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Seasonal Ranges of Dall's Sheep, Mackenzie Mountains, Northwest Territories

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ABSTRACT. The seasonal distribution of marked Dall's sheep in the Mackenzie Mountains was studied during 1968 through 1974 as part of a broader Canadian Wildlife Service project that included research into population dynamics and hunter kill statistics. Dyes were used to mark 247 sheep, and 118 were marked with collars, ear tags, and ear streamers. Aerial observations of sheep and their winter tracks were the basis for maps of seasonal ranges. Summer ranges were a 30-90% expansion of winter ranges within mountain blocks that were bounded by forests and stream valleys. Within the study areas, these mountain blocks served as year-long habitat for most members of family groups of ewes and juveniles. Winter ranges were characterized by shallow, lightly crusted or uncrusted granular snow that did not impede travel or seriously constrict feeding areas. A few sheep wintered in forests near river banks. During summers, mineral licks dictated the shape of family group ranges, as well as the length and patterns of their daily and seasonal movements.

Key words: Dall's sheep (*Ovis dalli*), seasonal ranges, Mackenzie Mountains, marking, dispersal, mineral lick

RÉSUMÉ. La répartition saisonnière des mouflons de Dall étiquetés, dans les montagnes du Mackenzie, a été étudié de 1968 à 1974 comme étant une partie d'un vaste projet du Service Canadien de la Faune, qui incluait la recherche démographique de la population du mouflon et les statistiques des prises de chasse. De la teinture fût utilisée pour étiqueter 247 mouflons, et 118 ont été marqués avec des étiquettes et des rubans, à l'oreille, et des colliers. Les observations aériennes des mouflons et de leur sentiers hivernaux étaient les éléments de base pour le traçage des cartes de leur pâturages saisonniers. Les pâturages d'été étaient l'agrandissement de 30% à 90% de ceux d'hiver, à l'intérieur de régions montagneuses bordées de rivières et de forêts. A l'intérieur des secteurs d'échantillonages, ces régions montagneuses étaient utilisées comme habitat à l'année longue pour la plupart des membres de groupes familiaux composés de femelles et de jeunes. Les pâturages d'hiver étaient caractérisés par la neige légèrement tôlée où non tolée granuleuse peu profonde qui ne gêne pas ou peu les déplacements, ni ne restraint sérieusement le pâturage. Quelques mouflons hivernaient dans les forêts près des rives d'un cours d'eau. Durant l'été, les dépots naturels de sel minéraux nécessaire aux animaux, imposent des restrictions quant à la grandeur et à la forme des pâturages familiaux et modèlent leurs déplacements journaliers et saisonniers.

Traduit par S. Léonard, Association Culturelle Franco-TéNOise, Yellowknife, T.N.O.

INTRODUCTION

The study of the seasonal distribution of marked Dall's sheep (*Ovis dalli dalli* Nelson) in the Mackenzie Mountains began in 1968 as part of a larger Canadian Wildlife Service project that included research into sheep demography and non-resident sport-hunter kill patterns. The research was designed to provide the Government of the Northwest Territories (N.W.T.) with baseline data for management of sport hunting in the Mackenzie Mountains. Sport hunting for non-residents was allowed for the first time in the Mackenzie Mountains in 1965. Field research on all segments of the Dall's sheep project ended in 1974.

STUDY AREA

Literature on the geomorphology, vegetation, and mammals of the Mackenzie Mountains is summarized by Simmons (1982). The distribution of flora has been greatly affected by glaciation and related climatic changes. Mountain refugia, missed by glaciers and in some cases warmed by hot springs, are of particular interest to ecologists (Simmons and Cody, 1974).

Compared to the better vegetated, well eroded west slope in the Yukon, the Mackenzie Mountains receive relatively little precipitation. The wettest months are July and August. The average annual snow and rainfall is a desert-like 25.4-30.5 cm, 40-50% of which falls during the May-to-September growing season. The average frost-free season is 70-75 days long, with frosts occurring during any month of the year (Raup, 1947).

The movements of Dall's sheep were studied in three blocks of mountains: two, designated 4f and 4g, north of the Keele River; and the third, called 6h, bounded on the west by the Keele River. For comparative purposes, two other areas were studied less intensely: area 4a which is bounded on the north by the Mountain River; and the Tlogotsho Plateau, south of the South Nahanni River (Fig. 1).

Late winter sheep populations were estimated to be about 110 in 4g and 100 in 6h. No reliable estimate was obtained for 4f. Winter densities were $1.3 \cdot km^{-2}$ in 4g and $1 \cdot km^{-2}$ in 6h, much lower than the winter density reported by Hoefs and Cowan (1979) for Sheep Mountain, Yukon Territory ($6.8 \cdot km^{-2}$). The populations were stationary (Simmons *et al.*, 1981). During the period of the study, all of the areas described above were lightly hunted, mainly by sport hunters after Dall's sheep. The Tlogotsho Plateau entertained no hunters during most of the study years.

Prior to 1967, no biological investigations of any of the above-mentioned study areas had been conducted. Stelfox (1967) visited the perimeters of areas 4f and 4g, and surveyed area 6h by air while he was gathering information on grizzly bears observed and collected by sport hunters. He

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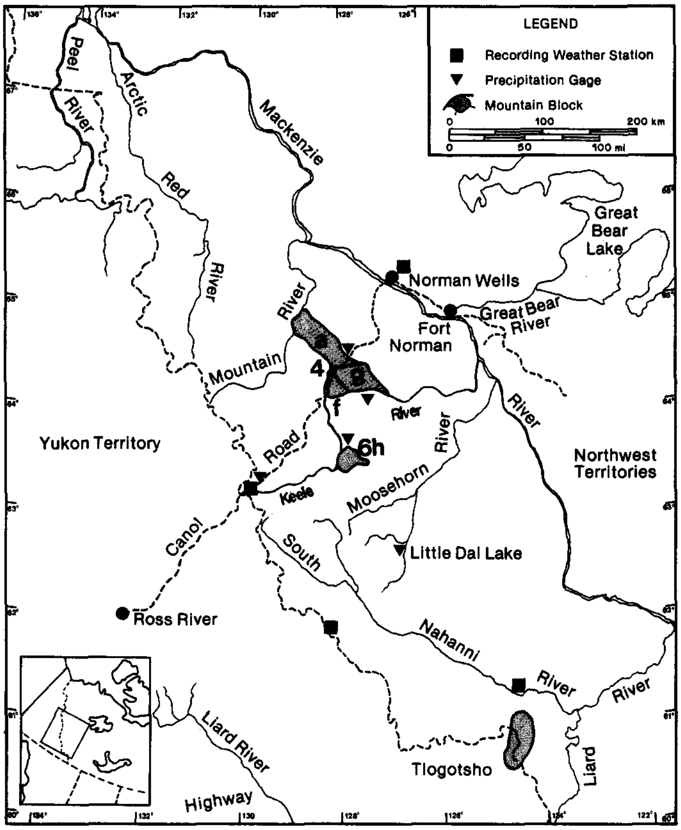

FIG. 1. Dall's sheep study areas in the Mackenzie Mountains, Northwest Territories, 1968-1974.

also wrote a detailed description of the vegetation on most heavily used winter range in areas 4a and 6h (Stelfox, 1978). In 1970, members of the International Biological Program surveyed parts of areas 4f, 4g, and 6h and described vegetation and soils (Simmons and Cody, 1974). In 1970 and 1971, G.W. Scotter and N.M. Simmons (Scotter *et al.*, 1971) visited the Tlogotsho Plateau as part of a study conducted for Parks Canada. In 1973, S. Miller and N. Barichello (Miller *et al.* 1982) began a study of grizzly bear movements in an area that encompassed 4a, 4f, 4g, and 6h. The study was completed in 1981.

METHODS

Dall's sheep were trapped, weighed, measured, and marked at two natural mineral licks at the south edge of areas 4f and 4g on the north shore of the Keele River (Simmons and Robertson, 1970). Sheep were also marked with dye within and on mountains near the study areas during the summers of 1970 through 1973 (Simmons, 1971). All sheep that were marked at traps and most dyed sheep could be identified as individuals. Periodic, irregularly timed searches for marked sheep were conducted from STOL aircraft, helicopters, and on foot as time and weather permitted during February, March, and June-September, each year of the study. Sightings were recorded according to range type, elevation, and association with other marked sheep. Recaptured sheep were weighed and measured. Sightings of marked sheep by pilots and sightings and recoveries by hunters were also recorded.

Winter habitat in the study areas was identified primarily by the presence of feeding craters in the snow, and also by observations of sheep and sheep tracks in February and March. Wintering areas were then mapped as a composite of all winter observations in 4a, 4f, 4g, 6h, and the Tlogotsho Plateau in 1969 through 1973.

Portions of the study areas occupied by sheep during the summers of 1969 through 1974 were mapped from records of six years of aerial and ground observations in the same study areas.

RESULTS AND DISCUSSION

Between 1969 and 1973, 106 sheep were captured and marked in the two traps on the Keele River; 12 of these were recaptured at least once. Of the 35 sheep that were marked at the lick in 4g, 21 (62%) were resighted at least once. Resightings of 10 sheep (29%) occurred in at least two separate calendar years. At the lick in 4f, 71 sheep were marked. Resightings of 41 (58%) occurred at least once, eight (11%) were resighted in at least two separate calendar years, and four (6%) were seen in four separate years.

In total, 247 sheep were marked with dye between 1970 and 1973. In 1970 and 1971, adult rams were avoided because hunters and outfitters would have objected. In 1972 and 1973, however, adult rams were marked in areas that were not hunted.

Winter Range

The climate in sheep winter range in the Mackenzie Mountain study areas is relatively stable. Between November and April, the weather is cold and dry, and the snow cover above treeline is shallow (0-30 cm), granular, and lightly crusted. In the four northernmost areas included in this study, sheep in search of food could roam freely across valleys between winter ranges without encountering barriers of deep (>50 cm) or crusted snow even in late winter. According to Hoffmann (1973), grasses and sedges (*Carex, Festuca, Hierochloe, Kobresia, Poa,* and *Trisetum,* among others) were easily available on the most favoured winter ranges in the study areas. Lichens (*Cetaria, Cladonia*) were also important in the sheeps' winter diet, a phenomenon common in Siberian snow sheep (*O. nivicola* Esch.) but not in North American mountain sheep (V. Geist, pers. comm. 1982).

A similarly arid climate exists in Hoefs's (1975) Sheep Mountain study area. He describes in some detail the feeding habits of sheep in relation to snow cover. In the Tlogotsho Plateau area, the sheep were restricted in travel by snow depths of 50 to >60 cm, but it was rarely dense or crusted enough to support a sheep's weight.

Generally the best winter range is also good summer range, and in most areas of the Mackenzie Mountains, the converse is also true. Areas along the Yukon Territorial boundary are not only blanketed with deeper snows, but they also have shorter growing seasons due to their high elevations. Some sheep do remain in isolated pockets in these areas in the winter, and they are present there all summer. Whether lengthy migrations occur from these areas near the Yukon is yet to be determined (Simmons, 1982).

The sheep were loosely grouped along canyon and ravine rims, close to but seldom below timberline. In late winter, the sheep abandoned the northern half of 4g, which in part is relatively gentle and evenly snow-covered, and in part is unstable, consisting of poorly vegetated steep limestone slopes. The rugged unstable cores and crests of 4a, 4f and 6h were also vacated.

On the Tlogotsho Plateau, the sheep withdrew in late winter to smaller areas that were not contiguous as they are further north. This was directly related to snow depth.

An example of the sheeps' repeated use of timbered areas as winter range was found near 6h along the steep banks of the Keele River. There the snow averaged 46 cm in depth in February and March (1971 and 1972), and was granular and uncrusted. *Vaccinium, Salix, Betula, Rhododendron, Dryas,* and *Potentilla* dominated the understory. Grasses such as *Festuca, Hierochloe,* and *Poa* grew well in that area. Three sheep collected in that area had been feeding mainly on sedges, lichens, and various shrubs, in that order of abundance. The steep river banks provided escape cover for the wintering sheep, but the cover was inferior to that found on the higher cliffs rimming the ridges of nearby 6h. The terrain above the banks is gently undulating for 2.4 km to the east and west, and is heavily forested with white spruce. Some, if not all, of the marked sheep wintering along the river bank in February, 1972, summered high on area 6h during 1971. Hoefs and Cowan (1979) noted that almost all areas that are heavily grazed in forests at low elevations have escape terrain nearby.

Marked sheep of nursery bands usually travelled 8 km from summer to winter range in late August and traditionally used the same winter ranges. Marked adult rams joined the ewes during the November rut. Such movements are described in more detail by Hoefs and Cowan (1979) and Hoefs (1975). Both rams and ewes, however, occasionally made major changes of winter ranges. In 1972 and 1973, a ram and a ewe were observed on winter ranges 14.5 and 25.8 air km, respectively, away from previously occupied ranges. The shifts probably occurred during snow-free months and may have involved a long-term change in home range.

Nichols and Erickson (1969) noted that the light snows of early winter do not significantly restrict the movements of sheep in the Alaska Range, Alaska. They move freely from slope to slope as they do in the Mackenzie Mountains. As winter progresses, however, the snow becomes packed and crusted and the sheep cannot dig through it. They become confined to wind-blown areas and their distribution becomes less like that in areas 4a, 4f, 4g and 6h, and more like that on the Tlogotsho Plateau.

As in much of the Mackenzie Mountains, winter range in the Alaskan Brooks and Alaska ranges is often merely a contraction of summer range (Heimer, 1973; Simmons, 1982). This is also the case on some Rocky Mountain bighorn (*O. canadensis canadensis* Shaw) ranges in the northern United States and in the western Canadian provinces, especially where pronounced topographical relief reduces the necessity for long movements to suitable habitat (Blood, 1963; Couey, 1950; Honess and Frost, 1942; Simmons, 1961; Smith, 1964).

Information on the daily activities of Dall's sheep on winter ranges can be gleaned from publications by Jones *et al.* (1963), Geist (1971), and Hoefs and Cowan (1979). Periods of inactivity during extremely cold weather are a significant feature of the sheeps' winter behaviour. Generally, however, there is a greater portion of time spent feeding, and a smaller percentage of time spent resting, than during summer. Hoefs and Cowan (1979) and Jones *et al.* (1963) noted nighttime periods of feeding when days were short (16-20 hours of darkness). Similar behaviour characterizes Rocky Mountain bighorn on winter range (Smith, 1954).

The reported effects of snow depth and density on Dall's sheep movements and health are most pronounced on the Kenai Peninsula (Alaska), in Mount McKinley National Park (Alaska), and in the Yukon Territory, where precipitation is greater and warm, moist winter winds more prevalent than they are in the Brooks and Alaska ranges and in the Mackenzie Mountains. In most of these areas, however, early winter snows, though deep, are usually soft enough to allow passage of sheep and cratering to feed. Sheep have been observed pawing feeding craters in soft, belly-deep snow in the Crescent and Surprise mountain areas of the Kenai Peninsula (Nichols and Smith, 1971). Geist (1971) described the relative effort expended by Stone's sheep (*O. d. stonei* J.A. Allen) when foraging in snow. He also found that sheep preferred feeding in snow no more than 25 cm deep.

Although the density of snow and surface crusting are most important qualities to sheep (Nichols, 1974), depth alone will restrict movement (Stelfox, 1978). Nasimovich (1955) stated that sheep and other mammals are restricted in movements when soft snow exceeds 2/3 of their chest height. According to Telfer and Kelsall (1971), mountain sheep are not as well suited as moose and caribou to deep snow because of their low chest height. Wolves, whose chest heights are occasionally greater than those of sheep and whose foot loads are similar, can prey effectively on sheep unless windblown escape terrain is nearby.

On the Kenai Peninsula, snow cover in valleys is too deep by January for sheep to cross (Nichols, 1973). In late winter, snow packs so hard that sheep are confined to small areas of open ridgetops where wind has exposed vegetation. This vegetation has been dessicated and scoured by wind and provides comparatively little nutrition. Therefore, the sheep in some areas are forced to depend mainly on stored body reserves for survival during late winter

(Nichols, 1974). The shearing and scouring of vegetation by winds also occurs in the Yukon Territory (Olsen, 1971). There the short, silt-laden vegetation wears down the teeth of sheep. On Sheep Mountain in the Yukon, 200 sheep were confined to 10.36 km^2 of exposed forage. In British Columbia, some sheep are confined in late winter to patches of terrain 274 m in diameter (Geist, 1971). Stone's sheep studied by Geist (pers. comm. 1982) moved to cliffs to obtain exposed vegetation.

It is in these areas of deep snows that winter and summer ranges are most widely separated. Such a situation probably prevails along the western border of the N.W.T. Murie (1944) described a 14.5-16.1 km separation of winter and summer ranges in Mount McKinley National Park. Summerfield (1974) reported movements between seasonal ranges extending up to 40 km in the Brooks Range. Hoefs and Cowan (1979) observed sheep moving 13-15 km between seasonal ranges. Olsen (1971) gave 16.1 km as an extreme separation of ranges in the Yukon. He stated that adult rams usually travel greater distances than ewes and juveniles between ranges. Stelfox (1978) described wide separations of winter and summer bighorn ranges in Canadian national parks, and said that winter distributions were greatly influenced by snow depth.

In areas of high winter precipitation and large temperature fluctuations, winter snow may bring disaster to sheep populations. Scott *et al.* (1950) and Murie (1944) have reported large numbers of Dall's sheep perishing of starvation and related causes when snow depth — alone or combined with thaws, freezing rain, and then sub-freezing temperatures — rendered the sheep immobile or confined them to inadequate areas of exposed forage.

It is evident, therefore, that the nature of sheep winter range in the Mackenzie Mountains is such that winter's contribution to marked population fluctuations is minimal, compared with the other areas described. The climate, and consequently the snow depth and quality, is comparatively constant throughout mid-winter, and therefore the availability of food is predictable. If a sheep survives its first winter, its survival is relatively certain, though due to the general sparseness of vegetation in the dry Mackenzie Mountains and the harsh cold of winter, lamb survival, and therefore secondary productivity, is low (Simmons *et al.*, 1981). Hoefs and Cowan (1979) also found that winter conditions did not cause marked increases in sheep mortality on Sheep Mountain, Yukon Territory, as they do in parts of Alaska.

Summer Range

The area of alpine tundra used by sheep began to increase in late May. In most parts of the central and northeastern Mackenzie Mountains, a simple expansion of each winter range occurred. But also noticeable was a reoccupation of vast areas in the west that had been vacated in the winter. Areas unused by sheep were heavily forested, inadequate in rugged escape cover, or comprised of poorly-vegetated slopes. Lengthy movements to summer ranges may occur in the northwest and west-central portions of the mountains (Simmons, 1982).

In area 4f, the 62.2 km^2 of habitat used in the winter expanded by about 46%, to approximately 90.6 km^2, by mid-summer. In area 4g, the 82.9 km^2 of winter range increased to 158.0 km^2, more than a 91% increase in area used for grazing. Here the sheep moved from timberline, many extending their range north and east onto gentler ridges that they avoided during mid-winter.

The shift in the pattern of areas used for feeding is less pronounced in area 6h. The change from winter to summer range may involve drifts by some sheep into the more rugged, less stable slopes of the southern half of the mountain block. About 101 km^2 were used during the winter; 129.5 km^2 were used during the summer, a 28% increase in area. As in area 4g, and perhaps 4f, the winter range (northern half) supports most of the sheep during summer. Marked sheep were found during summer within the forest near the Keele and Carcajou rivers at the east edge of the Mackenzie Mountains. However, they did not remain there for long periods as they did in winter, or as they did in summer on the tundra ridges.

Much of the tundra used by sheep during summer in area 4a and on the Tlogotsho Plateau encompasses the winter ranges. A cursory inspection of 4a indicates that a large part of the 919.4 km^2 of tundra could be used by sheep in the summer, but observations of sheep show that only a relatively small portion, 510.8 km^2, is actually occupied. Less than one third of that area, 152.8 km^2, is used during the winter. The gently rolling terrain northwest of McClure Lake seems to be the best year-round range. On most of the Tlogotsho Plateau, sheep merely move away from the plateau rims and into the lush vegetation of the gently rolling core. Due to the dissection of the plateau by long ravines, the movements are short.

Sheep movements to summer ranges are more dramatic in parts of Alaska. Sheep wintering on the north side of the Atigun River crossed the river to summer range in late June, though a few sheep remained on the north side all year long. The sheep returned to the north side in August (Summerfield, 1974). Heimer (1973) noted that sheep in the Dry Creek area of the Alaska Range went 19 km out of their way to visit a mineral lick on their way to summer range.

Observations of 50 dye-marked sheep in and near areas 4a and 6h, and observations of collared and unmarked sheep in areas 4f and 4g and south of the Keele River, reinforce my theory that most groups of sheep in the north-central Mackenzie Mountains, particularly those made up of ewes and juveniles, confine their year-round activities to relatively small areas, the shape and extent of which are governed in the summer primarily by mineral-lick locations. Winter ranges in all the study areas were only 3.2-8.1 air km from where the marked sheep were seen feeding in mid-summer. Several marked adult rams moved 4.8-11.0 air km in less than a week (Simmons, 1982).

Mineral licks were the foci of the activities of "ewe groups" (ewes and juvenile rams) in the summer months. Their fidelity to a lick, indicated by repeated re-sightings of marked sheep, is high. I made no attempt to quantify fidelity, but Heimer (1973) found that all of the ewes marked at a lick in the Alaska Range returned to the same lick and 80% of the marked rams returned to use the lick again. Stone's and bighorn sheep in Canada demonstrate similar loyalty to mineral licks (Geist, 1971).

The location of mineral licks significantly influenced the length and pattern of daily and seasonal movements of ewe groups. The licks began to be important to the sheep as soon as the ground thawed, around mid-May in areas 4f and 4g along the Keele River. The licks are not located in good summer range along the Keele River, so journeys of 4.8-19.3 km must be made from feeding areas to the licks. Heimer (1973) stated that some rams travelled 16.1-19.3 km to use licks in the Alaska Range. In the Brooks Range, sheep crossed the Atigun River in June during the low-water period to use a major mineral lick, and decreased their use of secondary licks (Summerfield, 1974).

Dispersal

A common characteristic of mountain sheep dispersals to new ranges is illustrated by Figure 2, and may be a reason for the low resighting rates of marked sheep. Most of the sheep moving between areas 4f and 4g were young rams. Geist (1967) observed that it was mainly young rams that make such exploratory excursions. Nevertheless, both Hoefs and Cowan (1979) and I noted movements of adult ewes and juveniles to new ranges. Fresh tracks of ewes and lambs crossing the swift Keele River from area 4g to the south side were seen in August 1970. Such a crossing was observed by native hunters in the same area in the early 1940s (G. Etchinelle, pers. comm. 1970). I believe these were dispersals. The longest dispersal observed was that of a marked ewe that had to travel from 4f through at least 5 km of forest and across the swift Twitya River to occupy another mountain block. Except for that ewe, the sheep that had dispersed were seen over periods of at least two years on their new ranges, and were not resighted on their old ranges. All sightings were of collared sheep positively identified as individuals.

Although there were exceptions to the pattern of fidelity to mountain block ranges, they involved few individuals.

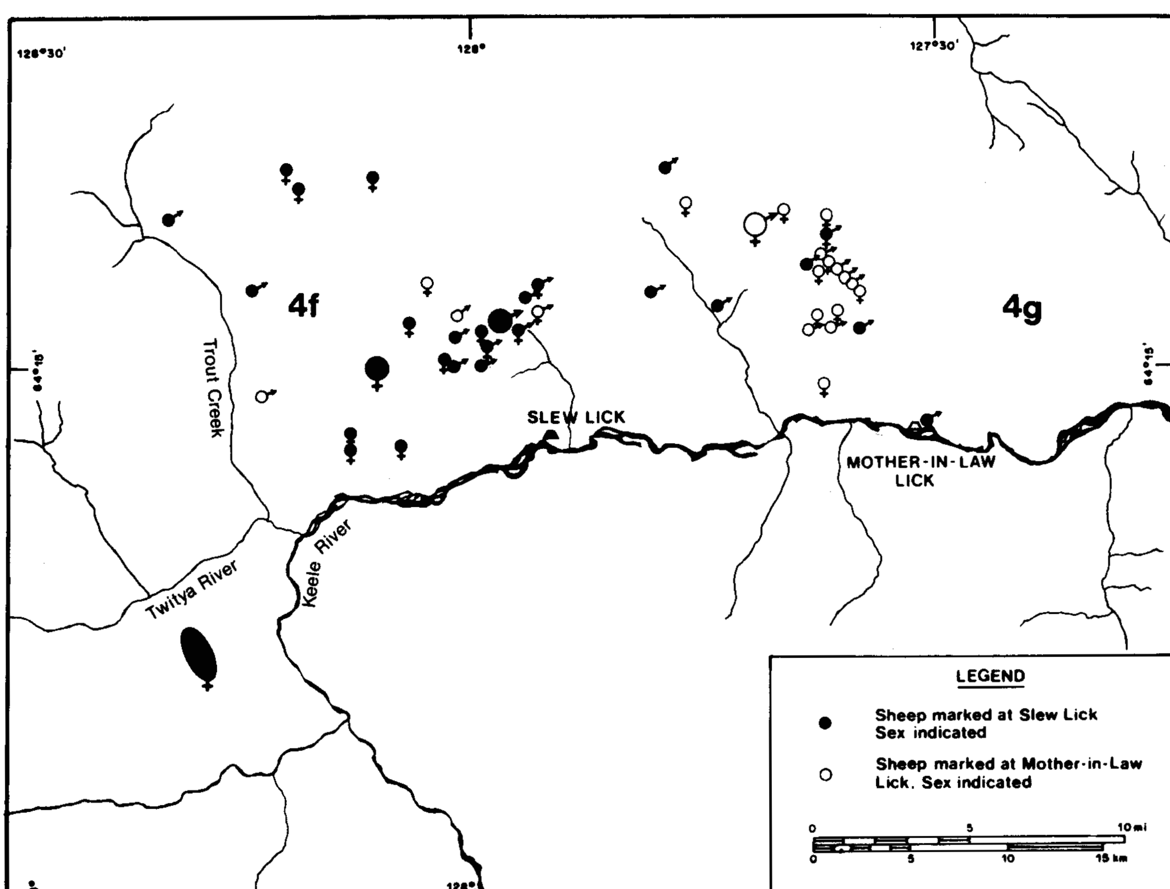

FIG. 2. Dispersal of marked sheep between areas 4f and 4g, 1968-1974. Larger symbols indicate less precise locations of marked sheep reported to the author.

Geist (1971), Hoefs and Cowan (1979), McCann (1953) and others relate dispersals to population size, but this was not confirmed in the Mackenzie Mountains. The study-area populations were probably stationary and lightly hunted (Simmons *et al.*, 1981).

Sub-populations such as those occupying the study areas are vulnerable to local extirpation. This event may soon take place in the Black Mountain (Mount Goodenough) sub-population in the Richardson Mountains (Hoefs, 1978; Simmons, 1973). Dispersal to other ranges becomes less likely as populations decline. Reoccupation of range vacated by a declining population is likely in open, unforested mountain ranges if adjacent sub-populations are healthy (Geist, pers. comm. 1982).

The importance of mineral licks to both species of North American mountain sheep has been described by several authors (Erickson, 1970; Heimer, 1973; McCrory, 1965; Smith, 1951). The presence or absence of licks in the Mackenzie Mountains may dictate summer-range use. Mineral licks could be created by wildlife managers in an attempt to change the summer range and movements of mountain sheep (Simmons, 1961; Smith, 1954). Artificial mineral licks may be useful for expanding summer range into unoccupied areas of adequate forage or to draw sheep away from areas of human disturbance such as mine sites and roads. Beyond range occupation, the importance of mineral licks extends to the maintenance of genetic homogeneity in the sheep population (Heimer, 1973). Young rams mingle at the licks with family groups other than their own and follow them into new ranges. This has been observed by Heimer (1973) and has occurred at licks in 4f and 4g in the Mackenzie Mountains. The physiological significance of the mineral licks has not yet been defined by researchers, but there is a definite connection between the need for minerals found at the licks and the demands of lactation and hair growth (McCrory, 1965, 1967). In the Mackenzie Mountains, few rams older than three years used the licks in the study areas.

Heimer (1973) suggested that, because of the fidelity of sheep to certain mineral licks, the licks provide the biologist with an inexpensive opportunity to observe population characteristics such as lamb:ewe and yearling:ewe ratios, and to estimate total populations from marked-and-resighted sheep. It was not possible to use the licks in our study areas for those purposes because there was heavy forest cover close to them, unlike those in Heimer's study area which were associated with sparse cover. An entire group of sheep visiting a lick in 4f or 4g was rarely visible at once.

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