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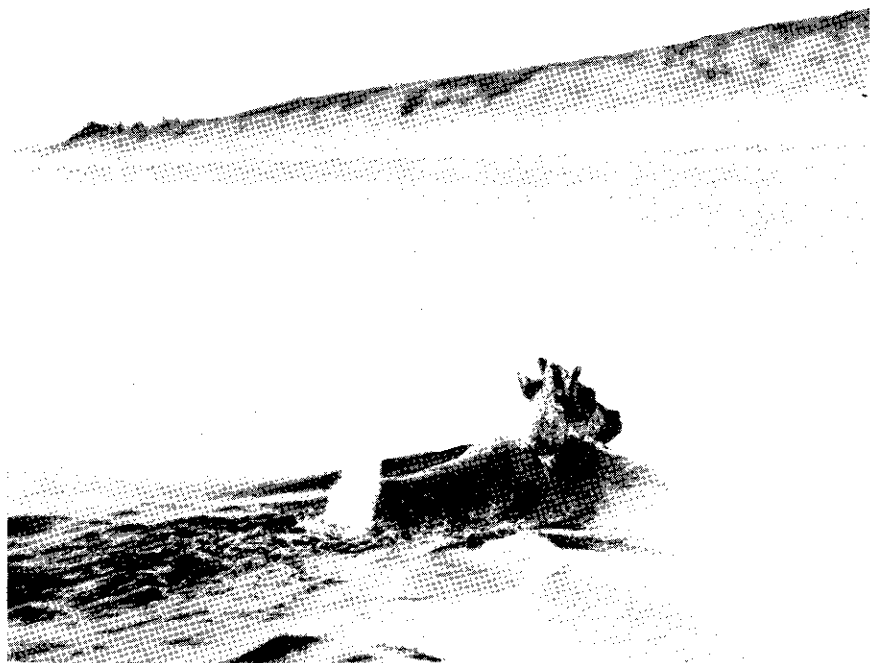
A BIOLOGICAL INVESTIGATION OF THE
THELON GAME SANCTUARY

BY

C. H. D. Clarke



PLATE I



82:81

Yearling cow barren ground caribou in Thelon River.

Price, 50 cents

CONTENTS

	PAGE
Introduction.....	1
Itinerary.....	2
Acknowledgments.....	2
General description.....	3
History of the region.....	3
Natives.....	4
Indians.....	5
Eskimos.....	7
Physical geography.....	11
The Thelon route.....	13
Vegetation.....	16
Climate and seasons.....	23
Fauna.....	26
Mammals.....	28
Birds.....	39
Lower vertebrates.....	62
Fur trade.....	62
Cycles and diseases.....	63
General discussion.....	63
Factors in cycles.....	68
Musk-ox.....	73
Musk-oxen of the Thelon.....	73
Distribution of musk-oxen in the sanctuary.....	75
Movements of herds.....	76
Musk-oxen on the mainland outside the sanctuary, with estimate of mainland herds.....	78
Original numbers and distribution on the mainland.....	79
Factors affecting the numbers of musk-oxen.....	81
Increase.....	81
Decrease.....	82
Value of the musk-ox.....	83
Barren ground caribou.....	84
Observations in 1936-7.....	85
Caribou of the Thelon sanctuary region.....	91
Caribou of the barrens of Mackenzie and Keewatin.....	91
Migration of caribou.....	93
Early ideas.....	93
Fallacies.....	95
Actual nature of migration.....	96
Missed migrations and irregular migrations.....	98
Influences affecting migrations.....	99
Philosophy of migration.....	100
Numbers of caribou and carrying capacity of range.....	101
Increase of caribou.....	103
Decrease of caribou.....	103
Factors affecting forage.....	106
Predators.....	107
Hunting.....	110
Summary.....	110
Importance to natives.....	112

CONTENTS—*Concluded*

	PAGE
Fishes.....	112
General discussion.....	112
Annotated list.....	113
Fisheries.....	117
General description.....	117
Waters.....	118
Aquatic life.....	119
Spawning and seasonal movements of fish.....	119
Local use.....	120
Growth of fishes.....	121
Summary.....	125
Conclusion.....	125
Bibliography.....	127

Illustrations

Plate I. Yearling cow caribou in Thelon River.....	Frontispiece
II. Thelon Eskimos in 1937.....	9
III. Eskimo dogs at east end of Thelon game sanctuary.....	10
IV. Dickson Canyon, Hanbury River.....	14
V. Foot of Dickson Canyon.....	15
VI. Helen Falls, Hanbury River.....	17
VII. Caribou Rapids, Hanbury River.....	19
VIII. Section of tree from "Wardens' Grove".....	21
IX. "Wardens' Grove" seen from the ground.....	22
X. Old stand in "Wardens' Grove".....	24
XI. Regeneration in "Wardens' Grove".....	26
XII. Aerial view of Grassy Island region, Thelon River.....	29
XIII. Aerial view continuing, except for a short gap, downriver from Plate XII.....	31
XIV. Aerial view of Finnie River flats.....	45
XV. Timber on Finnie River flats.....	49
XVI. Finnie River, near its confluence with the Thelon.....	51
XVII. Last timber at Crystal Island, Artillery Lake.....	61
XVIII. Musk-oxen on Grassy Island, Thelon River.....	75
XIX. Musk-ox on Thelon River.....	77
XX. Barren ground caribou from the air.....	85
XXI. Another herd, disturbed by aeroplane.....	87
XXII. Small herd of barren ground caribou at Caribou Rapids, Hanbury River.....	89
XXIII. Open Boreal forest at Reliance, showing caribou trails.....	97
XXIV. Narrows of Lac de Gras, showing caribou trails.....	101
XXV. Dead barren ground caribou below Ford Falls, Hanbury River.....	105
Figure 1. North-central Canada, including the range of the barren ground caribou.....	2
2. Map showing present known and reported distribution of musk-oxen on the Canadian mainland.....	84
3. Map showing midsummer (July) distribution of barren ground caribou about 1850.....	112
4. Map showing midwinter (January) distribution of barren ground caribou about 1850.....	112

A BIOLOGICAL INVESTIGATION OF THE THELON GAME SANCTUARY, WITH REMARKS ON THE NATURAL HISTORY OF THE INTERIOR BARREN LANDS

INTRODUCTION

The interior barren lands, formerly known only to a few explorers, have within the last few years been prospected for minerals. This, accompanied as it has been by aerial mapping and other governmental activities, has added immensely to our knowledge of these areas. Nevertheless, it must be remembered that during the long years when the whole region was a blank on the map it was subjected to considerable commercial exploitation and contributed in no small measure to the welfare of the country. Although white men seldom visited them, the treeless plains were well known to the natives, who reaped from them a living in game and fur, and, then as now, the caribou, chief meat product of the barrens, in its annual migrations delivered itself faithfully on the hoof to the fur-trading establishments.

The Thelon game sanctuary, though belonging in point of time to the modern period, was actually necessitated entirely by conditions arising out of the earlier exploitation. After the middle of the nineteenth century and the destruction of the buffalo, the barren ground musk-ox became increasingly valuable in commerce for its hide, which was in vogue as a carriage robe. It is easily killed, and, as we now know, its numbers were never very large and its distribution was always rather local. The uttermost fastnesses of the unexplored barrens were visited in the hunt for robes, and finally the musk-ox became almost extinct, and in 1917 it was given the fullest legal protection. In 1925 Mr. John Hornby and Capt. J. C. Critchell-Bullock (35)¹ made a trip down Thelon River, an old musk-ox stronghold, and discovered that there, at least, a few were still to be found. When the sad state of the musk-oxen was brought to the attention of responsible authorities it was seen that the Thelon region, of all the areas still inhabited by them, offered the best assurance of their preservation. It had also many advantages as a sanctuary for wild life in general, and as the "Thelon Game Sanctuary" an area of some 15,000 square miles was set aside by Order in Council on July 15, 1927.

As soon as the Thelon sanctuary was established arrangements were made for an investigation to determine the distribution of musk-oxen in it and how they might best be protected. This work was undertaken by W. H. B. Hoare, assisted by A. J. Knox, afterwards a game warden. Hoare reported (93) an estimated 250 musk-oxen. In recent years the sanctuary has been supervised by the Royal Canadian Mounted Police for the Department of Mines and Resources. In 1935 it was visited by the Harry Snyder expedition, with Col. F. M. Steel as government observer, and 171 musk-oxen were seen (65). In 1936 the aerial mapping of the whole Reliance region by the Air Surveys Section and the Royal Canadian

¹ These numbers refer to the Bibliography, p. 127.

Air Force presented an opportunity for a zoological investigation. The writer was put in charge of this work under the Division of Biology, National Museum of Canada, and was fortunate in obtaining the assistance of W. H. B. Hoare, whose wide experience in the north included a first-hand knowledge of the sanctuary itself. In 1937 an independent investigation was projected by the Museum, and again carried out by Hoare and the writer.

ITINERARY

In 1936 Reliance, at the east end of Great Slave Lake, was reached by water on July 10, on which date there was still ice in McLeod Bay. The Royal Canadian Air Force and the Air Surveys Section were there engaged in mapping the area. We had reconnaissance flights over the Thelon sanctuary on July 20 and July 21, in which musk-ox herds were located and caribou migrations observed. We then worked two ground stations, Plover Lake and Prairie Lake, near the height of land between Thelon and Back Rivers. After this was completed we moved by air to Artillery Lake and worked the western part of the sanctuary by canoe.

In 1937 we left Ottawa on June 13 and arrived in Edmonton on June 16. Arrangements for flying had already been made and our outfit had been forwarded in time to reach Fort Smith ahead of us. We left Edmonton on June 16 with Canadian Airways, Limited (pilot R. Heuss), picked up our outfit at Fort Smith on June 17, and reached Reliance on June 18. On June 19 we tied our canoe, a 17-foot "prospector" stored from the previous year, to the aeroplane, and flew a few miles over Artillery Lake to Heuss Lake, one of the headwaters of the Hanbury. Heuss Lake was free from ice, but, except for the extreme south end, Artillery Lake was closed.

On June 20, at Heuss Lake, we packed for our canoe journey, which was started next day. On July 16 we reached the junction of Hanbury and Thelon Rivers where we stayed until July 20. On July 27 we met a wood-gathering party of Eskimos and on July 31 we visited their camp and the government cache on Beverly Lake. We reached Baker Lake on August 20 and collected there until September 2, when we took passage on the new Roman Catholic mission boat, the *M.F. Thérèse*.

ACKNOWLEDGMENTS

The writer wishes first to express his deep personal indebtedness to Mr. W. H. B. Hoare. His immense knowledge and experience has been called on continually throughout the course of the investigation and of the preparation of this report. Thanks are also extended to the Royal Canadian Air Force for their fine co-operation, and the interest that Flight-Lieut. L. E. Wray and his flight of 1936 took in our work. Valuable co-operation in the preparation of this report has been given by members of the Bureau of Geology and Topography, and J. F. Henderson. M. G. Cameron, Eric Fry, and John Carroll contributed field observations. A. E. Porsild, of the National Museum of Canada, contributed the observations made on his Keewatin expedition of 1930. P. A. Taverner and R. M. Anderson, of the same institution, contributed records they

had compiled and helpful criticism in the preparation of the report.

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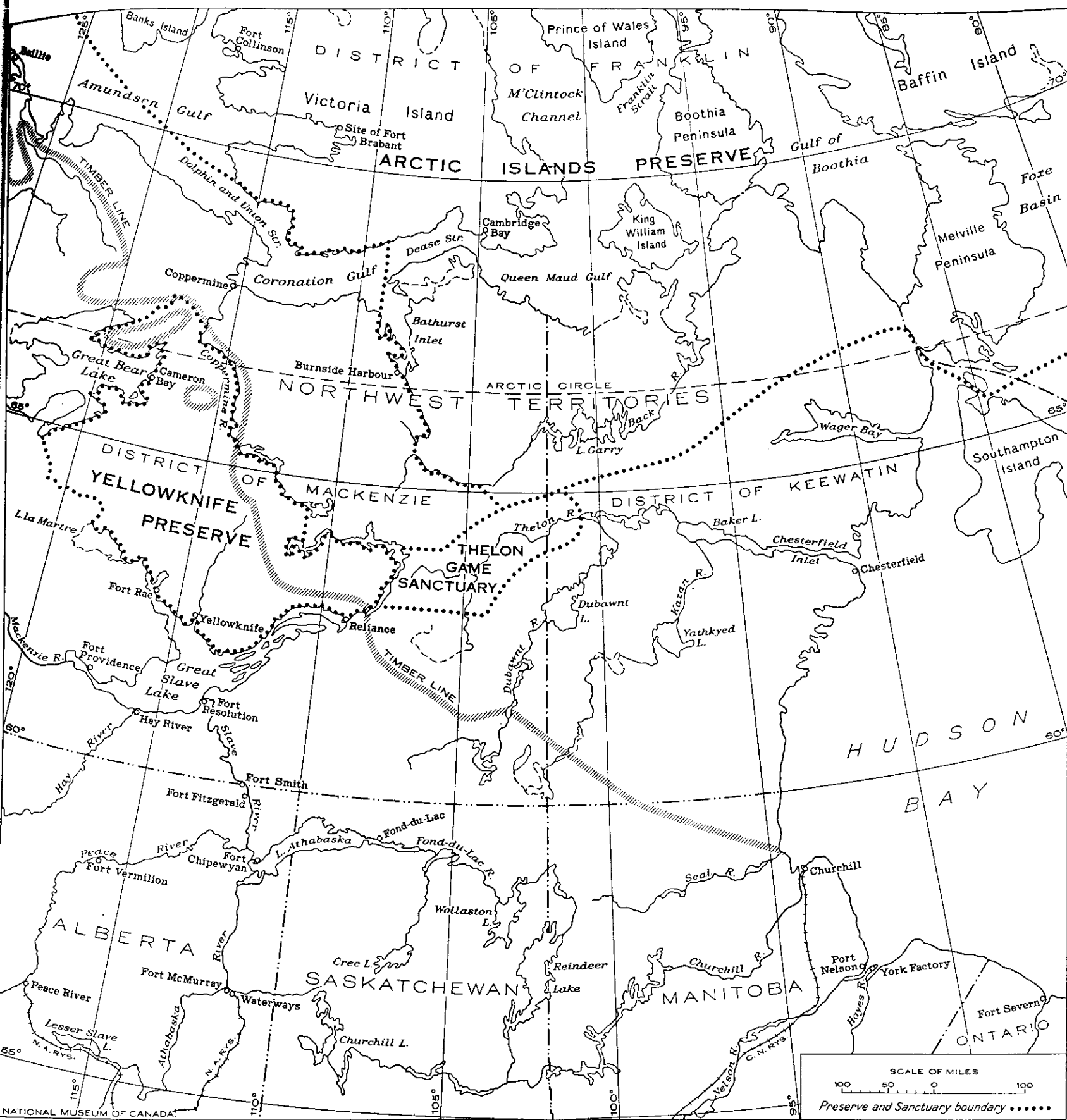


Figure 1. Map of portion of north-central Canada showing positions of Thelon game sanctuary and the Yellowknife and Arctic Islands preserves.

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had compiled and helpful criticism in the preparation of the report. Diamond Jenness has checked over the references to natives and A. W. Jolliffe has examined the statements on geology. The administration of the Northwest Territories has co-operated in every way in facilitating the field work and rendering information in its possession available for use in the preparation of this report. Full co-operation was also received from the Royal Canadian Mounted Police; we are especially indebted to the Great Slave Lake subdivision under Inspector Martin. The Hudson's Bay Company Edmonton Wholesale, the Mackenzie River Transport, the Nelson River District of the Hudson's Bay Company, Canadian Airways, Limited, and the Roman Catholic Mission of the Diocese of Hudson Bay also co-operated by facilitating our movements in the country.

In the part of this report dealing with Fishes and Fisheries acknowledgment is made of the aid rendered by Professor J. R. Dymond, of the Royal Ontario Museum of Zoology, and Dr. F. E. J. Fry, of the Ontario Fisheries Research Laboratories. Their help has made possible the proper interpretation of the material collected.

Finally, the writer would like to acknowledge his gratitude to all the various white trappers, traders, police, and others from whom verbal information was obtained, remembering, in the capacity of hosts, Mr. A. L. Cumming, District Government Agent at Fort Smith in 1936, Corp. J. Robinson and Constable W. J. G. Stewart, in charge of the Reliance detachment of the Royal Canadian Mounted Police during our visits, and Mr. A. Lunan, Hudson's Bay Company, Baker Lake.

GENERAL DESCRIPTION

HISTORY OF THE REGION

The first traveller in the interior barrens was Hearne (90) who made three visits, in 1769-1770, 1771, and 1772. The interior was next crossed by the expeditions of Franklin (60) in 1820 and 1821, and Back (12, 110) in 1833, 1834, and 1835. In 1855 Chief Factor Anderson and party repeated Back's trip in search of traces of Sir John Franklin (4a, 5, 6).

Next in order of time come several short expeditions (86, 98, 126, 197), of which Pike's (138, 130, 41, 116a) was the most important. In 1893 and 1894 J. B. Tyrrell (189) mapped Dubawnt, Kazan, and Ferguson Rivers. In 1899 Hanbury (83) ascended the Thelon, and in 1901 he descended the same river. The following year, he crossed from Beverly Lake to the Arctic coast. The Thelon was mapped in 1900 by J. W. Tyrrell (190).

From the point of view of natural history the short canoe expedition of Seton (166, 167) and Wheeler's visit with the Dog-Ribs (195, 195a) are very important. The Thelon was descended by Pelletier (25), Radford and Street, and Hornby and Critchell-Bullock (35). In 1927 Hornby and two companions perished in a cabin on the Thelon (28) and a police patrol visited the scene of the tragedy (158). The killing by Eskimos of Radford and Street resulted in a police patrol across the barrens from Baker Lake to the Arctic coast (160).

In recent years there has been much governmental activity in connection with mapping, mining, the reindeer industry, and the protection of musk-oxen and caribou, involving visits by Blanchet (16, 17, 18), Hoare (92, 93) and Porsild (141). The years 1928, 1929, and 1930 saw extensive aerial prospecting (19) in the barrens, and one ground party went down the Thelon, discovering the bodies of Hornby and his companions en route. In more recent years there has been great activity on Great Slave Lake (178, 62, 108, 57).

White trappers have been in the Reliance area at least since 1913-14 (85), Jack Stark being the pioneer. Since Hornby and Critchell-Bullock wintered (35, 193) in the barrens there has been a considerable penetration by white men. In most cases their activities centre around clumps of spruce; a few, however, live in sod-walled tent camps and burn willows. All of the "barren landers" in the west are now transported by aeroplanes. In the east the prospecting effort brought many white men into the Hudson Bay region, where, along the coast, and to a certain extent inland, white men are now to be found trapping. Some of them come within the area from which records have been assembled for this report.

Mention of the work of Preble (145) has not been made in the previous paragraphs for a special reason. In 1901, 1903, and 1904 E. A. Preble carried out a biological investigation that took him all along the travelled Athabaska-Mackenzie route and also to Fort Rae, thence by a new canoe route to Great Bear Lake and Norman. Later on he went down to MacPherson. In elaborating the results of his work Preble made a most complete compilation of all the scattered references in literature. The complete regional fauna that resulted serves as a datum from which other work can begin. Since Preble's time there may be mentioned the works of Anderson (176, 7, 10) and Harper (85). The writer has attempted to compile an up-to-date fauna for a large area eastward of Preble's route, including records by Captain Critchell-Bullock and much from Fairbairn (57), Seton (166, 167), and Wheeler (195), whose observations extended to the west of the area defined below.

NATIVES

A historical background for this report should properly begin with the Indians and Eskimos, but because our knowledge of their history results entirely from their contacts with whites it has seemed advisable to reverse the natural order.

There are at present, in the region defined on page 27, trading establishments at Snowdrift, Baker Lake, and Padley; police posts at Reliance and Baker Lake; and two mission establishments at Baker Lake. All of these are recent developments, and it, therefore, follows that most of the contacts of natives of the region with whites in the past have been on the Hudson Bay or Arctic coast, excluded from the faunal discussion (page 27, *et seq.*), the Athabaska-Mackenzie waterway west of our area, and one or two posts to the south. The extent of these contacts has naturally varied according to the ease of access of the posts. For many Eskimos regular contacts did not occur until recently, and for all the Indians regular

contacts go back many generations. The relationship of the present generation of Eskimos to the barren lands and to the Thelon region is only slightly different from that of their ancestors. The manner of life of the present Indian population differs in certain significant respects from that of their forefathers, and to weigh their present position in the country it is necessary to glance briefly into the past.

In the fundamental fact of their dependence on the barren ground caribou, the position of both races as inhabitants of the region of which the Thelon sanctuary is the centre is the same as it was when they were discovered.

The boundary between Indian and Eskimo runs diagonally across the region dealt with here. In the west it is well out from the timber-line. On Kazan River it touches the timber-line. It has varied from time to time.

In southern Keewatin there is a considerable history of hostile contact between Eskimo and Indian (*See* 90 and 15). The writer was told at Eskimo Point that survivors of a killing of Eskimos by Indians had died there only recently, and that Padley was once the scene of a similar "massacre". Even in 1894 (189) Indians wandered in summer to Yathkyed Lake. For the Thelon-Back-Burnside River areas Franklin (60) and Back (12) have recorded raids of Indians on Eskimos that appear to have been stimulated by the acquisition of firearms and were practically confined to one generation of Indians. At the Hanbury-Thelon Junction the two races continued to come in contact, and apparently also in the Rum Lake region (197). Each was, and still is, very much afraid of the other. The activities of white men have brought about racial contact in recent years in the Coppermine region and in Keewatin.

Indians

The caribou-hunting Indians in the days of the first explorers were divided into tribes, namely the Chipewyans (including the "Caribou-Eaters" of the upper Taltson), the Yellowknives (or Copper Indians), and Dog-Ribs, each having frontage on the barrens (104). The tribes fought with each other, as described by Hearne (90), Franklin (60), and Back (12). Today the tribal system is perpetuated by the Treaty, but the tribes have almost ceased to exist and the family is the social unit.

In the early times the Indians frequented the barren lands in summer and the woods in winter. Birket-Smith (15) makes the statement that "the Chipewyan round Churchill and Reindeer Lake have almost just as great a superstitious fear of living under trees in summer as the Eskimos". This is a strong statement and could not be applied to some of the groups farther west. Even Hearne remarked that the Indians ranged over rather than inhabited the barrens. However, the barren lands were certainly their original home in summer, and just as certainly they retreated to the woods in winter. It is necessary to emphasize this because the present generation of Indians completely reverses this behaviour.

The first change in habits came in the 1880's and '90's. Due to the practical extermination of the buffalo on the western plains, the value of musk-ox robes went up, and Indians were encouraged to get as many as possible. Around the familiar summer deer passes they were soon killed

off, and the problem arose of how to reach the more distant haunts of the animal and transport the hides. There was only one answer—by sled. Because it involved a change of habit the Indians were reluctant to venture out on the barrens in winter. According to Whitney (197), the Dog-Ribs were the first to do so, an interesting fact as originally they were probably less on the barrens than the others. Accounts of sportsmen and naturalists who accompanied the Indians (197, 161, 138, 98) are full of the hardships of the trip.

In 1899 in the midst of the musk-ox hunting period (1880-1916), when the Indians were more on the barrens than at any time in their history, came the Treaty whereby they surrendered their title to the land in return for certain guarantees as to the security of their livelihood, and an annuity. The payment of treaty annuities brings all the Indians to the trading posts at a season that formerly saw them far out on the barrens.

After 1917 there was no longer any excuse for long winter hunts in the barrens because the musk-ox was protected. However, the tradition of extended hunts in early spring still persists. It is interesting to note that the present generation knows an area practically identical with that known to Back's (12) guides 100 years ago. Their knowledge also includes the location of caribou crossings and camping places used constantly in summer prior to 1899, and visited in recent years only in winter. Wheeler's (195a) account of the life of the Dog-Ribs is important, as it presents the Indian point of view.

The eastern Chipewyans were not affected by the musk-ox hunt. In their country the musk-ox must have passed out of the picture soon after the introduction of rifles.

The relation of the Indians to the present Thelon sanctuary area is important. Hearne (90) gives a very interesting account of a band of Indians that he met—several young men with their women and children—who belonged to a family settled on the timbered banks of a river in the barrens easily identified as the Thelon. An Eskimo place name (151) near the eastern end of the Thelon trees is "Itqilet nunat" (the Indian country). In 1833 (12) they were no longer there, probably starved out, as there are no caribou on the Thelon in winter. Near the present Fort Smith, Back (12) met an Indian "le Camarde de Mandeville", who from a description of his home range obviously belonged to the Caribou Eaters, the present Nonacho Lake Chipewyans. This Indian knew the Thelon down to a short distance below the Junction, but not to the big bend. King (110) obtained from other Indians a map of a route to the Thelon by Tazin River and Nonacho Lake to Whitefish and Lynx Lakes. Two other "contacts" of Back's trip knew rather less about it than the present inhabitants, but it was plain that the Indians actually living in the Artillery Lake region knew the Douglas Lake-Smart Lake-Sifton Lake system of waterways, the Hanbury Portage route, and the portage route to the upper Thelon. As long as the Indians continued to spend the entire summer on the barrens they continued to both walk and canoe as far as the Junction, and, on occasion, farther. In 1835 there were Indians on the Thelon, according to King (110a). Below Grassy Island was a place where spruce trees had been stripped of bark, and as care had been used to get

only clear pieces it would seem that canoe-making was the object. Counting rings on the scar enabled the writer to date the occurrence as the summer of 1860. Catholique, a Reliance Indian, had been on all the canoe routes in his childhood, but not recently. Blanchet (18) found the same thing true of the Nonacho people. (Incidentally, the usual form of this name is "Nonallachotue", or "Two-big-islands Lake.")

The younger men among the Indians of Artillery Lake have hunted in winter as far as Carey Lake, the Junction, and Musk-ox Lake. None of them has seen Eskimos as their fathers did because the Eskimos ceased getting wood at the Junction at least 20 years ago, and possibly 40 or 50 years ago, as Eskimo cuttings are more recent in the Finnie district than at the Junction. Present summer limits for Indians are Artillery, Sandy, and Whitefish Lakes, and winter hunts at the time the sanctuary was established were to Sifton and Campbell Lakes and the upper Thelon. If the Indians went farther they were after musk-oxen.

The name Thelon or "Teh-lon", as the Indians say it, is an Indian word, yet the present generation does not know its meaning. King (110), who was at more pains than Back in getting his Indian phonetics and meanings correct, was attracted by a similar problem, namely that the river had several names. He lists them as The-lew, Teh-lon, Thelew-cy-aze, Thlew-y-aze, all synonyms of Thlewy-dezza, which he translates as Fish River. Because the native generic for fish is also the same as the specific for whitefish it could also be called Whitefish River, and it is well to remember that the river rises in a Thlewy-tue, which is translated all through the country as Whitefish Lake. Teh-lon or Thelon probably refers to whitefish or fish, but the meaning is lost to the present generation because they have lost the story that goes with it.

Eskimos

Unlike the Indians, the Eskimos have actually fairly large and important groups living entirely in the interior barrens. In addition to these, there are others who, like the Indians, make hunts into the interior, which are a vital part of their existence, and, until recent years an important section of the Arctic littoral group made frequent journeys to the Thelon for wood, in the course of which they met Eskimos of other groups near Akilnik and traded with them there.

The Copper Eskimos and the Netsilik people east of them had a culture based on winter sealing and summer hunts inland. Some of the Copper Eskimos made trips (103) far inland from Coronation Gulf and Bathurst Inlet. Occasionally they had hostile contact with the Indians (197), who in earlier days spent a great deal of time in that area. We have no record of the Indian winter musk-ox hunts meeting them; when these occurred the Eskimos would be at their sealing grounds. However, the presence of traders on the coast has changed the habits of the Eskimos in the last few years. They must have white foxes to get trade goods. It is hard to combine sitting over a seal hole with white fox hunting; it is much easier to combine caribou hunting with fox hunting, and, besides, there are more likely to be plenty of foxes on the caribou winter grounds. The Rum

Lake country is a fine caribou wintering ground and in recent years a large number of Eskimos have hunted there, so that they are inland both summer and winter, burning caribou fat instead of seal fat. The writer was told at Fort Rae that the Indians were displeased at this development. Some of the Bathurst Inlet Eskimos have regularly frequented Beechy Lake in summer. Mr. Fry found their camps there in 1936, as did Pike (138) in 1890.

East of Bathurst Inlet and inland, around the great lakes of Back River and between them and Baker Lake and Wager Inlet live about one hundred Eskimos, represented by twenty hunters trading at Baker Lake. They belong to the Hanningaiongmiut and Utkuhikhalingmiut, as they are called at Baker Lake, and have relatives on Back River near the coast. They are dependent on caribou, which are found in their country in winter. In former days their country lay on the trade route to Akiliniq, on Beverly Lake, from the Arctic. One route entered the country from Bathurst Inlet (103, 160) and another one from around Ogden Bay (103, 83), on Queen Maud Gulf.

West of Hudson Bay (and south of Wager) there are Eskimos who hunt both on the coast and inland. Another group stays inland all the time (15, 149, 150, 151). Undoubtedly those who now visit the coast once lived inland. Rasmussen and Birket-Smith call them all Caribou Eskimos. The people of Maguse and Ferguson Rivers as far as Yathkyed Lake (Hikoligdjuak) spend most of the time inland, but come down to the coast regularly. On upper and lower Kazan River, and on Beverly, Aberdeen, and Schultz Lakes, live the people who do not go to the coast at all. In 1893 (189) the lower Dubawnt was also inhabited; now it is deserted, although the natives met by us knew very well that up the "Avalitkok" was a great lake, called Tulemaligdjuak. The only reason given why the lake and river were deserted was that it was because of the aggressions of a sort of great fish that could not only destroy boats in the water, but could also reach up and pick men off the bank. Not only is the north-east end of the lake deserted, but also the southeast part. The Dubawnt white trappers find signs around Kamilukkuak Lake and River, but no Eskimos (158). A few years ago a band struck out in that direction from the Kazan and starved on the way (158, 123). There is every indication that the Eskimos have been drawn up the upper Kazan in recent years by the trading posts at Brochet (1873 or earlier), and lately at Windy Lake. At present they live right at the timber-line and burn wood (158). A recent scarcity of caribou even forced them to hunt in the continuous forest country to the south (158). Thus, the north-south continuity of the Inland Eskimo along the Dubawnt has been lost in modern times. The Thelon-Kazan people still mingle freely. The first people we met in 1937 on the Thelon came from the Kazan. The Qaernermiut of Baker Lake who hunt north of the lake and around it do not go to the west.

The Eskimos depend on the caribou just as do the Indians, and like them, also, the social unit is the family, not the tribe.

In their occupation of the barrens the Eskimos travel just as freely in the summer as the Indians, but less by boat, except for such recent acquisitions as outboard motors. In addition, their whole culture is of a nature to make winter travel in the barrens safe and easy, and it is at

that time that their most remarkable journeys are performed. Critchell-Bullock (34, 35) in stating that snow-house building requires conditions hard to find in the barrens and that the Eskimos are not free to travel, has been most completely misinformed. The Eskimo taboo against sewing winter clothing except in snow houses assures that they will be built as soon as snow is available. In the summer the Eskimos can fish at one place all summer and get whatever caribou happen along, but in the winter mobility is a necessity.

PLATE II



82438

Thelon Eskimos in 1937.

The Thelon has the distinction of being a place visited by the Eskimos for a special purpose and not regularly inhabited. Only right at the lakes are they sure of caribou in winter, and hence the Tibielingmiut or Akiliningmiut, as they are variously called, the permanent inhabitants of the region, live on Beverly, Aberdeen, and Schultz Lakes in winter. In the summer they live between the lakes and on the Thelon just up from Beverly Lake. To these lakes came the northern Eskimos on their way in for wood, and the southern Eskimos to meet them. The meeting place was near Akiliniq ("on the other side"), a name applied to the north shores of all the lakes, but more particularly to the rugged and beautiful northwest shore of Beverly Lake, which is a landmark seen in descending the Thelon and from the hills near the mouth of the Dubawnt. Hanbury applied it in error to Thelon River. Within sight of the hills of Akiliniq trading took place and the wood gatherers prepared for the journey up the river. Thus, we read that the Bathurst Inlet Patrol (160) found both Back River and Padley people at Aberdeen Lake, natives of regions distant from it in opposite directions. The wood-gathering trip was a hard one in those days, the people having no whale boats to sail up the river and freight the wood down. Presumably they headed for the Finnie, where

there are Eskimo cuttings of all ages, signs of cooking on Lookout Hill, but no tent rings. Summer camps now, and probably formerly, are below the ice mark and traces would be wiped out. There are also many cuttings in the region of good trees from the Hanbury Junction to Hornby's cabin, but the writer did not see a tent ring, though Knox believed he had seen some. They probably camped near the river, where the shingle is free of snow and dry early in the season. Such are their present sites on the river. It should be mentioned that there are not enough trees on the Thelon for Eskimos to be in the least hampered in camping by superstitions about them (*See Rasmussen, 149, 150*). We have no account of wood gathering where the place can be identified as the Junction rather than the Finnie. However, Mr. John Carroll of the Bureau of Geology and Topography found, at one of his ground stations between the Back-Baillie Junction and the big bend of the Thelon, a camp-site where the Eskimos had left part of a load of wood. This shows that a direct route to the Junction was known and was used on this occasion on the return trip. The Thelon Indians whom Hearne (90) met told him that the Eskimos resorted to their district to get wood. A letter from Alex. R. McLeod, one of Back's party, to King (110a) records the fraternizing of Indians and Eskimos on the Thelon in 1835. It is stated that some of the Eskimos were from Back River.

PLATE III



82437

Eskimo dogs at east end of Thelon game sanctuary.

As no description has ever been published of the Eskimo "logging camps" on the Thelon, some remarks may be in order. In several cases it was possible to see the way in which a tree was cut up, and in one instance someone had gone away and left a fully prepared log on the ground. The stumps and timbers are exactly as they would be if one were to cut such a tree down with an ordinary hunting knife, i.e., smooth

on the stump and not much undercut on the timber. The next cut is about 5 feet above the stump, giving a short log of the largest part of the tree. In the deserted whole specimen aforementioned this had been split in two. Food troughs, tables, and many other objects could be made of pieces split from such a log. The next cut was a long log, obviously a sled log. Once this piece was taken out there was nothing much left in an ordinary Thelon log worth carrying on a long journey. Only the roughest of preliminary work was done on the spot, and the logs must then have been packed to a more convenient place.

PHYSICAL GEOGRAPHY

Although rapid progress has been made in mapping and surveying the barren lands and wooded region adjoining, there is still a vast area not known in detail and much that is not known at all. The eastern part of Great Slave Lake (178, 62), the wooded area to the north (108), and a considerable part of the wooded area to the south (62, 18, 17) have been explored geologically, but so far very little is known of the geology of the barrens. Tyrrell (189) published a geological map of his route, and an area inland from Rankin and Dawson Inlets has been mapped (194).

The eastern end of Great Slave lake is a very rugged and beautiful region. Precambrian sediments have been intruded by dykes and sills of diabase and deeply eroded (178), so that the arms of the lake penetrate a region of great cliffs that often rise sheer from the water. In the country adjoining the lake there are enough similar non-granite areas to give a rough topography.

In the barren lands south and west of Bathurst Inlet there is found the rugged country known to Hearne (90) as the "Grizzle Bear Mountain," to Franklin (60) as the Willingham Mountains, and to Russell (161) as the Musk-ox Mountains. This region, as will be seen farther on, winters a great herd of caribou and still has many musk-oxen, for which it was famous in the past. The "mountains" must be the explanation for the presence of these animals.

East of Great Slave Lake a granite-gneiss formation of low relief prevails in the southwest part of the Thelon sanctuary, and probably south of Granite Falls on the upper Thelon into Keewatin, where, however, much of the area was found by Porsild (141) to be drift covered. A large non-granite area extends inland from Rankin and Dawson Inlets (194) and the country there is rough.

The Thelon itself flows through a sandstone formation that, though Precambrian, is unaltered and lies nearly horizontal. Above the Junction the granite is encountered at Granite Falls (190), but the sandstone cannot extend more than a few miles to the west of the river. On the Hanbury the contact is at the foot of Dickson Canyon. Helen Falls is a vertical falls over strata of unaltered sandstone. North of the Thelon, towards and possibly to Back River, is a rolling prairie underlain by sandstone. The exposures seen by us there in 1936 were of pink, unaltered strata, with beautifully preserved ripple-marks. East of the upper Thelon, towards Dubawnt Lake, the same type of country is found, and possibly the sandstone formation as well.

Beyond the sanctuary the sediments continue on Aberdeen and Schultz Lakes as pebble and boulder conglomerates, and finally as breccias. The hills of sedimentary rock in this region have a characteristic shape, typified by the landmark "Nauhak" or "Sugar Loaf Mountain" south of Baker Lake. Hills of this type can be seen to the southward in the region of the mouth of the Dubawnt. Actually, the sandstone is reported to extend to Dubawnt Lake (19) and the falls of the Kazan (141). At the outlet of Schultz Lake on the Thelon itself one comes to exposures of a red, fine-textured rock with crystalline nodules (porphyry?), a rock already familiar to the westward through forming a large proportion of the boulders in the conglomerate.

The part of the Thelon sanctuary not yet mentioned, the northwest region penetrated by the long arms of Sifton Lake, is underlain by grey granite.

The rest of the interior barrens, drained by Back River, is the least known of all. Blanchet (19), who has flown over much of it, says that the country between Back River and the Arctic coast is of low relief, and that the great lakes of Back River lie in a huge sand-plain. The region between Baker Lake and Wager is known to be very rugged (19), and between Wager and Back River various travellers have reported very rough country (19, 63, 83, 146). The association of rugged country with wintering caribou and musk-oxen occurs again here. So far as the writer can ascertain no white man has ever penetrated the region between Wager Inlet and Pelly Bay, and little is known of it, except that it has musk-oxen (*See below*).

The whole country bears the marks of Pleistocene glaciation. Hills have been rounded, furrows have been gouged, retreating glaciers have dumped loads of rubble, and great eskers cross the country for miles in straight lines. There are old marine beaches far inland. As in all of the glaciated Precambrian shield, lakes are abundant, but although there is no part of the country that has not many lakes, there are local differences in surface water area. The fact that the ground is frozen in the barren lands greatly impedes drainage there and makes possible such things as lakes on the tops of eskers. The region containing most lakes is the grey granite upland northeast of Clinton-Colden Lake, at the northwest boundary of the Thelon sanctuary. It is a tableland of low relief, eskers being the most prominent physical features. There is very little soil, rather just a hard granite surface scraped and furrowed by glacial action, with every hollow full of water. Next in water surface are the granite-gneiss areas, such as that along the Hanbury. In these also the highest hills are eskers and the lakes are innumerable. The sandstone regions are rather better drained, as are also the more rugged areas, for example that north of Baker Lake, where there are hills high enough that eskers do not attain prominence. It is an easy matter to fly over the Hanbury drainage and not recognize it because the short stretches of river are of so little prominence. Blanchet says the same of the upper Kazan and Dubawnt, and it is probably true of the uppermost reaches of the Back and the Coppermine. They are in granitic areas. On the other hand, no one could mistake the Thelon or the middle reach of the Back, or, presumably, that part of the Coppermine below Redrock Lake.

Characteristic of the headwaters of streams are great lakes, which occupy heights of land. Lac de Gras (Coppermine River), Ayimer and Clinton-Colden Lakes (Lockhart River), Campbell Lake (Hanbury River), Eileen Lake (Snowdrift River), Whitefish and Lynx Lakes (Thelon River), are such lakes. Burnside River rises in Rum Lake, now known to be a very large lake (one end of which was mapped by Franklin (60)) that lies at the foot of Willingham Mountains. It also has a stream of lesser importance, which flows out to Back River, a fact reported to Back (12) by the Indians. This is by no means rare in the Canadian shield, where heights of land may cause waters to mingle rather than divide. At the headwaters of streams flowing into the Arctic north of Back River there is at least one large lake (160). At the head of Dubawnt and Kazan Rivers the country has many small lakes and much muskeg (189). These rivers fill large depressions on their courses, as do also Thelon and Back Rivers.

The Thelon Route

The interior barrens may be reached by canoe from Reindeer Lake (189), Stony Rapids (189), Camsell Portage (18, 110), Fort Fitzgerald (18), Reliance, Yellowknife (60, 161), and Fort Rae (145), as well as from points on the Arctic and Hudson Bay coasts. Routes from Camsell Portage and Fort Fitzgerald lead eventually to the headwaters of the Snowdrift, and hence are the same as one route from Reliance. From the east end of Great Slave Lake all canoe routes lead to the Pikes Portage system of lakes and portages leading to Artillery Lake. True, it is possible to walk to the barrens from points on the shore of McLeod Bay, but few care to portage it. Half-way across Pikes Portage a southern route may be taken to Snowdrift River, and from its headwaters at Sandy Lake to Whitefish Lake, at the head of the Thelon. Sandy Lake may, however, also be reached by the Trout Creek portage route from Artillery Lake. Whitefish Lake joins Lynx Lake by a narrows and from the foot of Lynx Lake flows the Thelon, the westerly branch of the two at Granite Falls. Indians say there are portages on this stretch. The Thelon sanctuary is entered above Eyeberry Lake. By another route, portaging to Douglas Lake, the headwaters of the Hanbury may be reached from Artillery Lake. Douglas and Campbell Lakes, the two heads of the Hanbury, drain through rapids into Heuss Lake and on to Smart Lake by a short riffle and river. The more familiar route to the Hanbury from Artillery Lake is via Ptarmigan and Clinton-Colden Lakes to Deville and Smart Lakes (190). This is the route used by Hanbury (83) and mapped by Tyrell (190), and it has been used by others because of the maps. The Indians and the first white trappers preferred to travel to Whitefish Lake and thence to the Thelon, because, among other reasons, there are more trees on that route. The Hanbury route below Smart Lake is through a series of lakes on a granite-gneiss height of land, as described by Tyrell (190). We varied it by using an Indian portage at Timber Rapids, just north of the rapids. There were ancient tipi rings and markers on it. There is also a portage from the foot of Lac du Bois to the south end of Hanbury Lake. From Hoare Lake the river (now plainly such) runs around the north end of a high

ridge in what is practically one continuous rapid at low water, and then plunges down the cataracts over 500 feet to the Thelon. At Dickson Canyon portage is an old (marine?) shoreline.

PLATE IV



82453

Dickson Canyon. Hanbury River.

The Thelon in its northeast course is deeply cut into the sandstone. There are two large marshy stretches, and in many places the shores are marshy. Below Hornby's cabin a low-lying area is reached, through which the river flows, often between ice push banks. At the "big bend" it turns suddenly eastward, flowing between cliffs of sandstone until it takes a turn to the southeast into a great flat, where its course is poorly defined and featured by small lakes and gravel islands. At the mouth of Finnie River high land is reached again, and the second stretch of "marshes" below the Finnie lies between uplands, through which the river takes a northerly direction. The hills to the east become more prominent, and finally the river runs

rapidly through them into Beverly Lake. Before the lake is approached distant blue hills are seen—the rugged country of Akilnik, "the other side" (northwest) of Beverly Lake. The lake extends to the northeast beyond the dimensions indicated on most maps. Shortly past the Thelon the Dubawnt pours its floods into the lake, and the result is that the whole southern part is full of sandy islands, in addition to a number of islands due to natural elevations. The shores of the next lake, Aberdeen, are low except at the northeast end, where an upland begins, which continues around Schultz Lake.

The valley of the Thelon is largely a narrow trough. The river receives one tributary at Granite Falls (the one flowing over the falls), which comes from a large lake to the east, and one about 10 miles below Granite Falls, also from the east. From there to Beverly Lake the only navigable tributaries are the Hanbury and the Finnie. As the Finnie divides a short distance up from its mouth it is unlikely that a canoe could

PLATE V



Foot of Dickson Canyon, showing the first exposure of sandstone.
(*Photograph by J. W. Tyrrell.*)

be taken any distance up it. At Beverly Lake the Thelon receives the Dubawnt, roughly equal to itself, and from there to Baker Lake there are no tributaries mapped, though there may be a river flowing into the foot of Schultz Lake. The flats at the big bend, Grassy Island, and above and below the Finnie are beds of post-glacial lacustrine or marine expansions. The river is definitely not navigable for anything but canoe or York boat or the type of whaleboat without centreboard now in use on it by the Eskimo.

Because it has been closed to prospecting, there has been a great deal of speculation over the mineral possibilities of the Thelon game sanctuary and some rather persistent rumours, amounting almost to legends in some cases. The oldest of these, that the Thelon is suitable for placer mining, traces back to Inspector Pelletier's report of his trip (25) down the river. This suggestion should be dismissed once and for all. A more recent report is that John Hornby had discovered gold on the Thelon (at the Junction, according to some versions). No mention of gold, however, is made in Christian's diary (28). Hornby's prospector's hammer, which the writer found at the cabin, was unmarked except by rust and appeared never to have been used. The only possible foundation for the story that the writer has so far seen is in the report of the Royal Canadian Mounted Police Inspector investigating the Hornby tragedy, where it is reported (28) that a small piece of quartz wrapped in an old sock was found in Hornby's trunk. There is no indication where it came from or that it contained gold. In his report on the area Hornby expressed himself on its mineral resources as follows: "This area possesses no minerals, containing only sandstone and sand, consequently can afford no inducement or excuse for men to go on a prospecting trip" (93).

It is common knowledge that traces of mineralization have been found near the borders of the southwest part of the sanctuary, indications being that the finds are of no commercial value.

The larger part of the sanctuary is included in the sandstone and grey granite areas. A small portion lies in the granite-gneiss region.

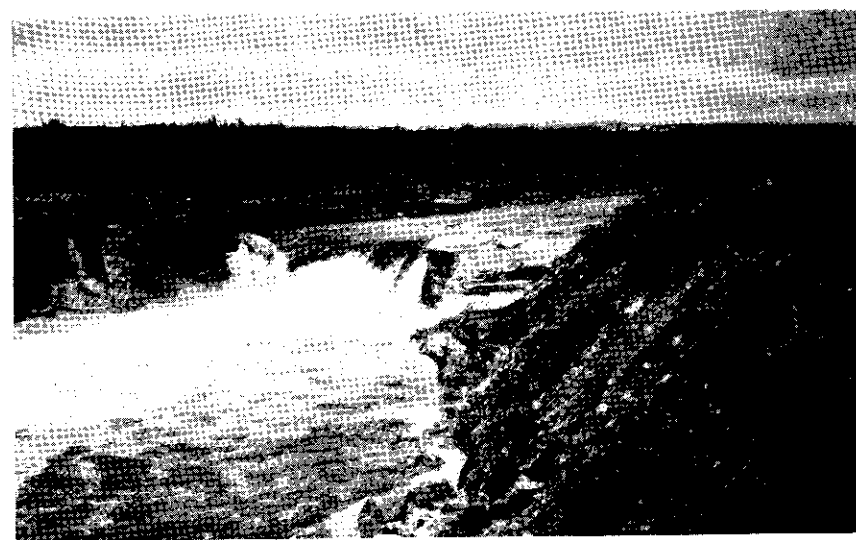
VEGETATION

The vegetation of the region, described on page 27, belongs to the Northern Transition section of the Boreal forest region (81a) in the wooded parts and to the Tundra formation in the barrens. The writer made small collections of plants, and other members of recent survey parties have done likewise. Plants were collected by the expeditions of Franklin (60) and Back (12), by the Tyrrells (189 and 190), and by Critchell-Bullock (35). Porsild's (141) collection, made in Keewatin in 1930, is more important by far than all the rest combined. The frozen tundra imparts a character of its own to the flora. Griggs (77) has drawn attention to the lack of well-defined ecological units in the arctic vegetation. Though large areas are comparatively sterile, a collection from one of these contains approximately the same species as does a collection from an area of luxuriant growth. Even on a sand esker the ground is frozen quite close to the surface in the parts of it carrying much vegetation.

Apart from the few small collections of plants mentioned, the only study of vegetation we made was concerned with the problem of the distribution of trees. The timber-line is by far the most impressive faunal and floral boundary in Canada. East of Great Slave Lake it is a real line; the forest marches up to Timber Bay on Artillery Lake and halts. Because of the sudden change in altitude from Great Slave Lake to timber-line at Artillery Lake, one passes his last poplar, last jack pine, last tamarack, etc., one after another inside a few miles.

Anyone familiar with the aftermath of a logging operation in the eastern pulpwood areas will have observed that the regeneration of spruce is along the haul roads and skidding trails. In the natural mature forest it is in windfall areas. On humus and vegetation mats few seedlings will be found, but the writer has seen an almost solid cover of spruce seedlings growing along with *Equisetum* on a silted area. In other words, the exposure of mineral soil is favourable to the regeneration of spruce (both white and black), whereas humus and vegetation mats are unfavourable. The arctic floral complex is a vigorous, dominant growth over frozen ground, a growth that tends to perpetuate the frozen condition that favours it. If the trees are able to grow in exposed positions they may gradually advance

PLATE VI



Helen Falls, Hanbury River. (Photograph by W. H. B. Hoare.)

into the sheltered places, and even into muskegs. The limit of spruce, and spruces being the dominant species, the timber-line, is reached where the trees are unable to establish themselves under fairly exposed conditions. Beyond that line the spruce is most likely to be found in some sheltered spot where conditions unfavourable to the dominant arctic vegetation and favourable to spruce prevail. Thus, on the loose sand of eskers in the Hanbury region, small, stunted clumps of spruce are frequently found, both black and white spruce, in tight little clumps of a few yards square and 3 or 4 feet high, or even higher at times. The best clump on the Thelon is in a place where springs emerge from sandstone and wash down to mineral soil. The Finnie flats are silted. Other clumps are on ice pushes or cut banks.

Botanically viewed, these clumps, in spite of their edaphic nature, are outposts of the Forest formation. In so far as the vertebrate fauna is concerned, if these isolated growths are in a chain sufficiently close to one another the birds and mammals of the forest will extend their ranges to the limit of the chain. Thus, varying hares are found far down Horton River (176), the tree growth there being practically bridged over at one point to Anderson River. The Thelon on the other hand is too isolated for many such occurrences, and there is neither botanical nor zoological justification for stretching the timber-line over several thousand square miles of barrens in order to reach a few acres of spruce and tamarack.

There is actually, however, a limit of trees beyond the timber-line, namely, the limit of occurrence of black spruce, white spruce, and tamarack as species (which is roughly the same in each case, tamarack being outliers in Keewatin (141) and white spruce in the Thelon region). This is also the northern breeding limit of several species of birds (e.g., tree sparrow), and possibly also a southern breeding limit in the case of the snow bunting. It bounds a rather wider zone east of Great Slave Lake than the Northern Transition forest itself, though because of the few species involved it is perhaps not worthy of recognition as a valid life zone. There are, none the less, so many tiny clumps of spruce that were any climatic change to occur making it possible for trees to occupy exposed situations in that region the occupation would be rapid.

Timber-line runs from near the mouth of Seal River to Nueltin, Windy, and Ennadai Lakes, as shown on recent maps. The timber-line region on the upper Dubawnt is a muskeg country; true timber-line extends at least to Boyd Lake, although there is much open muskeg above and also clumps of trees down to Carey Lake (189). West of Boyd Lake the police at Reliance found the country very rocky and barren, so that the line takes a dip south. On the upper Taltson it is practically at the height of land; on the Snowdrift the timber-line just touches the west side of Lake Eilcen. Thence it runs to the south end of Artillery Lake and up to the west side to Timber Bay. The so called "last woods" (190) are isolated clumps, but Crystal Island is true Boreal forest, and includes red squirrels and muskrats in its fauna. On Hoarfrost River, Back (12) found Cook Lake treeless, and aerial photographs show the timber-line to touch the south end of Barnston Lake. Lac du Mort also lies near timber-line, according to McKinley (41, 116a). It then turns sharply north and the air maps pick it up at Grizzle Bear Lake and Snare Lake, with a tongue going to Fort Enterprise. From Snare Lake it goes to the Coppermine, follows the river to the mountains, and turns westward towards Great Bear Lake, where we leave it. It might be mentioned, though, that the air map shows considerable barren areas between the Coppermine and the McTavish Arm of Great Bear Lake.

Isolated tree clumps are reported in the country south of the Maguse (19), at Padley (19) on the upper Kazan (189), and on the lower Dubawnt (189), giving a rough limit of ground spruce in Keewatin. The clump at Padley was reported (19) to cover several square miles, and was, therefore, much larger than any of the clumps on the Thelon. In 1937 the writer was told that it had been all used up by the post there, a hint of what might follow were any elaborate establishment made on the

Thelon. On the Thelon, the south shore of Beverly Lake is at the limit of ground spruce; clumps are found on many of the northern tributaries almost to the headwaters of Back River. There is a clump at the north end of Sifton Lake, some on Hanbury Portage, and a clump on Ptarmigan Lake. None has ever been mentioned from Aylmer or Clinton-Colden Lakes, but there is some on MacKay Lake and on or near Lac de Gras.

PLATE VII



82441

Caribou Rapids, Hanbury River. Scene of caribou crossing described in text.

Wheeler found a good clump of trees at Diri Ti (195) north of the Coppermine, and presumably on eastern tributaries of that river there are others. A small stream east of the mouth of the Coppermine is called "Napartoktuak," but apparently Tree River (farther east) is a misnomer. Back River is the only large stream absolutely free of tree species in all parts of its drainage, but the Thelon drainage is also entirely beyond

timber-line. The Coppermine, Dubawnt, and Kazan are touched by timber-line at some point in their watersheds, but all are comparatively free of forest growth.

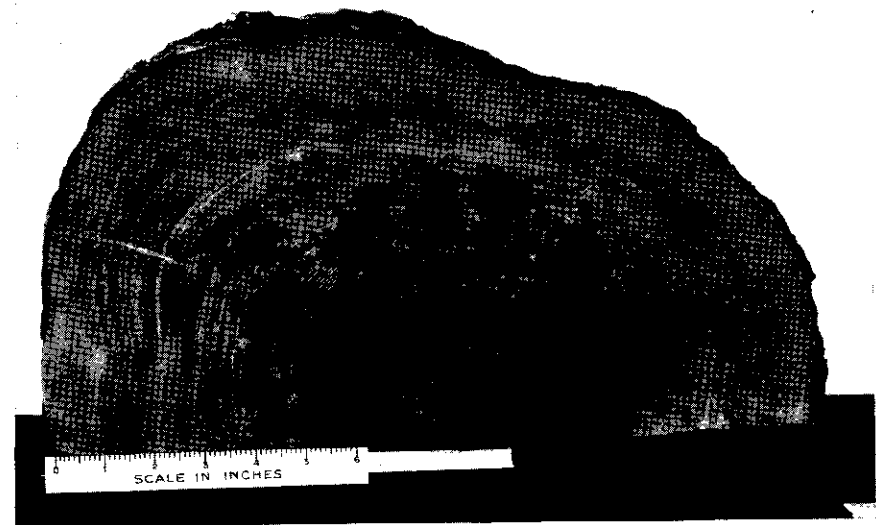
The trees of the Thelon have been described in the past (25) in terms that in themselves have given a grossly exaggerated impression of the timber. Hanbury (83) protested that people whom he met had gained a wrong impression by contact with the Tyrrell party. Tyrrell's report (190) is literally accurate, but is capable of being misread by those who take on themselves the task of placing the emphasis instead of quoting literally. First, it must be stressed that there are only stunted clumps on the Hanbury. Accounts of groves on the upper Thelon show them to be of a rather stunted muskeg type in most cases. Much muskeg can be seen from the air at Eyeberry Lake, apparently mostly treeless. The grove on the Finnie, the most densely wooded area in the valley, is 200 miles from the nearest clump of similar size.

There is timber on the Snowdrift at Sandy Lake, a long, narrow lake at the head of the river. From Sandy Lake a portage of $2\frac{1}{2}$ miles leads to Whitefish Lake at the head of the Thelon. Whitefish Lake is barren except at the northeast end, but there are trees at the narrows between it and Lynx Lake, and some on Lynx Lake, mostly in sandy areas. Apparently there are not many on the first piece of the Thelon, but there is a grove at Granite Falls and a growth of tamarack is reported nearby. Tyrrell (190) indicates sixteen small clumps and scattered trees on the upper Thelon, and there are others away from the river. Most of the upper Thelon trappers are able to burn spruce. Right at the Junction a considerable growth of stunted spruce occurs, but a few miles down is a stand of quite respectable trees, in which the warden's establishment was first located (93). There is another patch on a small stream across the river. Below Grassy Island trees are found in fair clumps as far as Hornby's cabin. From Hornby's to Finnie River flats, tree growth is confined to tiny clumps on ice pushes and cut banks and scattered wrist-thick sticks in muskegs; the "good growth," which commences at the Junction, skips 100 miles. At Finnie River an alluvial area brings about a luxuriant growth of both spruce species and tamarack. We did not notice any tamarack just below the Junction, though there is some on the upper river. Below the Finnie good timber is found back from the river as far as the "Deer Pass" bend, and even beyond in places.

Should there be any objections to areas with so many trees being withdrawn from the Forest formation and relegated to the Tundra, there are reproduced here three Royal Canadian Air Force photographs (Plates XII, XIII, XIV) that show a good three-quarters of all the timber trees worthy of the name on the whole Thelon system. The best growth on the river is in the clump just below the Junction, containing the abandoned warden's cabin. The area of the clump is not over 2 acres, and the volume of timber not over 30 cords of pulpwood (long cords to a 3-inch top), if indeed it is as much. There are three age classes to be seen, one of which is the growth after a spring fire, quite possibly due to natives. Diameters are 10 to 15 inches, 7 inches, and 3 to 4 inches for the various classes. A 15-inch specimen (diameter breast high) of the

old stand was 50 feet long and 325 years old at stump. The parent trees of the clump were not located, but the present is the first main stand covering the ground, at any rate. It must have been established at least 1,000 years ago, and there are other stands on the river that are evidently older. There was no growth as good anywhere else on the river. Occasional trunks on the stretch below Grassy Island towards Hornby's cabin are as thick, but not as high. On Finnie River the trees are much smaller (6 to 8 inches in diameter), though the growth is more extensive.

PLATE VIII



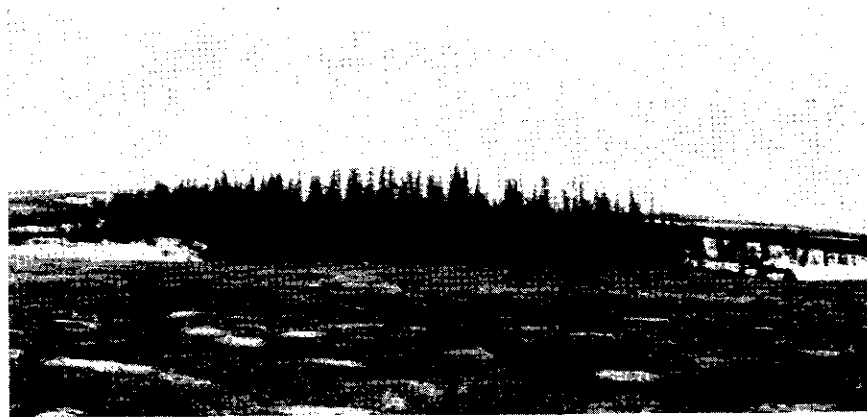
Section of tree from "Wardens' Grove." (Photograph by Dominion Forest Service.)

A proper investigation of these isolated stands would undoubtedly reveal much of the history of the area. The Thelon must have looked much as it does now for hundreds of years, and similar climatic and physical conditions must have prevailed for a couple of thousand years anyway. There are many measures of a geological nature present in the area; for instance, the Thelon has cut through much drift and sandstone since the glacial retreat. It is of interest to note that Helen Falls on the Hanbury as photographed by Tyrrell in 1900 is identical, even to some minor spouts, with the 1937 contour; it is a vertical fall over sandstone. Ford Falls may be considerably cut back; certainly we did not make the same portage as Tyrrell.

Timber-line east of Great Slave Lake seems to be relatively stable. It is also a fairly sharp line, and capable of being located within a mile or two. In other places it is not so sharp, but the difference is a minor one. The clumps of trees in the barrens may be neglected (cf. again aerial photographs of the best of them, Plates XII, XIII, XIV).

Wheeler (195) observed no sign of regeneration in the 90 year old clearing at Fort Enterprise, and considered the stand to be 500 years old. Timber-line on Artillery Lake is certainly the same as it was in Back's time (12). King (110) was of the opinion that the isolated clumps in the barrens were diminishing in area. The so-called "Last Woods" on Artillery Lake (190) is an isolated clump. Seton (167) estimated that the trees were 300 to 325 years old. The clump has practically disappeared, certainly through human agency, but another in a hollow in an esker near the "Buttes" several miles farther north has gone ahead and some trees actually show over the top of the esker. Had this been so in Tyrrell's time

PLATE IX



"Wardens' Grove" seen from the ground. (Photograph by W. H. B. Hoare.)

he would probably have noted it on his map. Timber Rapids on the Hanbury were named in jest by Tyrrell's (190) crew because of a small spruce there (in 1900). Now there is a small grove, with the parent tree dead in the midst. Many traces can be found of clumps that have perished, leaving only bleached sticks to tell the tale, and there are others obviously new. On the whole there seems to be a very slight gain in these clumps more often than the contrary, and the writer believes that they are now vigorous; certainly they are not sterile. Comparison of photographs taken at the Hornby cabin in 1937 with those taken by the R.C.M.P. in 1929 (28) shows that several willows and spruce have grown up in the clearing. One young white spruce growing at the southeast corner of the cabin has evidently averaged at least 6 inches height growth a year. In the case of the main standards, trees of 5 to 10 inches (diameter breast high), the relative position of the lower branches drooping over the graves has not changed more than an inch or two. The

middle reach of Back River seems to be just as suitable for trees as the Thelon, and the writer is convinced that the only reason outliers have not reached it is because they have not had time to do so.

The position of the timber-line in Alaska has been studied by Griggs (76, 77, 78). There it has advanced in a decided manner, compared with which the line east of Great Slave Lake is quite stable. Except in a broad historical sense he does not think it a climatic line. At Great Slave Lake the impression gained is certainly that it correlates with certain climatic phenomena. The phenomenon of "break-up" moves in an orderly manner from the Mackenzie lowlands forest to the Northern Transition region and then out to the Tundra, the Tundra being 2 weeks or more behind the Northern Transition. The "freeze-up" is the same thing in reverse. It is even true that Artillery Lake south of Timber Bay opens with the Transition forest, whereas drift ice ordinarily stays in the rest of the lake until late July or August. Other influences may, however, be at work in this case, but the climatic correlation in general seems too strong to be denied, although just what factors are most important is not at all clear.

CLIMATE AND SEASONS

The region is one with a cold and protracted winter and a summer with very few days that are really hot. It is also a region of winds, at all seasons of the year.

The only record of winter temperature in the heart of the barrens known to the writer is that of Christian at Hornby's cabin (28). In his diary from November 25, 1926, to April 14, 1927, there were only ten recordings above zero Fahrenheit; of these all were below 32 degrees except April 14. There are over 100 days in the same period recorded as below zero Fahrenheit, and many days not recorded. There was no real thaw until May 18; in mid-October previous the river was still running, there being a fair current at that spot. So far as is known the season was an average one.

Summer temperatures are available for June, July, and August of 1900 from Lofthouse's records kept on Tyrrell's (190) Thelon expedition. Summer temperatures on the Kazan for a period from July 31 to August 23, 1934, are recorded by Porsild (141). The latter are noon temperatures and may be compared with the noon temperatures of Lofthouse's record. Out of 19 days recorded Porsild found eleven temperatures of 60° F. or over at noon, of which 3 were 70° F. or over. The mean was 59.7° F., and the lowest temperature was 46° F. Lofthouse's June temperatures were maximum 74° F., minimum 32° F.; mean 55.6° F. In July it was maximum 77° F.; minimum 44° F.; mean 56.8° F.; the highest temperature for the day is used once where no noon temperature is recorded. In August the maximum, 60° F. on 4 different days, is the same as Porsild's mean for 1930; minimum 38° F.; mean 51.2° F., well under Porsild's figures.

It may be said that the similarity between the conditions in June and July on Tyrrell's trip and those in 1937 was remarked on by Mr. Hoare and the writer. We had his report and for a time kept pace with him day by day, on the same route. In August, however, he had some snow, which we did not experience. During his hottest days, in June, Artillery Lake was full of ice.

Records of ice conditions are of interest, and follow here, along with some isolated weather records. In 1833 Back (12) found the northwest part of Clinton-Colden Lake full of drifting ice late in August. In 1834 he found Clinton-Colden, Aylmer, and Musk-ox Lakes solid early in July, and later on in the month the big lakes on Back River were full of drifting ice, all of which was gone on their return in August. We have no information of other years until 1893 when the Tyrrells (189, 191) found Dubawnt Lake full of drifting ice in August. On August 11 the ground was frozen and all the little ponds covered with new ice, and J. W. Tyrrell says "it was

PLATE X



82468

Old stand in "Wardens' Grove."

a point of discussion with us whether the season of this land was spring or autumn" (191). In 1900 J. W. Tyrrell (190) seems to have hit an open year on the Thelon in spite of frost and snow in August. Many canoe parties have been held up on Artillery Lake in July. In one year (1934?) a crossing is reported by dog sled late in July by Mr. M. P. Murphy; ordinarily it seems to be clear by the end of that month. Critchell-Bullock's note, which we found on Smart Lake, stated that the lake was solid on June 23, 1925. On June 23, 1937, the ice was practically gone at the same place. On May 27,

1928, Mr. Hoare records (93) the first heavy thaw at Artillery Lake. The same year travel on the Hanbury ended on September 30. In 1929 the ice went out on the Thelon on June 23, but there were still miles of floe ice in Aberdeen and Schultz Lakes in August (93). Returning from Baker Lake the same year, A. J. Knox froze in on the Thelon in mid-September (less open than 1926 or 1928). Porsild (141) found 1930 an open year in Kcewatin. Mr. Hoare was able to travel on Aberdeen Lake in mid-July 1931 it being then open as compared with August 1929. In 1934 heavy snow came at Artillery Lake before the end of August, and in 1936 we encountered ice in Great Slave Lake on July 9. On July 21 Artillery, Clinton-Colden, and Aylmer Lakes were still full of drifting ice, and ice had disappeared from such lakes as Smart and Steel only a few days before. It was all gone by August. Freeze-up in the barren land lakes came before the end of September. In 1937 the break-up was exactly a month earlier than 1936, and the season was generally considered to be open beyond all precedent. So far as the writer can judge from Tyrrell's account it was about the same as 1900. Unmelted, stranded ice was seen at the foot of Aberdeen Lake in August.

Plainly, the Thelon opens in June instead of May, as sometimes suggested (25). It freezes in September or October. Taking the larger lakes into consideration, the minimum navigation season is August 1 to September 15, or 6 weeks, and the maximum July 1 to October 1, instead of the season suggested by Tyrrell. The average is in between or a few days over 2 months. The flying season is roughly from the first week in July to mid-September for pontoons. There are probably years when lakes such as Dubawnt have drifting ice all summer. Often these lakes have some ice in August, but probably lose most or all of it before the end of September.

The summer seems to run its course fairly well without frosts, but there are few hot days. Right at break-up there seems to be a week or so of cloudless days, but they are not necessarily calm; most of the time there are winds. The average summer day is one of scattered clouds and sunshine mixed. Cruising around in an aeroplane one sees many veils drooping from the clouds to the earth. On the ground the passing of one of these means a minute's drizzle—nothing more. The clouds look black enough, but neither thunder nor high winds are with these veils. Squalls are not common; although a nor'wester or nor'easter may rise quite suddenly, it can do so out of a cloudless sky, and its coming is usually noticed before it gets bad. Occasionally a fog sets in from the north, reducing visibility to a few yards.

According to the reports of trappers the autumn also usually has its cloudless warm days—a brief Indian summer of a week or so. When winter comes its grip is decisive and not relaxed until May. Christian's record has been reviewed. There is no weather station in the interior barrens and at present no white establishment other than trapper's tent camps. The combination of low temperatures and high winds makes the insulation of caribou skin clothing necessary to comfort.

There are many who have objected to the expressions "Barren Ground" or "Barren Lands" or "Barrens". To the Eskimo it is his land, and he

neither knows nor thinks of any other. The term "barrens" with the thoughts it raises in a white man is a psychologically adequate expression of the Indian "Detchin-ule" (no trees), which the Indian himself translates as "No-stick-stop", even though in the botanical sense it is a complete misnomer. Simply to say "treeless plains" does not express the feelings either of white man or Indian travelling over the hard-packed snow. The

PLATE XI



82467

Regeneration in "Wardens' Grove."

country exacts both from animals and plants extremes of adaptation. Such biological resources as it has must always be less per unit of area than those of other lands because the plant growth, which is the basis of life, is slow.

FAUNA

Records were kept both in 1936 and 1937 of the vertebrate animals encountered. Specimens were collected wherever possible, but the circumstances under which we travelled, by light aeroplane and light canoe, made systematic collecting impossible. Even those specimens that the

writer knew very well were most desirable could usually not be obtained without a special hunt. In 1937 a special effort was made to get fish specimens, this being a group that was absolutely unknown and that could not be determined in the field. Most of the birds and mammals collected by us in 1937 were damaged when an Eskimo whaleboat was swamped at night by waves raised in the inconsiderable width of Thelon River by a very high wind.

The field notes were more complete. Both birds and mammals were familiar, and the writer was aided in 1936 by good 6 x glasses, and in 1937 by Zeiss glasses, 10 x 50. It was the intention at first to assemble the records of animals for the region from Great Slave Lake to Baker Lake to show a distribution from the country covered by Preble (145), Harper (85), Russell (161), and Anderson (176) towards Hudson Bay, but not including anything from the littoral. It soon became evident that it would be easy to include all the available records for the interior barrens, as the writer was going through the sources for data on musk-oxen and caribou. In this connection it should be stated that the writer has had the privilege of examining and using records of birds assembled by P. A. Taverner, and of mammals by R. M. Anderson. A. E. Porsild has very kindly supplied notes made by him in Keewatin in 1930, on a trip which took him, in the interior, to the upper waters of the Tha-anne (locally Big River), and to Yathkyed Lake, the lower Kazan, and Baker Lake. From all these sources have been assembled records for a list of vertebrates from the following area:

(1) Timbered zone—Great Slave Lake east of Gros Cap and the islands, north to the timber-line, including Fort Enterprise and the upper Yellowknife River, and, to the south, Snowdrift Valley and the upper Taltson.

(2) Barren lands—upper Coppermine, upper Burnside, and Hood Rivers, Back River, Thelon River, Dubawnt River, and Kazan River, including the interior barrens, but not the littoral, either Arctic or Hudson Bay.

This sounds like a large compilation, but actually it is a very small one, this immense area having been visited by few naturalists.

The first naturalist was the incomparable Hearne (90), who was, fortunately, an accurate observer of nature. The next was Richardson on Franklin's first expedition (60, 182), who put Fort Enterprise and Point Lake on zoological maps for good, though the places themselves may be deserted. Back's expedition was next, and King (12, 110) still has the honour of being the only zoologist to visit Back River. The contributions of the hunters Whitney (197), Pike (138), Jones (98), and others were small. Valuable observations were made by the Tyrrells (189, 190), but it is only within recent years that any faunal lists have been made. This was done by Seton (166, 167), Wheeler (195), Critchell-Bullock (35), Blanchet (16, 17), Fairbairn (57), and Hornby (95), who did most useful work. Most of them refer to the region of the eastern end of Great Slave Lake and the adjacent barrens, but Critchell-Bullock and Hornby made the Thelon trip. Christian's diary (28) adds several interesting notes to the Thelon fauna. The Thule Expedition has published records from

Baker Lake and Kazan River (96, 37). The writer has endeavoured to make a critical use of these lists, but has not quoted the references at length because at the present stage of knowledge the sources should be referred to by anyone interested in the records.

The timbered area here covered lies in the Boreal forest (81a), as discussed before. Thelon River area is too isolated to constitute a valid extension, in so far as the vertebrate fauna is concerned. One mammal, the marten, and a few birds, are all that it does not share with the adjacent barrens. It lies outside the timber-line, but within the tree-line.

It may be stated again that except for the eastern end of Great Slave Lake, Lockhart River, and the Thelon route, there are no systematic notes published on the fauna of the "interior" of the Northwest Territories, and an almost total lack of collections, even from accessible places such as Reliance and Baker Lake (See 35, 3, 12, 182, 167).

MAMMALS

The arrangement of mammals in this list is after Anderson (10). Asterisks indicate species recorded from the Thelon game sanctuary.

1. Mule Deer *Odocoileus hemionus* (Rafinesque)

The extension of the "Jumper" into the Mackenzie region has been noted (10), but there is no known published account of its equally remarkable extension of range towards Hudson Bay. Information was given in 1929 by Mr. T. Lamb that it has occupied areas east of The Pas, Manitoba, in the last 40 years, and around Reindeer Lake in the last 15 years, and in 1937 it was learned that it had recently been discovered at the edge of timber, at Nueltin Lake. If it continues to extend its range it will soon occupy the wooded part of the region considered here, but can hardly be expected to extend out on the barrens.

2. *Moose *Alces americana* (Clinton)

The moose ranges to the tree limit and is not uncommon in the wooded part of the area (16, 17, 18, 145, 167, 90, 178). Two were killed at Artillery Lake in 1935, and they are seen regularly on Pikes Portage. Various government parties in the Yellowknife area in 1937 reported moose as regular but not common there.

Moose stray regularly out on the barrens, and it is in such a light that occasional occurrences on the Thelon are to be considered. From the meagre description given it is quite possible that the moose brought in to Back (110) was killed on the upper Snowdrift or Taltson rather than on the Thelon. Two obvious strays have been killed at Hudson Bay, as recorded by the Thule Expedition (37). One of the Eskimo met by us had killed a "Tuktoovuk" in 1936 at Beverly Lake, the only one ever found by them there, although they had heard stories of such things happening before. He identified a photograph of a female moose. While at Eskimo Point in September 1937 we noticed a moose hide on a cache, and found in a tent nearby the man who had killed the moose. He had killed it during the previous season at "Hikoligdjuak" (Yathkyed Lake), and we learned that another one had been taken there that season. In



Aerial view of Grassy Island region, Thelon River, summer home of many herds of musk-oxen.
(Photograph by Royal Canadian Air Force.)

November 1937, one was killed near Eskimo Point, according to a report from the R.C.M.P. there. Hanbury (83) found fresh signs on the Thelon, and J. W. Tyrrell (190) found moose horns embedded in the sand of the river in two places. No moose has ever been encountered there, and we saw no sign at all.

3. ***Barren Ground Caribou** *Rangifer arcticus* (Richardson)

Subject of a special discussion (See page 84).

4. **Woodland Caribou** *Rangifer caribou* (Gmelin)

Woodland caribou are very rare in Reliance district, and only occasionally reported within the limits of this list, in the region south of Great Slave Lake. Ingstad (97) mentions killing four at Nonacho Lake, and has a photograph of a dead animal. North of the east arm of the lake, and in the islands, it is reported absent (See also Russell (161)), and in view of this fact it is necessary to question Hearne's (90) account of it there. He says that no other species except moose is found when actually that statement is true of the barren ground caribou. He also states that they are "sandy red during the winter", which fits the barren ground better than the woodland deer.

Probably no Canadian game animal is in greater danger of extermination than the woodland caribou. Its abundance must have been only local at all times. Haviland (88) says that in the international reindeer zone in Scandinavia the maximum population per unit is one deer to 4.44 square miles. As this is in part a woodland area, it suggests a comparison with our woodland caribou range. The inference is that the maximum possible population in Canada is under half a million woodland caribou. Today most of the range has been ravaged by fire, which largely ruins an area for caribou for a long period of years. In consequence, the woodland caribou must be numbered in scattered tens and dozens, rather than thousands.

In Reliance area the range of the woodland caribou is overrun for more than half the year by herds of the barren ground species. This must greatly reduce the carrying capacity for the woodland caribou.

5. ***Musk-Ox** *Ovibos moschatus* (Zimmerman)

Subject of a special discussion (See page 73).

6. **Black Bear** *Ursus americanus* Pallas

In the wooded portion here considered the black bear is common (16, 12, 57). On September 9, 1936, fresh signs were seen on Utsingi Point, Great Slave Lake. Just prior to our arrival at Reliance in 1937 a certain amount of damage had been done to the Domex buildings by a cinnamon frequenting that part of Fairchild Point. Corp. J. Robinson gave information in 1936 of a white individual reported by the Indians, but not killed by them. Mr. A. M. Perry of the Geological Survey reports signs of bear common in the Yellowknife area in 1937, and Mr. G. H. Wood of the Dominion Water and Power Bureau observed two in the same region.



Aerial view continuing, except for a short gap, downriver from Plate XII. Arrow indicates position of musk-ox in Plate XIX. Farther downriver is "Hornby's bend." (Photograph by Royal Canadian Air Force.)

Hanbury (83) reported black bears on the Thelon. He did not see one and because, apart from his suggestion, no evidence has ever been found of such an occurrence, whereas the barren ground bear is well distributed on the Thelon, it must be assumed that the signs he observed were of the barren ground bear. Freuchen (37) gives several accounts of the supposed occurrence of the black bear in the barrens. None was based on personal observation, and no account whatever is taken of the possibility that the barren ground bear might be involved. The Eskimo name used (aklaq) is that by which the barren ground bear is known to the same group of Eskimos (*See also* 151). A brown bear shot in 1936-37 in the Padley district is nearer to the known range of the black bear than to that of the barren ground bear.

7. *Barren Ground Bear *Ursus richardsoni* Swainson

A recognition of this species in this area is implied in Hearne's (90) "Grizzle Bear Mountain" in the barrens. However, it was definitely identified by Franklin's (60) first expedition. It was reported by the Indians at Grizzle Bear Lake, and four were seen (one killed) on the Coppermine. It was identified on the Thelon by Tyrrell's (190) party, one being killed. Wheeler's party (195) killed one, presumably near Fort Enterprise, and Harper (85) notes one probably killed in the same region. One was traded at Fort Rac in 1937 by an Indian.

In 1936 there was at Reliance a skin and skull of the barren ground bear, the property of Mr. George Magrum, one of the barren ground white trappers. The bear was shot at Outram Lakes in August 1935, and was in a short, very dark pelage except for an unshed area of bleached winter fur along the back.¹ In 1934 several of these bears were observed in the region of Aymer and Musk-ox Lakes. Mr. Alan Stewart saw tracks near Musk-ox Lake as late as November. Information was given at Reliance in June 1937 that signs of this bear were seen in 1936 at Outram Lakes. In 1930 one was shot at Artillery Lake by the Indian Catholique's two sons, Jean Baptiste and Jerome. The Reliance Indians know the species well, and call it *Sass cho*, the big (or great) bear. *Sass cho* is seldom molested by them, prudence and veneration being apparently combined in their attitude (*See also* 97). Most of their observations are made at Artillery Lake, the part of the barrens most visited by them.

In 1937 we found few signs of bears on the Hanbury until the cataracts were reached. In this region, where carrion in the form of caribou, carried over the falls is fairly abundant, bear tracks were quite well distributed, it being impossible to say how many bears were involved. At our camp at the foot of Dickson Canyon the following measurements were made at an impression in the sand at the enlargement of the river:

	Mm.
Hind foot without claws.....	200
Claws	60 or 100
Breadth of hind foot.....	160
Front foot without claws.....	140
Claws.....	60
Breadth of front foot.....	180

¹This specimen has recently been acquired by the National Museum of Canada.

It was impossible to find a clear hind claw impression. As the foot measurement is of the implanted surface and the tip of the heel bone probably did not touch the sand it will be seen that the track was of a big bear, impressive to see in the sands of the barrens, where somehow or other one never thinks of such an animal. On July 10, the writer made a trip across to the head of the canyon, picked up a load and returned. About one-quarter mile from the foot of the portage (and our tent) was a small sand ridge, which lay in the course that we were following. Dropping the load and heading back at once, the sand hill was reached only a few minutes after it had been crossed with the load. In the interim a bear had dug out a Parry's ground squirrel. While the writer was examining the excavation Mr. Hoare appeared from the other direction with a pack that he was portaging. Despite the fact that the bear must have been close, at least at the first, we did not see him though we hunted all day.

Tracks were seen again below Grassy Island. At the point where we met the Eskimo wood-gathering expedition there were quite a few signs. The name of the region just across the river is recorded by Rasmussen (151) as "Aklajet," the place of land bears, the present species being certainly the one meant. When they went away from camp all carried their rifles and laid them aside only to work, for, as they said, though one rifle may do for getting meat it might not be enough for a bear. These people informed us that on July 18, not long before our arrival, they had fired at a female with cubs, at their camp, and missed. At least two had been killed recently at Beverly Lake, one at the mouth of the Dubawnt, apparently an eastern record. Another Eskimo sketch map recorded by Rasmussen has the place-name "Aklaktok" on Back River somewhere above the great lakes. There is no doubt whatever of the identity of these bears as barren ground bears.

The distribution of this bear is hard to explain. It is also present in numbers for a short time in places that have not known it as common for some time. During his residence on the Arctic coast Mr. Hoare once saw more than twenty in one summer at Inman River, none having been seen the summer before at that place. They must fluctuate and wander widely, as surely the bear production of one season in one locality is not as great as twenty.

The occurrence of the barren ground bear on the Thelon should be an occasion for rejoicing. Here at least should be one place where they may be freed from the threat of destruction at the hand of man. There is no reason for supposing them prejudicial to the increase of the musk-ox or of any other animal there. In the barren lands generally they may be as numerous as the musk-ox, but on the Thelon the bear is much the rarer of the two.

One is recorded in the Baker Lake fur returns for 1928-9. The R.C.M.P. report one killed by Eskimos at Rum Lake in 1937. These natives reported the barren ground bear as uncommon, and most of the records given by the police refer to the coast.

8. *Marten *Martes americana* (Kerr)

All the wooded area around the eastern end of Great Slave Lake is the home of the marten, though of late years they have seldom been

common. Marten were taken near Reliance in 1935, and it was learned that 1936 was an unusually good marten year around Snowdrift (See King (110)).

There was no sign of marten on the Thelon, but, apart from tracks in the sand, our discovery of their presence could only have been an accident. However, in grubbing around Hornby's cabin in 1937, in hopes of finding skulls (a wolverine skull having been found in 1936), the skull of a marten was found. The publication of Christian's diary (28) reveals that in 1926-7 marten were found to inhabit the woods at the cabin. One is noted as captured, and one as having escaped. It is doubtful if more than a scattered few occur on the Thelon.

Freuchen saw a marten traded at Baker Lake in 1923 that had been trapped at Yathkyed Lake (37). One was also traded in 1930-1, according to the fur returns from that post.

9. **Richardson Weasel** *Mustela cicognanii richardsonii* Bonaparte

This weasel was noted by Seton at Kah-d'nouay Island, Great Slave Lake (167), and is probably the one found at Reliance, where weasels of an appropriate size are not uncommon.

10. **Least Weasel** *Mustela rixosa rixosa* (Bangs)

Seton (167) got a specimen of the least weasel at old Fort Reliance. It is interesting to read in Christian's diary (28) that on January 4, 1927, at Hornby's cabin, on the Thelon, he "got 1 very small Weasel." This suggests a possibility of least weasels on the Thelon. No weasel remains at all were found at the cabin.

11. ***Arctic Weasel** *Mustela arctica* (Merriam)

Available records indicate the Arctic weasel to be well distributed on the barrens (4a, 145, 191, 167). A number of weasels, probably of this species, were taken by the Hornby party (28). There remains, however, a possibility of some of these being Richardson's weasel. In 1936 Mr. Hoare shot one at Hanbury Portage. In 1937 the writer got one at the portage on the lower Thelon River, and several were collected for him by Eskimo children at Baker Lake.

12. ***Mink** *Mustela vison* (Schreber)

It is claimed by fur traders that the mink around the east end of Great Slave Lake and Fort Rae are smaller and darker than those of Slave River. According to R. M. Anderson, this statement corresponds with the characters given for the Hudson Bay mink, *M.v. lacustris* (Preble), and the north-western mink, *M.v. ingens*, which should meet in this area.

During the season of 1935-6 a mink was taken on Back River by Mr. Alan Stewart, and several were taken on Ptarmigan River. Of the latter, we were able to get some carcasses with skulls from Mr. A. J. Knox. In 1936-7 Knox only got one mink there.

13. ***Wolverine** *Gulo luscus* (Linnaeus)

So far as can be ascertained the wolverine inhabits all of the region here considered (4a, 110, 138, 41, 191, 145, 16, 17, 35, 95, 28). Hornby and

Critchell-Bullock trapped a few on what is now the west border of the Thelon sanctuary (35). Knox has taken them also at the west border of the sanctuary, and they are taken by all the Reliance group of white trappers. Hornby's party apparently found them not uncommon in winter on the Thelon. On our first visit to the cabin, on July 21, 1936, a skull was picked up that had been boiled for food until the sutures had given way. In August 1936 one was seen near Beechy Lake by Mr. Eric Fry, of the Air Surveys Section, and in 1937 we saw tracks in the Hanbury cataract region. Seton records a female with young at Artillery Lake.

14. **Otter** *Lutra canadensis* (Schreber)

Otter were reported at Reliance as occurring in the east end of Great Slave Lake. Douglas (40a) records an otter taken at Baker Lake just before Christmas 1927, possibly the same animal as that later recorded by Blanchet (19). Information was given in 1937 of recent occurrences in the vicinity of Padley, so that there are occasional wanderers on the barrens. Mr. G. H. Wood reports seeing old sign in the Yellowknife region in the summer of 1937.

15. ***Coloured Fox** *Vulpes fulva* (Desmarest)

The coloured fox is found in fluctuating abundance in the wooded portion, and at intervals wanders far out on the barrens (16, 19, 35, 95). The term "Coloured" is used advisedly, because a high proportion of the catch along the edge of timber is made up of cross, silver, and black foxes. One of the barren land trappers was reported to have taken all coloured foxes in 1936-37. A few are traded at Baker Lake. Among the articles found by the R.C.M.P. (28) at Hornby's cabin is noted the remains of a silver fox skin. Coloured foxes may yet be found summering on the Thelon; Mr. Hoare saw a den that may have belonged to this species.

16. ***Arctic Fox** *Alopex lagopus* (Linnaeus)

The white fox is spread throughout the barrens in summer in varying abundance. In 1936 we saw them at Hanbury Portage, and signs at Plover Lake, Prairie Lake, Artillery Lake, Eileen Lake, and Ptarmigan Lake. Ordinarily they penetrate a short distance into the timber in winter. In some years they travel far to the south and west. In 1937 signs were scarce in the western part of the Thelon sanctuary, and only a few tracks and one individual (Shultz Lake by Mr. Hoare) were seen in the east. Their fluctuations are discussed elsewhere (See page 66). Skulls from Artillery Lake, Ptarmigan Lake, and Baker Lake were brought out (records are to be found in 4a, 12, 138, 41, 83, 167, 35, 189, 16, 17, 18, 37, 115).

Blues are scarce, but a few are brought in both to Baker Lake (37) and to Great Slave Lake (115).

17. **Coyote** *Canis latrans* Say

Corp. J. Robinson, R.C.M.P. at Reliance in 1936, stated that a coyote was found during the trapping season of 1935-6 at Timber Bay, Artillery Lake, by an Indian. In 1937 it was learned that a coyote had been taken at the edge of timber inland from Eskimo Point. The R.C.M.P. (158)

have recorded its appearance in 1928 on Anderson River. It would seem that the occupation of the wooded country by this species is now complete, whatever it may have been in the past.

18. ***Wolf** *Canis lupus* Linnaeus

Wolves are found throughout the region here considered (4a, 60, 110, 83, 189, 191, 25, 167, 16, 17, 18, 19, 35, 37, 95, 160, 93). In the wooded parts the wolves are just as white as on the barrens (cf. Blanchet July 8, 1925, on the upper Talston (18), and photograph in Blanchet (16) taken at Taltheilei Narrows, Great Slave Lake on July 1, 1924). Throughout the area many wolves are quite white, still more are largely white, and some are brindled, black, or even yellowish. The numbers and packing of wolves are discussed with the caribou. In 1936 we saw signs everywhere, and individuals at Plover Lake, Clinton-Golden Lake, and Smart Lake. Quite a few were seen from the air by the Royal Canadian Air Force. In 1937 we saw signs in many places and encountered six individuals. Skulls were collected at Artillery and Ptarmigan Lakes.

19. **Dog** *Canis familiaris* Linnaeus

There were apparently once two well-marked strains of dog in the country—the Indian dog, long-legged and suited to travel in the bush, and the more short-legged Eskimo dog, adapted to the barrens. There has been a great deal of mixture between one region and another and with shepherd dogs and other inferior breeds, so that modern dogs are said to be less hardy, and, in particular, tender-footed. There is still a sufficient stock for breeding purposes, and if good working animals were carefully bred by those in a position to do so, without bringing in outside stock, there is no reason why the tough-footed and vigorous condition of former years could not become standard, and, with good care and feeding now prevalent among white men, all former performances would surely be surpassed.

The comparative isolation of both eastern and western ends of the Thelon country suggests a possibility that a purer stock might exist there than elsewhere. Certainly dogs belonging to R.C.M.P., white trappers, and natives of the Reliance area were not excelled by those of more western posts, and ran to a large, long-legged type. Dogs seen at Beverly Lake were of the true Eskimo type, but heavier than those of Baker Lake and Chesterfield.

The diseases and distemper of dogs are dealt with elsewhere (See page 70).

20. ***Canada Lynx** *Lynx canadensis* Kerr

In the wooded part of the region the lynx is of regular occurrence in fluctuating numbers (See 167). It wanders out on the barrens only on occasion. The Beverly Lake Eskimos had never encountered such an animal, though they thought it might be something of which they had heard other Eskimos speak. Seton (167) records taking one on Artillery Lake, within the present sanctuary. The Thelon rises in "Cheezy-tha tue", or as the Indian himself translates it, "Lynx Sit-down lake", signifying that a lynx had been found there rather than that they "stopped" or were regular inhabitants there.

21. ***Parry's Ground Squirrel** *Citellus parryi* (Richardson)

This animal is found in all parts of the barrens included here (154, 12, 110, 145, 138, 37, 144, 95, 16, 19, 35, and presumably also the "Ground hogs" of 4a and 41). If Artillery Lake is any criterion its limits should, in the interior, be the same as the timber-line. We found it abundant at all our stations in the barrens. After mid-August it is venturesome and more conspicuous, apparently preparing for winter. Critchell-Bullock (35) gives October 20 as the last day on which it was seen above snow and May 23 as the date of emergence. Porsild found it numerous at Yathkyed Lake, and on the Kazan, in 1930.

22. **Red Squirrel** *Tamiasciurus hudsonicus* (Erxleben)

Abundant in timber (57, 110, 167) up to its limits. On Crystal Island, within hearing of the border of the Thelon sanctuary, the "farthest out Red Squirrel" was collected.

23. **Beaver** *Castor canadensis* Kuhl

Hearne (90) reported beaver around the eastern end of Great Slave Lake, and Blanchet (18) encountered them on the upper Taltson. The writer was informed that there were some good beaver colonies on the upper Snowdrift, which appears to be the only place in the Reliance area where beaver management could reasonably be attempted. At the foot of Kipling Lake, on Pikes Portage, there are ancient signs. Mr. G. H. Wood found signs in the Yellowknife region in 1937. According to information received from the R.C.M.P. two beaver were seen in the autumn of 1937 at Eileen Lake.

24. **Northern White-footed Mouse** *Peromyscus maniculatus borealis* Mearns

Abundant up to timber-line; none collected at Crystal Island, however (See 110, 57, 167, 35). Specimens were taken at Reliance, especially in buildings.

25. ***Back Lemming** *Lemmus trimucronatus trimucronatus* (Richardson)

First described from Point Lake (153), it is, so far as can be judged, well distributed on the barrens (12, 110, 167, 35, 37). Many popular accounts do not distinguish the species of lemmings, despite the fact that the next turns white in winter, whereas this one does not. It was collected at Clinton-Colden Lake, Beverly Lake, and Baker Lake. As discussed elsewhere, we were not favoured with an abundance of lemmings of either species. A. E. Porsild found it common in 1930 on the Kazan.

26. ***Richardson Collared Lemming** *Dicrostonyx groenlandicus richardsoni* Merriam

Like the preceding, apparently well distributed, but often not distinguished (35, 12, 60, 167, 37). We got it at Clinton-Colden Lake, Heuss Lake, and Baker Lake, and it was common on the Kazan in 1930, according to A. E. Porsild.

27. **Athabaska Red-backed Mouse** *Clethrionomys gapperi athabascae* (Preble)

Seton (167) records this species at Kah-d'nouay Island and "Caribou Island" in the Great Slave Lake Archipelago.

28. ***Dawson Red-backed Mouse** *Clethrionomys dawsoni dawsoni* (Merriam)

This is the red-backed mouse at Reliance, according to Seton (167). In 1936 the writer took it at Crystal Island, Artillery Lake. It is also the red-backed mouse of the barrens, where Seton (167) found it as far as Aylmer Lake, and it was taken in 1937 at three places on the Thelon and at Baker Lake. Its limits on the barrens are not known. Sutton (180) describes catching a red-backed mouse at Mistake Bay, but neglects to say which species it was.

29. ***Drummond Meadow Mouse** *Microtus pennsylvanicus drummondi* (Audubon and Bachman)

Within the limits of collecting done in this region, this field mouse is well (probably universally) distributed both in woods (167, 57) and barrens (167, 35), where it is the only form so far determined. In 1936 it was collected at Clinton-Colden Lake and at Crystal Island, Artillery Lake, and in 1937 one was taken about midway down the main Thelon. Several were seen in the grass, but it was hard to trap.

30. ***Muskrat** *Ondatra zibethica* (Linnaeus)

According to Mr. A. J. Knox, muskrats are found regularly in the ponds on Crystal Island, Artillery Lake, at the extreme edge of timber, and he once found a wanderer at Ptarmigan Lake. In the eastern end of Great Slave Lake there are few marshes suitable for large numbers of rats, and there is only one record (McDonald Lake (57)).

31. **Porcupine** *Erethizon* sp.

Recorded for the eastern end of Great Slave Lake (145, 41, 167).

32. ***Arctic Hare** *Lepus arcticus* Ross

Found in all parts of the barrens where travellers have penetrated (41, 161, 110, 28, 189, 60, 83, 145, 167, 16, 19, 35, 37, 195a). We saw it at Plover Lake, Artillery Lake, and Clinton-Colden Lake in 1936, and Sifton Lake and Aberdeen Lake in 1937. In no place was it abundant, but old droppings were found practically everywhere.

33. **Varying Hare** *Lepus americanus* Erxleben

This most famous of the periodic mammals is found around the eastern end of Great Slave Lake, and though seldom recorded, was first noted by Hearne (90, 57, 26, 51, 52, 55). We were told that it was scarce at Reliance in 1936 and 1937.

34. **Cinereous Long-tailed Shrew?** *Sorex cinereus* Kerr?

Shrews undoubtedly occur widely in the region both in the barrens (32) and in the woods, but the species has never been identified nor have

the shrews been properly recorded. None was seen or collected. When abundant (or as near that state as they get), they frequent the meat caches of white trappers and simply hole up for the winter in a carcass, surely an example of the abundant life.

Bats. Darrell's (145) account of bats (sp.) on the Hanbury is hardly credible, and cannot be included formally, as the observation has not been repeated. The bats, if found, must have been strays. A treeless country, which only has twilight for night in summer, can hardly be considered attractive to bats.

BIRDS

The greatest difficulty in obtaining notes on the birds of the district in which we worked was to get to work in time. In 1936 we arrived at Reliance in July. Eggs were hatching in the nests that we were shown there, and the first burst of song was over. When we got out on the barrens the shore birds were already migrating, and although other species still stayed around the "season of biological production" was over. In 1937 we reached the sanctuary in June. Nesting had just begun. In August, when bird study is most unsatisfactory, we were east of the Thelon sanctuary. We were on the ground at the right season, and were able to get a day by day record of a rich bird fauna, which would have been missed had we been there later in the season. Our use of paddles instead of a motor meant that in June and July, when the birds were singing, we could accumulate observations as we travelled.

Names and arrangements in this list are after Taverner (183). Asterisks indicate species recorded from the Thelon game sanctuary.

1. ***Common Loon** *Gavia immer*

Particular attention was paid to loons in the field, especially in 1937. The present species was not observed at all, either in 1936 or 1937. However, it must be kept in mind that field observations inside the timber-line were practically confined to Reliance. Observations by Preble (145), Fairbairn (57), Pike (138), and Seton (167) show the common loon to be common up to the timber-line. There are a few records on the barrens. King (110) noted one at Clinton-Colden Lake, and Seton (167) saw one on the same lake on August 28, 1907. Critchell-Bullock (35) identified this loon on August 2, 1925, on the Thelon, apparently well to the eastward. The "Great Northern Diver" mentioned by McKinley (41) as having been shot on June 12, 1890, south of Aylmer Lake on Pike's summer expedition may well have been a yellow-billed loon, as Pike (138) states specifically that the common loon "does not appear to visit the Barren Ground." Wheeler (195) mentions this species as having been shot on June 5, 1910, north of Lac de Gras, but in his account he makes no reference at all to the yellow-billed loon. The common loon appears to be found only occasionally in the interior barrens. Freuchen (96) did not distinguish this species from the next in his barren-land notes. One common loon specimen is recorded (96) from Baker Lake, where only *adamsi* was seen in 1937.

2. *Yellow-billed Loon *Gavia adamsi*

This species is abundant in the region, but its southern and eastern limits are not known. In 1936 it was found in the eastern part of Great Slave Lake, one being taken in a net (*See also* Seton (167)). On September 16, while the M.S. *Dease Lake* was windbound in Yellowknife Bay, a flock of this species, estimated to number 300 at least, with a few red-throated loons, swam around the island to which we were moored. Franklin (60) mentions it as the last of the waterfowl to quit Fort Enterprise in autumn. It was found to be abundant on Artillery, Ptarmigan, and Clinton-Colden Lakes (*See also* 35, 16, 17). At Prairie Lake a group of four seen August 4 appeared to be composed of two adults and two young. In 1937 the yellow-billed loon was found from the headwaters of the Hanbury to Baker Lake, where one was lying dead on the beach when we arrived. A. E. Porsild found it common on Yathkyed Lake and the lower Kazan. South of Yathkyed and Eileen (18) Lakes the observations needed to fix its limits are lacking. Critchell-Bullock (35) gives its arrival date on the headwaters of the Hanbury as May 30, 1925. He found two nests on June 27, below Sifton Lake, and another on July 1. We found a nest with two eggs on an island in the river between Heuss Lake and Smart Lake on June 21, 1937, and two nests of two eggs each on June 29, in the river below Sifton Lake. As the loons were abundant, many sets might have been found by systematically visiting small islands. All nests were on ice-push islands.

3. *Arctic Loon *Gavia arctica*

Except for one questioned identification in the Inconnu Channel in Great Slave Lake, no notes were made of this species in 1936. In 1937 it was noted in the Thelon marshes, from the Junction down, though not found in 1936 north of the river. East of the sanctuary, particularly on Aberdeen Lake, it was common. Critchell-Bullock (35) records it only east of the sanctuary (breeding on Aberdeen Lake), and Tyrrell (189) writing of the birds seen on the Dubawnt and Kazan, remarked of this species that it was encountered towards the shore of Hudson Bay (*See also* 96). Porsild considered it very common during the month of August 1930 on Yathkyed Lake and the lower Kazan. A specimen in the collection of Mr. Hoyes Lloyd was taken at Baker Lake by W. O. Douglas.

It is evident from Seton (167), Fairbairn (57), and Preble (145), that the Arctic loon is a regular inhabitant throughout the eastern part of Great Slave Lake, within the timber-line. Records by Seton (167) for Clinton-Colden Lake (August 12, 1907) and Aylmer Lake (August 13, 1907), and one "shot by Mr. Pike (41) on June 11 near David's Lake" (south of Aylmer Lake), show that it is occasionally found in the rugged barrens near Great Slave Lake, though certainly scarce or irregular. This leaves a hiatus in its distribution, as it is found at timber-line, not found on the innermost barrens, and found again towards Hudson Bay.

4. *Red-throated Loon *Gavia stellata*

So far there has been no area found within the region where this loon is not common (167, 145, 189, 138, 57, 96, 35). In 1936 it was noted on

Great Slave Lake and thence to Clinton-Colden Lake, and in 1937 it was found all along the route followed. Critchell-Bullock (35) found a nest on Sifton Lake on June 25, 1925. The writer found a nest of two eggs on Smart Lake on June 25, 1937, and collected a young bird at Hanbury Portage, Clinton-Colden Lake, on August 18, 1936. It was common on the Kazan and Yathkyed Lake, according to Porsild. Two specimens in the Lloyd collection were taken at Baker Lake by W. O. Douglas.

5. Pied-billed Grebe *Podilymbus podiceps*

A record of this species on Murky Lake by Fairbairn (57) is, curiously enough, the only grebe record found for the region treated in this list.

6. *Whistling Swan *Cygnus columbianus*

There are a number of accounts (12, 41, 167, 35, 28) of migrating swans being seen in the western part of the region. Among them Back (12) remarks that a place apparently near the present site of Snowdrift was resorted to by the Indians for the purpose of shooting swans. Hornby and Critchell-Bullock (95, 35) were the first to report that swans bred in the Thelon marshes between the Junction and Beverly Lake. We found, in 1937, twelve adults spread over more than 100 miles, and one additional bird was considered to be a well-grown young one. Cygnets must have taken cover as we came along. Freuchen (96) reported them as occurring in summer at Baker Lake. Porsild observed none on the Kazan.

7. *Canada Goose *Branta canadensis*

There are some Canada geese in the eastern part of Great Slave Lake; we have breeding records from Anderson (4a) and Seton (167). They are not common on the barrens of the western part of the Thelon sanctuary and adjacent regions. The writer saw twenty-five on Artillery Lake on August 12, 1936. Seton (166, 167) records twenty on the same lake on September 20, 1907, King (110) notes them on Clinton-Colden Lake in June 1834, and Richardson (153) records them at Fort Enterprise May 12-20, 1821. On the Thelon we found them abundant, commencing with Sandy Lake, on the Hanbury. On July 20 a brood of downy young was seen above Grassy Island. Specimens taken here are referred by P. A. Taverner to *B.c. leucopareia*. Hanbury (83) found them nesting on the Thelon. East of the sanctuary they were abundant, to and including Baker Lake (*See also* 96). According to Hoare (93), they arrived at the Junction on May 27, 1929. Tyrrell (189) saw them on Dubawnt Lake. From the writings of Back (12), King (110), and Anderson (5, 6), it is evident that they are very abundant on Back River from the Junction of the Baillie down to the great shallow lakes. The Anderson and Stewart party were able to feed largely on Canada geese (4a, 5, 6), most of which were killed on Back River, though some were taken farther west. J. W. Tyrrell (190) called attention to the abundance of geese on the Thelon. Porsild saw a large flock on Baker Lake and found many on Kazan River.

8. *White-fronted Goose *Anser albifrons*

The observations of Blanchet (16, 17), Pike (138), Anderson (4a), McKinley (41), Seton (167), Wheeler (195), and Richardson (182) show

this species to be tolerably common in the region of the upper waters of the Coppermine (195, 16), the Back (4a, 138), and the Lockhart (16, 167, 41). Wheeler (195) gives its arrival date for 1910 at Fort Enterprise as May 23. It is obviously on its breeding grounds (note particularly 138, 16, 17) in an area not much frequented by other species of geese. Critchell-Bullock's (35) observations extend the region of its occurrence to include also the headwaters of the Hanbury, where he established a breeding record on July 12, 1925, by the collection of a downy young bird. He notes its arrival at Smart Lake on May 26, 1925. We observed none on the Hanbury, possibly because we were on the headwaters before hatching time and canoe travel is not conducive to finding nests. However, this species cannot be abundant there in the sense that the Canada goose is abundant at Beverly Lake, or we could not have missed them. We saw the white-fronted goose on only one occasion, a flock of fifteen on the Thelon about 30 miles above Beverly Lake on July 31, 1937. Critchell-Bullock (35) likewise noted two flocks well down the Thelon in July. It is impossible to tell from these observations whether or not the Thelon region is included in the breeding grounds of this species.

This species is undoubtedly the "Blue Goose" which trappers insisted breeds near Musk-ox Lake.

9. ***Snow Goose** *Chen hyperborea*

"Waveys" pass through the region of the eastern part of Great Slave Lake, and the barrens to the east of it, both in spring and autumn (93, 35, 166, 138, 60, 195). Autumn dates are in September. Its arrival is recorded on the Hanbury headwaters on May 27, 1925 (35), and at Fort Enterprise on May 26, 1910 (175).

One individual of this species was seen in the Thelon sanctuary on July 31, 1937, with the flock of white-fronted geese noted above. Just east of the sanctuary, on Beverly Lake, we encountered a flock of adults and young on August 7, 1937. It also occurs around Baker Lake, where Porsild saw large numbers unable to fly on the mountain Nauhak on August 29, 1930 (See also 96), and may presumably be expected anywhere in the region between Baker Lake and Beverly Lake, though none was seen. It is scarce compared with the Canada goose, according to our observations.

10. **Blue Goose** *Chen caerulescens*

Stated in Richardson's appendix to Parry's second voyage to have been seen at Fort Enterprise (153).

11. **Ross's Goose** *Chen rossi*

Hearne's (90) is the only authentic observation of this species in the interior barrens, and it obviously concerns the bird as a migrant and not on its breeding grounds. It certainly migrates through the barrens now, but in the interior there are very few observers there at the right time to record it. Mr. M. P. Murphy in September 1934 saw a flock of small white wavies, which he thinks may have been galoots, on Musk-ox Lake.

There has been a great deal of speculation concerning the breeding ground of this species, as yet undiscovered. Most of the white men in the north have been circularized, and it is possible to make something of the

results. From the mouth of the Mackenzie to Bathurst Inlet are many white men, traders, trappers, and others. East of Bathurst Inlet white trappers are excluded, but there are still many white men. Along the Hudson Bay coast similar conditions prevail. No observations of Ross's goose have been forthcoming, which suggests that the species may not cross into the islands. In the interior we have from Hearne (90) as good a hint as any yet available. He remarks that though the Indians in their summer walking excursions on the barrens often found the nest of the white-fronted goose, no one had ever seen that of the "Horned Wavy", in those days much more abundant than now. It may be remarked in passing that a walking party of a hundred or so with children and dogs would find just about any kind of nest there to be found. This information excludes a large area. We have left the Back River drainage, which has been travelled by King (110, 12), a naturalist under Richardson's directions, and the areas between Back River and the coast, and between Back River and Committee Bay, which have been travelled by no white men at all in summer. The only report of Ross's goose breeding obtainable referred to the headwaters of Ellice River, and might well be true. Anderson (4a) mentions "Laughing Geese" in addition to "Gray Wavies" on Back River. If Ross's goose is meant then they were migrants. It is assumed the "Gray Wavies" were white-fronted geese.

12. **Mallard Duck** *Anas platyrhynchos*

Noted at Basile Bay, Great Slave Lake by Fairbairn (57).

13. ***Black Duck** *Anas rubripes*

The writer jumped a black duck from one of the lagoons of Finnie River on July 26, 1937. It was seen at very close range. Some 30 miles below the Finnie a small flock was seen on the Thelon on July 29.

14. ***Pintail** *Dafla acuta*

It is possible that this species occurs to some extent in all of the region here considered. In 1936 no sign was seen of it except a mummified head lying on the shore near the north end of Artillery Lake. In 1937, however, a few were found on the Hanbury, and it was abundant in the Thelon marshes, where many broods of young were seen. It was not seen east of Beverly Lake, to Baker Lake, but may yet be found to occur in that area. Considering its abundance in the Thelon marshes, it is highly probable that it occurs also in the marshes of Back River. For the east end of Great Slave Lake and the tributary region there are practically no records to be found. Wheeler (195) noted it on May 26, 1910, at Fort Enterprise. Porsild saw none in the Keewatin interior.

15. ***Green-winged Teal** *Nettion carolinense*

On July 20, 1937, at the Grassy Island marshes on Thelon River a single individual of this species was observed. It performed the "broken-wing" show repeatedly, sometimes coming within a few feet of us, but we saw neither nest nor young. Preble (145) reports it on the Simpson Islands of Great Slave Lake and at Gros Cap.

16, 17. *Scaup Duck

In 1936 (August 12) the writer fired into a brood of scaup ducks on the Ptarmigan River section of the Lockhart, getting a young bird, which cannot be identified to species. On July 26, 1937, a female scaup duck with a brood of young was seen on one of the lagoons of Finnic River. The female flew and the young were spared as useless for identification. Critchell-Bullock (35) saw scaups on the Hanbury. Preble (145) took a pair of *Nyroca marila* on Loon Island in Great Slave Lake. Seton (167) identifies as *N. affinis* scaups observed on August 17, 1907, on Aylmer Lake.

18. Buffle-head *Charitonetta albeola*

The buffle-head was recorded at Gros Cap by Preble (145).

19. *Old-squaw *Clangula hyemalis*

On the barren land lakes this species is abundant in all areas from which we have records (16, 110, 167, 35). We saw many groups of young at Plover and Prairie Lakes and at Hanbury Portage in 1936, and many observers speak of them as breeding. It does not frequent the Thelon marshes at all, though it may be found on barren land lakes within a short distance of the river (See also 35). Critchell-Bullock (35) records its arrival at Smart Lake on June 1, 1925, and Freuchen notes its occurrence at Baker Lake and Yathkyed Lake (96). In the Kazan River-Yathkyed Lake area Porsild found this the only common duck.

20. King Eider *Somateria spectabilis*

A specimen in the National Museum of Canada was taken at Baker Lake in June 1926 by W. O. Douglas. Freuchen (96) notes this species for Baker Lake. The writer was told that eiders (sp. ?) were found there, but saw none.

21. *White-winged Scoter *Melanitta deglandi*

From being common in some localities in the eastern part of Great Slave Lake (167, 57), this species extends in numbers obviously not large into the barrens. Seton (167) saw four on Artillery Lake in September. Critchell-Bullock (35) observed it at Sifton Lake (June 27, 1925) and Helen Falls (July 20, 1925). Four were seen on the Thelon just below Finnic River on July 27, 1937, and several others farther down the river on July 31.

Although this is the only species of scoter definitely recorded on the interior barrens, scoters of one or both of the other species were noted on the Hanbury, unfortunately not under conditions permitting identification.

22. Surf Scoter *Melanitta perspicillata*

Not positively identified, though large flocks seen out in Yellowknife Bay in mid-September 1936 were probably surf scoters. Seton (167) records this species in numbers in the eastern part of Great Slave Lake. Wheeler (195) notes them as arriving at Fort Enterprise on May 15, 1910, and remarks that a fully developed egg was found in a female killed May 24.



Aerial view of Finnic River flats, with growth of spruce and tamarack. Note also glacial striation. (Photograph by Royal Canadian Air Force.)

23. **American Scoter** *Oidemia americana*

In some small flocks of scoters seen on July 8 in the islands of Great Slave Lake on the Inconnu Channel the "butter-bill" was prominent, and together with the glossy blackness of the plumage identified them as this species. MacFarlane (116) records that "two males and one female of this species were procured by the late Mr. James Flett, the Manager of Fort Resolution, Great Slave Lake, two of them from 'Fond du Lac'" (Reliance).

24. ***Common Merganser** *Mergus merganser*

The identification of mergansers in the field is often not easy. The writer is convinced that both this and the next species are found through the region under discussion. No mergansers were seen on the big lakes below the sanctuary. The present species was identified on both the Hanbury and Thelon in 1937, and doubtfully on Great Slave Lake in 1936.

25. ***Red-breasted Merganser** *Mergus serrator*

This species, like the preceding, was identified on both Hanbury and Thelon Rivers in 1937, and doubtfully on Great Slave Lake in 1936. Seton (167) called it abundant on Great Slave Lake and thence northeast to Clinton-Colden Lake. Porsild reports it as seen on Kazan River and Yathkyed Lake in August 1930.

26. ***Sharp-shinned Hawk** *Accipiter velox*

One was seen on Acres Lake (Pikes Portage) on September 3, 1936, and one at a clump of trees on the Thelon just below the Grassy Island marshes on July 21, 1937. Blanchet (16) records one from the west end of MacKay Lake.

27. ***Common Rough-legged Hawk** *Buteo lagopus*

The abundance of this hawk on the barrens and elsewhere may well fluctuate with its food supply. At least we saw none in 1936 and a fair number in 1937. It is found within the fringe of the wooded area as well as on the barrens (167). Most observers have noted it as abundant on the barrens (16, 35, 167). In the Keewatin interior it was considered quite common in 1930 by Porsild.

We noted eighteen locations for this species in 1937 from Hoare Lake to Baker Lake, all at cliffs. At Dickson Canyon we looked down from the top of a cliff and saw three young in a nest. Many of these birds were dark.

That this bird does not always nest on cliffs is seen from a nest on Hoare Lake, not now occupied but which was at the time of Mr. Hoare's visit in 1929. It is on the top of a big stone on the skyline of a hill.

Critchell-Bullock (35) noted nests at Dickson Canyon and Helen Falls, each with two young. There was no nest at Helen Falls in 1937. A nest containing three eggs was found by Lofthouse on Tyrrell's exploration of 1900, at Artillery Lake (June 4, 1900) (116).

28. ***Golden Eagle** *Aquila chrysaetos*

The few accounts available seem to indicate that the rugged country around the east end of Great Slave Lake is favoured by the golden eagle. McLean (117) reported a nest on a cliff in the islands. It was noted there by Seton (167) and at Gros Cap and in the islands by Preble (145), and Blanchet (18) reports one seen by him at Nonacho Lake. Records of this bird on the barrens indicate that it is only to be found a short distance beyond the edge of timber. The only two reports are, in fact, those of Seton (167) for Musk-ox Lake and Clinton-Colden Lake. Hornby (95) reports a pair nesting in 1921-22 north of Fort Reliance on Lockhart River.

On July 20, 1936, a visit of a few minutes duration was paid to the cache on Crystal Island, Artillery Lake, at the extreme edge of timber. As we walked towards the cache an eagle identified as a golden eagle flew away from the cliff. When we returned in August there was no eagle to be found, but of two nests on the cliff one bulky one was attributed to it and another smaller one to the peregrines, which were still about. Lofthouse (190) records "eagle's eggs" as found at Artillery Lake. It is considered that if the golden eagle is found at all in the barrens, the cliffs along the Thelon would be a most suitable place. We did not see it there. Mr. John Carroll reports that a pair of eagles frequented a cliff at Gordon Lake in the summer of 1937.

29. **Bald Eagle** *Haliaeetus leucocephalus*

This bird is recorded as common around the eastern part of Great Slave Lake. It is noted by Back (12), Preble (145), Seton (167), Fairbairn (57), Hornby (95) (two nests), and Christian (28) (nest with two young).

30. **Marsh Hawk** *Circus hudsonius*

The region of the eastern part of Great Slave Lake provides few places suitable for this species, and the only record is that by Fairbairn (57) for Murky Lake. Blanchet (16) mentions it around Artillery and MacKay Lakes in the barrens; we have no further observations to confirm its presence there.

31. **Osprey** *Pandion haliaeetus*

There is an observation of the osprey at Talthcilei Narrows, Great Slave Lake, by Seton (167), and in the Simpson Islands by Preble (145).

32. ***Gyr Falcon** *Falco rusticolus*

Richardson's (182) finding of a nest of this species at Point Lake in 1821 is the only breeding record in the eastern interior barrens. Porsild saw one in late August 1930, near the falls of Kazan River. It is often seen in winter (95, 35, 28). Trappers describe the birds as varying considerably in colour, with many quite dark.

33. ***Peregrine Falcon** *Falco peregrinus*

We found the peregrine in 1936 at Crystal Island, Artillery Lake, and in 1937 at twenty-one "locations" from Timber Rapids to Baker Lake (See

also 95, 35). It would be surprising if it were not found among the cliffs of the east end of Great Slave Lake, where it would not be much molested. The fact that it has not been recorded shows how little attention has been paid to this region. Besides localities above, Seton (167) notes it on Clinton-Colden and Aylmer Lakes.

Critchell-Bullock (35) found nests at Timber Rapids and Helen Falls. The writer is convinced that all of the above twenty-one locations are nesting sites. In some cases the young could be seen. On July 1, 1937, four eggs were seen on the second portage at Timber Rapids.

34. Pigeon Hawk *Falco columbarius*

Fairbairn (57) found this hawk common at Snowdrift and Murky Lake. Seton (167) collected it at Reliance. One was seen on the barrens at Ptarmigan Lake on August 17, 1936, and two at timber-line at Crystal Island, Artillery Lake, on August 31, 1936. Birds seen by Porsild on the Kazan on August 19, 1930, and at Baker Lake on August 27-29, 1930, could not from his description have been other than this species.

35. Spruce Grouse *Canachites canadensis*

Hearne (90) found this grouse common near the timber-line north of the east arm of Great Slave Lake in 1772. Fairbairn (57) reported it "common throughout" the region traversed by him, and Preble (145) took a female accompanied by grown young in the Simpson Islands. Mr. Hoare observed this bird on Pikes Portage during his previous visit (1928-29).

36. Ruffed Grouse *Bonasa umbellus*

The Royal Canadian Mounted Police at Reliance report that a single bird was once taken there (presumably in 1934), which turns out to be the only record for the region under discussion. It was considered unique by residents and its presence there may have been connected with a peak in numbers on the normal range.

37. *Willow Ptarmigan *Lagopus lagopus*

This species is, so far as can be ascertained, distributed throughout the barrens in the breeding season (167, 189, 41, 195, 16, 96, 12, and 60). We found it all along our route. Porsild found it numerous in Keewatin in 1930. In late summer the two species are difficult to distinguish in the field. The wooded part of the area now discussed is invaded by these birds in winter. Presumably it is found also on the barrens in winter, though writers usually do not separate the two species, and if they do, usually mention the next.

At one place on the Hanbury on June 30, we found a brood of young, a nest with young freshly hatched, and a third female close together, all under the care of one male.

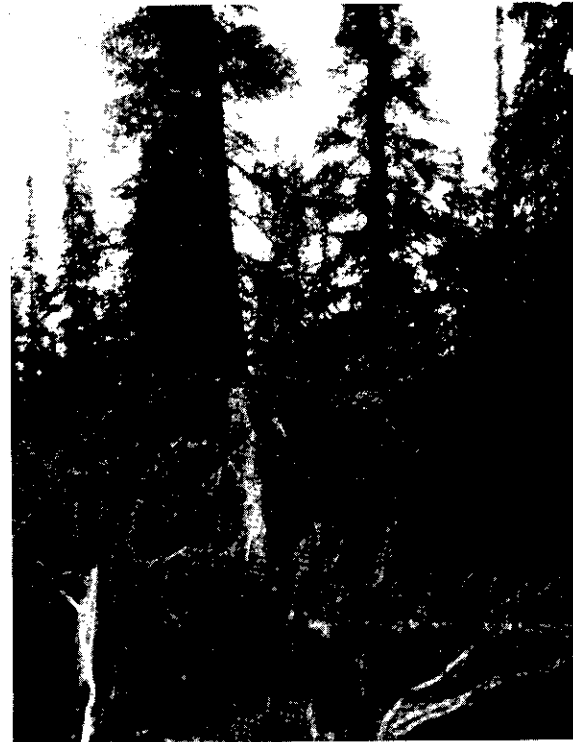
38. *Rock Ptarmigan *Lagopus rupestris*

The rock ptarmigan appears to be just as well distributed in the barrens in the summer as its congener (41, 195, 96, 129). We found it

wherever we travelled. For the first part of our 1937 trip, on the Hanbury, the cocks were still white and easy to distinguish, but in July they changed rapidly.

Although the rock ptarmigan migrates in winter at least to Reliance (110), it winters widely in the barrens (161, 28). The two species pack together.

PLATE XV



S2435

Timber on Finnie River flats.

39. Sharp-tailed Grouse *Pedioecetes phasianellus*

Russell (161) mentions eating a sharp-tailed grouse on his trip up the Yellowknife in 1893. Mr. C. Linden, sr., told the writer at Fort Rae that this species had been abundant at Yellowknife in 1934. These records are on the western border of the area selected for this list.

40. Whooping Crane *Grus americana*

The writer was informed at Baker Lake that a white crane had been killed in that region within the last couple of years.

41. *Sandhill Crane *Grus canadensis*

This crane seems to occur widely in small numbers. Seton (167) saw a flock of six flying over Fort Reliance in September. Critchell-Bullock (35) noted its arrival on May 24, 1925 (east of Ptarmigan River), and records it also on Hanbury Lake and the Thelon (noted by Hornby (95) as well). One was heard at Prairie Lake on August 1, 1936, and four seen at the south end of Clinton-Colden Lake on August 18. On July 31, 1937, one was seen about 20 miles west of Beverly Lake. Mr. Hoare believes the species to be more common at Beverly Lake than elsewhere. Hørring reports it numerous and breeding at Baker Lake (96), and Porsild saw a pair there in September 1930.

42. Sora Rail *Porzana carolina*

Preble (145) saw one on Loon Island, Great Slave Lake.

43. *Semipalmated Plover *Charadrius semipalmatus*

In the barrens this species is well distributed, and along the Hanbury and Thelon quite common (See also 96, 35, 167). It has not been recorded inside the timber-line on Great Slave Lake, in summer, though it may occur there. Blanchet (18) notes it at Nonacho Lake early in July.

A nest with four eggs was found on June 20, 1937, at Heuss Lake, and another on June 22 at Smart Lake. Critchell-Bullock records two nests on Sifton Lake (35).

44. *Golden Plover *Pluvialis dominica*

When we landed at Plover Lake on July 24, 1936, to set up our first barren ground camp of that season, we were greeted by the whistling of this species, and while there were hardly out of sound of it. The same condition prevailed at Prairie Lake, and the bird was seen also at Artillery and Clinton-Colden Lakes. Had our survey stopped there it would have been thought one of the most characteristic birds of the barren land region. However, in 1937, it was found only on Sifton Lake, and hence the statement must be revised so that it now stands as a characteristic and abundant bird of the northern and western part of the sanctuary, and thence, according to Blanchet (16), westward at least to Lac de Gras. Hørring records it at Baker Lake in spring (96), and Porsild saw a few, including a juvenile, at Yathkyed Lake in August 1930.

45. Black-bellied Plover *Squatarola squatarola*

Observed by Critchell-Bullock (35) on Aberdeen Lake, undoubtedly in migration.

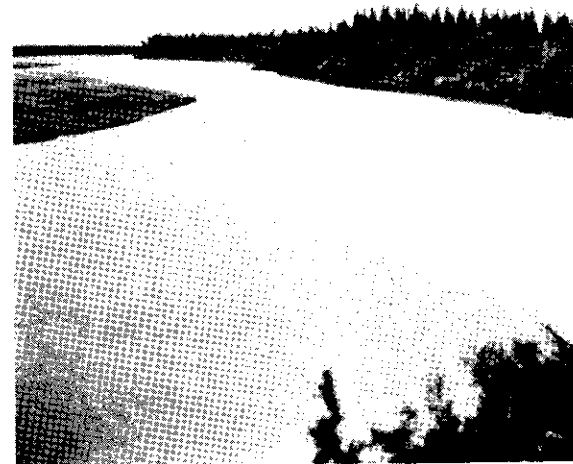
46. *Wilson's Snipe *Capella delicata*

For the entire area of this list there is no published record of this species. On July 22, 1937, a female and two young were jumped in the Thelon marshes 50 miles below the Junction. On the next day they were seen again in the same place. This is very close to the centre of the area. The characteristic winnowing of this species was not heard.

47. Hudsonian Curlew *Phaeopus hudsonicus*

Porsild saw two pairs on the upper Tha-anné River on July 11-12, 1930. Mr. J. Carroll, Air Surveys Section, saw one of the curve-billed shore birds in the southern part of the sanctuary in 1936. As the curvature of the bill in the hudsonian godwit is not pronounced, and the eskimo curlew is very rare or extinct, the bird was probably a hudsonian curlew.

PLATE XVI



82434 Finnic River, near its confluence with the Thelon.

48. Eskimo Curlew *Phaeopus borealis*

It is possible that the Eskimo curlew bred throughout the interior barrens, including the Thelon sanctuary. The only breeding record in northern Canada, apart from those established by MacFarlane in the Anderson River country (113), is that made on June 13, 1821 (given as 1822, when he was not at Point Lake), on the shores of Point Lake by Richardson (182). If such was the case it is the largest gap in the present Thelon fauna.

49. *Spotted Sandpiper *Actitis macularia*

This sandpiper is common in the eastern end of Great Slave Lake (57), and breeds there (167). Seton (167) also found it, in August, at Clinton-Colden and Aylmer Lakes.

It was not seen at all in 1936, and in 1937 was not seen on the barrens until the lake at the foot of Dickson Canyon was reached. From this point on it was seen throughout the marshy part of the Thelon past the Finnie.

50. ***Solitary Sandpiper** *Tringa solitaria*

Although the solitary sandpiper was definitely recorded only in the marshes in the eastern part of the sanctuary (collected in the Finnie flats), it probably occurs in the Grassy Island region, where it was noted under uncertain conditions. There are no published records for this region (See Preble (145), Taverner, and Sutton (185)).

51. ***Yellow-legs** *Totanus flavipes*

This species was recorded (57) at Basile Bay, in the eastern end of Great Slave Lake by Fairbairn, at Artillery Lake by Blanchet (17), and at Ptarmigan River by Seton (167). Blanchet (18) also notes it on the upper Taltson River.

In 1937 we found it at the Hanbury-Thelon Junction, and from thence down the Thelon to the end of the marshes, beyond Finnie River. On July 11-12, 1930, Porsild observed this species on the upper Tha-anne River.

52. ***Pectoral Sandpiper** *Pisobia melanotos*

This species was noted in August 1936 at Prairie Lake, and at Hanbury Portage, Clinton-Colden Lake. On July 7, 1937, its winnowing was heard at Hoare Lake and two individuals were seen. It was heard again at the Junction on July 16.

53. **White-rumped Sandpiper** *Pisobia fuscicollis*

On August 7, 1937, a small migrating flock was seen at Aberdeen Lake.

54. ***Baird's Sandpiper** *Pisobia bairdi*

Not recorded except as a migrant by Seton (167) on Ptarmigan River and Aylmer Lake. Migrants were noted on Artillery Lake (August 30, 1936), on the Thelon (July 20, 1937), and Schultz Lake (August 10, 1937).

55. ***Least Sandpiper** *Pisobia minutilla*

There are no published records for the area included here. In 1937 we found this bird common on the Thelon around the Junction and Grassy Island. It was not seen in the Finnie River region, but conditions there are similar to the Junction.

56. **Dunlin** *Pelidna alpina*

Taken at Baker Lake in July by the Thule expedition (96).

57. ***Stilt Sandpiper** *Micropalama himantopus*

Everything said about the distribution of the golden plover could be repeated for this species, except that, as it was not seen after July 30 (1936), it was seen only at Plover and Prairie Lakes. In 1937 it was seen only at Sifton Lake. Blanchet (17) records it for other parts of the barrens, mostly in the northwestern part of the sanctuary.

58. ***Semipalmated Sandpiper** *Ereunetes pusillus*

Common in every part of the barrens traversed, both in 1936 and 1937, though those seen around Aberdeen and Schultz Lakes were migrants. Critchell-Bullock (35) noted its arrival (Hanbury headwaters) on May 31, 1925, and found it less common along the Thelon itself than elsewhere, which the writer was able to confirm. A downy young was taken on August 2, 1936, at Prairie Lake. It was not found after August 24, 1936 (Artillery and Clinton-Colden Lakes), or after August 12, 1937 (Schultz and Baker Lakes). Bangsted took one at Baker Lake in July (96). Porsild observed it in all parts of Keewatin visited by him in 1930 and took a juvenile on August 1 at Yathkyed Lake.

59. ***Northern Phalarope** *Lobipes lobatus*

As this species was not seen after July 26, 1937, it is not remarkable that we failed entirely to see it in 1936. In 1937 it was found abundant on the Hanbury and Thelon until the date mentioned. King's (110) supposed Wilson's phalarope from Artillery Lake must surely be this species. Seton (167) saw one on August 20, 1907, at Aylmer Lake (See also 16, 96). It was very common on the upper Tha-anne on July 12, 1930, according to Porsild. He also saw a few at Yathkyed Lake in August.

60. **Red Phalarope** *Phalaropus fulicarius*

Taken at Baker Lake in July by Bangsted (96).

61. **Pomarine Jaeger** *Stercorarius pomarinus*

Porsild saw one of these large jaegers in the third week of August 1930, on Kazan River just below Yathkyed Lake.

62. ***Parasitic Jaeger** *Stercorarius parasiticus*

This species is apparently found in summer throughout the area covered here, both the barren lands and the eastern end of Great Slave Lake (167, 96, 145, 57, 35). It was abundant in every part of the barrens visited in 1936 and 1937, although rarely seen on the Thelon itself (cf. Critchell-Bullock (35)). Its arrival is noted by Critchell-Bullock for May 30, 1925 (Hanbury headwaters).

Critchell-Bullock records its food as "mice." We found it feeding largely on the longspur millions of the barrens (See also Blanchet (17)), which it was adept at catching. Two jaegers often took part in the hunt, one flying near the ground and the other about 20 feet up. The longspur when first started, is hotly pursued by the jaeger near the ground. In desperation it mounts in the air; the second jaeger takes up the hunt and it is soon forced to the ground. The relative positions of the two jaegers may reverse in this process. The hunt always ends on the ground, and quite suddenly. Presumably, the longspur suddenly stops perfectly still, as many a wounded bird will do when pursued by human hunters, and is immediately snapped up. Many hunts of this sort were seen, carried out by both species of jaeger, and it was observed that, once the hunt really got under way, the longspur was doomed. He might escape when first attacked, but not thereafter. Though many times the chase seemed to us to take a long time, it was actually more of a case of much action in a short period of time.

63. ***Long-tailed Jaeger** *Stercorarius longicaudus*

Our observation showed this species to be just as universally distributed as the parasitic, though a little less numerous. Like its congener, it is not seen often on the Thelon. It has not, however, been recorded for the east end of Great Slave Lake in summer. As this species is mentioned in Critchell-Bullock's (35) list of specimens, it seems probable that the name "Pomarine" is used in his annotated list where the present species is meant. Porsild found the long-tailed jaeger common in the Keewatin interior.

64. ***Herring Gull** *Larus argentatus*

No bird is more universally distributed throughout the region covered here than the herring gull (145, 167, 35, 16, 17, 57, 195, 95). There are many breeding records (145, 35, 16, 17, 18, 57). Wheeler (195) gives its arrival at Fort Enterprise as May 21, 1910, Critchell-Bullock (35) (at Ptarmigan River?) May 18, 1925, and Hoare (93) at the Hanbury-Thelon junction on May 19, 1929. Both from the air and on the ground Porsild found it common in the Keewatin interior.

We found no nests in 1936, but young birds were seen at the Caribou Narrows of Clinton-Colden Lake. In 1937 nests were found at Heuss Lake (three eggs June 21), the river between Heuss and Smart Lakes (three eggs June 21), Sifton Lake (three eggs June 26), Hanbury below Sifton Lake (hatched June 29), Hanbury river, 7-foot falls (three eggs July 6), Macdonald Falls (nests on the rocks), and Helen Falls (nesting on the side of the cliff). Young were very noticeable at Aberdeen Lake (July 7-9).

In the barren land summer whenever and wherever a caribou is killed or a fish net begins to do business these birds put in an appearance. Over fish we saw them fight viciously, but at a carcass they form a ring at some distance, each one advancing in turn to help himself to a few choice portions. On a fresh carcass they seem to know at once how to get at the kidney fat, and proceed next to the gut fat.

65. **California Gull** *Larus californicus*

Although the California gull breeds (145, 167) in the western part of the Great Slave Archipelago, it is doubtful if it ranges much towards the eastern limits of the lake.

66. **Ring-billed Gull** *Larus delawarensis*

Rarest of the Great Slave Lake gulls according to Preble (145), it is doubtful if this species ranges much into the region here considered. Russell (161) reported a colony up Yellowknife River.

67. ***Short-billed Gull** *Larus canus*

On rounding an island in the Inconnu Channel of Great Slave Lake on July 8, 1936, we were in time to see downy young of this species scrambling over a rocky island while adults circled anxiously overhead. In this part of the lake it is abundant (167, 145). East of the lake it has not been recorded in the region covered here except on the Thelon in the "marshes"

area. Critchell-Bullock (35) noted it at Grassy Island and thereafter to a point about 75 miles up river from Beverly Lake, where one was shot on August 6, 1925. The writer noted it first at Grassy, and from thence down river to within 30 miles of Beverly Lake, at the end of the marshes.

68. **Bonaparte's Gull** *Larus philadelphia*

Not noted except by Blanchet (18) in the Nonacho region. He speaks of a nest of two eggs on an island in a lake south of Lake Eileen.

69. **Common Tern** *Sterna hirundo*

Seton (167) gives two observations of this species in the eastern part of Great Slave Lake (See also 17, 145, 57).

70. ***Arctic Tern** *Sterna paradisaea*

In 1936 the Arctic tern was first seen on July 9 at the Talttheilei Narrows of Great Slave Lake, thereafter several times on Great Slave Lake, and commonly on the barrens until August 20. Young were seen at different places, all able to fly. In 1937 it was seen along the entire route. On June 29, four nests, two of two eggs, and two of one egg each, were found on an island in the Hanbury below Sifton Lake. Both notes and mannerisms of this species were unmistakably different from the common tern. The writer saw one of this species cause a yearling caribou much annoyance by flying at it. Its occurrence in the eastern part of Great Slave Lake has been recorded (145, 167), as has its breeding (145) there, and its presence on the barrens (35, 167, 16, 96). Critchell-Bullock (35) noted its arrival on the Hanbury as June 7, 1925. Wheeler (195) found eggs, presumably of this species, at Snare Lake on June 26, 1910. On Kazan River and Yathkyed Lake Porsild found it fairly common.

71. ***Snowy Owl** *Nyctea nyctea*

We did not see this bird at all, and, curiously enough, it has never been recorded in the Thelon sanctuary in summer, though Seton (167) found it at no great distance from the northwest corner. Whether it is like the snow bunting (q.v.), or whether observations have been carried on entirely in poor lemming years is impossible to say now. There are many post-breeding observations in many parts of the area (110, 35, 28, 95), and Mr. Hoare tells me it was present at the Junction in the winter of 1928-29. Hørring (96) records Freuchen as calling it common at Baker Lake both summer and winter. Porsild saw one on July 12, 1930, on the upper Tha-ane, and found it common from Yathkyed Lake to Baker Lake in August and September.

72. ***Hawk Owl** *Surnia ulula*

King (110) saw one on Back River just above the Baillie on September 11, 1834, and Preble (145) collected one on Artillery Lake on September 3, 1907 (167). These are all the available records.

73. **Short-eared Owl** *Asio flammeus*

Found at the eastern end of Great Slave Lake (110, 57) and on the barrens (167, 16, 96). Seen at Crystal Island, Artillery Lake, August 5, 1936, and at Baker Lake several times in late August 1937. Two specimens in the Lloyd collection were taken at Baker Lake by W. O. Douglas (110b).

74. **Belted Kingfisher** *Megascryle alcyon*

Fairbairn (57) records one on Murky Lake, in the Snowdrift region.

75. **Yellow-shafted Flicker** *Colaptes auratus*

This species has been noted in the region of the east end of Great Slave Lake to timber-line at Reliance and Fort Enterprise (110, 167, 195, 57). We found it abundant at Reliance, and on June 18, 1937, Constable W. J. G. Stewart pointed out a nest with eight eggs. On June 19 these eggs all hatched.

76. **Arctic Three-toed Woodpecker** *Picoides arcticus*

Seen at Reliance on July 23 and July 24, 1936. It was recorded at Fort Reliance in winter by King (110). Fairbairn (57) noted one near Snowdrift.

77. **Amerian Three-toed Woodpecker** *Picoides tridactylus*

One of this species observed on Pikes Portage on September 6, 1936. Fairbairn (57) records it from McDonald Lake, and Bangs (13) mentions two specimens from Fort Reliance.

78. **Eastern Phoebe** *Sayornis phoebe*

Two nests were seen on buildings at Reliance on July 10, 1936, one having eggs and the other young. On June 18, 1937, there were no nests on the R.C.M.P. buildings, but there were some on the Domex buildings across the cove. Seton (167) observed it at Taltheilei Narrows and Kah-d'nouay Island, and Fairbairn (57) reported it "as far as Snowdrift".

79. **Richardson's Pewee** *Myiochanes richardsoni*

A pewee was heard at Reliance on June 18, 1937. Although we were there much longer in 1936, none was heard (See Preble (145)).

80. **Olive-sided Flycatcher** *Nuttallornis mesoleucus*

Fairbairn (52) records it at Snowdrift.

81. ***Horned Lark** *Otocoris alpestris*

Horned larks are very numerous everywhere on the barrens in the breeding season (167, 37, 195), but have not been found breeding in timber and are scarce near the tree clumps on the Thelon (See also 35). We found them at all our barren land stations. Critchell-Bullock (35) found four nests, including one on June 23, presumably near the note that he deposited on that date on Smart Lake. The Thule expedition (96) found it breeding at Baker Lake. Macoun (121) records eggs collected on Artillery Lake. A nest of three eggs was found at Timber Rapids on June 30, 1937, and one of three eggs at Dickson Canyon on July 10, 1937. Many young were seen at many places, including Plover Lake, July 29, 1936. Wheeler (195) gives its arrival date at Fort Enterprise as May 26, 1910, and Critchell-Bullock (35) reports its arrival at Ptarmigan River on May 16, 1925, and departure November 4, 1924. Porsild considered it only moderately common in the Keewatin interior.

82. **Barn Swallow** *Hirundo erythrogaster*

The barn swallow is found throughout the region of the eastern end of Great Slave Lake (167, 57). Preble (145) records it nesting at Gros Cap. Several individuals were seen at Reliance on June 18 and 19, 1937, but no nests.

83. ***Cliff Swallow** *Petrochelidon albifrons*

The great cliffs of the eastern end of Great Slave Lake are eminently suited to this species (167, 57). Seton (167) found a colony on the Beaver Lodge, Artillery Lake, and in 1936 one was found on Crystal Island. Richardson (182) notes it "to Fort Enterprise," and records a colony on Point Lake, where it arrived on June 12, 1821. He also speaks of its frequent occurrence in the barrens. Wheeler (195) saw one on June 1, 1910, on the barrens beyond the upper Coppermine. There is a colony at Tyrrell's Hawk Rock on the Hanbury close to the Junction, which was first seen by Tyrrell (190). It was discussed by Critchell-Bullock (35) under the name "Bank Swallow." In 1937 it was in a thriving condition, but appears not to have changed much from time to time. There are literally dozens of similar sites unoccupied along Hanbury and Thelon Rivers.

84. ***Canada Jay** *Perisoreus canadensis*

Whisky Jack has been reported all through the wooded part of the area here discussed, from Gros Cap east to Reliance and the timber-line, and from Fort Enterprise to the upper Taltson (145, 167, 110, 57, 60, 18, 95). It winters throughout its range there. It is also noted as one of the woodland birds that has discovered the Thelon (95, 35), where it winters (28). We saw it in 1936 at Reliance and Pikes Portage. In 1937 it was seen on the Thelon from Helen Falls to Finnie River.

85. ***Raven** *Corvus corax*

The raven is found well distributed in the region here discussed. It is particularly abundant at the eastern end of Great Slave Lake and near the timber-line (57, 167, 145, 16, 18). In the barrens it can hardly be called abundant in summer. Porsild observed only a single individual on Kazan River in 1930 (See also 35). We found family groups in 1937 about the Hanbury cataracts, with their many dead caribou, and along the Thelon in several places. It winters throughout the area (60, 110), including the Thelon (28).

Five eggs found on Artillery Lake on May 24, 1900, by C. Fairchild, of Tyrrell's party, have been (196, 121, 116) several times recorded. Loithouse, of the same party, noted a nest of young on the same lake, on May 26 (190).

86. **American Crow** *Corvus brachyrhynchos*

The crow was common at Reliance, though less so than the raven. On September 1, 1936, a flock of twenty was seen at the foot of Artillery Lake, apparently coming in off the barrens, but possibly coming from the edge of timber at the head of Snowdrift River. They were headed towards Reliance.

87. **Brown-headed Chickadee** *Penthestes hudsonicus*

This bird is common around the eastern part of Great Slave Lake (57, 167), and was seen at Reliance.

88. ***American Robin** *Turdus migratorius*

The robin is common in the timbered part of the region considered here (4a, 16, 60, 166, 167, 57, 195). At Reliance on June 18, 1937, the young had left the nests there. It goes beyond the edge of timber in the Artillery Lake region in dense willows at least to Ptarmigan Lake, where it was observed. It also occurs on the Thelon (190, 35, 93), where we found it from Dickson Canyon to the extreme limit of trees below Finnie River. Hoare (93) has recorded its nesting in June 1929 at the Junction. Wheeler (195) found it beyond timber-line on the upper Coppermine. It arrived at Fort Enterprise on May 14, 1821 (60), and May 17, 1910 (195).

89. ***Grey-checked Thrush** *Hylocichla minima*

Common from Simpson Islands (145) to Artillery Lake (166); found in 1936 at Crystal Island. In 1937 it was found on the Thelon, from Dickson Canyon and the Junction to below Finnie River, in isolated clumps of trees.

90. ***American Pipit** *Anthus spinoletta*

Not only is the pipit a bird of the barrens, it has also been found around the rocky shores of Great Slave Lake in summer (167). It is localized, being abundant in all the rocky places visited and not elsewhere. It is very numerous at Crystal Island. On July 10, 1937, a nest was found at Dickson Canyon, containing young. It was under a rock, impossible to reach. There were many pipits in August at Aberdeen, Schultz, and Baker Lakes.

91. **Bohemian Waxwing** *Bombycilla garrula*

Abundant at Fort Reliance in the spring of 1834 (110). Wheeler (195) saw it at a spruce grove past the upper Coppermine, in the barrens, on May 6, 1910.

92. **Northern Shrike** *Lanius borealis*

Seton (167) collected one at Fort Reliance on September 15, 1907.

93. **Tennessee Warbler** *Vermivora perigrina*

Found at Reliance July 15, 1936, and at Crystal Island, August 7. Seton (167) saw one near the eastern end of Great Slave Lake on July 28, 1907.

94. **Yellow Warbler** *Dendroica aestiva*

Seton (167) carries the range of this bird along the north shore of Great Slave Lake to Reliance. Fairbairn (57) reports it breeding at Basile Bay. The Royal Canadian Mounted Police at Reliance reported in 1936 that they had seen it there once.

95. ***Myrtle Warbler** *Dendroica coronata*

Reported common in the east end of Great Slave Lake (57) and Nonacho Lake (18). Observed feeding young at Reliance on July 14, 1936, and likewise feeding young at Crystal Island on August 5, 1936. Seton (167) found it at "Last Woods" in the sanctuary opposite Crystal Island on September 3, 1907.

96. ***Black-polled Warbler** *Dendroica striata*

This species is abundant in the wooded part of the area (145, 57, 167). It was found in 1936 at Reliance and at Crystal Island. Seton (167) found it breeding at Last Woods. It is common in the woods on the Thelon to beyond the Finnie, and was seen at one stunted patch on the Hanbury (Caribou Rapids).

97. ***Black-capped Warbler** *Wilsonia pusilla*

Preble got a specimen (167) at the "Last Woods" on Artillery Lake, and the species was encountered on Crystal Island, a few miles away. In the area between the edge of timber and the region traversed by Preble (145) it must be present, but so far overlooked.

98. **Rusty Blackbird** *Euphagus carolinus*

Present around the eastern end of Great Slave Lake and Fort Enterprise (145, 166, 195, 57, 110), and breeds on Pikes Portage (166). It arrived at Fort Enterprise on May 13, 1910 (195). King (110) records its staying at Fort Reliance until December 1833.

99. **Brewer's Blackbird** *Euphagus cyanocephalus*

Snyder (172) records a stray collected at Baker Lake in November 1923.

100. **Crow Blackbird** *Quiscalus quiscula*

One believed by him to be a straggler was seen at Snowdrift by Fairbairn (57), and one was seen by members of the R.C.M.P. at Reliance in 1935.

101. **Pine Grosbeak** *Pinicola enucleator*

This species has been recorded in the eastern end of Great Slave Lake up to the timber-line (110, 167, 57).

102. ***Arctic Redpoll** *Acanthis hornemanni*

In 1936 the writer observed this species at Plover Lake (July 25). In 1937 it was seen from Heuss Lake on down the Thelon. In August the sight identification of redpolls requires better conditions than earlier, the white rump of the present species being less plain in the new plumage. It was not identified east of the sanctuary. A nest of five eggs was found at the Caribou Rapids of the Hanbury on July 6, 1937. Hørring records its breeding at Baker Lake (96).

103. ***Redpoll** *Acanthis linaria*

This species is found within the wooded area (145, 167) in summer, and is particularly common on the edge of timber (167, 195, 35). It is just as common on the barrens in suitable places. We found it numerous

on Crystal Island in 1936, also on Ptarmigan Lake. Along both Hanbury and Thelon Rivers it swarmed in spruce and willow clumps, and was identified also at Baker Lake. Wheeler (195) observed it on the upper Coppermine as early as May 8, and Critchell-Bullock (35) records its breeding on the Hanbury headwaters. Mr. Hoare found a nest with four eggs on June 21 at Heuss Lake. By the time we reached the Thelon in 1937 young of the year were flying.

104. ***White-winged Crossbill** *Loxia leucoptera*

Seen on Pikes Portage on September 3, 1936, crossbills having been heard flying over at Reliance in the previous July. King (110) notes it at Fort Reliance in winter, as does Critchell-Bullock (35) at Artillery Lake. Wheeler (195) found it in April south of Snare Lake. The most interesting note of all is in Christian's (28) diary, where it is stated that a flock of these birds visited Hornby's cabin on the Thelon on December 4, 1926.

105. ***Savannah Sparrow** *Passerculus sandwichensis*

Apparently the savannah sparrow is found throughout the region in the timber (145) and on the barrens (167, 16, 17). There must be few suitable places in the eastern Great Slave Lake region. In 1936 we saw it at all our barren land stations, and Crystal Island, and in 1937 all the way to Baker Lake.

106. **Slate-colored Junco** *Junco hyemalis*

Abundant around the eastern part of Great Slave Lake (167, 57). One was observed feeding young at Reliance on July 17, 1936.

107. ***Tree Sparrow** *Spizella arborea*

Apparently this species starts its range as a summer bird just about at the western boundary of the region here included (12, 145, 57, 167). It becomes very abundant at the edge of timber, where it was observed at Crystal Island in 1936. Along the Hanbury and Thelon it frequents spruce and willow thickets, and is recorded in 1937 notes as common every day on the Thelon to Beverly Lake. In the more rocky area east of the sanctuary it is scarcer, but two were seen at Baker Lake on August 29, 1937. According to Wheeler (195), it reached Fort Enterprise on May 23, 1910. A nest with three eggs was found on July 7, 1937, at Hoare Lake.

108. ***Chipping Sparrow** *Spizella passerina*

The only published record of the chipping sparrow, stating it to occur within the bounds selected for this list, is Preble's for Loon Island (145). However, in the clearing at the police post at Reliance it is common; a nest with three eggs was pointed out on July 10, 1936, by Corp. J. Robinson. This species was seen also at Crystal Island in 1936. In 1937 two individuals were observed singing at two places in the barrens, namely, Grove Rapids (July 3 and 4) and Dickson Canyon (July 9). It was not seen on the Thelon.

109. ***Harris's Sparrow** *Zonotrichia querula*

In the eastern end of Great Slave Lake Harris's sparrow is found in summer (167), and Blanchet (18) mentions it at Nonacho Lake, but it is

not until timber-line is reached that it attains its maximum abundance. Seton (167) found the first nest at Artillery Lake. On Crystal Island it literally swarms. It was seen there in 1936, also at Reliance and at Ptarmigan Lake. In 1937 it was common on the Hanbury, frequenting willows and ground spruce, and abundant on the Thelon, though strangely enough it was not seen past the bend, i.e., not on Finnie River where (as suggested previously for the least sandpiper) conditions are such that it might well be found and may yet turn up.

Mr. Hoare (93) has put on record his search for the eggs in 1929 at the Junction. In 1930, Warden A. J. Knox found a set without difficulty at Crystal Island, but had the misfortune to have them destroyed by his dogs.

PLATE XVII



81213

Last timber at Crystal Island, Artillery Lake.

110. ***White-crowned Sparrow** *Zonotrichia leucophrys*

Very abundant around the east end of Great Slave Lake in summer (145, 57, 167), and also in the Fort Enterprise (195) and Nonacho Lake areas. At Artillery Lake it is abundant at the timber-line, and in 1936 was found beyond the timber-line as far as Ptarmigan Lake. Wheeler (195) noted it beyond the timber-line on the upper Coppermine. Unlike the Harris's sparrow, it does not frequent the ground spruce and willow thickets along the Hanbury. It reappears on the Thelon in the woods there, extending to the tree limit past Finnie River. According to Wheeler (195), it arrived at Fort Enterprise on May 31, 1910.

On July 10, 1936, Corp. J. Robinson pointed out a nest and five eggs just hatching, at Reliance. On June 18, 1937, at Reliance Const. W. J. G. Stewart showed the writer a nest of five eggs, which hatched the next day.

111. **Fox Sparrow** *Passerella iliaca*

Seton (166) records the fox sparrow from the "Last Woods" on Artillery Lake (August 5, 1907), and from Pikes Portage (September 11, 1907).

82551-5

112. *Lapland Longspur *Calcarius lapponicus*

Found in great numbers everywhere on the barrens visited, and wherever records are available (167, 195, 35, 16, 17, 96). Hørring (96) records its breeding at Baker Lake, and Critchell-Bullock (35) mentions three nests. We found two nests of four eggs each on June 19, 1937, at Heuss Lake, and in July young were to be seen everywhere. Wheeler (195) gives its arrival (presumably at Fort Enterprise) as May 19, 1910. Critchell-Bullock (35) states that it was last seen on Ptarmigan River on October 9, 1924, and first seen on May 11, 1925. In Keewatin Porsild found it common.

113. Smith's Longspur *Calcarius pictus*

Seton (167) records one of this species from Aylmer Lake on August 13, 1907.

114. *Snow Bunting *Plectrophenax nivalis*

This bird seems to require the ultimate in barrenness for its home. It has not been recorded in summer in the Thelon sanctuary, though it may well occur in the Clinton-Colden Lake part of it, or on Akilnik, the rugged northwest shore of Beverly Lake. It has been found breeding beyond the limit of ground spruce, where Seton found it (166) on Clinton-Colden Lake (See also King 110), and we found it in 1937 on Aberdeen Lake (feeding young in both cases). It was common at Baker Lake, where the Thule expedition found it breeding (96). Porsild noted a few along the lower Kazan River.

Critchell-Bullock (35) noted its arrival at Ptarmigan River on April 6, 1925, and its departure November 13, 1924.

LOWER VERTEBRATES

There are no records of Amphibia or Reptilia in the region discussed. The fishes are considered farther on.

FUR TRADE

Apart from the beginning of mineral production on its western border, the sole wealth of the region whose fauna is here considered is in the fur trade. The production is small, as may be expected of any biological resource in such a climate, and it is further hindered by the problem of animal fluctuations, which can never be understood until more complete biological research is carried out on the ground.

Fur returns for Reliance and Snowdrift combined, and for Baker Lake, for 10 years, as furnished by the Bureau of Northwest Territories and Yukon Affairs, give an idea of just what the resources of the country at either end of the Thelon game sanctuary are.

TABLE I

Fur Production for 10 Years, 1928-29 to 1936-37

	Reliance-Snowdrift	Baker Lake
Otter.....	134	0
Beaver.....	581	0
Marten.....	884	1
Mink.....	3,313	0
Muskrat.....	4,634	0
White fox.....	8,406	20,058
Blue fox.....	19	51
Red fox.....	1,424	11
Silver fox.....	56	3
Cross fox.....	454	2
Wolf.....	947	106
Wolverine.....	31	23
Coyote.....	14	0
Lynx.....	134	0
Skunk.....	1	0
Ermine.....	874	17
Black bear.....	14	0
Barren ground bear.....	0	1

This does not include all the furs from the region, but only such as were exported. Many furs of wolf, wolverine, black bear, and barren ground bear are used locally by natives or whites. "Ermines" are not sought after at Baker Lake. Many furs from the Reliance-Snowdrift region are traded at Fort Resolution or exported by white trappers themselves to Edmonton from Fort Resolution. Some of the furs, on the other hand, may have come from west of the faunal area (e.g., the skunk). Despite these defects, a good idea of the fur resources and the animals contributing may be obtained from the table.

CYCLES AND DISEASES

General Discussion

Many arctic animals fluctuate greatly in numbers from year to year. It is now quite generally understood, and in a number of cases satisfactorily proved, that some of the most important have regular cycles in numbers. Among the groups considered here, two types of cycle, one of about 10 years and another of about 4 years, have been shown.

What may be spoken of as the 10-year cycle (averaging slightly less in cases where long records are available), has been found for snowshoe rabbits in the region tributary to Hudson Bay (118, 119), and for a number of fur-bearing animals in the Canadian northland in general (118, 91, 167). It has also been demonstrated for ruffed grouse (29) and other species of grouse in Canada and the United States (cited in 29). For ptarmigan, the barren land representatives of the grouse family, a

similar cycle is strongly indicated by data from the Canadian Labrador (32). However, in the Newfoundland Labrador an 8-year cycle is reported (11), and in Norway a short cycle like that of the lemming (107).

In the Arctic the short cycle has appeared more prominently in investigations made to date. Elton (53) derives a 4-year cycle from the arctic fox returns of the Hudson's Bay Company at Chimo. He discusses a number of cycles for fox, lemming, snowy owl, and others, and shows a wide area of occurrence in the north. A short cycle has been shown in various Microtine voles in widely separated parts of the world (54, 30, 125, 84). Hamilton (84) quotes Vinogradov (192) as attempting to demonstrate a cycle of the longer, 10-year, period in voles in the U.S.S.R. This is strongly disputed, however, from other Russian sources, including some reported by Vinogradov. Johnsen (107) assembled statistically valuable records dealing with the wild life of Norway, and found short cycles from lemming, ptarmigan, rough-legged hawks, fox, and other animals, which seem to be associated. A study of snowy owl migrations by Gross (79) showed a cycle roughly corresponding with the 4-year fox cycle found by Elton at Chimo.

To what extent the fluctuations of animals dwelling in the interior barrens-eastern Great Slave Lake region conform to the ideas of periodicity that have grown up in the last few years is hard to say. They certainly fluctuate in a manner typical of the familiar cycles, but evidence is lacking as to whether the periods of the cycles are identical, and, conditions being vastly different from those in other parts of the country, it is at least possible that they are not. The animals are here treated species by species, in which any evidence pertinent to the problem of periodicity was seen or heard. Published records dealing directly with the region are assembled.

The fur catch has in the past, as now, contributed to the general assemblage of returns from which cycles have been derived. Fur returns for Snowdrift (and Reliance) and Baker Lake were obtained from the Northwest Territories Division of the Lands, Parks, and Forests Branch. These posts are too recent to present a record comparable with those on which our present ideas are based, and also include a certain amount of fur from west and east of the region. In so far as they contribute to our knowledge, these returns are included in the discussion below.

The investigations now being carried out by the Bureau of Animal Populations at Oxford on fluctuations in northern Canadian wild life have obtained considerable information from the borders of this region, which has been included in their publications (26, 51, 52, 53, 55, 56, 27). This represents the only attempt being made at present to obtain and organize information on this most pressing problem. It is as yet not accompanied by field work in Canada, but is based on questionnaires completed by officials and other residents, and the comparatively uninhabited region of which the Thelon game sanctuary is the centre is of necessity a blank on the map.

Moose. Repeated occurrences of moose as wanderers on the barrens might be associated with abundance on their ordinary range. Besides those already noted in this region, information was given that in 1935-6 moose were unusually common on Anderson River, and had strayed out to the coast in that region.

Caribou. The barren ground caribou fluctuate widely, and the woodland caribou probably do also, though in the latter case recent fluctuations have all been downward, and this has been to a certain extent true of the barren ground caribou. It is difficult to tell with the barren ground caribou whether they have changed their route of migration or actually changed in numbers. These problems are discussed below. It may, however, be said here that a cycle whether of migration numbers or disease would constitute a problem worthy of being considered beside the arctic fox or lemming problem. There is one piece of published evidence that could appropriately be mentioned, namely, the tabulation of Hudson's Bay Company returns in the introduction to Poland's "Fur Bearing Animals" (139). If the column "Elk and Deer" be plotted there can be seen a definite cycle of about 35 years, with several gaps in the record. An examination of the text shows that the skins included in that column for the years in which this cycle appears must have been almost entirely of woodland and barren ground caribou from posts on both sides of the bay, with a few moose. The company was not then in a position to obtain skins of elk, black-tailed or white-tailed deer, or antelope, and as even in early days, moose skins were actually imported from Russia by the company for sale to Indians in Rupert's Land (139), it is hardly probable that many moose skins entered into the figures.

If such a graph may be projected, then it can be said that we are at or just past a caribou peak (which could well be believed in the southern part of their range), and can expect the caribou to decrease in the near future despite everything that may be done to protect them. However, the figures are of doubtful bearing on the barren ground caribou of the Northwest Territories. Authentic statistical material probably exists in the Hudson's Bay Company records, and an investigation of the problem would be most useful. Murie, who has made a complete study of the Alaska-Yukon caribou, thinks that they have a periodic cycle (127). Food supply and disease might be suggested as possible factors in this (as yet hypothetical) cycle.

Caribou in the Hanbury-Thelon region are now equal in abundance to anything in past records. Back (12) found a shortage, which his own records show could only have applied right at Fort Reliance and for 50 miles or so around for a few crucial months in winter. This condition has occurred in more recent years. There has been no evidence in such instances to show that the herd itself was at a low point. For about 8 years caribou have been scarce at Baker Lake. The range there seems overgrazed.

Barren Ground Bear. Information already discussed shows that this species fluctuates very greatly in circumstances on which information is utterly lacking.

Marten. The marten is familiar in the fur returns. The number bought at Snowdrift is small, and in the country at large its peaks have weakened. It is easily caught and so valuable that it pays even in poor years. It needs reservoirs, untrapped areas, in which to build up its numbers, but in recent years in Canada generally it has been pursued to the limits of its range. At Snowdrift 1932-3 was a high year, 1934-5 was a low, and in 1936-7 it picked up a little.

Weasel. Our observations of weasels have already been given in full. In the trade the species are not distinguished. At Baker Lake they are rarely traded. At Snowdrift the number purchased is small: 1930-31 was a "peak" and 1934-5 was a low, with an increase in 1936-7.

Mink. At Snowdrift 1931-32 was a decided high for mink; 1935-6 was a low, but in that year, strange to relate, they were found on the barrens.

Otter. The number of otter traded at Snowdrift is hardly significant; 1932-3 was a high year.

Coloured Fox. In 1934-5 the number of coloured fox "strays" traded at Baker Lake went up to six. That year was also the peak at Snowdrift, where a fair number are traded.

Arctic Fox. At Baker Lake the arctic fox is the only significant fur-bearing animal. There, in recent years, the short cycle has been indicated, 1930-31 and 1933-4 being peak years. At Snowdrift 1931-2, 1933-4, and 1934-5 have been recent peaks, indicating a similar cycle. The peaks there are not high, there being always caribou around Snowdrift, so that, with foxes following the caribou, there may be little difference from year to year in the catches of the top men. In good years foxes are everywhere, and no one misses out on them, but in bad years some trappers may not see a fox. This exception may be noted, namely, that 1936-7 was a real low year, with foxes unmistakably scarce. On the Thelon, 1926-7 seems to have been (28) a fairly good year. Our observations of foxes were few and far between, though in 1937 it can be said that tracks were more abundant around Beverly Lake than on the Hanbury.

Wolf. There is no evidence as to whether or not there is a cycle in the wolf population. The numbers in recent years at Baker Lake have gone down, as have also the caribou.

Lynx. Only a few lynx are traded at Snowdrift; 1933-4 was a "high" year.

Mice and Voles. Mice and voles of all sorts were in comparatively low numbers in 1936-7.

Muskrat. A most decided fluctuation in this species is revealed in the fur returns for Snowdrift, the high being in 1930-31 and the most recent low in 1933-4, with good numbers in 1936-7.

Lemmings. The two species of lemmings are not distinguished by the inhabitants, and in actual practice many observations have to be lumped. Our observations in 1936-7 in so far as they refer to one species or the other separately are confined to the specimens already detailed. Apart from these, however, the characteristic runways and coproids of lemmings, not to be distinguished as one species or the other, are seen regularly, and as estimates of numbers are more often based on these than on actual examination of specimens it is more useful to lump them together.

In this way it was possible to observe that, at Plover Lake, Prairie Lake, and Clinton-Colden Lake in 1936 the "niggerheads" were riddled

with lemming runways, but there was scarcely a lemming to be found in any of these places. So fresh were the traces that it seemed certain to us on the ground that the lemmings had been abundant in 1935. Reports of observers were heard, to the effect that in their areas lemmings had been abundant in 1935. However, in 1937 there were other areas seen, in particular Sifton Lake, where it was evident that lemmings had been abundant in 1936. In most of the country runways were hardly to be found, and there were few signs of small mammal life. Lemmings had obviously been scarce for a year or more. At Sifton Lake and Baker Lake signs were abundant, but lemmings were scarce; at Baker Lake we were informed that the lemmings had died off in the spring of 1937. In the Beverly-Aberdeen Lakes region there were plenty of runways; in some spots lemmings seemed to be still abundant, in others they were gone and the occasional body on the ground placed the dying off in the winter of 1936-7 or the spring of 1937. On the shore of Aberdeen Lake there were literally windrows of lemming "seeds" (coproids). There must have been, at some time before break-up, large numbers of lemmings on the ice either of the lakes or of the Thelon above them. In brief, there must have been a lemming migration. Records of such migrations in Canada are not common, only that of Rae (147) and the two reports published by Anderson (8) having been seen. Two of these three refer to the Arctic coast and the collared lemming (*Dicrostonyx*). The third refers to Baker Lake in 1926, and Back's lemming. It is to be noted that lemmings were reported abundant at the headwaters of the Thelon (27) in 1935-6. In 1936-7 there was a migration over the ice of Whitefish Lake. This was reported by the Royal Canadian Mounted Police at Reliance, who did not see the lemmings themselves, but did see their tracks. It was also learned that there was a migration of lemmings northward along the shore of Hudson Bay in the spring of 1937. Most of the reported migrations have been northward, but no significance can be attached to so few observations. Migrations of lemmings may be a regular occurrence; where there are no observers there can be no records.

Besides the observations already mentioned, and the data given by Chitty and Elton (27), Mr. M. P. Murphy reports that lemmings were common at Musk-ox Lake in 1935 and Mr. A. E. Porsild that they were common at Yathkyed Lake and on the Kazan in 1930.

The consensus of opinion in the Reliance area is that the fox-lemming relationship does not hold in a place like Artillery Lake where caribou (and wolves) are common in winter. Some trappers are willing to admit that it might hold in places not in the winter range of caribou, but many of them "don't believe in it." In the present state of knowledge it is not possible to comment, beyond saying that the Snowdrift fur returns do give some indication of the short cycle.

Varying Hare. The hare cycle is quite pronounced at Reliance. Fairbairn (57) found the varying hare scarce in 1929. For 1932-3 the Bureau of Animal Populations found (52) increase, epidemic, and decrease all in this region. In 1933-4 increase was reported (55), in 1934-5 it was increase or no change (56), and in 1935-6 it was decrease or no change

(26). In 1936 we found no rabbits at Reliance. They were scarce then and still scarce in 1937; apparently they had been abundant in 1935 or thereabouts. They were reported scarce in 1937 on the Yellowknife by Mr. G. H. Wood. In the spring of 1936, the writer was told, the "hare epidemic" took place on Anderson River.

Arctic Hare. Though the arctic hare has not been the subject of any published investigation, its fluctuations are surely among the most remarkable. At its peaks it is found often in droves or swarms that are a source of wonder to all who have seen them. In 1936-7 we found arctic hares rather scarce, but were informed in 1936 that they had been abundant in 1935 at Ptarmigan and Musk-ox Lakes. We found more signs in 1937 east towards Baker Lake, and information there tended to the opinion that their last peak was earlier than 1935 and that they were recovering their numbers. In 1935-6 they were numerous at some points on the Hudson Bay coast, however. Like all the other species their peaks vary from place to place, and without even knowing the length of the cycle it is hard to associate them. In the Lockhart region they were abundant in 1924 (16) and in 1930 (19) they were reported "numerous" (1928-9?) west of Hudson Bay. They appear to have been fairly common on the Thelon in 1926-7 (28).

Ptarmigan. There was no similarity or connection to be seen in the condition of the ptarmigan population in the western and eastern ends of our route of 1937. In 1936 ptarmigan were found at all our stations, and in 1937 both species appeared to be at or near a peak in numbers on the Hanbury. This corresponded to our information for the winter of 1936-7 in the Reliance region. At Baker Lake we were told that the peak had been several years before, in 1933 or 1934 perhaps, and the ptarmigan population had the appearance of a population at the first stage of recovery, i.e., scarce, but with large broods in the autumn.

Notes for other grouse are given in the list.

Owls. Few owls were seen, but old pellets, full of lemming remains, were often seen.

Factors in Cycles

Food. One factor that may contribute to these cycles, namely, food, and a periodic fluctuation in the food species, has been already mentioned. Its best example is the lynx-rabbit relationship, which has been shown to be a true one (118). Another relationship suggested in the past is that of fertility. Seton (167), speaking of the Lynx in a time of rabbit scarcity, says "none of the females were bearing young." He also says that snowshoe rabbits when on the increase have two or three litters each season, with eight to ten young in a litter, whereas when they are decreasing they have only one litter of two or three young. MacLulich (119) found such a relationship not sufficient to explain the cyclical "crash". Hamilton (84) found the size of vole litters affected by cyclical decline.

The only contribution the writer can make in this particular connection is to pass on observations reported at Reliance. There it was learned that

the number of embryos found in arctic foxes varies in different years from none at all to twenty and even more. In 1930 at Artillery Lake the females had no embryos, the writer was told. As this information seldom comes from foxes caught in the legal season it is probably haphazard as to date but correct as to the main fact. It was, naturally, always given as hearsay. It is typical of the sort of information that can only be obtained properly by a working Arctic research station. Such variations, if true, would be an important factor in the study of the fur cycle.

Heape (89) believed that in green growing substances there are excitants that favour reproduction. If such substances are eaten by lemmings, the excitants are transferred to the lemming tissues and to any animal feeding on lemmings. He suggests that lemmings feed on lichens, and their reproductive capacity is influenced by the early growth of these under the snow. It is certainly true that pregnant lemmings are found in mid-winter. Heape assumes that lemmings migrate because of food conditions, and that the disappearance of lemmings (and of their predators) is due to a lack of mysterious excitant. Such a contention is not borne out by observations on the ground. The writer has seen a number of areas where lemmings had recently died off, and some from which it is possible that they had emigrated. Although the vegetation was riddled with tunnels, there was apparently as good a supply of lichens and other food as in areas where no signs of the recent presence of lemmings were to be seen, and no such events had occurred for more than a year at least. The slow regeneration of lichens, and the use of the same lichen areas by herds of caribou, make the idea of lichen exhaustion by lemmings appear preposterous.

Emigration of Lemmings. Emigration is assuredly associated with peaks in population (173, 50, 53), but whereas dying off occurs cyclically emigration may not do so. The following suggestion as to the cause of emigration by lemmings might be tested experimentally. During the winter the habitat of lemmings is a maze of tunnels under the snow. As time goes on a limit is reached with respect to the penetration of the vegetation by tunnels in relation to the ease of tunnelling, and the extension of the tunnel system becomes more or less confined to feeding. At a very high population level, the system becomes so fouled that before spring the naturally cleanly lemmings desert it. However, the problem of emigration may well work itself out on vastly different lines.

Disease (General). In the end, as Seton says (167), we must seek not the reason for the increase, which is natural enough, but for the destructive agency that ended the increase. At some point or other all cycles lead back to an epidemic, which must work out in a cyclical manner. Whether or not there is some cyclical agency behind that in turn cannot be said; supposed examples are known now not to hold (118, 186). To prove the cause of a cycle is most difficult. Elton (48) lists many instances of the association of cycles with epidemics, but few of the etiological agents are known. Vole epidemics in Great Britain have been associated (58) with *Toxoplasma*. Snowshoe rabbits taken alive in Minnesota during the cyclical dying-off have shown a predisposition to hypoglycemic shock (75). A *Leucocytozoon* was found associated with

the dying-off of ruffed grouse (29). Parenthetically, the known habit of small rodents of eating their own dead (e.g., 35) may be suggested as a possible method of disease transmission. Reindeer are also known to eat small rodents (127, 102).

We were able to make one or two general observations of cases of disease and parasitism. Particular attention was paid to caribou. Although the parasites collected still await identification, it may be asserted that no unusual or unexpected condition was found.

The diseases and parasites of reindeer and caribou have been studied by Hadwen (80, 81) and Murie (127). Among these parasites are intestinal tape-worms and round worms, tape-worm cysts in the flesh, lungworms, and protozoa (*Sarcosporidia* and the nearly related *Fibrocystis tarandi* Hadwen, which causes a roughening of tendons and bones). The most spectacular parasites of reindeer and caribou are the flies, *Oedemagena tarandi*, whose larvæ are found under the skin in large numbers, and *Cephenomyia nasalis*, the larvæ of which gather in the throat. Among other diseases might be mentioned foot-rot, dermatitis, keratitis, papilloma, rheumatism, and rickets.

A most significant observation was reported in 1936 by Flying Officer H. H. C. Rutledge. At Conrod Lake, near Back River, in mid-August, he saw five dead caribou, four calves and a bull, on which no mark of injury could be seen. Although this could easily have resulted from one of the well-known diseases or parasites, it should be reiterated that caribou fluctuate and may be cyclic, and their numbers may well be controlled by diseases under conditions not yet known. Reindeer plagues are known in Siberia and have caused shifting of native populations, according to Jochelson (106). Epidemics among Alaskan reindeer have also been recorded (100, 101); these were associated by the observers with the dog-fox disease, to be discussed.

We also collected internal and external parasites from dogs, ground squirrels, and other small mammals, and from various birds. These are not to be associated with the problem of cycles, and have not yet been identified except that dog tape-worms collected at Reliance were of a type obtained by eating caribou meat. Lemmings found dead have already been mentioned, and it should be added that two young Parry's ground squirrels were found dead in a burrow partly excavated at Prairie Lake in 1936. Information on the parasites of fur-bearers is contained in a United States Department of Agriculture Bulletin (169).

Several blood parasites were found in birds, of which two are certainly important. A *Leucocytozoon* has been found associated with the dying off of ruffed grouse (29); similar organisms were found in ptarmigan from the Thelon sanctuary. Still another *Leucocytozoon* has been found (132) to be the cause of a destructive disease in ducks, and *Leucocytozoon*, probably the same species, was found in a scaup shot on Ptarmigan River. The possible rôle of this organism in the waterfowl shortage should not be overlooked.

Dog-Fox Disease. Epidemics of a disease resembling encephalitis among dogs and white foxes have been disastrously recurrent as far back

as our few records go. Elton (49) has summarized much information on the dog-fox disease problem, mostly dealing with the eastern Arctic, and collected by him in a special inquiry. He considers these epidemics as probably regularly periodic. The concensus of opinion among observers is that the dog disease is identical with that of foxes. He quotes observations to the effect that the same disease is to be found in wolves, coloured foxes, and caribou. Its possible connection with mortality in reindeer and caribou has already been mentioned. The epidemics mentioned in Dr. Jackson's Reindeer Reports (99, 100, 101) are very vividly described, and may be added to the list of those published or referred to by Elton. Definite records of dog disease in the interior barren land area are those of Hanbury (83) and Buffalo Jones (98).

Elton has very justly drawn attention to the fact that this Arctic disease is similar to, if not identical with, the contagious encephalitis of ranch foxes studied by Green and his associates (66, 67, 68, 69, 70, 71, 72, 73, 74). When we arrived at Reliance in 1937 dog sickness was in full swing in the Royal Canadian Mounted Police dog corrals. Several dogs were paralyzed or practically so. Barring possible infection from wild animals, they had been exposed to other dogs at Snowdrift early in May. They were in fair condition up to the time when this attack developed. Apart from the drooping ears and erect hair indicative of sickness generally, the symptoms succeeded one another as follows: running eyes and nose; excess salivation, hysteria, paralysis.

None of the dogs actually died. As the writer had an opportunity to observe the dogs for a short time only, he cannot give much information on the epidemic, but fortunately Constable Stewart's excellent report of this outbreak to his commanding officer has been made available. He says:

"With reference to the Dogs on charge at Reliance Detachment, I have the honour to report that a peculiar condition, or sickness, prevailed amongst all of the dogs, from about the beginning of June until well on towards the latter part of the same month.

"Shortly after we started feeding Dog-Biscuit to them, some of them showed signs of fear, nervousness and even hysteria. The young dogs running loose in one of the corrals were the first ones to show the signs; that of running around the corral at full speed, howling and frothing at the mouth. After about five minutes of this, a dog became so exhausted that he did not see where he was going and would dash into the fence. He would seek a corner, growling and snapping at the other dogs in his way. These dogs would make no attempt to fight back, seemingly knowing that the other dog could not help it. The dog that was running around, after he had gotten into a corner would become well again after about an hour, and would not have another attack for five or six hours. All the dogs had the same symptoms. In some it lasted much longer than in others. It did not make much difference in tying them up, except that it kept them from racing around the corral. The younger dogs were left with a weakness of the legs and were half blind. This has now cleared up, and all the dogs are in as good health as ever."

Constable Stewart then goes on to report that the dogs were wormed and given cod liver oil. He also reports that at the time of the outbreak fresh food (fish and meat) was not available at the detachment.

All the symptoms of the dogs observed pointed to an encephalitis, probably due to a virus. These symptoms differ in no way from those generally described for the dog-fox encephalitis. It is quite probable that the dietary deficiencies discussed by Constable Stewart had lowered the resistance of the dogs and rendered them more susceptible to infection. For such a condition of lowered resistance the cod liver oil would be an effective treatment. It is interesting to note further on in Constable Stewart's report that he knew of no dogs sick at Snowdrift in May, and that none of the white trappers reported any dog sickness. This sickness might represent an instance of a non-fatal outbreak of the northern dog sickness. It will be noted that young dogs were the most seriously affected, and the possibility of diet entering into consideration in such an outbreak is most interesting.

It is unfortunate that the homologies of the virus involved in the dog-fox sickness have never been determined. The virus of the fox encephalitis can be kept alive for 2 years in properly collected tissue. Thus, a specimen could be sent to a laboratory such as that of Dr. Green from any point in the Arctic. We were not equipped to collect the virus at Reliance, but it certainly should be collected and checked against the fox virus at least.

It is noteworthy that dog disease was reported south of Snowdrift in 1935-6 (27), and that 1936-7 was a very poor year for arctic foxes in the Reliance district.

Disease in Wolves. It is most important to know whether or not the dog-fox disease affects wolves. Certainly wolves, with their large litters and early breeding, must have some such check on their numbers; their rate of increase is greater than that of their chief prey, the caribou. The burden of evidence goes to show that wolves are actually subject to the dog disease. MacFarlane (115) states definitely that such is the case, and gives March 1868 as the date of a great wolf epidemic. Ingstad (97) quotes testimony of Indians to the same effect, and says "it is said that there are times when the wilds are strewn with their dead." Blanchet (19) quotes a similar native report. Buffalo Jones (98) describes a case of the disease in his dog team, which he believed contracted by contact with wolves. He stated his "firm belief" that the numbers of wolves are kept in check by this disease. Seton (167) mentions epidemics of "rabies." Diseased wolves are mentioned by Critchell-Bullock (35). According to Pike (138): "There was some sort of disease, resembling mange, among them in the winter of 1889-90, which had the effect of taking off all their hair, and, judging from the number of dead that were lying about, must have considerably thinned out their numbers"; also "The Indians have stories of crazy wolves that run into the lodges, kill the children, and play general havoc." The diagnosis of mange may not be a final one; the important thing is that the Indian account of the "wilds strewn with their dead" is borne out. The mange story has been repeated by others (167, 17), obviously based on Pike.

To all this the writer adds his own observations. On July 10, 1937, at Dickson Canyon, on the Hanbury, a wolf was watched for some time through field glasses. It was on the opposite side of the river, running around in circles and howling in a manner identical with dogs at Reliance in the "hysterical" stage.

It seems quite certain that wolves are subject to the dog disease, and probably other diseases, which constitute the real check on their numbers, rather than any activities of trappers, who do not take a number large enough to be significant in a species with the potential increase of the wolf.

Not much has been added to existing knowledge of cycles by the discussion above. It may be pointed out, however, that the time is about at hand when the information gathered by reports should be supplemented by field work at a field station. In this connection, there is no place in the north where a larger number of significant animal species are found in abundance than the Reliance-Artillery Lake region.

MUSK-OX *Ovibos moschatus* (Zimmerman)

MUSK-OXEN OF THE THELON

The Thelon game sanctuary, although it is a splendid refuge for the whole range of wild life found in the barrens, owes its founding and much of its present interest to the musk-ox. From its first discovery the Thelon has been distinguished as a refuge for them, Hanbury having written ". . . there still remains one spot in this Great Barren Northland which is sacred to the Musk-ox" (83). J. W. Tyrrell, who mapped the river a year after Hanbury's discovery, remarked on the ". . . numerous bands of musk-oxen feeding upon the luxuriant grass or sleeping on the river bank" (190).

At the time when these explorers made their trips the trade in musk-ox robes was at its height, and areas where they were probably more common, originally, than on the Thelon were being rapidly depleted. The reason why the musk-oxen persisted on the river was because it had no permanent inhabitants. In 1900 (190) the Indians were still making their hunts to Clinton-Colden Lake and the Eskimo (83) still getting hides in Keewatin. Subsequently, there must have been more pressure on the Thelon herds. A report given by Harper (85) indicates that by 1913-4 the work of destruction in the Clinton-Colden and Aylmer Lakes area had brought the musk-ox well on towards its present state. It was never completed; there are still musk-oxen there and have been all along (16, 17), in a country continuously hunted. Back (12) and Pike (138) give some idea of what fine musk-ox country that particular region originally was. North of Providence Lake there were musk-oxen some 30 years ago (195a), and there are still a few.

Inspector Pelletier (25) saw only three musk-oxen on his Thelon trip, and there is no record of those seen by Radford and Street. The police investigating the deaths of Radford and Street found musk-oxen in 1917 (160) just north of Thelon River.

About this time realization of the plight of the musk-ox led to their complete protection. As the reports from the newly established posts on

the Arctic coast came in (159), there were grave doubts as to whether or not the large mainland variety was going to survive. However, in 1925, Critchell-Bullock (35) and Hornby (95) made the Thelon trip and observed about fifty musk-oxen, securing still and motion pictures. About the same time Blanchet (17) discovered that there were still survivors in the Clinton-Colden Lake district. No musk-oxen are recorded for Hornby's disastrous expedition of 1926-7 (28); six were seen by the police patrol to the scene of the tragedy (158).

In 1927 the Thelon game sanctuary was set aside, and early in 1928 Mr. W. H. B. Hoare, assisted by A. J. Knox, went in to investigate and patrol it. Mr. Hoare went out by way of Baker Lake in 1929, after spending more than a year in the sanctuary. He encountered 126 musk-oxen during his reconnaissance. Of these 93 were seen at one time, on June 26, 1929, near the Junction. He estimated (93) the number in the sanctuary to be 250. In 1935 the Harry Snyder Barren Ground Expedition, with Col. F. M. Steel as Government observer, went into the sanctuary. They spent 4 days, from August 2 to August 5, cruising over the sanctuary by aeroplane (65) and stopping to observe and photograph musk-oxen. Col. Steel reported a total of 171 musk-oxen observed.

During the present investigation, the itinerary of which has already been given, evidence amounting to a census was accumulated on the distribution of musk-oxen in the Thelon region. The sources of this evidence may be summarized as follows:

In 1936:

(1) Aerial observations by Mr. Hoare and the writer, and by members of the Air Surveys Section and the Royal Canadian Air Force.

(2) Ground observations by the same. Valuable negative evidence is obtained by ground parties, because if musk-ox herds visit an area the tufts of hair on the bushes persist for at least 1 and often 2 or more years. We had ground stations on the Thelon-Back height of land and the area worked by canoe. The Air Surveys Section, Messrs. Eric Fry and John Carroll, had a number of stations evenly distributed over the whole area.

(3) Parties engaged in the Coleman-Fortey search. It should be noted particularly that the entire area from Point Lake to the Jervis-Back junction, south to or near the edge of timber, was flown in 8-mile strips by flights of two planes each, searching for these aviators.

The writer feels sure that practically no musk-oxen were missed on the high barrens by these combined efforts, which were responsible for the actual observation of 174 musk-oxen in 1936. In particular, "the Back River country," which had been suggested by the Snyder party, and previously by Seton (167), as a probable musk-ox stronghold, was thoroughly covered. Beverly Lake area was not touched, but the late Commissioner of the Royal Canadian Mounted Police, Sir James MacBrien, made a flight over it (112) and saw thirteen musk-oxen.

In 1937 information was obtained by the following methods:

(1) A canoe trip across the sanctuary, with visits on foot to all well-known musk-ox areas near Thelon River, on which 65 musk-oxen were seen.

(2) Verbal information of Eskimos met on the river, who were familiar with the Beverly Lake region.

Although the aerial observations carried out would reveal any musk-ox herds on the high barrens, their use as a census is diminished because the chief summer range of the musk-oxen is not on the high barrens; it is in the dense willow jungles along Thelon River. When in this area they wander in and out; thus a flight along the Thelon one day might reveal no musk-oxen when the next day a number of herds might be seen. Musk-oxen in the willow jungle are invisible from the air, and cannot be counted on the ground. In 1929 Mr. Hoare saw most of his musk-oxen on the Hanbury, and we saw some there in 1936. In 1937 there was not a musk-ox to be seen on the Hanbury; they were all a few miles away at Grassy Island, though shortly before our visit there must have been many at Helen Falls.

PLATE XVIII



82431

Musk-oxen on Grassy Island, Thelon River.

In 1935 the Snyder party saw their largest groups of musk-oxen at Snyder Lakes, west of the Thelon below Grassy Island; in 1937 there were three bulls there, and they headed for the Thelon as soon as they were observed. The estimates made are based on the consensus of observations rather than on any single observation or counts in 1936 or 1937. In the first preliminary report a detailed account of observations was given, which need not be repeated now that it becomes evident that these herds move over a large area. As will be noted hereafter, the musk-oxen started to leave the willows for the uplands about September 1, 1936. Unfortunately the Coleman-Fortey search left the Thelon area about the same time, and advantage could not be taken of the strip flights.

Distribution of Musk-oxen in the Sanctuary

Tourgis Lake Region. No musk-oxen were found in the Back River region, nor in the area covered north of the sanctuary, except Tourgis Lake. Tourgis Lake region, where herds estimated to total forty were found, lies entirely north of the sanctuary, but near enough to the boundary that the range of some herds may include parts of the sanctuary. Far from being, as supposed, a musk-ox range, the only musk-oxen ever seen in that part of Back River Valley where the river flows nearly east were a

few seen by Anderson (4a) between the Cascades and Warren River. An old skull found south of the river by Mr. John Carroll is the only available evidence of their presence there since 1855.

Clinton-Colden Lake. In 1936 a single musk-ox was observed on the shore of Clinton-Colden Lake, in the sanctuary.

The Junction Marshes. The herds of musk-oxen frequenting the Thelon in summer are divided into two completely separated groups. The one considered here ranges over the Junction area, down to the "big bend." A herd of sixteen seen in 1936 away from the river is included, as at the time it was seen the drift away from the marshes had commenced. The number of musk-oxen in this group is estimated at 190.

The Eastern Marshes (from Finnie River down to the point where the Thelon turns sharply eastward into rocky country). The total population of this area, from our own observations and those of Eskimos, is estimated at 100.

Thus, the musk-ox population of the Thelon sanctuary is 290, or roughly 300, allowing 10 for part use of the sanctuary by herds of the Tourgis Lake region. Lack of aerial observations at the eastern end of the sanctuary prevents complete confirmation, but this is made up in part by the fact that the observations of the natives were obtained.

Summary of musk-ox population of the Thelon game sanctuary in 1937:

Junction	190
Eastern	100
Boundary	10 (as share of 40 found in region north of the boundary)

MOVEMENTS OF HERDS

There has been complete disagreement as to the extent to which the musk-ox does or does not move from place to place. Sabine (60) claimed for them a proper migration equal to that claimed for the caribou. This was denied, however, by Fisher's (59) book, which gives first hand information of the same locality (Melville Island) to which Sabine was referring. Hanbury (83) and Critchell-Bullock (94) have given instances that seem to indicate that the musk-oxen keep strictly to one locality, but this is not at all borne out by other observations in the same places. Though there may be musk-oxen to be found around some places almost any time, they may be different musk-oxen. MacFarlane claimed that the herds of the Anderson River region migrated into the woods in the winter and out on the barrens in the summer (115). The musk-oxen of the Anderson are a thing of the past, but if they did such a thing they were reversing completely the behaviour of the Thelon animals. In general, musk-oxen seek hills and rugged places in winter, deserting the sheltered meadows, marshes, and willow thickets that were their home in summer. Much depends also on what MacFarlane meant by woods; altogether not much can be made of his observation. Musk-oxen persisted within 60 miles of Reliance apparently until 1930, and certainly until 1922, but there was never any record made of their presence inside the timber-line, which is there quite clear cut.

Whereas the burden of testimony is all against migration, the case for seasonal changes of habitat is conclusive (e.g., Anderson in Allen (4)). The Thelon herds are an excellent example of the movements of musk-oxen. The only herd of which any significant amount is known is the large group in the Junction area. The eastern group in the sanctuary have been found in winter in the hills near their summer ground (160), and we found old signs of their presence in winter right at Beverly Lake, but that is about all that can be said. The Junction group wander up and down the lush pastures of the Thelon in July and August. Around the end of August and the beginning of September they leave the river and go into the high

PLATE XIX



S2456

Musk-ox on Thelon River. Exact position indicated by arrow in Plate XIII.

lands nearby. Signs are to be found on both sides of the river. They then drift south. This drift was observed in September 1936 by Stan McMillan, of the Mackenzie Air Service, who was flying supplies to Steel Lake for the Royal Canadian Air Force. On one day he saw four musk-oxen at Hanbury Lake; the next day they were 20 miles farther south. There is no truth in the Indian story of musk-oxen wintering in a wooded valley towards Back River. The flying in 1936 proved that there is no such valley. There is no doubt in the least that the musk-oxen winter in the southern part of the sanctuary. They were seen headed in that direction in 1936, and there has been observed several times a movement from that direction in spring towards the Thelon. On their wintering grounds they are probably

more scattered than in the summer. Mr. M. P. Murphy saw one as far west as Smart Lake, and Corp. J. L. Halliday, of the Royal Canadian Mounted Police (158), on a patrol from Fort Smith obtained information from the Caribou Eater Indians that they had several times seen musk-oxen between Tyrrell Lake and the upper Thelon. Mr. Hoare tells me that Mr. Hjalmar Nelson, a trapper, reported seeing some near the south boundary of the sanctuary. All information available on the Indian hunts is that the place where they expected musk-oxen in early spring was just south of the Hanbury and west of the Thelon. In May and June they drift on to the Hanbury, where they are sometimes seen in July, but we found in early July 1937 that the large herds had been on the Hanbury from Sandy Lake to the Junction, but were no longer there. From this area the marshes are not far distant, and in fact there may be some musk-oxen on the Hanbury all summer.

MUSK-OXEN ON THE MAINLAND OUTSIDE THE SANCTUARY, WITH ESTIMATE
OF MAINLAND HERDS

Mention has already been made of one herd of musk-oxen outside the sanctuary, that at Tourgis Lake. During the course of the flying and ground work done in 1936 the existence of other small groups was discovered. A herd of five was seen on Aylmer Lake. Individuals have been seen from time to time at Musk-ox Lake by the white trappers there, and a herd of seven was reported to exist near MacKay Lake. Reports are also heard of musk-oxen north and east of Providence Lake. In all, it is estimated that there are twenty animals in that region.

Farther west, in the country north of Rum Lake and west of Bathurst Inlet, drained by Burnside River, an undetermined number of musk-oxen is found, according to information in the possession of the Northwest Territories Administration. Natives report them to be numerous; some herds are said to have as many as 80 head, according to reports by the Royal Canadian Mounted Police. There are also musk-oxen north towards Wentzel River. There are probably upwards of 500 in this whole region, but these figures are indefinite, and as this whole remote area is ranged over by Eskimo hunters, they may be altered drastically should these people at any time have difficulty getting caribou.

We were told that there were still musk-oxen on Dease River in 1930. In 1933 a total of 37 was reported to the Royal Canadian Mounted Police as seen near Haldane River. Hence, there may still be some musk-oxen (estimate 50) in Great Bear Lake region.

East of the Thelon sanctuary there are musk-oxen in the Pelly Bay-Wager Inlet region. Just how many there are we have no way of knowing, but possibly 200 is a fair estimate. There are also still musk-oxen on Boothia (estimate 100); they may connect up with the Pelly Bay herds. There is at least one other musk-ox to the eastward of the Thelon, as the Eskimos reported at Baker Lake in 1937 that they saw a track at Schultz Lake (winter 1936-7). North of Schultz Lake, towards Wager Inlet, is a stretch of rugged country that might well have a few musk-oxen left. None of the Back River or Meadowbank River Eskimos has reported any musk-oxen for a number of years. In 1930 R. M. Anderson (93) included in his estimate a group supposed to inhabit

the country west of Yathkyed Lake (Hikoligdjuak). This was, the writer is informed, based on reports of natives, and it is just possible that the natives meant the Thelon, as these natives are acquainted with the Thelon. However, Mallet (123) refers to an incident that would indicate that the Kazan Eskimos believed that there were musk-oxen towards Dubawnt Lake. Mallet (124) saw one himself in 1927 on the Kazan, and some "good places" for them were mapped by natives for Rasmussen (151). The Kazan is used continuously by Eskimos, and there are no recent observations of musk-oxen reported. On the other hand, the Dubawnt, which was musk-ox country in 1893 (189, 191), has been completely deserted by Eskimos, so that any left there have had a fine chance to increase. Literally, for all we know, there might be a hundred, again there may not be any. There were, therefore, some 1,200 musk-oxen on the Canadian mainland in 1937. A very definitely known 300 of these are in the Thelon game sanctuary, an area excellently adapted for permanent maintenance as a sanctuary.

In 1930 Anderson estimated the musk-oxen of the Canadian mainland at 500 (93). He allowed for musk-oxen in the sanctuary (based on Mr. Hoare's estimate), in the Wager-Pelly Bay region, in the Adelaide Peninsula region, and in other areas. For Great Bear Lake and Yathkyed Lake an indication was made on the map, but no allowance was made in the estimate. Reference has already been made to Great Bear and Yathkyed Lakes; there is still a lack of exact information on these areas. The Thelon sanctuary herds have at least held their own, and in the future it is expected that there will be a strict control over natives visiting the area. The Wager-Pelly Bay region has also been mentioned. The herds "south of Adelaide Peninsula to Perry River" have ceased to exist. There were undoubtedly, in 1930, other groups than those noted by Anderson. Hornby (95) knew of a herd near Walmesley Lake in 1922, but in 1925 apparently it was gone; there was a report current in the country in 1936 that the last one was killed on Artillery Lake in 1930, and there seems no reason to doubt it. About the same time another group is reported to have been wiped out near Clinton-Colden Lake. As we have already seen, there are still some twenty left in the region just west of the sanctuary. For the region west of Bathurst Inlet, Anderson had no evidence of musk-oxen. The part where they are now most numerous was crossed by Mr. Hoare on his caribou investigation, and although he saw none, he says that the natives were sure at the time that there were some left. Burwash (22) had evidence of a small band south of Gray Bay.

There were, then, groups of musk-oxen on the mainland in 1930 not reported to Anderson, some of which have been killed off, and others have increased. On the other hand, one of the most important groups of that time has been wiped out. All in all, the musk-ox population of the mainland must have doubled in the last 10 years.

ORIGINAL NUMBERS AND DISTRIBUTION ON THE MAINLAND

The records relating to the distribution of musk-oxen have been fairly thoroughly assembled (2, 4, 94, 144, 145) and the group has been thoroughly

monographed (2, 4), but there has been no attempt whatever made to plot their original population density in different regions. It is very plain, though, that it varied very greatly indeed. Attention has been drawn (94) from time to time to the fact that they were absent from such places as Baffin and Southampton Islands and Melville Peninsula, where conditions seem, off-hand, the same as in other places. Even more curious is their absence from or rarity in places in the heart of the range. There has also been no record of the musk-ox in that part of the barrens to the south of the Thelon sanctuary and around the upper Dubawnt. It is to be noted that MacFarlane (115) in listing the posts at which musk-ox skins were traded does not mention Fort Smith or Smith Landing, or any post on Lake Athabaska, these being the places at which the Indians from that part of the barrens traded. There may have been some musk-oxen there, but if so they were so scarce that they were killed off almost as soon as the Indians got rifles.

In Manitoba there are only a few ancient records (105, 90), and a most remarkable modern one, recorded by Preble (144), which must have been a stray. It was stated definitely from the very first that musk-oxen were not abundant. Jérémie says (105) "Il n'y a pas une grande quantité de ces animaux; ce qui feroit que les Sauvages les auroient bientôt détruits, si on en faisoit faire la chasse." The scarcity of records for many miles north of Churchill shows how right he was. For that part of Keewatin tributary to Eskimo Point there are no records; Hearne (90) saw some within 100 miles of Churchill, and one of his encounters seems to have been in the Upper Kazan region. MacFarlane also (115) reports that the Inland Eskimos brought skins to Brochet, and Buchanan (21) saw skins in that region in 1914. There were none on the upper Kazan in 1894 (189). Chief Factor Christie reported to the Senate Committee of 1888 (165) that it took him several years to obtain a hide for a friend while he was at Churchill. Most of the skins traded at Churchill came from Chesterfield Inlet and northward (20, 189, 191), and even the earliest accounts (90, 23) show that there were more musk-oxen to be found to the north of Chesterfield Inlet. A hunt by whalers described by Schwatka (164) took place at Cape Jolobert. Hides were traded to Hanbury's boat at Term Point (83); how near to the point the musk-oxen were then found cannot be said. Possibly they were on the lower Kazan. Preble (144) states that hides collected at Churchill came from "several days' journey northward from Cape Eskimo." The actual source was probably Yathkeyd Lake (where they were seen by Hearne (90)). Mr. A. E. Porsild tells me that he found remains of musk-oxen at various places on the lake and on the lower Kazan.

To the westward, the headwater lakes of the Lockhart and Coppermine, Rum Lake, and the country towards the Arctic coast were centres of a considerable abundance, and there are still musk-oxen in the region. South of the Coppermine they did not long survive hunting (161). Franklin (60) found them on the lower Coppermine, there are many records towards Great Bear Lake, and the westernmost part of their range has been discussed by Anderson in detail (4, 176). Chief Factor Anderson's party (4a) saw 85 musk-oxen in the general vicinity of Beechy Lake, 2 on the upper

Back and two large bands on lower Back River. McKinley's diary of Pike's journey of 1890 (116a) records 108 musk-oxen around Aylmer and Musk-ox Lakes, and more than 255 on Back River above Beechy Lake. It is possible that herds now ranging the upper Burnside, especially the east branch, may reach Back River in summer.

A map (Figure 2) has been prepared to show the present-day distribution and density of the musk-ox population of the mainland of Canada. It is unavoidable, however, that in many places there are more dots in the stippling than the individuals of musk-oxen that they represent. The animals were never at any time or in any place continuously abundant. On his third trip Hearne (90) walked in the barrens from the Hanbury headwaters to the Coppermine by way of Aylmer Lake, the Back River headwaters, Rum Lake, and the "Musk-ox Mountains," through the country from which came the thousands of hides traded at Fort Resolution and Fort Rae when the natives hunted more musk-oxen than anything else (161, 197, 138). Despite the large amount of hunting done there for generations, there are still musk-oxen, yet in 1771 Hearne walked through this country and did not see a musk-ox until he had passed Rum Lake. There were plainly never very many anywhere at any time (See also Schwatka (163)). The writer had an idea that he might make a collection of birds' nests containing some of the wool that is draped so abundantly on the bushes wherever musk-oxen are found. Actually birds used ptarmigan feathers and caribou hair, even though there was wool hanging from the very bushes in which the nests were located. Nest building by birds is an inherited behaviour, constant and fixed in its main features, established by processes of evolution, and changed only by similar processes. Therefore, apparently ptarmigan and caribou have occurred side by side with tree sparrow and redpoll constantly and long enough to enter into the development of nest-building behaviour, but not so the musk-ox.

FACTORS AFFECTING THE NUMBERS OF MUSK-OXEN

Increase

Information (from unpublished sources) on the herds kept by United States and Norwegian Governments indicates that musk-oxen do not breed until they are 3 years old, and the cows calve only alternate years, unless the calves are forcibly weaned or lost in the first year. This is a slow rate of increase, and means that there will normally be only a small proportion of young in the herds. Twins are known (94). So far as can be ascertained one or two calves a year in a herd of ten is normal, and agrees with what was observed on the Thelon. The yearly increase of the present Thelon herd would be upwards of thirty calves.

The size of calves of the year in herds observed in 1936-7 was so variable that it must be assumed that calving time varies by months in different cases; the breeding season must be correspondingly extended. Evidence assembled by Hone (94) shows calving in April and May. In the Thelon it must extend into June. The rutting season is July and August, and the herds in the Thelon marshes contain the breeding animals. Mr. Hoare saw (85) two bulls in combat on June 26. The many single bulls

to be seen are presumably the losers of such combats, and we found them to be of a surly and aggressive disposition, whereas herds took flight almost as soon as they were aware of our presence. Associated with the rut is the musky taste of the bull, which Pedersen (quoted in 94) claims is found only in the summer. This agrees with the information obtained from the Thelon Eskimos; far from disliking the meat in this condition, they are very fond of it, and informed us that they considered raw and very musky omentum fat as a particularly delicious titbit. The Reliance Indians asked about musk-ox meat, said that they liked it better than caribou.

Decrease

Having established that the musk-oxen increase very slowly, it remains to be seen what causes of decrease are at work.

The musk-ox habit of forming a circle when attacked is a unique defence, which makes them safe from predators but at the same time particularly vulnerable to human attack, both with modern and primitive weapons. Before rifles came to the north the last stand of the hunted musk-ox was as noble and magnificent as the later picture was wretched. To the shouting of the hunters and the barking of dogs he went down at last under spear or arrow wounds, the infliction of which was often accomplished at great personal risk on the part of the Indians or Eskimos. After he had fallen nothing was wasted. At a later time the hunters merely stood off and butchered the animals as they stood in their circle; the only difficulty was the remarkable capacity of the helpless animals to hold bullets. The hides were ripped off to glut a fashion of the carriage age that had already done for the buffalo. One might ask, cynically, wherein the difference lay, as in either instance the animals were killed. When we refer to the vivid accounts of hunts in the writings of Russell (161), Pike (138), and Whitney (197) we see that the musk-oxen ran when they saw the dogs until they were brought to bay, and that it was difficult for the dogs to hold them, as they were capable of breaking past the dogs and making a getaway. However, if the dogs could hold them until the hunters came the latter could stand off and shoot them all. When the hunters had to rush in with the dogs the chances of a successful break by the musk-oxen were enormously increased.

According to Hone (94), six of the United States Government herd fell victims to the common black bear in 3 years, admittedly not under natural conditions, as the animals were young, and enclosed. The black bear is not a normal inhabitant of the musk-ox range, but the much more formidable barren ground bear is. Hornby (95) "saw in two places signs of where one of these bears had eaten a musk-ox" (presumably at Great Bear Lake). Of the two species, musk-ox and barren ground bear, however, it is a question which is the rarer and the more worthy of preservation as a "nature monument." Certainly on the Thelon there are more musk-oxen than bears. We saw not the slightest sign of bears frequenting musk-ox feeding grounds or disturbing or preying on musk-oxen in any way.

The musk-ox circle formation was plainly evolved through contact with wolves, and is an admirable defence against them. That the musk-

oxen themselves may not regard the wolf as much of an enemy is indicated by Sverdrup (181), who saw a pack of seven wolves circle a herd of four musk-ox cows, each with a calf. The cows did not even bother to get up. Nevertheless, instances of wolves killing musk-oxen are given by Sverdrup (181) and MacMillan (120), one animal being a yearling and the other a bull. Wolves obviously can isolate and kill musk-oxen on occasion, but the occasions must be rare. In the Thelon sanctuary caribou, and, consequently, wolves, are rare for most of the winter, and in the summer the wolves are not in packs. Back (12) and Hoare (93) give instances of wolves "prowling" musk-oxen. Mr. Hoare informs me he believes no significance can be attached to the case reported by him, as the musk-ox was not attacked and the wolves may have been watching him and yet have been afraid to attack him. Critchell-Bullock was of the opinion (35) that musk-oxen are not much bothered by wolves. The Alaskan herd is reported (128) to be very destructive to dogs, which seem not yet to have learned to keep their distance.

At first glance it might seem that the peculiarities of distribution of musk-oxen might be explained by their feeding habits. Actually nothing is known of seasonal or other range requirements, and it is impossible to guess to what extent the population is controlled by them. All that can be said is that it will be some time before the musk-oxen increase so that any such controls become operative in Canada. Evidence assembled by Hone (94) suggests that musk-oxen are general feeders, rather less fond of lichens than caribou. On the Thelon Critchell-Bullock (35) saw only one instance of grasses eaten where willows abounded. We saw them repeatedly standing in the shallow water by the river banks eating grasses, and J. W. Tyrrell noted (190) the same.

There is nothing, apparently, known of the diseases of wild musk-oxen, though if they have none they are certainly unique. It is perfectly useless to speculate on what natural controls existed on the numbers of an animal so invulnerable to predators, because the recorded history of the musk-ox has been one of recession before human hunters. There must have been some such controls, possibly food or disease.

VALUE OF THE MUSK-OX

As game, the chief value of the musk-ox was that it persisted in winter in many places that were not frequented by wintering caribou. In other words, it made the barrens safe for travelling. This is the chief benefit to be gained by its re-establishment, as carriage robes are no longer in demand. The skin was of comparatively little value to natives, but, besides the meat, the horns were used by Eskimos for a number of valuable utensils. To the Indians the musk-ox was a sacred animal, to which they could speak in their own language. That many of their words were deceptions intended to lure the musk-ox to his doom did not seem to matter.

It is impossible to see the musk-ox on his native heath without thinking of the possibilities of domestication. The writer was very much interested to see that in outlining a discussion of this subject he had, unknowingly, made use of some expressions identical with those of

Stefansson (159). The caribou is, after all, a wretched, harried, fly-bitten creature, continually on the move, snatching his food on the run. The musk-ox, as we saw him, was a placid lord of creation, predator-proof and fly-proof, capable of getting his living on a comparatively limited area of the barrens. Surely if there is ever to be anything of the nature of animal husbandry in the barrens, the domestication of the musk-ox might be one of the first steps. No animal could be more easily herded, and the value of a properly utilized carcass would be considerable. The "wool" is unfortunately smooth and not true wool, and cannot be used by itself. However, the live animal might furnish milk, and might be comparable to the yak as a pack or saddle beast. Any such step will belong many years in the future, but it is a present necessity to preserve the species, particularly the large mainland variety, so that it will be available for such work when the time comes to try it out.

In conclusion, two things seem outstandingly significant. One is that the places where the musk-oxen have survived down to the present on the mainland are those where they were most numerous 100 years ago. The second is that one thing menaces them more than anything else, namely, a shortage of caribou, which would force the natives to kill musk-oxen.

NOTES ON FIGURE 2

Reports indicate that there may be 1,200 musk-oxen on the Canadian mainland, although the Thelon region, containing 300 in 1937, is the only part for which accurate information is available.

Musk-oxen were once found in all parts of the barren lands, but in many parts they must have been scarce. The areas where they are found now, indicated on this map, are those in which they were formerly most abundant, though in some of the smaller centres of abundance they have been exterminated.

BARREN GROUND CARIBOU *Rangifer arcticus* Richardson

The barren ground caribou¹ is one of the most important wild animals in Canada. In addition to the direct value of the products obtained from it, most of which are used by the natives of the regions where it occurs, it is the chief support of large districts engaged in a valuable fur trade. Its presence is solely responsible for human settlements where otherwise there would be no inhabitants.

The barren ground caribou is found throughout the Thelon game sanctuary and in all of the area described in the introduction to the faunal part of this report, in numbers varying greatly from place to place and from season to season (38). It is also found in the littoral regions, in forests and barrens to the west of this area, and in winter extends its range many miles south into the forests of Alberta, Saskatchewan, and Manitoba.

¹The barren ground caribou is known to the older English speaking people of the northwest as "deer," an abbreviation of "reindeer." To the French and half-breed population it was always "caribou." When called "deer" the cognate terms "buck," "doe," and "fawn" have been used. As the word "caribou" gradually acquired a position in the English speech of the country, the terms "bull," "cow," and "calf" likewise entered. Now that both reindeer and mule (jumping) deer have put in an appearance, the term barren ground caribou is often necessary to avoid misunderstanding. Actually, where no ambiguity can result the greatest freedom prevails in the use of the terms listed, and an expression such as "caribou fawn" is just as likely to be heard as "caribou calf." Writers dealing with Newfoundland, where the deer differ but little from our barren ground deer, have also used the words "stag" and "hind," but these are never heard in the northwest.

OBSERVATIONS IN 1936-7

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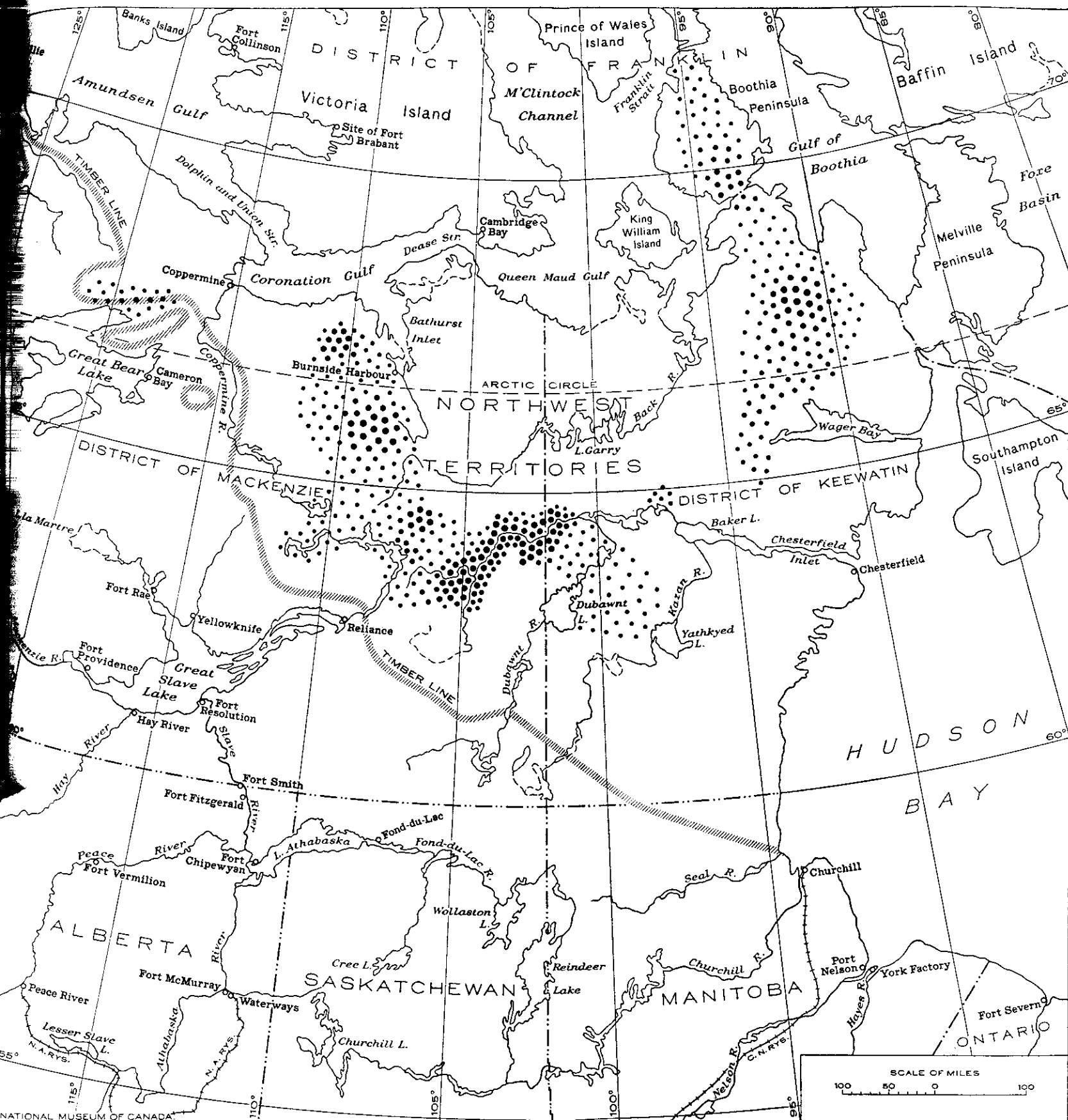


Figure 2. Map showing present known and reported distribution of musk-oxen on the Canadian mainland; the relative density of this distribution is shown by various sizes of black dots. See notes on page 84.

Stefansson (159). The caribou is, after all, a wretched, harried, fly-bitten creature, continually on the move snatching his food as it

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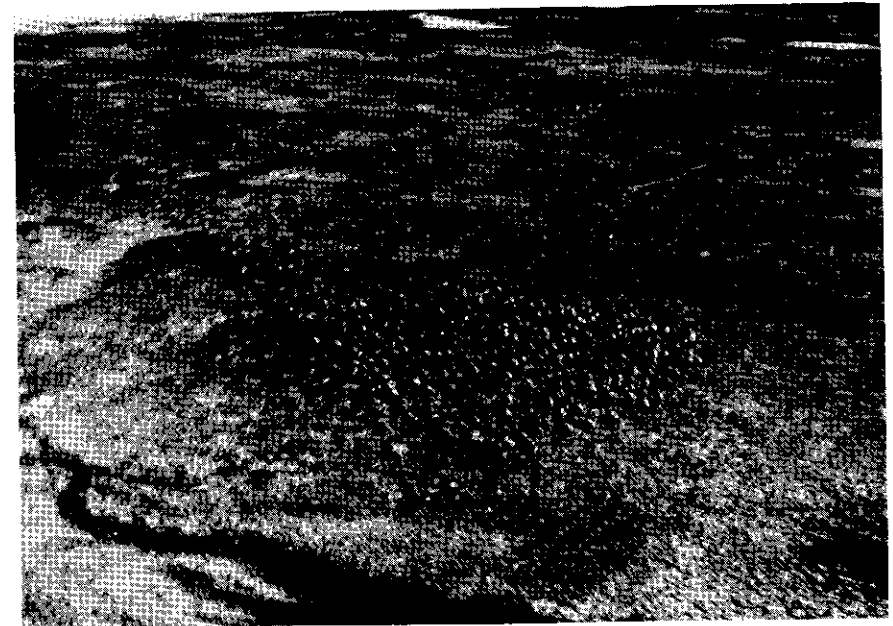
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OBSERVATIONS IN 1936-7

In 1936 we first encountered caribou on our reconnaissance flights. On July 20 only a few individuals were seen, but on July 21 a herd of several hundreds was seen at Grassy Island. On July 23, Mr. John Carroll, of the Air Surveys Section, saw three distinct bands of several hundreds each proceeding southward in the southeast corner of the sanctuary. He camped in that area, and during the next 24 hours saw large numbers of caribou on the opposite side of the lake on which he was camped. Photographs (Plates XX, XXI) taken from the air show several hundreds in

PLATE XX



Barren ground caribou from the air. Thelon game sanctuary. July 23, 1936.
Herd undisturbed. (Photograph by John Carroll.)

each of two herds seen on July 23. Mr. Hoare and the writer were moved on July 24 to Plover Lake, north and west of the Hanbury-Thelon Junction. This area was covered with the hoof-prints of southward bound caribou, but only one was seen while we were there. The passing of the herds had been so recent, however, that a strong stockyard smell filled the air.

These observations represent the July migration discussed later. The latest migration of this sort observed that year was on July 31, at Tourgis Lake, where Mr. Eric Fry, of the Air Surveys Section, saw some hundreds of caribou going south. At Plover Lake and Prairie Lake up to August 3, we saw only a few individual caribou, but during the first 2 weeks of August small herds moved in over the whole region of Hanbury,

Artillery, Clinton-Colden, and Aylmer Lakes. The southern extent of the migration is shown in data taken from the observations of Geological Survey field parties under J. F. Henderson working in the Taltson watershed. He writes "The first caribou were seen by a party working on a lake 18 miles southwest of Taltson on August 11. The caribou were in small herds of 4 to 6 and frequently only one would be seen at a time. Another party travelling down Taltson River between King and Taltson Lakes reported seeing the first caribou in small herds of 1 to 6 on August 1. A third party working south on Thekulthili Lake did not see a caribou until they reached the extreme southwest end of the lake on August 16. The fourth party working on Nonacho Lake saw the first caribou on August 18.

"All the parties saw many caribou in small herds of 2 to 6 practically every day from the date they saw the first ones to about September 5. From September 5 to September 25, when we left the area, not as many were seen, but we usually saw one or two every 3 or 4 days."

Thus we see that a wave of caribou passed over the sanctuary and the barrens south of it into the woods as far as Thekulthili Lake, in late July and August. On in August this wave seems to have spent itself, as shown by the caribou being generally distributed over the country. In the latter part of the month there was a recession; on August 19, at our camp at the height of land between the Hanbury and Clinton-Colden Lake, we watched a northward movement of caribou that lasted all day. Others made like observations, and Mr. Henderson's letter indicates that at the southern limits of the migration there was a reduction in the number of caribou. August and September were months in which caribou were to be seen over the entire area covered by various people in the field.

Had it not been for a search for two missing fliers, all parties would have been out of the country early in September and the movement that has been described would have been the only one observed. As it was, intensive flying and aerial observation went on almost until freeze-up, and on September 18, northwest of Lac de Gras, Flight Lieut. L. E. Wray observed a long line of caribou pushing rapidly south, six or seven abreast, led by a buck 100 or so yards in advance of the column. He estimated that there were several thousand animals in the herd. At the same time the upper Back River Valley was noticeably full of caribou, an observation made by Mr. Eric Fry. These caribou belonged to a second wave, which swings into the Reliance region about freeze-up every year. In the autumn and winter of 1935-6 caribou had been abundant at Reliance. In 1936-7 they were less abundant at Reliance, but in fair numbers at Snowdrift.

In 1937 there were a few stragglers at Heuss Lake when we landed, but none from then (June 20) on to Grove Rapids (July 3). At our campsites along the intervening waterways there were tracks of only occasional caribou. According to our preconceived notions, the Hanbury herd should have gone north in June and have been somewhere around Back River by the first of July. That there was no sign of its passing we took to mean that it had gone farther east, or else that there had been a reduction in the numbers of caribou, as was suggested at Reliance because of the scarcity there the previous winter. We hardly thought that we would encounter them.

On the morning of July 3, while portaging at Grove Rapids a band of caribou was seen near the shore. Beyond them was another band, then another and another, and on looking farther and farther it was seen that the land across the river as far as eye could see was full of caribou. From the top of a hill it was possible with the glasses to see what was going on. The deer were storming up from the river at the foot of Hanbury Lake. The foot of Hanbury Lake was a moving mass, and there was herd after herd along the shore of the lake and the left bank of the river as far up as Lac du Bois. Caribou were streaming over the distant hills, to the limits of vision. The whole land, on the north side of the river, was full of caribou in large and small herds, some milling, some grazing peacefully, and some running in files. We counted several thousand in herds a few hundred yards away across the river, and by counting the number of similar groups made an estimate of 20,000 as the minimum of those in sight at one time. The manner of forward movement in the migration was most characteristic. The units were herds of from 100 to 2,000. A herd would mill in a compact mass. Then one deer would head in the direction of migration and break into a trot, with the rest following until the entire herd was an extended line. In a mile or so the leaders started to graze and as the others caught up they also would graze or stand quietly about. Then they would mill again, and again a leader would strike off.

PLATE XXI



Barren ground caribou from the air, July 23, 1936. Another herd, disturbed by aeroplane. (Photograph by John Carroll.)

It became obvious that the caribou were not going to cross to our side of the river, and that we were not going to be able to photograph them from our position, so we finished the portage, and on every trip saw the migration continuing up the shore of Hanbury Lake. At sunset there were herds still around the foot of Lac du Bois.

The next day we went down Hanbury Lake and camped at the foot of the next rapids, to which Tyrrell did not give a name. It will stick in our memories always as the Caribou Rapids. There were no caribou in sight at all at Grove Rapids, and as we slipped down the lake the events of the previous day might have been an hallucination for anything that was to be seen from the water. When we landed at the head of the rapid, however, even if we had not seen the previous day's procession there would have been no doubt as to what had taken place. The whole mile of the portage smelled like a stock corral. Hardly a foot of ground was without hoof prints. Where the deer had come trooping up from the crossing there was nothing but mud and dust, with a few remnants of willows and dwarf birches. Tree sparrows, Lapland longspurs, and Harris's sparrows were chirping disconsolately; although some males were singing, it was plainly to be seen that nests were trampled and nesting territories altered almost beyond recognition.

A pair of ptarmigan were flushed. The female was covering a 2-day old chick, which must have been hatched just before the living avalanche arrived. The parents must have spent the previous day fighting caribou, and had managed to bring only one of their family through alive.

Part way across the portage was a solitary doe. She ran away, and where she had been we found her exhausted fawn, which limped away at our approach. Some minutes later we saw the same doe with two fawns; whether the second was a twin or a hanger-on we could never know. At the foot of the rapid, out among the rocks, the body of a 3-year old buck, caught by one leg, bobbed grotesquely. Half-way up the body of a fawn was similarly wedged, and away down the river some gulls hovered significantly over one place. These caribou were the dead; there were also the wounded. Two fine bucks limped painfully away from a meadow at the foot of the portage, and there were others to be seen around. The crossing had taken place above, below, and through the middle of the Caribou Rapids, a photograph of which is reproduced (Plate VII). The last half mile is a long white chute, which Mr. Tyrrell's voyageurs found "too rough to run" (190). In order to appreciate the phrase it is necessary to come unexpectedly on some of the rapids that Tyrrell's map does not even dignify as "strong currents," such as, for instance, that leading into Hoare Lake. The strange habit of caribou of picking rapids for crossing places, and its disastrous results on the Hanbury are dealt with later. The bodies bobbing in the Caribou Rapids were the usual toll that the Hanbury takes; surely three dead are as nothing to the thousands that struggled safely through the white water the day before.

We thought perhaps the migration was over, but on our second trip over the portage several herds came up from the river, and the movement went on intermittently for the rest of the day—to the number of about 1,000 in all (Plate XXII).

Whereas some of the bands that we had seen to best advantage on the previous day at Lac du Bois and along the river were entirely made up of males, the bands seen on July 4 and 5 were mostly females, yearlings, and young about 1 month old. There was absolutely no reason for assuming any difference in the proportions of sexes or ages from that of the general population.

At 3 a.m., July 5, a grunting and bawling was heard in the rapids in front of camp. The sky was full of rain clouds, and although the sun was up it was seldom visible. The bawling was coming from two calves, struggling to cross the river in front of our tent. The grunting was from a herd in the river a couple of hundred yards up, and from which the two calves had been swept by the current. There were several herds inland, which had already crossed, and it was impossible to tell how long the crossing had gone on before we noticed it. The two little fellows made the crossing almost a quarter of a mile below the place where they entered the water, and rejoined the herd. Other herds were coming down to the opposite shore, so a stand was chosen at a spot on the bank overlooking their landing place. The caribou milled on the opposite bank and then rushed to the river in file and crossed practically in single file at first, though the late comers packed in together, stemming the current with slow, powerful strokes. They then rushed up the bank and milled around the chosen vantage point. The bulls shook themselves and started to pick at the remnants of vegetation, but the cows and calves darted nimbly in and out of the herd, grunting and bawling, the cows seeking their young and the calves their mothers. Apparently they are hopelessly scrambled in the crossing. As the herd became sorted it slowly moved on, leaving behind its casualties. Stray young and wounded adults were to be found here and there all along the portage.

One herd took a sudden fright in the early morning light and dashed madly back across the river again.

PLATE XXII



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Small herd of barren ground caribou at Caribou Rapids, Hanbury River.

Inclement weather held us at the portage until July 6, when we pushed off down the river. The winds, and the recession of the river from its spring high left the shores lined with hair. This we were to see for 200 miles. At the Junction it was a continuous mattress (all the animals being shedding at the time of the crossing), and it was still quite noticeable at the place where we met the Eskimos.

On our way down the river we made several stops to examine some of the "strong currents" before running them. At these places the trampled

ground and stockyard smell showed that there had been herds there too. On the morning of July 7 a herd of about 150 appeared just as we were starting out and rushed madly down to, and across, the river. Odd deer were seen along the river. At Dickson Canyon on July 12 a herd of 200 appeared from the south, trotted to the head of the canyon, and then, instead of plunging in, swung off to the foot of the canyon and crossed there. On July 16, when we reached the Junction, a migration of a number of small herds was going north along the right bank of the Thelon. They seemed to have crossed the upper Thelon just above the Junction. At 8 a.m., July 17, from our camp on the Thelon opposite the abandoned warden's cabin, three large bands of caribou were seen on the cabin side of the river. One band seemed ready to cross, but got our wind. The whole herd milled on the shore until there were only two bands separated out, each of 2,000 deer, according to an estimate made after carefully counting sections of the herd with the 10-X glasses. The river is about 600 yards wide. One band went along the shore almost to the Gap and crossed the river. The other just simply milled on the shore for the whole forenoon, working its way up river literally foot by foot in a compact mass until it disappeared from sight.

The last of the northward migration was a herd of 75, which crossed the river just below our camp early in the morning of July 19. When such a migration has passed there are strays to be found in its wake, especially in this case when the fawns were only a month to 6 weeks old. We went on down the river too soon to see the return of the herd from the north at the end of July, but signs of the northward trek were abundant at Grassy Island and just below it, and also right at the big bend. Eastward there was no sign of a massed northern migration. At the "Crossing Place" and eastward a few deer were going south. Just before we reached the lower Thelon Portage a band must have crossed there, as the tracks were on the portage.

It seems certain that the migration witnessed on the Hanbury was the equal of anything on record, although we were unfortunate in not having been camped at the Caribou Rapids while the first wave was coming over. The front was over 50 miles, but a large proportion of the caribou were crowded into the westernmost 20 miles, where signs of great numbers were more numerous than elsewhere, although there were certainly large numbers in the Junction region. It is hard to estimate numbers; there were at least 100,000 animals in the whole movement, but not as many as 200,000. That herd is the "Hanbury herd" mentioned later, and this statement is in effect that there were at least 100,000 animals in this group in the spring of 1937; possibly there were more, but this is doubtful.

Were the migration described in vague terms an impression of large numbers could be conveyed without actual exaggeration. There were "tens of thousands" in sight, and the shores of the Thelon were lined with hair for over 200 miles, which is a large amount of hair to anyone not familiar with the way a caribou sheds.

It should always be remembered that the herd unit is probably not more than 2,000, and larger groups are incidental agglomerations. Such herds can be described as temporary.

CARIBOU OF THE THELON SANCTUARY REGION

What caribou herds have been seen in the Thelon region and the interior by the various travellers who have been there? Back (12) had no caribou at Reliance in the winter of 1833-4. At no time since has so much hardship been recorded as attending a caribou failure. In 1834 he saw a great concentration along middle Back River in mid-July and later on the lower river. Anderson and Stewart (4a, 5, 6) did not encounter many caribou. Pike (138) saw the autumn migration at Camsell Lake, and Munn met the southward migration in late July on Artillery Lake (168, 126). Jones (168) saw a mass movement at Clinton-Colden Lake at freeze-up, and J. W. Tyrrell (190) met a southward migration on the Thelon on July 23, 1900. Hanbury (83) in 1901 met a late July migration on Sifton Lake, not in large numbers, and he saw a similar movement on Aberdeen Lake. Inspector Pelletier (25) met the July southward migration in full force on Artillery Lake. Seton (167) encountered some such migration, but he was either a few days too late or the main herd was farther east. He saw 1,000 on August 2, 1907, certainly a large number not to be associated with some such movement. The Indians expected such a migration on Pikes Portage, and Louison d'Noir (Weeso) told Seton in September that caribou would be in the woods to the southward. Had Seton waited on Artillery Lake for a band of 1,000,000 caribou he would still be there, as there is no evidence of the existence of any such single herd, and, as we shall see later, every reason to believe there never was such a herd. The presence of wintering caribou on Schultz and Aberdeen Lakes was discovered by Hanbury and the R.N.W.M. Police (160). Critchell-Bullock (35) observed the July southward migration of caribou on the Thelon. He also gives a complete record for autumn, winter, and spring on Ptarmigan River. Hornby (95) describes a northward recession in early November 1924, after the autumn migration. Hoare (93) records a May and June northward migration at Ford Lake, and a massed southward migration on Campbell Lake on July 20, 21, 1928. In 1929 he records the early July migration northward, and again in late July southward, also a migration in May at Hornby's cabin. He gives a complete account of winter movements between Reliance and the Thelon. Blanchet (19) and Burwash (22) have noted a southward migration at Reliance in late November. That the July migration occasionally brings caribou to Pikes Portage, or even west of it, is shown by McLean (117) and Hanbury (83). A. J. Knox saw them on the portage on August 6, 1934.

CARIBOU OF THE BARRENS OF MACKENZIE AND KEEWATIN

The above account gives a brief sketch of the outstanding pieces of published and verbal information that may be coupled with observations made in 1936 and 1937 to give a picture of the movements of caribou in the Reliance-Thelon region. Commencing in 1934, the Administration of the Northwest Territories has distributed each year to residents of the Territories a questionnaire on caribou. In this way advantage has for the first time been taken of the present-day dispersion of posts, white trappers,

and prospectors, and present-day improved communications, to collect observations on caribou made in one season at different places. This information has been placed at the disposal of the writer. In 1935 Mr. Gordon MacLaren saw herds of caribou around August 1 within a comparatively few miles of Goldfields and Fitzgerald. The recession of caribou northward out of this region in late August is also confirmed. For example, Mr. Louis Mercredi of Chipewyan says that the caribou come to Hill Island Lake in August, go back out again, and then come in to the lake again in November. In the summer of 1937 Mr. John Carroll saw caribou in that region from July 27 on.

Just as published, verbal and departmental sources give a fair picture of the movements of the herds tributary to the Reliance region, so there is now available material sufficient to give a fair general picture of the caribou movements and migrations in the barren grounds at large, and the present occasion seems opportune to throw the whole question open for discussion.

Two maps (Figures 3, 4) are given to show the segregation of the barren ground caribou into "groups," and the approximate location of these groups (really groups of herds) for mid-July and mid-January. The chief sources of information for these maps have been the annual caribou questionnaire sent out by the Northwest Territories Administration to residents of the Territories and of the caribou country lying within the provinces, letters, interviews, personal observations, and published records.

As the barren ground caribou move around freely over hundreds of miles, and the same individuals that are found on the Thelon in July may reach Wood Buffalo Park in mid-winter, it is necessary in order to give meaning to a discussion of caribou to go far beyond the limits arbitrarily set for the general faunal discussion. The maps show the distribution of caribou of the mainland of Canada, except for those of Mackenzie, Anderson, and Horton River areas, and the area north of Great Bear Lake. For this, the information in MacFarlane (115), Anderson (176), Bell (14), Porsild (140), and Stone (179) is about all that is available. A few caribou are still found in this region. For the rest, the whole mainland is included, and such of the island herds as migrated to the mainland.

The groups of caribou on the mainland may be separated as:

- (1) Summering on the Arctic islands (Victoria and King William) and wintering on the adjacent mainland.
- (2) Summering east of Great Bear Lake, wintering in the area south of the lake to Fort Rae.
- (3) Summering at Rum Lake and vicinity, wintering in the Yellowknife area.
- (4) Summering in the Bathurst Inlet region, wintering around Rum Lake (one part of which has been mapped by the Indian name of "Contwoyto" or "Fire-water Lake," and another as Fry Lake).
- (5) Summering in the Bathurst Inlet region and wintering in the Reliance region.
- (6) Summering in the Hanbury-Back River area, wintering east of Fort Smith and in northern Alberta.
- (7) Summering on the Dubawnt and Kazan and wintering in northern Saskatchewan and Manitoba.

(8) Summering on the lower Kazan and eastward, and wintering in southern Keewatin.

(9) Summering in southern Keewatin and wintering in northern Manitoba.

(10) Summering in Wager-Back River area; wintering on the Back River lakes and Aberdeen and adjacent lakes, and north of Baker Lake.

(11) Summering in Boothia and Melville Peninsulas and wintering to the southward.

The summer and winter grounds as shown on the map are, of course, true for only a few days during the season, and allowance must be made for shifts. Such shifts may cause caribou to miss, as discussed later, or may combine groups to make caribou exceedingly numerous for a season where otherwise they are scarce. The maps are preliminary and subject to revision. It is to be hoped that they will tend to call forth information from those who observe inaccuracies, rather than that they will be accepted as a final arrangement. In so far as available information goes, they represent the true case. When such information has accumulated for years it may be possible to make maps showing the average distribution and density of caribou at intervals of 4 or 2 months, or even 1 month.

In making these maps the consistent lack of caribou in certain areas has been just as important as their presence in others. The complete absence of caribou from the heart of the Thelon sanctuary in mid-winter is an example. The few strays found by the unfortunate Hornby party (28) only served to raise vain hopes. A portion of the Yellowknife preserve west of MacKay Lake towards Yellowknife River is another blind spot. It was so in Pike's (138) time, and was referred to by Hearne (90). On occasion it may possibly be overrun by great herds, but so far as records go it has only a few deer, and serves to emphasize the segregation of the Reliance and Fort Rae herds. The delineation of other such areas by observers would be most useful.

MIGRATION OF CARIBOU

Early Ideas

Before going on to a description of the migration of various herds, it seems advisable to consider ideas prevailing in the past on this subject. The most complete and detailed accounts have been built up on inadequate observations, taking the caribou from this place to that as though they had been ear-marked and watched. Other observers, finding these pictures not borne out by fact, went to the opposite extreme and rejected the whole thesis. The caribou do make regular migrations, and the flaws in the old accounts are best seen by taking them in historical order and watching the growth of the tradition.

Hearne's version (90) is that the caribou migrate in an east-west direction. The two sexes meet in October on the barrens. In November the bucks drop their horns and enter the woods, remaining there until the horns sprout again. The does always stay on the barrens. He gives the migrations of the sexes as always reversed. The story is an Indian one, affected by the fact that the Indians of that time were not familiar with the barrens in winter. Hearne saw many does in the woods, and although they appeared to worry him a little, he explained them away as exceptions.

Franklin's (60) story is that the herds enter the woods in October and leave in April, undoubtedly based on observations of the herd that passes Fort Enterprise. When he adds that they go to the coast, he is extending this particular herd farther than is justified. Presumably, he did not know of the presence of deer at Rum Lake in winter, which are, by inference, more likely to be those that drop their young near the salt water.

Sabine (162) has to be blamed for the idea that caribou migrate to and from the far northern islands. Nowadays the caribou of these islands are recognized as residents, and separated as belonging to a different subspecies.

The publications resulting from Back's trip [Richardson in Back (12) and King (110)] both treat the caribou as a unit, and take them north to the coast in summer.

Richardson in the *Fauna-Boreali Americana* (154) repeats the assertion that the entire herd goes from the coast to the woods and back. In effect he used both ends—woods and coast, of his observations on Franklin's trip, and assumed that the same caribou were involved without actual knowledge of the summer and winter conditions in the barrens between Enterprise and the coast. He also asserts a complete sex segregation except in the rutting season, and states that only females reach the coast. Presumably, this must have been his observation on Franklin's voyage. Pike's (138) version is identical with the *Fauna-Boreali Americana*, as is also Whitney's (197). Other popular accounts (e.g., 24) kept repeating this version for many years, and it still crops up from time to time (e.g., 94) in unexpected places, despite the objectors to be mentioned immediately.

An early dissenting voice was Russell (161), who wrote "It is said that only the females reach the sea coast where they drop their young in June, but I have seen both sexes wading in the shoal water of the Arctic ocean."

Schwatka (63, 164) found plenty of caribou in winter in the Wager-Back River region, and took exception to the story that all went to the woods.

Hanbury (83) raised real objections. He was told by the Eskimos that the male caribou travelled farthest out on the coast, in complete and absolute contradiction to the Richardsonian account. From his personal observations he knew that a great many caribou of both sexes were found in the barrens in the winter, and that there were tribes of Eskimos depending on them. He discarded to a great extent the old idea.

Preble's (145) map would seem to give a graphical shape to many of the errors discussed above. However, the only really erroneous impression conveyed concerns the extent of migration to and from the Arctic islands. Preble was fully aware of the significance of Hanbury's observations, and first suggested the dissociation of the caribou into "different herds, or aggregations of herds, which never associate with each other at any time of the year, and which have somewhat different habits". He even suggests that in time different subspecies will be recognized in such aggregations.

Blanchet (16, 17) started out by repeating the Richardsonian concept in full, but added thereto so many of his own observations that in his second publication (17) he stated the segregation into several groups quite plainly. Observations from the air in Keewatin brought him completely

in line (19) with the views of Hanbury. His aerial observations were of the greatest significance in building up our present knowledge of caribou distribution.

Seton's "Lives" (168) rejects the migration to the islands, but in the main repeats Richardson's ideas.

Fallacies

The fallacies and some of the most prevalent errors with respect to caribou migrations are here listed.

(1) *Unity of the Herd.* It is now abundantly proved by simultaneous observations that there are many herds or groups, as Preble (145) suggests (See also 95).

(2) *Extent of Migration to the Arctic Islands.* The behaviour of herds making this migration is discussed later.

(3) *Sex Segregation.* There is no evidence that within a group, such as the Hanbury herd, there is any complete sex segregation. However, a herd of 100, or even 1,000, may be all bulls. The caribou nearest to us on the Hanbury on July seemed to be mostly bulls, but the migration as a whole was well mixed. In this respect there is no evidence of seasonal variation in the amount of segregation in the herd as a whole. Claims of sex segregation are very common, and may be well founded, but accurate information on its incidence and extent in caribou is lacking. It is most interesting to note that the Indian story of complete sex segregation repeated by Hearne (90) and Richardson (154) is completely contradicted by the Eskimo version given by Hanbury (83). Both versions are still doing yeoman service, and may be found in the current crop of Northwest Territories caribou questionnaires. Tyrrell's (189) photographs may be mentioned as showing a full assortment of ages and sexes in July.

(4) *Effect of Horn Growth on Migration.* There is a period of about 2 months when the caribou of the Hanbury are away from the woods. During that period the horns are growing rapidly, but they are even more awkward in late July when the migration inward begins and have almost 2 months to go in the velvet, during most of which time the bulls are in the woods. After the rut the bulls drop their horns long before cows and immatures, but there is no evidence that their use of wooded range is in any way conditioned by the presence or absence of their horns. The Hanbury herd may spend about 10 months in timber.

(5) *Influence of Mosquitoes and Flies.* Murie (127), who observed the Alaskan caribou over 3½ consecutive years, including all seasons, for the United States Bureau of Biological Survey, paying particular attention to details of its life history, could find no basis in his observations for the importance frequently ascribed to mosquitoes in caribou movements. Observations did show them to be momentarily uneasy in the presence of adult warble flies. The writer would say from personal observation of caribou and other game animals, that although they tend to linger in wind

or smoke offering relief from these pests, the reasoning that would have the caribou consciously make a long journey to escape them is entirely teleological. Although a caribou may well be irritated by flies, it is a different matter to concede him brain power enough to plan for relief.

(6) *Influence of the Wind.* Critchell-Bullock (35) set to work on this problem of the relation of the wind to the direction of caribou migration, by keeping a daily log of both wind and caribou. He was unable to find any relationship between them. No connection could possibly be argued between the migration we saw on the Hanbury and the winds blowing at the time, or during the days preceding.

Actual Nature of Migration

Having dealt with some of the erroneous ideas about migration, it is time to present some of the actual details revealed by investigating the various sources already mentioned. We can only talk of one aggregation at a time, and because it has been the object of the writer's personal observations and is well covered by observers reporting to the Northwest Territories Administration, the Hanbury herd will be discussed as a type for comparison with the others.

A detailed account of the crossing of Hanbury River by this herd in early July of 1937 has been given. Somewhere towards Back River this herd turns south again in July. By August 1, 1936, they had nearly all passed, and the van had put in an appearance in the timbered region. The report of Mr. Gordon MacLaren, already mentioned, shows that they go almost as far as the limits of their winter range. During late August and early September there is a well-marked recession back to the north, a sort of reverse migration, which we encountered in the field and which has been already described. Then the herds go south again in late September and October. In November there is a recession northward of herds in the Reliance area, and probably this herd does the same, but a direct statement is not available. In December it reaches feeding grounds well to the south, and its movements are described by some as a swing to east or west, continuing during the winter. Just when this particular herd turns north is not known. It does not put in an appearance on its final trek north of the barrens until June. Calving takes place on the way north.

Another herd whose movements are known in some detail is the one that visits Reliance in winter. It puts in its appearance just after freeze-up. In November there is a northward recession, after which the herds return. Their movements back and forth in the winter were described by Mr. Hoare as setting into a counter clockwise movement, gradually working out in March. By the end of May they are gone to the north.

The migration at Fort Enterprise observed by Franklin (60) and Richardson (154) is comparable. The caribou came in October. There was a recession, or back-wash, in November and irregular movements took place in the winter. In April Richardson (154) describes what seems like an outward migration to the barrens, followed by a recession to the forest. The caribou then went (in May) to their summer grounds. At his camp on the barrens at Providence Lake Mr. Gus D. De Steffany observed

caribou of this herd to come south in July, recede in August, return in October, recede in November, and then leave until February, when the first northward movement took place. The migration northward continued until June.

The herds from east of Great Bear Lake pass down the east shore in October with a back-wash in November, after which they go to the wintering grounds near Hottah Lake.

PLATE XXIII



Open Boreal forest at Reliance, showing caribou trails.
(Photograph by J. W. Tyrrell.)

Caribou from the Dubawnt and Kazan were observed going south in July and August, by Tyrrell (189). These herds appear to be those that winter in the Cree Lake-Reindeer Lake region, and thus have the longest migration of all.

Mr. Carl Buchholz, of Churchill, describes the caribou migration at the 60th parallel, north of Churchill, as a southward migration in August, northward in September, and then south in the autumn.

On the maps the condition shown for Boothia and Melville Peninsulas is that found by Parry (136), Rae (146), and Ross (157). Parry found Melville Peninsula empty of deer in winter, whereas Rae found a migration at Repulse that he could tap as a food supply. Present day testimony is that the caribou of this region are only a remnant. Ross found a migration on Boothia Isthmus. Mr. L. A. Learmonth, of Gjoa Haven, King William Island, reports that the natives of this region have to go elsewhere for caribou, and that this condition has prevailed for some time.

The migration to the Arctic islands actually involved only Victoria Island and King William Island. The evidence of Captain Bernard given before the Reindeer and Musk-ox Commission (159) shows that it was never very large, and even in the pre-rifle days only made up part of the herds of the Coppermine area. The crossings from the islands in autumn took place mainly in November (31, 149). There was no caribou migration at any interior point that can be related to this crossing, and the island deer, as R. M. Anderson pointed out (159), actually wintered at no great distance south of the Arctic coast.

This crossing no longer takes place, and has not taken place for about 14 or 15 years. There is no doubt that the caribou that were in the habit of making this crossing continued to do so until they were exterminated. It has been argued that they were diverted. If so, there has been no corresponding increase noted in any of the interior groups. Captain Bernard's comparison (103, pages 243-4) of conditions in Coronation Gulf in 1911, 1916, and 1919 shows a gradual decline in the caribou rather than a sudden emigration. The island caribou were particularly vulnerable to slaughter. In 1923 alone, 160,000 rounds of ammunition were supplied to Kent Peninsula (64). This was more than enough to account for all the island caribou that crossed there in a season, and may be considered an example of what had been in progress in that region since 1917, when posts were established. An additional incentive at that period was the trade in caribou skins. The re-establishment of the island migration will be an evolutionary process, but it is possible, and in fact there are reports that it has actually started, though only a few animals are involved.

It should be mentioned that there are in Victoria Island insular herds whose movements are confined to the island. They are not numerous.

An interesting feature of caribou migration is the fact that on occasion stragglers of the barren ground species are left behind, and stay in such places as Cree Lake (187, 188) and the south shore of Lake Athabaska all summer. Information was given at Fort Chipewyan of herds south of Lake Athabaska that were left behind by the break-up in 1936.

Missed Migrations and Irregular Migrations

There are a great many places where the natives have gone at certain seasons for generations—to meet the caribou. Usually they are rewarded by the appearance of the herds, but sometimes in the best of places they miss out. Reliance has had a comparative scarcity apparently three times since 1920, including 1937. The caribou were not absent on these occasions; rather they were not present in expected numbers. Back's first year at his fort (12) was one of the worst on record. Every group of caribou-hunting Indians has its place to go and get skins in the early part of the autumn. Were the caribou not reliable to a high degree these people would never have been able to carry on such an existence. In like manner, some of the Caribou Eskimos depend on these animals throughout the year.

Much more worthy of notice than places where caribou are almost always to be found, but occasionally missed, are those where they are not ordinarily found but appear at intervals. After all, in the first category

there is always a suspicion that there may have been a large herd a few miles away. An instance of a white trapper who waited weeks at the foot of Pikes Portage and then found that thousands had passed on one of the upper portages is famous throughout the Reliance region. If the deer do not come up the bay and between the house and the kennels at the R.C.M.P. barracks at Reliance on many occasions during a season the migration is abnormal. On the other hand, Preble (145) learned that caribou herds approached Slave River in 1900-01 for the first time in many years. In 1909 (95) and 1917-18 (198) they did so again, and in 1934-35-36-37 they approached and crossed the river. In 1937 they were in Wood Buffalo Park (175). Harper (85) quotes a report that they cross Lake Athabaska at Burntwood Island and Bustard Island about once in every ten winters. Caribou have crossed the north arm of Great Slave Lake in numbers in 1877 (161), 1905 (145), and 1934. In 1909 they came close to Mackenzie River (95). They had done this before; Whitney (197) remarks that some of the river posts had formerly been known as meat posts. MacFarlane gives the record of migration of caribou at Brochet (115). None was observed in 1873. They were present thereafter until 1884. From 1884 to 1889 they were absent, the record ending with 1890. Buchanan (21) records them again in 1914, and remarks that at that time they were more abundant than they had been previously.

Some of these records seem to indicate periodic cycles. They do not agree with one another, and, as already indicated in discussing the possibility of cycles in numbers, it is impossible to say whether they are cycles in numbers or cycles of migration.

One might hope that light might be shed on the comparative scarcity at Reliance in 1937 by simultaneous observations at other points. Actually there was a great increase in the wintering herds of the area tributary to Bathurst Inlet. These caribou, and those normally wintering in the Reliance region have, to an unknown extent, common summering grounds. It is quite conceivable that the increase in one was caused by a diversion from the other that showed a decrease, but there is, of course, no proof. The ground is not covered completely enough to exclude other possibilities.

Influences Affecting Migrations

Influences that might affect the migration routes of caribou herds may be discussed under several main groupings.

(1) *Physical Influences.* In the days of the island migration the sight of caribou milling on the shores of Victoria Island in late October and early November, waiting for the straits to freeze, was familiar to natives and travellers. Large stretches of open water anywhere are, of course, a barrier, and if an ice crossing has been normal, the herds may be deflected. Stretches of glare ice would be just as effective as open water, though the snows of this land seldom allow such a condition to last for long. The smoke of a forest fire might also affect the caribou, and Mr. Hoare once observed (92) caribou come out to Bathurst Inlet in advance of the smoke from a large fire in the Fort Rae region.

(2) *Influences Related to Food.* If the same migration route is used year after year, in time the country becomes over-grazed. The passing of large herds is more destructive than would be the case were the deer spread evenly over the migration front. Nothing is more natural than that the over-grazed range will be deserted in time. Range destruction by fire will also force the caribou to desert the affected area (138, 85, 134, 95), and if the range is rendered temporarily unavailable by being coated with ice, the caribou will be deflected or pass on (158).

(3) *Psychological Influences.* The barren ground caribou is a social animal. Lone animals are restless; one cannot help being amused by the dismay shown in every motion of the one or two animals seemingly always found grazing on the edge of a milling herd when they lift their heads and find that the herd has moved away. Although the massed herds break up as soon as the forward impulse is spent, there must be something akin to gravitational force active in their forming. It is at least to be postulated that one herd occasionally draws another out of its accustomed path.

It is frequently suggested that the presence of a number of carcasses will cause a herd to swerve. This suggestion is presented usually more as a subject for controversy than as a fact to be accepted, and is a point on which observations would be welcome. The writer would be inclined to doubt it, having seen them start at a carcass, and having also seen them feed unconcernedly near one.

Philosophy of Migration

There are many different kinds of movements of animals called migratory. Heape's (89) title "Emigration, Migration and Nomadism" is an indication of the problem. Some birds use approximately the same nesting and wintering grounds year after year, separated by hundreds of miles. This is what is ordinarily meant by migration. The migration of the lemming hordes is an emigration; they never return. Some birds, such as crossbills, appear irregularly in various parts of the country and then disappear as they came. Their nesting is equally irregular. They are nomads. The caribou fit in with the true migrants, but have peculiarities of their own. During the course of the northward migration of the Hanbury herd calving takes place. They then keep on for many miles farther north, turn, and come south. Bearing in mind the recessions, or back-washes, already discussed, the rut takes place during some phase of the southward migration. The migratory behaviour of different groups varies.

In searching for the components of the migratory behaviour of the caribou we must turn to accounts of the reindeer. Palmer (134) says "Reindeer become attached to their accustomed haunts, and once well located on a range will unerringly return to it if moved away," and gives a good example. Farther on he says "Unless restrained the reindeer instinctively seek successively their favourite fall, winter, or summer pastures." In these observations evidence of homing, the mental basis of bird migration, is given. The effects of increasing the diminishing sunlight, which have been widely investigated in studying the physiological basis of bird migration are unknown.

NUMBERS OF CARIBOU AND CARRYING CAPACITY OF RANGE

It is to be hoped that there will never be so few caribou that it will be possible to count them. It should, however, be possible to find some basis for an estimate. The only acceptable basis yet discovered is that of Anderson (7, 93), namely, to estimate the carrying capacity of the caribou country from

PLATE XXIV



Narrows of Lac de Gras, showing caribou trails. These trails cover the barrens, but aerial photographs rarely show them. (Photograph by Royal Canadian Air Force.)

a basis of known facts about caribou range requirements and the extent to which they are fulfilled. Anderson (7) estimated 1,050,000 head of barren ground caribou, based on a carrying capacity of 5 head to the square mile for 210,000 square miles. Later, in reviewing this estimate, he notes

that his estimated carrying capacity of one deer to 60 acres was confirmed by investigations on Alaskan reindeer by United States authorities, but that his previous estimate of the range area was too small. Increasing the range area of 250,000 square miles and reducing his estimate of water and waste land to 40 acres the square mile, he finds the estimated principal range to have a capacity of 2,500,000 caribou, and doubts if the number in the periphery is great enough to bring the total over 3,000,000.

The most widely circulated estimate of the numbers of the barren ground caribou is that of Seton (168) of 30,000,000. Speaking of his visit to the "Arctic Prairies" he says, "A year afterward, as I travelled in the fair State of Illinois, famous for its cattle, I was struck by the idea that one sees far more Caribou in the north than cattle in Illinois. This state has about 56,000 square miles of land and 3,000,000 cattle; the Arctic Plains have over 1,000,000 square miles of prairie, which, allowing for the fact that I saw the best of the range, would set the caribou number at over 30,000,000." Reasoning of this sort condemns itself to anyone thinking in scientific terms, no matter how abysmal his ignorance of caribou. The writer would hesitate to use such expressions were it not that these preposterous 30,000,000 caribou "with the wind blowing through their whiskers" continue to crop up in both scientific and popular writings year after year, although Anderson's soundly based estimate has been available since 1924. It should also be said, however, that Seton's description (167) of the herds seen by himself is particularly charming and effective in conveying an impression of the caribou as they are to be seen on their native barrens.

One newspaper account of the caribou (33) puts the number at 6,000,000, stating this to be the unanimous opinion of a number of residents of caribou country. No such unanimity is to be found in the replies to questionnaires on caribou by persons distributed throughout the caribou range.

To review Anderson's estimate in the light of our present increased knowledge of the caribou range does not involve important alterations to the resulting total. Since 1930 the caribou range has been largely viewed from the air by surveyors of various Government departments. Thousands of square miles have been photographed and mapped and simultaneous observations have been obtained from various parts.

The grand total area of all the range occupied by the migratory herds is roughly 600,000 square miles. Careful discussion of this area with Mr. Eric Fry, of the Air Surveys Section, who has probably seen as much of it as anyone else, brought the conclusion that 40 per cent should be taken off as water and unsuitable. The number of rocky areas not suited for range is small; the rugged area around the east end of Great Slave Lake, for example, is fine winter lichen range. The wooded part of the range has not suffered nearly as severely from fire as many other parts of Canada. In estimating the water, photographs, maps, and visual observations are considered.

This leaves the actual range area at 360,000 square miles, or 230,400,000 acres, with a capacity of 3,840,000 caribou, using the Alaskan reindeer figure (134) of 60 acres a head. However, we know that important herds,

namely those crossing from Victoria and King William Islands, and Melville and Boothia Peninsulas, are either entirely or nearly exterminated, and in some other parts of the range the numbers are below former levels; the Alaskan range is also better than most of ours (141), so that the total of the present migratory herds of the eastern barrens may be estimated at around 3,000,000 caribou, or less.

Besides these herds we have in Canada barren ground caribou in Ungava and the Arctic islands, which are known to be few in numbers, probably some tens of thousands only. We have also the migratory Alaskan-Yukon herd studied by Murie (127), which is estimated at more than half a million. It ranges partly in Canada (as far east as Aklavik) and partly in Alaska.

Increase of Caribou

Information pertinent to an evaluation of the biotic potential of the caribou is hard to get. The Royal Canadian Mounted Police at Reliance examined in 1935 and in 1936, during the early months of winter, most of the females killed in that vicinity. They found almost 100 per cent pregnant. Apparently some females drop calves at the end of their second year. Calving is around June 1. An annual increase of 30 per cent might hold for reindeer, but the caribou are probably not so fertile; how much less the figure should be we can only guess. By some who know them well the increase has been put (Northwest Territories and Yukon Affairs Bureau, caribou files) at 15 per cent. A figure between the two estimates, namely an annual increase of 750,000, may be taken as representing the best information available.

Decrease of Caribou

A discussion of all the ills and accidents that can befall a caribou is out of the question here. The intention is to discuss the importance of various factors of actual, potential, or reputed importance in killing caribou and try to get some idea of what part they really play.

Disease. The diseases and parasites of caribou have already been discussed, as well as the possibility of caribou being involved in the dog-fox-wolf epidemics of the north. Reference has also been made to the existence of plagues in reindeer, with the obvious possibility of similar happenings in the herds of caribou. This, the unknown factor, may very well be the most important.

Infant Mortality. A varying proportion of dry cows is to be found in summer. Of the few examined by the writer all had been milking not long before, although they had already begun to put on fat. The calves and yearlings are the most subject to internal parasites, and the hardships of migration tell most on them. After the July 1937 crossing of the Hanbury a number of waifs were seen; they were not feeding, but spent their time running about bawling in a most pitiful manner. A great proportion of the caribou left behind in the area traversed by the herds con-

sisted of cows and calves. We actually saw a cow and very small calf drop out of a stampeding herd and stop for some hours, during which time the herd crossed the river and presumably continued on its way. These strays keep moving and are, presumably, picked up by the southward bound herds a few weeks later.

Accidents. The hazards of river crossings are the only ones worthy of special mention here. Caribou are excellent swimmers, yet one is forced to wonder if they actually do not dislike very much to take to the water. At a river crossing they invariably head for the shallowest places. Many of these are distinguished by a riffle and a noise of running water. There is no doubt that the sound of a rapid attracts caribou. Through the vast majority of these they can trot without any trouble, and without the necessity of swimming. The rapids on the Hanbury, however, are different. To these the caribou herds rush in their spring migrations at the end of June, and on their return in late July. Should they enter the water below the rapid they can swim through easily and may even be able to trot through the shallows. When they enter the water in or above the rapids, and it seems to be entirely a matter of chance where they enter, they are at once forced into a heroic struggle against the current. It is a sight not to be forgotten to see a grunting file of caribou inch its way across directly into the current, with slow, powerful, and regular strokes. It is remarkable to see the force of current that they are capable of stemming. There are, however, in all the main rapids, chutes into which they are unable to avoid being drawn, and down which they are swept like chips, and the whole canyon region, Macdonald Falls, Dickson Canyon, Ford Falls, Helen Falls, and the Last, or 10-foot Falls, constitutes a hazard to the migratory herds. To a lesser extent Lockhart River may also be a hazard (117). Anderson (4a) records drowned deer on Back River.

A few caribou were killed in the crossing that we saw at the Caribou Rapids. There were one or two stale carcasses in the canyon region, particularly below Dickson Canyon and Ford Falls, and some along the river to and including the Junction. Killings at the upper rapids are probably only occasional, but treacherous conditions are found at the canyon region all the time, and there may be an occasional addition to the death toll at all seasons when caribou are in the country. The reason for believing so is that an association of carrion eating animals is to be found there that is hardly to be duplicated elsewhere. Among mammals there were many more signs of wolverine, wolf, and barren ground bear there than elsewhere. Among birds the herring gull nests in numbers, and where safe nesting sites are not available on the level ground it shares the ledges with the duck hawks and ravens. Ravens are not common on the barrens in summer; most of those seen by us were in this region. Critchell-Bullock (35) even notes that a rough-legged hawk collected there by him had been feeding on caribou.

The number of carcasses observed was not large. However, in 1929, a Royal Canadian Mounted Police patrol under Inspector Trundle went in to Hornby's cabin in July to investigate the tragedy that had taken place there. After making a complete investigation and burying the bodies of Hornby and his two companions (28) they returned to Reliance. There

were signs of a great migration of caribou (158) along the Hanbury and Thelon, and between Ford and Helen Falls they counted 525 dead caribou (See Plate XXV). It is probable that 525 is an unusually large number of caribou to be killed in the falls. The association of carrion-eating animals above mentioned is certainly based on a much smaller number.

PLATE XXV



Dead barren ground caribou below Ford Falls, Hanbury River. (Photograph by Royal Canadian Mounted Police, Thelon patrol of 1929.)

It is interesting to observe the behaviour of caribou at Dickson Canyon. The deep roar of the canyon is not a sound to be compared to the rippling noise of the lesser rapids, which has been presumed to be attractive to them. One herd, which came to the head of the canyon, swerved, and crossed in the shallows at the foot, has been mentioned. Observing a few animals approach the head of the canyon, the writer noticed that the sandy shallows extending out above it seemed to attract them, but as they came opposite the canyon they were very alarmed, and retreated. Mr. Hoare on a previous visit saw a herd of a couple of hundred go into the water of the little lake between Macdonald Falls and the Dickson Canyon. Almost immediately they were swept into the canyon. They struggled with the current and a number were able to get safely up some steep side draws. The rest were swept through the entire 3 miles of rushing water, including chutes like that illustrated (Plate IV). He expected to find a number of dead; actually he was only able to find three, although there were several observed to be injured. It is, of course, quite possible that a drop of 60 feet in one chute like Ford Falls is worse for the caribou than the long 213 feet that Tyrrell (190) gives for the canyon. Mr. Hoare was of the

opinion that injuries were sustained when the deer were packed closely together and then thrust by the current against the wall of the canyon, or some obstructing rock. The Indians are well acquainted with the buffeting that the caribou get in Hanbury River, and attribute to it wounds and broken limbs found by them in animals that they have shot.

Roughly though the caribou may be treated by it, one cannot assign to the Hanbury any great importance in controlling their numbers. The group making a crossing in the canyon region normally represents only a part of the Hanbury herd, and is hardly to be reckoned in the grand total. Even were 525 taken each year, which is very doubtful, it would not be a significant number by itself, out of a herd of 100,000 or more.

Factors Affecting Forage

Fire. Ungava Peninsula used once to have its migrant herds; today they are practically gone, at least in comparison with their former abundance. It has been claimed for them that they moved from such and such a region to another region. Just as with the Arctic islands herds, there is a great reluctance to admit that they might be gone entirely. However, when we look for a corresponding increase in the direction in which they were supposed to have gone, we find no such increase; rather do we find that there, too, the caribou have decreased or gone. We can find no evidence of disease, of excessive hunting, or of unusual abundance of predators. What we do find is that about the time the Ungava herds started to decrease there were enormous forest fires that swept the whole country (111).

Other reports confirm this in all details, and suggest that the unburnt wooded parts of Ungava were not very large. The whole winter range of these caribou was wiped out, and one feels that there is no need to look further for causes of their disappearance.

Palmer (134) considers that it may take a burned-over lichen area as much as 25 years to come back. If the humus is destroyed, the loss is to all practical purposes permanent. He places fire first among reindeer enemies.

The winter range of the caribou of the eastern barrens has not been injured very greatly as yet, but the penetration of prospecting operations into it should be watched very closely. During July 1936 a pall of smoke hung over the Yellowknife region, so that the Royal Canadian Air Force was compelled to leave some areas unphotographed. Just how much range was destroyed is not known. Harper (85) has described the effects of fire on the lower Taltson country. The carefully considered opinion of Mr. Eric Fry, of the Air Surveys Section, is that the wooded portion of the range of the barren ground caribou has suffered less from fire than forested regions bordering it on the south. A change in this one factor alone might easily reduce our caribou by half in a short time.

Trampling. Palmer (134) remarks that "much trampling in summer when the plants are dry and brittle may entirely kill out the cover". Devastation followed the crossing of the Hanbury, but its extent was limited and many of the roots would send up shoots the next year. In effect,

the only evidences of the passing of the herds that persist are the trails. From the air these are seen as irregular lines all over the country, converging on narrows, points, and at the bottoms of bays (See Plate XXIV).

Over-grazing. Although 60 acres a head may be the carrying capacity of the range of a gregarious animal, grazing is irregular, certain areas being over-grazed and others very lightly grazed. If any one group of caribou were to attain excessive numbers, damage would be done and if such numbers were maintained it would eat itself out. In practice it is hard to know whether or not grazing-out of a range has had the effect of reducing the numbers of caribou. The range on the Hanbury and in the Reliance region is in excellent condition, and at Mistake Bay the range seemed good. At Baker Lake, however, the lichen range seemed very greatly depleted. The deer have not been abundant for the last few years, and there is no reason for assuming that they have gone elsewhere.

The Alaskan reindeer range, according to Palmer (134), takes "possibly 15 or 20 years" to recover after full cropping.

If any large area of range were to become ice coated the caribou would starve. An instance is reported (158) where the ground in a small area became coated in autumn and stayed so all winter. In such a case the range is not destroyed and the caribou could simply move on.

In passing, an opportunity may be taken here to make a contribution to the question of what caribou feed on by preference. Murie (127) found grasses and lichens most important, followed by mosses, willows, birch, and *Vaccinium vitis-idaea*. Although caribou were found to crave lichens, and to feed on them eagerly even in summer when the maximum of other food is available, they could, as was found on Unimak Island, do entirely without lichens. In 1936, six paunches, all from animals killed in August, were examined. Lichens made up the bulk of the food in all cases. A significant amount of browse was present, but the amount of grass was small. Anything else was incidental. In 1937, five paunches were examined, all from animals killed in July. One was sucking. In the rest the food was largely browse, with a significant amount of grass. The lichens and other plants in these July stomachs could well have been there by accident. The sex and age distribution was good in both years for such a small number.

Predators

To the predatory animals is popularly ascribed the chief rôle in reducing the numbers of caribou. In order, however, to make a just evaluation of the importance of these creatures it is necessary to abandon preconceived ideas and to treat the information available according to its value as evidence.

Wolf. The wolf is the chief caribou predator, and the only one of any importance except man, the "arch-predator". Wolves are peculiarly adapted by nature for caribou hunting and certainly kill large numbers. In order to weigh their importance, it is necessary to go into some details on wolves, which have been omitted from the faunal part of this report for special treatment here.

Wolves are spread remarkably evenly over the interior barrens in summer. That in itself suggests that they are territorial when on their breeding grounds, i.e., that the breeding pair arrogates unto itself a stretch of barrens around its den and keeps this from invasion. There exists, of course, no proof of this; it is merely one of the many points on the life history of northern animals that await investigation. Mr. H. N. Hamar, a barren land trapper of wide experience known as one of the best wolfers in the country, who has paid particular attention to the location of dens, is of the opinion that one den, with a total of 6 wolves, to 100 square miles represents the average condition in the barrens. He has never seen less than 3 or more than 8 to a litter. This is interesting as agreeing with the observations of Mr. A. E. Porsild, botanist of the National Museum of Canada, whose years of botanizing in the barrens have put him in a position to make a similar estimate. We have given the caribou country as 600,000 square miles. This allows for 36,000 wolves as a population, based on the estimates given above.

The next question is, to what extent do these wolves use caribou? During the winter the life of wolves is the pursuit of caribou, in which pursuit they form themselves into larger or smaller packs. This life begins, apparently, with freeze-up. About the first of April the wolves begin to establish themselves in pairs on their breeding grounds (35), where the den will later be located. Such, at least, is what the available reports indicate. Thereafter they "stay put" whether there are caribou around or not. Actually there are many areas where caribou will probably not be around for any length of time, and the behaviour of wolves on the summer range suggests that they find other food. With derelict and wounded caribou all around the Caribou Rapids, there was no sign of a wolf kill. Some of the lost calves seen on the Hanbury must have been wandering several days. There were wolves all through the country, and it is well known that calves are often killed by wolves on the summer range, but the killing must be comparatively haphazard.

Freuchen (37) reports that when lemmings are abundant wolf stomachs and excrement are full of their remains. Wolves will use other food than caribou at any season, if and when readily available. In some cases a wolf finds a trap-line to be a more reliable source of food than the wandering herds. This happens often enough to cause the wolves to be excreted for that reason only.

One commonly hears it said that a wolf kills one deer a week. However, one hears, this is not what the wolves eat, but what they could kill. Presumably a pack of wolves could kill 100 deer a day; actually there is more reason for believing that they do not get enough to keep themselves fat. Were deer always available, surely no wolf would acquire the "trap-line habit." The condition of wolves taken varies from very fat to very emaciated, but so far as the writer has been able to ascertain their condition is like that of the Indian dogs, sometimes well fed, but usually a little on the gaunt side. Were every person killing a wolf to record its condition and the contents of its stomach, whether full or empty, or containing caribou meat or other food, then some idea could be obtained of the use of caribou by wolves. Lacking this information, the old familiar

"50 deer a year" must be rejected because the circumstantial evidence is against it. One can imagine a wolf, one of a pack at Artillery Lake in the dark days of mid-winter, with caribou herds drifting here and there on the wind swept barrens. The snow is covered with old trails, which do not mean much to a wolf, as they are mostly cold. The eyes of the pack do them little service, and should the game be startled the trail will soon drift over and they will be lost if a kill is not made at once. An unlucky wolf pack could be hungry even with the caribou around them in fair numbers.

As, therefore, the wolves are not dependent on caribou in hunting around their dens, and actually are hunting them in packs for only about 7 months, and because there is reason for believing that wolves hunting caribou are not on the average fat, we shall credit our 36,000 wolves with 400,000 caribou a year.

In 1936-7 the total of wolf pelts taken in Alberta, Saskatchewan, and the Northwest Territories was 1,569, of which 1,106 were taken in the Northwest Territories (39). The Manitoba figures do not distinguish wolves and coyotes, but would probably add no large number to the total. Of the wolves taken in the Northwest Territories, a large proportion was from the caribou country where wolves are much more common than elsewhere.

It is at once apparent that even though the number of wolves may be much less than given above, the catch could be raised considerably without taking the natural increase. With four pups at a den the increase is so much greater than that of the caribou that the wolves would soon deprive themselves of a food supply. We have already seen that such indications of a cycle as are found in caribou are of a long cycle. Also, although the wolves may not be fat, no evidence has come to light of their having been found in numbers in a starving condition. There is, however, strong evidence that they are subject to disease, as discussed in detail above. It is to this that we must look to discover the secret of how nature controls the wolves. It is doubtful if the efforts of white or native hunters are of any importance whatever in the control of wolves in the caribou country, or could, under present circumstances ever be of any importance.

Of course, it is unlikely, taking disease into consideration, that the number of wolves stays at a level. It probably has its ups and downs, and the degree of caribou predation likewise would fluctuate. As already mentioned, a proper investigation to determine whether or not there is a wolf cycle has never been made.

Minor Predators

Tyrrell (189) says of wolverines, "In one instance four of these animals were following one full-grown deer, and they seemed to be driving it gradually down into a lake." There one would think it could escape easily. This is the only reference I can find to the wolverine as a possible caribou predator.

Seton (167) gives some evidence that the lynx may attack caribou. Murie (127) suggests that when rabbits are scarce a lynx may come to the point where it will attack caribou, though it probably does not normally do so.

The barren ground bear is probably capable of killing caribou, though in actual fact it is too scarce to matter, and apparently more addicted to roots and berries and ground squirrels. Murie (127) suggests that grizzlies get a few Alaskan caribou.

Hunting

The number of white trappers using caribou extensively in the Northwest Territories may not exceed 100. Among the Indians, those of Great Bear Lake, Fort Rae, Yellowknife, Rocher River, Snowdrift, and the "Caribou Eaters" of the upper Taltson live to a considerable degree on caribou. A large proportion of the Eskimos depend on them. In the provinces there are the Indians of Lake Athabaska and Cree Lake, of Black Lake, Wollaston and Reindeer Lakes, and of a large area tributary to Churchill, all using caribou. The caribou country of the provinces is reported to be well occupied by white trappers. Accurate information on the total kill of caribou by those hunting within the range of the migratory herds is not obtainable, but on the basis of available information on the conditions prevailing there is no hesitation in putting the human kill by all agencies at 200,000 a year, as a minimum.

In the olden days the Indians hunted with bows, spears, and snares. Elaborate devices, some like those described by Murie (127), were constructed to drive the caribou for spearing. Since the coming of firearms these have been abandoned, except that the Indians still make extensive use of stones erected on the skyline, or rows of brush or moss on the ice, to draw the caribou towards the concealed hunters. The Eskimos formerly used, and some of them still use, such devices to get the deer into the water, where they were speared from kayaks. Eskimo winter hunting has been well described by Hanbury (83). How the destructiveness of these ancient methods compared with that of modern weapons we have no way of knowing. MacFarlane (115) predicted that the introduction of steam on the Athabaska (1883) and the Mackenzie (1886) would afford a surcease to the migrant herds, which had before that time furnished huge quantities of dry meat to the York boat brigades. The population of both Indian and Eskimos has also very largely decreased, although now it begins to show an improvement. Opposed to these factors, there is the influx of white trappers into caribou country, and the opening up of mining camps. The commercialization of caribou is forbidden in the provinces; in the Northwest Territories it is subject to strict control, and (remembering the trade in hides of a few years ago (64) and the ancient export trade in tongues) is less than ever before.

Summary

We have, then, an estimated increase of 750,000 caribou, with an estimated predation of 400,000 and an estimated minimum hunt of 200,000.

The rest may be assigned to infant mortality, a factor even more important in wild than in human populations, and disease. Actually these figures probably vary widely. In all likelihood the total caribou population has at times gone down quite low, and at others exceeded for a while the carrying capacity. It must be remembered that the vulnerability of the caribou to wolves probably increases greatly with each increase of caribou over certain limits. Such a supposition is in accord with the results of modern research on the subject of predation. It is clear that were the increase of caribou to go on unchecked over the carrying capacity on which our figures are based a disaster would result.

These relationships are not at all simple, and we do not understand their workings at all clearly. All we can do is to watch carefully that no new factor enters into operation to a degree affecting any large number of animals. In this respect it is plain that where a white trapper and a native enter into competition it is imperative to favour the native in the interests of stable economics, even though the white man may be a very estimable person. The reason for this is that few white men are actually maintaining homes and families at the scene of their trapping operations.

A case in point in respect to the entering in of new factors is Newfoundland. At one time a large migration of caribou came each autumn from the northern peninsula into the more southern parts of the island. About the beginning of this century (1) the wolf became extinct in Newfoundland, and according to popular beliefs about wolves, the caribou should have increased enormously. So far as can be found, however, there was no change. If one immediate check is removed the animals concerned become vulnerable to another. About the same time, however, a railway was built, which cut directly across the migration route. For a number of years there was no harmful effect to be seen; the area most directly affected was made a sanctuary (42). However, the caribou had been made accessible to hunting as they had not been before. In 1919 (43) the migration ceased. The added, unnatural destructive factor had proved of more importance than the natural one that was removed (*See also* 127).

In Canada the caribou country seems to have skipped the railway age and gone directly into the age of aerial transport, which is fortunate for the game. They may escape the destruction of range and increased hunting that would surely follow the building of a railroad. However, when we think that there has as yet been a comparatively small amount of range destruction, and that the country is just opening up, we wonder about our caribou. Hunting can be controlled, and sale to mining camps. The wolves have always been with us. Fire is the thing to fear, with its destruction of the forested winter range, and fire is something that has so far never failed to accompany prospecting and lumbering.

The Thelon game sanctuary protects portions of several herds for short periods of the year and no more. It has caribou, but whether or not they will always be there depends on factors operating elsewhere. We cannot completely protect the whole range of any mainland herd, because where there are caribou in winter there are also natives. The only thing that can be done in the way of a preserve is to have the entire range of a herd included in a native game preserve.

IMPORTANCE TO NATIVES

The importance of the caribou to the Indians and Eskimos cannot be stressed too much. They are caribou people in life and in thought. Both races have so adapted themselves to caribou hunting that they are capable of living entirely by it. On the other hand, it is hard to see any future for them without the caribou. The life of the Caribou Indians, not so familiar as that of the Caribou Eskimos, is described very well by Robinson (155a).

Almost all the peculiarities of a given area with respect to its use by natives can be explained by the caribou movements in that area. Eskimo wood-gathering on the Thelon is an exception. The fact that caribou are present in the upper Tazin-Taltson region for months longer than in any other wooded area suggests that this area could have played an important part in the development of a caribou culture among the Indians. Birket-Smith, speaking of the distribution of the Caribou Eskimos, says (15) "The boundary on the west is quite different. Here it is neither the geography of the country nor a strange population which marks the barrier, but simply the smallness of number of the Caribou Eskimos themselves. It is human life that ebbs out and creates one of those voids that are characteristic of thinly populated countries." The writer would suggest rather that it is the distributional peculiarities of the caribou (See Figures 3 and 4), without which there can be no Caribou Eskimos.

Although the natives themselves (whose population we may expect to increase) are capable of completely exhausting the capacity of the country to provide a livelihood by hunting, the presence of herds of caribou is a great boon to the mining development, which is the white man's portion in the country. The natives are also a great aid to development. The preservation of the caribou in their original numbers is an administrative task of such importance that measures of extreme caution are fully justified.

NOTES ON FIGURES 3 AND 4

These figures show the segregation of the caribou into herds. Although reports indicate that concentrations are fairly constant from year to year, in some years the centre of distribution of any given herd may be 50 or even more miles from its position on these maps.

Herds indicated on the Arctic islands are those wintering on the mainland. No attempt is made to show endemic island herds. Herds migrating from the Arctic islands and those of Boothia and Melville Peninsulas are now apparently extinct, so that these maps are dated 1850, at which time these herds were assuredly still in existence.

FISHES

GENERAL DISCUSSION

There is surprisingly little information available on the fishes of the interior region. Most of the travellers have contented themselves with saying that the fishing was good or mentioned a few fishes without much information as to just where they were encountered.

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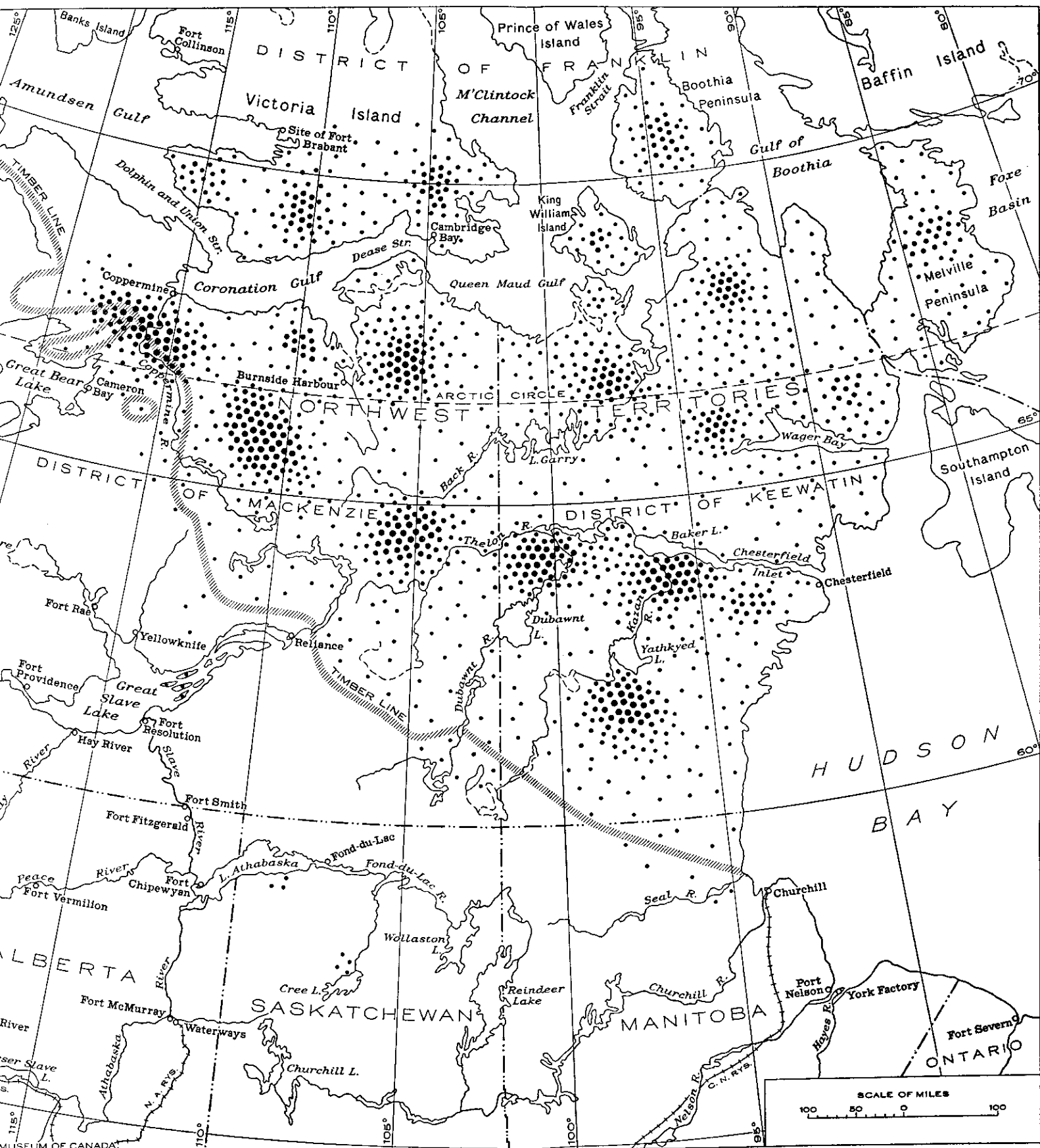
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Map showing midsummer (July) distribution of barren ground caribou about 1850; the relative density of concentrations is shown by various sizes of black dots. See notes on page 112.

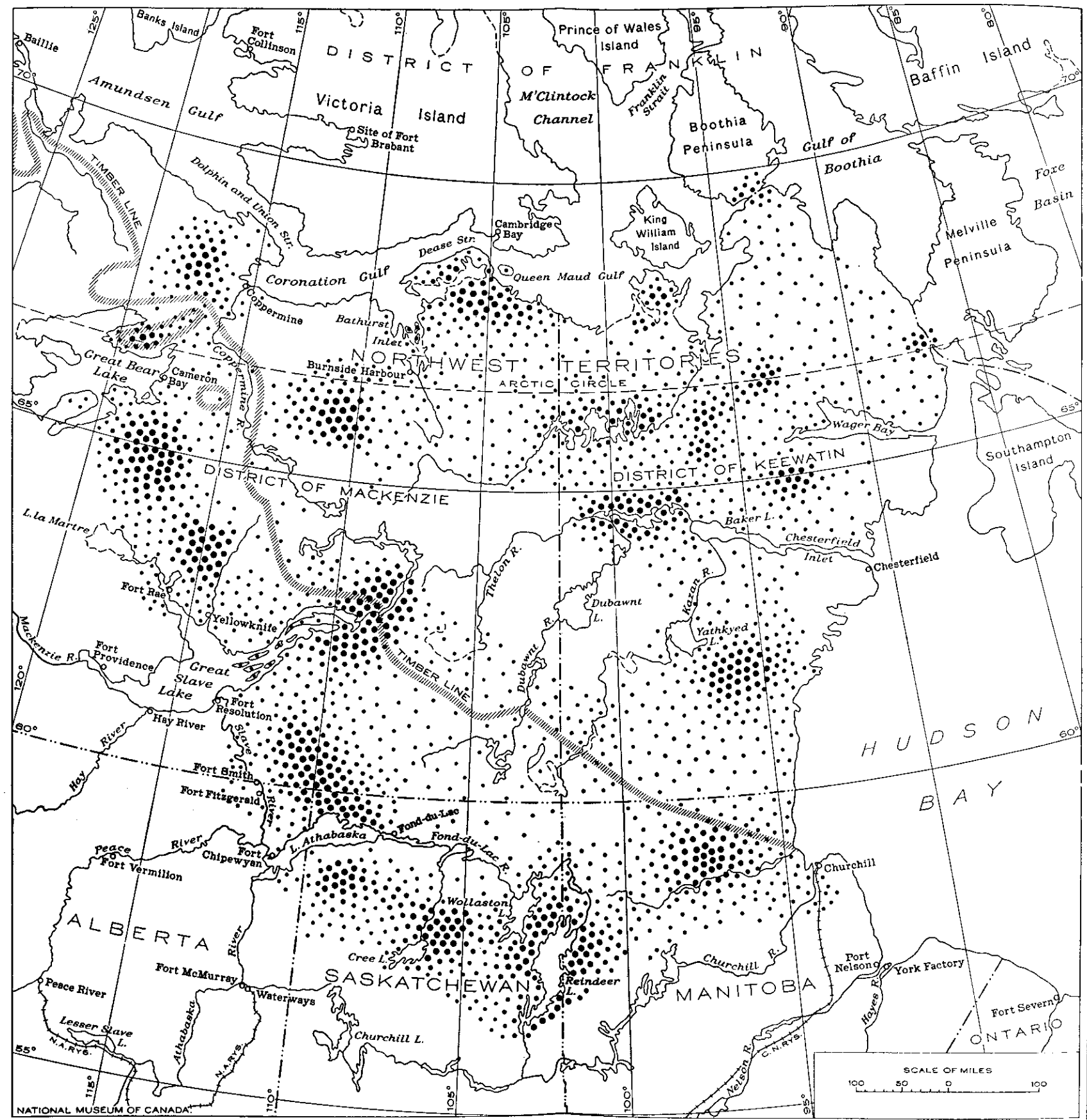


Figure 4. Map showing midwinter (January) distribution of barren ground caribou about 1850; the relative density of concentrations is shown by various sizes of black dots. See notes on page 112.

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King (110), one of the earliest travellers, was to have made a detailed investigation of the fauna of the barrens, but his commanding officer, Back (12), had other work for him, and the trip of exploration was so arduous that practically no information on fishes was obtained. The history of their attempts at fishing at Reliance is, however, of much importance.

Hanbury (83) and Critchell-Bullock (35), the latter especially, gave us some account of the fishes they encountered. Except for a few specimens taken by the Thule expedition at Baker Lake (137), our thirty-six specimens were the only ones from the interior. All were in good condition and have been identified by Professor J. R. Dymond, of the Royal Ontario Museum of Zoology, Toronto, who has kindly read this manuscript.

Our specimens were displayed on several occasions to reliable Eskimos, and the names they gave were written down as they sounded at the time. These names are given in the annotated list that follows. There are several published lists of Eskimo names, however, that constitute in themselves generalizations on the fish of the region. In several cases there is a recognizable similarity to a name given to our specimens.

They are to be found in the writings of Birket-Smith (15), Rasmussen (151), Blanchet (19), and J. B. Tyrrell (189). The lists are distributional material only in so far as one can be satisfied with the identifications.

ANNOTATED LIST

The following fishes are known to occur in the region defined on page 27, with asterisks indicating those recorded from the Thelon game sanctuary.

1. **Amphiodon alosoides** Rafinesque; Goldeye

Critchell-Bullock records (35) the capture of this species in Great Slave Lake "as far east as the Narrows."

2. ***Christivomer namaycush** (Walbaum); Lake Trout. Eskimo: Fakalluk.
Possibly "Eqalluk" gives the same sound.

Very generally distributed in lakes and rivers. In actual records it was found by Franklin's party at Carp Lake and at Fort Enterprise (60), and by Inspector Pelletier on the Hanbury (25). Mr. Hoare caught this trout at the foot of Macdonald Falls (i.e., between Macdonald Falls and Dickson Canyon), and Critchell-Bullock (35) mentions taking it at the foot of the canyon (i.e., between Dickson Canyon and Ford Falls). Lake trout constituted nearly all of the small catch made by Hornby's party through the ice of Thelon River in the winter of 1926-7 (28). Observations communicated by Mr. S. H. Wood of the Dominion Water and Power Bureau show lake trout abundant in Yellowknife and Beaulieu Rivers. Of particular interest is the 15-minute catch, all of this species from Artillery Lake, illustrated in J. W. Tyrrell's report (190). This species was represented in the Fifth Thule Expedition collection from Baker Lake (137).

In 1936 we had an opportunity of observing the fishery, almost entirely for this species, in the eastern part of Great Slave Lake. The difficulties of the fishery are discussed below, and it may be simply said here that at Reliance in July the supply of lake trout taken in nets was excellent, with a good distribution of sizes, from 1 pound or even less to one of 28 pounds. Food consisted of tullibees, miller's thumb, and the refuse from caribou killed on the ice.

On our way in to Reliance we stopped long enough to hook a 12-pound fish at Talthilei Narrows, one of the most famous summer fishing places on the lake. The troll was scarcely in the water before a fish was taken.

From Prairie Lake, a headwater for one of the small tributaries of the Thelon, four trout were taken, averaging about 10 pounds. One contained a small fish of its own species, two stomachs were empty, and one contained a quantity of snails of a species found abundantly in the lake.¹

When we first landed at Artillery Lake on July 20 the lake was largely full of drifting ice and big lake trout were numerous along the shore. In early August the ice was gone and the schools along the shore were dispersed and more generally distributed. Two small specimens taken at Crystal Island both contained mosquito larvæ. Of two small specimens taken in the upper rapids of Ptarmigan River, one was empty and one contained a well-digested small fish.

In 1937 we found an abundance of lake trout from Heuss Lake to Baker Lake, with an excellent distribution of sizes in the Thelon. Specimens were from Aberdeen River and Baker Lake. Preference was given in our collecting to species less easily identified.

We were told that the trout of Artillery Lake come into the shallow water in spring to rid themselves of worms, and it might be mentioned that we found leeches on trout at Crystal Island.

3. *Salvelinus alpinus* (Linnaeus); Arctic Char. Eskimo: Eakallukpik (Eqallukpik); other names for this species seem to refer to degrees of pinkness of the flesh.

There are few records of the char in the interior. The Thule expedition (137) collected it at Baker Lake. Porsild (141) notes that it stops at the falls on the lower Kazan.

In 1937 we took it first in the river between Aberdeen and Schultz Lakes. From thence down to Baker Lake it was abundant. It was the fish most highly prized at Baker Lake.

4. *Stenodus mackenzii* (Richardson); Inconnu (abbreviated usually to Coney).

Back (12) notes that the capture of an inconnu in the eastern half of Great Slave Lake somewhere around Utsingi Point surprised the Indians in his company. The writer was given to understand that the species is rare in the eastern part of the lake, but had been taken at Reliance. He also heard of Yellowknife River having been called the Beg-ule (Toothless Fish or Inconnu).

¹ Snails collected at Prairie Lake were identified by A. LaRocque as belonging to three species. *Stagnicola palustris* (Müll.), *S. emarginata* (Say), and *Valvata lewisi helicoidea* Dall.

5. **Leucichthys artedi* (LeSueur); Tullibee, Cisco, or Lake Herring. Eskimo: Anaglit.

Abundant along our route in many places. We brought out no specimens from the Great Slave Lake drainage, so that the above name applies only to the fishes collected from the Thelon system and Baker Lake. Prof. J. R. Dymond comments on these specimens as follows: "Four of the five specimens of *Leucichthys* examined undoubtedly belonged to the species usually identified as *artedi* (Dymond 1933 (46), 1927 (45)). These are from 14 to 16 inches long. A fifth specimen, about 12 inches long, from Baker Lake, differs from the others in a number of respects—larger eye, more slender body and caudal peduncle, shorter fins, fewer scales and gill rakers, and may represent a distinct species, but not enough specimens of *Leucichthys* from the Northwest Territories have yet been studied to make identification possible. Three of the *artedi* are from Baker Lake and one from the river between Beverly and Aberdeen Lakes."

Tullibee similar on inspection to the above were found at Reliance in 1936. A few were taken in nets, but many more were seen in the stomachs of lake trout.

Tullibee are noted by Hornby (95) as abundant in October 1924 in Artillery Lake, and Critchell-Bullock (35) writing of the same expedition called them abundant in Great Slave and Artillery Lakes.

6. **Coregonus clupeaformis* (Mitchill); Common Whitefish. Eskimo: Kakkiwiaktuk.

Here again the names only apply to the Thelon drainage and Baker Lake, whence came our specimens. Professor Dymond states: "The collection examined consisted of eight specimens, 15 to 20 inches in length. Six of them are from Baker Lake and two from Thelon River. In most respects they are similar to the whitefish of the Great Lakes, the most conspicuous difference being that the fish from the Northwest Territories have less depth of body, but the present collection gives no indication of a species differing from that of Hudson Bay and the Great Lakes."

Whitefish were taken by us in abundance in the Thelon and all the way to Baker Lake. In 1936 a few were taken at Reliance. These were all of the "Crooked-back" variety, which seems to be an entirely distinct species, although something in the nature of a hump is found on some of the ordinary whitefish. Besides the "Crooked-backs", ordinary whitefish were seen at Yellowknife Bay, where they were netted by the Indians. Proper material for the identification of the "Crooked-back" whitefish of Great Slave Lake has not yet been collected.

The Thelon is famous for its whitefish, now for the first time identified properly. As previously stated, the name itself probably means whitefish. Pelletier obtained them on his trip (25), and Hornby (95) and Critchell-Bullock (35) both note them from the Hanbury below the Caribou Rapids. J. B. Tyrrell found them in the Dubawnt system, especially abundant in Dubawnt Lake (189).

In the Great Slave Lake drainage whitefish (sp.) to the number of 1,200 were taken at Carp Lake, and at Fort Enterprise by Franklin's party (60). Critchell-Bullock (35) also found whitefish (sp.) abundant in

Great Slave Lake, with a few also in Artillery Lake, where it had previously been mentioned by J. W. Tyrrell (190). Hornby (95) refers to it as taken in October 1924 in Artillery Lake. Mr. A. J. Knox said that he had taken it in Ptarmigan Lake. Mr. G. H. Wood found whitefish (sp.) in the Yellowknife district.

7. ***Prosopium quadrilaterale** (Richardson); Round Whitefish. Eskimo: Kakkiwiaktuk.

Concerning our collection Professor Dymond remarks:

"The collection of round whitefish examined consisted of six specimens, 12 to 16 inches long, five from Baker Lake and one from Aberdeen River. Five of the specimens agree quite closely with the form recognized as *quadrilaterale* from northern British Columbia, Hudson Bay, and Lake Nipigon (Dymond 1935 (47), 1933 (46), and 1927 (45)). The species was originally described by Richardson, who said, 'we found it in the small rivers about Fort Enterprise' (60).

"The smallest specimen differed from the others in having a much shorter and deeper head and larger eye. In the absence of other specimens it is impossible to say what the significance of these differences may be."

This small whitefish is probably often unrecognized by those who take it (*vide* Eskimo name the same as for *Coregonus*). It will be observed that, as was also the case with the Tullibee, we took it in the lakes and not in the Thelon proper. A small specimen was rescued from an Arctic tern at Hanbury Portage, Clinton-Colden Lake, in 1936.

8. ***Thymallus signifer** (Richardson); Bluefish, Grayling. Eskimo: Hoolukpaugak.

Franklin (60) mentions this species at Hunter Lake, on the Yellowknife route, Richardson (60) took it in Little Winter River, and it is listed by Franklin (60) in the catch at Fort Enterprise. Back (12) records it from Hoarfrost River, upper Back River, and Pelly Lake (on Back River), and Inspector Pelletier (25) found it on the Hanbury. Hornby (95) and Critchell-Bullock (35) found it at the foot of Dickson Canyon and Helen Falls. Critchell-Bullock (35) also mentions it at the Last Falls of the Hanbury, and the narrows of Great Slave Lake. The Thule expedition collected it at Baker Lake (137).

In 1936 the writer saw bluefish taken at Reliance, and took some himself in Ptarmigan River. In 1937 we took them on the Thelon and all along the route to Baker Lake.

It is doubtful if even the lake trout is more universally distributed than the bluefish in this region.

9. ***Catostomus catostomus** (Forster); Northern Sucker.

"Carp", as they were called, were taken by Franklin's party (1823) in Carp Lakes on the Yellowknife (60). "Red Carp" are also mentioned in the catch at Fort Enterprise (60). Hanbury (83) did not take any on the Thelon, but he got a few at the headwaters of the Hanbury. J. W. Tyrrell reported (190) it in Artillery Lake, but Critchell-Bullock (35) states that he and Hornby were only able to get one. They found it, however, in the Thelon, and immediately below Dickson Canyon on the Hanbury. Hornby (95) gives similar information.

Our nets took no specimens of this fish.

10. ***Esox lucius** (Linnaeus); Jackfish, Pike. Eskimo: Hiulik.

As soon as we got below the falls of the Hanbury and into the Thelon waters we encountered this fish. Once we passed the marshes we took no more. Our specimens were small, but while we were camped with the Eskimos they took a large one.

Franklin mentions (60) it among the Fort Enterprise fishes, and Russell (161) found it common in Yellowknife River. Christian's diary (28) records a large jackfish as taken in a net under the ice of the Thelon at Hornby's cabin on December 20, 1926. It is mentioned by Tyrrell (189) among the fishes of the Dubawnt and Kazan. Mr. G. H. Wood in observations communicated to the Northwest Territories Administration reports it common in the Yellowknife both above and below the rapids, and Anderson (4a) found it in a lake north of Great Slave Lake. J. W. Tyrrell mentioned it for Artillery Lake (190), but we have no confirmation of its presence there.

11. ***Lota maculosa** (LeSueur); Loche, Ling.

Among the fishes at Fort Enterprise Franklin (60) mentions the "methye". Critchell-Bullock (35) calls the loche, "almost absent from the Hanbury-Thelon system". A loche (misinterpreted from the handwritten diary as "lacke") is recorded by Christian (28) as having been taken through the ice of the Thelon on a hook by Adlard, at Hornby's cabin on December 11, 1926.

We took none. At Baker Lake the writer was told that there was one fish found there, the tiptalik, which was not in our collection. So far as could be ascertained this was the loche. It is also reported in the lakes on the Lockhart River system.

12. **Pungitius pungitius** (Linnaeus); Nine-spined Stickleback.

We took this small fish at Baker Lake, where it is also recorded by the Thule expedition (137). All captures of small fish were of necessity pure chance, as we had no equipment to get them.

13. ***Cottus cognatus** (Richardson); Miller's Thumb.

This species is recorded from the Hanbury (35) and Baker Lake (137). We found it at Reliance and on the Lockhart system in 1936, and were able to catch one at Heuss Lake in 1937.

Parasites. Besides the leeches referred to parasites were collected from trout and whitefish. They have not yet been identified. Some dog parasites are probably derived from fish, though those collected by the writer came from eating caribou.

FISHERIES

General Description

Of the fourteen species recorded above (giving the "Crooked-backed whitefish" recognition) only eight are common enough or large enough to be of economic significance. Almost anywhere the lake trout, one or more of the whitefish, tullibee, and bluefish may be expected in quantity. The char is only important in the lower Thelon, lower Kazan, and Baker Lake region. The pike, so far as can be determined, is only important in a few places on Thelon River. All the rest can be left out of consideration.

The importance of fishing in the lives of the people of Mackenzie River and Great Slave Lake has been represented effectively by Preble (145) in discussing the fish fauna of that region. To the eastward an entirely different condition is to be found. The Caribou Indians fish with enthusiasm for a few days in spring when they welcome a relief from their caribou diet of the winter. In a very few meals they have had all the fish they want, and for the rest of the year fish only through necessity and in a most half-hearted way. No effort whatever is made to fish for dog feed. The Caribou Eskimos are the same. When (at Baker Lake) Mr. Lunan and Mr. Hoare at my behest asked one Kineraknak what fish he liked the best he replied "Tuktu" (caribou), and others, laughing at the joke, gave a hearty assent. The use of a net was taught the Beverly Lake people by a trapper, Hjalmar Nelson, the nets being provided by the Department of the Interior and given out by Mr. Hoare. These people are now expert fishermen, but it is quite probable that there are Eskimos in the vicinity who still do not know how to set a net. They have their spears and leisters, but the part played by fish in their lives is most certainly not proportionate to the abundance of fish in their country.

Records of the fishing effort of white men in this region begin with Franklin (60) at Fort Enterprise, and Back (12) at Fort Reliance. Franklin detailed a couple of men to fish and they took 1,200 whitefish, along with other fish, during October. The fishery failed and was given up on November 5. At Fort Reliance Back's party put up fish for a few days in September, but by September 29, 400 fathoms of net were not taking enough fish for the needs of the day. Fish were taken in October, but "after the first haul the nets were invariably found empty".

The history of fishing operations at the east end of Great Slave Lake in recent years has been no different from that of 1833. The writer was informed that the trading establishments are at Snowdrift rather than at Reliance because there is something of a fishery at Snowdrift but the fishery at Reliance is too unreliable. Fishing in the eastern part of Great Slave Lake is usually with large mesh and short lengths of net attached to the shore. There is a good yield of fish in July, August, and September, but the supply does not permit putting up fish in September.

In Artillery Lake the experience is that along the shore in summer a setting soon ceases to yield, and it is easier to get the trout by trolling. In Ptarmigan River there is a somewhat better yield. Fishing in Baker Lake compares with Reliance in every respect, despite the presence of another species, the char.

Some points that came out in the course of our work have a decided bearing on the problem of why the fishery in this region, where death by starvation still occasionally occurs, is not of more use to the inhabitants, and will be brought up in the discussion that follows.

Waters

The waters of the eastern end of Great Slave Lake and the barren lands remain, as previously noted, covered with ice for long periods,

and the larger lakes have drifting ice long after the general break-up. When landing or embarking at Crystal Island, Artillery Lake, from an aeroplane or a loaded canoe it is necessary to wade in the water, unless the landing is carefully chosen. We did this in July, August, and September. The first time the lake was full of drifting ice, the next time the ice had just gone, and the last time was during the storms that herald the autumn. In each case the feet became numb after a few seconds immersion. None of our bathing efforts in 1936 or 1937 were more prolonged than was absolutely necessary. The Thelon was warmer than Artillery Lake, as was also Aberdeen Lake. The temperatures of 60° F. and upward recorded by Porsild (141) for Yathkyed Lake seem high in comparison with our experience, but he had an open year and we have no thermometer readings to compare.

It is very significant that heavy rains were followed by hatches of insects, and that in the early season fish were gathered near the shore. Much of the warmest weather is lost on the larger lakes because they have ice in them when it comes. It seems a safe assumption that the temperatures of the waters of the region never keep to a level high enough for rapid growth of aquatic life for any long period. Nine months or upwards are lost, and for the remaining period the temperatures are like Lake Superior (which the writer can compare from experience).

Aquatic Life

The aquatic life, then, must grow slowly. It is quite rich—in some places possibly very rich. We found the waters full of plankton organisms. Porsild (141) remarks that none of the lakes of Keewatin are transparent to a depth of over a few feet, and no two the same colour. The first he considers due to an abundance of aquatic plants and the second to a varying composition. This is not true to the same extent in the western part of the Thelon sanctuary, possibly due to less glacial till in the substratum, but the life, plant and animal, is there. It is simply that it grows very slowly. The growth of larger aquatic plants in Thelon River is very noticeable from the air.

Spawning and Seasonal Movements of Fish

When the larger lakes are full of drifting ice the trout gather along the shore, presumably because of a larger supply of food insects there. The food of some of the lake trout caught in 1936 has been already mentioned. When we arrived at Artillery Lake early in August the schools of fish that had been near the shore in July had already dispersed.

At Baker Lake on August 20 both trout and char were nearly ripe, and a different shore concentration, the spawning run, had started. By the end of the month all the fish taken of both species were spent, and the run had fallen off. When we were at Ptarmigan River in 1936 the trout were running down stream at the end of August. One thing observed at Reliance must be mentioned, although it is hard to relate to other observations. Some of the trout taken there in mid-July of 1936 were dead ripe, and spurted eggs when touched. Possibly some of the inequalities

and changes of temperature in Great Slave Lake as a whole have something to do with this apparently unseasonable spawning in McLeod Bay. At Fort Resolution early in July the water was warm enough for comfortable bathing.

There are no early season schools of whitefish and tullibee along the lake shores. The nets set near shore take only a few of these species. In August the spawning run begins. Tullibee and round whitefish were ripe in Baker Lake within a few days of the trout, and presumably spawning was over early in September. The whitefish were later in spawning, and examination of specimens from Baker Lake showed the eggs to be less developed than those of tullibeas and roundfish taken at the same time.

There was a good run of grayling along the shore right at the settlement of Baker Lake in August. The fish were at a stage of egg development comparable to the whitefish.

After the spawning run it is to be expected that the fish become more generally distributed in the lakes again.

Local Use

There are, then, times when the lakes and rivers are well supplied with fish. As will be shown shortly, they are not capable of supporting a sustained intensive fishing effort, but all the needs of the residents could be supplied without the supply of fish being in any way affected. Any method that would help the natives, most of whom have gone hungry at some time, to get more fish would be welcome. Actually no dependence is placed on the fishery except for day to day needs in summer. The trouble lies in the movements and distribution of the fish, which do not allow of a large stock of fish being put up in September, according to the ancient northern custom.

It is impossible with the present lack of knowledge both of the waters and of the fish to offer any constructive plans or policies that might be expected to make for a better use of the fish resources of the region. A few suggestions may be thrown out, which might point the way to experiments by some persons who might have an opportunity for such work. They concern:

Equipment. The catch at present seems too largely made up of trout, taken in meshes of 4 to 5½ inches. According to generally accepted biological principles there should be in the order of 50 pounds of whitefish and tullibee taken for every pound of trout or char. Smaller mesh could be used in twine of the same strength now in common use, and should take a better balanced catch. Also, during the seasons when fish are more evenly distributed in the waters it is necessary to have more fathoms of net in the water to get as many fish as can be taken in a run. Where the waters are so transparent as in this region, nets are not very effective unless kitched.

Sets. When shore sets are taking all the fish needed, there is no necessity to use any other kind. Often, however, the shore fishery falls off, and in such cases shoal or even deep water sets off shore should be

tried. It is perfectly safe to say that the waters of McLeod Bay, Artillery Lake, Baker Lake, and the rest have never been explored from the point of view of fisheries. It is hardly fair to say that the fishing in a lake is not reliable simply because a net stretched out from shore in front of a camp does not catch fish. Rivers and narrows should be more reliable than lakes if the twine used is of a size that permits taking the spawning runs as they come. Then a run of tullibeas, for example, could be expected after the run of trout has played out. They would not be taken in significant numbers in a 5½-inch mesh.

Growth of Fishes

During 1937 scales were taken whenever possible from large-scaled fish, and the length and weight of the fish noted on the envelope. The sample was not large and the distribution of sizes was poor. Dr. F. E. J. Fry, of the Ontario Fisheries Research Laboratories, Department of Biology, University of Toronto, very kindly superintended the preparation of the scales and the reading of the ages. The scales in question are being kept for the present at the Royal Ontario Museum of Zoology, Toronto, where Professor J. R. Dymond is engaged in work on the fishes of northern Canada. The scales were in some cases very difficult to interpret, and the lack of younger specimens was a handicap.

Following are some of the results, this being a selected group omitting uncertain readings where there was no indication of a figure different from the general average. Weights were taken with a cheap spring scale.

TABLE II
Growth of Fishes

Locality	Age Group	Length, Inches	Weight, Pounds	Specimen No.
<i>Jackfish Esox lucius</i>				
Thelon River.....	V		1	1
Thelon River.....	V	13	1	4
Thelon River.....	V	17	1	5
Thelon River.....	VII (VI?)	16	1	3
Thelon River.....	IX XII	26	6 12 Est.	2 6
<i>Bluefish Thymallus signifer</i>				
Baker Lake.....	III or IV	Medium size		6
Baker Lake.....	IV	Medium size		4
Baker Lake.....	IV	Small		9

TABLE II—Continued

Locality	Age Group	Length, Inches	Weight, Pounds	Specimen No.
Bluefish <i>Thymallus signifer</i> —Concluded				
Baker Lake.....	V?	Small		3
Baker Lake.....	V	Medium size		5
Baker Lake.....	V	Medium size		8
Schultz Lake.....	V	13 $\frac{1}{2}$	$\frac{1}{2}$	10
Schultz Lake.....	V	13 $\frac{1}{2}$	$\frac{1}{2}$	11
Aberdeen River.....	V	13 $\frac{1}{2}$	$\frac{1}{2}$	20
Baker Lake.....	VI	Medium size		2
Schultz Lake.....	VI	13 $\frac{1}{2}$	$\frac{1}{2}$	13
Schultz Lake.....	VI	12	$\frac{1}{2}$	15
Aberdeen River.....	VI	14 $\frac{1}{2}$	1	19
Aberdeen River.....	VI or VII	15	$\frac{3}{4}$	16
Schultz Lake.....	VII	13 $\frac{1}{2}$	$\frac{1}{2}$	12
Thelon River.....	VII	12	$\frac{1}{2}$	17
Aberdeen River.....	VII	14	1	18
Schultz Lake.....	VIII	15	$\frac{3}{4}$	14
Round Whitefish <i>Prosopium quadrilaterale</i>				
Aberdeen River.....	VI	15	1	1
Baker Lake.....	VI	15 $\frac{1}{2}$	$\frac{1}{2}$	6
Baker Lake.....	VI	12 $\frac{1}{2}$		15
Aberdeen River.....	VII	17	2	4
Baker Lake.....	VIII	15	$\frac{3}{4}$	9
Baker Lake.....	IX	16	1 $\frac{1}{4}$	11
Baker Lake.....	IX	15 $\frac{1}{2}$	1	12
Aberdeen River.....	X	17 $\frac{1}{2}$	1 $\frac{3}{4}$	2
Aberdeen River.....	X	15 $\frac{1}{2}$	1	5
Baker Lake.....	X	14 $\frac{1}{2}$	1	8
Aberdeen River.....	XI	18	1 $\frac{3}{4}$	3
Baker Lake.....	XII	16 $\frac{1}{2}$	1	7
Whitefish <i>Coregonus clupeaformis</i>				
Aberdeen Lake.....	IV	13	$\frac{1}{2}$	36
Aberdeen Lake.....	V	13 $\frac{1}{2}$	$\frac{1}{2}$	33
Aberdeen Lake.....	V	14	$\frac{1}{2}$	31
Beverly River.....	V	14	1	28

TABLE II—Continued

Locality	Age Group	Length, Inches	Weight, Pounds	Specimen No.
Whitefish <i>Coregonus clupeaformis</i> —Concluded				
Beverly River.....	VI	12	$\frac{1}{2}$	29
Aberdeen Lake.....	VI or VII	13	$\frac{1}{2}$	37
Aberdeen Lake.....	VII	14 $\frac{1}{2}$	$\frac{1}{2}$	32
Aberdeen Lake.....	VIII	14	$\frac{1}{2}$	38
Aberdeen Lake.....	VIII	13	$\frac{1}{2}$	30
Thelon River.....	IX		2	16
Aberdeen River.....	X	17	2	44
Aberdeen River.....	X	18	2	43
Aberdeen Lake.....	X ca.	15 $\frac{1}{2}$	1	40
Beverly River.....	X	17 $\frac{1}{2}$	2 $\frac{1}{4}$	26
Aberdeen Lake.....	X	17	2	34
Aberdeen River.....	IX	16	1 $\frac{1}{2}$	42
Aberdeen Lake.....	IX	18	2	39
Beverly River.....	XI	19	3	24
Thelon River.....	XI	16 $\frac{1}{2}$	1 $\frac{3}{4}$	7
Thelon River.....	XII	15	1 $\frac{1}{2}$	3
Thelon River.....	XII	18 $\frac{1}{2}$	3 $\frac{1}{2}$	5
Thelon River.....	XII	15	1 $\frac{1}{2}$	14
Aberdeen Lake.....	XIII	20	3	41
Thelon River.....	XIII	17 $\frac{1}{2}$	2 $\frac{1}{2}$	4
Thelon River.....	XIII	2		18
Beverly River.....	XIII	18	2 $\frac{1}{2}$	19
Aberdeen Lake.....	XV	16	1 $\frac{1}{2}$	35
Beverly River.....	XV	17	2	20
Beverly River.....	XV	18	2 $\frac{1}{2}$	22
Thelon River.....	XIX	19 $\frac{1}{2}$	3 $\frac{3}{4}$	2
Tullibee <i>Leucichthys artedii</i>				
Aberdeen River.....	V	13 $\frac{1}{2}$	$\frac{1}{2}$	13
Baker Lake.....	V	15	$\frac{1}{2}$	1
Aberdeen River.....	V or VI	14	$\frac{1}{2}$	11
Aberdeen River.....	V or VI	14	$\frac{1}{2}$	8
Aberdeen River.....	VI	16	1	21
Aberdeen River.....	VII or VIII	15	1	9
Aberdeen River.....	VIII	16	1	23
Aberdeen River.....	VIII	15	1	17
Aberdeen River.....	VIII - X?	14	$\frac{1}{2}$	16

TABLE II—*Concluded*

Locality	Age Group	Length, Inches	Weight, Pounds	Specimen No.
Tullibee <i>Leucichthys artedi</i> — <i>Concluded</i>				
Aberdeen River.....	VIII	14	$\frac{1}{2}$	14
Aberdeen River.....	VIII	15	1	12
Aberdeen River.....	VIII	14	$\frac{1}{2}$	10
Schultz Lake.....	VIII	15	1	7
Schultz Lake.....	VIII	14 $\frac{1}{2}$	$\frac{1}{2}$	4
Baker Lake.....	VIII	15		2
Aberdeen River.....	VIII or IX	14 $\frac{1}{2}$	$\frac{3}{4}$	25
Aberdeen River.....	VIII or IX	15	$\frac{3}{4}$	19
Schultz Lake.....	IX	13	$\frac{1}{2}$	3
Schultz Lake.....	IX	16	1	5
Aberdeen River.....	IX	14	$\frac{1}{2}$	15
Aberdeen River.....	IX	16	1	18
Aberdeen River.....	IX	15 $\frac{1}{2}$	1	20
Aberdeen River.....	IX or X	15	$\frac{3}{4}$	24
Aberdeen River.....	IX	14 $\frac{1}{2}$	$\frac{3}{4}$	26
Aberdeen River.....	X	14 $\frac{1}{2}$	$\frac{3}{4}$	29
Aberdeen River.....	X	15 $\frac{1}{2}$	$\frac{3}{4}$	22
Schultz Lake.....	XI	15	$\frac{3}{4}$	6
Aberdeen River.....	XI	15	$\frac{3}{4}$	27
Aberdeen River.....	XII	15 $\frac{1}{2}$	1	28

This is slow growth. It may be compared with Hart's record of whitefish growth (87).

Among the specimens collected, bluefish of 13 inches, whitefish of 18 inches, round whitefish of 12 inches, and tullibee of 13 inches showed evidence of approaching spawning.

In reading the scales there seemed to be a difference between those of Aberdeen Lake and above, where the water is shallow and possibly warmer, and Schultz Lake, which is deep and possibly colder. It may not be apparent in the lists, but a greater number of scales from the latter were rejected because of difficulty in interpretation. It would be interesting to compare such a lake as Artillery Lake, which is most decidedly cold and deep.

Evidence of an even slower growth is of possible academic interest only, however. The situation of these lakes with respect to fisheries is shown very plainly in the figures given. They have a large accumulated capital of fish, which gives an erroneous impression of great resources. There is a wealth of fish, but no resource. The actual production of the waters is very slow. The point that needs to be clearly established is this, that a lake produces so many pounds a year. In an Arctic lake this

production may go towards the maintenance of a large capital stock, in which case a weight corresponding to the productive capacity of the lake may be removed each year with the expectation of its being replaced, or it may go towards the exceedingly slow replacement of a depleted capital stock.

Summary

There is no indication that the use of fish by natives would ever deplete the stock in the country at large, though it might do so in a given lake or stream. It is when new demands on the fish resources are contemplated that the growth must be taken into consideration, particularly for commercial fishing. For example, if a commercial fishery were to establish in Aberdeen Lake, they might be lured by the large capital stock of fish to establish on a scale commensurate with the capital stock. The inevitable result would be a large yield for a season or two, followed by a rapid diminution of yield through which the fishery would cease to pay. It is doubtful if such a large lake could be fished so closely that the fish would be so reduced as not to put on an annual increase equal to the capacity of the lake. The whole point is that if one is entitled to only a few tons a year it is easy to take that much out of an abundance and difficult and uneconomical to take it out of a scarcity. It is foolish to fish a lake out in a year and then come back in 20 years and repeat, especially where the interests of a native population are involved. Before any commercial fishing is begun, even in such a lake as Great Slave Lake, there should first be a biological investigation to determine just how much ought to be taken from the lake.

Mr. A. E. Porsild has given a truly classical illustration of the condition of northern lakes. From a small lake near the Government reindeer station 2,200 fat whitefish were taken in one winter's fishing. The winter following only 22 were taken under nearly identical conditions.

CONCLUSION

The Thelon sanctuary, in so far as its location and boundaries are concerned, fulfils most adequately the purpose for which it was designed. From what has been written of the musk-oxen it will be seen that there is no important part of the sanctuary where musk-oxen have not been found in recent years, whereas the musk-ox range in the same region outside the sanctuary is of little importance.

In addition to its unique position as the home of the barren ground musk-ox, the Thelon game sanctuary has a number of features that must surely destine it to remain for all time a wilderness game preserve. The geological formation is such that it can hardly be expected to contribute to the mineral wealth of the country, and its use by natives is so limited that their interests can very easily be made compatible with the preservation of the sanctuary. It has, also, besides the musk-ox, a full complement of barren land animal life, including such unique animals as the barren ground bear. A "first-class nature sanctuary" has been defined (170) as

"any area of original vegetation containing all the original animal species in numbers sufficient for permanent maintenance." Few indeed are the areas in the world conforming to so rigid a standard (*See* 200). Except for the migratory birds and the caribou, the Thelon sanctuary is such an area. For the barren ground caribou on the Canadian mainland, no preserve could be made to fulfil these conditions unless the natives were included as part of the wild life. Actually, eternal vigilance over its whole range is needed to protect the caribou. Apart from these exceptions, the Thelon sanctuary is most happily situated to preserve for posterity the animal life of the barrens. The natives being located at either end, it is not necessary for the officers administering to do anything more than keep in touch with them. The south boundary is the only one that need be surveyed. By adjusting Native Game Preserve boundaries and keeping an eye on white trappers, the present indefinite north and east boundaries can be made to serve for years yet. As general information on the north increases and aerial transportation improves, Canadians will surely wake up to the fact that here and here only in all of North America is to be found the thrilling and spectacular in animal life, the features that have drawn visitors from all parts of the world to the great game preserves in Africa. The writer has seen many of the moving pictures of animals that have come out of Africa and many stills, but rarely anything to compare in sheer numbers with the caribou herds on the great plains of the north. Were an expedition equipped for motion pictures and sound, like those of the late Mr. Martin Johnston, to go to the Thelon and make a similar record of the caribou and other wild life the result would surely stimulate pride and interest throughout Canada. Something of the sort should be done anyway as a scientific record while the caribou are still with us.

We should always be careful that in our search for new resources we do not destroy what we already have. Much of our northland will always be a wilderness. If we can keep it a true wilderness, its spiritual value will remain, but if the wild herds are lost it will not be a wilderness, but a desert.

The protection necessary to keep the barrens from becoming a desert must take the form of vigilance in preventing the disaster rather than in strict regulations after the disaster has occurred. In this respect, the constant and carefully calculated conservation propaganda of Government officials concerned with wild life protection among the residents of the Northwest Territories, native and white, should be mentioned as important beyond any other factor. The administration of the Northwest Territories has also taken steps to assure itself of a constant supply of accurate information on which to base its actions in conserving the resources of the Territories. There is an undeniable need for biological research on the fur cycle, on caribou, and on the predators, to be carried out on the ground, preferably in the Reliance region where they are to be found in greatest numbers and variety.

The northern barrens have a beauty of their own. There is something in the boundlessness of the rolling plains that is even more humbling than mountains, and the monotony disappears completely on close inspec-

tion. The strange light and cloud effects are constantly changing. Everywhere there are lakes; to the natives who know Athabaska and Slave Rivers so much crystal clear water is in itself a constant cause for praise. Nothing has been said about flies; both mosquitoes and black flies are in large numbers. Canadians to whom these insects are a deterrent are denying themselves a share in most of the "boundless heritage" of which we hear so much. Actually, an ordinary summer breeze has a clear sweep of the whole barrens, and between wind and fog more than half the time it is possible to go about in complete comfort. Such a condition is hardly to be found in any wooded part of Canada.

The beauty of the barrens has never been described better than by Saltatha (138), one of the Caribou Indians, in answer to a priest who was telling him of Heaven. "My father, you have spoken well; you have told me that heaven is very beautiful; tell me now one thing more. Is it more beautiful than the country of the musk-ox in summer, when sometimes the mist blows over the lakes, and sometimes the water is blue, and the loons cry very often?"

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