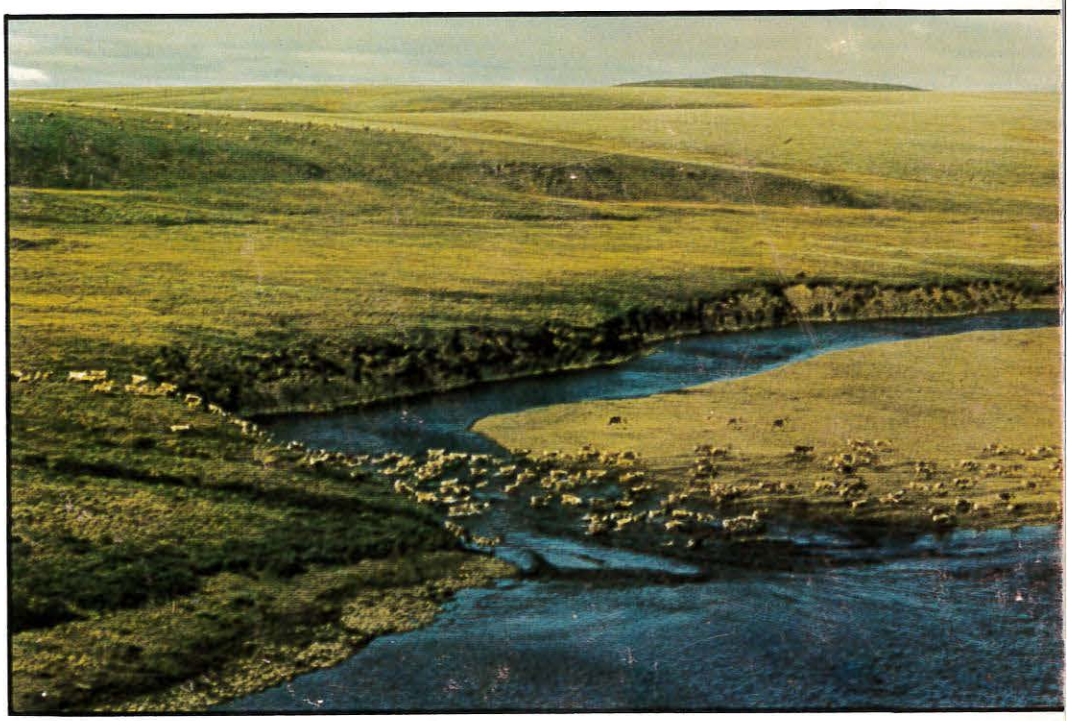
The Distribution Movement Patterns of Caribou in Alaska

by James E. Hemming



ALASKA DEPARTMENT OF FISH AND GAME

Wildlife Technical Bulletin 1

THE DISTRIBUTION AND MOVEMENT PATTERNS OF CARIBOU IN ALASKA

James E. Hemming

State of Alaska
William A. Egan
Governor

Department of Fish and Game
Wallace H. Noerenberg
Commissioner

Division of Game
Frank Jones
Acting Director

Alaska Department of Fish and Game
Game Technical Bulletin No. 1
July 1971

Financed through Federal Aid in Wildlife Restoration Project W-17-R

To the memory of a very special

group of biologists–those who

have given their lives in

unselfish devotion to Alaska's

wildlife resources.

ACKNOWLEDGMENTS

I am indebted to Robert A. Rausch for his continuing assistance and encouragement during the course of this study. This report would not have been possible without the extensive work of Leland P. Glenn, Jack W. Lentfer, Terry A. McGowan and Ronald O. Skoog, all of whom preceded me as leaders of the caribou project. I am also grateful to those who pioneered caribou movement studies before Alaska became a state, Edward F. Chatelain, Sigurd T. Olson, Ronald O. Skoog and Robert F. Scott. Robert E. LeResche read the manuscript and made helpful suggestions for its improvement. Of the many staff members who have contributed to this study I wish to thank especially Richard H. Bishop, Charles Lucier, Kenneth A. Neiland, Robert E. Pegau and Jerome Sexton. I should like to express my gratitude to the U. S. Bureau of Land Management and the U. S. Fish and Wildlife Service for their cooperation during this study. To bush pilots Charlie Allen, Tony Bernhardt, Jack Lee, Orin Siebert, Theron Smith, Averill Thayer, Nelson Walker and Glenn Wheeler I offer special thanks for flying members of the caribou project safely through rain, snow, fog and smoke. To these persons, as well as to others not individually named, I express my sincere thanks.

CONTENTS

FIGURES

METHODS

All data were recorded and summarized by herd. A caribou herd is defined as a group of animals annually utilizing a given area for calving, but perhaps mingling with adjacent herds at other times of the year.

Aircraft provided the best means of transportation, because surface transportation in Alaska is limited and foot travel does not allow field biologists to keep pace with the continual wanderings of caribou. Monthly reconnaissance flights were found to be most suitable for recording seasonal distribution and movements. During survey flights the location, direction of movement, trail patterns and approximate numbers of caribou were recorded on U. S. Geological Survey topographic maps at a scale of 1:250,000 (1 inch = approximately 4 miles). Annual movement patterns were determined by summarizing data from monthly surveys. Supplemental information was obtained from bush pilots, guides, local residents and cooperating agencies. All place names are according to "The Dictionary of Alaska Place Names" by Orth (1967).

The distribution maps included in this report will likely be subject to future revision but reflect current knowledge of Alaska's caribou herds.

Caribou bull in the western Brooks Range. Photo by the author.

INTRODUCTION

The caribou *(Rangifer tarandus)* is widely distributed on arctic tundras, mountains and boreal forests of Eurasia and North America, including the Arctic Archipelago and the north coast of Greenland. Of nine living subspecies of caribou in the world, the barren-ground caribou *(Rangifer tarandus granti)* is the only one found in Alaska (Banfield, 1961).

There are at present 13 caribou herds in Alaska, including two introduced populations. The total caribou population of Alaska exceeds 600,000. In addition, there are 18 domestic reindeer herds in Western Alaska (Pegau, 1968).

North of the Yukon River caribou continue to provide a major source of meat for Eskimos, Indians and white settlers. Sport hunters annually harvest more caribou than all other big game species combined.

As a result of expanding industrial development and settlement of Alaska's arctic and subarctic regions, the future status of this important big game species has become a matter of concern. Whether or not caribou populations will continue to occupy their historic ranges in Alaska hinges upon our ability to implement land use plans that protect the integrity of critical caribou habitat.

This report describes the current distribution and movement patterns of caribou as learned from 22 years of federal aid funded studies in Alaska by state and federal biologists.

Fig. 1. Approximate location of main caribou herds in Alaska

SEASONAL MOVEMENTS

Throughout the year caribou herds are almost constantly in motion. They visit some areas annually, and may utilize others only once in a decade. Even preferred areas are used for only a few weeks each year. Despite such variability, a certain periodicity and pattern are evident in both daily and seasonal movements.

Contrary to popular belief, caribou do not normally move in large compact herds. They usually cover a wide area, and a migration is often an intermittent stream of animals moving in one direction. Occasionally they do gather in large bands of thousands, but these seldom persist. Migrating herds tend to use fairly well-defined routes between preferred winter and summer ranges. Dispersion is maximal in late summer and midwinter.

Small herds may not demonstrate definite seasonal movements but instead wander locally (Banfield, 1951; Skoog, 1968). As herds become larger, definite seasonal movement patterns are established. Studies by Banfield (1951) and Skoog (1968) revealed that as the caribou density increases, the animals extend their movements farther and farther into marginal areas from the most favorable portion of their range. During periods of extremely high numbers, movements may become quite erratic and herds may join with others or split apart with completely unpredictable frequency (Kelsall, 1968; Skoog, 1968). However, in most herds fairly predictable patterns are evident.

In late winter cows and their calves of the previous year form into increasingly larger aggregations. Between mid-March and mid-April they begin moving toward the calving grounds. At first this movement is slow, but as the calving period approaches the pace quickens. During spring migration the calf-cow bond breaks down and many calves (short yearlings) leave their mothers. Males also migrate toward the calving area, but usually at a more leisurely pace. Loose aggregations of males lag far behind the females and many never reach the calving grounds. About two weeks after the calving period ends cows and their new calves form into increasingly larger groups (DeVos, 1960; Pruitt, 1960). Females and calves often remain in fairly large aggregations until early August. Bulls and yearlings may also form into large bands but they usually remain segregated from the cows throughout the summer.

The primary movement patterns of caribou appear to be governed by the seasonal energy demands of the species. Dietary requirements are greatest in spring and summer, when caribou must fulfill the demands of calving, lactation, antler development and molt (Klein, 1970). Movement patterns at that time are usually directed toward areas containing the most abundant good quality forage.

The constant harassment of insects, including mosquitoes (Culicidae), black flies (Simuliidae) and bot flies (Oestridae), in midsummer tends to keep caribou aggregated (Kelsall, 1968). During the day caribou are often found in compact groups on windswept ridges or on remnant patches of snow or ice. Extensive movements do not occur, but the incessant attacks of bloodsucking and parasitic flies often cause the animals to dash madly from place to place. Only when wind or cool temperatures offer relief from insect attacks can the animals disperse, feed and rest. According to Zhigunov (1961) and Kelsall (1968) the end of the fly season allows caribou to disperse. This reduces competition and allows the animals to accumulate winter fat reserves.

In late August or early September the herds begin a leisurely drift toward winter ranges. Rut occurs en route and the pace becomes more rapid and movements more direct until the animals settle on their winter range. In winter caribou enter a state approaching physiological dormancy that results in reduced food intake, growth rate and metabolic rate (McEwan and Wood, 1966).

MAJOR HERDS

ARCTIC HERD

Caribou in northwestern Alaska are currently more abundant than at any other time in this century. Since 1900 the Arctic herd has increased steadily, and a census in 1970 revealed a minimum population of 242,000 animals.

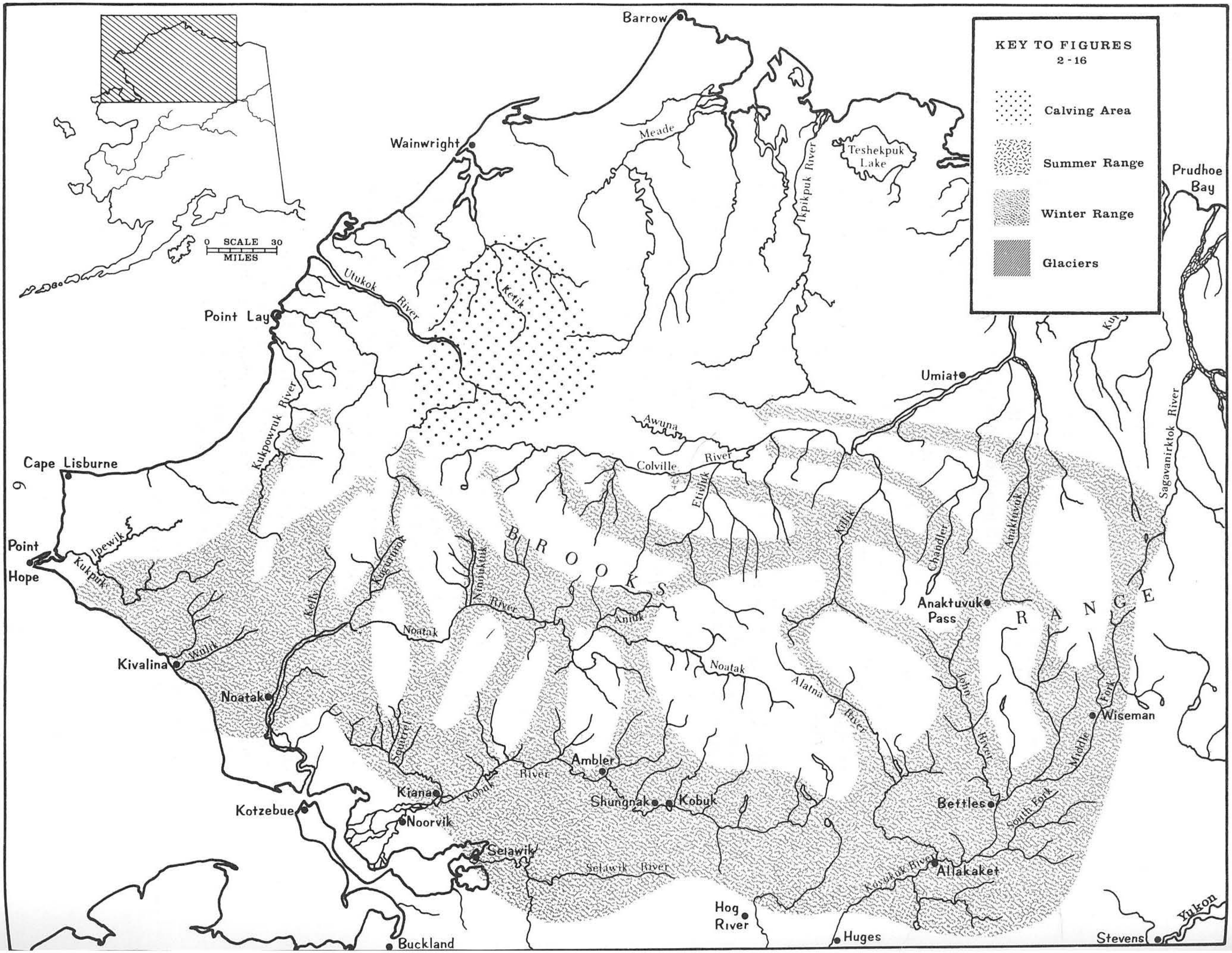
During the most recent population low in the late 1800's, the few remaining animals occupied a small area of the North Slope including the present calving grounds (Schrader, 1904; Murie, 1935; Skoog, 1968; Birch, pers. comm.). As the herd increased in numbers the animals gradually expanded their range to the east, west and south. By 1945 seasonal movements reached as far south as the Kobuk River (Skoog, 1968).

In 1948 the U. S. Fish and Wildlife Service began studies of the distribution and abundance of caribou in Alaska. Scott et al. (1950), reporting on these early studies, tentatively identified four caribou populations in northwestern Alaska and estimated that they contained 119,000 caribou. Subsequent studies by the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game revealed that only one caribou population existed in northwestern Alaska. The Alaska Department of Fish and Game and the Arctic Institute of North America continued studies of the Arctic caribou herd after 1959 and most of the information presented here is derived from those studies.

The Area

The Arctic caribou herd presently occupies a range of approximately 140,000 square miles in northwestern Alaska, with all but the southernmost portion lying north of the Arctic Circle (Figs. 2 and 3). Northwestern Alaska is noted for its high-velocity surface winds. Summers are cool and short (May-August) and winters are long and cold (September-May). Within the range of the Arctic herd temperature extremes range between 90°F and -55°F. Annual precipitation averages about eight inches.

The gently undulating tundra plains spreading southward from the Arctic Ocean are dotted with innumerable ponds and lakes interspersed by wet meadows. This region slopes gradually from sea level to an altitude of 600 feet. Farther south the Arctic Foothills consist of rolling plateaus, low mountains and broad east-trending ridges rising from an altitude of 600 feet on the north to 3,500 feet on the south. This area is dominated by tussock meadows. Here most streams are swift with braided courses spreading across broad gravel flats.


KEY TO FIGURES
2-16
Calving Area
Summer Range
Winter Range
Glaciers
0 SCALE 30
MILES
Barrow
Wainwright
Point Lay
Cape Lisburne
Point
Hope
Kivalina
Noatak
Kotzebue
Kiana
Noorvik
Selawik
Buckland
Ambler
Shungnak
Kobuk
Hog
River
Huges
Allakaket
Bettles
Wiseman
Stevens
Anaktuvuk
Pass
Umiat
Prudhoe
Bay
Teshekpuk
Lake
Meade
Ikpikpuk River
Utukok
River
Ketik
Kukpowruk River
Awuna
Colville
River
Etivluk
Killik
Chandler
Anaktuvuk
Sagavanirktok River
Ipewik
Kukpuk
Kelly
Kugururok
Nimiuktuk
River
Noatak
Aniuk
Wulik
Squirrel
Kobuk
River
Noatak
Alatna
River
John
River
Middle
Fork
South Fork
Koyukuk River
Selawik River
Yukon
B R O O K S
R A N G E

The western and central Brooks Range and its associated mountain groups consist of rugged glaciated ridges and mountains with summits 7,000 to 8,000 feet high. There are many passes, particularly in the western portion. In the higher parts of the Brooks Range from the Schwatka Mountains northeast of Kobuk to Mount Doonerak north of Bettles, the terrain is particularly rugged and small cirque glaciers are common. The latter areas serve as barriers to spring caribou movements and are traversed only rarely by caribou in late summer.

The boreal forest to the south of the Brooks Range includes an area of diversified topography. There are compact groups of hills, ridges and low mountains surrounded by rolling plateaus, broad lowland flats and lake dotted plains.

Winter Distribution

The primary winter range of the Arctic herd lies south of the Brooks Range along the northern fringe of the boreal forest (Fig. 2). Here the caribou utilize horsetails *(Equisetum sp.)*, sedges *(Carex sp.)* and lichens *(Cladonia sp.* and *Cetraria sp.)* that occur on mountain slopes, lake margins, stream banks, marshy meadows, ridges and knolls–semiopen areas that are relatively free of snow.

In normal winters, when snow conditions do not limit movement and feeding, most of the herd moves well into the forest zone. When snowfall is unusually heavy and/or severe crusting occurs south of the Brooks Range the caribou may remain within the mountains or on the Arctic Slope.

Each year since 1950 the Arctic herd has wintered mostly to the south, extending from the Waring Mountains, Baird Mountains and lower Koyukuk River eastward to the Wiseman area (Lent, 1966; McGowan, 1966; Glenn, 1967; Skoog, 1968; Hemming and Glenn, 1968; Hemming and Glenn, 1969; Hemming and Pegau, 1970). In the winter of 1956-57 the snow was deep and crusted south of the Brooks Range and very few animals reached the forest zone (Olson, 1958).

Even in normal winters some caribou remain on the Arctic Slope. These animals utilize the coastal fringe of uplands where strong winds lay bare the *Dryas* fell-fields and tussock meadows. When the first deep snow falls on the Arctic Slope the caribou move slowly toward the coast. From December through February caribou are fairly sedentary and move fewer miles per day than at any other time of the year. In the winter of 1957-58 large numbers of caribou remained on the Arctic Slope, particularly in the Chandler-Etivluk River area, but most animals moved to traditional winter ranges south of the mountains (Olson, 1959a).

Occasionally the winter ranges of the Arctic caribou herd and the Porcupine caribou herd overlap in the Wiseman-Chandalar area. It is unknown whether permanent exchange of animals has occurred. However, as the caribou move north in spring they separate upon reaching the Arctic Slope and move toward their respective calving areas. Recent studies by Childs (1970) and Sage (1971) suggest that mutual spring migration routes along the Dietrich River and the Chandalar River were used by a portion of each herd in 1969 and 1970.

Spring Migration

Spring movement to the calving grounds usually begins in March. This movement continues until all parturient females reach the calving grounds. Males and many yearlings tend to move north somewhat later and more slowly than females. By mid-March the snow has receded on exposed mountain slopes and hills over which the caribou pass.

In years with unusually heavy snow accumulation and/or late spring thaw, spring migration may be delayed or slowed to the point where some calving occurs en route. According to Lent (1966) the greatest delay recorded in this century was in 1962 when heavy snow cover severely restricted movements and calving was observed as far south as the Kobuk River. Many animals were still moving northward in early June (Skoog, 1963). Normally cows calving en route proceed to the traditional calving grounds and mix with caribou already on the Arctic Slope.

Exceptions to the "rules" of caribou movement may always be found. McGowan (1966) observed calving activity in 1965 between Walker Lake and Ambler River. These animals were part of a large group of caribou that wintered in the area between the Kobuk and Koyukuk rivers. That year a majority of the Arctic herd moved north on schedule. Most of the calving segment was north of the Brooks Range by early May. This deviation from the norm, in the absence of limiting environmental factors, cannot be explained.

If spring movements are not inhibited, animals reaching the calving grounds prior to the calving period remain in the area but move in large circular patterns (Lent, 1966).

Caribou wintering on the Arctic Slope usually begin moving toward the calving area a few weeks to a month later than animals wintering to the south, probably because of the delayed phenology of the area.

The most direct routes from winter range to the calving grounds are usually used during spring migration (Fig. 2). On the west end of the Brooks Range major movements are directed northward parallel to the Kelly, Kugururok, Nimiuktuk and Anisak rivers. To the east caribou move north along the John River and parallel drainages. Upon reaching the summit of the Brooks Range the animals swing west through the mountains and foothills, heading directly for the calving grounds.

Calving

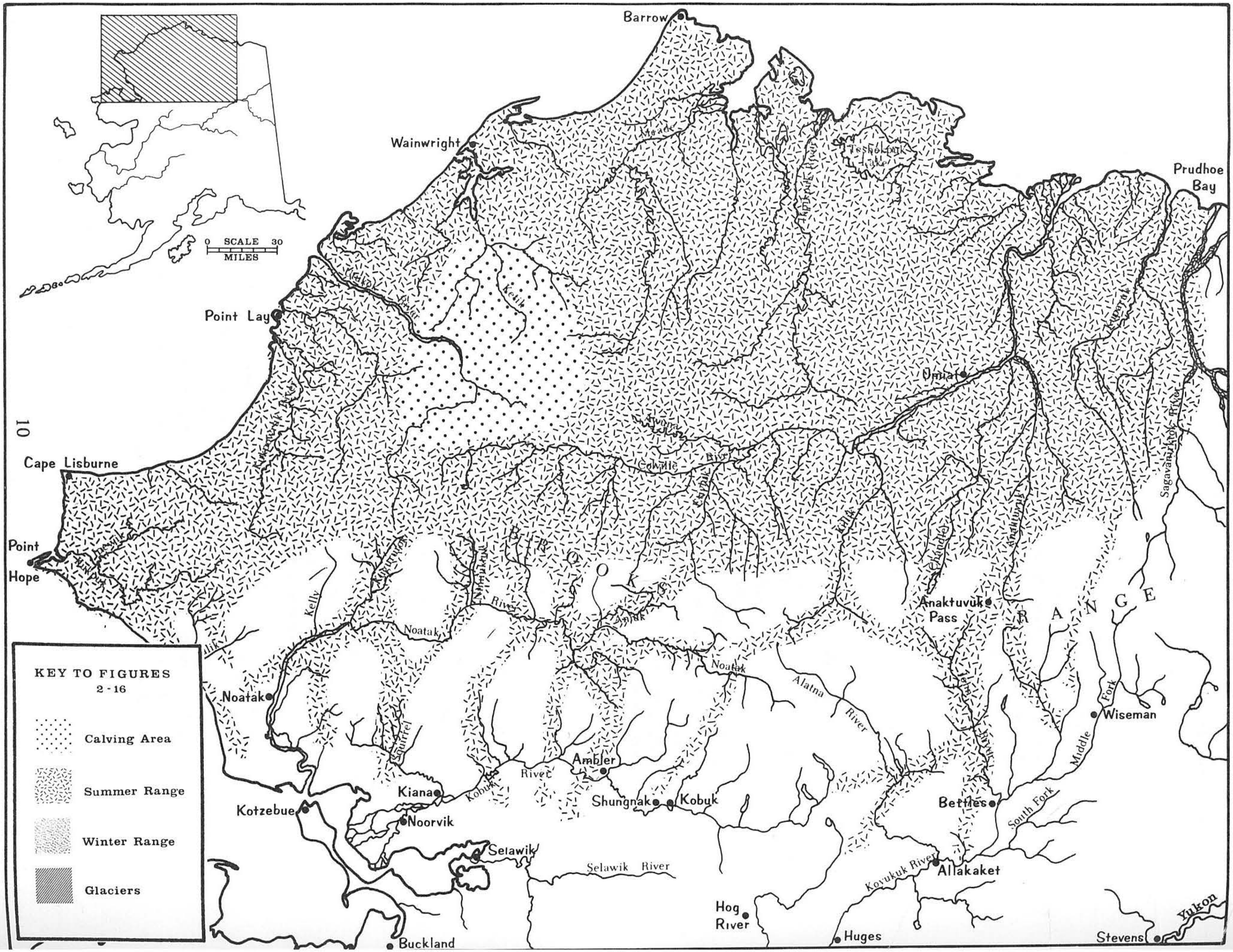
The major calving area is located along the headwaters of the Colville, Ketik, Meade, and Utukok rivers (Fig. 2). This area is 500 to 2000 feet above sea level and consists of foothills and upland meadows. Its dominant vegetation is cottongrass *(Eriophorum vaginatum)*, a tussock forming sedge. Cottongrass shoots are the most important food item during the calving season, and timing of the arrival of caribou onto the calving grounds appears to be closely correlated with receding snow and the appearance of the first *Eriphorum* buds (Lent, 1966). Calving grounds usually have little snow cover compared to adjacent areas (Benson, 1969). The calving period extends from about 25 May to 25 June, peaking about 5 June (Skoog, 1964; Lent, 1966).

Postcalving Movements

When the cotton-like flowers of *Eriophorum* begin to form in mid-June, caribou leave their calving area. The animals then join into increasingly larger masses and begin to move. This activity marks the start of a circular movement that takes the animals southwest to the high country of the Kukpowruk, Kukpuk and Wulik rivers (Scott, 1953b; Lent, 1966). By the first of July the caribou attain their highest degree of aggregation. Then they swing east through the DeLong Mountains and adjacent foothills and through the mountain valleys of the north slope of the Brooks Range. As this movement progresses dispersal begins. Although the tendency is to shift northward onto the Arctic coastal plain, some animals remain in the mountains all summer.

Lent (1966) offered the following explanation for the circular postcalving movement of the Arctic caribou herd:

> "By the end of the calving season, the cottongrass has turned white. However, at this time the vegetation of the coastal tundra and low northern part of the foothills remains quite brown. The willows and grasses have not yet undergone any significant new growth. But by mid-June, as the caribou swing south away from the influence of the Arctic Ocean, the southern foothills, in particular the flood plains and dry meadows, are green with new growth. By the end of June, many herb species are in flower and were observed being used by the caribou.
>
> From late June through late July, the browsing of willow shrubs and dwarf birch is perhaps the most important feeding activity. As the caribou move west and then east through the mountains, they pass across all the major streams and are thus alternately feeding in *Dryas* fell-fields and in shrub vegetation along the rivers. Tussock meadows receive only minor use at this season.


Barrow
Wainwright
Meade
Teshekpuk Lake
Prudhoe Bay
Point Lay
Ketik
Umiat
Colville River
Cape Lisburne
Point Hope
B R O O K S
R A N G E
Anaktuvuk Pass
Kelly
Noatak
Noatak River
Alatna River
Sagavanirktok River
Wiseman
Middle Fork
South Fork
Ambler
Kiana
Kobuk River
Shungnak
Kobuk
Kotzebue
Noorvik
Selawik
Selawik River
Bettles
Allakaket
Koyukuk River
Hog River
Huges
Buckland
Stevens
Yukon
0 SCALE 30
MILES
KEY TO FIGURES
2 - 16
Calving Area
Summer Range
Winter Range
Glaciers

> Animals that swing north again in mid-July return to the low foothills and onto the coastal plains at a time when the willows and grasses of these areas are green and at the peak of their growing season."

Thus the progression of succulent forage growth leads the caribou on a counter-clockwise journey through northwestern Alaska in early summer.

Summer Distribution

After the postcalving concentration, movements are essentially random. Portions of the Arctic herd may be found anywhere west of the Sagavanirktok River, from the summit of the Brooks Range to the beaches of the Arctic Ocean and the Chukchi Sea (Fig. 3). Occasionally caribou move as far east as the Canning River, an area that is regularly used in summer by the Porcupine herd. Throughout the summer adult bulls tend to move off into small groups, but the cows and young animals remain in much larger aggregations.

Fall Migration

The fly season ends as the frequency of frost increases in early August. By this time the animals are well dispersed over the entire Arctic Slope and the release from insect harassment allows them to feed uninhibited. In late August a leisurely drift toward tree line begins.

By 1 September only a few animals remain on the Arctic coastal plain and major movements are directed toward the Anaktuvuk Pass-Killik River area, the Aniuk-Nimiuktuk River area and along the Chukchi Sea coast (Fig. 3).

As the breeding season approaches bulls move to rejoin the cow segment of the herd. By late September both sexes and all ages are fully represented in most large groups.

The rut begins in early October as the animals move onto the south slope of the Brooks Range. Migration continues but at a slow pace until the end of the breeding period. After the rut the tempo of movement increases until the wintering grounds are reached.

PORCUPINE HERD

The Porcupine herd, one of Alaska's largest, ranges over remote portions of northeastern Alaska, northern Yukon Territory and the narrow fringe of Northwest Territories lying west of the MacKenzie Delta. This population contained approximately 140,000 caribou in 1964 (Lentfer, 1965) and appears to be increasing.

Adult female caribou in October. Photo by the author.

Caribou have occurred within the present range of this herd for at least 100 years. Prior to 1900 a portion of the Porcupine herd and caribou from Canadian herds to the east used the forested bottomlands of the MacKenzie River as mutual winter range (Pike, 1892; Russell, 1898). Some interchange of animals may have occurred at that time.

Apparently seasonal distribution patterns in the late 1800's were very similar to those observed today (Funston, 1896; Murie, 1935; Preble, 1908; Russell, 1898). In the early 1900's, however, this herd shifted away from the coast and MacKenzie Delta toward the southwest (Harrison, 1908; Porsild, 1945). This shift toward the central Brooks Range may have resulted in the use of more westward passes during seasonal migrations. Simon Paneak, a resident of Anaktuvuk Pass, reported that during the period from 1900 to 1920, caribou moved north through Anaktuvuk Pass in the spring and turned east upon reaching the Arctic Slope. This occurred at a time when the Porcupine herd occupied the central Brooks Range and the Arctic herd was greatly reduced and remained throughout the year in the high mountains of the western Brooks Range (Birch, pers. comm.; Skoog, 1968). After 1920, most of the caribou traversing Anaktuvuk Pass in the spring turned west toward the Utukok River upon reaching the Arctic Slope. The latter activity coincides with the period of growth and range expansion of the Arctic herd.

For many years the relationship between caribou occurring in the eastern Brooks Range, the British Mountains and the Richardson Mountains was unknown. It was not until 1953 that Scott (1953a) recognized that caribou from the Chandalar, Porcupine and Richardson Mountain country were all part of the same herd.

The Area

The Porcupine caribou herd presently occupies an area of approximately 78,000 square miles in northeastern Alaska, Yukon Territory and Northwest Territories. Within the range of the Porcupine herd temperature extremes range between 90°F and -55°F. Coastal areas are typified by strong winds throughout the year–decreasing toward the Interior. Annual precipitation averages about 10 inches.

Along the eastern boundary of this herd's range the boreal forest extends north to the Arctic coast on the broad MacKenzie River Delta. This area consists of very wet, boggy tundra and spruce forest that tend to restrict caribou movements. To the north the Richardson and British mountains end abruptly at the Beaufort Sea, leaving only a narrow beach fringe along the Canadian coast. In Alaska the Arctic coastal plain and foothill zones become ever wider westward toward the Colville River.

The central and eastern Brooks Range is a wilderness of rugged glaciated ridges rising to summits of 7,000 to 9,000 feet on the north and 4,000 to 6,000 on the south. There is little vegetation above 4,000 feet. Small cirque glaciers and larger valley glaciers are common, particularly in the Franklin and Romanzof mountains north of Arctic Village. Except for the British Mountains in the extreme eastern part of the range, few north-south passes exist.

The forest-tundra south of the mountains is an area of diversified topography. The Porcupine plateau extends from the middle fork of the Chandalar River east to the Richardson Mountains, including the valleys of the upper Black and Porcupine rivers that spread south in broad dendritic patterns toward the MacKenzie Mountains. There are a few low ridges, rounded hills and low mountains rising to 3,500 feet. The Old Crow Flats lie between the British Mountains and the Porcupine River. This is a broad marshy basin, dotted with lakes, ponds and meandering streams.

Winter Distribution

In normal winters most of the herd moves well into the forest zone, dispersing south and west after a leisurely drift around the east end of the Brooks Range (Stevens, 1948; Soper, 1951; McEwan, 1952a; Scott, 1953a; Olson, 1958 and 1959a; Skoog, 1953; Hemming and Pegau, 1970). Adult males tend to penetrate farther into the boreal forest than females.

Apparently the Porcupine herd makes little use of Alaska's Arctic Slope in winter. However, in some years a portion of the herd may remain on the Canadian coast near Herschel Island (Olson, 1959a). Residents of Aklavik told me that large numbers of caribou remained in the Richardson Mountains just west of their village during the winter of 1967-68.

Caribou from this herd usually reach their respective winter ranges by early November and remain until March. However, movement onto winter ranges near Arctic Village may continue into December. Here, a circular winter movement occurs. In early winter the animals move west to the Big Lake-Chandalar area. In midwinter they turn around and return over their original route, passing Arctic Village again in April and May. Some animals remain scattered over the entire area throughout the winter (Fig. 4). Occasionally the winter ranges of the Arctic and the Porcupine caribou herds overlap in the Chandalar-Wiseman area.

McEwan (1952c) suggested that the caribou occurring south of the upper Peel River in winter are not a part of the Porcupine herd. I received similar reports from native hunters and bush pilots at Fort McPherson and Inuvik in 1970. According to these reports, Porcupine herd animals wintering in the Caribou-Road River area do not normally move south of the Peel River. However, recent studies by the Canadian Wildlife Service (Pearson, pers. comm.) and Gas Arctic Ltd. (Calef, pers. comm.) indicate that in some years winter movements of the Porcupine herd extend south of the Peel River into the Keel, Knorr, Ogilvie and Trevor mountains.

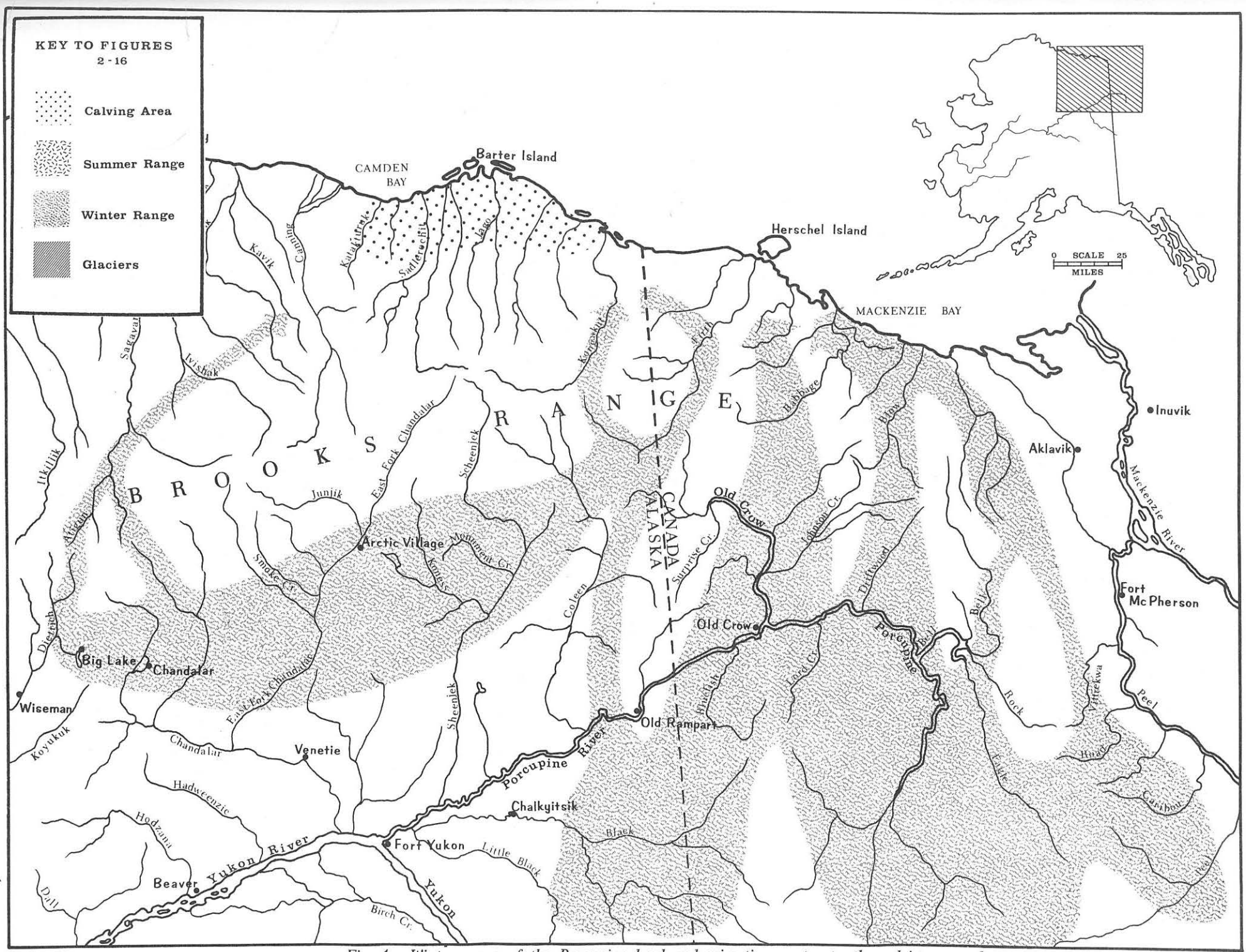


Fig. 4. Winter range of the Porcupine herd and migration routes to the calving grounds.

Little is known about the caribou to the south, along the drainages of the Ogilvie and Blackstone rivers, but local residents refer to them as the "Dawson herd". On 20 July 1964 I saw a group of approximately 300 caribou near the upper Blackstone River at mile 55 on the Dempster Highway. This group contained many cows and calves, suggesting that a calving area exists somewhere in the Ogilvie Mountains. Obviously these limited observations do not prove the existence of a new herd, but they do point up the need for more work in that area.

Spring Migration

March signals the start of a 400-mile trek to the Arctic coast. Adult females are the first to leave the wintering grounds and they proceed at a fairly rapid pace. Animals from the Caribou-Road River area move along the east slope of the Richardson Mountains toward Shingle Point. Most caribou in the upper Porcupine River country move north between Old Crow and the mouth of the Bell River, but a few move up the Bell River, crossing the Richardson Mountains via McDougall Pass. To the east, animals from winter ranges on the Black River cross the Porcupine River at two places. Some cross between the village of Old Crow and Driftwood River, while others use a historic crossing area just west of Old Rampart, where the spruce forest stretches north across the river (Fig. 4). In 1896 Funston reported that the area near Old Rampart was a traditional crossing and that there were no crossings downstream. Caribou from the Arctic Village area move northeast in spring toward the Firth River. Normally the most direct routes to the calving grounds are used. However, in the eastern Brooks Range passes west of the Kongakut River are extremely precipitous, with valley glaciers and heavy snow cover forming an effective barrier to spring movements. Therefore most of the Porcupine herd moves north via low passes to the Blow, Babbage and Firth rivers. Some years varying numbers of caribou remain in the Big Lake-Chandalar area in winter. In the spring these animals may move north along the Dietrich and Middle Fork of the Chandalar rivers.

Bulls and many yearlings drift north at a very leisurely pace, with some lingering on winter ranges until June.

Severe weather and deep snow may delay the spring migration and calving may occur en route. In 1935 a portion of the herd calved near Arctic Village and most of the calves died as a result of unseasonable snow and cold (Scott, 1953c). Delays of this magnitude are rare. More commonly, late migration results in some calves being born on the Canadian coast between Herschel Island and the Alaska border (Stevens, 1948; McEwan, 1952b). Cows calving en route proceed to their traditional calving grounds in Alaska.

In the northwestern part of the Ogilvie Mountains, the Porcupine and Fortymile caribou herds overlap in winter. It is known that in the springs of 1957 and 1964 large numbers of Fortymile caribou moved north with the Porcupine herd (Skoog, 1964). Unfortunately, aerial reconnaissance work during the past 15 years has been too limited to adequately measure the frequency of such population shifts.

Calving

The major calving area is located just south of Barter Island between the Katakturuk and Kongakut rivers, an area of about 2,500 square miles (Fig. 4). This region rises from sea level inland to an elevation of 500 feet. Its gently rolling terrain is dominated by sedge meadows laced with braided streams. Increasing amounts of sedge tussock are found toward the mountains to the south.

Calving occurs in late May and early June, peaking about 30 May (Skoog, 1962). At this time bulls, yearlings and nonpregnant cows are scattered from the foothills of the Brooks Range in Alaska to the Richardson Mountains in Canada.

Summer Distribution

Soon after calving cows and new calves begin assembling into increasingly larger groups. The postcalving movement brings these caribou south and east into the mountains where they spend much of the summer. By early July cows, calves and some bulls are well into the foothills of the Romanzof and British mountains. However, throughout the summer some bulls and yearlings remain scattered on both the north and south sides of the Brooks Range from Atigun-Dietrich Pass eastward into Canada. Apparently cool winds along the coast offer relief from biting insects. In late summer most of this herd can be found along the coastal range from the Arctic Wildlife Range east to the Blow River.

In general caribou of the Porcupine herd move into Alaska only during the calving period, and return to Canada for the remainder of the summer.

Fall Migration

Each fall this herd swings south toward the wintering grounds, with rut taking place en route. Passes to the east receive the bulk of movement (Fig. 5). However, those west of Kongakut-Sheenjek Pass are often used by bulls in late summer before the rut. These bulls must move a considerable distance to the east through the mountains to participate in breeding activities.

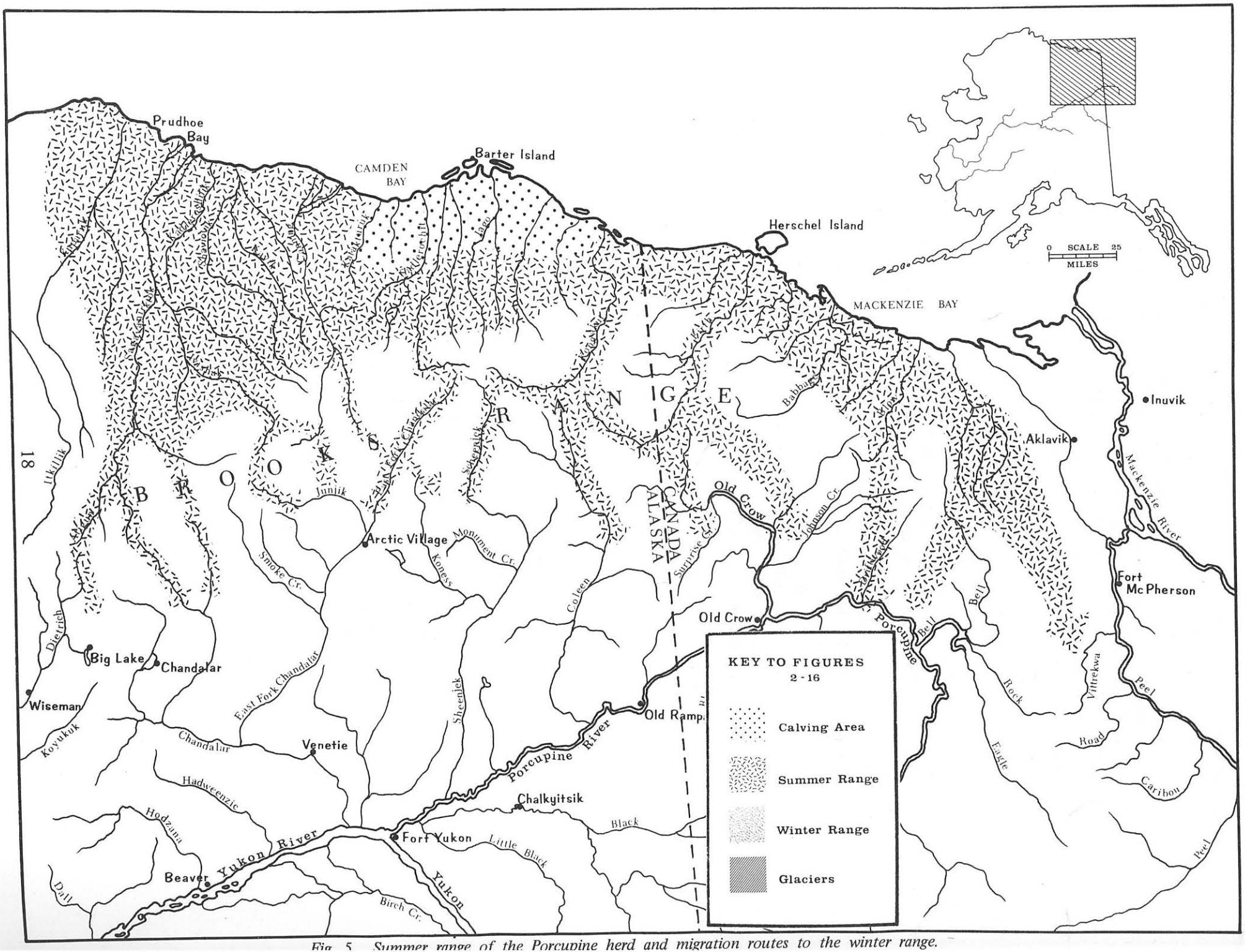


Fig. 5. Summer range of the Porcupine herd and migration routes to the winter range.

In the autumns of 1956 and 1958, large numbers of caribou crossed the Brooks Range between the Sagavanirktok River and the north fork of the Chandalar River to winter in the Big Lake-Chandalar area (Olson, 1957 and 1959a). Deep trails in the tundra along upper drainages of the Sagavanirktok are still evident even though major movements have not been recorded there since 1958. There are also many naturally-shed bull caribou antlers scattered along the upper Ivishak, Saviukviayak and Sagavanirktok rivers, indicating that caribou remained in this area until after the rut.

Summer forest fires may influence the autumn movements of caribou since newly burned areas are usually avoided. In 1950 a fire destroyed a portion of the winter range between the Bell, Eagle and Porcupine rivers. Only a few caribou moved into this area the following winter–most of the animals wintered north of the Porcupine River (Soper, 1951a; McEwan, 1952a).

The fall schedule is fairly regular, with the first caribou reaching Old Crow and McDougall Pass in early September. Movement continues through October.

NELCHINA HERD

Research on the Nelchina herd was initiated by the U. S. Fish and Wildlife Service in 1948, and in 1959 the newly-formed Alaska Department of Fish and Game assumed responsibility for this caribou research. This herd has grown from approximately 20,000 animals in 1948 (Skoog, 1959) to over 60,000 in 1970 (Hemming and Glenn, 1968).

The Nelchina herd has remained mostly within the boundaries of its present range since at least the mid-1930's (Skoog, 1968). In recent years major shifts have occurred within this range and more of the range is presently occupied. However, herd structure has remained intact and each year the cows return to the traditional calving area.

This herd is not isolated from neighboring caribou populations. At times through the years it has shared winter ranges with portions of the Delta, McKinley and Mentasta herds.

The range of the Nelchina herd is only partially limited by physical barriers. Skoog (1968) aptly described the avenues of dispersal available to the Nelchina herd:

In late fall caribou are clove-brown in color with a white neck, rump and feet, and often a white flank stripe. Photo by author.

> "Natural barriers to caribou movement are relatively few. Animals have been observed in every part of the range, and occasionally large numbers have extended into areas beyond what is considered the main range. The ice caps and rugged slopes of the Chugach Mountains present an effective barrier to southward emigrations. Although caribou could travel around the west end of the Chugach Range onto the Kenai Peninsula or south along the Copper River, such movements have not occurred in recent times. The Alaska Range in part presents a similar barrier on the north, but a number of passes provide easy access to the north slopes. On the far north and far east the broad spruce-covered valley of the Tanana River serves to inhibit caribou movement in those directions, but historical records indicate that this "barrier" has been transgressed on occasion. In recent years Nelchina caribou have crossed the Copper River Valley and reached the edge of the Tanana Valley. A similar terrain exists on the west along the lower Susitna River; there are no known records indicating a direct westward or eastward movement across the Susitna Valley. The main routes for dispersal by Nelchina caribou are 1) to the northwest via Broad and Windy passes and then west or east along the north slopes of the Alaska Range, or north across the Yukon River; 2) to the northeast via Isabel Pass, and then east or west along the Alaska Range, or northward across the Tanana Valley; and 3) to the east via Mentasta Pass, and then north or south along the Alaska Range, or east across the upper Tanana River."

It is not possible to predict when or where shifts in distribution will occur in the future. However, if the Nelchina herd continues to grow major shifts and egress will undoubtedly occur.

The Area

The Nelchina caribou herd presently occupies an area of approximately 20,000 square miles in Southcentral Alaska. The climate resembles that of Interior Alaska except that winter temperatures average somewhat milder. Within the range of the Nelchina herd temperature extremes range between 90°F and -50°F. Annual precipitation averages about 13 inches.

This is a diversified area of rugged, glacier-capped mountains, rolling uplands and broad forested plains. Four mountain ranges form the herd boundaries: the Alaska Range on the north, the Chugach Mountains on the south, the Talkeetna Mountains on the west and the Wrangell Mountains on the east. Rolling alpine foothills surround the broad Copper River lowlands. The eastern part of the lowlands is a relatively smooth, forested plain, 1000 to 2000 feet in elevation, trenched by the valleys of the Copper River and its tributaries. The Lake Louise Plateau to the west is a lake-dotted upland, 2200 to 3500 feet in altitude.

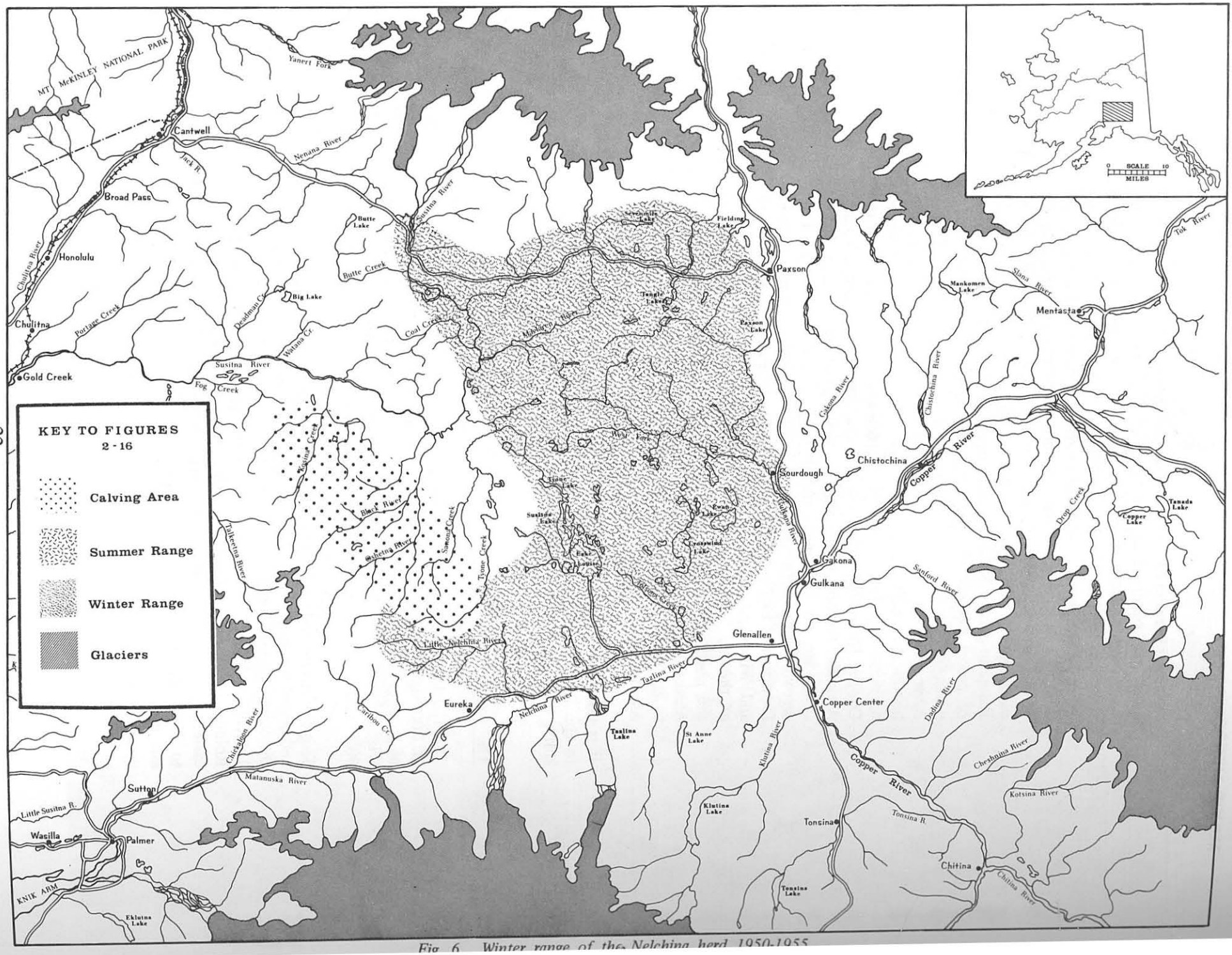


Fig. 6. Winter range of the Nelchina herd, 1950-1955.

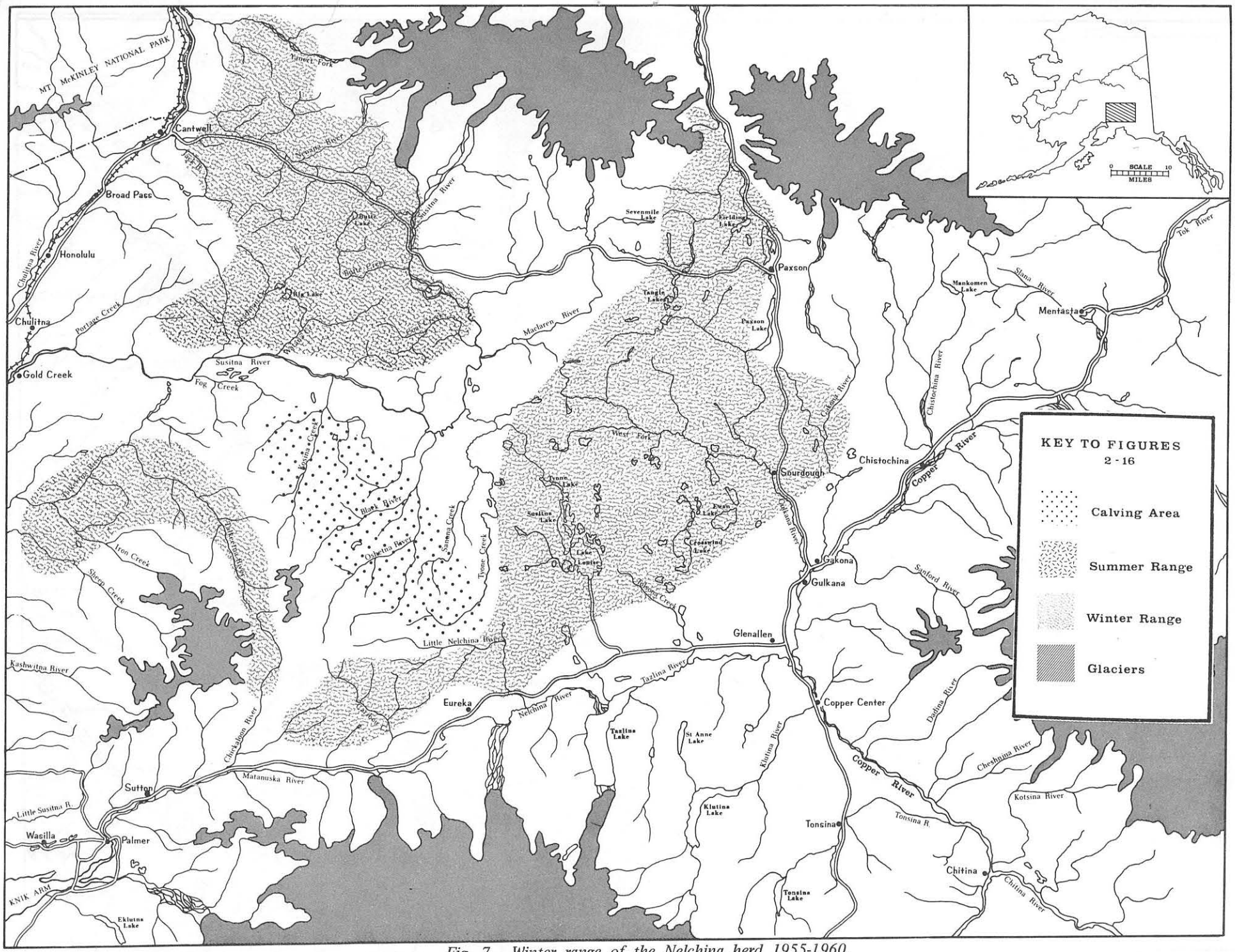


Fig. 7. Winter range of the Nelchina herd 1955-1960.

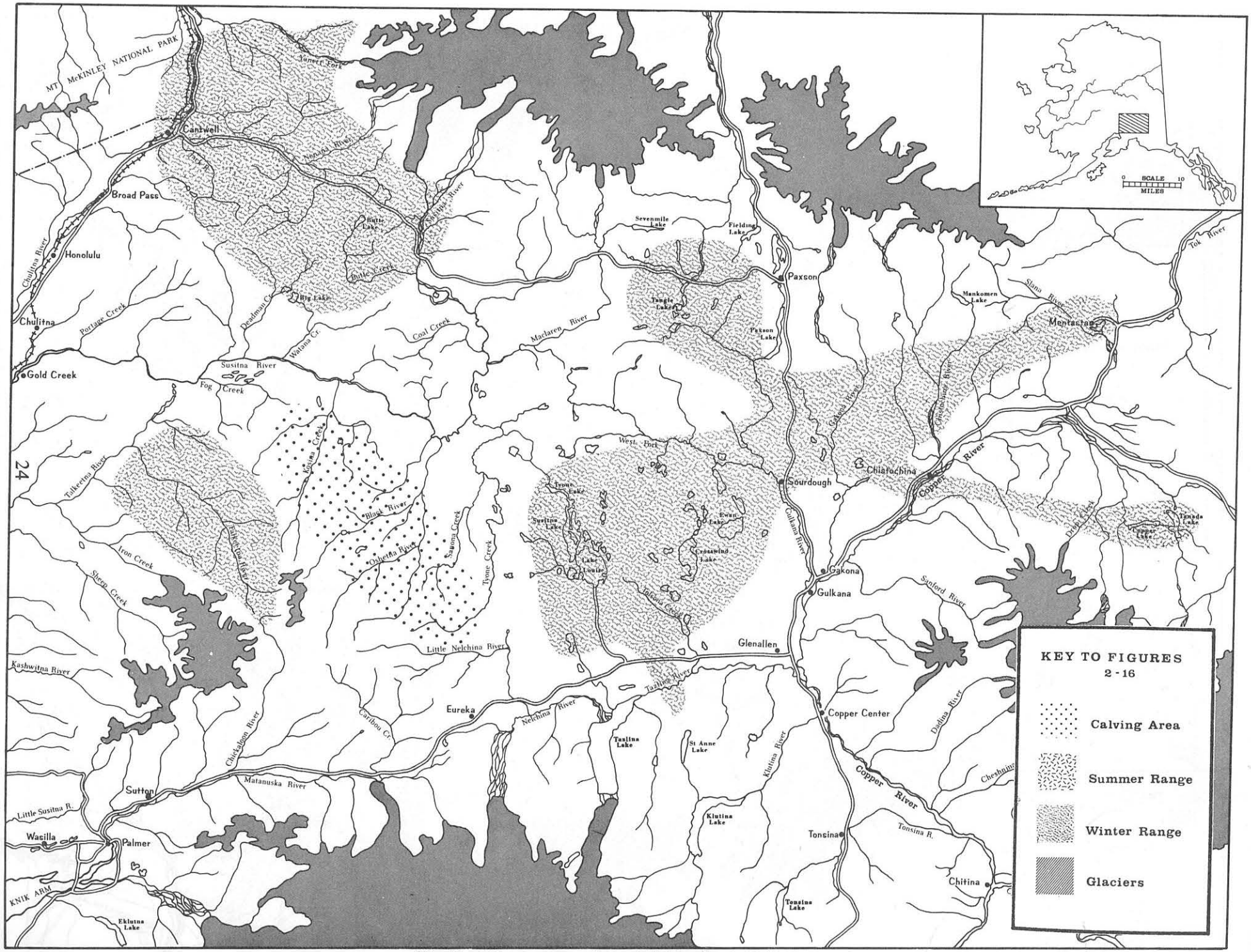


Fig. 8. Winter range of the Nelchina herd 1960-1965.

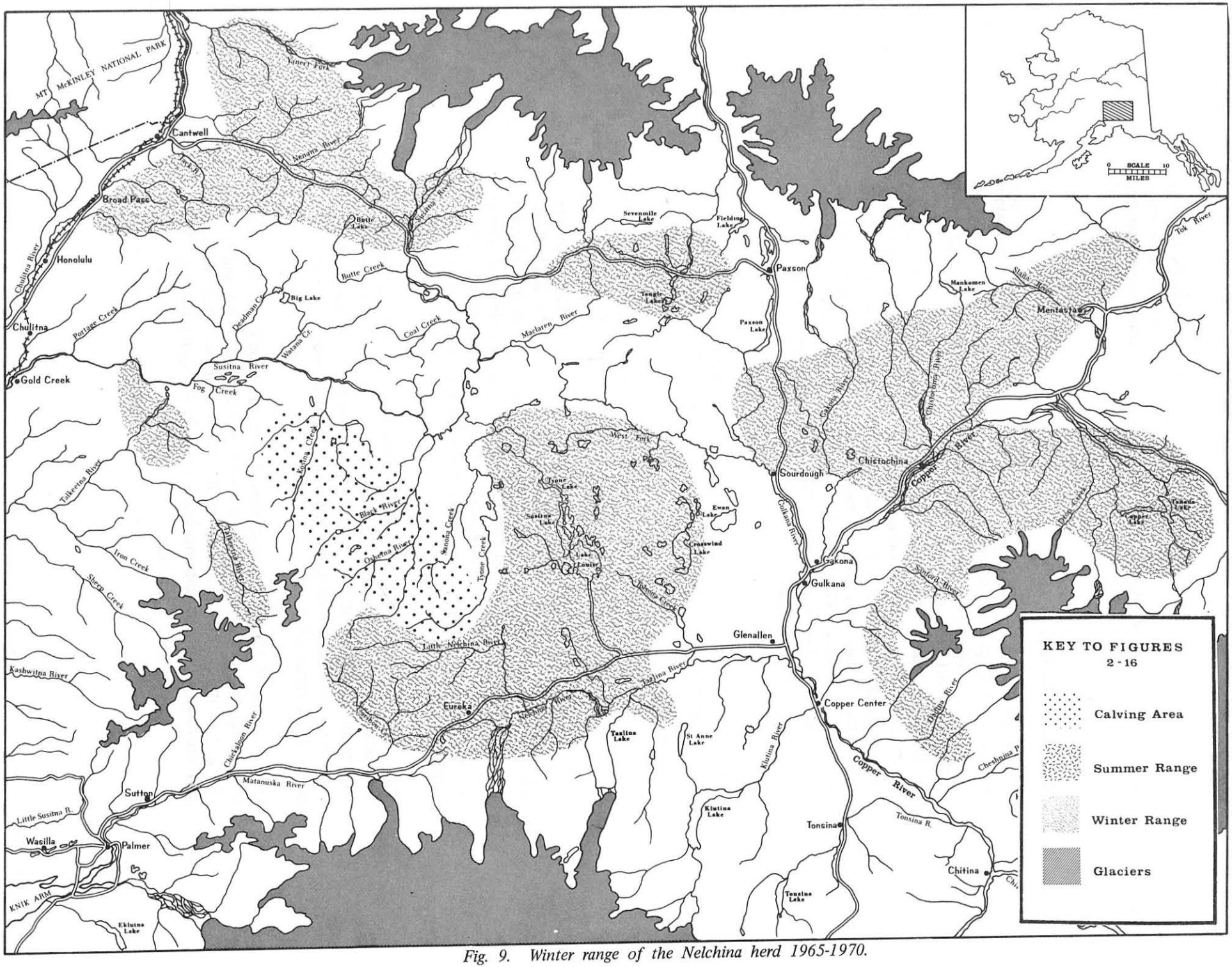


Fig. 9. Winter range of the Nelchina herd 1965-1970.

The eastern portion of this area is drained by the Copper and Delta rivers. The western part is drained by the Matanuska, Nenana and Susitna rivers. Most streams head in mountain glaciers in the surrounding mountains and are swift, turbid and braided.

Winter Distribution

In late September, as the first snows of winter begin to fill high mountain valleys, caribou of both sexes and all age classes begin to form integrated bands in preparation for the rut and the move to lower elevations. The bulk of the rut lasts only two weeks, and by mid-October this herd is on the move again. From late October through November the animals generally make a clockwise swing across the Lake Louise Flat. Here they feed on sedges (*Carex sp.*) common along margins of the abundant ponds and lakes. During only four of the last 22 years did these caribou fail to traverse the Flat. The animals usually disperse from the Lake Louise Flat during late November and early December, and move to their respective wintering grounds. Usually they are established on their winter ranges by mid-January.

Prior to 1955 primary winter ranges occurred in the area bounded by the Denali Highway on the north, the Glenn Highway on the south, the Richardson Highway on the east and the foothills of the Talkeetna Mountains on the west (Fig. 6). From 1955 to 1960, however, this herd shifted to the northwest and west, utilizing winter ranges along tributaries of the Nenana and Susitna rivers and the upper Talkeetna River (Fig. 7). The herd grew rapidly during this period. Irregular movements were recorded in the winter of 1956-57, when approximately 15,000 caribou moved north from the Paxson area through Isabel Pass to Black Rapids Glacier in early December. By the end of December most had returned, but in January another round trip through the pass was observed (Skoog, 1957). It is unknown whether any of these animals remained north of the Alaska Range, but periodic aerial surveys failed to reveal any permanent shift.

By 1957 the previously favored wintering grounds on the Lake Louise-Ewan Lake Flats had become almost deserted, with only a few thousand caribou remaining. The bulk of the herd was then using the Deadman Lake-Butte Lake area. In addition stragglers and stray bands occurred throughout the range at all times of year.

In the winter of 1958-59 caribou moved into the Broad Pass area where some emigration from the main herd may have occurred. That winter part of the herd moved into the range of the Delta herd on Yanert Fork, but they returned to their traditional calving area in the spring (Skoog, 1959).

From 1960 to 1965 the herd shifted to the east. Skoog (1963) reported the first evidence of this eastward shift in the winter of 1961-62 when some animals moved as far east as Mentasta Pass in the Alaska Range and Tanada Lake in the Wrangell Mountains. However, a major portion of the herd used winter ranges near Cantwell until 1964 (Fig. 8). In the winter of 1963-64 a large group of caribou moved east through Mentasta Pass and was last seen along the Upper Tok River (Lentfer, 1965). It is not known whether any of these animals returned to the Nelchina area because severe weather precluded further aerial surveys. From 1965 to present, most of the herd has wintered on the north slopes of the Wrangell Mountains and the south slopes of the Alaska Range east of the Richardson Highway (Fig. 9).

In summary, the Nelchina herd shifted winter ranges from the Lake Louise-Ewan Lake Flats to an area approximately 90 miles northwest of Monahan Flats then later shifted 180 miles east to the Wrangell and Mentasta mountains. This almost constant changing of winter ranges by the Nelchina herd during the last 22 years represents a phenomenon that has undoubtedly characterized Alaska's caribou populations for centuries. Nevertheless, these distributional shifts of the Nelchina caribou are difficult to explain. In particular, one might wonder why the animals would cross some 50 miles of spruce-covered flats to reach the Mentasta Mountains. Probably none of the animals participating in the first move (1962-62) had visited the area previously.

Spring Migration

As the calving period approaches, scattered bands of females begin to congregate and move cross-country in long lines, single file, on deeply worn parallel trails. Timing of this precalving movement is variable, but in most years the migration begins in early April. Skoog (1968) suggested that the onset of spring migration may be triggered by the appearance of new plant growth on snow-free areas. This movement involves mostly the cow-calf segment of the herd, plus some young bulls. Adult bulls seem content to linger near the wintering grounds.

The main movement proceeds by the most direct route to the calving grounds. Since 1965 caribou have moved north, south, east and west from their respective winter ranges to reach the calving area. Animals moving westward from the Wrangell Mountains cross the Copper River just south of Chistochina and proceed across the Richardson Highway, crossing the Gulkana River between Sourdough and Paxson Lake. This movement continues through the Alphabet Hills and the Lake Louise Flats to the foothills of the Talkeetna Mountains. Animals from the north usually cross the Susitna River between the mouths of Deadman Creek and Jay Creek. Caribou wintering along tributaries of the Talkeetna River move north over the mountains to the upper Kosina River.

Late spring thaws may delay movement to the calving grounds. In 1964, for example, exceptionally deep snow and a late spring thaw resulted in most calves being born en route between the upper Nenana River and the traditional calving area (Lentfer, 1965).

As parturition approaches large migratory groups break into smaller ones and spread out over the calving area.

Calving

For more than two decades pregnant cows have returned from wintering areas to calve in a region of about 1000 square miles, extending from Kosina Creek southeastward to the Little Nelchina River (Figs. 6-9). This area is generally above timberline, rising from 3000 to 4000 feet above sea level. Grasses *(Calamagrostis sp.)*, sedges and forbs are abundant on the mountain meadows and willows *(Salix sp.)* and dwarf birch *(Betula sp.)* dominate the stream valleys, particularly at lower elevations. Timing of the arrival of caribou onto the calving grounds is closely tied to the emergence of the first green shoots on scattered snow-free areas. Most calves are born from 15 May to 10 June, with the peak occurring on 25 May (Skoog, 1968). Noncalving groups occur in every portion of the range during the calving period.

Summer Distribution

Shortly after calving the caribou aggregate into ever-larger groups. At first these groups are comprised of cows and newborn calves, which are gradually joined by peripheral groups of noncalving animals. Usually the postcalving concentration reaches maximum aggregation by the third week of June. Throughout this period the animals move gradually to higher elevations, taking advantage of fresh green forage exposed by the receding snow.

In July these caribou normally separate into somewhat smaller groups. Most of them remain on windswept ridges of the Talkeetna Mountains, but one segment of the herd usually moves north across the upper Susitna River to the benchlands of the Chulitna Mountains (Fig. 10). Each of these areas contains scattered patches of snow and ice and windy places where caribou can find relief from the summer hordes of biting insects. Whenever the wind stops the animals begin to mill around, often running in a confused mass. Meanwhile bulls and many yearlings frequent areas closer to the wintering grounds–the headwaters of the Nenana River, the upper reaches of the Chulitna Mountains, and south through the Talkeetna Mountains to the headwaters of Caribou Creek and the Chickaloon River. These animals are often observed on mountain summits and glaciers above the summer pastures of Dall sheep *(Ovis dalli)*.

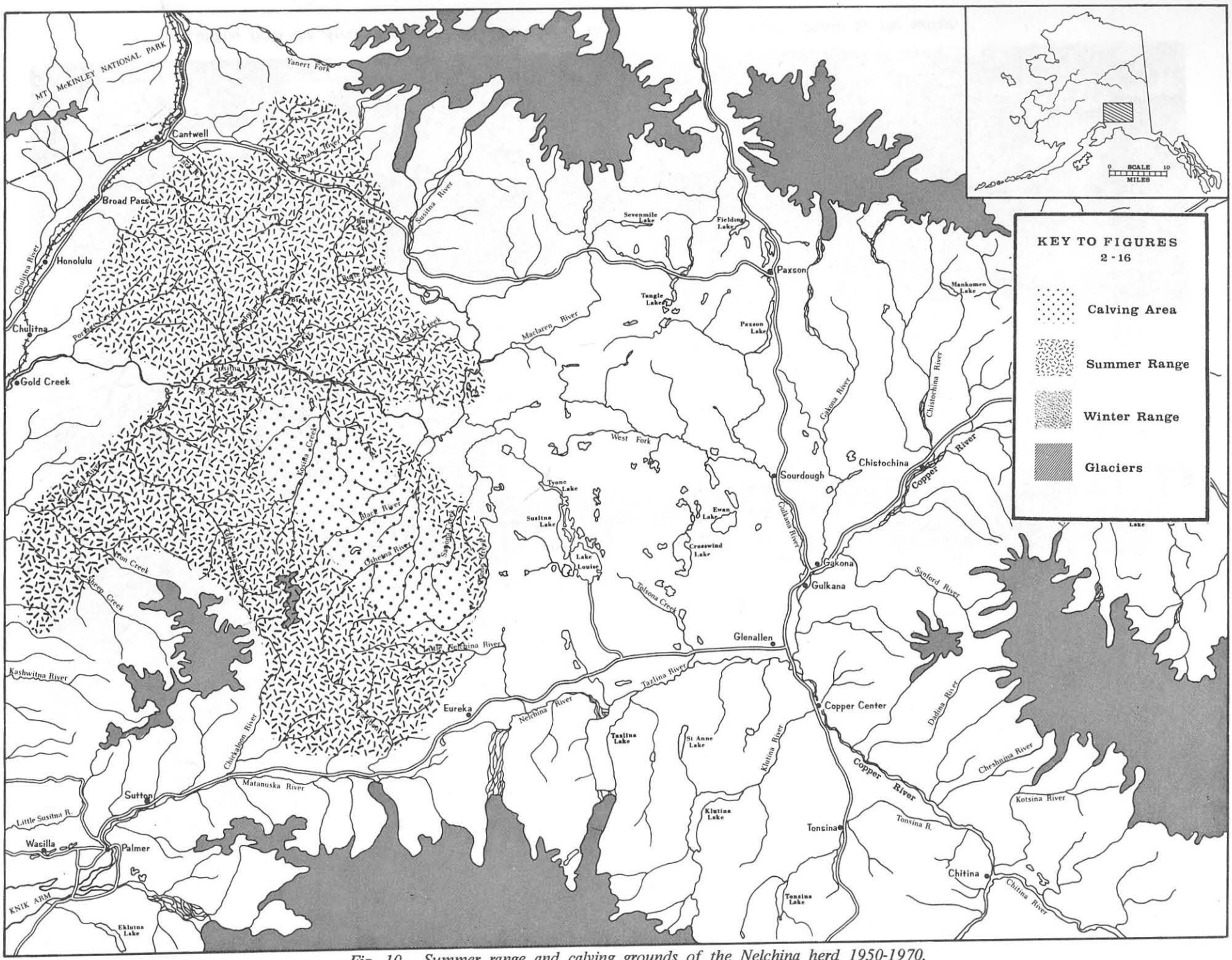
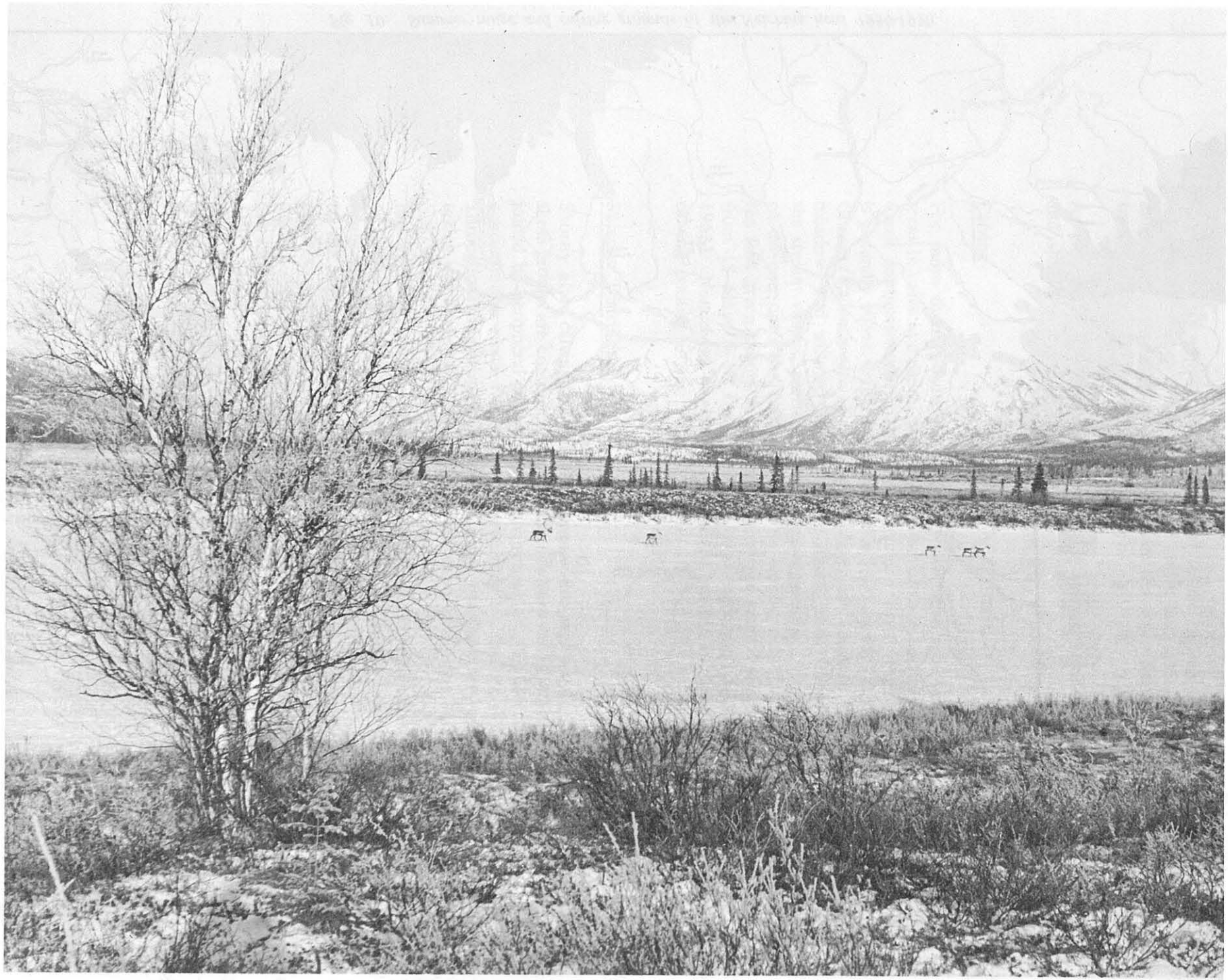


Fig. 10. Summer range and calving grounds of the Nelchina herd 1950-1970.



Caribou from the Arctic herd move into the edge of the boreal forest in winter. Photo by the author.

FORTYMILE HERD

In eastcentral Alaska and the Yukon Territory caribou are increasing in abundance. The Fortymile herd dwindled from a population of over half a million animals in the 1920's to a low of 10,000 to 20,000 in the early 1940's (Murie, 1935; Skoog, 1956). This decline was attributed to a shift to new ranges. From the late 1940's to the early 1950's the herd increased to approximately 50,000 animals (Skoog, 1956). The herd has not been censused since that time and its present status is unknown.

Even though caribou moved regularly through the gold fields of the Klondike and the Fortymile at the turn of the century, few men bothered to record observations of these movements. Thus early records are scanty. From the late 1800's to the 1930's, the herd ranged from the Yukon Flats southeast to Whitehorse and from the Dawson and Ogilvie mountains to the Copper River Basin (Osgood, 1909; Stuck, 1914, 1917; Murie, 1935; Palmer, 1940, 1941; Soper, 1951b; Skoog, 1956). This range included large portions of areas presently occupied by the Delta, Nelchina and Porcupine caribou herds. Later, as the population decreased, its range also diminished. Since 1941 the herd has moved essentially within the area between the Yukon and Tanana rivers (Skoog, 1956).

In 1952 intensive studies of this herd were initiated by the Alaska Cooperative Wildlife Research Unit, University of Alaska and the U. S. Fish and Wildlife Service. After 1959 the Alaska Department of Fish and Game continued studies on the Fortymile caribou herd. Most of the information presented here was derived from these studies.

The Area

The Fortymile caribou herd presently occupies an area of approximately 35,000 square miles in eastcentral Alaska and westcentral Yukon Territory. Within the range of the Fortymile herd temperature extremes range between 95°F and -60°F. Annual precipitation is low, averaging about 9 inches.

The Tanana Hills of Alaska and the Klondike Plateau of Yukon Territory consist of rounded, even-topped ridges with gentle side slopes. In the western part of this herd's range ridges and mountains rise to altitudes of 4,000 to 5,000 feet. Ridges in the eastern part are 3,000 to 5,000 feet high, but some domes reach 6,800 feet. The Ogilvie Mountains to the northeast are rugged, with precipitous slopes and deep, narrow valleys. There are no glaciers and the entire area is underlain by discontinuous permafrost. A few lakes are present, usually in valley floors and low passes. Dense forests of spruce and birch cover essentially all areas below 2,500 feet.

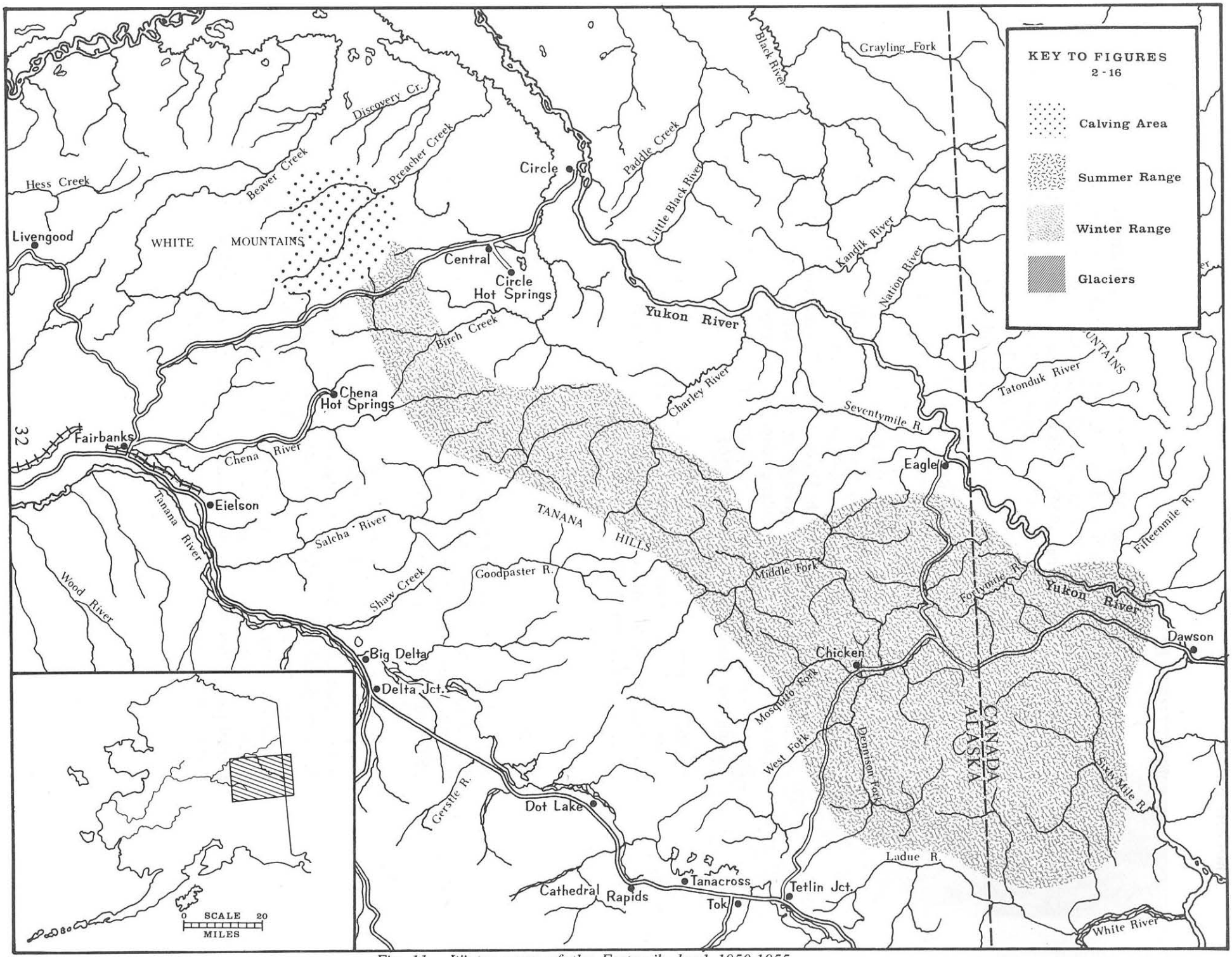


Fig. 11. Winter range of the Fortymile herd 1950-1955.

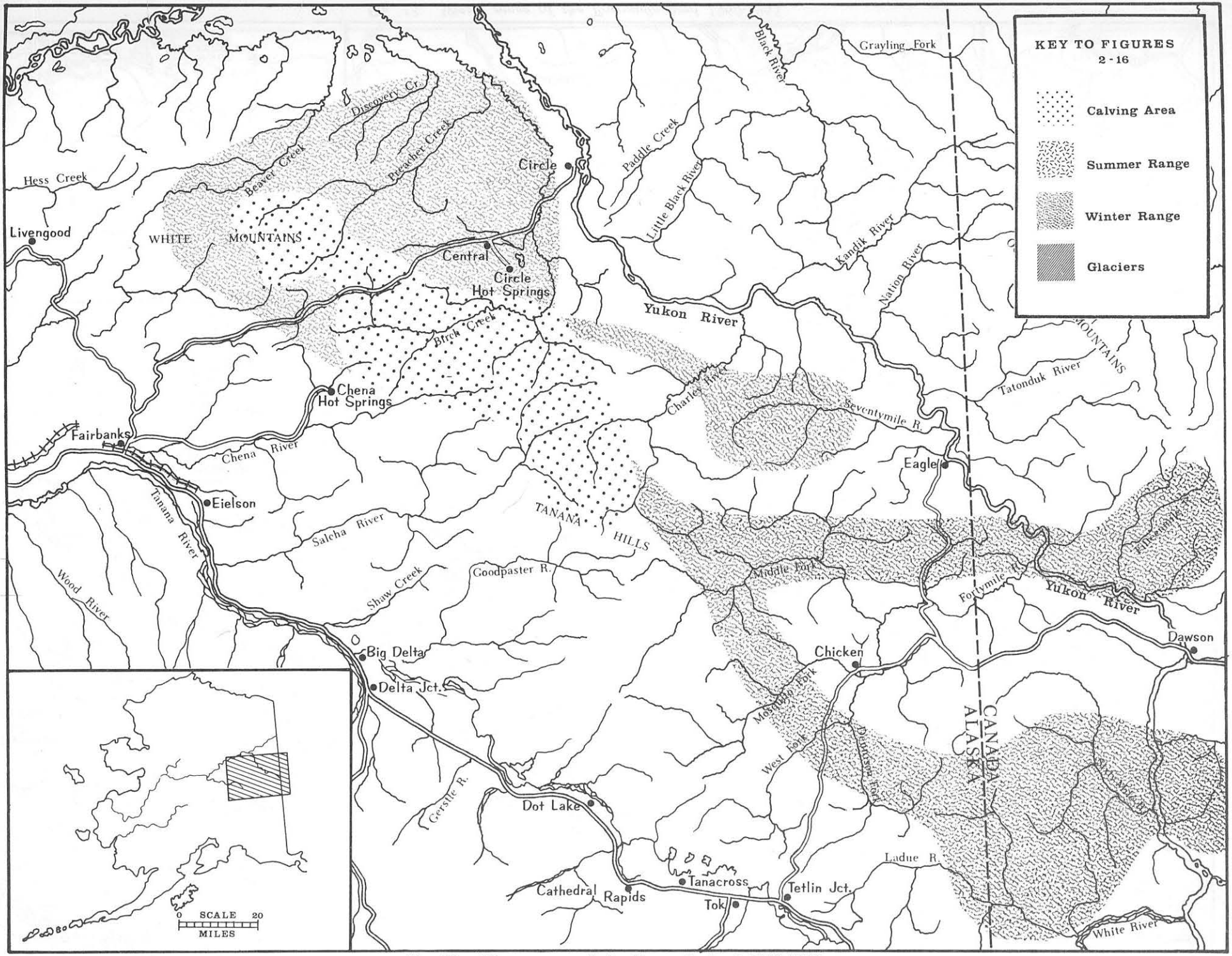


Fig. 12. Winter range of the Fortymile herd 1955-1960.

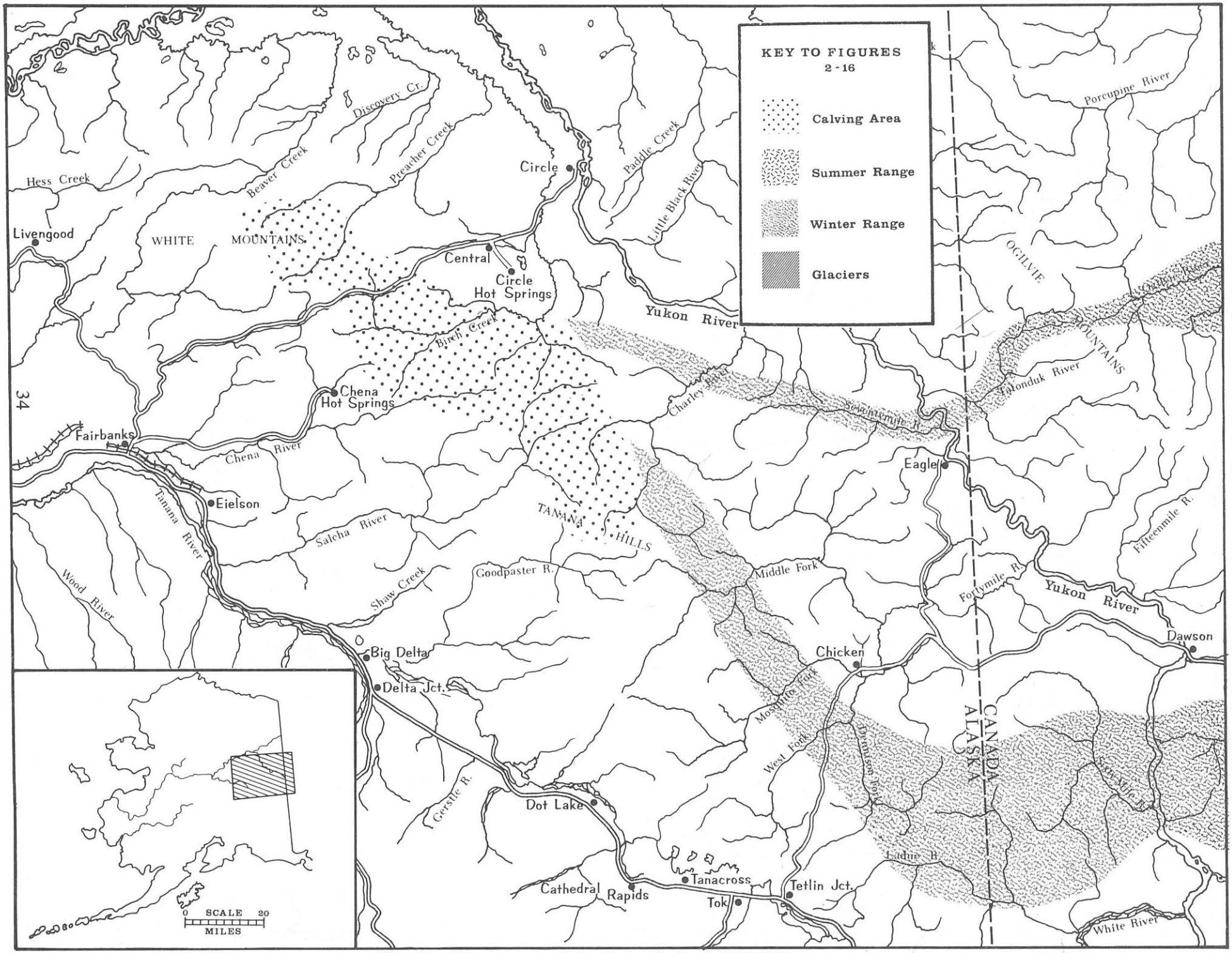


Fig. 13. Winter range of the Fortymile herd 1960-1965.

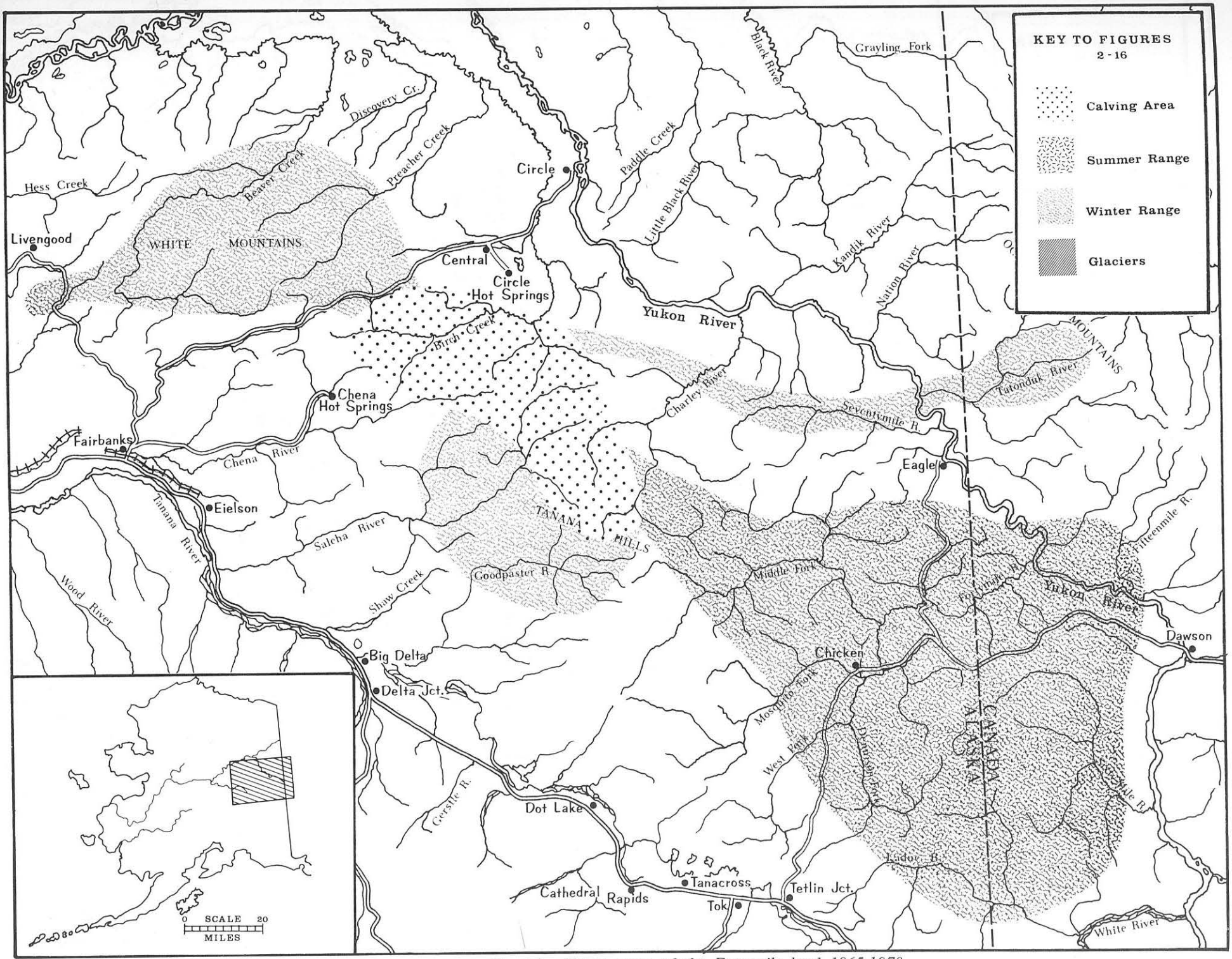


Fig. 14. Winter range of the Fortymile herd 1965-1970.

Winter Distribution

Shortly after the rut, as adult bulls begin to shed their antlers, many of these caribou leave the Tanana Hills and move into Canada for the winter.

The Fortymile herd is probably the least predictable of Alaska's caribou herds, and wintering areas have changed almost annually since 1952. Regardless, the Ladue River-Sixtymile River country has been the most important winter range since the 1930's (Murie, 1935; Olson, 1957, 1958, 1959b; Skoog, 1956, 1960, 1961, 1963, 1964; Lentfer, 1965; McGowan, 1966; Glenn, 1967).

From 1951 to 1955 the herd moved essentially as one unit to the Ladue River-Sixtymile River area in winter (Fig. 11). After 1955 the herd often split and moved to widely separated winter ranges in Alaska and Canada. Some moved eastward into the Dawson and Ogilvie mountains, while others wintered on the Yukon Flats, the White Mountains and the upper reaches of the Seventymile River (Fig. 12). In the winter of 1956-57, a major part of the herd wintered in the Ogilvie Mountains north of Dawson. Skoog (1968) estimated that about 30,000 of these animals moved north with the Porcupine herd the following spring.

From 1960 to 1965 winter movements often extended far into Canada. In 1960, 1962 and 1964 a portion of the herd crossed the Ogilvie Mountains, with some moving as far east as Hungry Lake on the Peel River Plateau. In the winter of 1964 some of these animals joined the Porcupine Herd. During the same period winter movements also extended into the Dawson Mountains (Fig. 13).

After 1965 major winter ranges included the Ladue River-Sixtymile River area, the foothills of the Ogilvie Mountains north of Dawson, the headwaters of the Goodpaster and Salcha rivers and the White Mountains (Fig. 14). In the winter of 1965-66, a few animals moved northwest to the Sawtooth Mountains south of Livengood.

Spring Migration

From March through April, while large rivers are still frozen, these caribou leave their respective winter ranges and move toward calving grounds. Major spring movements are directed northwest along the summit of the Tanana Hills. There are few barriers to caribou movement in this area and pregnant cows merely follow the path of least resistance to their calving grounds (Figs. 11-14).

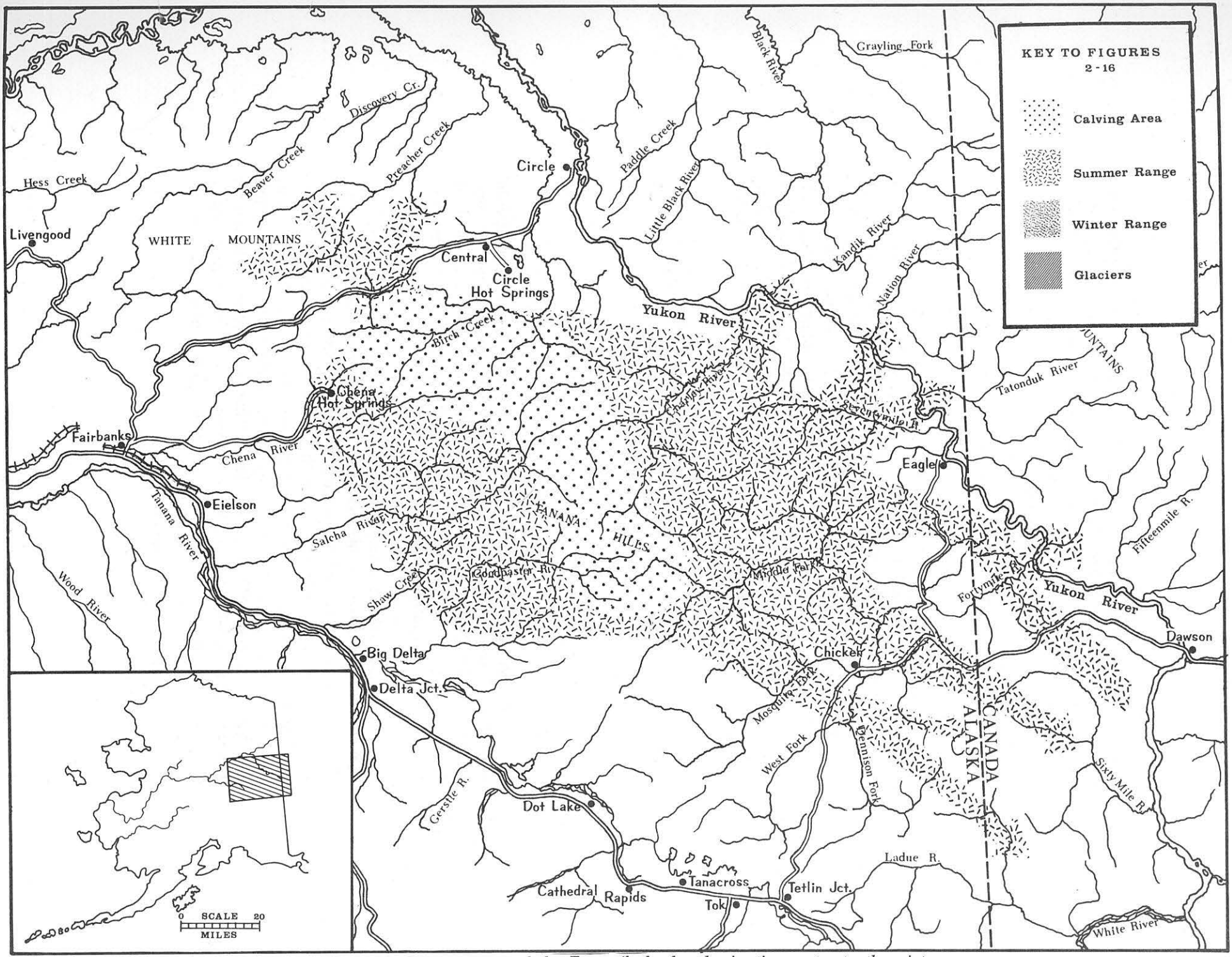


Fig. 15. Summer range of the Fortymile herd and migration routes to the winter range.

Spring migration is sometimes delayed by excessive snow accumulation and/or late spring thaw. In the winter of 1958-59 a large segment of the Fortymile herd wintered far to the east in Canada. That spring many caribou remained in Yukon Territory during the calving period, but the following year most of these animals returned to their traditional calving area (Skoog, 1960 and 1961). In 1962 heavy snow again delayed spring movements through the Tanana Hills and calving occurred en route.

Calving

During the 18 years before 1965 the calving area of the Fortymile herd shifted gradually toward the southeast (Skoog, 1956, 1960, 1961, 1963, 1964; Jones, 1963; McGowan, 1966; Glenn, 1967; Hemming and Glenn, 1968). In the early 1950's essentially all calving occurred in the White Mountains northwest of the Steese Highway (Fig. 11). However, from 1955 to 1963 calving activity extended from the White Mountains southeast across the Steese Highway to the highlands at the heads of the Salcha, Chena and Charley rivers (Figs. 12 and 13). Since 1963 essentially all calving activity has occurred southeast of the Steese Highway in the Tanana Hills (Fig. 14).

Calves are born from 15 May to 10 June on grassy meadows often laced with dwarf birch and low willows. The peak of calving occurs about 25 May (Skoog, 1968). The present calving grounds include an area of approximately 2,000 square miles.

Summer Distribution

Soon after calving these caribou form into increasingly larger groups and then disperse over the rolling mountains and hills encompassing the upper portions of the Chena, Salcha, Charley, Goodpaster and Fortymile rivers. Normally they remain on summer range until September when they begin to drift toward wintering areas.

In 1954 an unusual movement was observed (Skoog, 1956). Shortly after calving this herd moved southeast toward the Taylor Highway. In July the herd moved across the Eagle Road and Taylor Highway and into Canada. In late August and early September they returned to Alaska and moved northwest through the Tanana Hills and across the Steese Highway. Late in September they turned around again and moved back into Canada. Another movement north across the Taylor Highway occurred in November and the animals finally stopped to winter between Birch Creek and Charley River. During the two round trips the herd moved over 1,000 miles.

Fall Migration

In September many of the caribou leave the highlands of the Tanana Hills and drift toward distant winter ranges. Principal movements are to the southeast toward the Eagle Road and the Taylor Highway (Fig. 15). Caribou usually reach this road system in October and continue to cross well into November. The rut occurs en route and the pace of movement quickens after that period. Animals wintering to the north of their summer range usually cross the Steese Highway between Eagle Summit and Twelvemile Summit. Some animals remain in the Tanana Hills throughout the fall and winter period.

ALASKA PENINSULA HERD

The caribou herd on the Alaska Peninsula has increased from a low of about 2,500 animals in the late 1940's (Nelson, 1949) to a population of 14,000 in 1968, including 1,500 on Unimak Island (Hemming and Glenn, 1969). This herd consists of three segments: one north of Port Moller; one south of Port Moller; and one ephemeral population on Unimak Island. Caribou reach Unimak from the Alaska Peninsula by swimming about 1/2 mile across Isanotski Strait. Movements back and forth across the Strait have been fairly well documented since the late 1800's (Skoog, 1968).

In the mid 1800's caribou were abundant on coastal areas near Bristol Bay and along both sides of the Alaska Peninsula. Trading posts at Fort Alexander, located at the mouth of the Nushagak River and at Ugashik did a brisk business in caribou skins (Elliott, 1875 and 1897; Nelson and True, 1887; U. S. Census Office, 1893; Murie, 1959). At that time caribou moved seasonally on and off the Peninsula. By the turn of the century, however, large migrations across the Kvichak River had stopped and caribou moved only as far north as Becharof Lake (Osgood, 1904). Traders then shifted their operations to the tip of the Peninsula (Osgood, 1904; Radclyffe, 1904). In the early 1900's caribou numbers on Unimak Island reached full carrying capacity and most of the herd remained on the southwestern portion of the Alaska Peninsula (Murie, 1935). Later the animals shifted to the northeast, a move that may have been precipitated by the heavy volcanic activity occurring between 1929 and 1931 near Port Moller (Powers, 1958; Skoog, 1968).

Domestic reindeer were introduced to the Alaska Peninsula in 1932 (Rood, 1945), but this industry lasted only a few years. Apparently overgrazing in the late 1920's combined with extreme icing conditions and deep snow in the winter of 1938-39 resulted in heavy losses of both reindeer and caribou (Burdick, 1940; Rood, 1942). Caribou and reindeer populations reached a low during the 1940's and remaining reindeer herds were abandoned at this time. The Alaska Peninsula caribou herd has increased steadily since 1949 (Nelson, 1949; Skoog, 1963 and 1968; Hemming and Glenn, 1969).

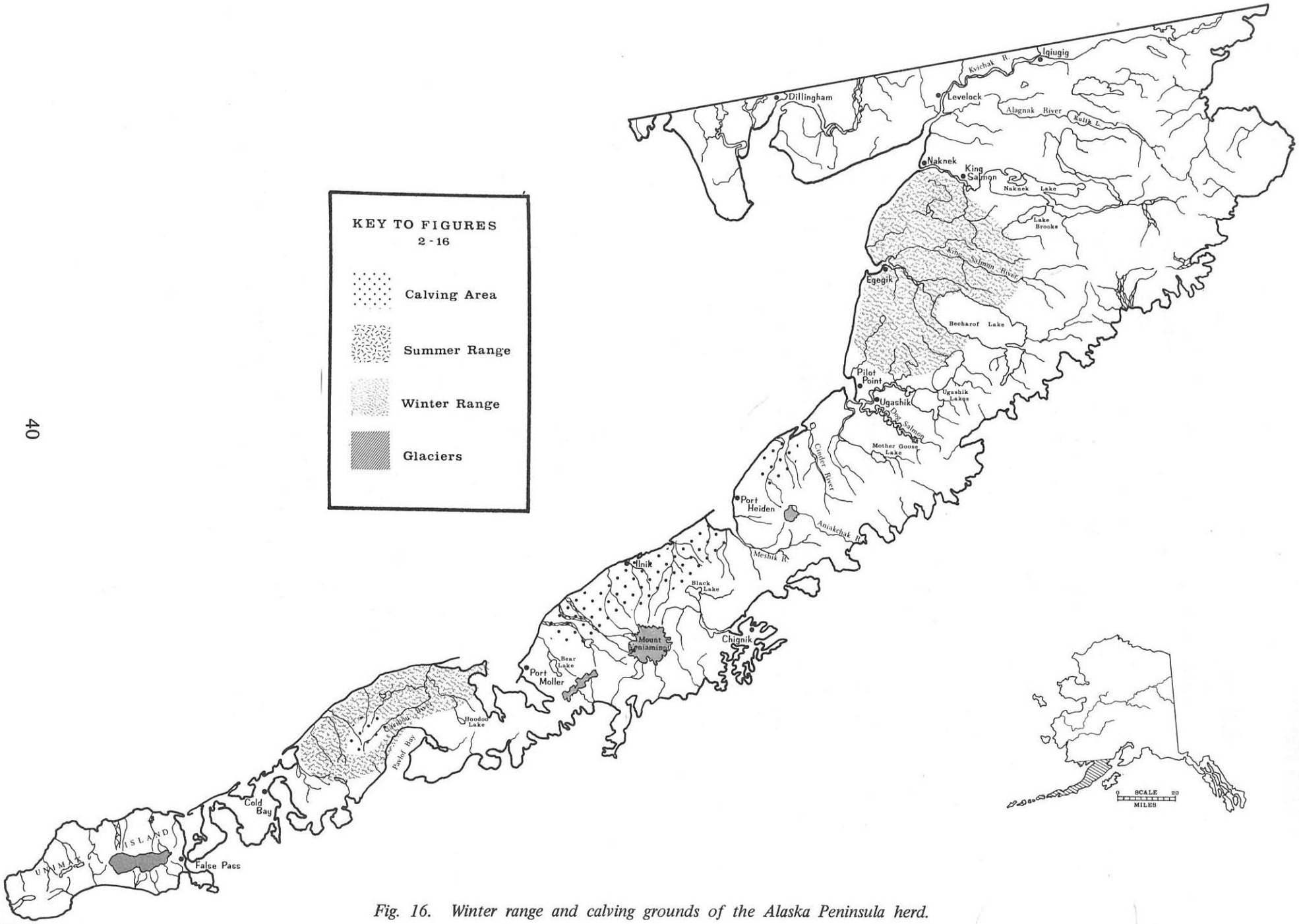


Fig. 16. Winter range and calving grounds of the Alaska Peninsula herd.

The Area

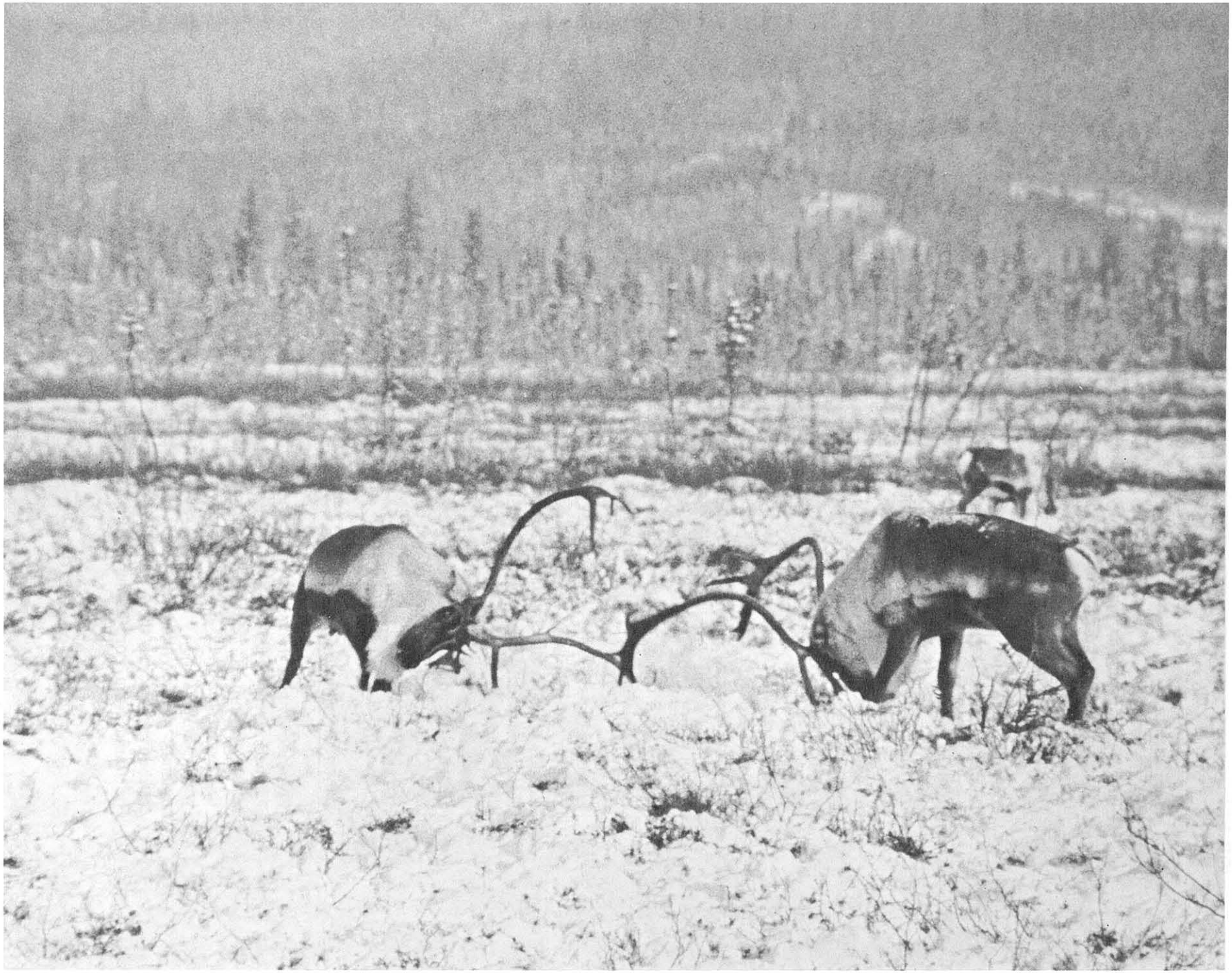
The Alaska Peninsula herd presently ranges over an area of about 30,000 square miles extending from Naknek Lake southwest to and including Unimak Island. Summers are cool and wet, with abundant storms moving through the area from both the Bering Sea and the Pacific Ocean. Winters are long but mild compared to those of Interior Alaska. Snow cover is relatively light, but severe icing conditions may occur periodically. Within the range of the Alaska Peninsula herd temperature extremes range between 80°F and -35°F. Annual precipitation averages about 30 inches.

The Alaska Peninsula is bounded on the northwest by the Bering Sea and the southeast by the Pacific Ocean. The rugged Aleutian Range, 1,000 to 4,000 feet in elevation, parallels the Pacific Coast for the entire length of the Peninsula, surmounted at intervals by volcanoes rising to peaks of 4,500 to 8,500 feet. Most volcanoes have glaciers on all sides and some have summit ice fields. The western portion of the Peninsula slopes gradually toward the Bering Sea. The northeast half contains many lakes and land adjacent to the Bering Sea is relatively flat and poorly drained; the southwest half is better drained and has fewer lakes. Mountains traverse the Peninsula at Port Moller, presenting the Peninsula's only barrier to caribou movement. Passes through the mountains are common along the entire length of the Aleutian Range. On the Pacific side, these mountains end rather abruptly at the sea, leaving a rugged coastline.

Spruce forests extend south as far as Becharof Lake. From the Naknek River to the tip of the Peninsula lowland areas are dominated by wet sedge meadows, interspersed with heath *(Cassiope sp.)* on the drier sites and willow along streams and river courses. At higher elevations toward the mountains heath, willow, alder *(Alnus sp.)* and grass communities become more abundant. Above 1,200 feet heath becomes dominant. Extensive volcanic cinder beds radiate in irregular lines on slopes surrounding Aniakchak Crater, Mt. Katmai, Mt. Veniaminof and others. Bare rock is common above 2,000 feet elevation.

Winter Distribution

Preferred winter ranges are on the lowlands between the Ugashik and Naknek rivers (Fig. 16). Sedges are numerous on these poorly-drained coastal plains and provide the most abundant winter food. However, in the region north of Becharof Lake lichens offer attractive winter forage where they occur as understory vegetation in the spruce forests of the drier uplands. Winter movements may extend as far north as King Salmon, but caribou rarely cross the Naknek River (Skoog, 1961). Scattered bands may be found from Port Moller to Pilot Point throughout the winter.



A sparring match between adult bulls during the rutting period. Photo by author.

Snow accumulations are usually light on the Peninsula and normally do not restrict caribou movements. However, coastal storms can result in severe icing conditions during some winters and may inhibit feeding activities over large areas.

The caribou presently occupying the area south of Port Moller winter on the marshy lowlands traversed by the Caribou River and west along the foothills north of Pavlof Volcano (Fig. 16).

On Unimak Island caribou frequent the lowland areas in winter.

Spring Migration

Instead of displaying the rapid and direct migration to the calving grounds typical of most other Alaskan caribou herds, the Alaska Peninsula herd begins a leisurely drift to the southwest in February or March. This spring drift spans a broad front, at times covering much of the coastal plain, but most cows follow a straight line paralleling the coast between the mouths of the Ugashik and Meshik rivers. Most cows reach the calving grounds by mid-May.

Calving

The segment of the Alaska Peninsula herd north of Port Moller calves on the coastal plains between Bear River and Port Heiden Bay. Occasionally some calving occurs between Port Heiden and Cinder River (Fig. 16).

South of Port Moller, the calving area is located on the slopes of Trader Mountain at the head of Caribou River (Fig. 16). No regular calving area has been identified on Unimak Island. The calving period lasts from 20 May to 15 June and peaks about 1 June (Hemming and Glenn, 1969).

Summer Distribution

Most of the cows and calves remain near calving areas from May through July, but bulls and yearlings scatter widely and may be found throughout the Aleutian Range and from coast to coast.

Fall Migration

In late August these caribou shift to the northeast. Cows and calves are the first to move. Movements proceed along the same coastal route used in the spring. As cows move northward they are joined by ever-increasing numbers of bulls and yearlings. Bands of adult bulls often lag far behind the cows and calves. By mid-September some caribou have reached the area near Becharof Lake but many still remain between Port Moller and Port Heiden. In October the bulls increase their pace to join with the cows for the rut. By mid-December most animals occupy a common winter range between the Ugashik and Naknek rivers.

MCKINLEY HERD

The McKinley caribou herd of Southcentral Alaska is relatively small at this time. Its population was estimated at 30,000 in 1941 (Murie, 1944), 12,000 in 1963 (Skoog, 1963) and limited observations in recent years suggest that the herd may now contain less than 10,000 animals.

The Area

This herd presently occupies an area of over 6,000 square miles extending westward from the eastern boundary of Mt. McKinley National Park to the North Fork of the Kuskokwim River, northward to Chitsia Mountain and southward as far as Rainy Pass. The region north of the Alaska Range is noted for cold winters and moderate snowfall. South of the Range winter temperatures are warmer but snowfall is heavy. Within the range of the McKinley herd temperature extremes range between 90°F and -45°F. Annual precipitation averages about 14 inches.

The central part of the Alaska Range consists of rugged glaciated ridges, 6,000 to 9,000 feet high, surmounted by groups of extremely rugged glacier and snow-capped mountains more than 9,500 feet in altitude. Mt. McKinley, rising to a summit of 20,269 feet, is the highest mountain in North America. Here the north and west parts of the Range drain to the Tanana and Kuskokwim rivers, while the south flank drains into the Susitna River.

The broad Tanana-Kuskokwim lowlands lie between the Alaska Range and the Kuskokwim Mountains. They are laced with braided glacial streams and are dotted with ponds and lakes.

The Kuskokwim Mountains are a monotonous succession of northeast-trending ridges with rounded to flat 1,500 to 2,000 foot summits and broad, gentle slopes. These mountains are drained by tributaries of the Yukon and Kuskokwim rivers. Spruce and birch forests cover most areas below 2,500 feet elevation.

Winter Distribution

Records of the winter distribution and movements of the McKinley herd are sketchy at best, but by consolidating all available information a definite pattern becomes evident.

Prior to 1931, when the herd was estimated at over 30,000 animals, several widely separated winter ranges were utilized. Part of the McKinley herd wintered in the Broad Pass area south of the Alaska Range while the remainder utilized the hills and lowlands near Lake Minchumina and the northern Kuskokwim Mountains (Brooks and Prindle, 1911; Riggs, 1920; Bone, 1923; Capps, 1927; Sheldon, 1930; Murie, 1944). From 1931 to 1961 winter movements were mostly north and west of the Alaska Range, centering in the Lake Minchumina area (Alaska Game Commission, 1931; Murie, 1935, 1944; Skoog, 1968). Since 1962 the herd has not reached the Lake Minchumina area (Murie, 1962; Prasil, 1968; Skoog, 1968). In recent years caribou have wintered in the foothills between the Nenana and Kantishna rivers and the foothills between the Little Tonzona River and Slippery Creek. Apparently the latter area carries the greatest number of caribou.

Spring Migration

In spring the animals move toward Mt. McKinley National Park. Caribou that wintered to the southwest move northeast along the foothills, while animals that wintered north of the Park move south along stream and river courses between the Toklat and Sanctuary rivers.

Calving

Calving has been observed as far west as the McKinley River, but normally cows move to the open rolling tundra between the upper Savage and Teklanika rivers (Murie, 1944; Skoog, 1968). Calving has been observed from 12 to 22 June (Murie, 1944).

Shortly after calving cows and their new calves move over the Alaska Range between the Teklanika and Savage rivers, to the area between upper Cantwell Creek and the west fork of the Chulitna River. This area has a long history of early summer use (Alaska Game Commission, 1936; Murie, 1944, 1962; Skoog, 1968). Perhaps the phenology of plant growth on the south slopes of the Alaska Range offers an abundance of succulent forage during June.

Summer Distribution

In late June or early July these caribou again cross the Alaska Range and then swing west, parallel to the Park road. This is a leisurely drift that leads toward the western boundary of the Park. Some animals turn north in the vicinity of Muldrow Glacier while others continue west along the foothills. In August and September only a few animals remain in the Park.

MINOR HERDS

DELTA HERD

The north slopes of the central Alaska Range support a small herd of caribou that may be descendents of the Fortymile herd that ranged into this area during the 1930's (Skoog, 1968). The first estimate of the Delta herd's numbers was made in 1957 when Olson (1957) reported that the herd was increasing and contained 1,000 to 1,500 caribou. In 1963 this herd contained at least 5,000 caribou (Skoog, 1963).

The Delta caribou herd ranges over an area of about 3,000 square miles on the north slopes of the Alaska Range between the Alaska Railroad on the west and the Richardson Highway on the east. Here the brief summers are warm while winters are long and cold. Temperature extremes range between 80°F and -50°F. Annual precipitation averages about 12 inches.

The northern foothills of the Alaska Range are flat-topped ridges, 2,000 to 4,500 feet high, separated by rolling spruce-covered lowlands. This entire region drains to the Tanana River. A few small lakes lie in lowland passes and morainal areas have shallow, irregular ponds. The Alaska Range rises abruptly from the foothills and consists of rugged, glaciated ridges 6,000 to 9,000 feet in altitude, surmounted by groups of extremely rugged glacier-capped mountains more than 12,000 feet high.

In winter the Delta herd ranges widely over the foothills of the Alaska Range between Delta Creek and the Tatlanika River and northward onto the spruce-covered Tanana Flats (Olson, 1958; Lentfer, 1965; Skoog, 1968).

As the calving period approaches, cows and many short yearlings move into the upper portion of Little Delta River and Delta Creek. Here the calves are born above timberline (Skoog, 1968). Meanwhile bulls and other short yearlings remain widely scattered through the foothills and mountains from Yanert Fork of the Nenana River to Delta Creek. After calving the animals disperse widely through the central Alaska Range.

Between October 1966 and March 1968, 205 caribou from the Delta herd were marked with metal ear tags and plastic ear streamers by the University of Oklahoma - Department of the Army Project 1577. Marked animals have been observed repeatedly in recent years and several have been taken by hunters. None of the tagged caribou have been observed outside their normal range since 1966 (Hemming and Glenn, 1969). In some winters the Nelchina herd moves into the range of the Delta herd in the vicinity of Yanert Fork.

In midsummer caribou find relief from insect attacks on remnant patches of snow and ice. Photo by Harry Merriam

MENTASTA HERD

According to Skoog (1968), this small herd is a remnant of the Fortymile herd that ranged into the Mentasta Mountains until 1932. In 1965 the Mentasta herd contained approximately 5,000 caribou (Lentfer, 1965).

These animals range over an area extending from the Mentasta Mountains at the east end of the Alaska Range southward onto the western slopes of the Wrangell Mountains. Annual temperature extremes range between 90°F and -55°F. Precipitation averages 10 inches per year.

The Mentasta Mountains consist of a single ridge broken at intervals by low passes. Their northern slopes drain into the Tanana River and their southern slopes into the Copper River. The Wrangell Mountains are an oval group of glacier-capped volcanoes more than 12,000 feet in elevation. Between the Mentasta and Wrangell mountains the Copper River lowlands form a relatively smooth, forested plain, 1,000 to 2,000 feet high.

In winter, caribou range over alpine areas and sparsely covered spruce flats from the west slopes of the Wrangell Mountains north to the Gerstle River. Calving usually occurs on west slopes of Mount Sanford, between Boulder Creek and the Sanford River, but local bush pilots have observed some calving activity on the Macomb Plateau east of the Johnson River (Skoog, 1968; Hemming and Pegau, 1970). The peak of calving occurs during the last week of May. Since relatively few caribou surveys have been made in the Mentasta-Wrangell Mountains area, it is possible that several small relict herds are present there also. The distribution picture is further complicated by the shift of the Nelchina herd to the Wrangell Mountains each winter since 1965. Obviously, more work is needed in this area.

MULCHATNA HERD

The Mulchatna herd of western Alaska ranges south of the Kuskokwim River along the drainages of the Mulchatna, Nushagak and Stony rivers. This herd contains approximately 5,000 caribou (Skoog, 1963).

Since the mid-1800's, when caribou moved seasonally from the Alaska Peninsula into the area presently occupied by the Mulchatna herd, few caribou observations have been recorded. In 1967 the Alaska Department of Fish and Game in cooperation with the U. S. Bureau of Land Management began studies to record the distribution and movements of ~~the~~ Mulchatna herd. These studies were completed in 1970 and their results are presented here.

The Mulchatna herd presently occupies an area of about 20,000 square miles in western Alaska. Within the range of the Mulchatna herd temperature extremes range between 80°F and -30°F. Annual precipitation averages 22 inches.

The Nushagak-Big River Hills, west of the Alaska Range, are largely rounded, flat-topped ridges rising to an altitude of 1,500 feet on the west and 2,500 feet on the east. Vegetation here is strikingly different from that of the adjacent Alaska Peninsula. Spruce with lichen understory is common in river valleys, sedge is found only on lake margins and dry, rocky hilltops are carpeted with *Dryas* fell-field and lichen.

The northern part of the hills drains to the Kuskokwim River and the southern part drains into Bristol Bay. Ponds and lakes are common in the eastern part of the hills and between the lower Holitna River and Swift River. From Rainy Pass to Iliamna Lake in the Alaska Range there are many parallel ridges, 4,000 to 6,000 feet high, with some peaks reaching over 11,000 feet. Extensive valley glaciers radiate from the higher mountains. Many large lakes are found in glacial valleys on the margins of the Range.

From 1967 to 1970 their major wintering area extended from the Lime Hills along the Stony River to the Bonanza Hills at the head of the Mulchatna River. Smaller numbers of caribou were found along the lower reaches of the South and Windy forks of the Kuskokwim River, the marshy lowlands near the mouth of Swift River, Nushagak Bay near Clarks Point and along the Kvichak River just west of Igiugig. The latter observations were particularly interesting because until 1968 caribou had not crossed the Kvichak River since the turn of the century (Osgood, 1904; Murie, 1935; Hemming and Glenn, 1969).

In March and April the cows begin to move toward the calving area. Animals wintering far to the north move up the South Fork of the Kuskokwim and through the mountains to the head of Stony River; then due south to their calving grounds. There are no barriers to movement for animals wintering to the west and south of the calving area and they move by the most direct route to the calving grounds.

Calves are born in the Bonanza Hills and on the mountain slopes between Telaquana Lake and Twin Lakes. This area is above timberline and consists of rolling alpine tundra. Calving occurs throughout the month of May, peaking from 16 to 19 May (Hemming and Glenn, 1969; Hemming and Pegau, 1970).

After calving, the caribou shift to the north, south and west. By midsummer scattered bands may be found along the west slopes of the Alaska Range from Iliamna Lake to the Swift River, and west through the Nushagak-Big River Hills to the Aniak-Nishlik Lakes area.

No definite fall migration pattern has been recorded, except for a tendency for animals to drift toward the slopes of the Alaska Range during the breeding period.

BEAVER HERD

The Beaver caribou herd of western Alaska ranges over the northern portion of the Kuskokwim Mountains. At last estimate, the herd contained about 3,000 caribou (Skoog, 1963).

The Kuskokwim Mountains have not supported many caribou during recent times. However, in the 1840's large herds occurred along the Innoko River (Lutz, 1960). By the early 1900's few caribou remained in the Beaver and Sischu mountains, but many old trails were still evident (Dice, 1921; Eakin, 1918). Scott (1952) reported small numbers of caribou in the Kuskokwim Mountains west of McGrath. This area had been occupied by the Twitchell reindeer herd in the 1930's. The Twitchell herd was abandoned in the early 1940's and the animals probably integrated with wild caribou in the area. Animals now occurring in the Beaver and Sischu mountains have the general appearance of wild caribou, but an animal with a pinto coat was observed during caribou surveys in 1969, suggesting that at least one of the characteristics of domestic reindeer is still being expressed. The herd presently ranges over 50,000 square miles in the Kuskokwim Mountains north of the villages of Georgetown and Stony River.

Winters are long and cold, but summers are short and mild. Annual temperature extremes range between 90°F and -55°F. Annual precipitation averages about 16 inches.

This region is covered by spruce forests interspersed with occasional alpine areas above 2,500 feet. There are two isolated groups of rugged mountains 3,000 to 4,500 feet high. The Beaver Mountains lie 40 miles west of McGrath and the Sischu Mountains stretch toward the northeast in an area about 37 miles north of Telida. The highlands are drained by tributaries of the Kuskokwim and Yukon rivers. Valleys are broad and flat. Lakes are few, but there are oxbow and thaw lakes in the valleys and a few cirque lakes in the mountains. There are no glaciers and most of the region is underlain by permafrost.

Based on limited observations since 1969, the Beaver herd winters in the area bounded by McGrath on the east, the Dishna River on the west, Cloudy Mountain on the north and upper George River on the south. Areas of fairly intensive use are the Nixon Fork-Takotna River flats, the Dishna-Innoko River flats and the upper George River area. Irregular use is made of the area between the Kuskokwim and Takotna rivers. Scattered small bands may be found throughout the Kuskokwim Mountains. As with most small caribou herds, no definite seasonal movements have been observed.

In the spring of 1969 the first calving observations were recorded (Hemming and Pegau, 1970). Calving occurred along the crest of the Beaver Mountains. Shortly after calving the animals dispersed to the north.

In summer this herd is widely scattered over alpine and subalpine ridges throughout the Kuskokwim Mountains. During the fall caribou have been observed along the Dishna, George, and Nixon rivers and in the Horn Mountains, 40 miles northeast of Aniak.

CHISANA HERD

The Chisana herd contains approximately 3,000 caribou (Skoog, 1963). During the late 1920's and early 1930's great numbers of caribou from the Fortymile herd moved into the Nabesna-White River country each fall. When these movements ceased in the early 1930's remnant groups of caribou remained on the northeastern slopes of the Wrangell Mountains. This herd is thought to have been developed from such groups (Skoog, 1968).

These animals now range through the Nutzotin Mountains along tributaries of the Chisana and White rivers. The Nutzotin Mountains consist of a single ridge 4,000 to 8,000 feet high, broken at intervals by low passes. The Chisana and Nabesna river systems drain to the Tanana River, but the White River flows directly into the Yukon River. Extensive glaciers capping the Wrangell Mountains form an effective barrier to westward caribou movement. Annual temperature extremes range between 95°F and -65°F. Annual precipitation averages about 7 inches.

No seasonal movement pattern has been recorded except for an altitudinal shift between winter and summer ranges. Local guides report that calving occurs from the benchlands along Sheep Creek on Mt. Sulzer to the rolling hills north of Ptarmigan Lake. In July, during the fly season, small bands of caribou are often found on nearby glaciers where low temperatures offer relief from biting insects.

INTRODUCED HERDS

ADAK HERD

In 1958 and 1959 the U. S. Fish and Wildlife Service, with cooperation from the National Military Establishment, transplanted 23 caribou calves from the Nelchina herd to Adak Island (Jones, 1966). These animals first produced calves in 1960 and by 1967 the Island contained 189 caribou. At the present time 50 animals are removed from the population each year to sustain a summer herd of 200 animals.

Adak Island is one of the Andreanof Islands in the central Aleutians. It has a land area of about 290 square miles and its coastline is deeply indented with bays and inlets. Adak's climate is characterized by a prevalence of fog and heavy overcast, with frequent rain in the summer and rain or slushy snow in the winter. Violent winds often arise suddenly. Annual temperature extremes range between 12°F and 70°F. Annual precipitation averages about 55 inches.

Rugged mountains, with summits over 1,900 feet high, occupy the central part of the Island. These mountains are surrounded by extensive rolling lowlands that are covered with lush alpine vegetation including sedges, grasses, mosses, lichens, heath shrubs and forbs.

Since 1959 the Adak herd has gradually expanded its range and now occupies the entire Island, except for the U. S. Naval Station on its northeast coast (Hemming and Glenn, 1968).

The total lack of biting insects, coupled with a low caribou population, abundant forage and unobstructed movements, results in the achievement of maximum growth and development by the animals. On 16 September 1968, an adult male weighing 700 lbs. (whole body weight) was killed. This is apparently the heaviest caribou ever recorded in North America.

KENAI HERD

Caribou occurred on the Kenai Peninsula until the early 1900's. Apparently loss of habitat, due to extensive fires, and intensive hunting around the turn of the century caused the herd to decline rapidly (Allen, 1901). Caribou became extinct on the Kenai Peninsula about 1913 (Spencer and Hakala, 1964).

The Kenai Peninsula includes an area of about 9,000 square miles. The Kenai Mountains on the east are heavily glaciated and rise to altitudes of 6,000 feet. Extensive spruce-birch covered lowlands dotted with lakes lie to the west. Annual temperature extremes range between 90°F and -30°F. Annual precipitation averages about 18 inches.

In the early 1950's the U. S. Fish and Wildlife Service conducted feasibility studies to determine if historic caribou ranges on the Kenai Peninsula would again support caribou (Alaska Game Commission, 1952). Suitable range was found in the Chickaloon River-Mystery Creek area, the Skilak-Tustumena Lake area and the Caribou Hills north of Homer. These areas were reappraised in 1964 by the Alaska Department of Fish and Game and the U. S. Fish and Wildlife Service.

In May 1965, 15 caribou were released near the Chickaloon River and in April 1966, 29 more were released at Watson Lake near Sterling (Glenn, 1967). This transplant was highly successful and since 1966 caribou have been observed at scattered points over the entire western half of the Kenai Peninsula.

At the present time the largest group, containing about 120 animals, occurs in the mountains south of Hope, between the headwaters of Resurrection Creek and the Chickaloon River. Smaller bands are present on the lowlands just north of Kenai Airport on the Moose River Flats, and near Indian Creek just east of Tustumena Lake. Based on population growth rates of other Alaskan caribou herds, the Kenai herd should contain at least 200 caribou by 1972.

LITERATURE CITED

Alaska Game Commission. 1931. Annual report of the Executive Officer to the Alaska Game Commission. U. S. Fish and Wildl. Serv., Juneau.

_____. 1936. Annual report of the Executive Officer to the Alaska Game Commission. U. S. Fish and Wildl. Serv., Juneau.

_____. 1952. Investigation to determine practicability of reestablishing caribou on the Kenai Peninsula. Fed. Aid in Wildl. Restoration Quarterly Rpt., 7(2):60-63.

Allen, J. A. 1901. Description of a new caribou from Kenai Peninsula, Alaska. Bull. Am. Mus. Nat. Hist., 14:143-148.

Banfield, A. W. F. 1951. The barren-ground caribou. Can. Wildl. Serv., Dept. Res. and Dev., Ottawa. 56 pp.

_____. 1961. A revision of the reindeer and caribou genus *Rangifer*. National Mus. Canada, Bull. 277, Ottawa. 137 pp.

Benson, C. S. 1969. The seasonal snow cover of arctic Alaska. Arctic Institute of N. Am. Tech. Rpt. (ONR-403:1). 86 pp.

Bone, S. C. 1923. Annual report of the governor of Alaska on the Alaska Game Law, 1922. U. S. Dept. Agr., Circ. 260. 7 pp.

Brooks, A. H. and L. M. Prindle. 1911. The Mount McKinley Region, Alaska. U. S. Geol. Survey, Prof. Paper No. 70. 234 pp.

Burdick, C. G. 1940. Report to the Secretary of the Interior, Reindeer Acquisition Unit. Alaska Native Service, Juneau. 33 pp.

Capps, S. R. 1927. The Toklat-Tonzona Region. U. S. Geol. Survey, Bull. 792(C):73-110.

Child, K. N. 1970. Impact of North Slope oil developments and trans Alaska pipeline on caribou movements, migrations, and habitat utilization. Alaska Cooperative Wildl. Res. Unit, Quarterly Prog. Rpt., 22(1):4-6.

DeVos, A. 1960. Behavior of barren-ground caribou on their calving grounds. J. Wildl. Mgmt., 24(3):250-258.

Dice, L. R. 1921. Notes on the mammals of interior Alaska. J. Mammal., 2(1):20-28.

Eakin, H. M. 1918. The Cosna-Nowitna Region. U. S. Geol. Survey, Bull. 667:1-54.

Elliott, H. W. 1875. A report upon the condition of affairs in the Territory of Alaska. U. S. Treasury Dept., Special Agents Div., Washington, D. C. 277 pp.

_____. 1897. Our arctic province. Charles Scribner's Sons, New York. 473 pp.

Funston, F. 1896. Along Alaska's eastern boundary. Harper's Weekly, 40(2041):103-104.

Glenn, L. P. 1967. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-15-R-1 and W-15-R-2, Juneau. 36 pp.

Harrison, A. H. 1908. In search of a polar continent. Musson Book Company, Toronto. 292 pp.

Hemming, J. E. and L. P. Glenn. 1968. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-15-R-2, Juneau. 41 pp.

_____. 1969. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-15-R-3 and W-17-1, Juneau. 37 pp.

Hemming, J. E. and R. E. Pegau. 1970. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-17-1 and W-17-2, Juneau. 42 pp.

Jones, F. F. 1963. Movements, distribution, and numbers. p. 63-66. In Caribou investigations. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-3, Juneau. 89 pp.

Jones, R. D. 1966. Raising caribou for an Aleutian introduction. J. Wildl. Mgmt., 30(3):453-460.

Kelsall, J. P. 1968. The migratory barren-ground caribou of Canada. Queen's Printer, Ottawa. 340 pp.

Klein, D. R. 1970. Tundra ranges north of the boreal forest. J. Range Mgmt., 23(1):8-14.

Lent, P. C. 1966. The caribou of northwestern Alaska, p. 481-517. In N. J. Wilimovsky and J. N. Wolfe (eds.), Environment of the Cape Thompson Region, Alaska. U. S. Atomic Energy Comm., Washington. 1250 pp.

Lentfer, J. 1965. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-5,6, Juneau. 20 pp.

Lutz, H. J. 1960. Early occurrence of moose on the Kenai Peninsula and in other sections of Alaska. U. S. Forest Serv., Alaska Forest Res. Ctr., Misc. publ. No. 1, Juneau. 25 pp.

McEwan, E. H. 1952a. Report on the caribou in the area west of the Mackenzie Delta. Can. Wildl. Serv., unpubl. monthly rpt. January 15, 1952. 4 pp.

_____. 1952b. Barren-ground caribou survey from Aklavik to Babbage River on April 18, 1952. Can. Wildl. Serv., unpubl. monthly rpt. 3 pp.

_____. 1952c. Barren-ground caribou survey from Fort McPherson on April 19, 1952. Can. Wildl. Serv., unpubl. monthly rpt. 2 pp.

_____ and A. J. Wood. 1966. Growth and development of the barren-ground caribou. I. Heart girth, hind foot length, and body weight relationships. Can. J. Zool., 44(3):401-411.

McGowan, T. A. 1966. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-6 and W-15-R-1, Juneau. 19 pp.

Munro, D. A. 1953. A preliminary report on the caribou of northern Yukon Territory. Can. Wildl. Serv., unpubl. rpt., Ottawa. 36 pp.

Murie, A. 1944. The wolves of Mount McKinley. U. S. National Park Serv., Fauna of National Parks U. S., Fauna Ser., 5:1-238.

Murie, O. J. 1935. Alaska-Yukon caribou. N. Am. Fauna, No. 54, U. S. Dept. of Agr. 93 pp.

_____. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. N. Am. Fauna, No. 61, U. S. Dept. of Agr. 406 pp.

_____. 1962. Mammals of Mount McKinley National Park, Alaska. Mount McKinley Nat. Hist. Assoc. 56 pp.

Nelson, E. W. and F. W. True. 1887. Mammals of northern Alaska, Part II, p. 227-293. In E. W. Nelson, Report upon natural history collections made in Alaska between the years 1877 and 1881. U. S. Army, Signal Service, Washington. 337 pp.

Nelson, U. C. 1949. Investigations to determine the abundance and distribution of moose, caribou, and sheep, p. 15-18. In U. S. Fish and Wildl. Serv. Fed. Aid in Wildl. Restoration Quarterly Rpt., 3(3):1-25.

Olson, S. T. 1957. Management studies of Alaska caribou movements, distribution and numbers–Steese-Fortymile herd, p. 45-48. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Job Completion Rpt., 11(4):1-132.

_____. 1958. Movements, distribution and numbers–Steese-Fortymile herd, p. 41-46. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Job Completion Rpt., 12(3)1-118.

_____. 1959a. Movements, distribution, and numbers–Arctic and other herds. p. 58-70. In U. S. Fish and Wild. Serv., Fed. Aid in Wildl. Restoration, Job Completion Rpt., 13(2):1-125.

_____. 1959b. Movements, distribution and numbers–Steese-Fortymile herd. p. 50-57. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Job Completion Rpt., 13(3):1-125.

Orth, D. J. 1967. Dictionary of Alaska place names. Geol. Survey Prof. Paper 567, Washington, D. C. 1084 pp.

Osgood, W. H. 1904. A biological reconnaissance of the base of the Alaska Peninsula. N. Am. Fauna, No. 24, U. S. Dept. of Agr. 86 pp.

_____. 1909. Biological investigations in Alaska and Yukon Territory. N. Am. Fauna, No. 30, U. S. Dept. of Agr. 96 pp.

Palmer, L. J. 1940. Caribou versus fire in interior Alaska. Unpubl. rpt. 5 pp.

_____. 1941. Caribou versus fire in Interior Alaska. Unpubl. rpt. 14 pp.

Pegau, R. E. 1968. Reindeer range appraisal in Alaska. MS Thesis. Univ. Alaska, College. 130 pp.

Pike, W. 1892. The barren ground of northern Canada. MacMillan and Co., New York. 300 pp.

Porsild, A. E. 1945. Mammals of the Mackenzie Delta. Can. Field Nat., 59(1):4-22.

Powers, H. A. 1958. Alaska Peninsula-Aleutian Islands, p. 61-75. In H. Williams (ed.), Landscapes of Alaska, their geologic evolution. Univ. California Press, Berkeley. 148 pp.

Prasil, R. G. 1968. Summary report on Stone's caribou observations in Mount McKinley National Park 1967-1968. U. S. National Park Serv. Special Report. 8 pp.(mimeo).

Preble, E. A. 1908. A biological investigation of the Athabaska-Mackenzie region. N. Am. Fauna, No. 27, U. S. Dept. of Agr. 574 pp.

Pruitt, W. O., Jr. 1960. Behavior of the barren-ground caribou. Biol. Papers of the Univ. Alaska, No. 3. 44 pp.

Riggs, T., Jr. 1920. Annual report of the Governor of Alaska on the Alaska Game Law, 1919. U. S. Dept. Agr. Circ., No. 88. 18 pp.

Radclyffe, C. R. E. 1904. Big game shooting in Alaska. Rowland Ward, Ltd., London. 292 pp.

Rood, J. S. 1942. Alaska reindeer herds. U. S. Office of Indian Affairs, Alaska Native Serv., Juneau. Annual report of reindeer supervisor. 151 pp.

_____. 1945. Building a reindeer business. Office of Indian Affairs, Reindeer Serv., Nome. Circ. No. 73. 43 pp.

Russell, F. 1898. Explorations in the far north. State Univ. Iowa, Iowa City. 290 pp.

Sage, B. L. 1971. Large mammal studies north of the Brooks Range 1969-1970. Alyeska Pipeline Corp. Rpt., Anchorage. 66 pp.

Schrader, F. C. 1904. A reconnaissance in northern Alaska. U. S. Geol. Survey Prof. Paper No. 20. 139 pp.

Scott, R. F. 1952. Caribou movements, abundance, distribution, p. 51-56. In U. S. Fish and Wildl. Serv. Fed. Aid in Wildl. Restoration, Quarterly Rpt., 7(2):51-59.

_____. 1953a. Caribou movements, abundance, distribution, p. 40-55. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Quarterly Rpt., 7(4):40-51.

_____. 1953b. Caribou movements, abundance, distribution, p. 8-10. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Quarterly Rpt., 8(1):5-10.

_____. 1953c. Caribou movements, abundance, distribution, p. 10-13. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Quarterly Rpt., 8(2):10-13.

Scott, R. F., E. F. Chatelain, and W. A. Elkins. 1950. The Status of the Dall sheep and caribou in Alaska. Trans. N. Am. Wildl. Conf., 15:612-626.

Sheldon, C. 1930. The wilderness of Denali. Charles Scribner's Sons, New York. 412 pp.

Skoog, R. O. 1956. Range, movements, population, and food habits of the Steese-Fortymile caribou herd. MS Thesis. Univ. Alaska, College. 145 pp.

_____. 1957. Movements, distribution and numbers– Nelchina herd, p. 37-44. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Job Completion Rpt., 11(4):37-44.

_____. 1959. Movements, distribution, and numbers– Nelchina herd, p. 1-49. In U. S. Fish and Wildl. Serv., Fed. Aid in Wildl. Restoration, Job Completion Rpt., 13(3):1-125.

_____. 1960. Caribou management investigations. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-1, Juneau. 263 pp.

_____. 1961. Caribou management investigations. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-2, Juneau. 128 pp.

_____. 1962. Method for estimating caribou herds. Alaska Dept. of Fish and Game, Informational Leaflet No. 20, Juneau. 6 pp.

_____. 1963. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-4, Juneau. 31 pp.

_____. 1964. Caribou report. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restoration. Project W-6-R-5, Juneau. 26 pp.

_____. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Thesis. Univ. California, Berkeley. 699 pp.

Soper, J. D. 1951a. Comments on the barren-ground caribou of northeastern Yukon Territory. Can. Wildl. Serv., unpubl. monthly rpt.

_____. 1951b. Status of the caribou (*Rangifer arcticus*) along the Yukon-Alaska Boundary. Can. Wildl. Serv., unpubl. monthly rpt.

Spencer, D. L. and J. B. Hakala. 1964. Moose and fire on the Kenai. Proc. Tall Timbers Fire Ecology Conf., 3:11-33.

Stevens, W. E. 1948. Progress report of caribou survey. Can. Wildl. Serv., unpubl. monthly rpt. 2 pp.

Stuck, H. 1914. Ten thousand miles with a dog sled. Charles Scribner's Sons, New York. 420 pp.

_____. 1917. Voyages on the Yukon and its tributaries. Charles Scribner's Sons, New York. 397 pp.

U. S. Census Office. 1893. Report on population and resources of Alaska at the eleventh census. U. S. Census Office, Decennial Census 1890. Vol. 8. 282 pp.

Zhigunov, P. S. (ed.). 1961. Reindeer husbandry. 2nd ed. Moscow. Translated by Israel Program for Scientific Translation, Jerusalem, 1968. 348 pp.