000 and 4000 caribou hides that had been secured from the natives during the previous winter, for distribution to eastern posts.

The recorded number of caribou hides traded annually in the Northwest Territories since 1938-1939 is presented in table 19. The amounts of the various caribou products traded at Duck Lake, Manitoba, in recent years are indicated in table 20.

Now modern European garments are replacing certain parts of this outfit. Woolen and horsehide mitts are generally worn in place of caribou hide mitts, since they wear better. Undergarments, such as woolen underwear and woolen stockings and shirts, and work trousers are generally worn in place of the inner caribou garments by most Eskimo tribes, other than the most isolated.

The number of hides necessary for a complete outfit varies tremendously. It depends upon pattern, the sex and age class of the hides used, and the completeness of the outfit. At Baker Lake I was told that the hides of young cows were the favourite for clothing. At Bathurst Inlet I was told that young bulls were used for clothing. At Contwoyto Lake I noted that calf and yearling hides were preferred for clothing. The average number of hides needed for a complete outfit may be calculated as follows: inner parka, 3; outer parka, 4; inner trousers, 2; outer trousers, 2; mitts, stockings and boots, 1; total, 12 hides. Some hides and parts of hides have special uses. The hide from the bulls' foreheads makes the best soles for boots. Calf skins are frequently used for stockings and the inner parka. The hide from the legs is used for boot leggings and for quivers. As has been indicated above, not all Eskimos own such complete outfits. It is probable that a total of 25 hides annually would clothe satisfactorily a family of two adults and two young children.

As the season progresses past September, the hair grows so long and thick that the hides are no longer in prime condition for clothing. Where caribou are scarce, the natives will, if necessary, use winter hides for clothing. At times the winter hides are clipped.

Table 19. The number of recorded caribou hides traded in the Northwest Territories

License Year	Mackenzie District	Keewatin District
1938-9	1429	13
1939-40	422	47
1940-1	740	16
1941-2	249	9
1942-3	386	553
1943-4	3408	148
1944-5	2957	857
1945-6	2027	553
1946-7	2851	---
1947-8	1253	---
1948-9	* 1697	* 512

* - Incomplete return.

Table 20. The recorded caribou products traded recently at Duck Lake, Manitoba.

Year	Hairless tanned hides	Haired hides	Babiche
1947-48	865	108	684 pounds
1948-49	654	341	516 "
1949-50	* 51		728 "

Note. * - Incomplete return.

Hides from caribou killed in autumn or early winter are used for a variety of purposes. The most important use is for sleeping robes, four or six hides being sewed together. They are also used for beds and for igloo doors and roofs in early spring when the snow is melting, as well as for covers to throw over caches, or to line the sides of carioles, or to throw over sleigh loads.

At one time an important Eskimo use of winter hides was for tents, which were cone-shaped. Richardson (1829), estimated that 60 to 70 hides were needed for a single tent. The Indian tribes also used tanned hides for tents when travelling upon the tundra. Although modern canvas tents have practically everywhere replaced the skin tents, a few caribou-hide tents are still used in such remote areas as Contwoyto Lake (see figure 50) and Kazan River. It is interesting to note that some of these tents are now fashioned after the pattern of wall tents. Lawrie estimated that 20 or more hides were needed to build a tent.

Winter hides are also used to insulate winter homes. Cracks in log walls may be stuffed with strips of hide, as observed at Fort Reliance, or the whole interior may be lined with hides, as observed at the tundra camp of Mr. M. Murphy at Muskox Lake.

Tanned hides from which the hair has been soaked off also serve a variety of uses. The Eskimos sew two small hides together to serve as a hunting bag. The hide is cut into long strips and is used for string or cord in lashings of all kinds. It was interesting to note that the caribou-thong lashings of the wooden supports for the clay chimney built by Captain Back at Fort Reliance in 1833 were still intact and functional in 1949. The inland Eskimos, lacking access to seals, use dehaired caribou hides to cover their kyaks (see figure 39). It may be necessary to use as many as 12 hides to cover a kyak. These tanned hides are also used to make summer moccasins.

The Chipewyan Indians of Fond-du-lac and Stoney Rapids and the Dog-ribs of Fort Rae tan a great many dehaired hides.for use in the manufacture of moccasins and jerkins. These articles are much inferior to those of moose hide because of the thinness of caribou hide and the numerous warble scars and perforations. It is likely that the great majority of these hides are taken during the winter and would be unsuitable for furred winter clothing. Within the past 5 years or so there has sprung up a small business of supplying these hides to tourists.

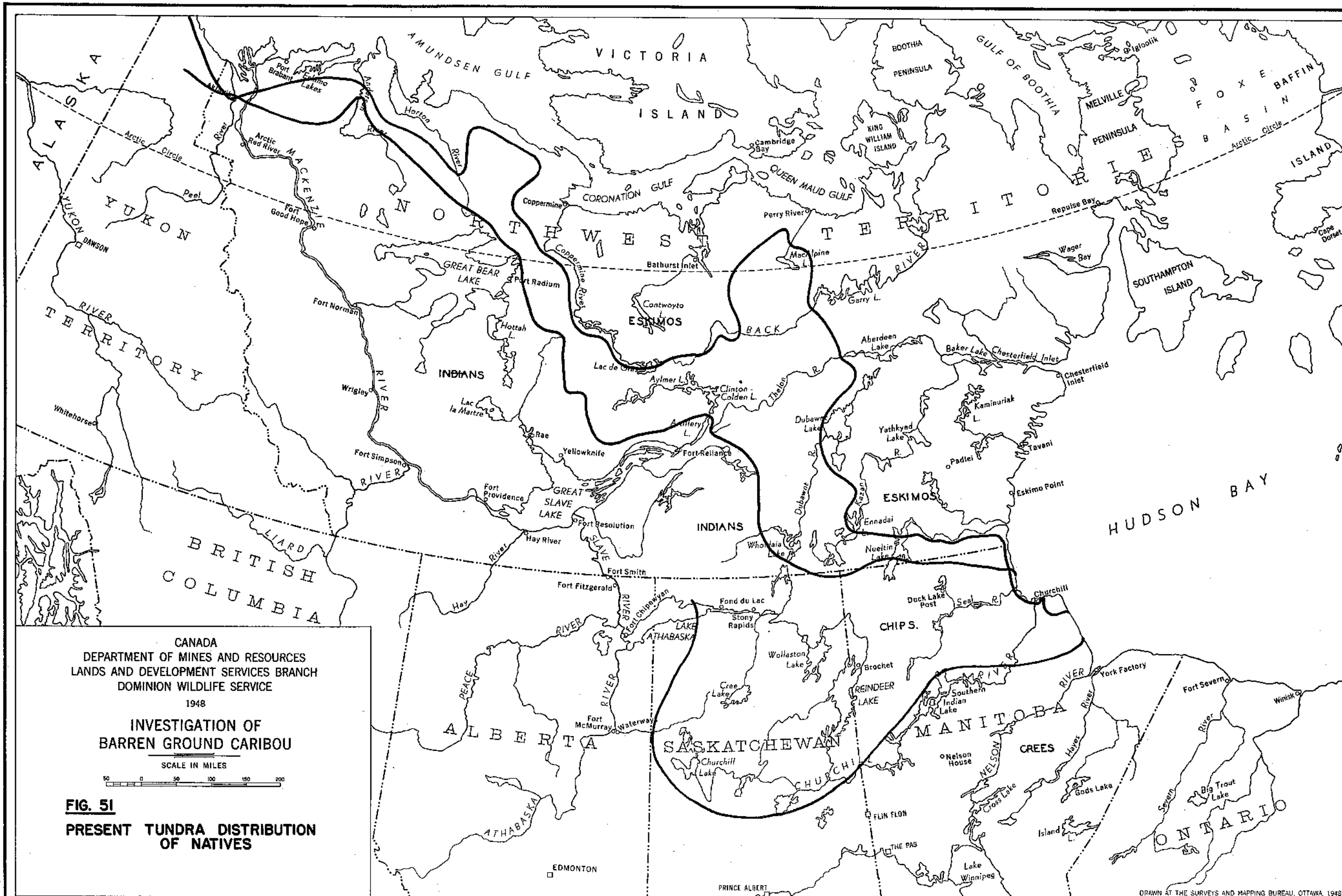
Before the advent of thread, the sinews along the spine were universally used by Eskimos and Indians for sewing or for braiding into lines. After skinning the animal, a slit was made with a knife beneath the superficial muscle fibers and sinews in the sacral region. A short thong was threaded under these layers, looped and then pulled forward, stripping off the muscle sheath. This was allowed to dry and was then cut into narrow slivers of sinew. The sinews were used as thread for sewing garments. Braided, they were used to reinforce bows, or as fishlines, or to form a network for snowshoes.

Even today, sinews are widely used for sewing. At Bathurst Inlet there is a considerable trade in sinews for export to other northern posts.

The antlers also provided many useful tools to the natives. Some of these have been replaced by the importation of European tools. Other uses of caribou antlers are still maintained. Sections of the tines are used for the handles of certain tools, such as ulu, knife and scraper. The beams are used as dog stakes and tent stakes or to hang meat on. The beam and palmate terminal tines are fastened upon sleighs in Keewatin District and used as brakes. When a foot is pushed upon the inverted beam, the tines dig into the snow. Occasionally in cabins, antler beams are used to construct chairs and to support the ridge-pole. Caribou ribs are sometimes used for drill bows.

Human Population in the Caribou Range

In order to obtain an estimate of the annual human kill of caribou, it is necessary to know the human population in the range of the barren-ground caribou. This is not easily obtained because there are different classes of residents -- Eskimos, Treaty Indians, half-breeds and whites. The settlements are small and scattered and the native population is largely nomadic. The basic data for the Treaty Indian population were derived from the Census of Indians in Canada, 1944, Department of Mines and Resources. The numbers of males more than 16 years of age in each band were also recorded. The total population figures were revised to July, 1950, by the Membership Division of the Indian Affairs Branch. Since the recent number of males more than 16 years of age was not available, it was necessary to adjust the 1944 figures in order to have an estimate of the total number of hunters in each band for calculation of total kill. It was assumed that all non-



CANADA
DEPARTMENT OF MINES AND RESOURCES
LANDS AND DEVELOPMENT SERVICES BRANCH
DOMINION WILDLIFE SERVICE
1948

INVESTIGATION OF
BARREN GROUND CARIBOU

SCALE IN MILES

FIG. 51

PRESENT TUNDRA DISTRIBUTION OF NATIVES

treaty Indians would be accounted for by the issue of trapping permits.

The basic data for the estimation of the Eskimo population were derived from the 1941 census of Canada. No age analysis by post was available, but a total analysis was given. It was noted that males more than 15 years of age composed 29 per cent of the grand total. From this ratio the number of hunters at each post was estimated. Such complete data are not available for any later date. From the Vital Statistics division of the Northwest Territories Administration I obtained a statement, revised to January, 1950, of the total number of Eskimos in the total study area. It was not possible, however, to analyse this to post populations. The 1941 Eskimo kill was therefore simply revised upwards to the higher 1950 population level.

Many difficulties were encountered in associating the native bands with their trading posts and determining whether their hunting areas were within the range of the caribou. The resultant census shown in table 21 is an estimation of population and human kill based on the best information at hand.

The present limits to which the Indians and Eskimos penetrate the tundra are indicated in figure 51. When compared with figure 36, the change in limits in recent years will be noted. Because of tribal shifts it is impossible to delineate the Indian tribal areas on the latter figure as on the previous one.

In the times of Hearne (1795), Franklin (1825), Back (1836), Simpson (1843) and Pike (1892), the Chipewyan Indians spent a good deal of the summer upon the tundra with the caribou herds.

Table 21. Total Average Annual Kill

Indian Posts	Pop.	M.>16	c/h	Total
York Factory, Man.	491	126	15.0	1890
Split Lake, Man.	521	170	20.0	3400
Duck Lake, Man.	199	62	50.0	3100
Nelson House, Man.	732	245	20.0	4900
Cross Lake, Man.	842	225	9.0	2020
Gods Lake, Man.	496	130	10.0	1300
Oxford House, Man.	474	135	10.2	1330
Brochet, Man.	346	94	75.0	7050
Pukatawagan, Man.	408	125	11.0	1375
Pelican Narrows, Sask.	707	187	2.0	374
Stanley, Sask.	509	177	5.0	885
Fond-du-lac, Sask.	540	140	30.0	4200
Fort MacKay, Alta.	94	57	4.0	228
Fort Chipewyan, Alta.	590	174	6.7	1170
Fort Smith, N.W.T.	181	66	8.5	562
Fort Resolution, N.W.T.	400	113	22.0	2486
Yellowknife, N.W.T.	164	42	30.0	1260
Fort Rae, N.W.T.	731	235	43.5	10250
Fort Simpson, N.W.T.	336	112	1.4	157
Fort Norman, N.W.T.	316	90	8.6	775
Arctic Red River	150	38	5.7	217
Fort Good Hope	207	65	3.5	227
TOTAL INDIANS	9,434			49,156

Eskimo Posts	Pop.	M.>15	c/h	Total
Aklavik, N.W.T.	377	109	0.5	50
Tuktoyaktuk, N.W.T.	121	35	1.0	35
Baillie Island	115	33	2.1	70
Pearce Pt.	19	5.5	2.7	15
Coppermine	186	54.0	21.0	1135
Bathurst Inlet	43	12.5	41.8	5000
Cambridge Bay	157	45.5	5.9	268
Perry River	131	38.0	16.6	630
King William Island	139	40.3	5.9	237
Boothia	182	53	8.5	430
Pelly Bay	82	23.7	8.5	202
Repulse Bay	64	18.6	8.5	154
Wager Bay	49	14.2	12.6	179
Baker Lake	267	77.0	54.3	4200
Chesterfield	201	58.0	11.3	655
Tavanni	100	29.0	50.0	1450
Padlei	112	32.5	50.0	1625
Eskimo Point	288	83.8	44.1	3680
Kazan Band	48	20.0	150.0	3000
TOTAL ESKIMOS, 1941	2681	-- Total Kill		22,630
TOTAL ESKIMOS, 1950	3135	Adjusted Kill		26,700

Table 21. Continued.		Pop.	c/h	Total
N.W.T.	trappers	395	---	2,210
"	hunters	66	5	330
Man.	trappers	1374	5.	6,880
Sask.	"	1289	5.	6,450
Alta.	"	90	4.	360
Sask.	hunters			550
Man.	"			130
Total kill by "others"				16,910
Grand Total kill				92,766

They also travelled to the Coppermine mountains to obtain native copper. In the autumn there were frequently muskox hunts on the tundra. During the present century this pattern of life has been geatly altered. The introduction of manufactured tools and weapons removed the necessity of visiting the lower Coppermine River. The closed season on muskox in 1918 put an end to the autumn hunt. Without the knowledge of building snowhouses or making fire on the tundra, the Indians never did visit the tundra in winter. When the fur industry encouraged winter trapping, the Athabaskan people took to traplines in the taiga at no great distance from the main Athabaska-Mackenzie River System or the Churchill River system and near the trading posts on these routes.

Briefly, the cycle of Indian activity now is to operate traplines, usually near the trading post, during the winter months and in summer to come into the settlements to fish on the large lakes and rivers or seek odd labouring jobs about the posts.

The advent of civilization had an opposite effect upon the Eskimos. They who were typically a maritime race were encouraged to travel inland to trap Arctic foxes. This inland movement of

Eskimos from the Arctic and Hudson Bay coasts is continuing. Today such regions as the upper Kazan River, upper Back River, Contwoyto Lake, Coppermine River and Dismal Lakes, which were considered Chipewyan territory in the time of Samuel Hearne, are inhabited by Eskimos, the majority of whom have never seen an Indian in their area. So the central tundra region of northern Canada is even more decidedly the home of Eskimos today.

It is difficult to obtain factual data on the populations of Eskimos and Indians in the past. It is only within the past few years that we have obtained our first counts of remote Eskimo bands. In general it seems that the native populations are increasing. With improved medical facilities, one can expect this trend to continue. This is the important factor in connection with the management of the caribou.

It seems likely that the utilization of caribou by Eskimos has increased from primitive times because the move inland to trap has made caribou available over a long period of the year and because of the increase in size of dog teams and the introduction of firearms.

It is more difficult to analyse the trend in Indian utilization. It has probably shown a gradual slight decline, because of the movement of the Indians towards the settlements on the Athabaska-Mackenzie drainage system and the Nelson and Churchill rivers and because the shift in Indian dependence to manufactured tools and clothes is more pronounced than the corresponding shift in the case of the Eskimos. Continuous trapping has made an auxiliary meat supply available from the carcasses of trapped animals.

On the other hand firearms and increased dog teams have tended to maintain the level of caribou destruction. It can be assumed that these trends will continue in the future, since the causative factors will probably continue in effect.

The total number of trappers - Europeans and half-breeds -- living within the caribou range has been ascertained with the aid of the Provincial game authorities. The Alberta Department of Lands and Forests reports 90 trappers in the area under consideration. The Saskatchewan Department of Natural Resources reports 1,289 trappers. The Manitoba Department of Mines and Natural Resources reports approximately 1,374 trappers within the range. In the Northwest Territories there are 395 trappers in the range.

It is probable that approximately 20,000 people, including Eskimos, Indians, European and half-breed trappers, their families, European traders, missionaries, and government officials, are dependent to a greater or less extent upon the barren-ground caribou for meat and winter clothing. The population of trappers is also indicated in table 21.

In the Northwest Territories, trappers have been required to report the number of caribou killed during the previous licence year. The total number of caribou reported since the 1932-33 season is shown in table 22. Similarly in Manitoba hunters have been asked since 1941-42 to report on their hunting licences the number of caribou secured. The number reported has been very small compared to the number of licences issued. The records are also given in table 22. For 1947-48 and 1948-49, the number of licences sold is indicated in brackets following the number of caribou reported killed. The approximate number of caribou licences issued to hunters in Saskatchewan for the 1947-48 and 1948-49 seasons is also shown in brackets in table 22. Since 2 and subsequently 3 animals were allowed on the licences, these figures are also indicated.

The great discrepancy in these records between the number of caribou reported, the number of licences sold and the number of trappers and hunters is emphasized. This lack of factual kill statistics is regrettable. It necessitates an arbitrary estimate of the caribou kill in the provinces as indicated in figure 21. Many of the registered trappers in Manitoba and Saskatchewan are half-breeds living the life of Indians. It has been observed that their economy leans heavily upon the caribou and their annual kill is probably similar to that of their Indian neighbours.

<u>Analysis of Native Game Returns</u> <u>(See pages 257-260</u>

Since 1932, the Northwest Territories Administration of the Department of Resources and Development has circulated "Game Return" forms for the purpose of recording the number of fur-bearers and game birds and mammals taken in each licence year by natives authorized to hunt and trap in the Northwest Territories under the Game Act and Regulations.

These forms are completed by the Royal Canadian Mounted Police after individual interviews with the natives, made during field patrols or at treaty payment meetings or when the natives visit the posts. An attempt to interview the majority of local hunters, or the chief hunters, annually is made.

Table 22. Number of Caribou Reported Killed by European and Half-Breed Hunters and Trappers.

Year	N. W. T.	Manitoba	Saskatchewan	Alberta
1932-3	2472	---	---	---
1933-4	2629	---	---	---
1934-5	2648	---	---	---
1935-6	2723	---	---	---
1936-7	2332	---	---	---
1937-8	1939	---	---	---
1938-9	2665	---	---	---
1939-0	1969	---	---	---
1940-1	2030	---	---	---
1941-2	1730	15	---	---
1942-3	1557	7	---	---
1943-4	1138	18	---	---
1944-5	2506	11	---	---
1945-6	2539	20	---	---
1946-7	2422	38 (240)		---
1947-8	1269	65 (133)	366? (122)	---
1948-9	* 1325		980? (490)	---
1949-50			550	

* Incomplete return

The numbers in brackets indicate the number of caribou licences sold.

These reports are subject to two main sources of error. Firstly, natives are not in the habit of counting the number of animals that they kill. It must be remembered that many of the older natives cannot count beyond 20. Then, when questioned, many natives do not remember how many caribou they killed during the year. Secondly, some natives do not report the total number of animals that they killed because they fear retaliation because of their excessive killing. The errors introduced by these factors are undoubtedly large. It is impossible to calculate the error at this time. From comparing actual Eskimo hunting take with their reports, it is estimated that the Native Game Returns may be approximately 20 per cent below the actual kill.

These returns are nevertheless of great importance and the analysis of these data produced information which encourages appreciation of their worth and reliability. The system has been in effect long enough to encourage confidence on the part of the natives and to encourage veracity, since they are not punished for killing excessive numbers. The analysis shows reasonable constancy in the number of caribou reported by hunters. The variation in the number of caribou killed per hunter has been found to correspond with known fluctuations in the local availability of caribou, due to changes in migration routes and ranges. An independent survey carried out by Manitoba Game Guardian A. Sinclair at Oxford House, Manitoba, during 1946 and 1947 confirmed the data for similar posts in the Mackenzie River valley. Finally, in order to manage this natural resource properly, it will be necessary to maintain kill records, which will of necessity form a system similar to the present one.

From all the factual information on hand at this time, as shown in table 23, it has been estimated that the annual human kill of caribou amounts to approximately 93,000 animals. From personal observations it is known that the estimates are too low in certain cases. The total annual human kill is probably nearly 100,000 animals. This total comprises approximately 50,000 killed by Indians, 30,000 killed by Eskimos and 20,000 killed by European and half-breed trappers and hunters.

Besides these records, some observations on human utilization were made during the present investigation. At Contwoyto Lake, 8 hunters of a group of 26 Eskimos killed 161 caribou in a period of eight days during the August hunt for clothing. This total amounts to 2.5 caribou per day per hunter. From the known movements of caribou, it is estimated that these hunters would have about 50 hunting days per year and would therefore kill approximately 125 caribou per year. This number of caribou is a reasonable estimate of an average hunter's annual kill for the isolated inland bands of Eskimos and Indians. This figure is substantiated by many traders and missionaries. Undoubtedly there are a few hunters who kill more than this number (up to 500 caribou), but their efforts are balanced by those of the majority of hunters, who kill less. After an acquaintance of several weeks, one Eskimo at Bathurst Inlet reported that he had killed 67 caribou last year, but could have used 100. Lawrie reported that an Thalmuit Eskimo hunter of the Kazan needed approximately 100 caribou per year to satisfy all family needs.

Four European trappers in the Northwest Territories reported killing, on an average, 65, 50, 50-60 and 45 animals per year. The records of another barren-ground trapper indicated that he killed 278 caribou between September 11 and November 3, 1947. At present, due to the poor fur prices and the restrictive measures of the Northwest Territories game regulations, the number of trappers, other than natives, on the tundra is decreasing rapidly.

Summary

The barren-ground caribou is an important renewable natural resource of the Northwest Territories and the northern sections of the three prairie provinces of Canada. On an area of approximately 600,000 square miles it is one of the basic factors in the economy of approximately 20,000 Canadians. In large areas of the Northwest Territories human habitation would be impossible without the presence of the caribou.

The caribou is a source of nutritious meat in areas remote from sources of domestic meat. The hides provide superior Arctic clothing which is difficult to surpass, even with the most modern fabrics. The hides are also used for bedding, tents, kyaks, bags and covers of various sorts. Besides these important products, caribou provide fuel oil, thread, lashings, tool handles and stakes. The present capital value of this resource is at least 50 million dollars.

It has been estimated that during the later part of the exploratory period in northern Canada, about 1900, the caribou population totalled about two and one half million animals. On the basis of aerial surveys during the present investigation it is estimated that the present population consists of about 670,000 caribou, indicating an apparent 75 per cent reduction. The areas

showing the greatest reduction in caribou numbers are: (1) the area north of Great Bear Lake, from Bernard Harbour to the Mackenzie Delta; (2) northern Keewatin District, including Adelaide, Boothia and Melville peninsulas, and the continental area east of the mouth of the Back River and north of Chesterfield Inlet; (3) King William Island; (4) the tundra adjacent to Hudson Bay from York Factory to the Severn River. In the central portion of the range there may have been a gradual reduction in numbers.

The drastic reduction in area (1) is thought to have been caused largely by the actions of whaling ships along the Arctic coast from 1890 to 1910. The reduction in areas (2) and (3) is thought to have been caused by the increased activities of natives supplied with introduced firearms and ammunition as a result of the introduction of the fur industry. The reduction in area (4) is thought to have been caused by the increase of human population in northern Manitoba, coupled with the introduction of modern firearms. The gradual reduction in the central portion of the range has been due to the increased human population, the introduction of firearms and the development of the fur industry.

The introduction of the fur industry to the caribou range has caused the native population to remain scattered over a vast area of northern Canada during the winter months, and it has encouraged winter travel, which has led to the development of large dog teams. These changes have been particularly noteworthy among the Eskimo population. Once a basically coastal people dependent upon a marine economy, these people have been encouraged to remain inland and trap during the winter months. These changes have led to increased caribou utilization.

In recent years, with the introduction of new industries along the Mackenzie River valley, the close season on muskox and the decline in furbearers and fur prices, the Indian populations have generally withdrawn from the tundra and timberline areas in summer and have taken up trapping areas nearer the trading posts. This fact has alleviated the drain on caribou to some extent, as has the gradual reduction in the number of barren-ground trappers. The introduction of European clothing and the local availability of imported food supplies have also reduced the utilization of caribou.

In future we must take into account the steadily growing population of native groups and the development of some areas for mineral, forest and other resources. The caribou range will be increasingly restricted by mineral developments, logging, forest and tundra fires and human settlement. With this change there will be increased demand by a growing population of non-native residents of the caribou range and a heavy native utilization of caribou at a level which provides the minimum basis of their economy.

The present annual human utilization of caribou has been estimated to be about 100,000 animals. This has been further segregated as to utilization by the following groups: Indians, 50,000; Eskimos, 30,000; other trappers and hunters, 20,000. Aside from man, the wolf is the most important predator of the caribou. Scanty data indicate that wolf predation accounted for 2.5 per cent of the population in one year in one instance. It was thought that maximum wolf predation might account for 34,000 animals annually. Disease was thought to be of lesser importance as a mortality factor. Accidents and weather losses were believed to have an appreciable effect. Losses due to disease and accidents might account for 10,000 animals annually. The annual increment has been estimated to be approximately 141,000 calves. The mortality figures indicate an approximate annual loss of 144,000 animals, or a deficit of about 3,000 animals per year.

Severe weather conditions during the rutting season or the calving season may cause a serious drop in a particular annual calf crop. Since accurate kill records are not available, it is considered that the human utilization figures are minimal. These two considerations indicate that the annual deficit might well be higher than that stated.

The present population of caribou is large enough to supply all the basic needs of the dependent human population on a continuing basis if only sifficient caribou for basic needs without wastage are killed. At present the human wastage of this resource is high enough to account for the excessive utilization of caribou beyond the annual crop. The wastage may be comparable in numbers to the loss by predators. This wastage is due in major part to the improvident and wasteful hunting techniques of the native population. Chief sources of wastage are: (1) loss by putrefaction of meat from animals taken in the late summer for the hides; (2) loss of meat by scavengers as a result of poor caches; (3) wounding of animals and failure to trail them; (4) excessive slaughter of caribou in a herd, beyond the actual need; (5) caches of meat along a route subsequently not revisited; (6) use of caribou meat for dog food when other foods, such as fish, are available; (7) failure to utilize the complete carcass.

Certain factors in the northern economy have also encouraged the natives to kill caribou in excess of their own needs. The reduction in the number of, or the extermination of, the native caribou in certain Arctic regions has placed a premium on the hides of caribou from regions where they are still plentiful. The natives of these regions kill many caribou in late summer and autumn beyond their needs, solely to obtain their hides for sale to trading posts for transportation to other posts. Hides, complete suits of clothing, sinews and thongs obtained in this way are traded. The meat from these carcasses generally spoils or is used for dog food.

In the Northwest Territories the sale of caribou meat by persons holding general trapping permits is allowed. A certain number of natives around a few northern posts kill caribou for this purpose. Individual traders and residents buy this meat. The largest number are sold to the Roman Catholic Mission establishments. There is considerable wastage, as the majority of these buyers take only hind quarters. Because of limited transportation facilities, much of the remainder of the carcasses and all the hides are wasted.

The barren-ground caribou supplies meat, hides and by-products to a vast area of northern Canada with a minimum of effort expended by man. In this way it has great advantages over the reindeer industry. It requires no stations, corrals or herders, no training of natives in herding technique, a minimum expenditure of time, and a minimum of protection, investigation and management.

It has recently been shown by Lantis (1950) that the open herding of reindeer on a commercial basis, or community basis, in Alaska has failed. The success of the new individual, small, "close-herded" herd system, now started, is still questionable. The Department of Resources and Development has already had abundant experience with the inherent problems of the reindeer industry in Canada. No further reindeer introductions into caribou range which would endanger the survival of the native caribou herds should be considered.

In the present report the present caribou ranges and migration routes and the migration dates of the major herds have been recorded and compared with the former distribution. A physical description of the species, including measurements, antler development, pelage, tooth succession and age classification, was also given. The physical environment, as well as the role of the caribou as a member of the Arctic and subarctic communities, was described. The behaviour patterns, society, ecological relations, vital statistics and reproduction were also discussed. An analysis of the vegetative communities in the caribou range prefaced a description of the food requirements.

From examination of mere than 75 carcasses data on the parasitic and bacteriological diseases of the caribou were obtained. It was found that the caribou is a member of a cycle, including man, which carries hydatid disease.

So far, the activities of the native population and the advance of civilization in the range of the barren-ground caribou have had little effect upon its habitat. There seems little likelihood that agriculture will ever menace the range or movements of the caribou. Lumbering activities in this region have been insignificant. Future demands may result in an increase in this industry along transportation routes. It is unlikely, however, that the timber resources of large regions of the subarctic forests of white spruce will ever merit exploitation. During the recent period of mineral exploration, there has been some caribou range destruction by forest fires. During the subsequent period of mineral production it is unlikely that the habitat will be affected as much. Fire remains the most important agency by which man affects the caribou habitat. Large areas of winter range have already been destroyed by fire. Because of the slow subarctic growth, these conditions may be of a semipermanent nature.

Man exerts his heaviest influence upon the barren-ground caribou as a direct predator. Management of this resource must therefore be directed primarily towards controlling the number of caribou killed annually, so that the utilization will be less than the annual surplus over environmental mortality. With wise management this resource will continue to supply food and clothing to residents of Arctic and subarctic Canada.

Recommendations

Future requirements for management of caribou may be briefly stated as follows: 1 - Instruction and persuasion of native populations in the conservation and wise use of their natural resources. 2 - Immediate supervision of hunting and utilization of caribou and enforcement of regulations. 3 - Collection of accurate kill statistics. 4 - Adoption of regulations allowing the taking of caribou for reasonable basic needs. With these fundamental considerations in mind, the following recommendations are offered.

1. Special personnel should be employed by the appropriate agencies to instruct natives, in their camps, in the conservation and proper utilization of their natural resources, including the caribou and to persuade them to adopt conservation practices.

2. In the Northwest Territories, there should be a definite allotment of responsibility in regard to the issue of licences, kill returns, supervision and enforcement of game regulations to cover the entire region.

3. Young natives of superior ability should receive special training in conservation of natural resources and be employed as assistant game officers to make contact with the native groups and assist departmental wildlife technicians in their investigations.

4. The Provincial Game Authority of each province concerned should require that every hunter under its jurisdiction should report the number of caribou taken on his licence.

5. The Indian Affairs Branch should insist that their field officers obtain a record, as complete as possible, of the caribou utilization by Indians. The present "Record of Production" cards should be changed to correct the present confusion between caribou and other deer.

6. All agencies should undertake increased fire prevention measures in the winter range of the caribou.

7. The number of skins required in those areas where caribou are scarce should be investigated annually by Government employees and reported to the Department. An export permit should then be issued to the traders, to allow export of the desired number of skins from areas of local abundance.

8. No caribou garments or furred hides should be exported from the range of barren-ground caribou.

9. No further introductions of reindeer herds into areas where these herds might come in contact with native caribou herds should be contemplated.

10. Every opportunity should be taken to use auxiliary supplies of reindeer and buffalo meat to supply minimum meat requirements of local hospitals and missions.

11. The sale of caribou meat in the settlements of Yellowknife, Fort Smith, Hay River, Fort Resolution and Norman Wells should be prohibited.

12. The open season for all classes of barren-ground caribou in the Northwest Territories should be from the 15th day of August to the last day of February. For males alone there should be a further open season for natives alone, without special licence, from the first day of March to the 15th day of May.

13. The number of caribou which a Government employee is permitted to kill annually under licence in the Northwest Territories should be reduced to one.

14. The warden staff of the Northwest Territories Administration should undertake, under the direction of the Mammalogists, the local control of wolves on an experimental basis on the caribou winter range. The methods used should be similar to those developed in Wood Buffalo Park. The experiments should include the use of aircraft to distribute the strychnine baits. Economy should be the essence of the experiments.

ANALYSIS OF NATIVE GAME RETURNS

TABLE 23

YEAR	1932-3			1933-4			1934-5			1935-6		
POST	C	H	C/H	C	H	C/H	C	H	C/H	C	H	C/H
Oxford House												
Ft. Chipewyan	20	3	6.7									
Ft. Fitzgerald												
Wood Buffalo Pk.												
Ft. Smith	172	33	5.2				581	55	12.9	92	18	5.1
Ft. Resolution	1432	93	15.4	793	86	9.3	1341	66		432	29	14.9
Snowdrift										791	22	36.0
Ft. Rae	5018	105	47.8	3745	72	52.0	3411	138	24.8	2074	73	28.4
Ft. Reliance												
Ft. Providence	84	68	1.2	179	113	1.6	133	66	2.0	254	90	2.8
Ft. Simpson	111	59	1.9	43	56	0.7	72	41	1.7	23	30	0.8
Ft. Wrigley	15	7	2.2									
Ft. Norman												
Ft. Franklin												
Ft. Good Hope	69	101	0.7	226	97	2.3	64	99	0.6	66	94	0.7
Arctic Red River	543	32	17.0	418	41	10.2	133	41	3.0	63	37	1.7
Pearce Pt.	24	12	2.0	27	20	1.3						
Baillie Is.	46	11	4.3							85	35	2.4
Coppermine	112	9	12.5	46	38	1.2	347	13	27.3	84	9	9.2
Bathurst Inlet												
Cambridge Bay	21	39	0.5				69	37	1.9	75	12	6.3
Perry River												
Repulse Bay	504	39	12.9	563	90	6.2						
Baker Lake												
Wager Bay	177	14	12.6									
Chesterfield	852	63	13.5	1238	71	17.5						
Tavanni												
Eskimo Point	416	18	23.2	1524	19	80.3						
Padlei												

Table 24.

1936-7			1937-8			1938-9			139-40			1940-1		
C	H	C/H	C	H	C/H	C	H	C/H	C	H	C/H	C	H	C/H
												183	10	18.3
			60	18	3.3	313	24	13.0	295	31	9.5	249	19	13.1
			238	65	3.7	331	34	9.7	304	19	16.0	606	69	8.8
513	27	19.0	346	27	12.8	1019	31	32.9	20	2	10.0	498	21	23.8
3280	104	31.5	8218	136	60.5	8669	164	52.9	8168	168	48.6	6444	163	37.5
									762	18	42.3			
155	77	2.0	212	113	1.9	91	78	1.2	92	59	1.6	89	97	0.9
			15	21	0.7				57	58	1.0			
									40	24	1.9			
			172	53	3.4	549	86	5.2	392	49	8.0	41	26	1.6
133	83	1.5	447	55	8.1	76	87	0.9				107	66	1.7
119	34	3.5	97	27	3.6	481	42	11.5	90	16	5.6	594	60	9.9
			12	14	1.0	4	7	0.8						
591	78	7.7	1401	61	23.0	2182	90	24.2	3279	76	43.2	1069	72	14.9
			305	50	6.1				1954	38	49.5	259	68	38.1
670	42	15.9												
												100	6	16.6
												75	26	3.0
2077	48	43.3	1410	54	26.0	762	24	31.8	1460	46	31.9	1208	40	30.2

Table 24 - Cont'd.

1941-2			1942-3			1943-4			1944-5			1945-6		
C	H	C/H	C	H	C/H	C	H	C/H	C	H	C/H	C	H	C/H
									1110	96	11.6	850	97	8.8
235	15	17.1												
			76	212	0.4	48	220	0.2	35	194	0.2	27	141	0.2
76	15	5.0	212	23	9.2				246	26	9.5			
416	58	7.2	116	21	5.5				246	32	7.7	123	16	7.7
393	18	21.8				135	10	13.5				728	24	303
6406	178	36.0	5958	174	34.2	5251	155	33.9	6455	125	56.7	9168	161	57.0
42	3	14.0	796	25	31.8				356	12	29.7			
37	82	0.4	75	81	0.9	76	70	1.1	97	87	1.1	34	37	0.9
		1.5	80	74	1.1	35	77	0.5	215	121	1.8	127	53	2.4
												8	3	2.7
									322	32	10.1	482	29	16.6
												254	8	31.8
171	37	4.6	253	67	3.8	150	97	1.5	309	56	5.5	155	35	4.4
0	15	0.0	296	83	3.6	10	35	0.4	27	36	0.8	33	25	1.3
1924	92	20.9	6885	155	44.5	2667	87	33.2	1691	66	25.7	241	36	6.7
129	40	3.2	519	74	6.9	1069	6.2	17.2				709	84	8.2
3021	59	51.2	2565	65	39.6	4735	73	64.9	5783	80	72.3	4760	83	57.3
									800	20	40.0	120	2	60.0
2349	44	53.5	1534	32	48.0	2554	42	60.8	1988	41	48.5	2170	42	51.7
										50	20.0	1500	50	30.0

Table 24 - Cont'd.

YEAR	1946-7			1947-8			AVERAGE
POST	C	H	C/H	C	H	C/H	C/H
Oxford House							10.2
Ft. Chipewyan							6.7
Ft. Fitzgerald							17.7
Wood Buffalo Pk.	610	160	3.8	108	209	9.5	0.9
Ft. Smith							8.5
Ft. Resolution							11.4
Snowdrift				515	16	32.2	23.2
Ft. Rae	9238	142	65.0	4552	176	28.5	43.5
Ft. Reliance	398	13	30.6				29.7
Ft. Providence	28	22	1.3	32	30	1.0	1.4
Ft. Simpson	56	55	1.0	206	103	2.0	1.4
Ft. Wrigley							2.3
Ft. Norman	965	42	23.0	23	38	0.6	8.6
Ft. Franklin	177	9	19.7				25.7
Ft. Good Hope	470	68	6.9	209	72	2.9	3.5
Arctic Red River	112	29	3.9				5.7
Pearce Pt.							2.7
Baillie Is.							2.1
Coppermine	563	57	9.9	1448	47	30.9	21.0
Bathurst Inlet							43.5
Cambridge Bay	204	42	4.9	324	80	4.0	5.9
Perry River							16.6
Repulse Bay							8.5
Baker Lake	4268	103	41.5	5152	97	53.2	54.3
Wager Bay							12.6
Chesterfield							11.3
Tavanni							50.0
Eskimo Pt.							44.1
Padlei							25.0

APPENDIX I

Manitoba Herd Population Estimate

Table 25.

Flight No.	Length of transect	Width of transect	Area	Caribou	Caribou /Sq. Mile
13	144	3	432	530	1.2
19	90	2	180	50	0.3
Average			612	580	0.95

Head of Migration	May 5, 1948	Churchill River
Tail " "	May 15, "	Ilford
Total Area of Route	4460. sq. miles	
Estimated Population	4240.	

Table 26. Migration Route - Cape Churchill Sheet 54 NW

Flight No.	Length of Transect	Width of Transect	Area	Caribou	Caribou /Sq. Mile
4	82	5	410	3790	9.25
8	26	5	130	370	2.75
9	15	5	75	50	0.67
13	38	5	190	160	0.84
Average			805	4370	5.45

Head of Migration	April 1, 1948	Churchill, Manitoba
Tail of Migration	May 11, 1948	" "
Area of route	225 Sq. miles	
Population estimate	1230	

Migration Route - Caribou River, Sheet 54 NW

Table 27.

Flight No.	Length of Transect	Width of Transect	Area	Caribou	Caribou / Sq. Mile
10	8	2	16	35	1.7
14	32	2	64	15	0.2
Average			80	50	0.63

Area of route 1280

Population estimate 800

Table 28. Migration Route - Hudson Bay Coast Sheet 54 NW

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou / Sq. Mi.
4	34	4	136	135	1.00
6	92	4	368	2600	7.1
7	60	4	240	500	2.1
9	80	4	320	50	0.2
10	48	4	192	300	1.6
12	80	4	320	425	1.3
13	102	4	408	980	2.4
14	86	4	364	350	1.0
15	18	5	90	195	2.2
17	80	5	400	565	1.4
18	98	4	392	650	1.7
19	56	4	224	830	3.7
20	90	4	360	350	1.0
Average			3814	8130	2.14

Head of Migration - April 1, 1948 Churchill River

Tail of Migration - June 2, 1948 " "

Area of route 4500 square miles

TABLE 29 Migration Route - Hudson Bay Coast, Sheet 55 SW

Flight No.	Length of Transect	Width of Transect	Area	Caribou	Caribou / Sq. Mi.
5	124	5	620	1700	3.7
7	168	5	840	405	0.5
8	70	5	350	530	1.5
15	100	5	500	8450	16.9
17	136	5	680	3695	5.4
Average			2990	14,780	4.94

Head of Migration Apr. 19, 1948 Eskimo Point

Tail of Migration June 2, 1948 Churchill River

Area of route 7050 Sq. miles

Population estimate 34,800

TABLE 30 Duck Lake Migration Route Sheets 62NE, 64 SE, NE, 65SE (etc.

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou / Sq. Mi
9	44	2.0	88	55	0.6
12	52	2.0	104	195	1.9
13	84	2.0	164	150	0.9
14	76	2.0	152	180	1.2
18	44	2.0	88	85	1.0
20	74	2.0	148	235	1.6
Average			744	900	1.22

Head of Migration - April 15, 1948 Split Lake

Tail of Migration - May 15, 1948 Split Lake

Area of route 12,500 sq. miles 190"

Estimated Population 15,200

TABLE 31 Brochet Migration Route, Sheets 64SW, NW, 65SE

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou / Sq. Mi.
9	80	2	160	275	1.7
10	94	4	376	440	1.2
12	130	4	520	1870	3.6
14	116	2	232	332	1.4
18	172	2	344	665	1.9
20	110	5	550	1228	2.2
Average			2182	4,810	2.20

Head of Migration April 22, 1948 Brochet

Tail of Migration May 12, 1948 "

Area of route 17,000 square miles 230 sq."

Estimated Population 37,500

TABLE 32 Population Estimate of Rae herd

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou /Sq. Mi.
35	88	4	352	100,000	283.
40	40	4	160	40,000	250.
42	48	4	192	467	4.4
Average			704	140,467	200.0

Head of Migration, April 28, 1949 Ghost Lake

Tail of Migration, April 29, 1949 Lac la Martre

Area of route 1050 square miles

Population Estimate 210,000

TABLE 33 Population Estimate of Hanbury Herd.

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou /Sq. Mi.
37	192	8	1536	31,750	20.7
38	152	8	1216	10,067	8.25
Average			2742	41,827	15.5

Head of Migration, April 26, 1949 Hanbury River

Tail of Migration, April 27, 1949 Sid Lake

Area of route 1150 sq. miles 179 sq. "

Population estimate 175,000

TABLE 34 Population Estimate of Aberdeen Lake Herd

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou / Sq.Mile
17	232	4	928	470	0.51
49	14	2	28	211	7.55
Average			956	681	0.71

Head of Migration: 12 May, 1948, Back River

Tail of Migration: 12 May, 1948, Baker Lake

Area of route: 8400 square miles 131 sq."

Population estimate: 6,000

TABLE 35 Population estimate of Yellowknife Herd

Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou / Sq. Mi.
36	12	3	36	20	0.55
39	20	3	60	85	1.4
46	52	4	224	219	1.0
Average			320	324	1.01

Head of migration: -

Tail of migration: - 27 April, 1949 Cape Gros Cap.

Area of route 3500 square miles

Estimate of population 3500

TABLE 36. Population estimate of Saskatchewan Herd

Flight No.	Transect Length	Transect Width	Area	caribou	Caribou / Sq. Mile
27	28	3	84	105	1.25
28	156	3	468	1224	2.62
29	8	3	24	16	0.67
30	56	3	160	41	0.25
31	120	3	368	164	0.46
32	16	3	48	12	0.25
33	136	3	308	163	0.53
Average			1460	1725	1.18

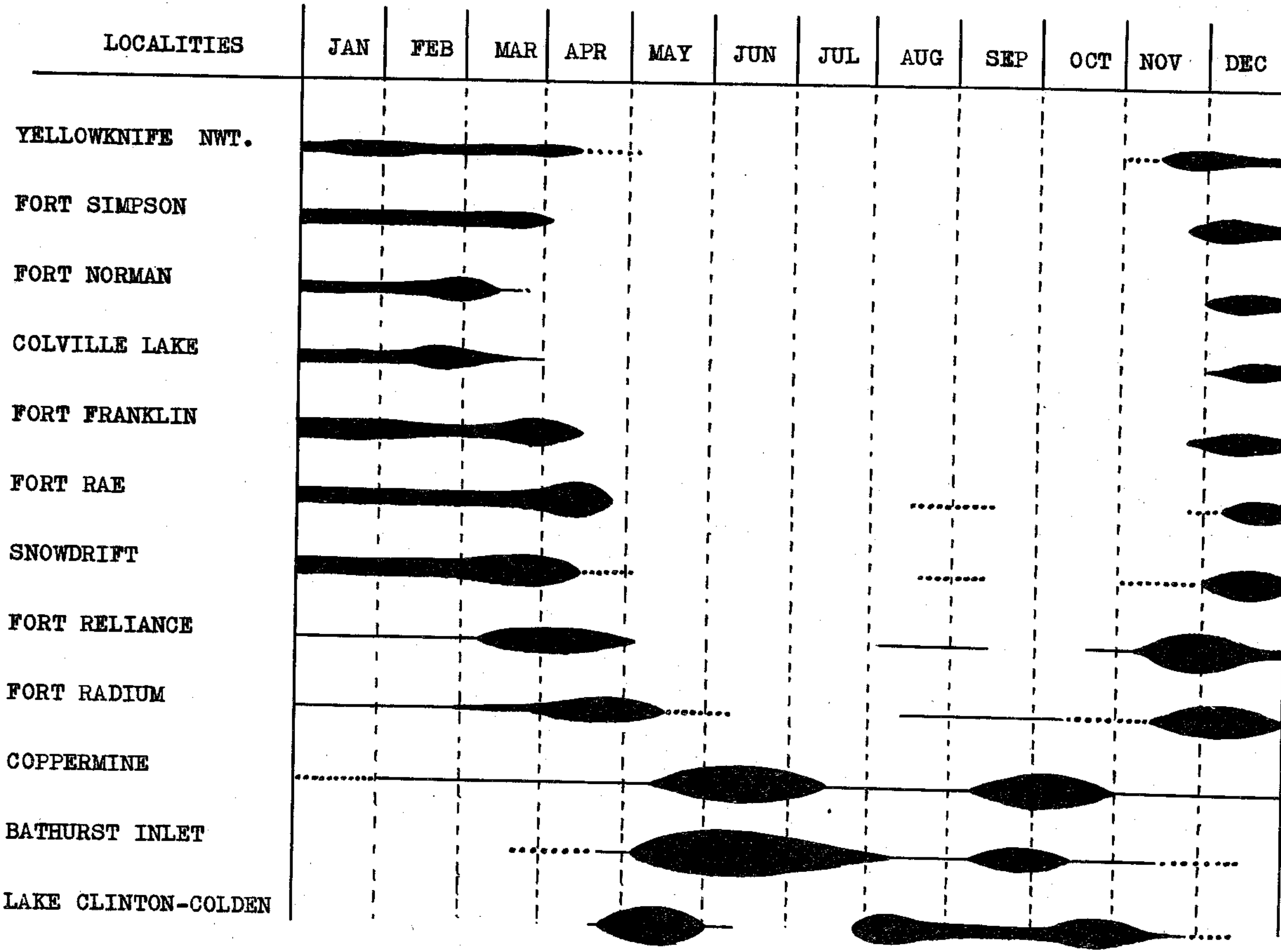
Area of route 17,024 sq. miles 266 sq."
Estimate of population 20,500

TABLE 37. Population estimate of Athabaska herd.

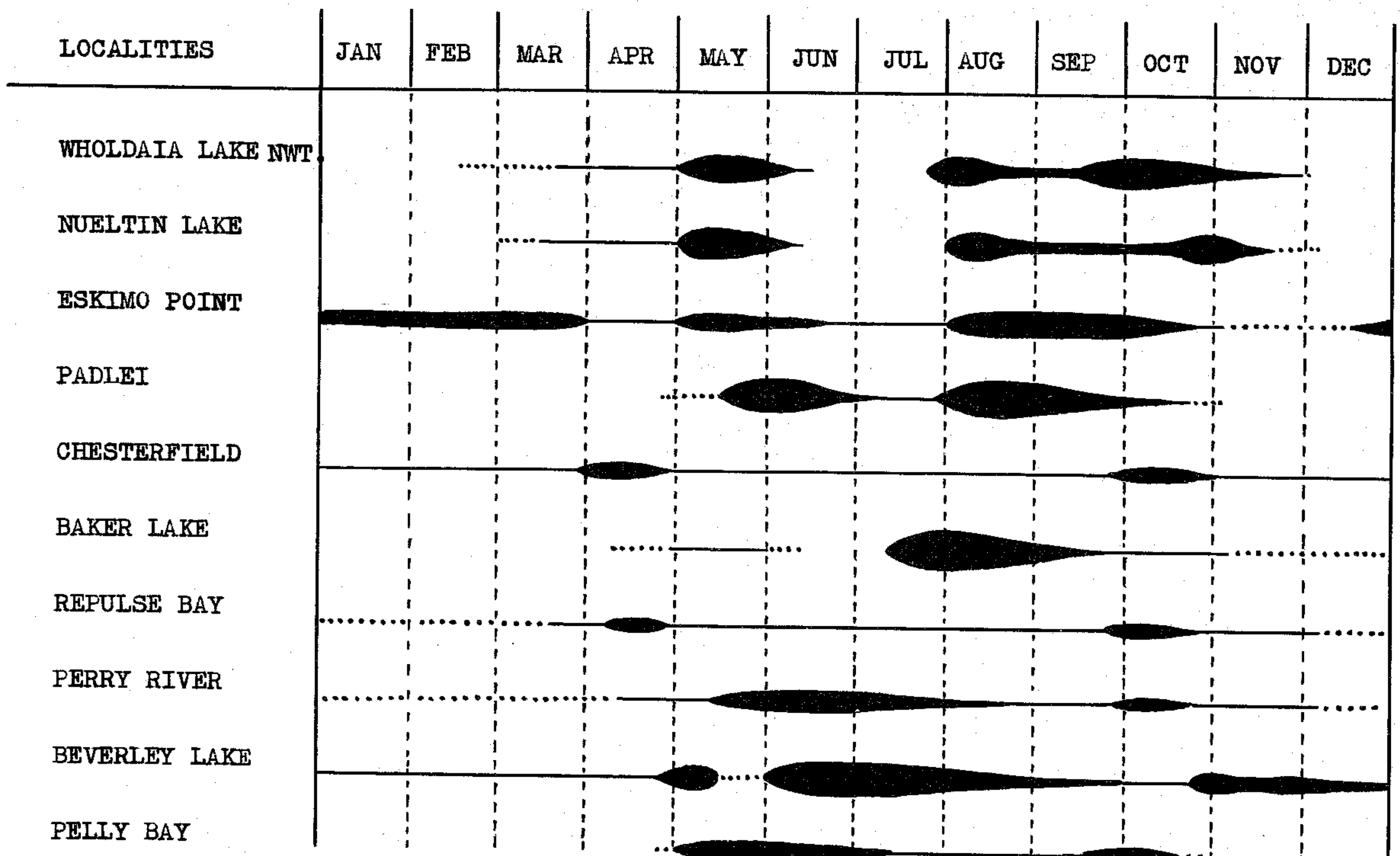
Flight No.	Transect Length	Transect Width	Area	Caribou	Caribou / Sq.Mile
52	8	3	24	17	0.71
53	96	3	288	500	1.74
54	192	3	576	120	0.29
12	208	3	624	1200	1.92
Average			1512	1837	1.22

Area of route: 10,000 sq. miles 156 sq. "

Estimated population: 12,200



APPENDIX 3. PERIODS OF OCCURENCE OF CARIBOU IN THE VICINITY OF NORTHERN SETTLEMENTS.



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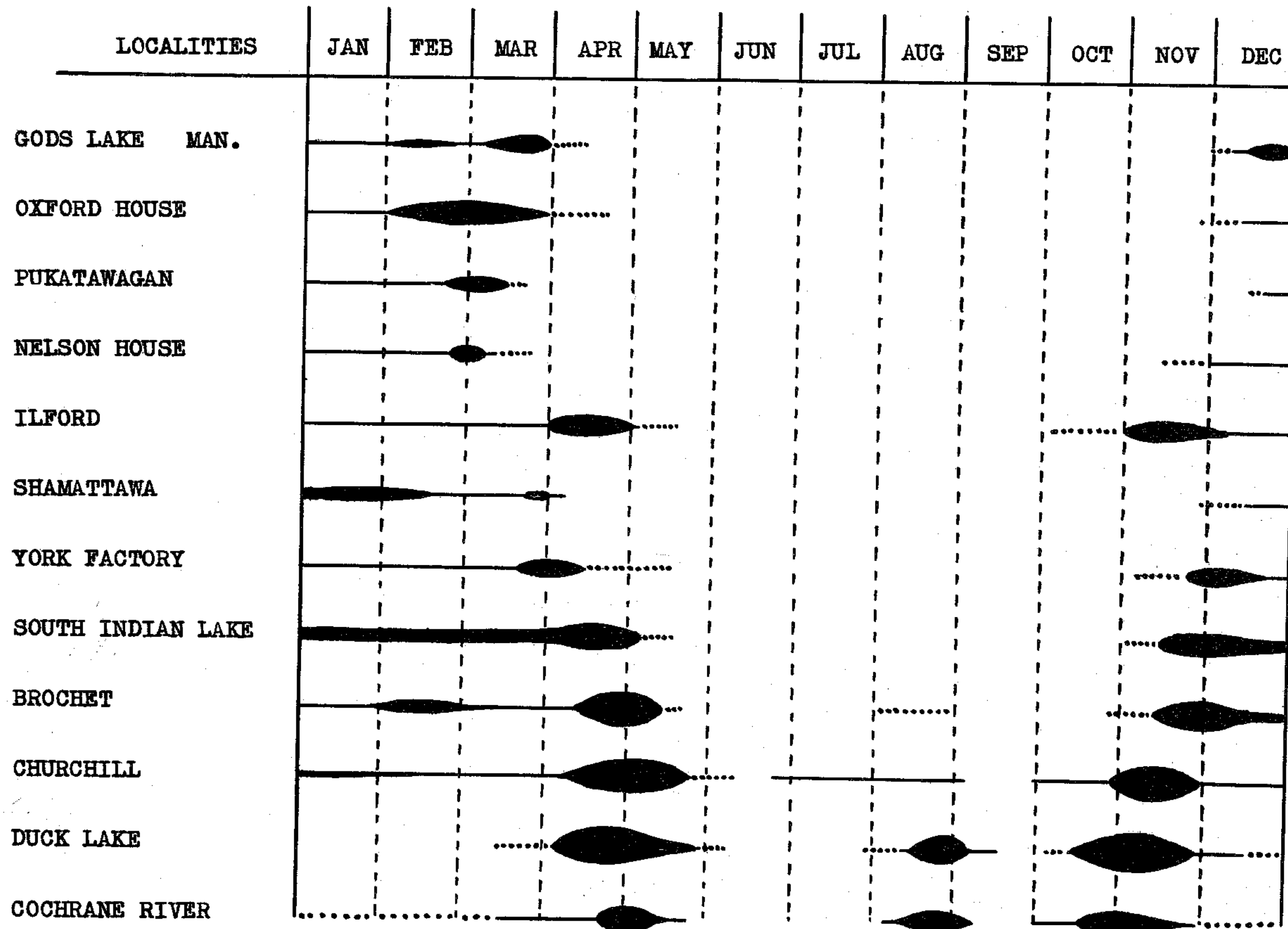

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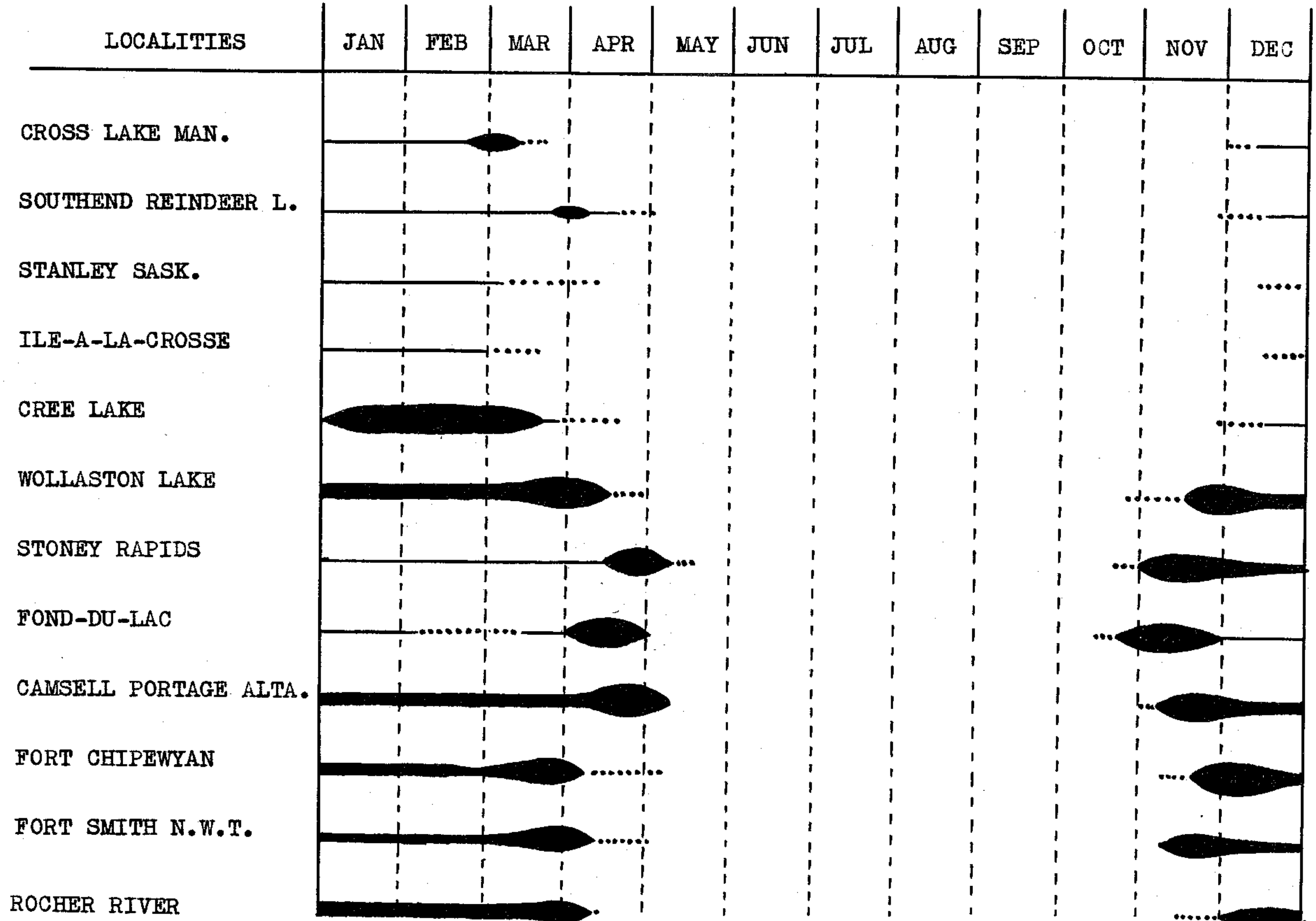

APPENDIX 3. PERIODS OF OCCURENCE OF CARIBOU IN THE VICINITY OF NORTHERN SETTLEMENTS.

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