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INTERIM FINAL REPORT

June, 1960

CARIBOU INVESTIGATIONS, NORTHWEST ALASKA

by Peter Lent

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College, Alaska

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Winter Range and Study Area

As a result of the aerial survey made in December, the northern boundary of the caribou winter range was clearly recognizable. This boundary followed roughly the Kukpuk River and extended east along the divide between the Noatak River drainage system and the rivers flowing north into the Arctic Ocean. Since December, this boundary has fluctuated appreciably only in the Kukpuk River area. No major movement of caribou has occurred south of the Selawik River this year; thus a convenient boundary was available on the south. The eastern limits are less clear-cut. It is known that scattered caribou may be seen in the winter at almost any point on the south side of the Brooks Range from the coast to the Canadian border. The extremely rugged mountains of the Schwatka and Endicott Ranges at the heads of the Kobuk and Noatak rivers, however, appear to prevent appreciable East-West mixing. Thus, the caribou which normally move south in October through the Anaktuvuk Pass region (Rausch, 1951) winter apart from those which move south through the coastal region. In years when the southern movement is extended, there may be mixing through the open expanses of the valleys of the Hog and Alatna rivers.

On the basis of Fish and Wildlife Service Reports (1953, 1957) and personal conversations with residents of Point Lay, Kotzebue, and Kivalina, I found that there is usually a large, isolated group of caribou that winters along the coast between the Kukpowruk and Utukok rivers. The location of this group seemed to warrant its inclusion in the present study. Thus the total area under examination is that...
which is drained by rivers flowing north and west between Icy Cape and Selawik. There is no evidence that the groups of caribou present in this locality one year are the same animals which will be present in following years. The separation of the arctic herds appears to break down during the fawning season. This will be discussed further later.

Aerial Technique

During the period of most intensive flying in late January and early February slightly over 10 per cent of the entire study area was put under actual observation. This per cent compares favorably with other comparable big game censuses in the North. Within the known winter range, as plotted on Caribou Map 1, about 20 per cent of the area was observed. In regions where heavy concentrations were found the coverage ranged from 50 to 100 per cent. Frequently it was possible to plan flight patterns on the basis of tracks seen on previous flights and from reports received from other fliers. In general, the flying has not been random. For several reasons a grid system of flight lines was found to be impractical: (1) Pilots are not familiar with much of the study area and the maps often prove inadequate for following exact flight routes; (2) when only a single observer is used, the pilot must also be utilized to spot caribou and is not able to devote time to detailed map work; and (3) the area under study is too large to permit the flying of a concentrated grid pattern by one observer without introducing error from caribou movement during the period of observation.

The above problems are all intensified and many new problems arise when the rugged mountainous areas are considered. Unpredictable
localized turbulence often causes a complete change in flight plan to another area. Good flying conditions occur so infrequently in some locales that these areas must be visited whenever conditions permit. It is impossible in the mountains to maintain a uniform altitude above the ground. Nor is it possible to keep a constant transect width under observation. Often the observer is faced with a valley perhaps 2,000 feet below the plane on one side and a mountain reaching up to the level of the plane on the other.

On selected flights, careful, detailed mapping was carried out to determine the average maximum distance from the plane at which caribou could be reliably spotted. On the basis of this experimentation, I found that an average transect width of one mile could be covered. In certain non-mountainous areas with uninterrupted snow cover and no high vegetation, a flight strip one and one-half miles wide could be covered by flying about 1,000 feet over the surface. At this altitude, caribou are not usually disturbed by the plane and it is possible to double back to recount or continue counts, if necessary. Random flights were made in non-mountainous areas, once the boundaries of caribou distribution had been determined.

A total of 169 hours of flying time in small aircraft have been devoted to the caribou investigation as of May 1.

Caribou Distribution

The poor conditions for flying which existed in December, as described in the January Progress Report, did not permit me to see any appreciable portion of the total caribou population. An accurate estimate of the caribou population was not obtained until the first week of February. This period was one of exceptionally good weather,
permitting continual flying under relatively calm, sunlit conditions. In most areas the snow cover was continuous enough to provide a good background for spotting caribou. The most important exception to this was the area between the Wulik and Kukpuk rivers where the tussock tops were blown bare of snow and appeared brown. This gave the landscape a speckled appearance from the air, making accurate counting extremely difficult. In general, there appears to be some positive correlation between this "speckled" landscape and high numbers of caribou.

During the period January 28 to February 10, forty-seven hours were flown, and 1,800 miles of low-level observation flying were accomplished (Caribou Map 2). A population of about 70,000 caribou has been calculated on the basis of this flying. The limits of this group are shown on Caribou Map 1.

Within the above limits there is great variation in the density of caribou numbers. Caribou Map 1 shows the major concentrations as well as average densities for each area within the winter range. These data are also presented in Table 1.

The majority of the caribou under study wintered in the Brooks Range Province and the Southern Section of the Arctic Foothills Physiographic Province (Payne, et. al., 1951). The Brooks Range consists of "several rugged, structurally complex ranges" (Britton, 1957) two of which are the Schwatka and Endicott Ranges. The central part of the Baird and DeLong Mountain Ranges forms the western end of the Brooks Range Province. (See below for caribou distribution in this Province.)

Britton (1957) describes the Southern Section of the Arctic Foothills Province as follows:
This section is characterized by great irregularity of topography and by complex structure including folds overturned to the north and reverse faults upthrust on the south. Isolated hills and ridges of Early Cretaceous, Triassic, and Mississippian rocks of sandstone, conglomerate, limestone and chert are common features. Great thicknesses of Triassic, Jurassic, and Early Cretaceous shales underlie the more resistant rocks. The land has been above sea since Early Cretaceous time and was not glaciated during the Pleistocene. Many hills throughout the area exceed 3,000 feet.

Most of the caribou in this Southern Section occurred along the coastal fringe and were very rare in the remainder of the Section.

Describing the Northern Section of the Arctic Foothills, Britton notes that "the topography is characterized by great regularity of ridges, mesas, and hills whose tops are approximately accordant in elevation." This unusual topography is evident even to the casual aerial observer. Such landmarks as Meat and Poko mountains typify the above description. Wintering caribou are not found in large numbers until one leaves the Northern Foothills Section and enters the Coastal Plains Province to the north. Here large numbers have been wintering in the vicinity of Point Lay and between Umiat and Point Barrow. Based on what little information is available at present, the Northern Foothills Section apparently coincides closely with the caribou calving area. The significance of this correlation between physiographic regions and caribou distribution is not clear at present, but the problem deserves further attention.

During February the largest numbers of caribou were found in the Baird Mountains, with a particularly large concentration (12,000) in the valleys of Cross Creek and Timber Creek and the adjacent tributaries of the Squirrel River, but not in the valley of the Squirrel River itself.
Throughout February, concentrations of feeding caribou were noted at one particular level in almost all the valleys running south into the main valley of the Kobuk. This level was easily recognizable by the altitudinal change in vegetation. About three-quarters of the caribou in these valleys were concentrated immediately above the level where the tall willow shrubs end and are replaced rapidly by a much lower shrub form. This area is described by Spetzman (1951):

Following the tall shrubs in the foothills, or the pioneers on the coastal plains comes a stage dominated by low shrubs—small willows, heaths and a few others.

He goes on to say that this area is characterized by an "...accumulation of organic debris, abundant growth of mosses, and reduction of summer thaw." Unfortunately Spetzman's paper neglects non-vascular plants and he made no mention of lichen cover in this area.

Hanson (1951) described a stand on the upper Kobuk River much more completely, calling it a tussock-heath community.

A stand near the Dahl Creek air strip, between Shungnak and Kobuk on the Kobuk River, ...low shrubs, 12 to 18 inches high, including Vaccinium uliginosum with numerous ripe berries (August), Ledum decumbens, Betula exilis were scattered over the gently sloping outwash plain below the mouth of the canyon. Vaccinium vitis-idea and small white spruce saplings were scattered. Lichens formed a dense growth over the ground, usually to a height of one to two inches, but under shrubs they were often three to four inches high. ...primarily Cladonia, Cetraria spp., Stereocaulon sp. and Lobaria varrucosa.

This stand may be typical of the areas where concentrations of caribou were observed. The group of 750 near Shungnak (Map 1) was definitely in an area similar to that described by Hanson. Thus, lichens appear to be of importance as winter food here. The highest

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>AVERAGE DENSITY (per square mile)</th>
<th>NUMBER OF CARIBOU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mulgrave Hills, lower Kivalina and Wulik rivers, DeLong Mtns.</td>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>Coastal hills, Ogotoruk Creek to Singoalik River</td>
<td>10</td>
<td>2,500</td>
</tr>
<tr>
<td>Singoalik River to head of Kukpuk River</td>
<td>25</td>
<td>8,800</td>
</tr>
<tr>
<td>Upper Kivalina River to upper Wulik River</td>
<td>10</td>
<td>3,000</td>
</tr>
<tr>
<td>Kelly River</td>
<td>--</td>
<td>9,300</td>
</tr>
<tr>
<td>Head of Kelly River to head of Kugururok River</td>
<td>--</td>
<td>4,100</td>
</tr>
<tr>
<td>Trail Creek to Nimiuktuk River</td>
<td>5</td>
<td>1,100</td>
</tr>
<tr>
<td>Valley of upper Noatak</td>
<td>3</td>
<td>2,500</td>
</tr>
<tr>
<td>Western Baird Mountains</td>
<td>4</td>
<td>2,900</td>
</tr>
<tr>
<td>Central Baird Mountains</td>
<td>10</td>
<td>14,000</td>
</tr>
<tr>
<td>Western Baird Mountains &amp; north side of upper Kobuk</td>
<td>5</td>
<td>8,000</td>
</tr>
<tr>
<td>Timber and Cross creeks</td>
<td>--</td>
<td>12,000</td>
</tr>
<tr>
<td>Shungnak River</td>
<td>--</td>
<td>750</td>
</tr>
<tr>
<td>Waring Mountains</td>
<td>2</td>
<td>2,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72,150</td>
</tr>
</tbody>
</table>
lichen growth may occur at a point at which the dwarf shrubs are tallest, as suggested by Hanson.

No quantitative information is available concerning winter food habits of the caribou in the study area. There are indications that lichens play an unimportant role in the winter diet of many of these animals. For example, an early reindeer grazing investigation (Palmer, 1927) states that lichens compose only 5 per cent of the vegetation in the vicinity of Kivalina.

A clarification of caribou food habits and their seasonal modifications is sorely needed. Gorham (1959) has observed that lichens in England picked up radioactive fall-out more than did angiosperms, showing counts per minute on the order of three times those of angiosperms collected in the same region. Hvinden (1958) noted that bones of Norwegian reindeer (*Rangifer tarandus*) contained up to four times the Strontium-90 that sheep bones did.

The remaining one-quarter of the caribou population in the southern part of the Baird Mountains usually appeared to be in movement, either along the streams in the valley bottoms or on top of the hills between the valleys. In the center of the Baird Mountain Range, away from the main drainage streams, caribou were found feeding primarily on the hilltops. Signs of feeding were frequently seen at elevations above 3,000 feet, and moving groups were seen at all elevations including the most rugged peaks and "knife-ridges."

Feeding activity in the mountains, then, was centered in two vegetation types: The Niggerhead Meadow (*Eriophorum vaginatum* and associated species), and Upland Dry Meadow. These type names are those utilized by Spetzman (1951). The Niggerhead Meadow is comparable to the
Eriophorum tussock type of Johnson, et al. (1959). Spetzman states that this Niggerhead Meadow is the most common vegetation of the foothills, but is uncommon above 3,000 feet. The Upland Dry Meadow is comparable to the Dryas fellfield type of the Ogotoruk Valley (Johnson et al. 1959), but my observations indicate that Carex spp. may be a more common member of this community in the Baird Mountains.

During March, a much larger percentage of the caribou were utilizing the Niggerhead Meadows and Upland Dry Meadow with fewer proportionately in the tussock-heath community.

Outside of the Baird Mountains, the largest winter concentrations have been within 50 miles of the coast, between the Wulik River and the Kukpuk River. The vegetation of this area is primarily Niggerhead Meadow with some Bog Meadows (Wet Carex Meadows = Eriophorum -Carex wet meadow type of Johnson, et al.). Dry Upland Meadows (Dryas fellfield) are found on the hilltops, particularly in the more rolling country closer to the coast.

In December, but less frequently later, groups of caribou were seen feeding on the edges of lakes between the Kivalina and Wulik rivers. They were apparently utilizing the emergent vegetation (Carex aquatilis and Eriophorum angustifolium) and the associated mosses along the shoreline. On several occasions I noted signs of digging and licking in the frozen mud.

The meandering stream beds with tall willow and cottonwood cover are neglected by the caribou, except for occasional movements through them. These movements are hindered by deep, soft snow cover.

During a two week period spent camped on the Kivalina River (Elaypuk) in February, I noted that very large, open expanses of tussocks were continually avoided in favor of small areas broken up by
streams and surface irregularities. This tendency on the part of the caribou may aid the hunter by permitting easier approach.

Small numbers of caribou wintered in the valleys of the Noatak and Kobuk rivers, with a higher density on the Kobuk, and almost none on the lower part of the Noatak (Caribou Map 1). These valleys are forested, primarily with spruce (*Picea glauca*). Cottonwoods are common on the Noatak, having been noted even on its upper reaches and north, well up the Nimiuktuk River. Large areas in the Kobuk Valley are composed primarily of cottonwoods and birches, as a result of past burns. These old burns support a large moose population, but they also had caribou sparsely scattered through them, particularly in the first half of the winter.

Apparently, not even the most cursory of botanical studies has been made on the spruce communities of the Noatak and Kobuk valleys. Therefore no evaluation of these areas as range is possible at present.

The spruce cover in the Noatak valley is quite sparse. This permits wind action to influence the qualities of the snow cover appreciably even in the center of wooded areas. Thus, the snow cover combines excessive depth (the snow being dropped by slight decrease in wind velocity) with a wind slab of considerable strength (see snow station No. 6).

Throughout the winter caribou densities have been greater in the upper parts of the Noatak and Kobuk than in the lower parts, as shown in Table 1. Not until early March did large numbers of caribou begin to move into the lower Noatak from the south (see Winter Movements). However, a group of about 200 spent the entire winter around the mouth of the Kelly River, and the individuals, mostly mature males,
were frequently seen moving in the sparse spruce cover. This group provided some hunting for the residents of Noatak, particularly after caribou vacated the Wulik River area.

Small, compact groups, numbering 25 to 100, have been scattered through the drainage of the upper Noatak all winter. This area is beyond the limit of appreciable spruce cover and is also little affected by the strong winds of the coast and mountains. The widely separated bands of caribou were seen feeding and moving in soft powdery snow which in some places exceeded two feet in depth. The uneven distribution of caribou in this locality and the long travel time from Kotzebue hindered a count with accuracy equal to that of other sections.

I spent five days in DeLong Pass while caribou were moving through in late April. During one snowy, overcast day all movement stopped and several hundred animals fed in the vicinity of the camp. This feeding took place almost entirely in Dryas types as described by Johnson et al. (1959), in particular, Dryas steps. Great effort was often made by caribou to gain access to the vegetation at the foot of the steps. On most steps the snow cover did not exceed four inches in thickness, and the hard packed snow of such thickness was easily broken into small slabs, leaving a cleanly exposed surface. However, in some spots caribou dug through hard packed snow up to 18 inches deep, leaving a large pile of snow chunks and only one or two square feet of surface exposed. Trenches up to four feet long were dug in the shallow snow along some steps. Several patches of Dryas type areas up to 100 square feet had almost 100 per cent of the snow crust broken up and a few slopes had areas of several thousand square feet in which half or more of the snow cover was disrupted. The disruption
of snow crust by caribou action greatly accelerates the rate of melting or sublimation. Small areas on exposed slopes were entirely bare within two days after the feeding activity. Some craters were dug in wetter types where grasses and sedges and low shrubs predominated.

It is evident from the observations made this winter that there is, in reality, no such thing as a winter range for the caribou under study. Instead, there is a general area in which the caribou are presented with a complex pattern of topographic, vegetative, and nival types, and a multitude of combinations of these various types. These combinations are in a state of constant change due to the normal progression of the season, variations in local weather conditions and effects of the caribou themselves. The majority of the caribou respond to the stimuli of these changing conditions to produce the corresponding changes in concentrations noted through the winter. A few ideas concerning the nature of these stimuli have been developed and some suggestions have been made in this paper but these are largely conjectural. More definite information will result only from considerably more observation and experimentation. It is probable that a successful winter range must possess enough variation in topographic and vegetation types to compensate for the normal range of climatic changes which occur in its locality. The caribou must be able to find a favorable combination of factors at any time of the season. The variation need not necessarily be great enough to be evident to the casual observer. Thus, any attempt to designate a given area as good caribou range on the basis of a single vegetation type may result in misleading oversimplification.
Winter Movements

Two important group movements during January may be recognized by comparing the results of the December and February flying. The caribou (2,500) in the vicinity of Misheguk Mountain were gone by the end of January. This may be the same group centered between the heads of the Kelly and Kugururok in February. Secondly, the dense concentration in February on the Upper Squirrel tributaries and Cross Creek resulted from movements down from the mountains to the north during January.

The principal movements during February and the first three weeks of March are shown on Caribou Map 3. This map shows the size and limits of the largest concentrations resulting from these movements. Caribou Map 4 shows flight lines during early March.

The movement of large numbers of caribou into the country between the Kukpuk and Kivalina rivers began in early February and was essentially completed by the first of March. By this time no caribou were left in the area between the Kivalina and Wulik. Almost all the animals previously in the Kelly River drainage moved west towards the Kukpuk and were replaced by others moving in from the mountains to the east and north.

According to the observation records of Point Hope hunters supplied by Mr. D. C. Foote, the caribou along the Kukpuk in the vicinity of Suklowlik Mountain were predominantly males. This group (approximately 5,000 in the first week of March) must have been composed primarily of animals formerly in the DeLong Mountains to the east rather than those which moved up from the south. Those previously in the Mount Jarvis area were predominantly females with young, and they moved into the area south of the Kukpuk and west to Cape Seppings.
Although no separation between the two groups in the Kukpuk River area was visible from the air, there was apparently little mixing.

No aerial work was possible from February 25 to March 2 because of continual bad weather. During this time, in the vicinity of Kotzebue, there was a steady wind from the south and daily temperatures well above zero. At the same time a general northward movement of caribou began.

By March 3 almost all the caribou had left the valleys of the Squirrel River and moved into the hills along either side of the divide between the Noatak and Kobuk drainages. The most northerly part of this group moved out into the valley on the south side of the Noatak. On March 5, 1,500 animals were feeding along a three mile front in the valley west of the Kelly River, and a few individuals had crossed over to the north side of the valley.

The northward movement out of the tributaries of the upper Kobuk was slower and easier to trace. The routes were marked by signs of intensive feeding on the hillsides. By March 7 caribou had left the lower parts of all the north-south tributaries and were concentrated mainly between the upper Salmon River and Bear Creek. Tracks indicated that this concentration included a large number of animals which had formerly been in the hills at the head of Trail and Cross creeks.

By mid-April the majority of caribou had crossed the valley of the Noatak. Only approximately 5,000 remained in the Baird Mountains, particularly south and southwest of Bear Creek. Although no flying was done in early April, tracks and reports from pilots showed that several thousand crossed the valley at each of two points: the mouth of the Kelly and the mouth of the Kugururok. Most of these animals moved northwest into the mountains where they dispersed widely, but
others continued in a more northerly course towards the heads of the Kelly and Kugururok rivers. This movement was also along the hills and ridgetops rather than in the valleys. Snow cover had melted off most of these low hilltops and made accurate counting impossible. The caribou coming up northwest from the Kelly headed towards the upper Wulik and then north through DeLong Pass. During the last two weeks of April about 10,000 moved through the pass and at least several hundred moved through the mountains on either side. Once through the high mountains, most of these again veered somewhat to the west towards the upper Kukpuk River and Mt. Kelly.

On April 19 a flight to Point Lay revealed scattered small groups, less than 100 in each, in the Northern Section of the foothills for the first time. These groups were seen most commonly on top or on the south sides of the east-west ridges. The flight followed roughly the course of the Kukpowruk River and about 600 animals were seen on the passage through the foothills. Another 750 were on the Coastal Plain along the Kukpowruk and Kokolik rivers. The number which wintered on the plain in the vicinity of Point Lay probably did not exceed 2,000. These animals began moving towards the hills about the first of April. On the return from Point Lay about 1,000 caribou were observed moving north on to the upper Kokolik from the mountains north of the Kelly.

Two flights were made in April to the upper Noatak and Schwatka mountains. Very few caribou were seen and there was no indication that any important northern movement had taken place this far inland, or that any would. No animals and very few tracks were seen in the vicinity of Howard Pass.
Caribou Movements in Recent Years

At the time this report was written, the caribou had been followed through about one-third of their annual cycle. However, neither of the important movements to and from the calving grounds nor the activity in the calving grounds have been followed in their entirety. Information, therefore, concerning caribou movements in recent years, has been gathered from several sources to see how typical this winter's observations have been and to predict what movements might be expected in the future.

Certainly no comparable sized group of large ungulates in North America has been as neglected by biologists as the caribou of Arctic Alaska. Much of the meager information available has been compiled in the "Job Completion Reports" of the Federal Wildlife Restoration Program (U.S. Fish and Wildlife Service, 1953, 1956-59), the earlier ones by Robert F. Scott, later by Sigurd T. Olson. Besides being based on the observations of Fish and Wildlife Service biologists, these reports include much information gathered from reliable, but untrained, temporary and permanent residents of Northern Alaska, and the results often of brief, chance observations. Therefore, the numerical values stated in them must certainly be of widely varying degrees of accuracy. In spite of this, the reports are a valuable contribution, and their weaknesses seem to be adequately recognized by their authors. Most of the following data have been summarized from these reports. In most cases I have deleted the names of individual observers.

Olson (1959) estimated the present caribou population of Arctic Alaska at 230,000, and there is no reason to doubt that the population is over 200,000. However, a more recent estimate (1960) by the Alaska Department of Fish and Game of 300,000 seems rather unsubstantiated.
In the winter of 1955-56 caribou ranged far south of what is normally accepted as being their winter range, and 20,000 were spread out between the Buckland and Huslia rivers. One observer stated that 200,000 animals crossed the Kobuk River in 1955. The northward movement of these animals began in mid-April and by the end of May all the caribou had moved north of the Brooks Range. Some local residents feel that the southern extension of the range occurs regularly, every four or five years. A similar movement is reported to have occurred in the winter of 1950-51.

The winter of 1957 represents the other extreme. No caribou were reported south of the Brooks Range. Animals were present in early winter along the coast between Point Hope and Kivalina and small groups were scattered throughout the drainage of the upper Noatak and Kivalina rivers.

Several thousand caribou were located north of Shungnak in January, 1959. Many thousands were also scattered between Kivalina and Cape Sabine at this time. From November of 1958 on, caribou were spread out through the Baird Mountains. Three thousand were on the Ambler and Shungnak rivers and 1,000 on the Salmon. In March, 1959, 5,000 were seen at the head of Hog River and 2,000 on the upper Kobuk west of the Selawik River.

The late winter concentrations along the Kukpuk between Angmakroq and Suklowlik mountains are a usual occurrence, according to statements by Point Hope hunters. On the other hand, concentrations on the upper Ipewik and in the vicinity of Kelly Mountain, which many natives of Kivalina and Point Hope seem to expect, have not occurred this winter. The continual wintertime presence of caribou in and near the Ogotoruk Valley is accepted as normal by everyone familiar with the area.
No information is available in the Fish and Wildlife Service reports concerning spring movements along the coast. Most natives and residents seem to feel that the caribou usually move north farther inland than has been observed by me to date (May 1). At the time of writing, however, an unconfirmed report has been received of several thousand caribou moving north through the mountains east of Kobuk. These caribou may be the same ones which reportedly moved south past Kobuk early in the winter but which were never contacted during the aerial work this winter. There may be some movement through Survey Pass, which has been beyond the range of this winter's work.

Available information indicates that the calving grounds are located in the hills of the upper Colville drainage, extending west to the upper Kokolik River. In 1959 caribou were moving into this area in large numbers in late May and early June. Olson and Miner counted 67,698 adult caribou, mostly cows with calves, and estimated a 100,000 minimum for the area. Caribou may be expected to converge on the calving grounds from every direction. Animals which winter to the north, east, and southeast have all been reported moving towards the calving area at various occasions (see also Rausch, 1951). The degree of mixing which occurs among these caribou which winter in different parts of the Arctic is entirely unknown.

In mid-July, 1959, Ray Woolford, Supervisor of Enforcement, Bureau of Sport Fisheries and Wildlife, estimated 120,000 caribou in the area bounded by the Nigu River and the Killik River between 68° and 68°30' N. Lat. The largest numbers were along the Killik itself. The caribou were in compact groups on high, exposed hilltops. Woolford and other observers noted a high percentage of young animals. Presumably, most or all of these caribou wintered between Anaktuvuk Pass and Bettles.
In the summer of 1957, several small herds were seen moving south in the vicinity of Cape Sabine. Approximately 20,000 were seen moving west behind Cape Lisburne in July. On June 22 and 23 of 1958, 108,000 are said to have been moving inland from Cape Sabine. In mid-July of that year an estimated 60,000, probably the same group, moved east through the DeLong Mountains towards Feniak Lake. These spent the summer on the upper Noatak before moving south into the Kobuk drainage.

Descriptions of late summer movements along the coast are confused and conflicting. Ordinarily, it appears, a large number of cows and calves enter the country between the Ipewik and the Kukpuk immediately after calving in June. Small groups of bulls spend the summer in the hills nearer the coast between Cape Lisburne and Cape Thompson.

Caribou are usually present inland from Cape Thompson and south to the Kivalina River from late September to November, including the period of the rut. Scott, in 1953, noted caribou movements in late September and October on the Kivalina coastal plain towards the Noatak Valley just west of the mouth of Kelly River. Foote (1959) described a counter-clockwise movement in the fall of 1958 and a similar movement in 1959. In both 1958 and 1959 caribou were present between the Ipewik and Kukpuk rivers and the coast during the time of the rut and eventually moved south behind Cape Thompson towards Kivalina.

**Caribou in the Ogotoruk Valley**

The Ogotoruk Valley is one of the few areas in Northwestern Alaska which are traditionally considered to invariably harbor caribou throughout the winter. Observations made this winter confirm this idea. Caribou in the Ogotoruk region tend to concentrate on the east
<table>
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<tr>
<th>Date</th>
<th>Observer</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 21</td>
<td>Point Hope hunter</td>
<td>One caribou taken</td>
</tr>
<tr>
<td>Dec. 27</td>
<td>Lent</td>
<td>75 scattered through Ogotoruk drainage to within three miles of coast</td>
</tr>
<tr>
<td>Jan. 11 &amp; 12</td>
<td>Harry Spencer &amp; Wien Pilot</td>
<td>In hills behind airstrip, 30 in hills to east</td>
</tr>
<tr>
<td>Feb. 4</td>
<td>Point Hope hunters</td>
<td>30 seen, 8 taken</td>
</tr>
<tr>
<td>Feb. 6</td>
<td>Point Hope hunters</td>
<td>26 caribou taken</td>
</tr>
<tr>
<td>Feb. 8</td>
<td>Lent</td>
<td>12 seen, poor observation conditions</td>
</tr>
<tr>
<td>Feb. 14</td>
<td>Pruitt</td>
<td>6 caribou on hillside 2 miles east of Ogotoruk camp. One male collected for specimen.</td>
</tr>
<tr>
<td>Feb. 16</td>
<td>Point Hope hunters</td>
<td>16 taken</td>
</tr>
<tr>
<td>Feb. 18</td>
<td>Spencer</td>
<td>36 above airstrip</td>
</tr>
<tr>
<td>Feb. 23</td>
<td>Kivalina hunters</td>
<td>3 taken, near airstrip</td>
</tr>
<tr>
<td>Mar. 2</td>
<td>Spencer</td>
<td>2 in draw 2 miles down coast</td>
</tr>
<tr>
<td>Mar. 3</td>
<td>Spencer</td>
<td>3 at same location</td>
</tr>
<tr>
<td>Mar. 6</td>
<td>Lent</td>
<td>31 in valley, 1 group of 10 entirely males, others included cows and young, 100 in hills to east of valley</td>
</tr>
<tr>
<td>Mar. 7</td>
<td>Spencer</td>
<td>30 in hills behind airstrip</td>
</tr>
<tr>
<td>Mar. 16</td>
<td>Lent</td>
<td>325 in upper basin of valley and along eastern rim.</td>
</tr>
<tr>
<td>Mar. 24</td>
<td>Amos Lane</td>
<td>7 caribou taken, 400 seen between Ogotoruk and Kissimilouk.</td>
</tr>
<tr>
<td>Mar. 24</td>
<td>Spencer</td>
<td>Tracks showed large number crossed creek towards west.</td>
</tr>
<tr>
<td>Mar. 26</td>
<td>Spencer</td>
<td>40 seen on snow-free south facing slope</td>
</tr>
<tr>
<td>Date</td>
<td>Location</td>
<td>Observations</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mar. 28</td>
<td>Amos Lane</td>
<td>6 taken (1 female, 1 young, 4 male)</td>
</tr>
<tr>
<td>Mar. 30</td>
<td>Amos Lane</td>
<td>3 taken</td>
</tr>
<tr>
<td>Mar. 30</td>
<td>Point Hope hunters</td>
<td>22 seen, 6 taken</td>
</tr>
<tr>
<td>Mar. 31</td>
<td>Point Hope hunters</td>
<td>27 seen, 4 taken</td>
</tr>
<tr>
<td>Mar. 31</td>
<td>Johnson &amp; Viereck</td>
<td>Approx. 100 in upper basin</td>
</tr>
<tr>
<td>Apr. 16</td>
<td>Pruitt</td>
<td>1 caribou on ridge northeast of OTK-34. Tracks on OTK-35. (near Big Bond of the Ogotoruk)</td>
</tr>
<tr>
<td>Apr. 17</td>
<td>Lent</td>
<td>30 in upper basin, observation conditions poor</td>
</tr>
<tr>
<td>Apr. 17</td>
<td>Pruitt</td>
<td>Feeding activity on plot near Big. Bend</td>
</tr>
<tr>
<td>Apr. 19</td>
<td>Pruitt</td>
<td>7 caribou 2 mi. northeast mouth of Ogotoruk Creek</td>
</tr>
<tr>
<td>Apr. 20</td>
<td>Pruitt</td>
<td>Many caribou in upland between Kissimilouk and upper basin of the Ogotoruk</td>
</tr>
<tr>
<td>Apr. 21</td>
<td>Pruitt</td>
<td>7 males on height of land between Ogotoruk and Kukpuk</td>
</tr>
<tr>
<td>Apr. 26</td>
<td>Pruitt</td>
<td>1½ male on Slate Mountain, Ogotoruk Valley. ½ collected as specimens</td>
</tr>
</tbody>
</table>
slope of the valley and on the hills to the east. They are more common in the upper part of the valley than in the lower.

During the early part of the winter the small groups of caribou in the valley appeared singularly isolated. No other caribou, except for a small number usually found in the vicinity of Angmakroq Mountain, were seen for fifty miles in any direction. Throughout the latter part of the winter the caribou in the valley were continuous with large concentrations to the east and north.

Table 2 presents a list of caribou observations during the fall and winter of 1959-60 compiled from various sources. The information about Point Hope hunters was extracted from data furnished by Mr. Don C. Foote.

**Population Dynamics**

It has not been possible during the winter months to obtain any accurate picture of the age and sex composition of the caribou population under study. There has been considerable segregation of the sexes into separate groups throughout the range. Males have tended to be predominantly in the northwest corner of the range, in the more inland sections, and in the most rugged areas. However, mixed groups have been common, and in all areas at least small groups of males were seen.

Accurate ground observations, made at several places during the winter, totalling about 300 female animals indicate that approximately 25 per cent of the female population was accompanied by young of the year in late winter. This count does not include groups known to have been subjected to heavy hunting pressure. Some groups in the Mt. Jarvis area under intensive hunting pressure were composed of 50 per cent animals under two years of age.
Considerable efforts will be made during the calving season to measure the calf production, and during the rut to determine the sex composition of the population.

Several caribou specimens have been collected during the investigation. These caribou have been utilized to gain as much information as possible from each individual. Standard measurements from these individuals are presented in Table 3. Besides these measurements, other observations have been made and some or all of the following materials have been collected from each individual for future examination: skulls, full skins, stomach content samples, hoofs, portions of reproductive tracts, and parasites.

There was no indication of widespread malnutrition or any starvation in the population during the relatively mild winter of 1959-60. A few animals examined were in rather poor condition and completely lacking in back fat. Oscar Swan, a Kivalina hunter, noted that such animals always have watery marrow, too, and this was observed to be so. Watery marrow has been found to be a reliable indicator of malnutrition in white-tail deer studies, and may have some application in caribou research programs.

An eleven-month-old female collected on April 26 was extremely thin and generally appeared in poor condition. This animal had 300 warble fly larvae attached to it and 20 nose bot fly larvae. Records of such a high number of these parasites in a young animal are unusual.

Only about 24 wolves were observed in the course of the winter study. About an equal number are known to have been taken by airplane-equipped bounty hunters in the study area this winter. Wolf hunters commented on the poor hunting conditions because of the general lack of snow cover. This may have resulted in the survival of more wolves.
than usual in the area. During the winter two airplane crashes occurred involving wolf hunters. One of these resulted in serious injury. Certainly the small number of wolves on the winter range has a negligible effect on the caribou population. It is impossible for anyone to say at present whether the population is expanding beyond the capacity of the range to support it.

Human predation is a factor of the utmost importance in the biology of the caribou. The importance of the caribou in the native economy has been well documented in several works. However, the reciprocal man-caribou relationship has received inadequate attention. A mere estimate of total caribou killed and a description of hunting technique is not enough. It must be determined to what degree the behavior, movement and composition of caribou populations is influenced by human predation. Cultural changes, including changes in hunting techniques, values, seasonal activities, and the numbers and location of human populations have occurred. These have certainly caused radical changes in the time, place, and age and sex composition of the caribou take which should be studied, as well as the efficiency of energy transfer from caribou to man.

Detailed records of hunting activity are being kept at present at Kivalina, Point Hope and Noatak, and a program for data collection was recently started at Point Lay. During the coming year I plan to expand the collection of caribou hunting data to include Kiana, Noorvik, Selawik, Ambler, Shungnak, Kobuk, and Kotzebue.

The collection of caribou jaws will also be carried out in conjunction with the data collection programs. To date 84 jaws have been collected at Noatak, Kivalina and Point Hope. These jaws will be analyzed by at least two different aging techniques to determine
TABLE 3. Standard Measurements from Caribou Specimens

<table>
<thead>
<tr>
<th>Spec.</th>
<th>Sex</th>
<th>Date (1960)</th>
<th>Total Length</th>
<th>Height to Shoulder (mm.)*</th>
<th>Ear (mm.)</th>
<th>Tail (mm.)</th>
<th>Hind Foot (mm.)</th>
<th>Total Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>♀</td>
<td>Feb. 14</td>
<td>1727</td>
<td>---</td>
<td>102</td>
<td>140</td>
<td>521</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>♀(young)</td>
<td>&quot;</td>
<td>1333</td>
<td>648</td>
<td>76</td>
<td>102</td>
<td>432</td>
<td>100</td>
</tr>
<tr>
<td>3.</td>
<td>♀</td>
<td>&quot;</td>
<td>1453</td>
<td>1010</td>
<td>120</td>
<td>127</td>
<td>457</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>♀</td>
<td>Feb. 16</td>
<td>1429</td>
<td>998</td>
<td>127</td>
<td>127</td>
<td>470</td>
<td>175</td>
</tr>
<tr>
<td>5.</td>
<td>♂</td>
<td>Feb. 16</td>
<td>1626</td>
<td>1016</td>
<td>134</td>
<td>152</td>
<td>508</td>
<td>175</td>
</tr>
<tr>
<td>6.</td>
<td>♀</td>
<td>Feb. 17</td>
<td>1613</td>
<td>---</td>
<td>127</td>
<td>152</td>
<td>503</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>♂</td>
<td>Feb. 17</td>
<td>1702</td>
<td>1029</td>
<td>127</td>
<td>152</td>
<td>519</td>
<td>190</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>♀</td>
<td>Mar. 22</td>
<td>1707</td>
<td>---</td>
<td>131</td>
<td>107</td>
<td>533</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>♀(young)</td>
<td>Apr. 26</td>
<td>1310</td>
<td>600</td>
<td>110</td>
<td>115</td>
<td>445</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>♀</td>
<td>Apr. 26</td>
<td>1590</td>
<td>1025</td>
<td>125</td>
<td>140</td>
<td>525</td>
<td></td>
</tr>
<tr>
<td>wop 1250</td>
<td>♂</td>
<td>Feb. 14</td>
<td>1810</td>
<td>1000</td>
<td>120</td>
<td>135</td>
<td>545</td>
<td></td>
</tr>
<tr>
<td>wop 1251</td>
<td>♂</td>
<td>Apr. 26</td>
<td>1774</td>
<td>---</td>
<td>126</td>
<td>161</td>
<td>555</td>
<td></td>
</tr>
<tr>
<td>wop 1252</td>
<td>♂</td>
<td>Apr. 26</td>
<td>1777</td>
<td>---</td>
<td>114</td>
<td>158</td>
<td>555</td>
<td></td>
</tr>
<tr>
<td>wop 1253</td>
<td>♂</td>
<td>Apr. 26</td>
<td>1685</td>
<td>1100</td>
<td>125</td>
<td>155</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>wop 1254</td>
<td>♀</td>
<td>Apr. 26</td>
<td>1650</td>
<td>1120</td>
<td>120</td>
<td>145</td>
<td>520</td>
<td></td>
</tr>
</tbody>
</table>

* Measured to dorsal tip of scapula.
the age composition of the caribou kill and the influence of hunting mortality on the life table.

Considerable time is being devoted to observation of human-caribou behavioral relationships. In particular, flight stimuli and flight reaction are being investigated.

A more complete analysis of the history of caribou in Northwestern Alaska will be necessary for the interpretation of the above data. At present the manuscript submitted by Foote (1959) to the Atomic Energy Commission is the best concise source of information on this. Murie (1935) also presents much of value.

**Snow Study**

In the above discussion of winter distribution and movement mention has been made several times of the snow conditions prevailing at various locations in the study area. The importance of the snow cover in determining caribou feeding areas has been discussed briefly. A kit of Standard Snow Instruments has been developed by the National Research Council of Canada for the standardized measurement of the qualities of a snow cover.

These instruments were used by Pruitt (1959) during caribou studies in the taiga of Northern Canada. He demonstrated their usefulness in presenting caribou-snow relationships in terms of measurements which may be easily repeated by other observers. In addition, he pointed out several easily observed phenomena which are indicators of nival conditions. However, it is apparent that little of the results of the snow studies in the taiga may be directly applied to conditions in the mountains and tundra of Northwestern Alaska. In short, much more work remains to be done before any generally applicable principles will be available.
For example, in the Canadian taiga the presence of qali on tree branches appeared to indicate a suitable nival environment for caribou. In the Kobuk drainage this winter, however, caribou were usually conspicuously absent wherever qali was appreciable. On the main stream of the Squirrel River, where thick qali was observed, no caribou were present all winter; but on its tributaries, flowing in from the north, large caribou concentrations were noted. These tributaries presented a much more wind-blown appearance and had no qali.

A set of Standard Snow Instruments has been obtained on loan from the National Research Council of Canada to continue investigations of the type begun by Pruitt in Canada. Unfortunately, the instruments arrived very late in the winter and received only limited use in connection with the caribou investigations this winter. Data collected at seven stations are presented in Figures 1 through 7. To obtain a significant amount of data, a large number of measurements will be made during the winter of 1960-61. The problem of interpretation is complicated by the mountainous terrain and the general lack of large areas of uniform snow cover. The tendency for caribou, particularly cows and young, to concentrate in areas of "speckled" tundra, and the altitudinal distribution on hillsides will be investigated in detail.

During March of this winter, the effects of increased solar radiation began to be noticeable, particularly along the coast. The snow cover on exposed slopes, already packed hard by wind action, developed an even harder sun crust. In open areas, the surface supported full grown caribou, whose hoofs left only slight marks on the crust. Ranges of hills may provide pathways of thin, hard snow cover for rapid spring movement. River and stream valleys were definitely
avoided during early spring movements. The large-scale movement of caribou through many areas coincided approximately with the melt of snow off the hilltops.

It is clear that the direction and velocity of wind is of great importance in determining the qualities of the snow cover in a given area. Thus, wind exerts an indirect influence on caribou movement. It has proven difficult, however, to isolate any direct influences of wind on winter movement. Opinions on this subject vary widely. On a few occasions I recorded large scale movements as occurring "with the wind" during winter winds, but other factors may have been exerting influence. Banfield (1951) compiled 210 observations which show that there is no particular angle of movement in relation to wind direction which is dominant. However, since his compilation is based on movements at all seasons and under all conditions, it does not exclude the possibility that under certain conditions the wind may exert a definite effect on caribou movements. Observations to determine such an effect must be made as part of a general evaluation of the changing environment.
FIGURE 1

Station No. 1
Upper Kelly River
March 5
Caribou feeding in area

\[ \begin{array}{ccc}
H & T & D \\
6000 & 12.5 \text{ cm.} & .28 \\
\end{array} \]

sedge tussocks
FIGURE 2

Station No. 2
Noatak River
March 5
Scattered caribou

H  T  D

800  22 cm.

no measurement  .27

low shrubs, thick moss
FIGURE 3

Station No. 3
Upper S.E. Kukpuk River
March 6
Heavy caribou concentration

<table>
<thead>
<tr>
<th>H</th>
<th>T</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 cm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td>no measurement</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>.24</td>
<td></td>
</tr>
</tbody>
</table>

low sedge tussocks
Station No. 4
Elaypuk Creek, north facing slope
March 13
No caribou

H  T  D

27.5 cm.

550  .20

600 no measurement

sedge tussocks
FIGURE 5

Station No. 5
Elaypuk Creek, south facing slope
March 13
No caribou

H     T     D

12.5 cm.

600    .27

sedge tussocks
FIGURE 6

Station No. 6
Spruce forest
Rabbit Creek, west of mouth of Kelly River
March 14
Scattered caribou

<table>
<thead>
<tr>
<th>H</th>
<th>T</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>47 cm.</td>
<td>no measurement</td>
</tr>
<tr>
<td>40</td>
<td>.25</td>
<td></td>
</tr>
</tbody>
</table>

low shrubs
FIGURE 7

Station No. 7
Upper Ogotoruk Valley, east shore of lake
March 16
Scattered caribou nearby

Surface

<table>
<thead>
<tr>
<th>H</th>
<th>T</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 cm.</td>
<td></td>
</tr>
<tr>
<td>4500</td>
<td>.33</td>
<td></td>
</tr>
</tbody>
</table>
LITERATURE CITED


Foote, D.C. 1959. The caribou of Northwestern Alaska: a brief description. Typed manuscript submitted to AEC.


----- 1959. Personal communication to Alaska Dept. of Fish and Game.