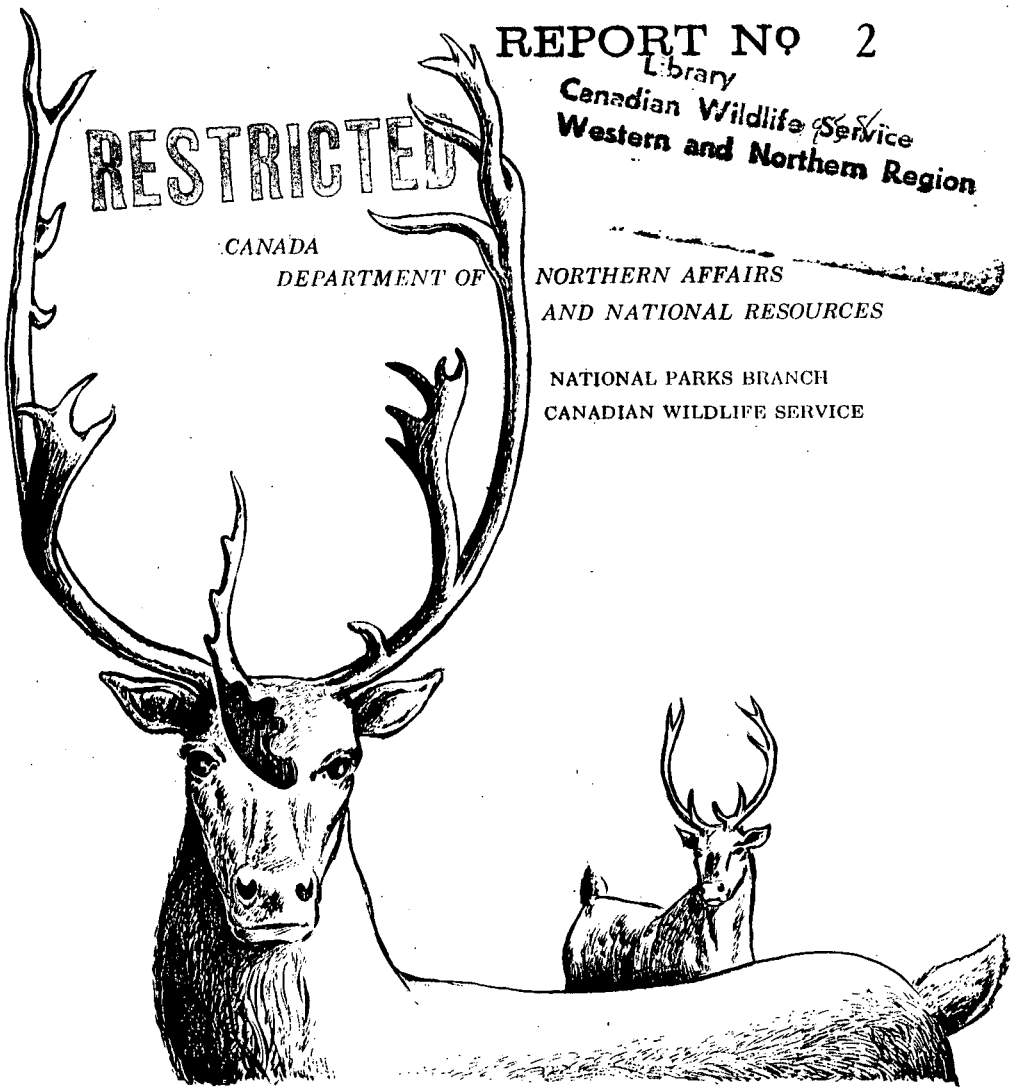
THE BARREN-GROUND CARIBOU

COOPERATIVE INVESTIGATION 1957-58

REPORT No 2

CANADA
DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

NATIONAL PARKS BRANCH
CANADIAN WILDLIFE SERVICE



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BARREN-GROUND CARIBOU RESEARCH PROGRAM

July 1 to September 30, 1957.

Report No. 2

by John P. Kelsall and A.G. Loughrey

Introduction

The barren-ground caribou research program has been proceeding well. The field men have been able to remain with the herd involved and study more elements of it than was thought possible. In some respects, however, we have had difficulties. During the break-up period in late June and July we were not able to reach some of our gasoline caches on the barrens because of late ice conditions. As a result, a great deal of unforeseen use of heavy aircraft was necessary. Also, the study herd migrated much farther north and east than was expected; during much of July our supply line extended well over 500 miles from Yellowknife. As a result, our expenditures to date have been much higher than planned for.

With a competent field staff, the field work has proceeded satisfactorily. Wilk, Loughrey, Terry, and Thomas were in the field until mid-July. At that time Ecologist E. Kuyt of the Saskatchewan Game Branch joined the field party. During part of July and early August, Pathologist H. Gibbs and Range Manager J.A. Mills were in the field. Mills spent late August and September keying certain caribou range areas in northern Manitoba and Keewatin District as a contribution to the general program. Terry and Thomas remained in the field except for short periods in Yellowknife, taken in rotation, until near the end of August. At the end of August, Kuyt and Terry returned to Yellowknife to remain there and write their reports until their next field period commenced about mid-October. Their places were taken by Thomas and Biologist E.H. McEwen of the Canadian Wildlife Service.

In mid-August, the field party was joined by R. Blais and R. Humble of the National Film Board, working on a caribou conservation film for general use and distribution. They remained in the field until the end of the month.

Biologist W.A. Pruitt reported at Yellowknife on August 30 and shortly thereafter went to The Pas, Manitoba, to outfit, and then to Churchill and Brochet for autumn studies of the Duck Lake caribou herd.

Biologist H.A. Wilk has found the means to undertake personal research during the coming autumn and winter and will not return to the field. Loughrey has received a promotion within the Canadian Wildlife Service and will not rejoin the field group. Temporarily only, it is hoped, this leaves a shortage of biologists for the October and November rutting period.

Thomas, who joined the research group for the summer only, has decided to remain for the balance of the research program.

Itinerary

At the end of June the field parties were temporarily immobile due to break-up conditions. Wilk, Loughrey, and Thomas were at Camp 5 (Map No. 1) on the south side of Beverly Lake, and Stewart and Terry were at Camp 4. It had been impossible to place Wilk with the latter party, as had been intended, because of an aircraft accident and fast-disappearing ice. A Beaver aircraft visited the field parties July 2 to 5, taking out a canoe and outboard motor, placing Wilk with Terry, and returning Stewart to Yellowknife. Ice still made landings at our field camps difficult except when favourable winds were blowing.

On July 9, Chief Mammalogist A.W.F. Banfield and Pathologist Harold Gibbs visited the field camps to take in necessary supplies and leave Gibbs for a period of field work. From July 10 to 13, a Beaver aircraft visited the field parties and considerable survey flying was done. Both camps were moved to a position on the Dubawnt River (Camp 6) and Loughrey and Thomas returned to Yellowknife with the aircraft to write up their field notes. Again on July 17 an aircraft carrying Kuyt and Kelsall visited the field camp. Between then and July 19 considerable survey flying was done and the camp was moved to latitude 64°08', longtitude 97°50' (Camp 7).

Gibbs returned to Yellowknife with Kelsall on July 19 and proceeded down the Mackenzie River for research at the annual reindeer roundup. Between July 23 and 26 a Cessna aircraft visited the field party. Thomas went with it to rejoin the party. Considerable survey flying was again necessary, and the camp was moved to a position at latitude 64° 48', longitude 98° 07' (Camp 8). On its return, the aircraft brought Wilk and Terry in from the field, the former to take a prolonged holiday in Europe, and the latter to spend a few days in Yellowknife.

By August 1, available gasoline supplies cached in the barrens were very low, and it was necessary to determine ice conditions at the remaining caches and at the same time cover a wide extent of country in search of the caribou. Therefore on that date two aircraft went to the field camp. A Beaver carrying Gibbs, Mills, and Terry followed a southern route over our Dubawnt Lake gasoline cache, which was found still surrounded by ice and unavailable, and then flew on to the field camp. Kelsall flew north in a Cessna along the Thelon River to our gasoline cache northeast of Beverly Lake, which was found relatively ice-free and available, and on to the field camp. En route on the latter flight a large massed herd of caribou was found on the Thelon River near Lookout Point. During the same day Kelsall visited Baker Lake to finalize plans for the gathering of caribou kill statistics from the Thelon River Eskimos by Acting Corporal Don Wilson, R.C.M.P. On August 2, with both aircraft participating, the field camp was moved to a position a few miles north of Lookout Point on the Thelon (Camp 9). By chance this camp happened to be only about three miles from a musk-ox study camp occupied by Biologist J.S. Tener of the Canadian Wildlife Service and his assistant, W. Holdsworth. On August 3, the Cessna aircraft went to our northernmost gasoline cache to secure fuel for both aircraft, and both then returned to Yellowknife.

Between August 8 and 10, a Beaver aircraft visited the field camp to try to retain contact with the rapidly moving caribou. It was decided to move camp again at the next opportunity. On August 11, an Otter aircraft proceeded to Baker Lake with E.H. McEwen, who planned a short study of white foxes in that area, and then to the field camp. Also accompanying it were Blais and Humble of the National Film Board.

The aircraft moved the caribou research party to the original spring campsite on Mosquito Lake (Camp 10) southwest of Dubawnt River, and then returned to Yellowknife bringing with it Tener's party and equipment as well as Mills and Gibbs. Since the distribution and whereabouts of the caribou were in doubt, Kelsall flew in a Cessna aircraft to Ennadai Lake and Mosquito Lake on August 17. The aircraft spent some time securing gasoline supplies on August 18 and then went to Baker Lake with the National Film Board men, returning early on August 19. Later on August 19 extensive survey flying was done and a fairly large herd of caribou located at the north end of Artillery Lake. Surveying en route, Kelsall returned in the aircraft to Yellowknife on August 20 with Thomas, who was due for another short relief period.

On August 25 an Otter aircraft moved Camp 10 to a new site near Kirk Lake (Camp 11) and returned to Yellowknife. On August 27 an Otter carrying Thomas picked up McEwen and the Film Board men at Baker Lake, and returned to Camp 11 and Yellowknife on August 28. With it were Blais, who wished to do some filming in town, and Terry, who was suffering from a painful leg and back. He went to Fort Smith and Uranium City for medical attention the following day. On August 31, a Cessna 180 visited the camp to do some survey flying and returned Kuyt and Humble to Yellowknife the same day, leaving McEwen and Thomas in the field.

On September 4, Kelsall attempted a search flight from Yellowknife to Ennadai Lake, which failed because of bad weather, and visited the field camp. To further supply the camp and do additional searching for caribou, Kuyt made a flight on September 14. On September 19, Kuyt went to Uranium City and from there was finally able to make a long search flight between Ennadai Lake and the field camp. On September 24, 25, and 26, Kuyt visited various barren-ground trappers, mapping caribou distribution en route, and then returned to the field camp. The crew was moved to Camp 12 at the south end of Artillery Lake at that time.

The Study Herd

Movements and Distribution

At the time of the last report, June 30, movements among the study herd were not entirely clear.

There are still phases of their summer movements and distribution not clearly understood, but the general picture is adequate. The major calving area is shown on Map 2, and herd movements between early July and September 30 on Maps 1 and 2.

Toward the end of June the caribou were dispersed in a manner which led the field men to believe that they might not have encountered the main herd. Most of the caribou, however, are believed to have been in the area shown on Map 2 as the main calving area. After the first week in July they bunched up remarkably along the west side of the Dubawnt River between Marjorie Lake and Beverly Lake. Similarly, but to a lesser degree, they assembled west of Beverly Lake and moved towards the Thelon. On July 12, they were swimming the Dubawnt, and the crossing continued until about July 17. This movement and others are shown on Map 2. Extensive flying during that period gave a reasonably complete picture of what was happening. Caribou numbering tens of thousands crossed the Dubawnt, and great many of them proceeded east rapidly toward Baker Lake. On the afternoon of July 18 the leading elements were only 16 to 20 miles from Baker Lake post. At that time Kelsall visited the post. The same evening, during the return flight westward, it was noted that the animals had reversed their direction of movement and were travelling westward almost as fast as they had travelled eastward only three or four hours previously. This appeared to be the turning point in the northern and eastern migration of the study herd. The reversal in movement was remarkably abrupt although some caribou remained well to the east throughout most of July.

It is certain that large numbers, probably half of the study herd, moved north of the Thelon toward the Back River during that period. The area believed to have been occupied and the water crossings utilized are shown on Maps 1 and 2. It is believed that the animals north of the Thelon moved eastward at least as far as Tehek Lake and as far north as the Back River watershed. Trails indicated that some animals actually crossed the Thelon west of Beverly Lake in June and, once across, travelled northeast into the above-mentioned area. It is likely that some calving took place there.

In the period following July 18 the heavy summer mosquito and black fly infestation commenced. The abrupt reversal in movement on the evening of July 18 appeared to be partly, if not entirely, due to a change in wind direction and velocity which necessitated movement to the westward by the caribou to get relief from flies. As mentioned below, the fly season commenced at least three weeks later than recorded in at least one previous year. It seems probable that if the flies had come earlier, the herd would have commenced erratic wanderings earlier, and would not have moved nearly so far north and east.

For several weeks after July 18 most animals observed were in large, closely-massed herds. Their distribution was such that it was clearly impossible to continue to move camps to keep caribou always near at hand. They moved so fast, particularly when wind velocities were low and the fly nuisance bad, that a herd of 10,000 to 20,000 might be in sight for only a few hours. During that period they wandered extensively north and east through the country shown as occupied on Map 1.

Further extensive flying between August 1 and 3 disclosed only one large group of caribou, on the Thelon River more than 130 miles west of the ground party's camp. It could be seen clearly at that time from trails and from the movement of smaller bands that the trend of movement had been west, and to a lesser degree south, for some days, even though many movements were still erratic. The animals which had gone north of the Thelon were withdrawing westward at a rapid rate. Some of them appeared to have stayed on the north side of the Thelon. The animals discovered at Lookout Point at that time were probably elements of that group. No large herds were found south of the Thelon, but trails provided every evidence that similar movements had taken place there.

Further extensive flying on August 11 and 12 and again from August 17 to 20 disclosed an unexpected situation. Only one large group of caribou could be found, and it was far to the westward on the upper Hanbury River. On August 20 it was some 16 miles north of Walmsley Lake, having gone around the north end of Artillery Lake and proceeded west-northwest. By September 15 it was still in the Artillery-Alymer Lakes area as shown on Map 1, but had scattered into

small bands. By September 25 the bands appeared to have started a slow movement southward.

A similar group was reliably reported to have moved northwest along the north shores of Clinton-Colden and Aylmer Lakes toward Contwoyto Lake. That group also is shown on Map 1. Possibly both groups were originally one, and were split by Clinton-Colden Lake. Elements of the second group were seen near the Upper Back River, south of Musk-ox Lake on September 25, and at that time they were starting to bunch in bands of several hundred.

Flights in late August were made over a large area from Artillery Lake in the west to Baker Lake in the east and southward to Ennadai Lake. Over all this country except that portion east of the eastern side of Dubawnt Lake, caribou were found in wide dispersal. It was usual to see only one caribou at a time, or two if a cow and a calf were involved. From both aerial and ground observations it actually appeared that the animals were deliberately shunning each other's company. Trails indicated that there had been some massed herds moving widely and erratically during early August, and some of these herds had actually penetrated a short distance beyond tree-line between Damant Lake and Boyd Lake on the Dubawnt River. These massed herds had either dispersed completely or could not be located when the August 17 to 20 flying was done. Single animals were moving in all directions and although many were simply standing tail to the wind when observed, the general trend of movement was decidedly westward.

Caribou remained scattered over much of this country until the end of September. Flights on September 24, 25, and 26 failed to disclose any concentrations other than those near Artillery Lake.

The return to the south and west from summer ranges took place along the lines indicated on Map 1 on a much wider front than the movement to the north and east in the spring. The extreme western movements have already been described above. Lesser movements were observed along the west shore of Dubawnt Lake and south through the complex of lakes between Mosquito Lake and Carey Lake. Another movement brought caribou from the northeast down the east side of Dubawnt Lake and both west between Dubawnt and Nowley Lakes and south around the east end of Nowley Lake. The animals

taking the latter route were, on August 17, only some 30 or 40 miles north of Ennadai Lake. When observed they, too, were widely dispersed and were moving largely westward. It appears that this trend must have been maintained, since in early September they had still not appeared at Ennadai.

Daily Movements during Northward Migration

During the early spring migration between Lake Athabasca and tree-line, the caribou seemed to travel between 10 and 15 miles per day, depending on topography. While in rugged, heavily forested country, movements forward approximated 10 miles per day. As the animals reached more level open country near tree-line their pace accelerated.

On reaching the barrens, where there was generally less snow underfoot, the daily rate of movement increased still further. Observations from the ground camps tended to confirm the figure of 15 to 20 miles per day, found by Loughrey in 1957, in the eastern Arctic.

On reaching the calving grounds, movements varied depending on topography and the composition of the caribou bands. Within the calving area the cows and calves did not display any consistent migration pattern, but more or less drifted about in the hilly country, with a general eastward movement. The bands of bulls, however, appeared to be moving with a purposeful direction throughout June and on into July. Typically, the bulls travelled in the morning and spread out to feed and rest during mid-day. In late afternoon, they would again start to move at a steady pace to the east.

Influence of Topography and Winds on Movements

It should be noted that physiographic features such as drumlins, eskers, raised beaches, and drainage systems, particularly frozen lakes and rivers, provide excellent ways of travel for migrating caribou. It is obvious that such barriers as open rivers, large lakes and deep snow banks form barriers which detain or cause migrating bands of caribou to detour and thus retard migration. An excellent example was afforded during this study when migrating caribou built up in numbers along the west bank of the Dubawnt River on account of the river being open, with large pieces of

ice floating down it, just after break-up. Under these conditions the caribou apparently did not attempt to swim the river, and their numbers built up until on July 10 it was estimated that almost 100,000 were found along the west side of the lower Dubawnt River. At that time, however, the ice was not discharging down the river in any great quantity and the caribou had commenced to swim across it.

During the calving period, and until the first heavy insect infestations, weather does not appear to have any great effect on the direction of movement of migrating caribou - although this may not be entirely true of herds composed predominantly of bulls. It does appear to exert some slight effect on their rate of migration. On hot days the caribou are noted to move at a more leisurely pace and to spend more time in resting and feeding. On cold days, or during wind storms, they appear to be more restless and move at a greater rate of speed.

During the period when insect infestations are at their height, wind direction greatly influences caribou movement, as mentioned above. They move persistently into even very light winds to get relief. If winds are strong, however, they often drift with them. Late in the insect season, when the caribou are tired from constant harassment, it is common to see them standing for hours in exposed positions with their tails to a strong wind. This was noted frequently during flying in August.

Before the calving period, a very strong wind can disrupt the strongest caribou movement momentarily at least. On May 10 and 11 while the herd was still in the forest and moving steadily northeast to reach the barrens, a strong northwest wind developed during the course of survey flying. The animals changed direction abruptly from northeast to northwest to head into the wind, and they maintained their new course until the wind dropped about two days later. Then they quickly resumed their northeast course.

The Calving Period

Ranges: Topography and Altitude

The main calving area of the study herd was located between Beverly and Wharton Lakes, west of the Dubawnt River. In that area the ground rises to a

maximum altitude of more than 640 feet above sea level. The surface rock comprises sandstone, particularly in the northern part, and porphyritic igneous rocks. It is a rolling area characterized by an overlay of glacial till and rubble-strewn hills. It is also characterized by several prominent eskers and drumlins. The largest lakes in the centre of the area are up to six miles in length and three miles in width. The drainage flows through a series of small lakes, sloughs and streams in several directions. The drainage from the central region flows to the northeast into the lower Dubawnt River and north to Beverly Lake, the Thelon River, and Finnie River. The shores of the Thelon River and Beverly Lake adjacent to that area are characterized by a series of raised beaches, with intervening swampy areas of former lake bottom, which rise to a height of 440 feet above Beverly Lake. Wright (1955), states that the presence of the former post-glacial arm of the sea is indicated by the deposit of marine shells at a height of 360 feet above sea level near Beverly Lake.

By June 11 the calving area was snow-covered except for the tops of the eskers and drumlins. By the 20th most of the streams and creeks were running with snow-melt water, and the marshes along the edges of lakes and streams were free of snow. However, the depressions between the drumlins were still snow-filled.

As might be expected, the vegetation of the Thelon Valley and the shores of Beverly Lake is much more luxuriant than the more xeric region of the calving area. In order to obtain quantitative differences between the calving and post-calving areas, line point transects (of 1,000 points), were taken in each area. The results of these transects are given in Table 1.

Ranges: Transect No. 1

The first transect was in the rocky ridge country immediately south of the camp on Beverly Lake. That area is characterized by sandy ridges with much boulder till and glacial debris. There has been some frost-sorting of smaller materials into polygons up to ten feet in diameter along the slopes of the hills. Quite a large percentage of this area was unvegetated, with 28.1 per cent of the sample points falling on clear ground, snow, water or rock. Mosses accounted for 8.8 per cent of the total ground cover; of these 4.5 per cent were small unidentified types.

Lichens were the predominant group, accounting for 28.8 per cent of the sample points. Of these points, 1.9 per cent consisted of small lichens of several insignificant species. Several species of lichens were identified; Cetraria cucullata and Alectoria divergens were the most important, accounting for 16.2 and 9.3 per cent of the total ground cover, respectively. Although numerous, neither of those lichens was large or densely massed enough to be considered of primary importance as potential caribou food.

Shrubby plants made up 9.0 per cent of the total ground cover; Labrador tea, Ledum groenlandicum, (7.6 per cent) was the most important species. Dwarf birch, Betula glandulosa, accounted for 1.3 per cent of the ground cover. However, it should be noted that the latter species tended to grow in dense concentrations, some of which were missed by the transects. The rest of the vegetation consisted of four other plant species and a number of unidentified grasses, sedges, and small annual plants. Grasses and sedges accounted for 4.4 per cent of the total ground cover. Crowberry, Empetrum nigrum, represented 5.3 per cent. Bearberry, Arctostaphylos rubra, and bilberry, Vaccinium uliginosum, accounted for only minor percentages of the total ground cover, 0.1 and 0.3 per cent respectively. Cranberry, Vaccinium Vitis-Idaea, 14.7 per cent, was second only to the lichen Cetraria cucullata in total ground cover.

Plant succession in the sandy areas was noted as follows: sand, small mosses, small lichens, large moss, Cetraria cucullata, Alectoria divergens, Vaccinium Vitis-Idaea, Empetrum nigrum, and Ledum groenlandicum.

Ranges: Transect No. 2

Transect No. 2 was taken in the post-calving area, extending inland from the south shore of Beverly Lake. The transect, consisting of 1,000 points, commenced 100 yards from the gravel shore-line of the lake and extended to the base of the first ridge. This area consisted of former lake bottom and was characterized by a sphagnum-bog which was being almost completely invaded and colonized by hydrophytic species of grasses, sedges, and several shrubby plants.

Only 12.1 per cent of the area was unvegetated and of this 9.1 per cent was snow and water. The snow was then in the process of melting and running off. Mosses accounted for 23.7 per cent of the ground cover, of which Sphagnum comprised the greatest proportion.

Lichens accounted for only 4.7 per cent of the total ground cover with Cetraria cucullata the dominant species. It was found in the more xeric locations on the tops of the grass-sedge hummocks. Of the four lichens identified only Cetraria cucullata could be considered significant as a potential caribou food item.

Shrubs accounted for 16.1 per cent of the total ground cover. Labrador tea, Ledum groenlandicum, 13.1 per cent, and dwarf birch, Betula glandulosa, 3.0 per cent, were the most important.

Grasses and sedges were the most important group, accounting for 25.8 per cent of the total ground cover. The most important species in this group included - bentgrass, Calamagrostis sp., Carex sp., and cotton grass, Eriophorum sp. Cranberry, Vaccinium Vitis-Idaea was the most common species of vegetation. Crowberry, Empetrum nigrum, bilberry, Vaccinium uliginusum, and bearberry, Arctostaphylos rubra, accounted for a minor portion of the ground cover - 2.2, 1.1 and 0.3 per cent respectively. Several unidentified annual plants together accounted for 1.0 per cent of the total ground cover.

Vegetation Utilized during the Calving and Post-Calving Period.

During the late spring and early summer the caribou shows great preference for fresh green vegetation. This preference appeared to be governed by the availability of the new growth and the date of its appearance. The following sequence of feeding and phenology was noted during the present study. From June 15 to 20, feeding on green vegetation, in addition to the lichens which were normally consumed, was confined to the fresh shoots of cotton grass, Eriophorum spp. About June 20, fresh shoots of other sedges and grasses became available and were selectively eaten, individually or along with the cotton grass. From about July 1 to 10, the dwarf birch, Betula glandulosa, came into leaf and extensive feeding on it was noted. A caribou was observed to feed on that plant by grasping the end of a leafy twig between its lips and then pulling its head backwards and upwards, thus stripping

the small tender leaves into its mouth. About July 10 the willows commenced to leaf and it appears likely that this item then became a major food of the caribou. It is also possible that Labrador tea, which was green at that time, would also become an important food item.

It should be noted that the cotton grass and the other sedges and grasses first become available in the low-lying areas along the lakes and drainage systems. Since the parturient cows seek the rocky ridges and remain there during the first few days after the calf is born, they have less opportunity to feed on the fresh shoots in the lower marshy areas. Consequently their feeding habits are still much the same as in winter; that is, they feed largely upon lichens and winter-killed vegetation. The bulls, on the other hand, are the first to seek out the marshy sloughs as soon as the cotton grass begins to become green. Consequently there is a slight separation of the calving bands and bull or non-calving bands of caribou.

The above description fits the general food habits of the caribou under observation, but at almost all times individual caribou can be observed feeding on lichens, chiefly Cetraria cucullata, and winter-killed vegetation.

Weather

The research program was fortunate in the general area in which the study herd calved in 1957. Considering the month of June as the calving period, we find that our field camps were progressively nearer Beverly Lake for the first part of the month, and close by that lake during the last part (Camps 1 to 5, Map 1). In 1948, a Canadian Wildlife Service field party under the direction of A.H. Lawrie spent the month of June, in an effort to observe calving, at Beverly Lake (Lawrie, 1948). Lawrie was not furtunate enough to observe the calving process at that time but he must have been near cows that were calving.

The 1948 calving season was exceptionally good. Of seven segregation counts including nearly 9,000 animals, taken on various parts of the mainland ranges, no counts showed less than 17 per cent of calves and one was over 28 per cent. Lawrie himself secured a small but, he believed, very significant segregation during the rutting period, when it was assumed animals were present in normal proportions in the herds observed. His count on that occasion showed calves making up 25 per cent of the total number of animals.

It is too early for positive statements in regard to calf segregations during 1957, but we seem to have definite indications that the crop will be no better than fair and will probably be poor. A crop no better than 16 per cent of total animals, and more likely around 10 per cent, seems likely (see Increment).

In presenting the results of caribou calving studies in 1952 Kelsall (1957) speculated extensively on the possibility of adverse weather having greatly reduced the survival of young calves in that year. Because Lawrie kept complete weather records in 1948 and because our field men kept comparable records for the same area in 1957, some further comparisons and speculations are warranted. The comparative weather records for the months of June 1948 and 1957 are presented in Tables 2 and 3. It is believed that some calving took place, in 1957 at least, in very early July, but it is likely that the month of June was the really crucial period.

The records show differences in several respects. In June 1948 there were only five days when temperatures dropped to freezing or lower, all of them in the first two weeks of the month. In June 1957 there were 18 such days. The mean minimum temperature in 1957 was more than six degrees below that of 1948 (31.6° as compared to 37.9°). The average mean temperature was exactly 10° higher in 1948 than in 1957. In 1957 winds were high and frequent and predominantly from northerly directions. In 1948 winds were far more variable in direction and the average wind velocity recorded was only about half as great. It should be mentioned here that wind velocities in 1957 were recorded in miles per hour, whereas Lawrie recorded them as force factors using the Beaufort Scale. The author has converted Lawrie's force factors to miles per hour using average figures for the forces given. In 1948 measurable precipitation was recorded on only four days and on only one of these days was snow involved. In 1957 precipitation in larger than trace amounts was recorded on 12 days and snow was involved on seven of them. On a number of those days in 1957 our field men recorded blizzard conditions.

All the evidence indicates an exceptionally cold, wet, and windy June in 1957 as compared to 1948. Possibly just as indicative of conditions as actual weather records, and somewhat more dramatic, is the

fact that Lawrie on June 27, 1948, recorded "A fine warm day marred only by the clouds of mosquitoes". From this it might be inferred that mosquitoes were present in some number even before June 27. In 1957 mosquitoes were not seen in significant numbers before July 17 and did not really become a nuisance until about July 20.

The disadvantage of the type of weather recording done by the field parties is that it does not provide a quantitative measure of the cooling effect of the weather which can be related directly to calf mortality. A slightly more refined expression for the cooling effect of air temperature and wind velocity is afforded by the use of a "windchill factor" which has been developed by Dr. Siple, the Antarctic explorer. The following data are extracted from Table of Winchill Values, prepared by Climatic Research Unit, C.Q.M.G. War Department, January, 1943.

"The tables were calculated from the original formula developed by Paul A. Siple, PhD., and Charles F. Passel of the United States Antarctic Service.

"The accompanying table of dry shade atmospheric cooling or 'windchill' (Figure 2 of this report) is intended as a quick reference to a practical measure of sensible temperature. Windchill is a measure of the quantity of heat which the atmosphere is capable of absorbing within an hour from an exposed surface one metre square (at a temperature 91.4° Fahrenheit) or equal to 10.76 square feet. For the sake of correlating heat loss with the customary values used by a physiologist to express human heat production and food requirements, the quantity of heat transferred is expressed in kilogram calories per square meter per hour per degree centigrade (0.369 B.T.U. per foot square, per hour, per degree Fahrenheit).

"Windchill expresses the rate at which the body of a naked human being would lose heat if placed out of doors under the given conditions. This value was calculated in the assumption that skin temperature remains at the comfortable level of 91.4 degrees Fahrenheit. In actual fact, the skin temperature falls on account of the loss of stored body heat, the rate of cooling dropping accordingly. The result and rate of actual cooling can be obtained from the table by reducing the air temperature by the number of degrees difference between 91.4 degrees Fahrenheit, and the reduced skin temperature."

The windchill factor for known temperature and wind velocities can be read directly from Figure 2.

It should be noted that this measure (windchill) does not take into consideration relative humidity. Relative humidity may be an important factor in cooling (body heat loss) at near freezing temperatures. Solar radiation in the Arctic on clear days may equal an addition of 200 calories per square meter per hour.

In applying the windchill factor to caribou and particularly to caribou calves, several variable factors must be taken into consideration:

(1) The body temperature of a caribou is slightly higher than 91.4 degrees Fahrenheit, upon which the windchill factor is based. This, however, could be compensated for easily in an equation for "caribou windchill".

(2) The body surface of a caribou is covered with hair which provides a high degree of insulation. The insulation value of the hair could be determined experimentally, but it should be noted that in a newborn calf still wet after parturition, the chilling effect from wind velocity and air temperature must be great. To a lesser degree the loss of body heat would undoubtedly increase as the insulating value of the body hair was lowered when wetted by falling rain and snow or in walking through slush and water.

(3) The windchill effect would be much more critical for small, new-born calves and this effect would decrease with increase in age and size of the animal due to the surface-to-volume relationship associated with heat loss.

(4) The windchill effect or body cooling is probably cumulative from hour to hour and day to day under extreme weather conditions. If the physiological cooling continues or the heat balance of the animal is disturbed to the point where the loss of energy through body heat dissipation exceeds the amount of energy available for body heat from resulting metabolic processes, then the animal might be considered to be suffering "physiological stress". If this stress is cumulative and severe, it undoubtedly can result in mortality.

In assessing the role of weather in calf mortality, it should be noted that it may operate either as a direct or as an indirect mortality factor. In the latter role, cold stormy days keep the caribou moving, and this may weaken calves one to two days old which are not able to travel long distances. Hence the weather promotes separation of the cows from their calves. This in turn makes the calves more vulnerable to predation through weakness and lack of the cows' protection. We might speculate further that there may be some loss during parturition in extended periods of severe weather.

The peak of calving was estimated to have occurred in the week from June 9 to 15. Since the weather was unfavourable from the 8th to the 13th, the calf mortality must have been heavy. Calf mortality in the study herd may be expected to be very high this year.

From the data obtained during the present survey, only a very crude measure of the physiological stress can be obtained. In Table 4, the daily maximum windchill factor for the month of June is provided.

It can be noted that a maximum windchill factor of 1,000 or more was obtained for 14 out of 30 days. It should also be noted that periods of several successive days of high windchill factor appeared to be frequent. This usually results from a cold front accompanied by high winds that persist for several days. Three periods of successive days with maximum windchill factors of over 900 can be seen in the table. The first period, June 1 to 3 inclusive, had an aggregate of maximum daily windchill factors amounting to 3,400 for 3 days. The second period, June 7 to 13 inclusive, had an aggregate of 7,300 for 7 days. The third period, June 16 to 21 inclusive, had an aggregate of 6,200 for 6 days.

Observations of dead calves in the field were limited because of the necessity of moving camp. However, of nine calves found on the calving grounds and believed to have died as a result of natural causes, four appeared to have died of exposure or starvation or both. There were two wolf kills, and for the remaining three the cause of death was undetermined. Seven of the total were found on June 13 and 14 and were judged to have been dead two to six days. This

would place the time of their death between June 8 and 10. From Table 3, it can be seen that that was a period of strong northwest winds with below-freezing minimum temperatures and scattered snowstorms. It corresponds to the second period of high aggregate windchill (Table 4). One calf believed to have died of exposure was found on the 21st and was judged to have been dead two days. The weather from the 18th to the 20th was also characterized by very strong northwest and west winds and below-freezing temperatures accompanied by snow, hail, and rain showers. (Table 3). This period corresponds to the third period of high aggregate windchill.

For the purpose of discussion an assessment of the role of weather as a direct cause of calf mortality has been attempted as follows.

It seems probable that a critical point is reached as a result of cumulative excess heat loss with resultant physiological stress. There is no doubt a threshold beyond which direct mortality due, as we say, to "exposure or exhaustion" is likely to occur. Liebig's law of the minimum is, in fact, operating under these conditions. Since actual calf mortality that was apparently due to unfavourable weather conditions was recorded in the field after periods with aggregate maximum daily windchill factors of 7,300 and 6,200 respectively, the following hypothesis is submitted.

When the average daily maximum windchill factor exceeds 1,000 for a period of six days or more, or when the total of daily maximum windchill factors for a period of less than six days amounts to 6,000, calf mortality that may be attributed to weather conditions is to be expected. This statement is necessarily only tentative, because of the previously-discussed variable factors which have not been evaluated and because of physiological differences between caribou and man.

Further field observations of calf mortality during the next calving season, correlated with an increase in the number of daily weather records, including humidity and perhaps solar radiation should yield a more accurate index of calf mortality in terms of the cumulative effect of windchill.

The practical value of such an index is that it could possibly be used not only to assess quantitatively the calf losses for different calving grounds from the

weather records, but also, on the basis of long-term weather forecasts, to predict losses in advance of the calving season. The advantages of such a system in caribou management are obvious.

It seems quite likely that the application of the windchill factor hypothesis, or a modification of it, for assessing mortality of newborn and young animals will have application in the management of other range species and perhaps waterfowl as well. The establishment of basic principles and the refinement of the technique for assessing the variables involved in a true measure of windchill and its role in contributing to mortality can be best accomplished from an experimental laboratory approach.

Females

The percentage of calving and non-calving female caribou on the calving grounds could not be determined directly during the course of this study. Wilk and Terry gathered information during April and May at Stony Rapids from the local hunters concerning the pregnancy ratio of mature cows killed by the local Indians. Of a sample of 63 adult cows examined or reliably reported on, 13 (20.6 per cent) were not pregnant and 50 (79.4 per cent) were pregnant.

It is not possible to express accurately the number of females remaining with the males during the calving season. The sex and age composition of the calving and non-calving herds is dynamic and fluctuates daily as a result of several variable factors.

From Table 5, it can be seen that for the week from June 20 to 26, 7.1 per cent of the non-calving herd consisted of mature cows, with no calves. The percentage of mature cows increased as the cows and their calves began to move from the calving hills inland to the lower regions occupied by the non-calving animals. Fewer than half of the three-year-olds and four-year-olds in the non-breeding herds were females. Of the one- and two-year-olds, less than half of the number in the non-breeding group were females (Table 6). No generalizations can be drawn from the above data but they do provide a picture of the composition of the non-calving herd during the time of maximum parturition. The composition obtained this spring was undoubtedly influenced by the proximity of the bull migration route to the edge of the calving area.

No evidence was obtained this spring of cows having died during parturition. Other causes of mortality are discussed elsewhere.

The shedding of the old antlers by parturient cows appears to be closely associated with the time of calving. The majority of cows appear to shed their antlers during a period of several days before or after parturition. In Table 7, the weekly percentage of mature cows with old antlers is given. The data are from the calving area. Data obtained during migration are not significant because the cows with old antlers are in the most advanced stages of pregnancy and are at the head of the migration. A marked decrease in the number of mature cows with old antlers was noted during the week following June 23, as can be seen from Table 7. This gives a rough indication of the period of the maximum parturition.

Calves

The general calving area for the main study herd in 1957 is depicted on Map 2. Figure 1 shows the number of calves born on each day from June 1 to July 1, 1957. The date of birth was calculated for 90 calves whose ages could be determined (based on the length and condition of the umbilical cord and on the colour, size, and actions of the animal). After some experience in using a combination of these criteria, it was possible to record age of calves fairly accurately from 1 to 7, and roughly from 8 to 14 days of age. From the figure it can be seen that the period of maximum calving was June 9 to 15 (cf. data of antler shedding for mature cows, Table 7.)

A sex ratio of one to one for males and females was found in twelve calves of known sex. The identification of the sex of young calves in the field was found quite difficult. It proved to be very difficult to approach them close enough to use the external genitalia as a criterion. It was necessary to supplement that method with identification by their urinating posture.

The process of parturition was not observed, although several hours were spent observing cows in pre-birth spasms. The following is a description by Thomas of a new-born calf's activity.

"The cow and calf were discovered 200 yards from a band of cows with calves, time 18.30 hours. The calf was lying on the ground. The cow was apparently lying down also for she was not seen until the other band frightened her. She got up and then lay down for a few seconds, then regained her feet once more. She then came within 75 yards of the calf before she ran away from it 50 yards, turned around, walked toward the calf a few steps, then ran away to the southeast. The cow appeared to be about five years old. The calf tried to gain its feet but could not do so. It must have been only a few minutes old for it was still wet. The calf tried to stand up again but could only reel around. At 18.40 hours the cow moved out of sight over the ridge, one mile to the southeast. Tag number 1,128 was put in the left ear of the calf."

At 20.30 hours, when the calf was approximately two hours old, Thomas again approached it. At that time it could walk a little although very wobbly on its feet. The calf was found dead two days later, 100 yards from where it had been tagged.

On one occasion Thomas chased a band of cows and calves, which varied in age from several days to a week, at the approximate speed of 8 miles per hour for nearly 3½ miles. He found that he was unable to close the distance between himself and the band. He reported that the adult cows appeared to be as tired as the calves by the end of the chase.

In Table 8, the activities of calves aged 1 to 14 days are shown. On June 13, Thomas recorded the following observation of a young calf which appeared to be about 6 to 10 hours old.

"The cow was in good shape and appeared to be possibly 6 years old. At 9:53 the calf suckled for one-half minute, after which it remained on its feet for one minute and then lay down. It remained down for 20 minutes while the cow grazed, sometimes 50 feet away. The calf then found its feet again, suckling once more for about two minutes."

From Table 8, it can be seen that a total of 711 minutes of observation of calves was built up. By the band sizes, it can be noted that during the first day or two the calf and the cow usually remained apart from the band, but after the second or third day they began to join bands of other cows and calves. The extent of suckling and grazing for various ages is also shown in Table 8.

Table 9 gives the amount of time spent suckling and grazing by calves from one to fourteen days of age. Some irregularities due to paucity of data are present. In brief, however, it shows a marked change of feeding habits from a primarily suckling to a primarily grazing type of feeding which occurred on the fourth day. The longest period of nursing was two minutes, by a one-day-old calf.

Several instances of yearlings suckling cows were reported. On June 28, Loughrey noted a yearling run up to a four-year-old cow which it approached from the side and commenced to suckle immediately for a period of 30 seconds. During that time the cow made no attempt to interrupt the nursing. Thomas noticed a similar occurrence on June 20. In that case, the yearling bunted the cow's udder several times, lifting the hindquarters of the cow completely off the ground. The yearling suckled 60 seconds and the cow made no attempt to interrupt the feeding.

Cow-Calf Inter-relationship

Records were kept in the field of the behaviour of or inter-relationship between cows and calves, as the opportunity permitted. The following is a description of normal behaviour for a cow with a one-day-old or two-day-old calf and its reactions when disturbed from a resting position. Upon perceiving an approaching object (the observer) and deciding by sight, smell, or sound that it is dangerous or unfamiliar, the cow gets to her feet and attempts to lead the calf away from the object of alarm. If the calf is one day old or less and the object is not too close, she may allow the calf to suckle ten to fifteen seconds before leading it away, and she may again allow the calf to suckle for a few seconds when she believes they are out of danger. This interaction between cows and very young calves appears to be quite important in establishing a conditioned pattern in the calves. That is, the calf probably follows the cow to satisfy a basic hunger drive after the short, interrupted suckling period. This in turn may lead to the establishment of a conditioned pattern, with the result that the calf follows the cow whenever she moves off rapidly.

If a cow with a day-old or "rubber-legged" calf is closely pursued she will usually run off and leave it. Although she will occasionally pause to wait for it, she eventually runs on, stopping only to look back. In no case was a cow noted to cache a calf

or make any attempt to conceal it. Occasionally a young calf, unable to keep up with the cow, lies down behind a hummock of grass or clump of birch. If the calf is left undisturbed the cow will eventually circle and graze slowly toward it, although this process may take several hours. She usually appears to have no difficulty in locating the calf and apparently recognizes and accepts it primarily by its scent. If she has difficulty locating the calf she usually wanders around the area uttering a peculiar bleat or pig-like grunt until the calf answers her. This call-and-search pattern is typical of cows that appear to have lost their calves as a result of weather or predators. One cow which appeared to have lost her calf was noted in the same vicinity for three days at the Dubawnt Lake camp, although other caribou were migrating through the area each day. A cow that has lost her calf usually appears to be quite curious and often runs up very close to an observer, bleating at him.

When a cow is closely pursued she occasionally abandons a young calf that is unable to keep up with her and joins a band of fleeing caribou. This was noted on two occasions; on each occasion the cow appeared to be quite young, and possibly this was its first calf.

If the observer should separate a young calf from the cow, walk up to it, and touch it, as in tagging operations, the cow will usually be much more reluctant to approach the calf closely and accept it. She seldom moves closer than within 100 yards of the calf after she gets the man scent. In two cases the cow abandoned the calf after returning to it close enough to detect the human scent. In one of the cases the observer merely lifted the calf's tail to sex it. In both cases the calf was only a day old and one was only a few hours old when it was tagged. A recent paper by Collias (1956) provides some interesting information on that type of behaviour. From his study of parturition in domestic sheep and goats he concluded that separation of young from the mother shortly after birth prevents an early fixation of mother-young interactions. Consequently, when the young is returned she is more apt to reject it. It seems that with this interruption of normal early post-parturient mother-young reactions, as when a cow is separated from its calf and the human scent is found on the calf as a result of handling, it is most likely that the cow will reject or abandon the calf. This seems a much more likely explanation than

that the cow fails to "find" the calf when she returns to look for it, particularly in view of the persistence of cows in seeking for lost or dead calves.

Increment

A great deal of segregation work has been done by the field parties. Much of the resulting data remains to be analyzed. Breakdowns of herd structure by age and sex classes are not attempted in this report but await the results of segregations during the rutting period. Necessary here, however, are some remarks dealing with segregations as they refer to increment.

The outlook in late winter and early spring, 1957, was for a reasonably good calf crop. A rough assessment of pregnancy among adult female caribou in the Yellowknife area, based on autopsies of animals killed for wolf bait and on Indian reports, indicated that about 80 per cent were pregnant. Among the study herd at Stony Rapids, Wilk and Terry were able to examine or get reliable reports on 63 adult females. Of these 50 were pregnant (79.4 per cent) and 13 were not (20.6 per cent). If calf survival were excellent, and if upwards of 40 per cent of the herd were adult females (a reasonable assumption), one would expect calves to make up over 24 per cent, possibly over 30 per cent, of total animals during the post-calving period.

Table 10 presents calf segregations made since July 12. The apparent calf percentage, in the neighborhood of 16 per cent, appears to indicate a fair calf crop. It could not be classified as good but it is about 6 per cent higher than the average of the past few year years. It would roughly indicate a calf loss of 35 to 50 per cent during the calving and immediate post-calving periods.

For a number of reasons, however, it is thought best not to assume that the present figures are truly indicative of a final increment figure, The large segregations made July 12 to July 17 almost certainly give a true picture of the calf ratios among those predominantly-calving caribou which remained in the area south of Beverly Lake and west of the Dubawnt River during the calving period. When the segregations were made, however, the herds did not appear to have their full complement of adult bulls; in fact only 196 bulls were segregated among the 5,592 caribou. It seems

certain that the predominantly-bull herds were elsewhere, out of range of the segregations, and that their inclusion would drop the calf ratio by possibly as much as 5 to 6 per cent.

The segregations of August 25 to September 26, present a somewhat different picture. Adult males, and other age and sex classes, appeared to be present among the group involved in reasonably representative numbers, and yet the calf ratio was almost as good as that determined in July. (Advance information on later segregations among the same group indicates calf ratios still higher - about 22 per cent.) A speculative explanation for this exists, which may, or may not, prove valid as more segregations are made on a wider cross-section of the total herd.

The animals worked with from August 25 to September 26 were the extreme western elements of the study herd. Movement data are not entirely conclusive, but it is quite possible that these were the animals that went north in May and June to the west of the Thelon River (Kelsall, 1957a). It is likely that the animals calved between the Thelon and Back Rivers, 50 to 100 miles west and northwest of the majority of the herds that were studied by the field parties. Trails and limited observations of moving caribou give every indication that these caribou retained their identity as the western-most element of the study herd during their return south (see Map 1).

If the above is true there is every reason to believe that early calf survival (and later calf segregations) are higher than among those elements worked with by the ground parties, because of better weather conditions at the time of calving. It is discussed elsewhere that weather at the ground camps was unfavourable for calf survival, and it is certain that many calves were lost directly, or indirectly, because of adverse weather. During the periods in June when the field crews were recording adverse weather the author was making daily checks with the Yellowknife weather forecast office. If the weather forecasts were correct (and they are considered reliable) the field men were subjected to long periods of storm which generally terminated not very far west of them. The author had an excellent opportunity to test this at first hand on June 20 and 21 when he flew out to help straighten out the difficulties resulting from the second Cessna crash (Kelsall, 1957a). This was during one of the

periods of high windchill factor shown on Table 4. In flying almost due west to Camp 3, the air was clear and visibility unlimited until the western edge of the rapid drop to the Thelon River valley was reached. Here a storm front was encountered, and within a few miles a blizzard, and near bilizzard conditions prevailed until the return over much the same route the following day. On the following day the front was again encountered as a sharp line only a few miles from where it had been previously. During these two days, and, it is believed,during a significant number of other days in June as well, calving was taking place west of the Thelon under sunny skies and gentle winds and east of the Thelon in blizzards and near blizzards. It would be surprising if calf survival in the two areas were not significantly different.

It is too early to make positive statements regarding the size of the current calf crop. Segregations on autumn and winter ranges should clarify the matter. Indications are, however, that the crop will be no better than fair and possibly as low as 10 per cent.

Predation

Wolf Predation during the Calving Period

In order to gather much needed data on wolf predation, the field men have been instructed to observe wolves wherever and whenever possible, to make careful notes on their observations,and to refrain from shooting or otherwise alarming the wolves. A considerable amount of qualitative and quantitative data has thus been gathered.

The following information deals with the period May 26 to July 17, from a few days before the observed birth of the first calves of the season until after all calves appeared to have been born. During the 53 days in question the field men observed wolves totalling 39 adults and seven pups at two different dens. Some of the adults were seen on several occasions, so there were not 39 different adults involved. Single wolves and groups of wolves were observed in an undisturbed state for a total of 4 hours, 52 minutes during the period. Since a number of the observations included groups of two or three wolves, total wolf-hours amounted to 10 hours, 15 minutes. During all the observations both field men and wolves were among

considerable numbers of calving caribou. Besides observations on undisturbed wolves, the field men amassed a good many hours of observation on wolves aware of the observers. In a surprising number of cases the wolves showed apparent indifference to the presence of humans.

As expected, wolves were relatively abundant in the calving areas investigated. That country is comparatively open and level and contains many eskers and other sandy tracts which wolves seem to prefer during the spring. The calving area investigated in 1952 (Kelsall, 1957) was exceedingly rough and rocky and apparently had a small wolf population.

During 15 observational periods on undisturbed wolves, they were observed killing, eating, or hunting caribou on nine occasions during much more than half the 10 hours 15 minutes time of observation. Seven observations involved single wolves only, seven involved two wolves travelling together, and in one case three wolves were seen together. Fifteen caribou evidently killed or eaten by wolves were found, including five adults, one yearling, and nine calves. Seven of the calves were found at two den sites examined. It appeared that the wolves were living almost entirely on caribou.

On only two occasions were wolves seen apparently searching for birds' nests, lemmings, and other small game. At a den site examined June 9, which contained three male pups and one female, the remains of two calf caribou and a few ptarmigan feathers were found. At a den site examined June 14, which contained three male pups, the remains of five caribou calves were found. It is elsewhere reported that there was heavy mortality among caribou calves during that period because of adverse weather. A number of the wolf-eaten calves may have been found dead by the wolves. There was no question, however, that wolves were feeding extensively on calves. It seems probable that if dead calves were not found the wolves would kill calves when needed.

On June 3 the field men were fortunate enough to witness an actual wolf kill. The description of the kill follows in the words (slightly edited) of Wilk.

"On the night of June 3 at about 8:25 I was at a point some half mile south of camp watching three bands of caribou crossing the ice. They were almost a

mile away. A couple of minutes later I was surprised to see the herds running at top speed just beyond a large pressure ridge. A wolf was running after the largest herd, which was following two smaller groups. The herds numbered 80, 28, and 28, respectively. The wolf appeared to be 100 to 150 yards to the rear. Almost 400 yards away was another wolf loping along at a leisurely pace in the direction of the chase (this was a smaller animal presumed to be a bitch). In a minute or so the caribou changed course and crossed the pressure ridge at top speed. The chase continued with the wolf slowly closing the gap. When the wolf was 50 yards or more away the herds joined into a tight mass of stampeding animals. The surface of the lake was rough and it appeared amazing that none of the caribou fell at this time or when crossing the pressure ridge. The wolf did not seem to speed up but kept the distance some 50 yards to the rear. Eventually, one of the animals in the centre of the herd, but toward the rear, tripped over a drift and the wolf immediately put on a spurt and shortened the distance to half before the animal righted itself and rejoined the fleeing herd. The wolf now increased his speed and soon was only a few yards behind the hindmost animals. Some of the caribou swerved to one side, but the wolf kept on after the animal which had fallen and in a matter of moments grabbed it by the left hind leg about four inches above the hock. The caribou was down immediately. The wolf apparently held it by this grip for two minutes during which the balance of the herd ran almost a mile before slackening pace. At 8:34 the wolf let go his hold on the leg and attempted to seize the caribou by the throat. During this proceeding the caribou managed to get up on its front legs. At 8:36 both the wolf and caribou were down again. At 8:42 the second wolf reached the scene and by this time the caribou was apparently dead because the wolf which had made the kill stood up and seemed to be feeding. Both wolves then commenced feeding and they continued until 9:32 at which time they commenced to move away in a leisurely fashion."

At 10 p.m. the wolves were resting within sight of the kill when the field men approached to examine it. It proved to be a pregnant female. It was discovered that one of the first things removed and eaten by the wolves was the unborn calf although they ate little more than 10 pounds of meat from the cow. At 6:45 the following morning the wolves had not returned but 20 minutes later they were again seen feeding on the carcass. They fed for only 15 minutes, possibly having been alarmed by the men, and did not return.

The circumstances under which one young calf was killed were described by Thomas as follows:

"A calf only a few hours old was found lying in the snow 50 yards from the nearest snow-free ground. The neck was broken and part of the neck had been eaten, as well as all of the internal organs. Tracks indicated that it had been killed by a wolf, as wolf tracks came off a knoll about 30 yards from the calf in long bounds until they reached the carcass, where they stopped. Tracks indicated that the wolf had dragged the calf ten feet, and also that the wolf had followed the bounding cow at a slow walk from the dead calf. Most of the head and all of the internal organs, the neck flesh, and the flesh from the front feet and front legs had been eaten."

It is interesting to note that wolves were seen to visit and feed on earlier kills repeatedly, and they also, on occasion, fed on carcasses of caribou killed by the field men for pathological examination. There was no evidence for the occasionally-expressed belief that feeding wolves insist on fresh meat and will not eat carrion. Caribou killed by wolves and left for a prolonged period shortly become unavailable for subsequent feeding, however, as gulls, ravens, jaegers, foxes, and wolverines consume them. The field men noted that the carcass of even an adult caribou was usually stripped by minor predators and scavengers within two days.

Post-Calving Wolf Predation

After the calving period, wolf observations diminished remarkably. Between July 17 and August 31 Kuyt observed only two wolves, both during the course of survey flying. Relatively few recently wolf-killed caribou were found during that period. The reasons may be inferred.

After July 17 and until August 2 the camps were some distance east of the Dubawnt River and away from the calving grounds where wolves and their dens were frequent. It is unlikely that the wolves, many of which must have been still attending young pups, would follow the caribou so far. The country there was alternately wet and rocky, with an absence of sand eskers, and could not be expected to harbour more than a few resident wolves. During early August the camp

was on the Thelon River. There seven wolf-killed caribou were found in a period of less than two weeks and doubtless wolves were abundant. They were probably not sighted because thick bush along the river provides excellent concealment for predators. From August 12 until the end of the month the camps were once more in open, wolf-denning country. Inspection of dens which had been occupied two months previously indicated, however, that the wolves had left. Presumably by that time the pups are old enough to take up a nomadic life following the caribou herd.

September data on wolves and predation are lacking at the time of writing.

Bears

Barren-ground grizzly bears (Ursus richardsoni) have been seen more frequently by the various field parties of 1957 than by any other such parties, to the author's knowledge. The observations were as follows:

Date	Bears Seen	Place
June 11	3 (1 adult, 2 yearlings)	near Mosquito L.
June 14	2 (1 adult, 1 yearling)	Mosquito L.
June 28	2 (adults)	Beverly L.
July 3	2 (adults)	Beverly L.
July 9	1 (adult)	Spruce Grove L.
July 11	1 (adult)	Spruce Grove L.
July 18	3 (1 adult, 2 yearlings)	Wharton L.
Aug. 12	4 (1 adult, 3 cubs)	E. of Thelon R.

The above records include 18 bears of which 10 were adults, five yearlings, and three cubs. It is possible that some of the adult animals were seen on more than one occasion.

Judging from the number of cubs and yearlings seen the past two years have been productive ones. This

is in line with sight records over the mainland barrens during the past five years. It has appeared to persons sufficiently interested to keep track of grizzly records that the species has greatly increased and extended its range in recent years. For example, they have been frequently found raiding caches of the Baker Lake Eskimos in areas where they were virtually unheard of before 1950. Since 1954 they have raided caches and camps at Musk-ox Lake in the central barrens, and in the Coppermine-Bathurst Inlet area, in places where they had never previously been a nuisance and were, indeed, very rarely seen. Despite the closed season on grizzly bears, probably more have been shot during the past three or four years in defence of camps and caches than were taken at any time before the closed season was imposed. The increase is believed to be a natural one, not influenced appreciably by men's actions.

The field party found no evidence that grizzlies were killing caribou. They were believed, however, to be scavenging and eating an appreciable number of caribou calves that had died from natural causes. Several of the bears seen were searching for lemmings and ground squirrels, as is their custom during the spring and summer. Most bear scats discovered were old, dating back to the previous autumn, and contained only lemming bones, berries, and other vegetation. It is likely that grizzlies can on occasion kill caribou but the extent of such predation is negligible.

A matter of more than casual interest although of little direct importance, was the sighting of three black bears (Euarctos americanus) on the barrens. One was seen on August 9 about 20 miles northeast of Mosquito Lake, and a second on August 20 about 60 miles east of Artillery Lake at latitude 62° 58', longitude 106° 10'. There appear to have been no previous sight records of black bears so far from tree-line.

The third black bear was seen on September 3 a few miles east of Eileen Lake at latitude 62° 15', longitude 107° 25', just a few miles north of tree-line. A bear, believed to have been the same one, was seen near the same place about September 20.

Other Predators

Wolverine, coloured and white foxes, eagles, and ravens have all been recorded by the field parties from time to time. To date there is little evidence

that they normally act as anything but scavengers about the caribou herds.

Accidents

Accidents to Calves

Adverse weather resulted in calf deaths in ways somewhat more direct than those mentioned above. The influence of adverse weather was compounded by the fact that considerable amounts of deep, wet snow remained on the ground. Physical barriers such as lake and river crossings remained as unusual hazards to young animals, because of abnormally deep and late snow about their margins. Thomas records the finding of a one-week-old calf as follows:

"The calf had apparently become stuck after crossing a small stream about two days previously. The calf had gone through five feet of water twelve to eighteen inches deep, twelve feet of slush twelve to eighteen inches deep, and then seven feet of snow, before becoming stuck. It had only three feet of snow to go through to reach bare ground. From tracks and pellets around the calf, the cow had apparently stayed with the calf for some time, possibly two days."

As late as mid-July some calves were lost in swimming the Dubawnt River because of late-thawing ice shelves out from the bank. On July 12, Loughrey noted that cows and calves swimming the river were sometimes drifted by the current into an ice shelf, which the cows could climb over but the calves could not.

The calves would often make futile attempts to leap up on the shelf. On abandoning these attempts they would either wade upstream, or swim downstream to the end of the ice shelf. The cows usually stood on the shore above the ice shelf with their ears pointed forward, grunting at their calves, which kept up a continual bleating until they were reunited with their mothers. On July 17 five calves were found dead by Terry at another such place, and it is believed that they died of exposure when unable to climb out of the water because of the ice shelf. The following observation by Loughrey gives some indication of the endurance of young calves - and their limitations.

A cow with a young calf and a yearling, after swimming the Dubawnt and nearly reaching the opposite bank, with the calf trailing by nearly 10 yards, turned back to the shore it had started from and almost reached it before again turning and heading for the other shore. The cow and the yearling reached the other shore about 300 yards below the point where they had entered the water. The calf appeared to have been weakened by the several crossings and was swept downstream a considerable distance on the final trip. Only by a sustained effort was it able to lurch out of the water on to the shore. When it gained the shore its right hind leg was drawn up against its flank; it was apparently suffering from a cold cramp. It experienced great difficulty in climbing the river bank, but the cramped leg appeared to be limbering up when it finally disappeared over the crest of the hill. That calf had been in the icy-cold water about five minutes.

A fatal accident was narrowly averted on July 13, when a calf was seen drifting downstream on an ice pan. The field men canoed out to see if it was alive, whereupon it sprang to its feet, leaped into the water and swam ashore. If it had not been disturbed it would have certainly gone over a large rapid about half a mile down river.

Calf loss due to drowning may be severe at times, as shown by Kelsall (1957). Such drowning is believed to occur usually when waves are running and the animals tire rapidly trying to keep their heads above water. Kuyt gives an account of such an occurrence witnessed at Camp 8.

"On July 25 a single calf had been observed wandering around by itself, calling (for its mother) at intervals. The second time the calf was encountered it jumped up from a lying position and ran away from the observer in the direction of Moon Lake. Apparently without hesitation it walked into the water and started swimming against a strong E.N.E. wind. The calf seemed to tire rapidly and stopped moving shortly afterwards. Presently it laid its head on the water and waves started breaking over it. At that point a retriever dog was sent into the water, which grabbed the drowning calf by an ear and pulled it ashore. The calf, however, was breathing very irregularly at that time and died within ten minutes."

While the calf above certainly died of drowning, as shown by autopsy, other factors (i.e. prior exhaustion or malnutrition) may well have contributed.

The field men themselves contributed largely to the accidental death of two calves. On June 30 a very young calf was found. Because it was so small it was not handled except for the tail which was lifted to determine the sex. The female completely abandoned that calf and it died of exhaustion. On July 2 a calf that had been ear-tagged when only an hour or so old was found dead, having been abandoned by the female. The field men concluded that the bond between calves and their mothers is remarkably weak when the calves are very young, and that man scent or acute disturbance can readily bring about desertion. Because of this the tagging of young calves was not pursued. Similar observations were made and discussed by Kelsall (1957). Harassment by predators, or by other agencies such as low-flying aircraft, might very possibly bring about similar results.

Accidents to Adult Caribou

Drowning has already been recorded as one of the commoner accidental deaths suffered by adult caribou (Banfield, 1954; Kelsall, 1957). Only two cases of adult animals having drowned were noted during the 1957 summer work. In both cases exhaustion mainly from fly harassment may have been a contributing factor. Many observations of swimming caribou during the past four months have led to the conclusion that drowning is unusual among caribou more than one year of age unless they are suffering physical debility or encounter unusual hazards. Caribou have repeatedly been seen to swim large rivers, in numbers, at exceptionally hazardous places, as above major rapids, without loss. They have been seen swept over considerable rapids and emerging unscathed. It is remarkable that more drownings have not been encountered.

Mature animals appear to be subject to injuries, particularly sprains and broken limbs, with considerable frequency. Accidents causing such injuries may occur when travelling rough and rocky country, when swimming rapid and rocky rivers, and when harassed by predators, insects and the like. Animals with crippling leg injuries, or infections, are almost invariably seen in the wake of a large moving herd. Some doubtless recover from their injuries, but many are lost directly or through predation and other causes. Kuyt has briefly described a

number of rather typical examples.

"On July 18, in a band of 14 cows and 10 calves, a cow was observed with a peculiar labouring gait. The animal's head bobbed up and down with every step. Closer observation showed a huge round swelling (approx. seven inches) immediately below the carpel joint on the right front leg. Although the cow (which had a calf at heel) seemed greatly handicapped, she and the calf evidently swam across the Dubawnt River just above the falls without incident as the two animals were observed grazing on the other side about an hour later.

"On July 25 a dead male caribou was examined. Cause of death could not be established. It was noticed, however, that the right carpel joint was abnormally 'loose'.

"On July 27 an adult male caribou was examined. This animal had a decided limp and was destroyed. It was found that (it) had been suffering from an abscessed fetlock on the right front leg. An open wound found between the dew claws could have been responsible for this abscess.

"On July 28, a herd of about 180 caribou passed by the Moon Lake field camp. One caribou was observed to be limping.

"(On August 15) ...the writer observed a limping caribou. This animal was later destroyed by F.W. Terry. The caribou, a female (who may have lost her calf, as her udder contained some thick yellowish fluid), had a slightly swollen carpal joint, but otherwise was in good condition. Upon incising the swollen joint, the writer observed two pockets filled with caseous pus, three other pockets filled with a semi-liquid substance."

The above accounts of caribou with leg injuries are typical of many made by all the field workers since May, 1957. It is believed that the majority of such injuries are come by accidentally.

No other significant accidents resulting in mortality among adult caribou have been recorded up to the time of writing.

Human Utilization

Thanks to the efficiency of the Provincial field officers in northern Saskatchewan, it is possible to present a final, accurate total of caribou killed by humans there during the 1956-57 winter. The figures are presented in Table 11.

Additional caribou were no doubt killed in Alberta during the period in question, but probably not in significant numbers. It will be noted that the total recorded kill, 7,359, exceeds the estimate given in the first report on the co-operative caribou investigation.

It is necessary to make some allowance for crippling loss in the presentation of total human utilization figures. It is believed that a crippling loss of 20 per cent of the total taken would not be excessive. This means that the total loss to the study herd in Alberta and Saskatchewan between October, 1956 and early May, 1957 numbered about 8,831.

In the first report it was pointed out that the calf crop during the winter of 1956-57 amounted to only a little over 8 per cent of total animals and that was thought to be a maximum, rather than a minimum figure. From our continued study of the herd it seems likely that the total number of animals involved numbers close to 100,000. Therefore, the human kill in Alberta and Saskatchewan almost equals the calf crop in number. It is apparent that the further losses that may have occurred from accidents, disease, predation, and utilization by Eskimos, constitute a net deficit in the herd.

After leaving northern Saskatchewan in May, the study herd moved northeast and for the next month and a half was free from human utilization. In late June, however, some elements of the herd arrived in the vicinity of Eskimo camps on the lower Thelon River. Statistics on the utilization of these caribou by Eskimos during late June, July, and early August will be gathered by Acting Corporal Don Wilson, R.C.M.P., at Baker Lake. Corporal Wilson plans a late-August patrol up the Thelon by canoe with an interpreter, and he will be in the best position to gather the data needed. Our field men could not undertake this work, largely because the Thelon Eskimos speak no English. A few remarks regarding Eskimo utilization might be appropriate at this time, nevertheless.

In 1951 there were between 30 and 40 Eskimos on the Thelon River in the area reached by the study herd. Judging from aerial observations, there are no fewer than that number, possibly more, at the present time. Eskimo encampments were seen between Beverly and Aberdeen Lakes, at the central narrows on Aberdeen Lake, and between Aberdeen and Schultz Lake. The people were camped strategically, without exception at water crossings used by the caribou during their movement north of the Thelon. Every camp observed showed evidence of relatively heavy utilization in the form of drying caribou hides, caches of meat and hides, and racks of drying meat. Limited aerial observations indicated very little deliberate wastage. Only one unutilized carcass was seen in the vicinity of the camps. It is thought very probable that the Eskimos took between 500 and 1,000 caribou.

It is worth noting that, according to report, the Eskimos mentioned above are practising reasonable conservation. At a time in late July when caribou were imminently expected at Baker Lake, Corporal Wilson organized hunting parties and gave specific instructions as to how many caribou could be taken. He set a quota at that time of only nine caribou for the several Eskimo families at Baker Lake. He believed that the majority of the Thelon Eskimos are so well aware of the need for caution in the utilization of caribou that the kill, even without supervision, would in no way be excessive.

By mid-August most elements of the study herd had withdrawn from Eskimo hunting areas and no significant human utilization took place after that time.

Antler Rubbing

Antler rubbing was noted throughout the month of June. Caribou of both sexes and all ages that had antlers in the velvet were noted to engage in antler rubbing. It was noted to be most prevalent, however, amongst the adult bull caribou, particularly just before the branching of the palmations at the tip of the antler. The posture assumed during the rubbing act was to stand with the legs spread slightly wider than normal; the head turned back even with the scapula and rotated about 45°, with the muzzle usually pointing down. The hind leg on the appropriate side was lifted and held slightly to the side. The tip of the antler was brought in contact with the anterior surface of the lower leg (cannon bone). The scratching was accomplished with either leg, either by holding the leg

steady and moving the head back and forth along the leg, or the reciprocal motion of holding the head motionless and lifting the leg up and down, thus rubbing it against the tip of the antlers. Seton (1910, p. 204) provides an accurate sketch of these motions.

Work in Progress or Planned

Parasites and Disease

The field parties have collected a good deal of pathological material, some of it, fortunately, during the period when Gibbs was in the field. Included among the material are warble and nose fly larvae, lung worms, several intestinal parasites (some of which will almost certainly be new to us), and cysts from visceral and muscle tissues. Blood smears are being collected, as well as blood serum, for laboratory examination. As yet we have no returns from the examination of that material.

In late July caribou were reported dying at Camp 8 under unusual circumstances and Gibbs was able to reach the field in time to make some first-hand investigation. His conclusions have not been received at the time of writing. He was able to catch one adult male animal by hand and the same animal was later shot and autopsied. It is believed that exhaustion, loss of blood and possibly malnutrition due to black fly and mosquito harassment were involved.

Reproductive Studies

As a possible aid to understanding fluctuations in reproductive success of the caribou, particular attention is being given to reproductive biology during the rutting period. Adult male and female specimens are being taken at regular intervals and histological material is being collected. It is expected that a study of the collected material will be made in Ottawa during the coming winter. The histological studies will be supplemented by quantitative and qualitative observational material, It is expected that one two-man party will be with the study herd in the west during the rut and that a second such party will be gathering comparative material in Manitoba.

Marking Program

Gibbs tested various drugs on reindeer in the Mackenzie Delta in July and has found a curare combination which appears excellent for immobilizing the animals.

After a great deal of experimental testing, however, a suitable weapon and missile for delivering the drug have yet to be developed. The R.C.M.P. ballistics laboratory is still working on the project. Coloured metal eartags are on hand. If other capturing techniques fail it is planned to try corralling animals on their winter ranges.

Range Studies

Some data on the composition of plant cover on calving and non-calving spring ranges has been gathered. Plans for more extensive investigation of winter ranges are being formulated. Pruitt will investigate snow depth and its relation to caribou movements, distribution, and feeding habits in winter. Mills is currently occupied in keying certain winter and summer ranges with a view to aiding in aerial photographic analysis of the ranges. Later he will plan nutritional studies of winter ranges. If funds permit, a sampling of forested winter ranges to define, age, and analyse burned areas is planned. This project could give results of interest to foresters and fur management men as well as to those engaged in the caribou research project.

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TABLE I

Composition of Ground Cover by Percentages on the Beverly Lake Calving and Post-Calving Areas of the Summer Range, June, 1957.

Item	Calving Transect No. 1	Post-Calving Transect No. 2
Snow	3.7	4.6
Water	0.3	4.5
Bare earth	13.9	2.8
Bare rock	10.2	0.2
Total unvegetated	28.1	12.1
Moss, small	4.5	1.0
Moss, large	4.3	-
Sphagnum	-	22.7
Total mosses	8.8	23.7
Lichens, small	1.9	0.1
Cetraria cucullata	16.2	4.0
Cladonia coccifera	0.3	0.2
Peltigera canina	0.3	-
Peltigera apthosa	0.3	-
Alectoria divergens	9.3	0.3
Sphaerophorus globosus	0.4	0.1
Umbilicaria decussata	0.1	-
Total lichens	28.8	4.7
Salix sp.	0.1	-
Betula glandulosa	1.3	3.0
Ledum groenlandicum	7.6	13.1
Total shrubs	9.0	16.1
Grasses and sedges	4.4	25.8
Empetrum nigrum	5.3	2.2
Arctostaphylos rubra	0.1	0.3
Vaccinium uliginosum	0.3	1.1
Vaccinium Vitis-Idaea	14.7	13.0
Annual plants	0.5	1.0
Total ground vegetation	25.3	43.4
Total percentages	100.0	100.0

TABLE 2

Weather Records, June, 1948

June 1948	Temp. °F. Max.	Min.	Wind Direction	Velocity (m.p.h.)	Precipitation
1	85	53	WSW	5.5	Nil
2	57	36	NNE	5.5	.01 Rain
3	56	32	ESE	2.0	Rain (trace)
4	68	32	SE	10.0	Nil
5	67	40	SSE	2.0	Nil
6	60	34	SE	5.5	.45 Rain
7	57	34	E	10.0	Nil
8	54	33	SE	2.0	.17 Rain
9	46	40	NW	21.5	.42 Rain & Snow
10	48	30	WNW	21.5	Nil
11	51	30	NNE	21.5	Nil
12	54	34	E	10.0	Nil
13	49	30	E	5.5	Nil
14	65	37	E	2.0	Nil
15	62	37	W	5.5	Nil
16	66	37	SSW	5.5	Nil
17	80	42	W	2.0	Nil
18	50	39	NW	15.5	Rain (trace)
19	68	29	ESE	10.0	Nil
20	56	45	NE	2.0	Nil
21	50	40	00	0.0	Rain (trace)
22	64	42	ENE	2.0	Nil
23	60	36	ENE	10.0	Nil
24	63	43	00	0.0	Rain (trace)
25	62	46	W	15.5	Rain (trace)
26	62	46	00	0.0	Rain (trace)
27	66	38	00	0.0	Nil (mosquitoes)
28	79	34	E	5.5	Nil
29	73	46	E	2.0	Nil
30	74	42	SSW	2.0	Nil
Average	61.7	37.9		6.7	
Average mean	49.8				

TABLE 3

Weather Records, June, 1957.

June 1957	Temp. °F. Max.	Min.	Wind Direction	Velocity (m.p.h.)	Precipitation
1	42	32	NW	14	Sleet (trace)
2	37	28	NE	39	.16 Rain & Snow
3	43	25	WNW	10	Nil
4	45	24	NNE	11	Nil
5	48	26	NW - W	10	Nil
6	49	34	NW	18	.13 Rain
7	52	32	NW	9	.05 Snow, cold and raw
8	42	25	NW	21	Snow (trace)
9	43	26	NW	21	Snow flurries
10	43	25	NW - W	30	.08 Snow
11	45	28	NNW	14	Nil
12	42	28	WNW	14	.01 Snow
13	54	29	SE	16	Nil
14	42	34	NE	9	.02 Rain
15	43	27	NE	12	Rain (trace)
16	42	34	SW	8	.06 Snow
17	40	38	SW	11	.05 Rain
18	37	32	NW	21	.10 Snow
19	38	32	NW	24	.10 Rain
20	40	33	NW	14	Rain (trace)
21	44	32	N	15	Rain (trace)
22	52	34	N	10	Nil
23	57	32	NW	3	Nil
24	58	33	NE	6	Nil
25	70	34	SE	4	Nil
26	60	40	NE	16	.02 Rain
27	74	38	Calm	Nil	Nil
28		42	NE	11	Nil
29	62	32	Calm	Nil	Nil
30	60	38	N	6	Nil
Average	48.3	31.6		13.2	
Average mean	39.8				

TABLE 4

Daily Maximum Windchill Factor for June, 1957.

Note: The temperatures and wind velocities in this table vary slightly from those in Table 3, as they were taken at different campsites.

June 1957	Min. Temp.	Wind Max. Velocity (Gusting)	Windchill Factor (To Nearest 100)		Periods High Aggregate Windchill
1	32	15	1,000		
2	28	35 (40)	1,200	(1,200)	3,400
3	25	10	1,200		
4	24	0	400		
5	26	10	1,000		
6	34	-	--		
7	32	10	900		
8	35	20 (25)	1,000	(1,000)	
9	26	20 (30)	1,100	(1,200)	
10	25	30	1,200		7,300
11	25	15	1,100		
12	25	10	1,000		
13	32	15	1,000		
14	34	5	700		
15	28	0	400		
16	28	10 (20)	900	(1,100)	
17	38	30	1,000		
18	30	30 (40)	1,200	(1,200)	6,200
19	30	20 (30)	1,100	(1,200)	
20	30	25 (35)	1,100	(1,200)	
21	30	10 (15)	900	(1,000)	
22	34	5	700		
23	32	5	700		
24	36	0	400		
25	30	5	800		
26	36	10	800		
27	34	0	400		
28	36	0	400		
29	34	5	700		
30	36	5	700		

TABLE 5

Percentage Composition of Non-calving Caribou Bands
June 20 to July 3, 1957,
Beverly Lake, N.W.T.

Date 1957	Total No. Segregated	Age Distribution					
		One Year	Two Years	3 & 4 Years	Mature Bulls	Mature Cows	Calves
June 20-26	269	6.0	16.0	23.4	43.5	7.1	0.0
June 27-July 3	309	19.1	13.9	25.6	24.0	15.5	1.9
TOTAL	578						

TABLE 6

Sex Ratios of Calves, Yearlings, and Two-Year-Olds in the Calving and Non-calving Herds (number segregated shown in brackets).

Herd	Calves		Yearlings		Two-Year-Olds	
	M	F	M	F	M	F
Calving	50	50 (12)	38	62 (29)	47	53 (66)
Non-calving	-	-	70	30 (57)	52	48 (77)
Summary	50	50 (12)	59	41 (86)	50	50 (143)

TABLE 7

Percentage of Mature Cows with One or Two Old Antlers in the Beverly Lake Calving Area
June 17 to July 7, 1957.

Date 1957	No. Cows Differentiated	Number with Old Antlers	Percentage with Old Antlers
June 17-23	102	43	42.2
June 24-30	98	7	7.2
July 1-7	56	3	5.3

TABLE 8

Activities of Calves Aged One to Fourteen Days, June, 1957.

Date	Period Observed (Min.)	No. of Times Suckled	No. in Band Incl. Calf	Age of Calf (Days)	Suckling (Sec.)	Grazing (Min.)	Lying (Min.)	Standing (Mins.)	Moving (Min.)	Max Dist. From Cow (Ft.)
1	30	5	2	1	30+30+10 + 60+15 (145)	1	0	10	20	10
1	116	4	2	1	4x15 (60)	0	51	20	45	10
13	30	2	2	1	90+120 (210)	0	20	5	5	50
3	10	2	2	4	2 x 30 (60)	0	0	2	8	10
29	60	1	11	4	70	1	36	5	19	40
16	135	2	31	5	2 x 15 (30)	½	133½	1½	0	10
27	60	1	6	5	15	10	36	16	8	10
16	135	0	31	7	0	½	134½	½	0	30
27	60	1	6	7	45	3½	44	9	7	20
25	10	0	22	14	0	1	0	2	8	225
27	5	0	2	14	0	1	0	3	2	90
27	60	0	6	14	0	6	31	21	8	30
Total	711	-	-	-	-	-	-	-	-	-

TABLE 9

Time Occupied in Suckling and Grazing by Caribou Calves One to Fourteen Days of Age.

Age (days)	Time Observed (Min.)	Time Spent Suckling (Min.)	Time Spent Suckling (% of Total)	Time Spent Grazing (Min.)	Time Spent Grazing (% of Total)
1	176	7.8	4.44	1.0	0.57
4	70	2.2	3.14	1.0	1.43
5	195	0.75	0.38	10.5	5.38
7	185	0.75	0.41	5.0	2.70
14	75	0.0	0.00	8.0	10.70

TABLE 10

Calf Segregations July 12 to September 26, 1957.

Date	Total Segregated	Calves No.	Calves %	Place
July 12	1,630*	270	16.6	East of Dubawnt River
" 12	180	34	18.9	Beverly Lake
" 13 to 17	5,592	926	16.5	Dubawnt River crossing
" 18 to 31	521	58	11.1	Camps 7 and 8
Aug. 2 to 24	112	10	0.9	Camps 9 and 10
Aug. 25 to Sept. 26	4,064	645	15.9	Camp 11
Summary	12,099	1,943	16.1	

*Aerial count - all others ground counts.

TABLE 11

Recorded Utilization of Caribou by Humans in Northern Saskatchewan and Alberta in Early Winter and Spring, 1956-57.

Settlement	To Mid-April	After Mid-April	Total
Fort Chipewyan	300	-	300
Cree Lake	21	-	21
Reindeer Lake	6	-	6
Fond du Lac	462	258	720
Black Lake	2,250	675	2,925
Stony Lake	1,000	300	1,300
Stony Rapids	372	115	487
Wollaston	650	-	650
Uranium & Camsell Portage	200	700	900
La Loche north	50	-	50
Totals	5,311	2,048	7,359

FIGURE 2. WINDCHILL FACTOR; NOMOGRAM OF ISOCHILLS.

Figure 2

Nomogram of dry-shade atmospheric cooling. Cooling is expressed in kilogram calories per square meter per hour, for various temperatures, and wind velocities. The cooling rate is based upon a body at a neutral skin temperature of 33°C. (91.4°F.). When dry cooling rate is less than the rate of body heat production, excess heat is removed by vaporization. Under conditions of bright sunshine, cooling is reduced by about 200 calories. Expressions of relative comfort are based upon an individual in a state of inactivity.

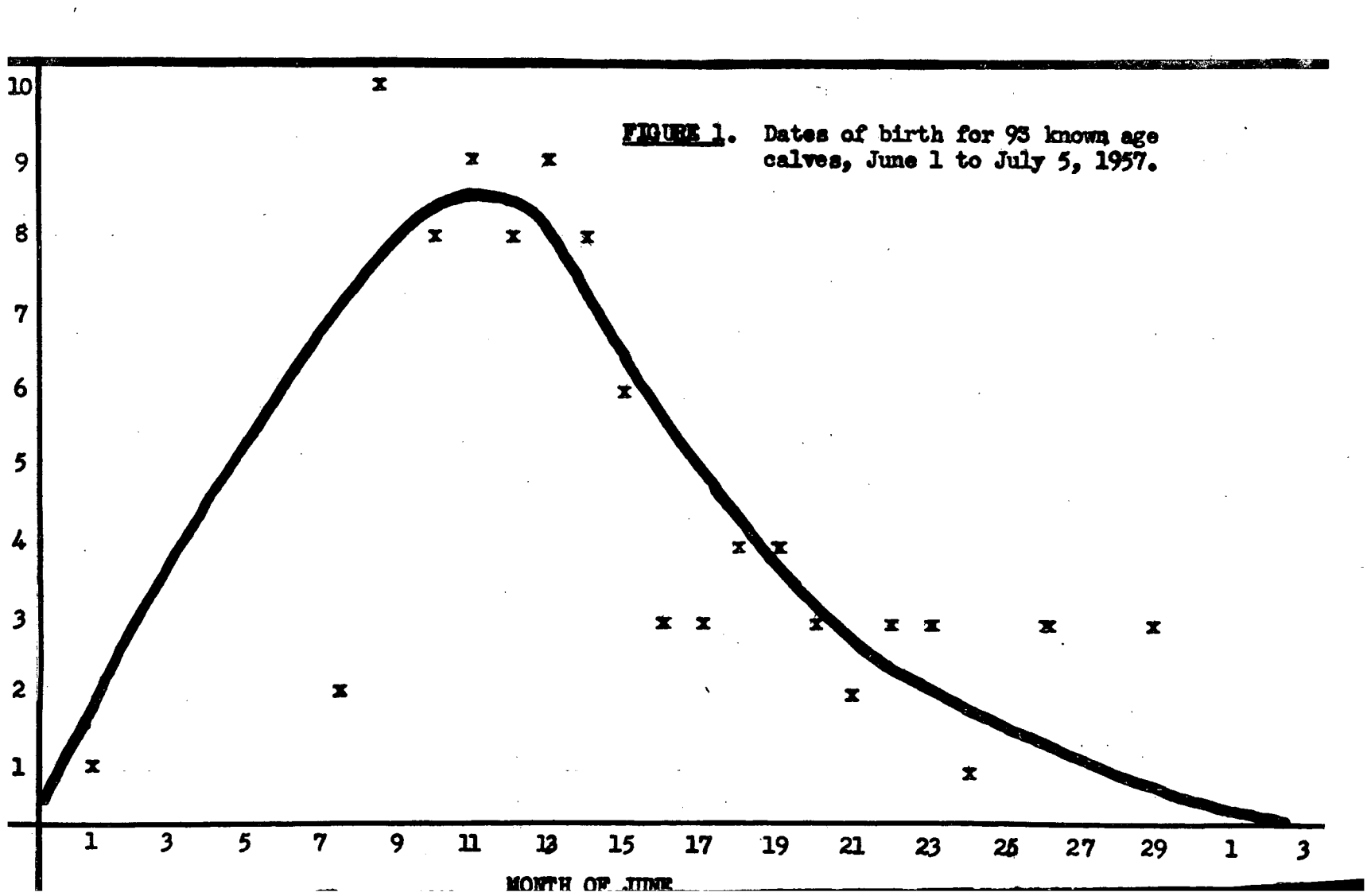


FIGURE 1. Dates of birth for 93 known age calves, June 1 to July 5, 1957.

MAP No. 2

Calving Grounds and Caribou
Movements June 13 - July 18

Direction of Movement ——→
Calving area - - - - - -

July 18
Easternmost
penetration

July 18

July 18

July 18

July 15 to 17

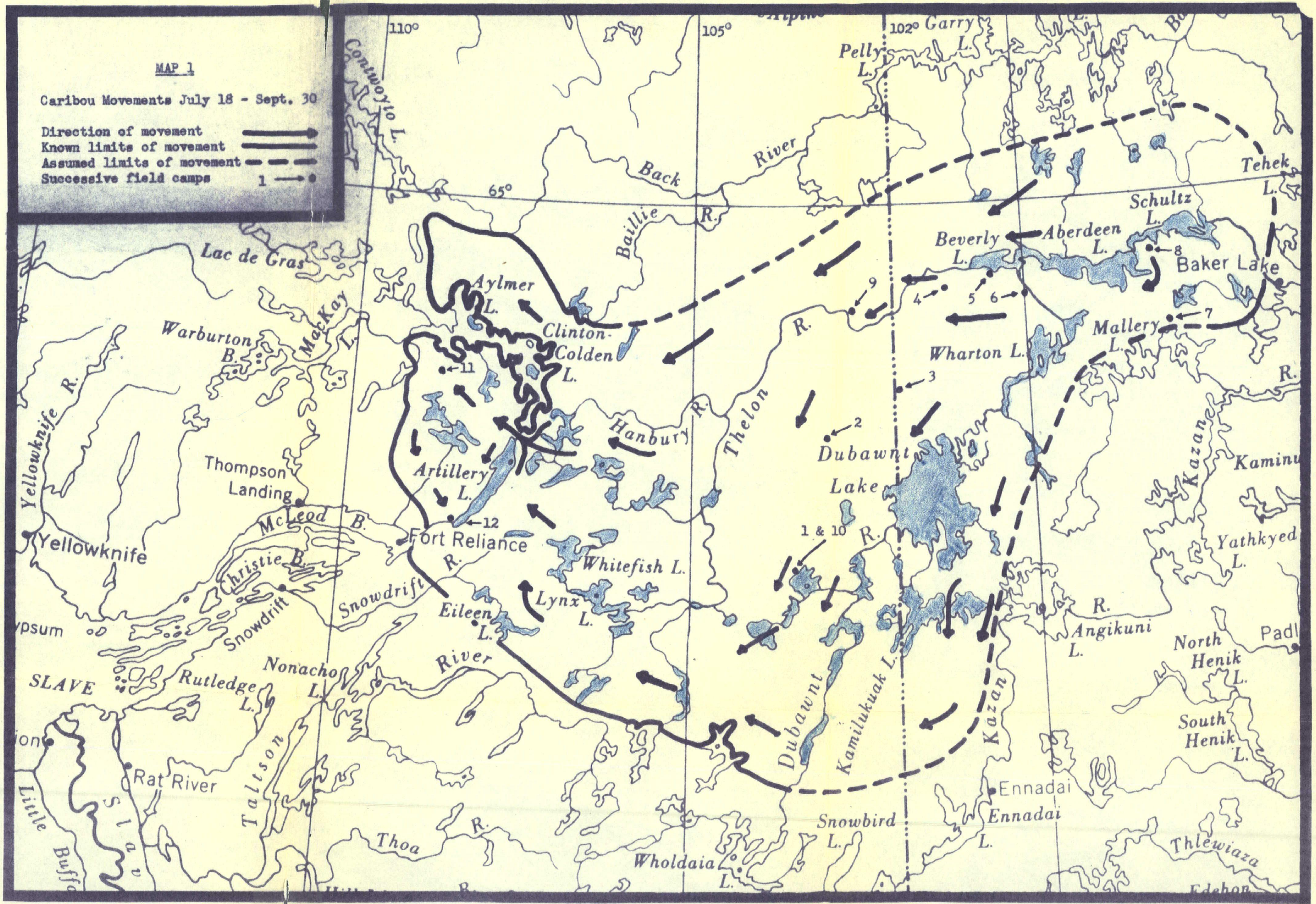
July 18

Crossings
July
12 to 17

Mid July
Late June
Mostly bulls ?

Bulls
July 11

June
13



MAP 1
Caribou Movements July 18 - Sept. 30
Direction of movement
Known limits of movement
Assumed limits of movement
Successive field camps
110°
105°
102°
65°
Contwoyto L.
Back River
Baillie R.
Pelly L.
Garry L.
Tehek L.
Schultz L.
Beverly L.
Aberdeen L.
Baker Lake
Mallery L.
Wharton L.
Lac de Gras
Aylmer L.
Clinton-Colden L.
Warburton B.
MacKay L.
Yellowknife R.
Yellowknife
Thompson Landing
McLeod B.
Fort Reliance
Christie B.
Snowdrift
Snowdrift R.
Artillery L.
Hanbury R.
Thelon R.
Dubawnt Lake
Whitefish L.
Lynx L.
Eileen L.
Nonacho L.
Rutledge L.
SLAVE
Taltson
River
Rat River
Thoa R.
Dubawnt R.
Kamilukuak L.
Kazan R.
Angikuni L.
Yathkyed L.
North Henik L.
South Henik L.
Ennadai
Ennadai L.
Snowbird L.
Wholdaia L.
Thlewiaza
Kaminu
Padl
1 & 10
2
3
4
5
6
7
8
9
11
12

Kelsall, John P.
Barren-ground caribou research program, July 1 to, ...

TITLE

DATE LOANED	BORROWER'S NAME
May 15/09	Frank Miller 12F