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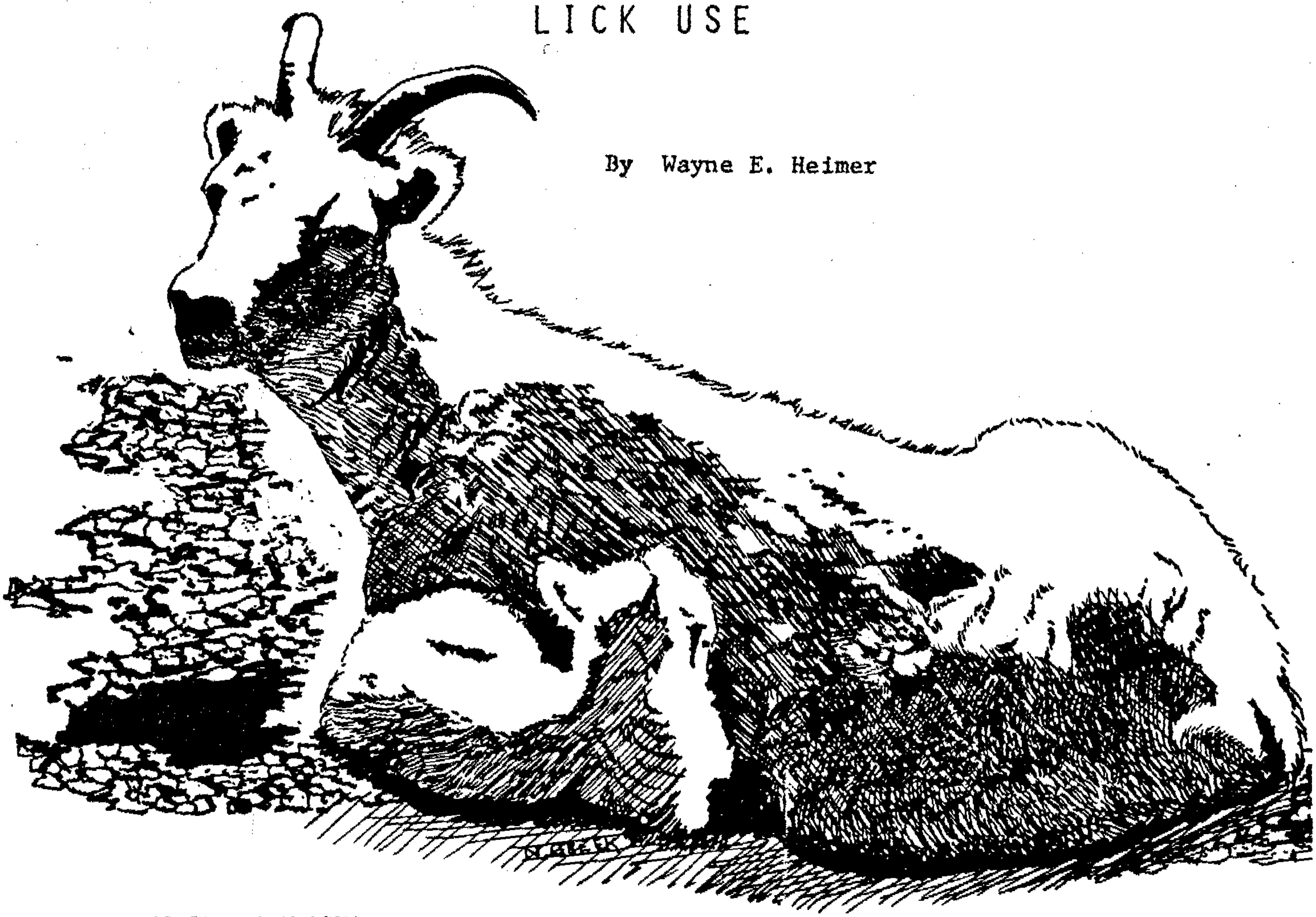
ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

DALL SHEEP MOVEMENTS AND MINERAL LICK USE

By Wayne E. Heimer



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State: Alaska

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Job No.: 6.1R Job Title: Dall Sheep Movements and Mineral Lick Use

Period Covered: October 27, 1969 to June 30, 1973

SUMMARY

Observations of sheep collared in previous years were made in order to determine seasonal home range, mineral lick influence on movement patterns, and mineral lick use characteristics. Collared animal sightings and re-sightings established the presence of at least three and possibly four distinct populations of ewes in the study area. Two populations occupy the west side of Dry Creek during winter. Their summer ranges are further up Dry Creek than the winter ranges. One or possibly two populations of ewes occupy the east side of Dry Creek. Winter and summer ranges for this population (or these populations) are apparently defined by snow cover rather than different geographic locations.

Four separate populations of rams were identified. Less is known about their home ranges than is known of the ewes'.

Sheep moved from winter range to the main mineral lick on Dry Creek, and then to summer range. In the case of animals having winter and summer ranges which are not geographically separated, a visit to the lick at this time occurred also. Some populations journeyed 12 miles out of their way to use the mineral lick before moving to different geographic summer ranges.

Lick use was found to reach a maximum early in summer. Multiple returns of collared sheep to the lick allowed estimation of the population size. The population of sheep using the lick was estimated to be about 1500 animals.

Observations of mineral lick use indicated no early preferential use by any population segment. Lactating ewes visited the lick more times and stayed longer per visit than other sex and age classes. Rams and non-lactating ewes had identical use patterns. Weather events may influence the movement from summer range as well as utilization of the mineral lick. A clear relationship between temperature and licking activity was seen.

Mineral lick use during the day was found to be either a function of time in the licking cycle or the number of sheep using the lick. At the time when large numbers of sheep were seen there was only one clearly defined peak of lick use. This was at 1200 hrs. and paralleled the activity of sheep not involved with the lick. When smaller numbers of animals were using the lick the pattern of use changed; the major peak shifted to 0400 hrs.

Preference for specific areas in the main mineral lick at Dry Creek was described. It is thought to be related to water content, substrate composition and mineral content of the soil.

Morphological and physiological characteristics of sheep were examined to assess their usefulness in characterizing sheep from populations in the Dry Creek study area. Serum transferrins from Dry Creek and the Kenai Peninsula were compared by electrophoresis. No apparent difference in mobility of transferrins was found. Comparison with reference sera from domestic sheep indicated that Dall sheep transferrins have the same electrophoretic pattern as domestic transferrin-D.

Examination of rumen contents revealed that ewes taken in winter had rumen contents consisting of 95 percent grasses and sedges, 4 percent willow parts and 1 percent other material. *Dryas* was notably absent. Ewes examined in summer had rumen contents composed of 82 percent grasses and sedges, 6 percent willow parts and 12 percent *Dryas* leaves. It appears that ewes examined in November were in positive energy balance at that time, but were very near equilibrium. Some data on seasonal extremes were gathered.

The probability of ewe returns to the main lick on Dry Creek is 100 percent. Mortality of some segments of the ewe populations was calculated. Ram loyalty was found to be about 80 percent.

Management recommendations are offered.

CONTENTS

BACKGROUND

Investigations of general group movements and seasonal distribution of Dall sheep *(Ovis dalli)* have been conducted previously in various areas in Alaska. Distribution of sheep in June, July and early August 1962 in Dry Creek, Alaska Range was plotted by Viereck (1963b). His data suggested an up-valley and up-slope movement trend from June through early August. Palmer (1941) listed areas used by sheep at different seasons in Dry Creek, the Little Delta River and Wood River areas. Scott (1951) outlined seasonal ranges and trails in the Indian Creek area of the Tonzona River region. Murie (1944) described sheep movements in Mount McKinley National Park, and Gross (1963) described sheep movements on Victoria and Schwatka mountains in the White Mountains. These studies indicated that sheep were seasonally present in certain habitats, but failed to establish whether they were wandering animals which were attracted to a given area or residents that were there each year.

In order to determine whether or not these are resident sheep it was necessary to mark individuals so they could be identified year after year. Information defining discrete populations is necessary before meaningful management programs can be instituted. These needs formed the basis for this study.

Mineral lick utilization by sheep is thought to have primary and profound effects on sheep distribution and movements. Pitzman (1970 p.28) stated "Sheep distribution...is also influenced by the use of mineral licks.... Mineral licks seem to be a characteristic of most Alaska sheep habitats that have been studied." Erickson (1970 p.1) agreed that, "One of the factors which may influence sheep population distribution is the presence of mineral licks." Palmer (1941) and Viereck (1963a and b) also made specific references to this concept. Regardless, few specific data are available to credibly support this seemingly reasonable idea.

To provide this information, observations of sheep mineral lick use were made incidental to sheep marking operations in 1969, 1970, and 1971. These observations have been reported earlier by Erickson (1970) and Smith (Nichols and Smith 1971). Because of the secondary nature of the observations and the disruptive effects of trapping it was deemed necessary to observe mineral lick use cycles without disruptive effects after animals had been marked. The results of all facets of recent interior Alaska Dall sheep investigations are presented in this report.

OBJECTIVES

To define and characterize the discrete sheep population or populations influenced by the main mineral lick in Dry Creek.

To determine the daily movement patterns and seasonal home ranges of sheep captured and marked at the main Dry Creek mineral lick; and to extrapolate to seasonal home ranges of the untagged population or populations.

To describe mineral lick use patterns in relation to age and sex of sheep using the main mineral lick at Dry Creek, and to relate lick use patterns to possible causative factors.

To gather information relating to the population dynamics of the population or populations influenced by the main mineral lick in Dry Creek.

PROCEDURES

Study Area and General Method

The sheep study area is centered on the Dry Creek drainage in the Alaska Range south of Fairbanks and includes adjacent drainages (Fig. 1). Animals for the movement and lick utilization portions of the study were captured and marked during June and July of 1968-1971 at the main mineral lick on Dry Creek using the drop net method described by Erickson (1970). Other animals were collected throughout the year from populations in the Dry Creek area and the Granite Mountains south of Delta Junction.

Characterization and Definition of Sheep Populations

Growth and Morphology of Dry Creek Sheep: After capture the living sheep were weighed using a spring balance and the following measurements were taken:

1. Contour length - measured from the tip of the nose to the end of the tail.

2. Shoulder height - measured from the hoof tip of the front foot to the top of the back.

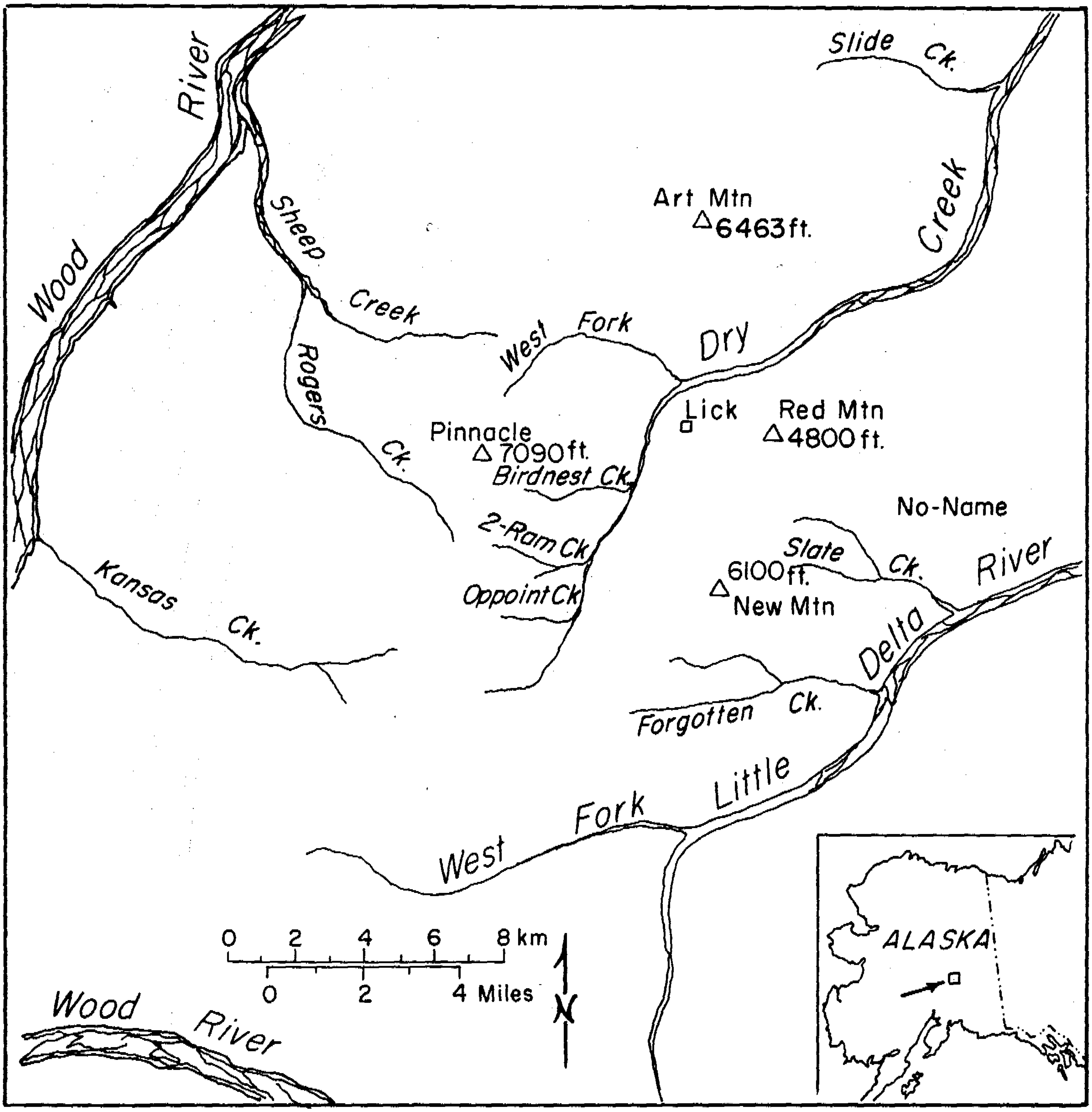

Fig. 1. Sheep study area in Dry Creek and adjacent drainages, about 70 miles south of Fairbanks, Alaska.

3. Chest girth - measured as circumference of the chest immediately behind the front legs.

4. Hind foot length - measured from hoof tip to the proximal end of the *tuber calcis* with the foot extended and reflected dorsally.

5. Other measurements (horn length, spread, and tail length) were also taken but were not used in comparison with other sheep because of their inherent variation.

Age was determined by the horn annuli method of Geist (1966). Sampling was not random; an effort was made to obtain the greatest number of animals possible from all age classes of the population. This resulted in bypassing some younger animals and selecting for older ewes. Consequently, the age structure of the population cannot be determined from the trapping data.

Similar morphological data from sheep of the Kenai Peninsula were provided by Lyman Nichols, Alaska Department of Fish and Game. These sheep were taken on Crescent Mountain between January and April 1971, with most collections taking place in February and March. Measurements were made as described previously.

Thirty ewe sheep made up the Kenai Peninsula sample. The Dry Creek sample consisted of 293 sheep of both sexes and all age classes.

Population Blood Genetics: Blood samples were taken from 109 live Dall sheep at Dry Creek, Alaska Range in June and July 1971. Serum was removed from the clotted blood and stored frozen in liquid nitrogen. After transport to Fairbanks the serum samples were analyzed by Peter D. Shaughnessy of the Institute of Arctic Biology. Serum samples were examined by acrylamide gel electrophoresis in an EC Apparatus Co. Standard Vertical Gel Cell (EC 470). For the examination of transferrin mobility, a gel buffer system similar to that of Kristjansson and Hickman (1965) was used. It consisted of 0.0136 M cacodylic acid, pH 7.6. The electrode solution consisted of 0.8 gm/l lithium hydroxide and 11.8 gm/l boric acid, pH 7.5. Each slot was loaded with 3 ml of serum diluted 1:4 with 20 percent sucrose. Gels were run for two hours with 300 volts across the gel cell, and then stained with amido black (a general protein stain).

For the examination of lactic dehydrogenase (LDH) activity the buffer system of Fine and Costello (1963) was used. Each slot was loaded with 3 ml of serum diluted 1:1 with 20 percent sucrose solution. Gels were run for four hours with about 200 volts across the gel cell, and then incubated at 37 C in a mixture of substrate, cofactors and dye coupler (see Fine and Costello 1963) for an hour.

Blood samples from 22 Dall sheep of the Kenai Peninsula were also analyzed. These samples were provided by Lyman Nichols of the Alaska Department of Fish and Game. The blood samples were taken from sheep collected on Crescent Mountain, Kenai Peninsula between January and April

1971. Nichols (Nichols and Smith 1971) detailed the collection procedures. The serum samples had been stored in the frozen state since their collection. Transferrin mobilities were also compared at pH 7.5 with reference sera from domestic sheep supplied by Dr. C. Stroment of the University of California, Davis.

Population Size and Composition: The number of sheep on the study area was determined by classifying all sheep entering the lick. Also, the average frequency of visitation by sheep was determined by dividing the number of visits by collared sheep by the number of collared individuals seen using the lick. It was assumed that lick use by these individuals was representative of the population. The total number of animals seen entering the lick during the observation periods divided by the figure for visits per collared animal provided an estimate of the number of individual sheep of all classes using the lick. Sex and age composition was determined by classification of all sheep using the lick at half-hour intervals. Overall composition percentages were calculated and the composition of sheep using the lick derived. During one lick use cycle (1972) special notice was taken of rams between yearling age and legal status, 3/4 curl. Horn growth data revealed that rams in this age class are from two to five years old (Heimer and Smith, unpublished data). For purposes of simplicity it was assumed that the number of individuals in this age class equalled the number of ewes of the same age. Also, the observed lamb:ewe ratios were used to calculate the number of lambs in the population using the lick. This number was added to the number of animals estimated by collar resightings.

assumes all age class have same use.

bias toward animals staying longer.

Biased

Food Habits, General Condition, and Nutritional Status: Mature ewes and yearlings were collected throughout 1972 and 1973 in conjunction with population characterization and parasite studies. These animals were returned to Fairbanks for autopsy. Morphological measurements, rumen and blood samples, organ weights, and indices of general body condition were taken. Blood samples were collected in the field, but these were generally of questionable worth because of the adverse working conditions. The parasite burden was assayed by the Region III laboratory staff. Lungs, abomasa, and intestinal tracts were examined and the preliminary results have been reported by Ericson and Neiland (1973).

Rumen samples were frozen and stored in plastic bags. When processed they were rapidly thawed and washed on a series of sieves. Identifiable material retained on the sieves was then separated into various food categories. The categories were: unidentified grasses and sedges, willow fragments, Dryas, and other specified trace plants. After separation the volume of each category was determined by displacement. The total volume of identified material was then calculated by adding the category volumes, and the percentage of each category was calculated.

Indices of body condition used were kidney fat index (Riney 1955), marrow fat (Neiland 1970) and thickness of the fat pad overlying the hip. Kidney fat index was determined by weighing the kidneys and their associated fat, stripping the fat from the kidneys and weighing the kidneys alone. The weight of the kidney fat was then divided by the weight of the kidney alone to give an indication of fat present relative to kidney size. It is assumed that kidney mass is rather constant.

Digestive function was evaluated for 16 animals taken in November and April. Immediately following death the rumen was opened, its contents mixed, and a sample placed in a polyethylene bottle for incubation. The bottle was maintained at an incubation temperature of about 37 C by using an insulated water-bath. Samples of rumen liquor were removed from the incubator at half-hour intervals. Later, the concentration of volatile fatty acids was determined. It has been shown that the rate of volatile fatty acid production is an indicator of fermentation rates in the rumen (Gasaway and Coady 1973).

Determination of Daily Movement Pattern and Seasonal Home Range

Daily Movement Pattern: Daily movement patterns were observed by following marked sheep as they left the mineral lick. Observers were equipped with standard backpacking equipment and food for three days. They were to follow sheep at a distance and record feeding, nursing (if applicable), locations during the day at half-hourly intervals and any other incidental information obtainable without influencing the movement of the sheep selected.

Seasonal Home Range: Dall sheep captured with a drop net (Erickson 1970) at the main Dry Creek lick were marked with collars and ear tags. In 1969 and 1970 large, safety-orange, plastic collars with canvas backing and black numerals were used (see Plate I). In 1971 collars consisting of polypropylene rope strung through a numbered pendant and secured around the sheep's necks using hog rings were used. Several similar collars were applied in 1968. Most animals were also marked with ear tags (Jumbo Rototag by Dalton Henley of England). Some metal ear tags were also used in 1968 and 1969.

The large collars are visible at great distances; numbers on the pendants are discernible at distances of up to 250 or 300 meters using a 60X spotting scope in good light.

Sheep were identified on home ranges throughout the year, and locations were plotted on topographical maps. Most observations were made on foot surveys, but some aircraft surveillance was utilized. Success of aerial survey techniques was limited to occasional sightings of collars which were used in 1969 and 1970. The smaller pendant collars used in 1968 and 1971 were impossible to identify from aircraft.

For purposes of analysis the individual sightings were recorded on "Unisort Analysis Cards" (Plate II). This data transformation allowed rapid selection of resightings by location, sex and season. Once resightings had been separated in this manner the locations of resightings on different seasonal ranges were plotted on 1:63,360 topographical maps of the study area.

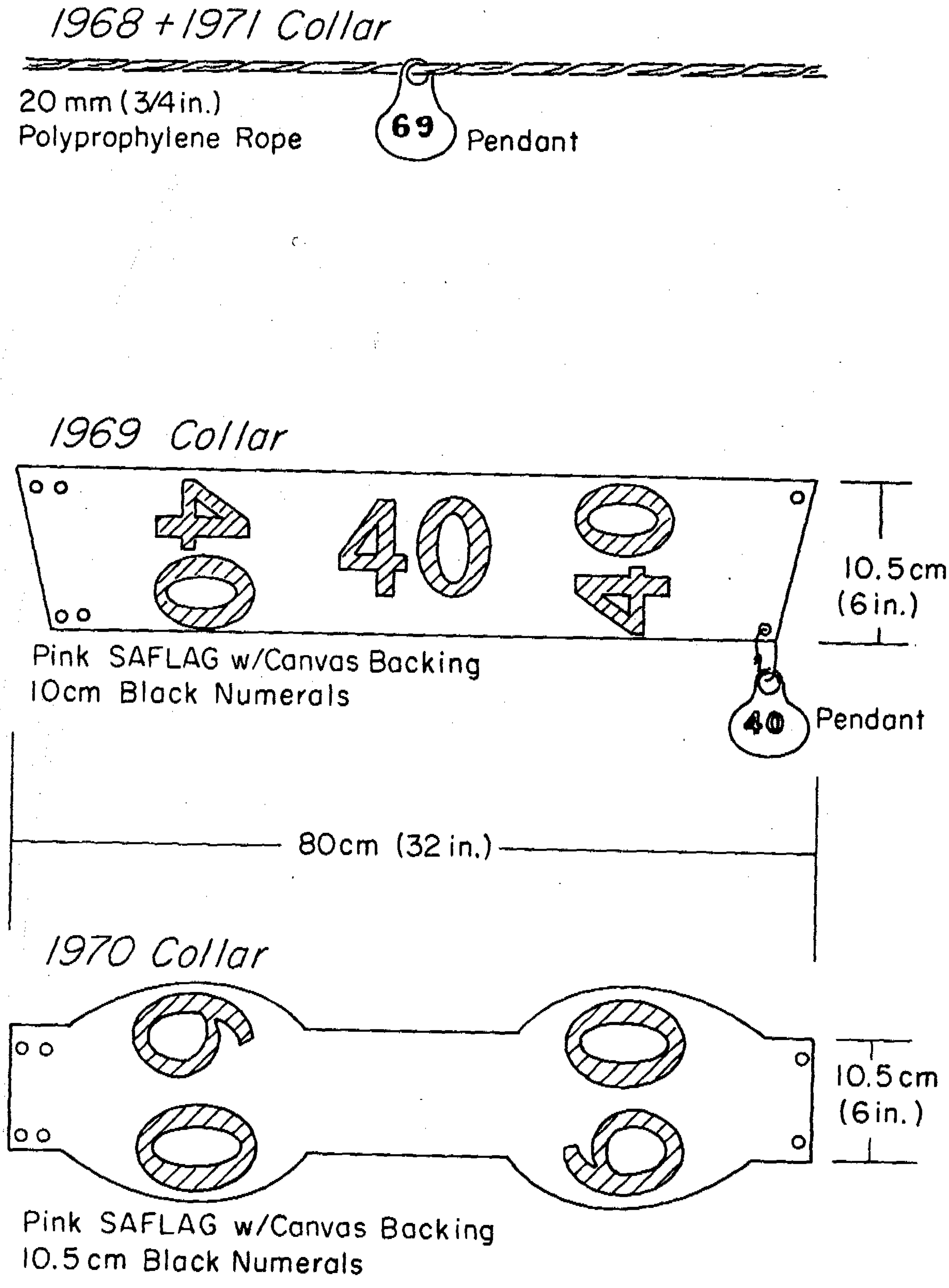

Plate 1. Collars used on Dall sheep captured during 1968, 1969, 1970 and 1971 at Dry Creek, Alaska Range.

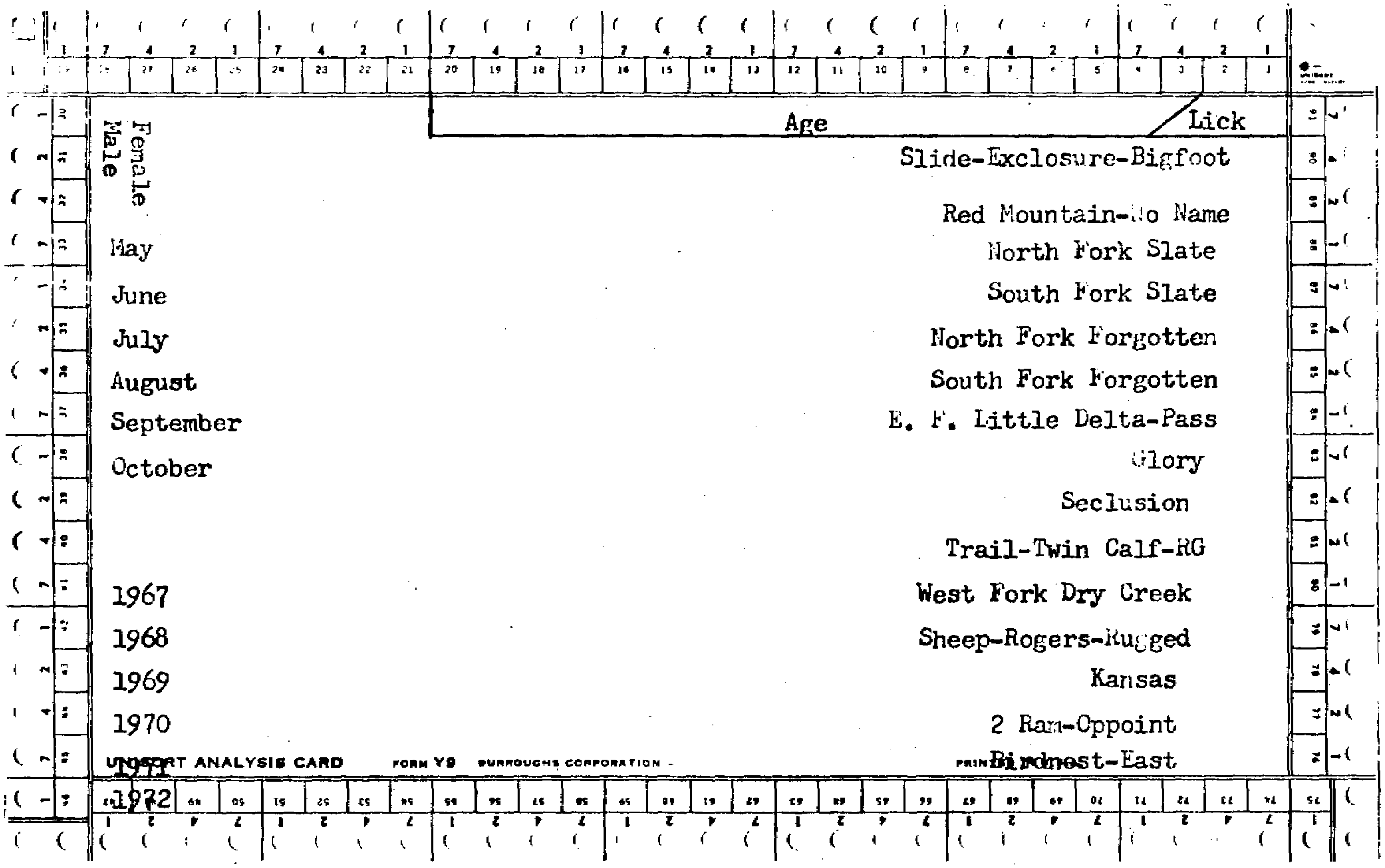

Plate 2. Movement data analysis card.

Known sheep trails were determined to be the routes of travel from the winter ranges to the lick and from there to summer ranges. Few of these movements were actually observed, but the routes are assumed to be those actually utilized by migrating animals. A further assumption is that all sheep travel to the mineral lick before moving to summer ranges. This assumption is based on the high fidelity (predictability of return) of Dall sheep to this mineral lick indicated by Heimer (Nichols and Heimer 1972).

Conclusive resightings of marked animals were limited to 28 paired observations (an animal seen both on summer range and winter range). These data are indicators of population movement and probably represent group movements. For purposes of this study summer range was defined as the range supporting animals in July, August, September and early October. Winter range was considered to be that portion of the study area carrying sheep in the months of November, December, January, February, March, April and early May. Resightings in late May, June and early July were not considered indicative of seasonal ranges because this period has been found to be the time of movement between ranges.

Population perimeters were outlined on 1:63,360 maps after resightings had been plotted.

<u>Mineral Lick Use Patterns</u>: Observations of mineral lick utilization at the main mineral lick on Dry Creek have been carried out since 1969. In 1969 observations were made from June 16 through June 25 from 0300 to 1800 hours. In 1970 observations were made continuously from June 3 through June 12 and from June 29 through July 3. In 1971 no organized observations were conducted, but collared sheep were noted as they entered the lick. All of these observations were made pursuant to the main objectives of those years which were to capture and mark sheep and obtain morphological data and blood samples. In 1972, continuous 24-hour per day observations of lick utilization were made from May 19 through July 5. For comfort during eight hour shifts of observation, observers were stationed in a plywood blind about 200 yards from the lick. In 1973 observations were made from 0400 to 1600 from May 26 through June 30.

In 1972 and 1973 all sheep coming into the lick were classified with respect to age and sex. Sheep within the lick were also classified and counted every 30 minutes. At these times weather conditions were also recorded. Records were also kept of the times of entry, movements and activities within the lick, and the departure times of all marked sheep using the lick in 1972. Similar observations were made during the years before 1972, but strict uniformity of technique was not practiced because techniques were changed to increase efficiency as information was gathered.

In an effort to determine what soil constituents attract the animals to the lick, soil samples taken from preferred licking sites and control sites (not used at all) were collected and analyzed for mineral and ionic content. The lick itself was arbitrarily divided into zones and the half-hour classifications were recorded by zone. This provided a use-index of licking sites within each zone and allowed discrimination of intensity of licking and comparison of intensity of use with mineral and ionic content. The use zones were as follows: Zone A was the upper end of the ravine which contains the lick, Zone B was the east side, Zone C the ravine floor, Zone D the west side and Zone E the mouth of the ravine.

Returns of the collared sheep to the lick allowed calculation of fidelity constants (Geist 1971) of sheep in different age and sex classes for the main mineral lick at Dry Creek. Lick use as a function of the time of day was recorded, the "lick use cycle" was described, weather influences were observed and the average length of time spent in the lick was calculated. Data on the diurnal activity of sheep not involved with the lick were also gathered.

FINDINGS

Characterization and Definition of Sheep Populations

Growth and Morphology of Dry Creek Sheep: The morphological data gathered appear in Appendix I. Critical analysis was limited to those parameters which were considered either of special interest, e.g. weight, or parameters which were independent of seasonal variation. It appears that sheep continue to grow throughout life, but growth is minimal for most of the morphological characteristics after the age of three years. A notable exception is body weight. Body weight for the Dry Creek sample was always taken at the end of winter; it appears to increase at a noticeable rate until the age of seven years. Further increases may occur after that time, but they are minimal. It appears likely that growth as reflected by body weight may continue at a greater rate for ewes in later years than for rams. This is the only parameter of those investigated which conforms to this pattern.

Figs. 2, 3, 4 and 5 show growth patterns of Dall sheep captured at Dry Creek in the Alaska Range. Growth patterns for Dall sheep ewes from the Kenai Peninsula are compared with those of Dry Creek ewes in Figs. 6, 7, and 8. Growth patterns and ultimate sizes of ewes from both populations are very similar. Consequently, it appears that there is little reason to separate the *Ovis dalli* ewes of the Kenai Peninsula from those of the Alaska Range on the basis of gross morphology.

Population Blood Genetics: No differences in serum transferrin or LDH mobility were detected among the 109 blood samples analyzed from the Dry Creek sheep. Serum transferrins from the 22 Kenai Peninsula sheep were found to have the same mobility as those of the 109 Alaska Range animals. These transferrins were compared with domestic sheep reference sera and found to have the same mobility as domestic sheep transferrin-D. No differences in LDH mobility patterns between the Kenai Peninsula and the Alaska Range were discovered.

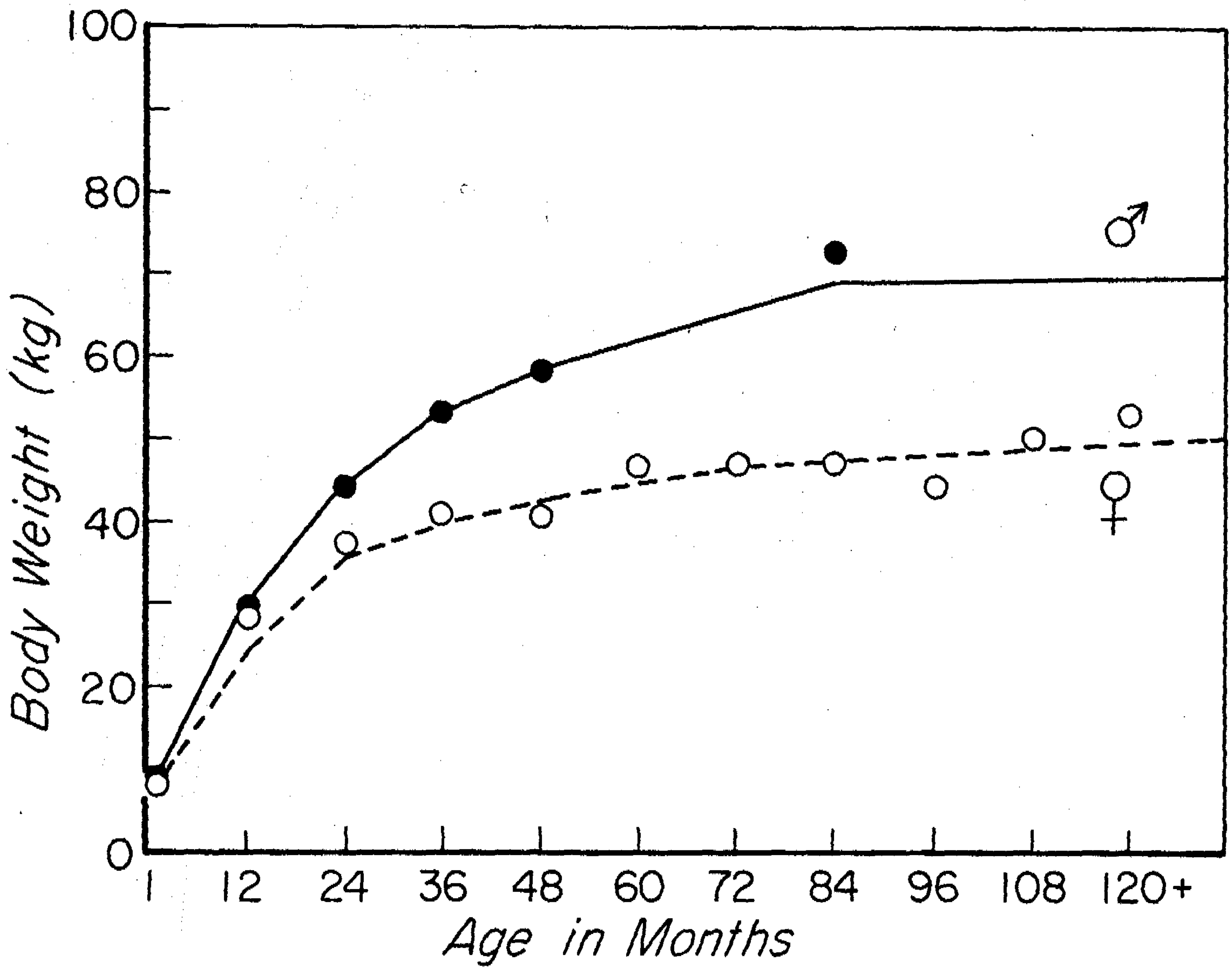

Fig. 2. Body weights and ages of Dry Creek sheep in early spring of 1969 and 1970.

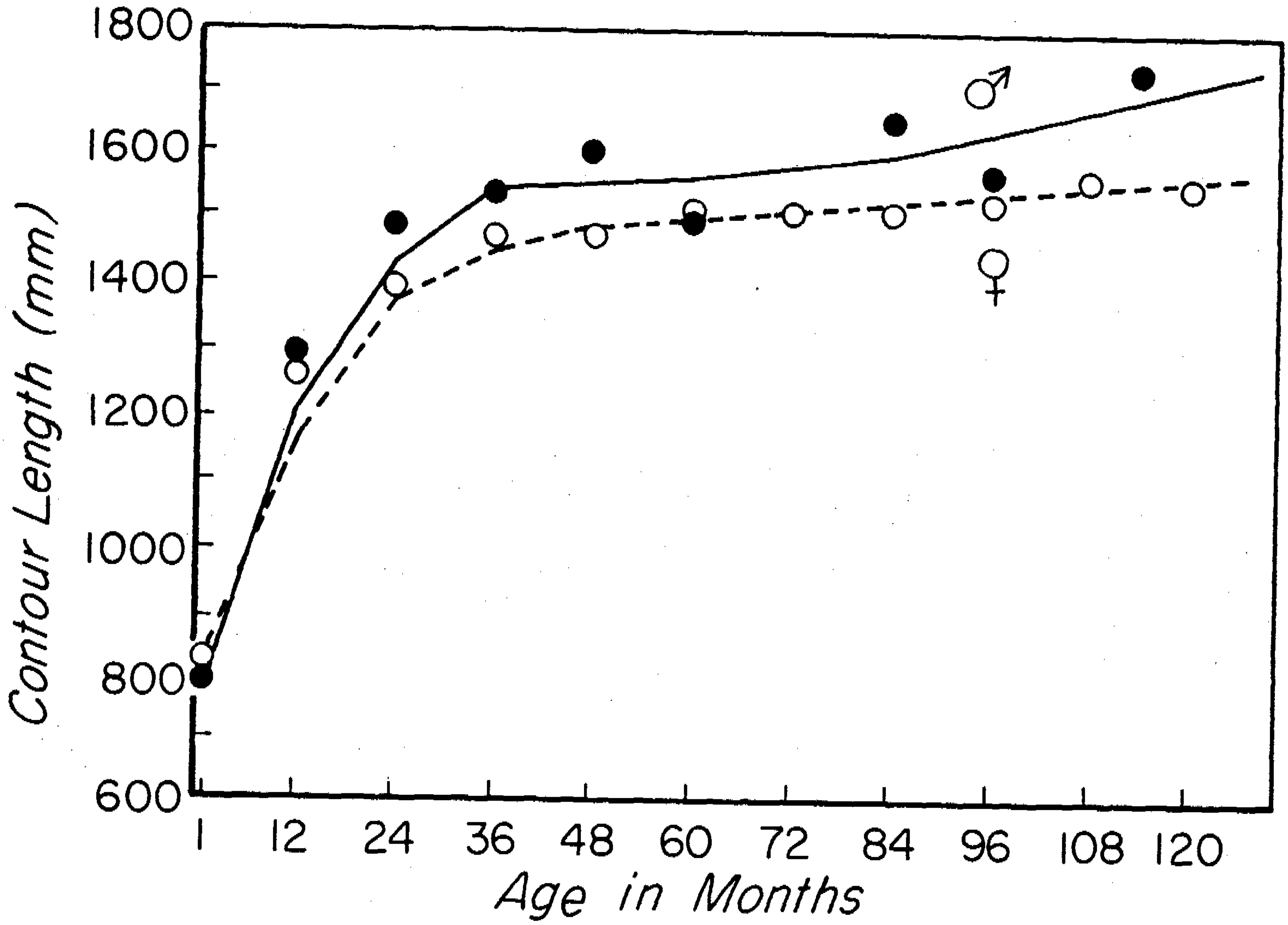

Fig. 3. Contour lengths and ages of Dry Creek sheep. 1969, 1970.

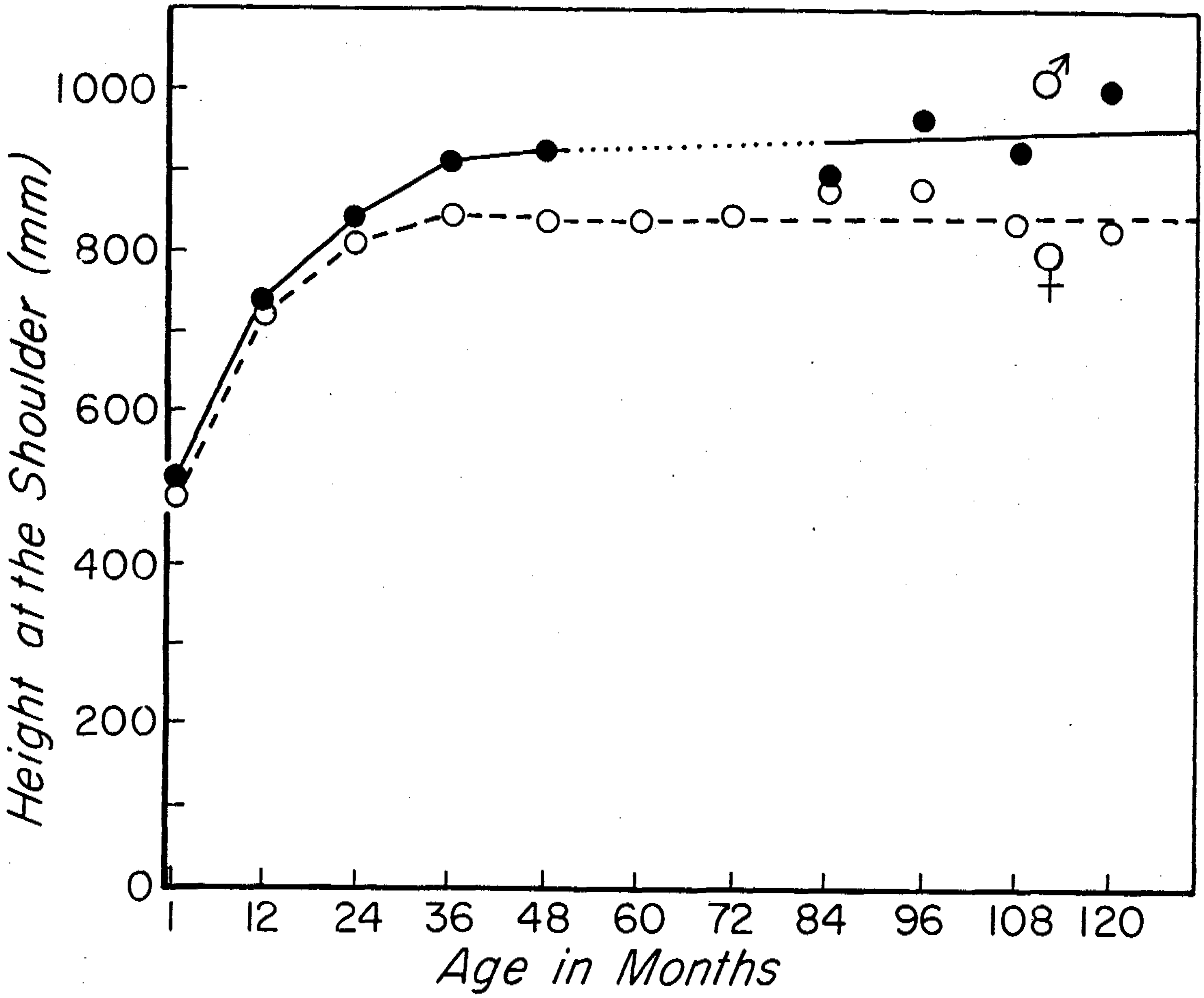

Fig. 4. Shoulder heights and ages of Dry Creek sheep, 1969 & 1970.

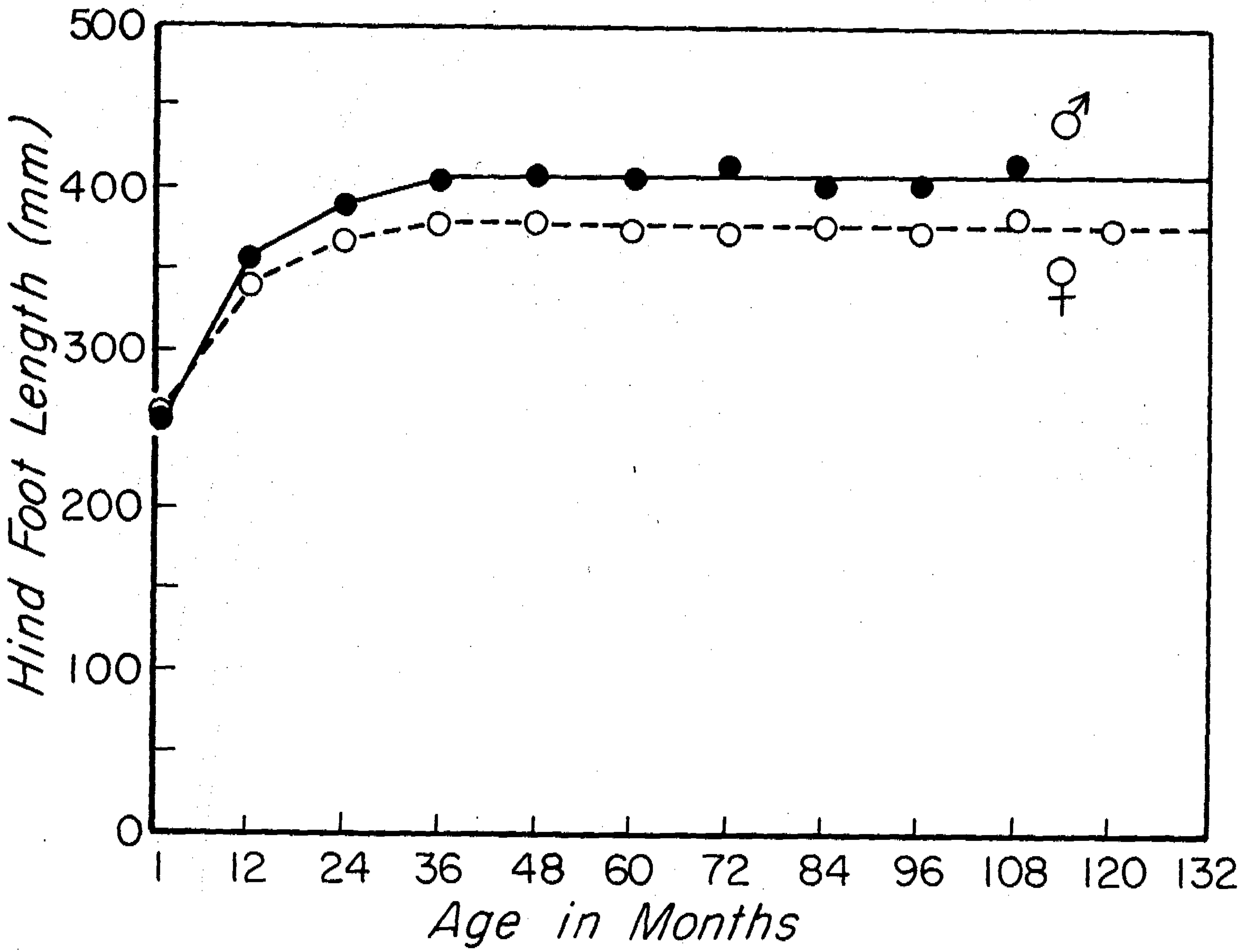

Fig. 5. Hind foot lengths and ages of Dry Creek sheep, 1969 & 1970.

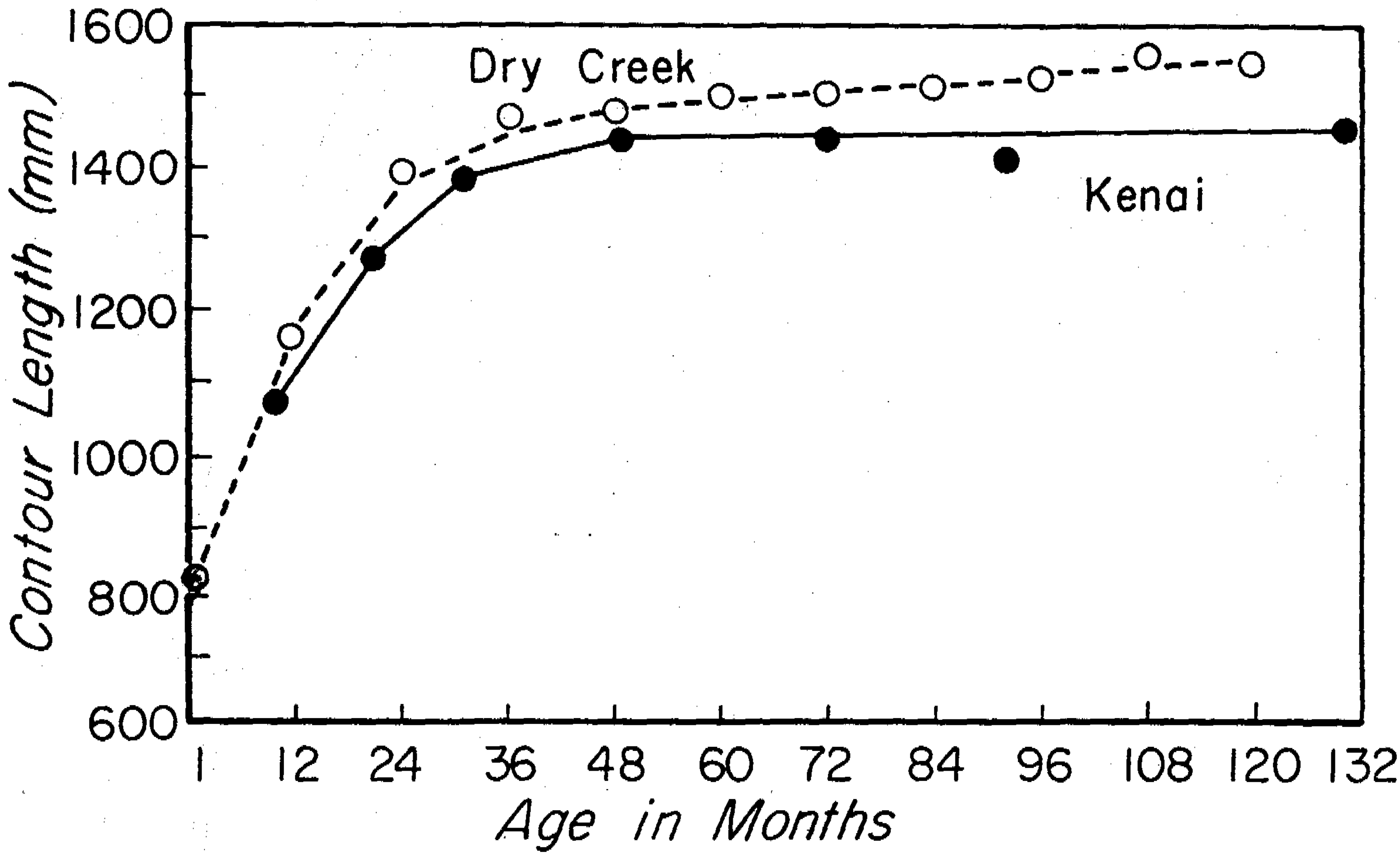

Fig. 6. Comparison of growth patterns in Dry Creek and Kenai ewes: contour length.

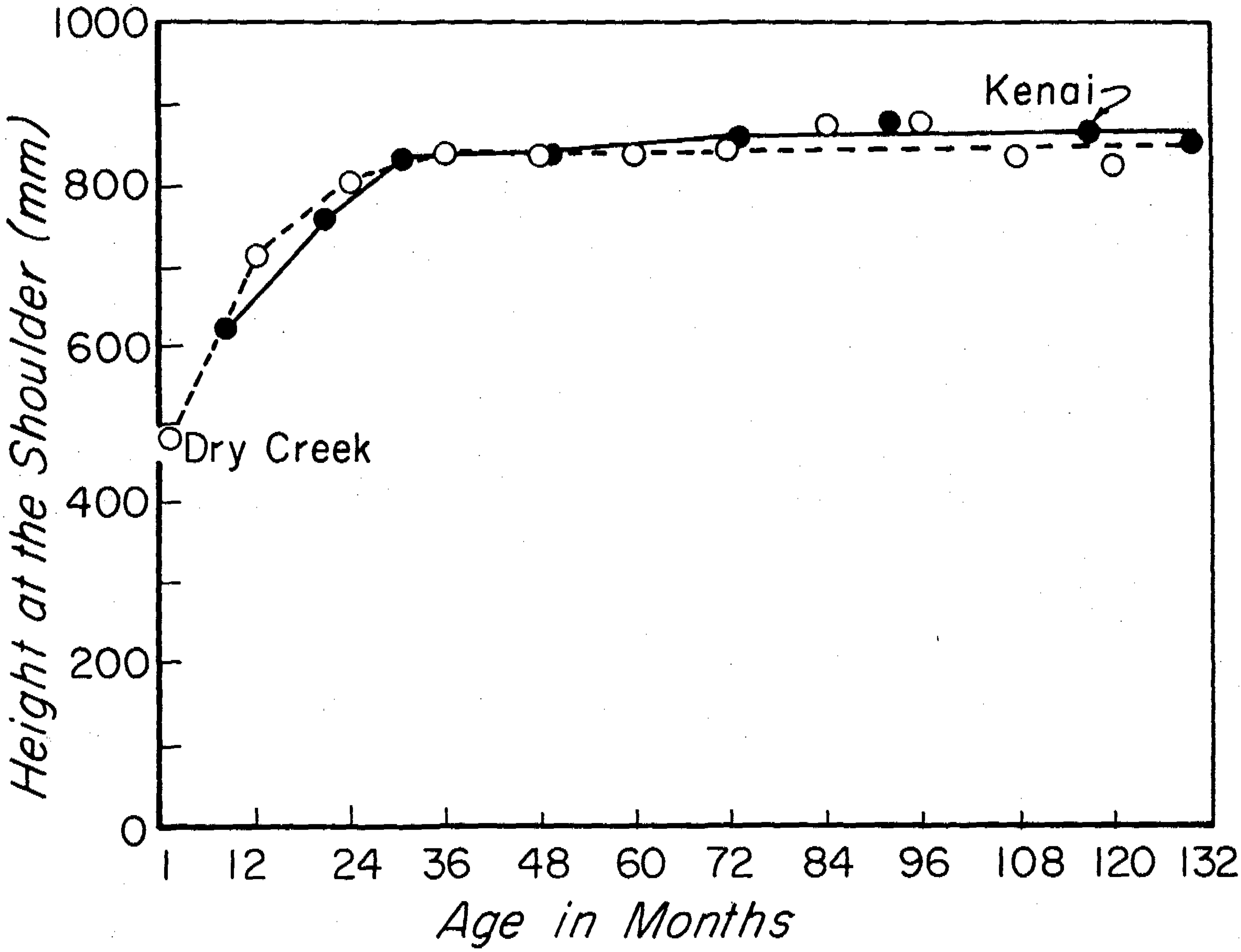

Fig. 7. Comparison of growth patterns of Dry Creek and Kenai ewes: shoulder height.

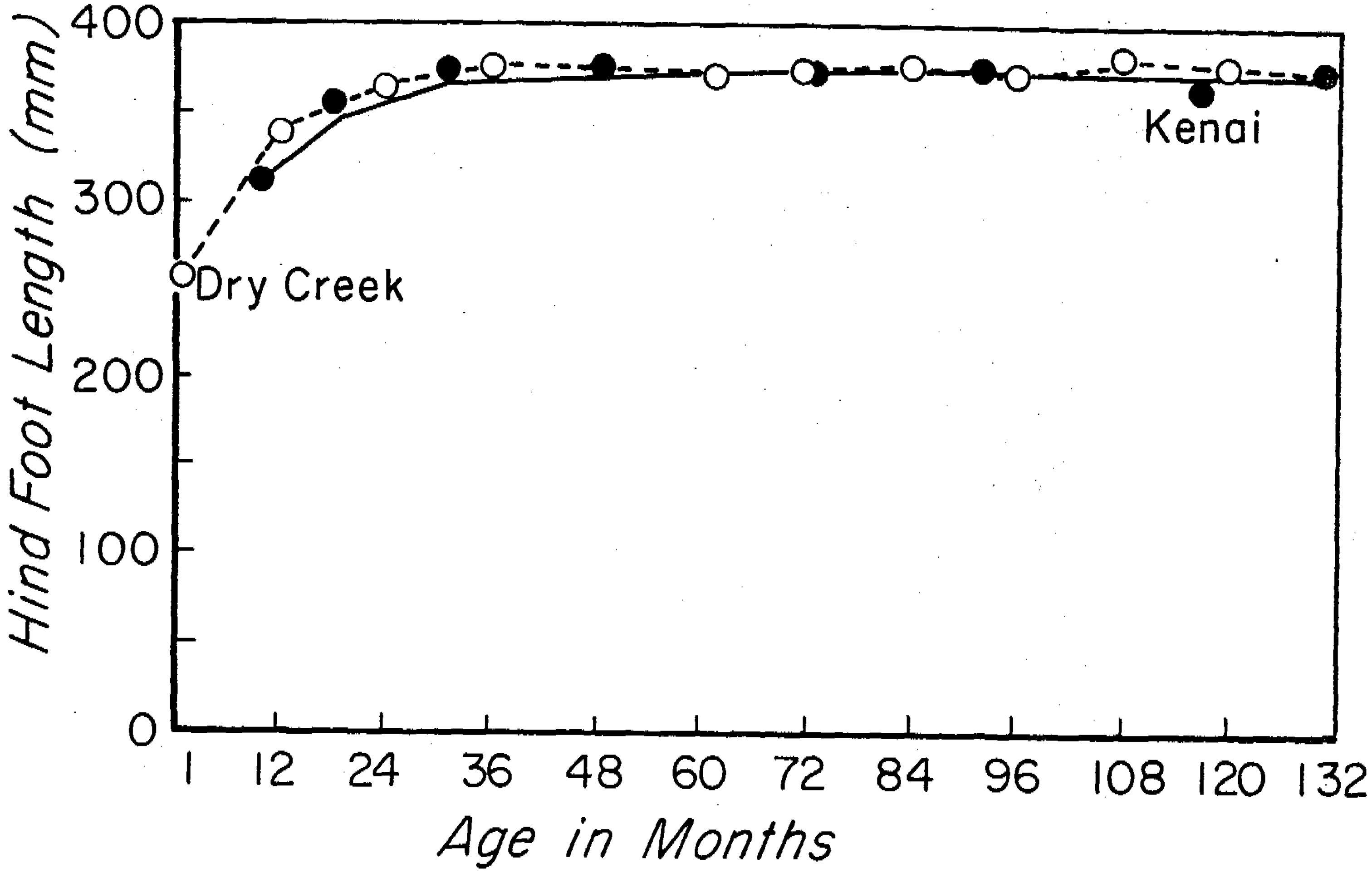

Fig. 8. Comparison of growth patterns of Dry Creek and Kenai ewes: hind foot length.

The failure to demonstrate differences in transferrin and LDH mobility between Dall sheep from the Alaska Range and the Kenai Peninsula suggests that there are no important differences between the two populations, or that they represent groups of sheep from the same ancestral stock which have not diverged to the point of demonstrable differences in blood transferrin structure. Failure to find a difference was somewhat surprising because the Dall sheep on the Kenai Peninsula are considered to be a different subspecies *(Ovis dalli kenaiensis)* than those of the Alaska Range, *(Ovis dalli dalli)* (Cowan 1940). It seems likely that if these animals represent distinct subspecies, different transferrin structures would be found, because differences in transferrin mobility have been reported between *O. d. dalli* from Kluane Lake, Yukon Territory, and *O. d. dalli* from the Chisana-Nabesna area (Nadler et al. 1971). Our findings suggest that the Kenai sheep population is no more unique than any other discrete Dall sheep population in Alaska. The morphological comparisons also support this hypothesis.

Population Size and Composition: In June 1972, the population of the study area was estimated to consist of 1473 sheep at the end of mineral lick observations. Composition of the population using the lick in 1972 was as follows:

	Observed %		Calculated No.
Legal Rams	3.3	or	43 animals
Yearlings	11.3	or	147 animals
Young Rams	17.7	or	256 animals
Young Ewes	17.7	or	256 animals
Mature Ewes 5 years old	51.4	or	505 animals
		Total	1207 animals: includes no lambs

These figures are in substantial agreement with composition data gathered during a winter ram count during December of 1972. Smith (1973) reported, "Mineral lick observations indicated that 3.3 percent of the sheep population were legal rams. The aerial survey indicated a lower percentage of rams (2.0%) but the sample size of only 256 sheep may have biased this figure." It should be noted here that Smith referred only to adult animals seen at the lick, and that when lambs are added the percentage of legal rams drops to three percent. He further stated, "It should be noted, however, that the harvest of rams during the hunting season occurred after the mineral lick observations and before the aerial survey in December and this might explain the lower percentage found during the aerial survey."

From the observed drop of ram percentage, from three percent to two percent following harvest, one may predict a ram harvest of one percent of 1473 animals or 15 rams. Harvest ticket returns from Dry Creek and the West Fork of the Little Delta River indicate that the ram harvest from these drainages in

1972 was 15 animals. This lends credibility to the population estimate of about 1500 animals in the study area.

Further support for a figure of this magnitude comes from population estimation data gathered in the summer of 1973. Using the same techniques as described for 1972 the population was estimated to be 1600 animals and composition was essentially the same as in 1972.

From June 28, 1972 to July 5, 1972 (a period of stable lamb percentage among sheep using the lick, Fig. 9) 474 ewes and 167 lambs were seen. This gave an observed ratio of 35 lambs per hundred ewes. Nichols (Nichols and Heimer 1972) showed that all ewes above two years of age are capable of producing lambs. Consequently, the number of productive ewes was calculated to be 761. Multiplication of 35 lambs/100 ewes times 7.61 hundred ewes gave a crop of 266 lambs. Addition of these 266 lambs to the 1207 animals calculated above provided a population estimate of 1473 sheep using the lick in 1972.

Because this population estimate is a product of extrapolation, the assumptions used in its derivation must be carefully reviewed. First, it is assumed that all animals entering the lick were seen. Observers were stationed at the lick at all times throughout the period of observation. The possibility that there were significantly more visits than 5080 is remote because it is usually a simple task to count the number of incoming sheep.

The second assumption is that all animals entering the lick did so at the frequency demonstrated by collared sheep. It was found (see Lick Use Patterns) that ewes with lambs used the lick more than ewes without lambs. If the collared sheep contained a disproportionately low number of lactating ewes the average number of visits per sheep might be too low and the resultant estimate of population size too high. The observed lamb:ewe ratio for all sheep was 35 lambs/100 ewes. The known lamb:ewe ratio among collared sheep was 27/100. It should be noted here that a ewe was considered to be lactating only if seen to nurse a lamb at the lick. Also, it was observed that lambs did not always accompany ewes known to be lactating. This strict definition may easily have led to the artificially low estimated lamb:ewe ratio among collared sheep, which apparently occurred. Ewes #58, G-2, and #194 had licking patterns which are characteristic of lactating females (Table 5 presented later), but were never seen to nurse a lamb. If they are considered on this basis to be lactating the ratio of lambs to ewes among the collared sheep increases from 27:100 to 35:100. Hence, it appears that there is little chance for error in this regard. Furthermore, there were 29 rams with an average of four visits per animal and 27 ewes having lick use patterns not characteristic of lactation with an average of four visits per animal. When the number of possible lactating ewes which were not seen is averaged with all collared animals, the average remains unchanged at four visits per animal.

The third assumption was that sheep did not lose collars between visits. Collared animals were also marked with ear tags. Only one collared animal was seen which was identified later by ear tag only.

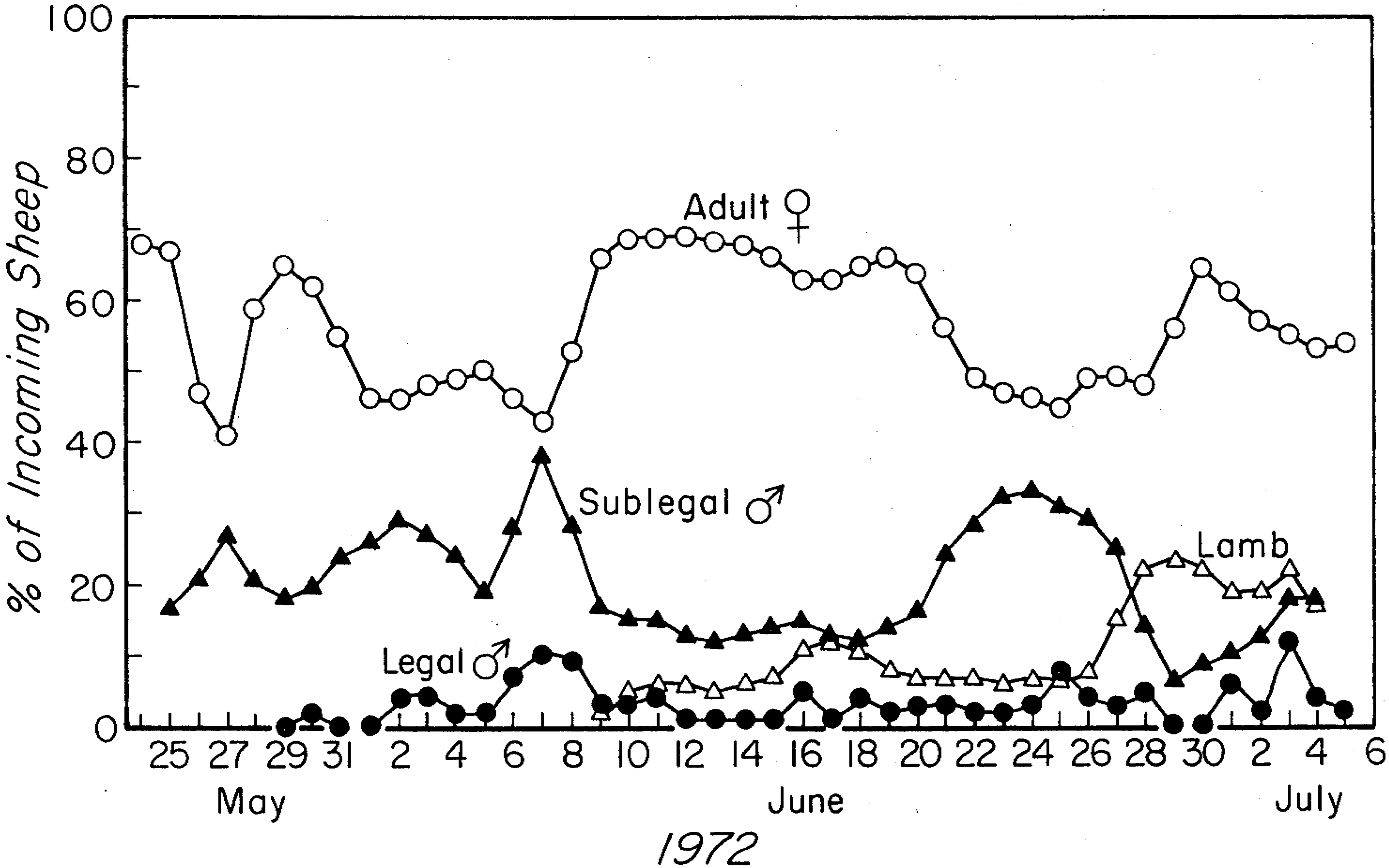

Fig. 9. Sex and age composition of incoming sheep at the main mineral lick, Dry Creek, Alaska Range, 1972.

All other marked animals retained their collars throughout the course of observations. The possibility that animals lost both collars and ear tags is extremely remote.

The possibilities just discussed are the only apparent ones which could have lead to overestimating the population size. Consequently, it is thought that at least 1473 animals were influenced by the lick, and that this is a conservative estimate.

It is somewhat artificial to consider all animals using the lick as a population since they occupy different geographic areas during the breeding season. It should be mentioned, however, that the defined study area is the apparent limit of geographical distribution for sheep marked at the mineral lick. The animals inhabiting the study area as a whole appear to be influenced by the main mineral lick on Dry Creek and may in that sense be considered a population. The calculated number of sheep inhabiting the study area was down somewhat from the aerial count by Smith in 1968 (pers. comm.). This count was made in a PA-18-150 Supercub and nearly 1600 animals were actually counted in the area at that time. The 1973 population estimate was 1600 sheep using the same techniques. Consequently, the population is thought to consist of about 1600 animals.

Food Habits, General Condition and Nutritional Status: Analyses of rumen samples from 16 collected ewes, 4 rams killed in the sheep harvest (samples supplied by guides), 2 yearlings and 1 lamb are shown in Table 1. These data indicate that there is little apparent change in the food habits of ewes with increasing age. Rumen contents of ewes taken from winter range contained an average of 86 percent grasses and sedges. Further identification of this material was not practical because the state of decomposition prohibited the use of conventional taxonomic keys. The remaining 14 percent consisted of 6 percent willow *(Salix sp.)* leaves, buds and twigs, and 8 percent other plants.

Ewes taken in July had a much greater incidence of *Dryas* leaves in their rumen contents (12% compared with virtually none in the winter animals). There was also a slight increase in the volume of willow, and a corresponding decrease in grass utilization. Summer rumen samples were more difficult to analyze because of the apparently higher digestibility of summer forage. Much material was highly digested and not identifiable.

The data presented here are in essential agreement with those of Murie (1944), who examined rumens from 75 winter-killed animals. His data showed that 96 percent of the contents he analyzed were grasses, sedges, willow and *Vaccinium*. Of this, 89 percent was grasses and sedges, 10 percent willow and 1 percent *Vaccinium*. Murie also reported that there was an increase in *Dryas* utilization in summertime. This is also suggested by our data even though the sample size is small and the reliability of summer samples is questionable.

Table 1. Food habits of Alaska Range sheep, 1972 and 1973.

Accession Number	Age (yrs)	Sex	Date Collected	Percent Unidentified Grasses and Sedges	Percent Willow Parts	Percent	Percent *vaccinium* (green)	Other Plant Species	Location	Comments
3868	3	F	Nov. 17, 72	96	1	1	1	1% *Ledum*, Saxifrage, moss	Exclosure *	
3559	4	F	May 5, 72	88	12	-	-	Trace of Saxifrage	Slate *	Lactating
3578	4	F	Mar. 20, 72	97	1	1	-	1% Lichen	Slide*	
Fld-2	6	F	Nov. 17, 72	97	1	T	1	1% Lichen	Exclosure*	
3579	7	F	May 5, 72	94	5	1	-		Slide*	
3580	7	F	May 5, 72	95	5	-	T		Exclosure*	Pregnant
3870	5	F	Nov. 18, 72	94	1	T	1	3% *Ledum*	Exclosure*	
Fld-5	5	F	Nov. 19, 72	99	T	T	T		Icing*	
3581	1	F	May 4, 72	94	6	-	-	Trace of Moss	Slide*	
Fld-6	0.5	M	Nov. 19, 72	99	-	T	T		Icing*	
3888	10	F	Apr. 5, 73	84	17	-	-		Granite Mtns.	
3889	10	F	Apr. 5, 73	81	16	3	-	-	Granite Mtns.	
3890	10	F	Apr. 5, 73	93	-	T	-	7% Lichen, moss	Granite Mtns.	
3891	10	F	Apr. 5, 73	52	20	-	5	23% *Ledum*, Lichen, fungus	Granite Mtns.	
3892	10	F	Apr. 5, 73	99	-	-	0.5	0.5% Lichen	Granite Mtns.	

Table 1. (Continued).

Accession Number	Age (yrs.)	Sex	Date Collected	Percent Unidentified Grasses and Sedges	Percent Willow Parts	Percent *Dryas*	Percent *Vaccinium* (green)	Other Plant Species	Location	Comments
3895	7	F	Apr. 7, 73	42	25	T	17	16% *Ledum*, fungi, lichen	West Fork Little Delta	
3894	2	F	Apr. 7, 73	70	9	T	15	5% *Ledum*	West Fork Little Delta	
3893	8	F	Apr. 7, 73	58	3	-	39	-	West Fork Little Delta	
3897	5	F	Apr. 7, 73	89	5	T	5	1% Lichen	West Fork Little Delta	
3896	8	F	Apr. 7, 73	91	-	-	9	-	West Fork Little Delta	
3695	1	M	July 8, 72	85	13	2	-		Lick	Actual % *Dryas* may be higher than recorded.
3697	4	F	July 8, 72	80	5	15	-		Lick*	
3696	11	F	July 8, 72	80	-	20	-		Lick*	Low confidence in this sample
R-1	9	M	Aug 27, 72	44	-	56	-		Questionable	33 inch horn
R-2	9	M	Aug. 16, 72	47	-	53	-		Questionable	34.5 inch horn
R-3	11	M	Aug.19, 72	1.5	1.5	-	-		Questionable	33.75 inch horn
R-4	11	M	Aug. 11, 72	100	-	-	-		Questionable	33.5 inch horn

* Dry Creek Drainage

Our data appear to be somewhat at odds with those presented by Viereck (1963a). He stated that sheep in the Tonzona drainage relied on bunch-grass meadows and *Dryas* mat communities for the bulk of winter grazing, and that during winter months *Dryas* leaves remain on the plant and provide large quantities of plant material for sheep. However, in a subsequent publication, Viereck (1963b) observed that Dry Creek sheep did not seem to feed extensively on *Dryas* leaves during the winter. This observation is consistent with the observations of Murie (1944) and our present data. Based on the further observations of Viereck (1963b) it appears likely that the species most likely to be important in the grass-sedge component are a small sedge, *Kobresia myosuroides*, and the grass *Festuca altaica*.

Analysis of rumen contents taken from four rams killed by hunters during the month of August revealed a clear dichotomy. Two animals had fed almost exclusively on grasses and sedges; the other two had values for *Dryas* of greater than 50 percent.

General Condition: General body condition is indicated by the magnitude of fat stores present in the body of any given sheep. The results of general condition analyses of the sheep collected in the Dry Creek study area are summarized in Table 2. These data reveal that general condition varies greatly with season and diet as reported earlier by Nichols (Nichols and Heimer 1972).

Riney (1955) reported that subcutaneous fat is the first depot mobilized under conditions of negative energy balance. This is followed by visceral fat, and finally by fat from the marrow of the long bones. Our results show that in animals taken in mid-November subcutaneous fat was present over the rump in pads from 1.2 to 1.5 cm deep. No subcutaneous fat was observed in animals taken in March, May, June and July of 1972. This indicates that the subcutaneous store of fat had been used *in toto* by March. Visceral fat, as represented by the kidney fat index (Riney 1955), was greatly depleted by March, and was not replenished by early July, 1972.

However, between July and November the kidney fat index (weight of kidney fat divided by weight of kidney alone) had increased 100 times. Further data will be necessary to elucidate the dynamics of body fat mobilization with season and nutritional status.

Marrow Fat: Analysis of our data and those reported by Nichols (Nichols and Heimer 1972) indicates that marrow fat percentage is lowest at the end of winter and highest just prior to the rut in November. Combining both sets of data gives a composite representation of what may happen to general body condition over the year (Fig. 10). Sample sizes are small from the Alaska Range, and the synthesis of a general model from data gathered in geographically separate locations may be legitimately criticized. However, it appears that sheep are reaching comparable levels of bone marrow fat in November and August. These are, however, close to maximum and may reflect re-fattening in summer. In any case, it appears likely that the tolerable extremes of condition are represented by marrow fat content ranges from near 99 percent in early winter to a low of near 40 percent in spring. The 40 percent value in May for Dry Creek sheep is about 10 percent lower than the

Table 2. Body condition parameters of Alaska Range sheep.

Accession Number	Age	Sex	Date Collected	Body wt. kg	Kidney Fat Index	Depth of Hip Fat Pad cm.	Omental Fat	Marrow Fat Percent	Comments	Location
3559	3	F	Mar 20, 72	39.7	-	0.0	-	46	Lactating	Dry Creek
3581	1	F	May 4, 72	28.4	-	0.0	nil	55		Dry Creek
3578	4	F	May 5, 72	36.8	0.23	0.0	nil	47		Dry Creek
3579	7	F	May 5, 72	41.8	9.06	0.0	nil	15		Dry Creek
3580	7	F	May 5, 72	49.5	0.46	0.0	nil	46	Pregnant (fetus 2.7 kg)	Dry Creek
3623	1	F	June 5, 72	30.2	0.23	0.0	nil	37		Dry Creek
3624	13	F	June 5, 72	47.7	0.16	0.0	nil	52	Pregnant (fetus 3.2 kg, kidney fat index = 0.49)	Dry Creek
3695	1	M	July 8, 72	25.0	0.11	0.0	-	63		Dry Creek
3696	11	F	July 8, 72	48.6	0.31	-	Trace	68	Lactating	Dry Creek
3697	4	F	July 8, 72	36.3	0.25	-	-	50		Dry Creek
3868	3	F	Nov 17, 72	48.6	-	1.2	Heavy	96		Dry Creek
3870	5	F	Nov 18, 72	59.9	10.89	1.5	Heavy	96		Dry Creek
Fld-2	6	F	Nov 18, 72	52.2	-	-	-	92		Dry Creek
Fld-4	6	F	Nov 19, 72	54.5	-	-	-	96	Lactating	Dry Creek
Fld-5	5	F	Nov 19, 72	51.3	-	-	-	97		Dry Creek

Table 2. (Continued).

Accession Number	Age	Sex	Date Collected	Body wt. kg	Kidney Fat Index	Depth of Hip Fat Pad cm.	Omental Fat	Marrow Fat Percent	Comments	Location
Fld-6	0.5	M	Nov 19, 72	26.8	-	-	-	92		Dry Creek
3888	10	F	Apr 5, 73	56.8	1.00	0.0	Sparse	99	Pregnant (fetus 1.82 kg)	Granite Mountains
3889	10	F	Apr 5, 73	55.5	2.63	0.0	Sparse	99	Pregnant (fetus 1.76 kg)	Granite Mountains
3890	10	F	Apr 5, 73	52.7	1.84	0.0	Sparse	98	Pregnant (fetus 1.30 kg)	Granite Mountains
3891	10	F	Apr 5, 73	53.6	2.02	0.0	Sparse	99	Pregnant (fetus 1.74 kg)	Granite Mountains
3892	10	F	Apr 5, 73	61.4	2.83	0.0	Sparse	99	Pregnant (fetus 2.81 kg)	Granite Mountains
3895	7	F	Apr 7, 73	52.7	1.6	0.0	Sparse	99	Pregnant (fetus 1.70 kg)	West Fork Little Delta
3894	2	F	Apr 7, 73	43.1	0.6	0.0	Trace	98	Barren	West Fork Little Delta
3893	8	F	Apr 7, 73	48.6	0.1	0.0	Trace	87	Barren	West Fork Little Delta
3897	9	F	Apr 7, 73	47.7	1.9	0.0	Sparse	99	Pregnant (fetus 1.57 kg)	West Fork Little Delta
3896	8	F	Apr 7, 73	50.0	1.4	0.0	Sparse	99	Pregnant (fetus 1.30 kg)	West Fork Little Delta

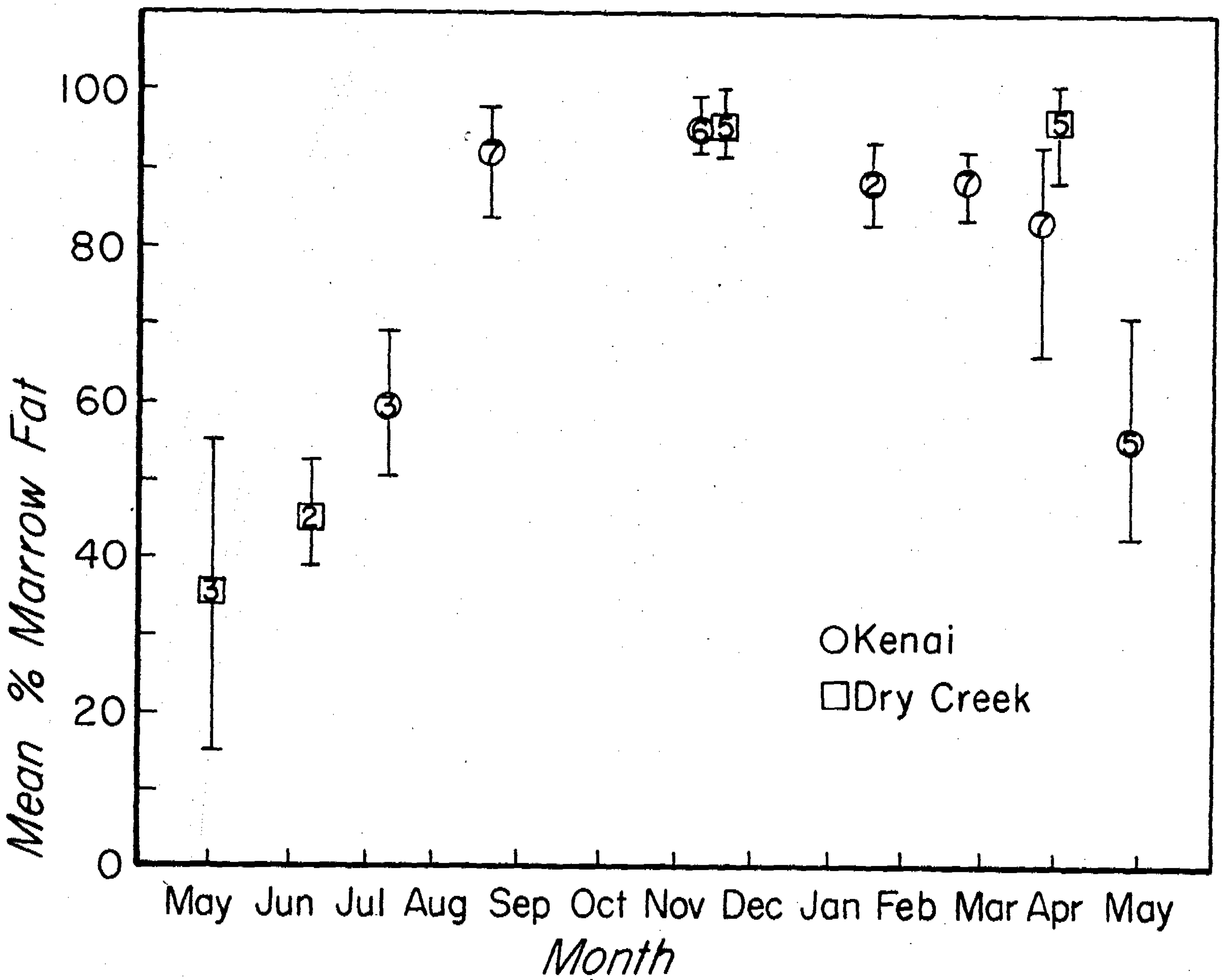

Fig. 10. Seasonal marrow fat values for Dry Creek and Kenai Sheep. (Sample sites and ranges are indicated.)

values reported for sheep on the Kenai Peninsula. This may be attributable to differences in winter severity or range quality, population differences, or insufficient sample size (n=3 for Dry Creek sheep).

Weight Loss in Winter: Mature ewes, five and six years old, collected in mid-November, 1972 had an average body weight of 54.5 kg in Dry Creek (n=4). The average early June weight of five- and six-year-old ewes captured at the lick was 46.5 kg (n=18). This represents a winter weight loss of 15 percent. Ewe sheep taken on the Kenai Peninsula had winter weights in November of 57.8 kg (n=6) and weights in spring of 50.4 kg (n=10), representing a weight loss of 13 percent. Ewes on the Kenai were about 4 kg heavier (7-8%), but the percentage of weight lost from mid-November to the end of winter was approximately the same as in Dry Creek. This suggests some similarity between the energetic requirements of sheep in both locations. The limited data available are only suggestive and firm conclusions cannot be made at this time.

One male lamb of the year was taken in November, 1972, at the age of six months. His body weight was 26.8 kg. The average weight of lambs considered to be one month old in early June at the Dry Creek mineral lick was 8.4 kg. This means that in the five intervening months the collected lamb had increased its body weight about three times. However, this animal was exceptionally small. The average body weight measured at the lick for animals of his age class at the end of winter was 29.3 kg or 9 percent greater than this individual at his peak yearly weight. Nichols (Nichols and Heimer 1972) presented data which indicate that a male lamb will lose 25 percent of his mid-November weight by spring. This means the lamb in question might have had a body weight of 20.1 kg had he survived the winter. If so, the animal would have been smaller than any yearling ram ever weighed in spring (the smallest male yearling ever weighed (n=20) was 22.2 kg). Consequently, he would have been only 2/3 as heavy as the average individual of his age class. It should be noted that when collected this animal had bone marrow fat of 92 percent and copious amounts of visceral fat.

It may be that the small size of this individual was exceptional, but the possibility also exists that his reduced size was a result of an exceptionally hard winter in 1971-72. The lamb:ewe ratio of this animal's year class was low, and the winter of 1971-72 was one of heavier than normal snowfall. Consequently, it might be expected that all offspring conceived and carried through this strenuous winter might be physically stunted. Robinson et al. (1961) reported that in domestic sheep, animals maintained on a bare subsistence diet have smaller lambs, and that these animals are stunted throughout life.

Digestive Function: Data from the analysis of digestive function in mid-November are presented in Table 3. It can be seen that the average caloric production per day from volatile fatty acid production was 1835 calories. This provided an estimate for metabolizable energy of 2621 kcal per day (Gasaway and Coady 1973). Theoretical basal metabolism for a 55 kg sheep would be $70 \times (55)^{0.75}$ or 1414 kcal per day according to Kleiber (1961). The estimated maintenance requirement of a 55 kg free-ranging

Table 3. Energy data for Dry Creek sheep in mid-November, 1972.

Animal	Date Collected	Age (yrs)	Sex	VFA Production (mol/day)	VFA $\frac{kcal}{day}$
1	November 17	3	F	8.9	2456
2	November 17	6	F	-	-
3	November 18	5	F	5.4	1490
4	November 19	6	F	9.5	2622
5	November 19	5	F	2.8	773
6	November 19	0.5	M	1.9	524

Average metabolizable energy per day (ewes) = 2621 kcal
Average metabolizable energy per day (lamb) = 750 kcal

Basal metabolism for 55 kg ewe = 1414 kcal/day
Basal metabolism for 27 kg lamb = 826 kcal/day

Estimated maintenance requirement for ewes = 2400 kcal
Estimated maintenance requirement for lamb = 1500 kcal

sheep is about 2400 kcal per day (1414 kcal/day x 1.7). This calculation, though admittedly somewhat arbitrary, shows that the calories obtained from the diet are about equal to maintenance requirements in adult ewes in mid-November.

Similar calculations for the lamb revealed that this animal had a dietary input of about 750 kcal per day and a requirement of about 1500 kcal per day. Consequently, this lamb was in negative energy balance while the ewes were just meeting their energetic needs with rumen fermentation products. The ewe accompanying this lamb was lactating, and this may have been providing energy to the lamb which we were not able to assess. The probable negative energy balance indicated in this lamb is in agreement with Nichols' (Nichols and Heimer 1972) data which suggest that young animals lose proportionately more of their body weight than do adults over the course of winter. Furthermore, it correlates with the small body size of the lamb and leads to doubts about its viability in other than a very mild winter.

The observation that ewes were meeting caloric demands by dietary input indicates that they may represent the extreme of seasonal fattening. This suggests that hip fat pads of 1.5 cm in depth and kidney fat indices of near 10 are the upper limits of fattening.

Ewes collected from the Dry Creek study area in early April 1973, showed lower fermentation rates than the animals collected in mid-November 1972. This is presumably due to lower quality forage which had lost available nutrients over the winter. Animals taken at this time had no fat deposits over the hips and little visceral fat (mean kidney fat index for the five animals was 1.12). Marrow fat, however, was about 96 percent. These indicators suggest that even though the ewes of the study area had been in negative energy balance for five months there were still some body fat stores present. The indicators also suggest that the winter of 1972-73 was milder than the winter of 1971-72.

Data from animals collected at winter's end in 1972 (Table 2) show that kidney fat indices and marrow fat were both lower than those found in animals after the milder winter of 1973. It seems likely that range quality may also influence the condition of ewes at the end of winter.

Five ewes collected from the Granite Mountains, an area about 70 miles to the east of the Dry Creek study area, were in better condition than ewes taken at the same time from Dry Creek. Table 2 contains data which indicate that ewes from the Granite Mountains had greater body weight, greater remaining stores of visceral fat, and those carrying fetuses had *in utero* lambs which were about 25 percent heavier. Range quality is implicated in these differences because the fermentation rates for ewes of the Granite Mountains are about 30 percent greater than those found for ewes in Dry Creek (Fig. 11). Differences in weather severity may also influence end-of-winter condition, and it is not known whether winter severity was the same on both ranges. Gross chemical analysis of the rumen contents did not reveal differences in range quality.

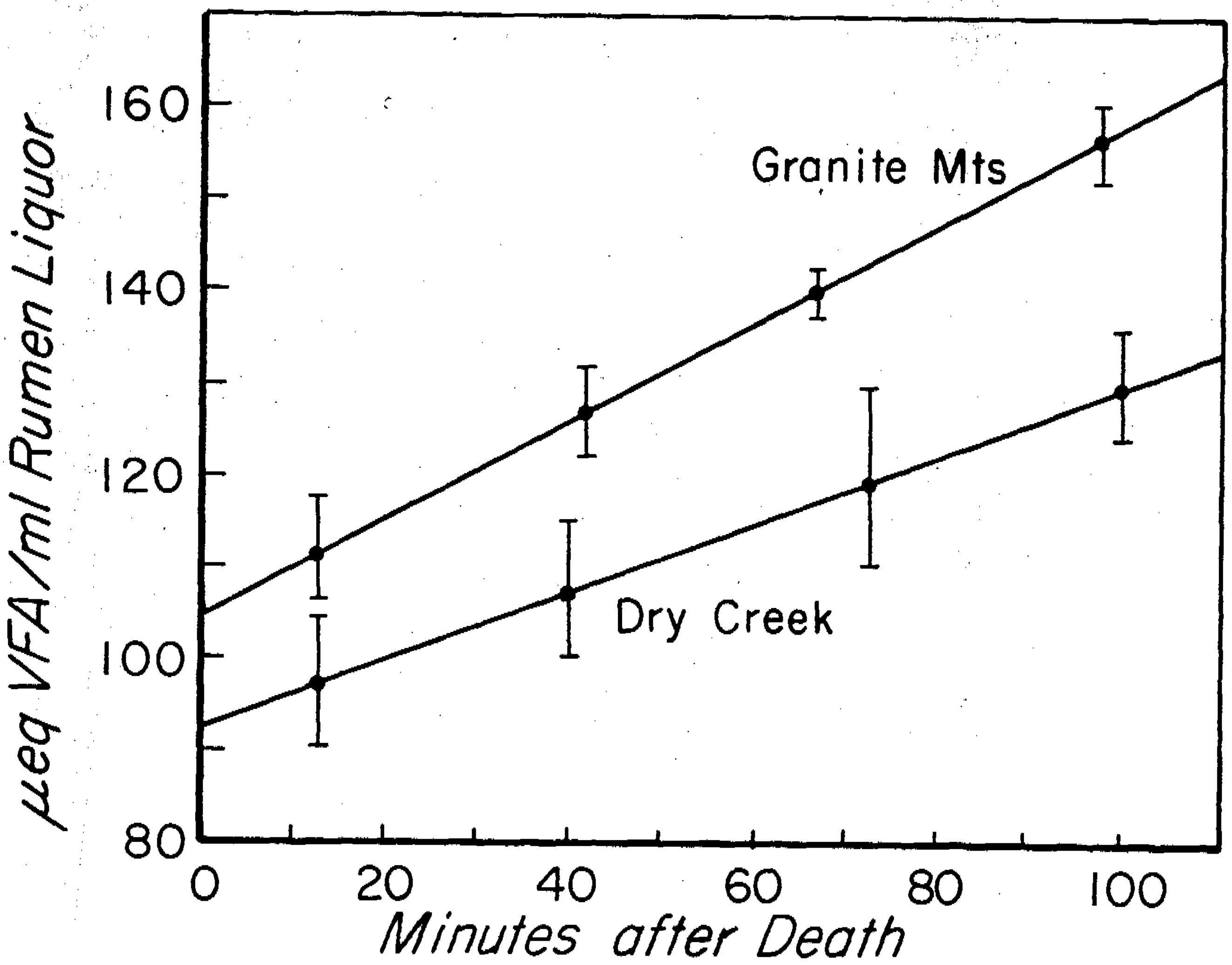

Fig. 11. Rumen fermentation rates (mean ± standard deviation) for ewes of Dry Creek and Granite Mountains, Alaska Range, April 1973.

Determination of Daily Movement Pattern and Seasonal Home Range

Daily Movement Pattern: Data gathered on daily movement patterns were few and of questionable worth. Inability of observers to keep track of individual animals coupled with the influence of the observers' presence on the movements of sheep combined to nullify this effort. In retrospect it seemed that there was little of management interest in the daily movements of Dall sheep in Dry Creek. For this reason, efforts to determine daily movement patterns were terminated in 1972.

Seasonal Home Range - Ewes: Analysis of collared sheep resighting data compiled since 1968 has revealed that there are two wintering populations of ewes on the west side of Dry Creek and at least one on the east side (Fig. 12).

Ewes wintering on the west side of Dry Creek are divided into two populations by Pinnacle Ridge and the West Fork of Dry Creek. Population #1 winters on Slide Ridge, Exclosure Creek, Bigfoot Creek and may move as far as upper Sheep Creek to the west. Its range is bounded on the south by the West Fork of Dry Creek and on the north by the precipitous terrain which drops away from the main chain of the Alaska Range proper. Population #2 winters south of Pinnacle Ridge as far up Dry Creek as Two Ram Creek, and as far west as upper Rogers Creek. Dry Creek is the eastern limit of its winter range.

Insufficient data preclude definitive delineation of the seasonal ranges of population #1. However, summer resightings indicate that population #1 (those ewes wintering on the Slide-Exclosure-Bigfoot area) moves to summer ranges on the south side of Pinnacle Ridge or perhaps into upper Sheep Creek. It may occupy some of the same drainages used by population #2 in winter. However, during summer vegetation is available at lower elevations, and this may support most summer foraging. Total distance from the southern extent of winter range to summer range is about nine aerial miles (14.4 km).

The ewes of population #2 move further up Dry Creek (to the south) in winter and occupy the area bounded on the north by Two Ram Creek, and east by Dry Creek and the south by the extreme upper reaches of Dry Creek. These animals occupy upper Dry Creek, upper Kansas Creek, and some areas of upper Rogers Creek. Populations #1 and #2 may overlap on the summer ranges but because they are clearly divided during the breeding season they are considered to be separate.

Seasonal range relationships of ewes which winter on the east side of Dry Creek are unclear because there is overlap between animals which winter on the ridge system from Red Mountain to No Name Creek, south to the northern limit of Slate Creek, and the animals which winter on the ridge systems between the South Fork of Slate Creek and the South Fork of Forgotten Creek. Some individuals have been seen wintering in both areas during different years, and the summer ranges seem to be vaguely defined as well. It is probable, however, that animals are confined to the area between Dry Creek and the West Fork of the Little Delta River. The northern limit of winter range is the edge of the Alaska Range proper. The west branch of the West Fork of the Little Delta River proper forms the southern limit of these seasonal ranges (Fig. 12).

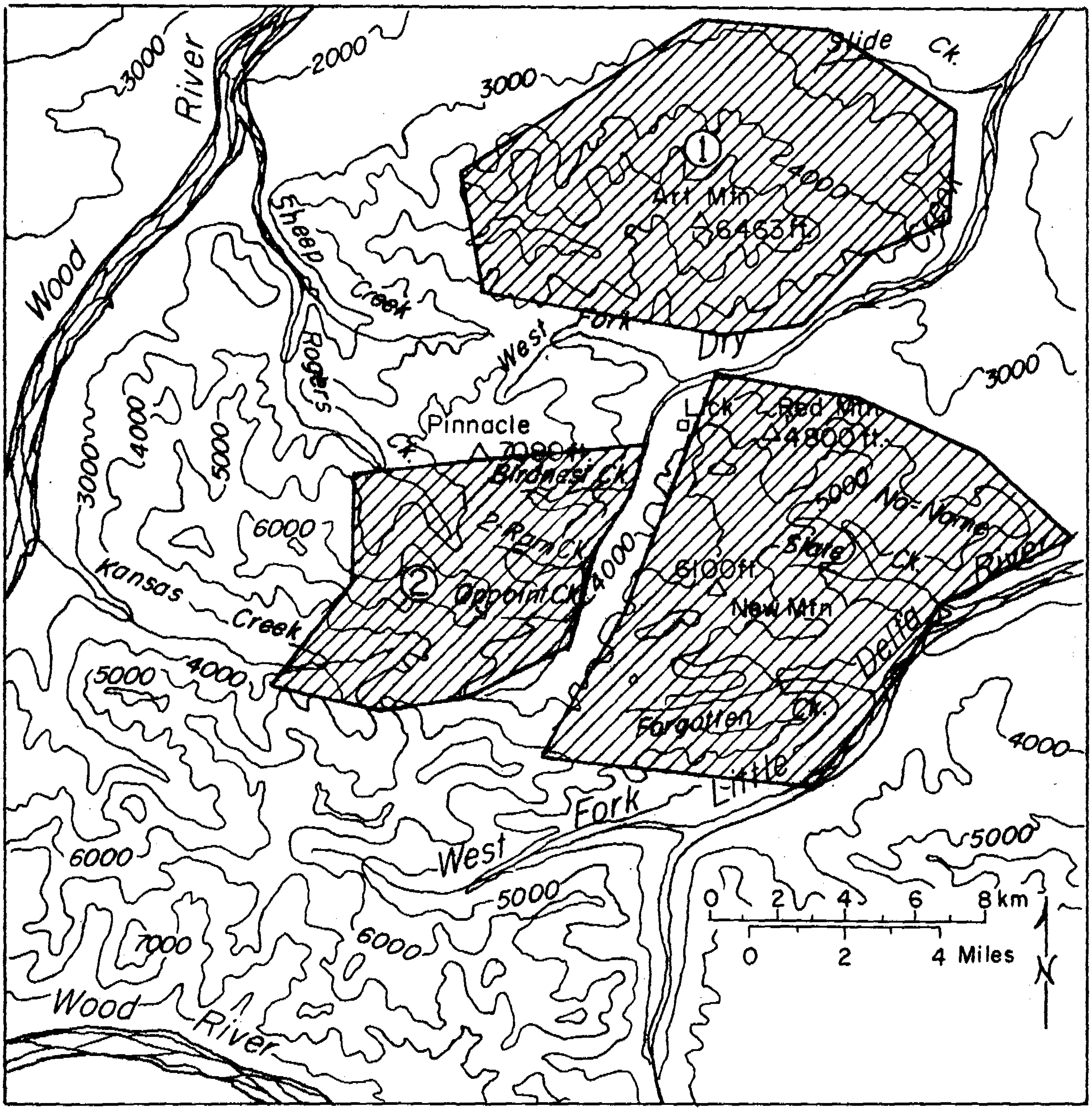

Fig. 12. Winter Range areas of Dry Creek ewes.

The area described above contains both the summer and winter ranges of the sheep which occupy it. This situation is unlike that described on the west side of Dry Creek where wintering areas and summer ranges are separated by several miles. In this situation (east of Dry Creek) the physiography and prevailing winds lead to snow deposition on some portions of the area where sheep are seen in summer. These conditions render the vegetation inaccessible in all but the mildest winters. These areas of snow accumulation are often gentle slopes and support grass-sedge meadows and *Dryas* mat communities. When snow melts in spring these areas become accessible to sheep and are subsequently used as summer range. The areas of such snow deposition are indicated in Fig. 13. The higher areas which are not marked can be considered winter range in a typical winter. It should be noted, however, that sheep utilize winter range throughout the year and that summer range is simply added to that area which is available in winter. The multiple resighting data which form the basis for these conclusions are given in Table 4.

In addition to the populations mentioned above it appears that there is some movement across Dry Creek from winter to summer range. It appears that at the present time these movements are insignificant and the majority of ewe movements are as described above.

<u>Seasonal Home Range - Rams</u>: Resightings have revealed that there are at least four ram bands which may be identified while on their summer ranges. It appears that there is a small band which inhabits the precipitous terrain on the east side of the Wood River downstream from Sheep Creek. These rams apparently rut with the ewes of the Slide-Exclosure-Bigfoot area, and winter with them as well. They may travel 10 miles (16 km) out of their way to be at the mineral lick.

A fairly large band of rams is also indicated by the data to inhabit Rogers and Kansas Creeks. Little movement data are available for these animals, but it appears that they may rut with both populations of ewes on the west side of Dry Creek. Our data are fragmentary for this group of animals; however, it has been reported by a long-time guide in the study area that this group is actually made up of three sub-populations of rams. These animals face a journey of up to 12 miles (19.2 km) out of their way to utilize the lick.

On the east side of Dry Creek there appear to be two bands of rams. One group summers in the vicinity of Red Mountain and No Name Ridge and has ready access to the lick throughout the summer. Some of these animals have been observed to cross Dry Creek and rut with the ewes in the Slide-Exclosure-Bigfoot area. Other rams of this group rut with the ewes which winter in the Red Mountain-No Name complex.

The final ram band described by the tagging operation summers on upper Forgotten Creek. Indications are that this is a fairly large group of rams and that these rams generally rut and winter with the ewes in the area of

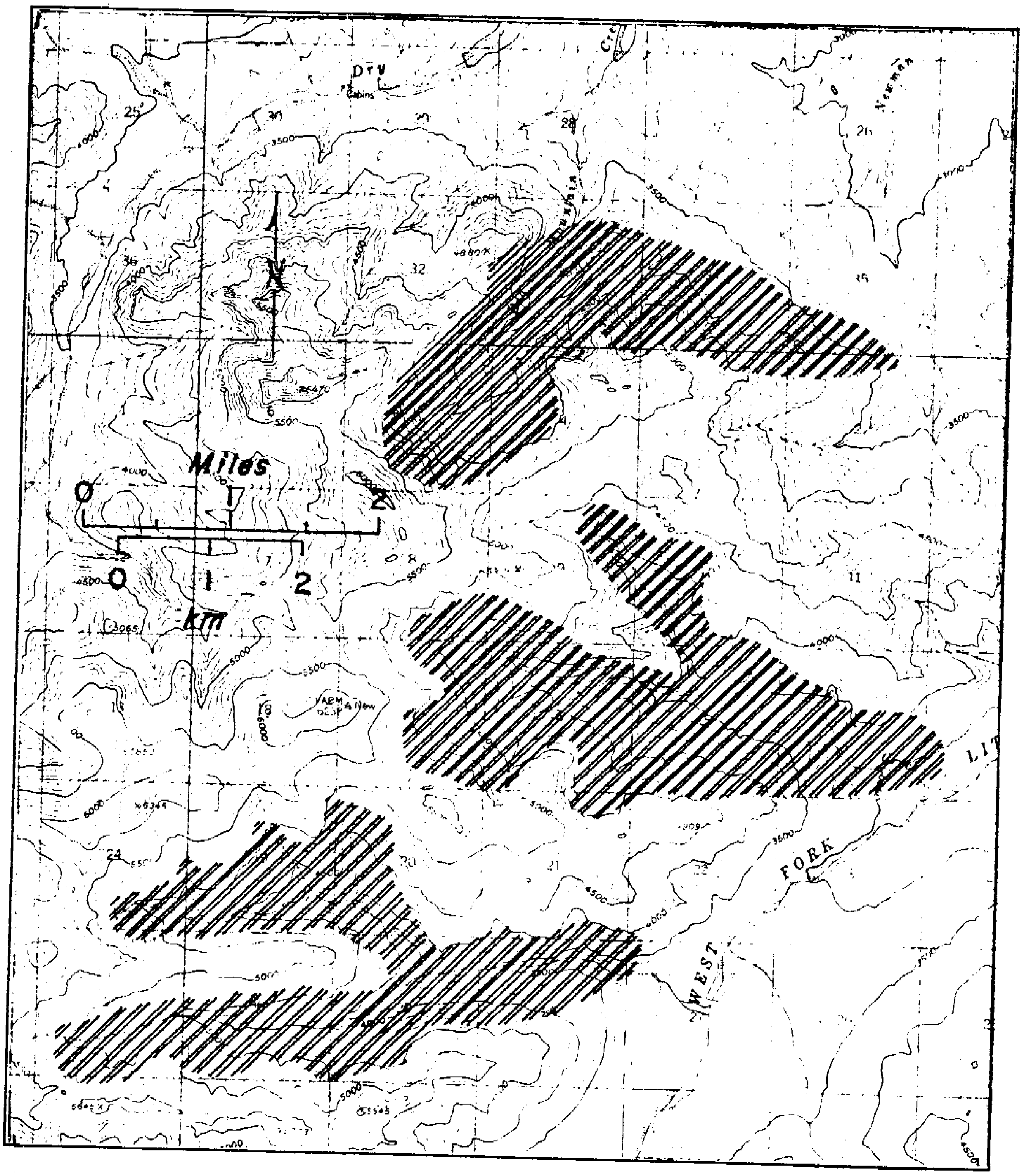

Fig. 13. Areas east of Dry Creek which are usually not available to sheep during winter because of deep snow.

Table 4. Ewe resightings on the east side of Dry Creek, Alaska Range, animals seen at least twice when not involved with lick.

Collar Number	Sex	Location	Date Seen
5	F	No Name-Red Mountain Complex	June 1969
5	F	North Fork Forgotten Creek	July 1972
32	F	South Fork Slate Creek	Winter 1969
32	F	South Fork Slate Creek	June 1969
32	F	North Fork Slate Creek	Winter 1972
32	F	No Name-Red Mountain Complex	May 1972
38	F	South Fork Forgotten Creek	Winter 1970
38	F	South Fork Forgotten Creek	July 1970
50	F	South Fork Slate Creek	June 1969
50	F	No Name-Red Mountain Complex	Winter 1970
58	F	South Fork Slate Creeek	July 1971
58	F	No Name-Red Mountain Complex	July 1971
58	F	No Name-Red Mountain Complex	August 1971
58	F	No Name-Red Mountain Complex	May 1972
58	F	No Name-Red Mountain Complex	June 1972
58	F	South Fork Forgotten Creek	July 1972
62	F	South Fork Forgotten Creek	July 1971
62	F	South Fork Forgotten Creek	Winter 1972
62	F	South Fork Slate Creek	June 1972
78	F	No Name-Red Mountain Complex	July 1971
78	F	No Name-Red Mountain Complex	August 1971
78	F	North Fork Forgotten Creek	July 1972
90	F	South Fork Forgotten Creek	Winter 1971
90	F	South Fork Forgotten Creek	July 1971
90	F	North Fork Forgotten Creek	July 1972
G-2	F	South Fork Forgotten Creek	July 1970
G-2	F	South Fork Slate Creek	August 1970
G-2	F	South Fork Forgotten Creek	July 1971
106	F	South Fork Slate Creek	July 1971
106	F	No Name-Red Mountain Complex	Winter 1973

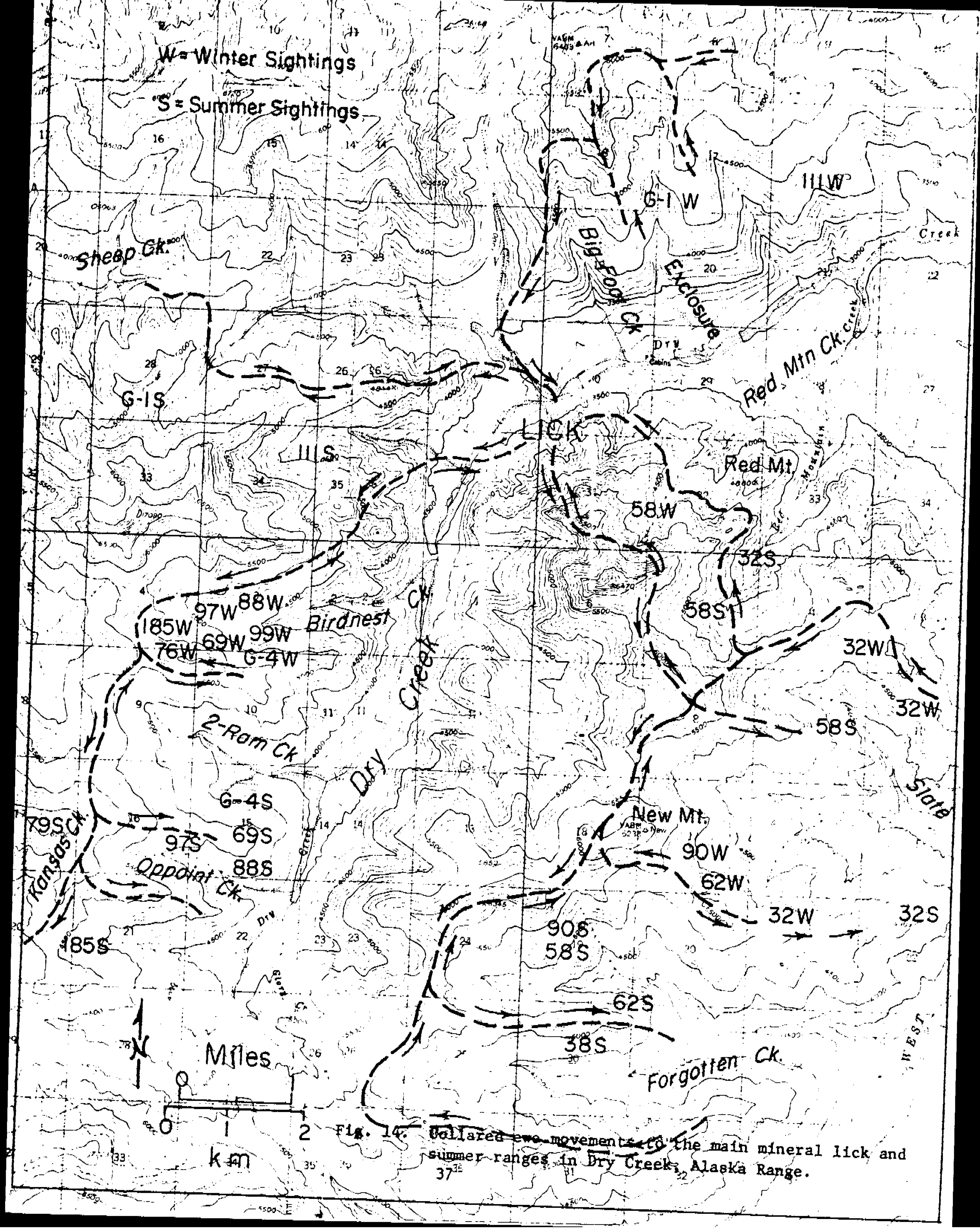

Fig. 14. Collared ewe movements to the main mineral lick and summer ranges in Dry Creek, Alaska Range.

"New" Mountain and Slate Creek Ridge. These rams must travel 6 miles (9.8 km) out of their way in order to utilize the main mineral lick at Dry Creek.

Mineral Lick Influence on Seasonal Movement Patterns: Heimer (Nichols and Heimer 1972) reported that fidelity of adult ewes to the mineral lick on Dry Creek was quite high (78% to 93%). These estimates have been revised upward with the accumulation of more data (Appendix II), and fidelity is now considered to be 100 percent. This means that every ewe seen at the lick in the previous year will visit the lick the ensuing year if able. The period of maximum lick use has been found to correspond to the movement of sheep from winter to summer ranges. During 1972 this period was observed to be from about the 16th to the 23rd of June. This may represent a later than normal movement. Other data indicate that the movement may occur as early as the first week in June.

Observed fidelity of rams to the main mineral lick at Dry Creek is less than that of ewes. However, ram fidelity has been observed to increase with each year of observation and the increased fidelity constants are probably due to more intensive observation. Ram fidelity has been observed to be as high as 90 percent. It is not known whether this represents the loyalty of older rams to the lick, and it is not certain that ram travel will definitely involve a visit to the lick at the time of movement to summer range.

The traditional use of the main mineral lick on Dry Creek by the animals of all sub-populations means that movement from winter to summer range is often much greater than the physical distance involved. For example, ewes wintering in Birdnest Creek and Two Ram Creek move to the lick and then to upper Dry and Kansas Creeks (Fig. 14); consequently the distance travelled is increased from approximately 2 miles (3.2 km) to about 10 miles (16 km). Ewes wintering on the Slide-Exclosure-Bigfoot area on the other hand, pass through the vicinity of the lick on their way to summer range. Ewes wintering on the east side of Dry Creek may be considered to have the lick on the periphery of their ranges. Journeys of 4 miles (6.2 km) to summer range are extended to approximately 8 miles (12.8 km) for those on the Red Mountain-No Name complex, while animals which winter on Slate Ridge increase their distance travelled from about 2 miles (3.2 km) to nearly 12 miles or 20 km (Fig. 14).

It appears that several populations of sheep inhabiting the study area overlap or mingle only at the main mineral lick on Dry Creek. The time of lick use corresponds with the time of movement to summer range, and it appears that animals travel out of their way to spend time at the lick during this period. It is not currently known whether the drive to use the mineral lick is physiological or social.

Mineral Lick Use Patterns: During the course of the study several trends in mineral lick use have emerged. One such trend is that rams have been observed to use the lick earlier than ewes. This was stated to be the case by Jones (Jones and Merriam 1963) and Smith (Nichols and Smith 1971). Data gathered in continuous observation of the lick throughout the period of use in 1972 indicate that this was not the case during that year. Fig. 9

(discussed earlier) shows the composition of sheep entering the lick from May 19 to July 6 of 1972. From this graph it can be seen that apparent times of high ram percentage in incoming sheep were June 7 and June 24. Fig. 15, which shows the average number of incoming sheep per day in 1972, indicates that these times were periods of low activity. The apparent increases of rams in the percentage of sheep may be artifacts of presentation because of the low numbers of sheep (50 and 25) using the lick on those days. This possibility is more acceptable when the behavior of sheep is considered. At this time of year animals move to their summer ranges; this results in segregation of rams from bands of ewes and lambs. Consequently, a low number of sheep entering the lick coupled with the presence at that time of a fairly large ram band could give the impression of preferential utilization by rams. I suggest that this set of circumstances may have occurred leading to the impression that the bulk of early utilization is by rams.

In 1973 the percentage of rams above yearling age in incoming sheep did decrease with time. From May 26 through May 30 the average percentage of rams in incoming sheep was 38 percent. From June 9 through June 14 it was 19 percent, and from June 24 through June 29 it was 12 percent. It should be noted that numbers of incoming sheep on these dates (shown in Fig. 16) were not comparable, and the impression gained could be misleading. It is certain, however, that unless it is feasible to monitor a lick for the entire licking cycle the composition data may not accurately reflect the situation in the population.

Peak Lick Use: Peak use of the main mineral lick at Dry Creek has been observed to be in early summer. In 1970 the day of highest use observed was June 6 (Smith in Nichols and Smith 1971), in 1972 the day of maximum use was June 19, and in 1973 June 27 was the day of maximum use. The extent of use during the maximum period is apparently dependent on the manner in which winter snows disappear, the conditions of warming in spring, and immediate weather conditions. In 1972 snow accumulation was great and melt-off was not complete until mid-June. Peak use that year was about mid-June, and corresponded quite closely with local ambient temperatures which rose to averages of above 60 F at that time. Snow accumulation was light in 1973 and melt-off was essentially complete by June 6. However, local ambient temperatures did not reach daily means of nearly 50 F until the last week in June. Under these conditions lick use was spread over a greater interval and the intensity was less than in 1972.

Intensity of lick use in 1972 was reflected by the entry of 580 sheep in one 24-hour observation period on June 19. In 1973 about 350 sheep entered the lick on June 27.

Time Spent per Visit and Frequency of Visitation: The length of time a sheep spends in the lick is a function of how many times it has been at the lick during the yearly cycle of lick utilization as well as the sex and reproductive status of the animal. Ewes that are nursing lambs appear to spend more time licking. Data on the length of time spent by collared individuals are presented in Appendix III.

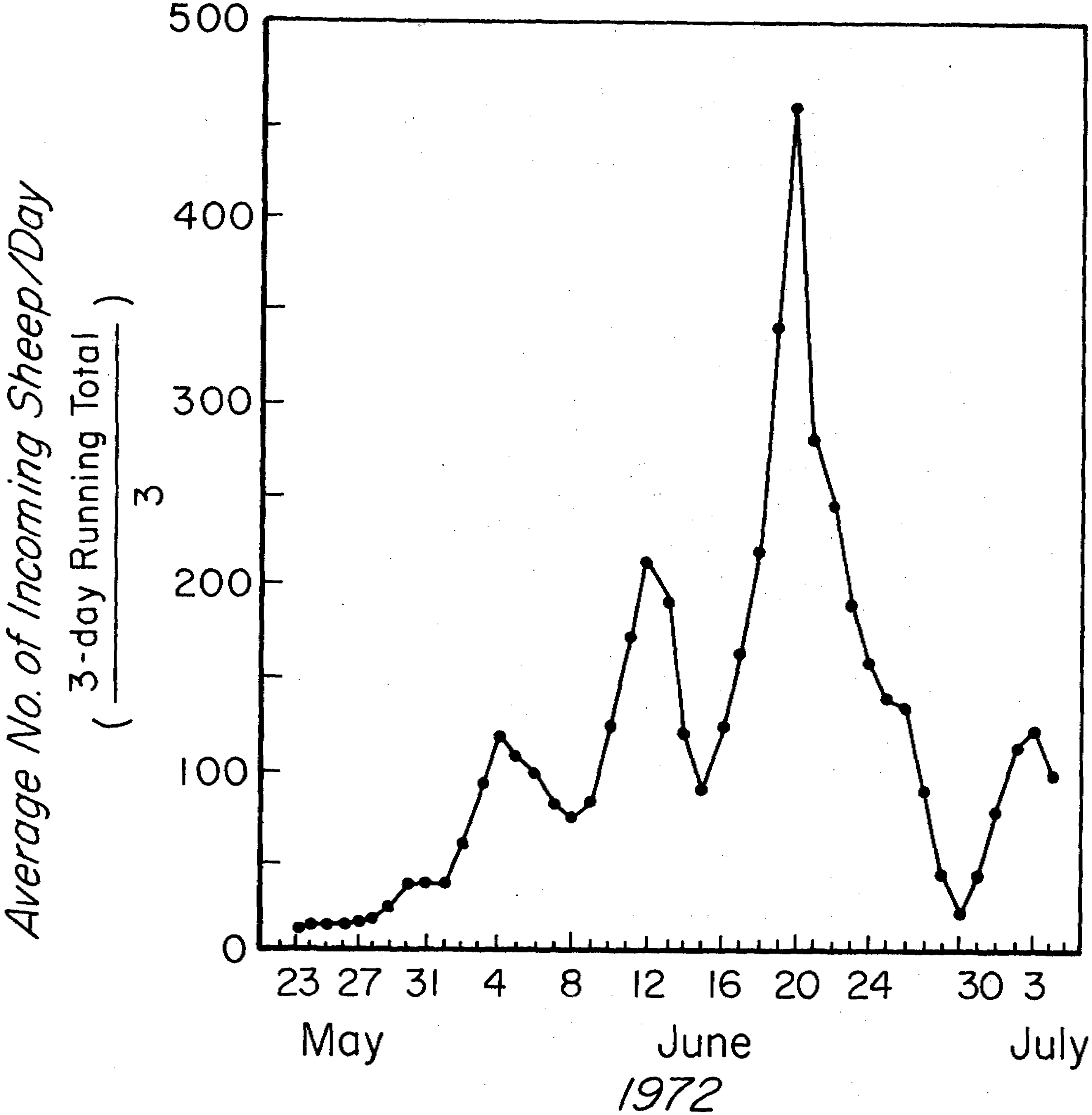

Fig. 15. Lick use during 1972, Dry Creek, Alaska Range.

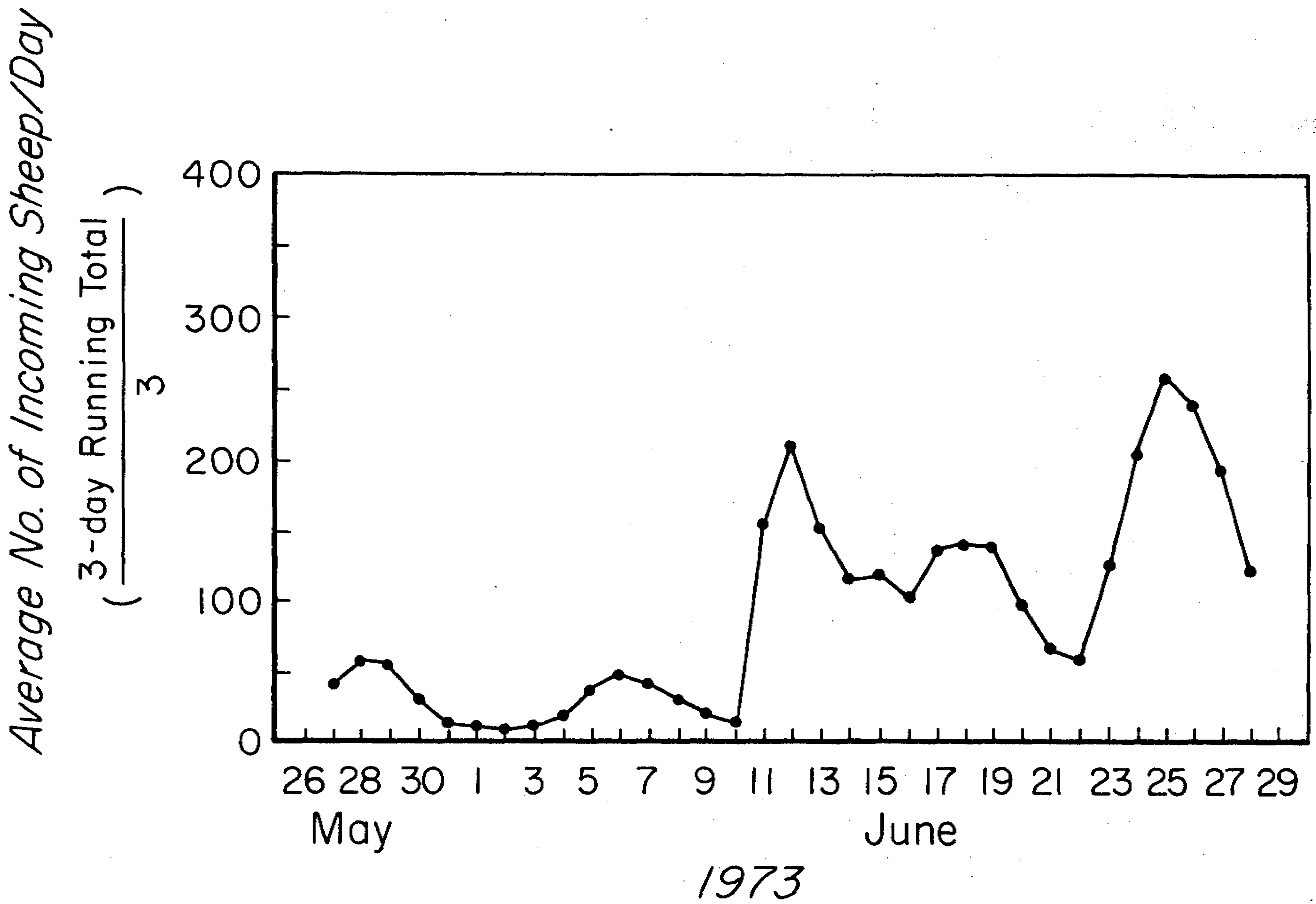

Fig. 16. Lick use during 1973, Dry Creek, Alaska Range.

Sheep spent virtually all of their time present in the lick eating soil or licking. In 1972 the average length of time spent in the lick during the first visit of the year for all collared animals was 75 minutes. The average time spent licking during this first visit was 70 minutes. Data presented in Appendix III show that for the first visit the sheep spent 93 percent of the time they were in the lick eating soil. Similar calculations for the second visit (hereafter defined as the first visit of the second day an individual was seen at the lick) show that 95 percent of the time present in the lick was spent licking. For all other visits combined the average time spent licking was 93 percent.

For purposes of this calculation all observations were pooled regardless of age or sex. Because the averages are virtually 100 percent it is unlikely that any one group of sheep spends much time in the lick performing activities other than eating soil.

In 1972 a total of 70 collared sheep made 293 visits to the lick; an average of four visits per collared animal. Of these animals 29 were rams; they accounted for 122 visits for an average of <u>four</u> visits per ram during the season. Thirty animals were ewes that were never seen to nurse a lamb. These ewes made 124 visits to the lick for an average of <u>four</u> visits per animal. The remaining animals were ewes that were seen to nurse lambs; they were 11 in number and made 57 visits for an average of <u>five</u> visits per sheep. Consequently, it appears that there is no difference in lick use between ewes which are not lactating and rams. The average age of rams returning to the lick in 1972 was four years. These rams were generally in ram bands, but not yet legal, i.e. 3/4 curl in horn development.

The rams which utilized the lick made 122 visits in 71 sheep days for an average of 1.7 or 2 visits per day (Table 5). The average length of time which elapsed between visits for those rams visiting the lick on separate days was two days. The average number of visits per ram was four. This means that the average ram spent at least four days involved with the lick. It appears that certain rams used the lick only one time (perhaps for four days) while others, typified by numbers 1, 87, 105, 149, 160 and 193 (Table 5), visited the lick on days which were separated by 7 to 19 days. Of these rams only numbers 87 and 105 have been seen during summer when not at the lick. These are rams which summer in the vicinity of the lick and may use it intermittently throughout the summer. Other populations of rams frequent other licks throughout the summer. The reasons for preferential use of specific licks are not presently known.

Ewes without lambs made a total of 124 visits in 79 days for an average of 1.6 or 2 visits per day. The average length of time which elapsed between visits of those sheep which revisited the lick was 198 days between 118 visits or 1.7 days between visits (Table 6). The average number of visits by this group of ewes was four. Hence, the average ewe with no lamb spent four days involved with the lick as did the average young ram.

Table 5. Licking duration (minutes) per visit: Ewes without lambs, 1972.

Collar Number	First Yearly Visit	First visit of Second day seen at lick	Other visits (First of day)
5	80	105	35
7	81	124	157, 86
32	83	87	68, 55, 50, 44, 50
50	41	70	
56	45		
58	105	60	10, 20, 70
60	61		
62	66	62	28, 84
72	99	40	
76	10	27	
88	75		
96	70		
G-2	150	90	75, 73, 66
102	83		
103	95		
129	88	30	77, 220
133	74	20	
141	25		
148	90	140	
166	81	15	43, 30
168		92	57
169		30	18
178	55		
185	66	131	
190	54		
194	129	109	
202		48	16
	$\Sigma = 1806$ $n = 24$ $\bar{x} = 75.2$ minutes	$\Sigma = 1280$ $n = 18$ $\bar{x} = 71$ minutes	$\Sigma = 1432$ $n = 23$ $\bar{x} = 62$ minutes

Leaving out probable lactating ewes (279 minutes for G-2 and 58)

$$\frac{1527}{22} = 69.4 \text{ minutes}$$

Table 6. Licking duration (minutes) per visit: Rams, 1972.

Collar Number	Age	First Yearly Visit	First Visit of Second day seen at lick	Other visits (first of day)
1	5 yrs	60	58	96, 102, 22
36	5 yrs	32		
73		62		
83	6 yrs	45	69	
87	4 yrs	65	55	68
G-5	4 yrs	125		
100	4 yrs		12	
104	3 yrs	65		
105	3 yrs	54	67	58, 55
115	4 yrs	60	40	52
116	3 yrs	100		
126	3 yrs	65	79	25
127	3 yrs	32	137	
135	5 yrs	20	60	
144	3 yrs	91	65	51
146	4 yrs	58		
149	3 yrs	54	50	
150	4 yrs	40	52	
151	4 yrs	55	65	15, 40
156	3 yrs	100		
158	3 yrs	72	34	21, 70, 74, 25
159	3 yrs	70		
160	4 yrs		37	60
167	9 yrs	69	43	40
171	4 yrs		80	
176	3 yrs	35	50	
177	4 yrs	87		
193	5 yrs	79	118	30, 30, 10
Broken tag		33	17	
		$\Sigma = 1628$ $n = 26$ $\bar{x} = 63$ minutes	$\Sigma = 1188$ $n = 20$ $\bar{x} = 59$ minutes	$\Sigma = 944$ $n = 20$ $\bar{x} = 47$ minutes

By way of comparison, ewes with lambs made 57 visits in 36 sheep days for an average of two visits per day. The average length of time which elapsed between visits of those sheep which revisited the lick was 69 days between 36 visits or 2 days between visits (Table 7). The average number of visits made by the sheep in this group was five. Hence, these animals must spend six and one half to seven days involved with the lick. This is approximately 1.6 times more than animals without lambs. The more extended use of the lick by ewes with lambs is indicated by the data shown in Tables 7 and 8. For purposes of comparison the data in this section were arbitrarily divided into initial visits which occurred on different days. The first visit of the year was recorded and subsequent visits that day were placed in the category "other visits." The second visit of the year was considered for purposes of comparison to be the initial visit of the second day an animal appeared at the lick.

When the data were handled in this manner it appeared that ewes with lambs (lactating ewes) spent 25 to 50 percent more time than rams and ewes without lambs on their first visit of the year; ewes with lambs 93 minutes, ewes without lambs 75 minutes, and rams 63 minutes (Tables 8, 9, and 10). During the second visit the situation was less well defined, with ewes with lambs spending 64 minutes, ewes without lambs 71 minutes, and rams 59 minutes. However, all other visits combined show that ewes with lambs had an average time of 76 minutes, ewes without lambs an average of 62 minutes and rams an average of 47 minutes.

Lactating ewes visited the lick more times throughout the course of the season, spent about 1.6 times as much total time involved with the lick, and spent more time licking on most visits than other ewes and rams.

It also appears that ewes which have lambs also may return to the lick throughout the course of the summer with greater regularity than other animals. It can be seen from the data in Tables 6 and 7 that several ewes, notably 79, G-6, 154 and 76 as well as 62 and G-2 and 68, 129, 169, 22, and 202, had exceptionally long intervals ranging from 10 to 17 days between some visits. Resighting data indicated that 76, 79, G-6 and 154 had summer ranges in area 2 (Fig. 12). Animals 62 and G-2 had summer ranges on the east side of Dry Creek. Animals 22, 62, 129, 269 and 202 were not observed on their summer ranges. The long interval between lick use "bouts" in these animals suggests that they used the lick once and returned to winter range and then used it again on the way to summer range. Alternatively, they may have returned to the lick throughout the course of the summer. The dates during which the lick was utilized by animal 76 indicate that she may have returned to winter range after using the lick one time. Her second visit was on June 13 which was still quite early, perhaps just at the beginning of the general movement to summer range.

The remaining animals known to have summered in area 2 (Fig. 12), 79, G-6, and 154, were all animals seen with lambs. Their dates of lick utilization (Appendix III, Part 3) span both sides of the dates of general movement

Table 7. Licking duration (minutes) per visit: Ewes with lambs, 1972.

Collar Number	First Yearly Visit	First visit of Second day seen at lick	Other visits (First of day)
69	50	90	50, 50
78	98	38	65, 61, 33, 78
79	165	73	
90		40	
97	55	70	
G-4	125	46	
G-6			103, 50, 50
106	90	77	78
154	82	36	55, 217
175	71	31	108
182	102	140	63
	$\Sigma = 838$	$\Sigma = 641$	$\Sigma = 1064$
	$n = 9$	$n = 10$	$n = 14$
	$\bar{x} = 93$ minutes	$\bar{x} = 64$ minutes	$\bar{x} = 76$ minutes

Table 8. Return frequency and interval between repeated visits to main mineral lick, Dry Creek: rams, 1972.

Collar number	Number of visits	Days elapsed between visits
1*	5	1, 15, 1, 1
83	2	5
87*	3	9, 1
100	2	1
105*	4	1, 14, 1
115	4	1, 1, 1
126	3	7, 1
127	2	1
135	1	3
144	3	1, 1
149*	2	9
150	2	1
151	4	1, 1, 1
158	6	2, 1, 4, 1, 1
159	2	1
160*	4	1, 1, 19
167	3	1, 1
171	2	5
176	2	2
193*	5	7, 4, 1, 1
Broken tag	2	2
	63 visits	135 days

$$\frac{135 \text{ days}}{63 \text{ visits}} = 2.1 \text{ days/visit}$$

*Rams with notably great elapsed time between visits.

Table 9. Return frequency and interval between repeated visits to main mineral lick, Dry Creek: Ewes without lambs, 1972.

Collar number	Number of visits	Days elapsed between visits
5	2	4
7	2	7
22*	2	16
32	7	3, 6, 2, 6, 2, 5
50	1	1
58*+	5	6, 1, 4, 1
60	2	3
62*	4	1, 1, 17
68*	3	5, 10
72	2	1
76*	2	10
G-2*+	5	2, 1, 3, 10
129*	4	14, 1, 4
133	2	1
141	2	1
148	2	1
166	4	1, 1, 4
168	3	1, 1
169*	7	1, 1, 2, 1, 11, 3
185	2	1
194	2	7
202*	2	13
	118 visits	198 elapsed days

$$\frac{198}{118} = 1.7 \text{ elapsed days between visits}$$

*Animals with notably great elapsed time between visits.
+Animals with use pattern characteristic of ewes with lambs.

Table 10. Return frequency and interval between repeated visits to main mineral lick, Dry Creek: Ewes with lambs, 1972.

Collar number	Number of visits	Days elapsed between visits
69	2	1
78	4	1, 4, 2
79*	6	1, 1, 14, 1, 1
90	2	1
97	2	1
G-4	2	1
G-6*	5	1, 12, 1, 1
106	2	1, 1
154*	4	1, 1, 16
175	3	1, 1
182	4	1, 1, 1
	36 visits	69 days

$\frac{69}{36}$ = 1.9 elapsed days between visits

*Animals with exceptionally long intervals between visits.

to summer range (Fig. 15) and hence suggest that these animals used the lick after migration to summer range. There are known licks on upper Kansas Creek which might be more available to these lactating ewes than the main lick on Dry Creek, but it is not known whether these animals utilize these licks.

The animals from the east side of Dry Creek, 62 and G-2, have dates and utilization which are similar to those above. Animal G-2 apparently visited the lick and then returned to winter range (visits on 6/1 and 6/15). Animal 62 apparently used the lick during the summer. Both of these animals are from an area which has known licks which are closer than the lower lick on Dry Creek, e.g. the Glory Creek lick. It is not known why they prefer the use of one lick over another, however, it should be noted that these animals are somewhat "local" with respect to the main mineral lick on Dry Creek and may utilize it throughout the course of the summer.

It may be important to note that those animals which are not considered "local" (e.g. those in area 2, Fig. 14) yet which returned to the lick after migration to summer range were lactating ewes.

Weather Influences: Lick utilization is apparently linked to weather, specifically temperature. Consequently, a weather measuring device capable of recording temperature, barometric pressure and relative humidity was utilized throughout the course of observations in 1972 and 1973.

In 1972 barometic pressure correlated strikingly with lick use. Pressure changes may logically result in local movements when they precede major weather events, but it is difficult to relate the possible meteorological correlates of barometric pressure to lick use. In 1973 there was no apparent correlation between lick use and barometric pressure.

It appears that of the three weather parameters measured, temperature has the most readily explainable role in sheep movement to the mineral lick and perhaps from winter to summer range. In 1972 mineral lick utilization was essentially zero from May 19 through May 28. A noticeable warming trend was evident through the 26th of May which may have caused a general upsurge in movement to the lick resulting in the first peak of utilization seen on the 4th of June (Fig. 17). However, the cold weather of May 30 through June 6 could have resulted in the depressed lick use observed around June 8th. Following the cold weather of the last week in May and early June there was a sharp rise in temperature from a mean of 40.5 F on the 6th of June to a mean of 66.5 F on the 13th of June. This is a mean rise of 26 F in 7 days. It appears that this sudden rise in temperature resulted in an increase in lick utilization from about 80 animals during the 8th of June to 215 animals on the 12th.

This sudden, steep rise in temperature coupled with the heavy snow of June 7 resulted in extremely high water in Dry Creek due to snow melt. During this period Dry Creek was a raging torrent and is estimated to have been three to five feet higher than normal at the usual crossing site. It is impossible to imagine sheep successfully fording such a cataract. This

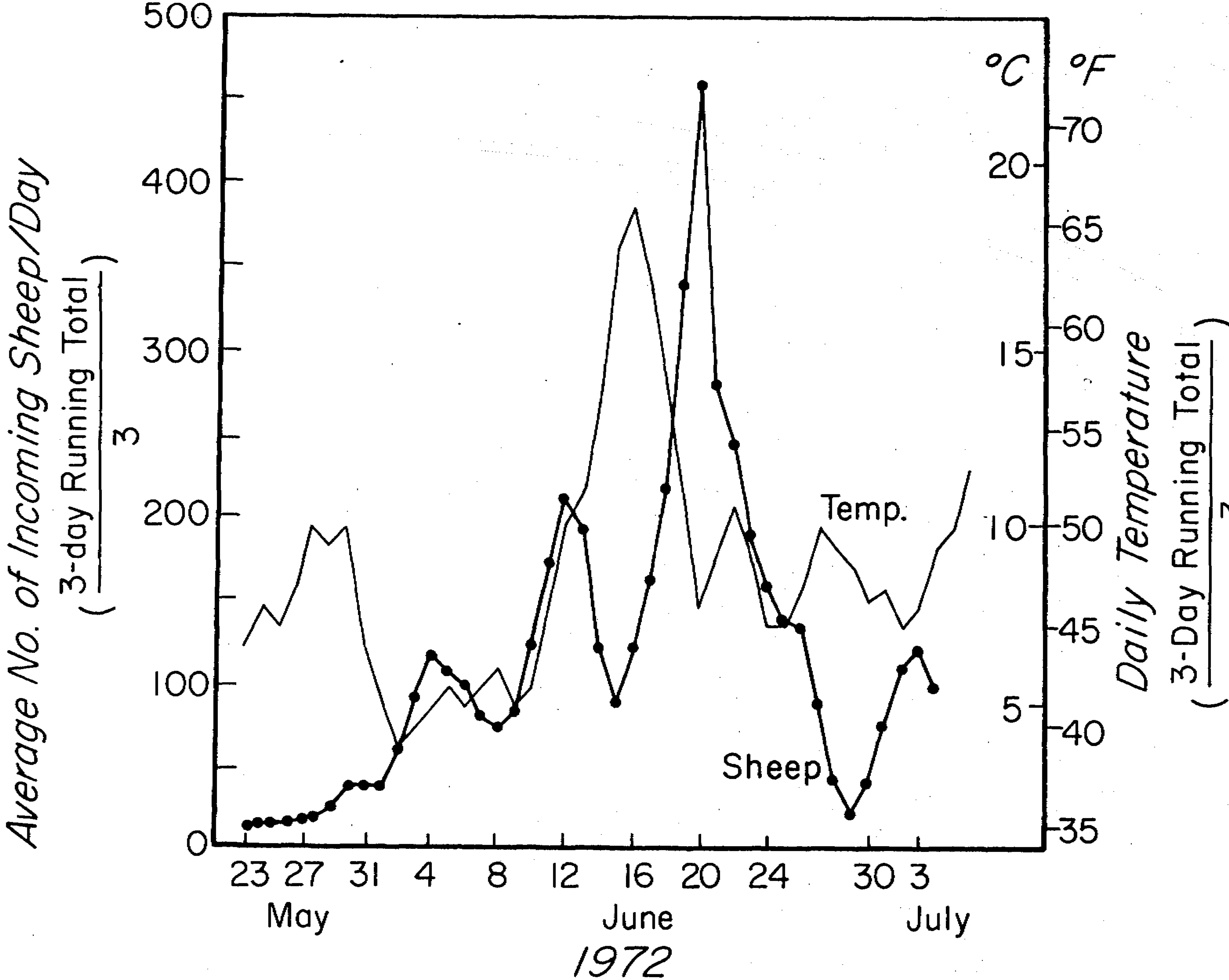

Fig. 17. Temperature and lick use at Dry Creek, 1972.

resulted in sheep from the west side of Dry Creek being prevented from moving to the lick, and may have caused the decline in utilization seen around the 15th of June (incoming numbers were cut in half) even though the main peak of lick use may have begun with the sudden warming trend of June 6th through 13th. When the waters receded to normal there was an explosion of lick activity which resulted in the 580 animals being seen entering the lick on June 20. As this peak of activity declined animals were no longer seen on their winter ranges, and it was assumed that the major peak of lick use had ended. Further use was limited to those animals in the local area.

In 1973 mineral lick use as reflected by the number of incoming sheep corresponded well with mean daily temperature. Fig. 18 depicts temperature and mineral lick use patterns. There is little apparent influence of relative humidity on lick use.

Daily Activity Patterns: Fig. 19 reveals that in 1972 cumulative lick use for the period of observation was at its lowest ebb from 2000 hrs. to 0200. From 0200 to 0600 there was an 11-fold increase to the time of maximal daily utilization. Then a decline occurred through the next three hours and another small peak occurred at 1000 hrs. Use then declined to about half its maximal (0600 hrs.) use and remained at about that level until 1900 hrs. when it declined again to the low level described for 2000 to 0200.

Figs. 20, 21, 22 and 23 show that the daily lick use pattern was not constant in 1972. It appears that during the maximal use period, June 10 through June 22 (Figs. 20 and 21), the major activity peaks were earlier than during very early, June 2-6 (Fig. 20), or very late, July 1-4 (Fig. 23) use periods. The peaks which occurred during the period of intense use were primarily in the morning hours from 0400 to 0600 hrs. while the highest activities during the other periods occurred from 0800 until 1200 hrs.

An analysis of daily activity patterns by sheep not involved with the lick revealed that the daily activity pattern early and late in the mineral lick use cycle (Fig. 24) paralleled the daily pattern of lick use. Data for this comparison were collected by observing sheep on the surrounding hills which were not involved with travel to or from the lick. These sheep were considered active if standing and inactive if recumbent. As the animals moved to summer ranges it became impossible to collect data comparable to these for other periods throughout the lick use cycle. The data collected suggest that at this period of time, May 29 through June 4, there was a base line of activity at about 30 percent (Fig. 24) activity. There was an increase in the early morning hours to 60 percent activity followed by a sharper increase in activity to a peak activity of nearly 100 percent at midday. This declined somewhat, to about 75 percent by 1400 hours and then held at about that level until 2000 hours when it fell sharply to the basal level of 30 percent. The data showed a decrease in activity at 0900 hours which may be due to small sample size but which does correlate with the decreased lick utilization seen in those hours for early utilization (Fig. 20).

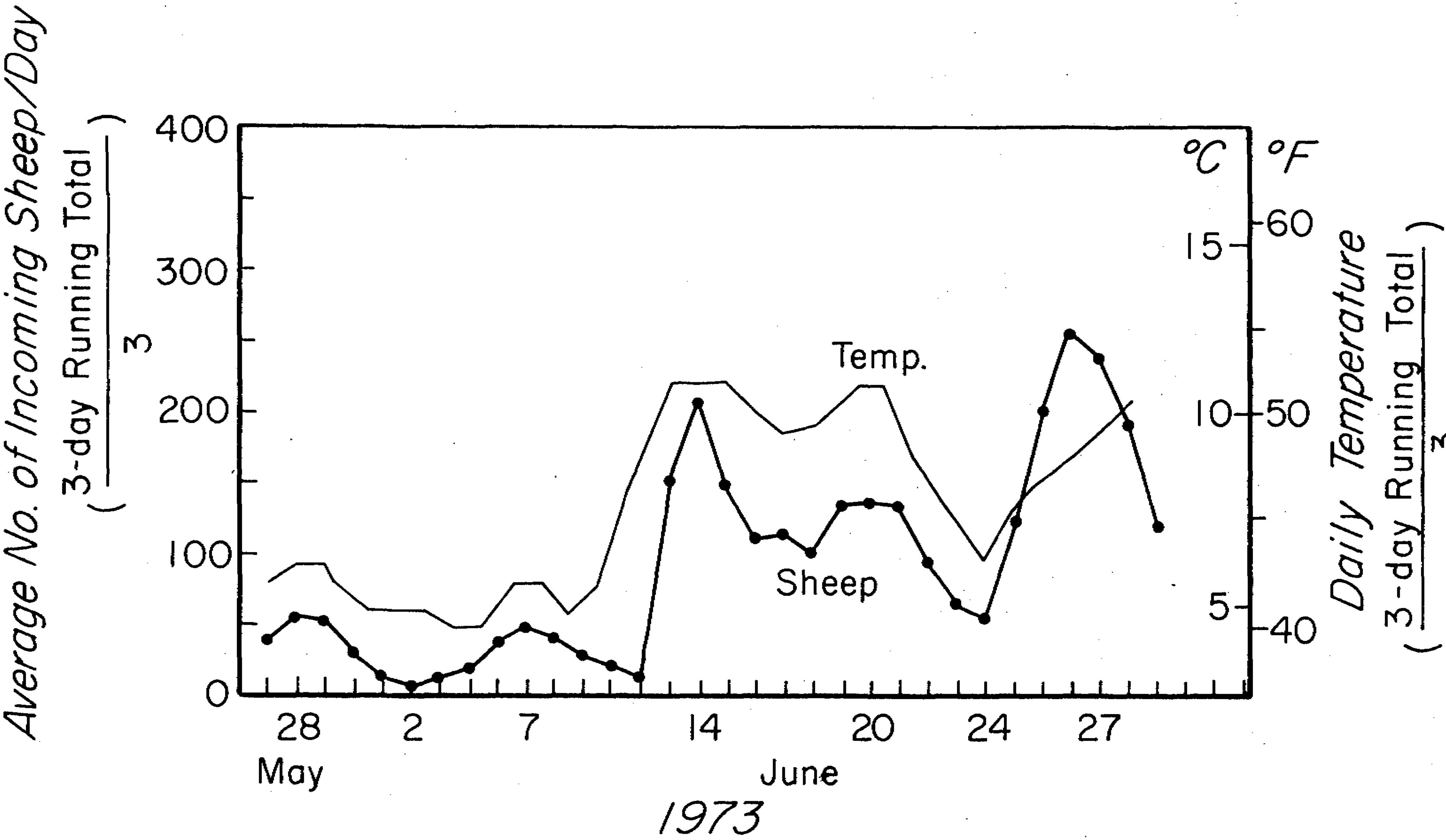

Fig. 18. Temperature and lick use at Dry Creek: 1973.

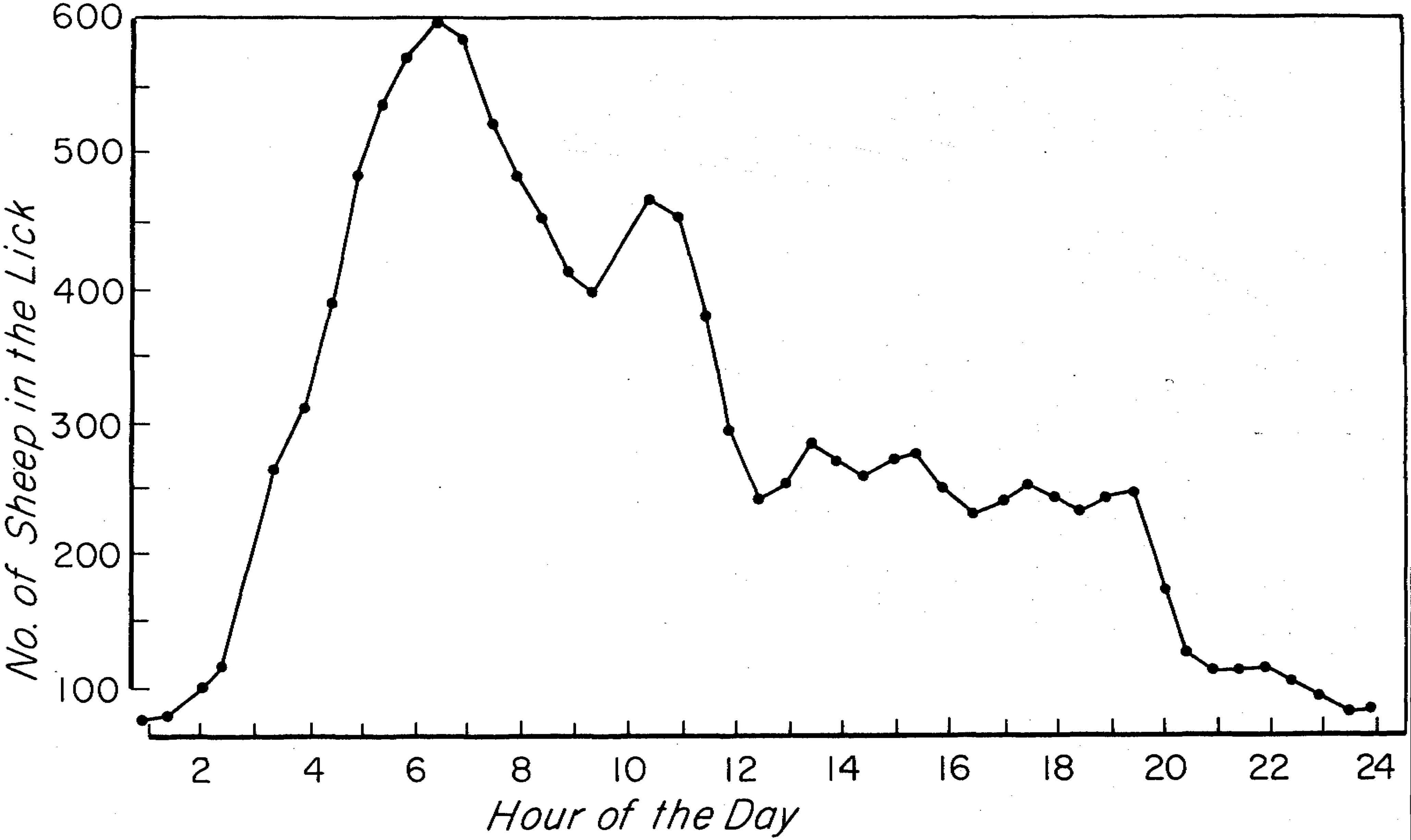

Fig. 19. Cumulative hourly mineral lick use at main mineral lick on Dry Creek, 1972.

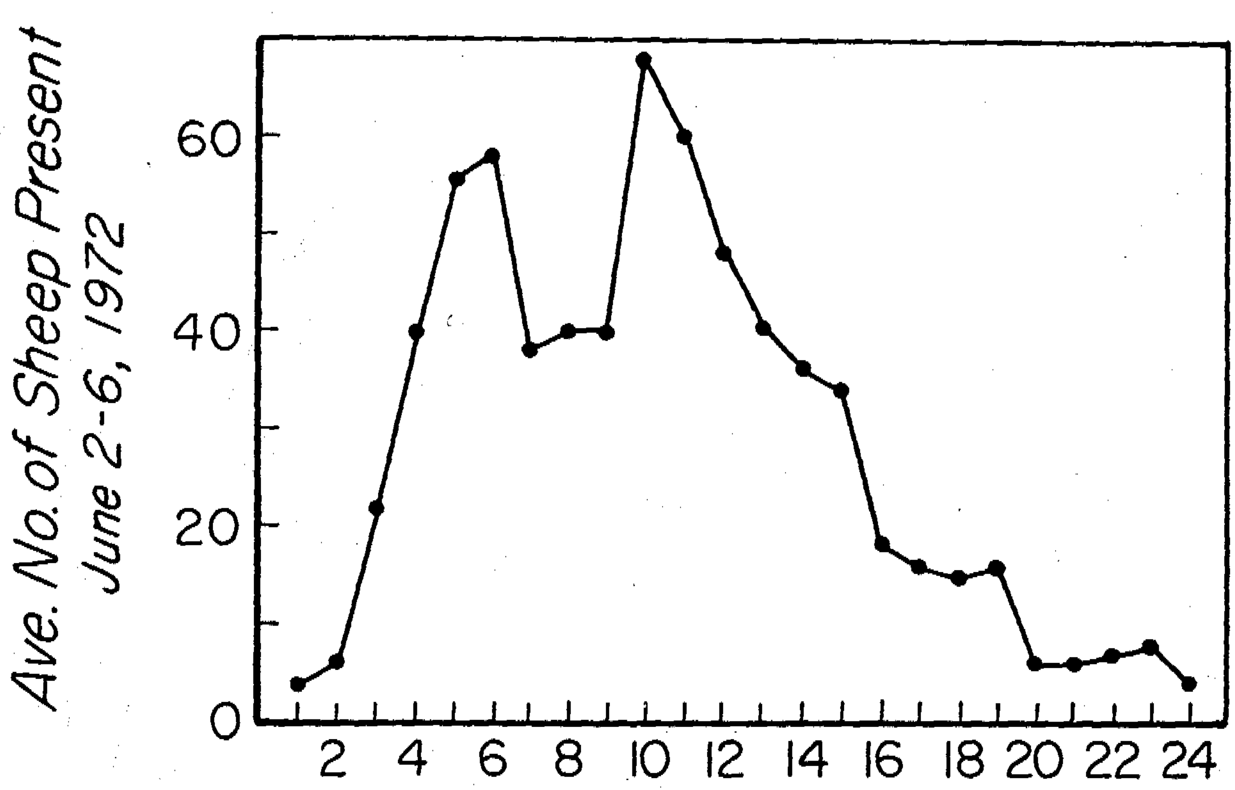

Fig. 20. Hourly lick use early in the licking cycle.

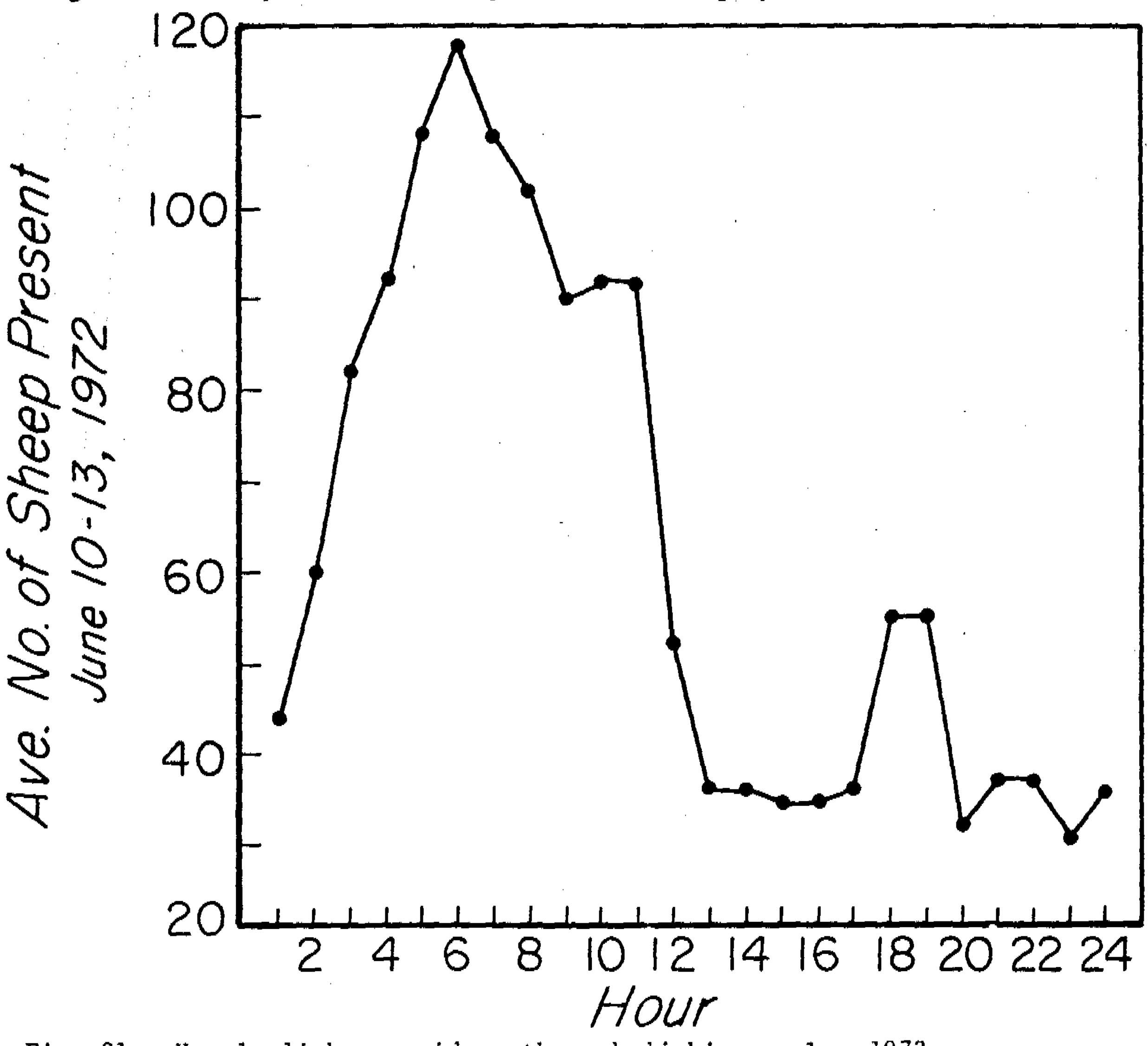

Fig. 21. Hourly lick use midway through licking cycle, 1972.

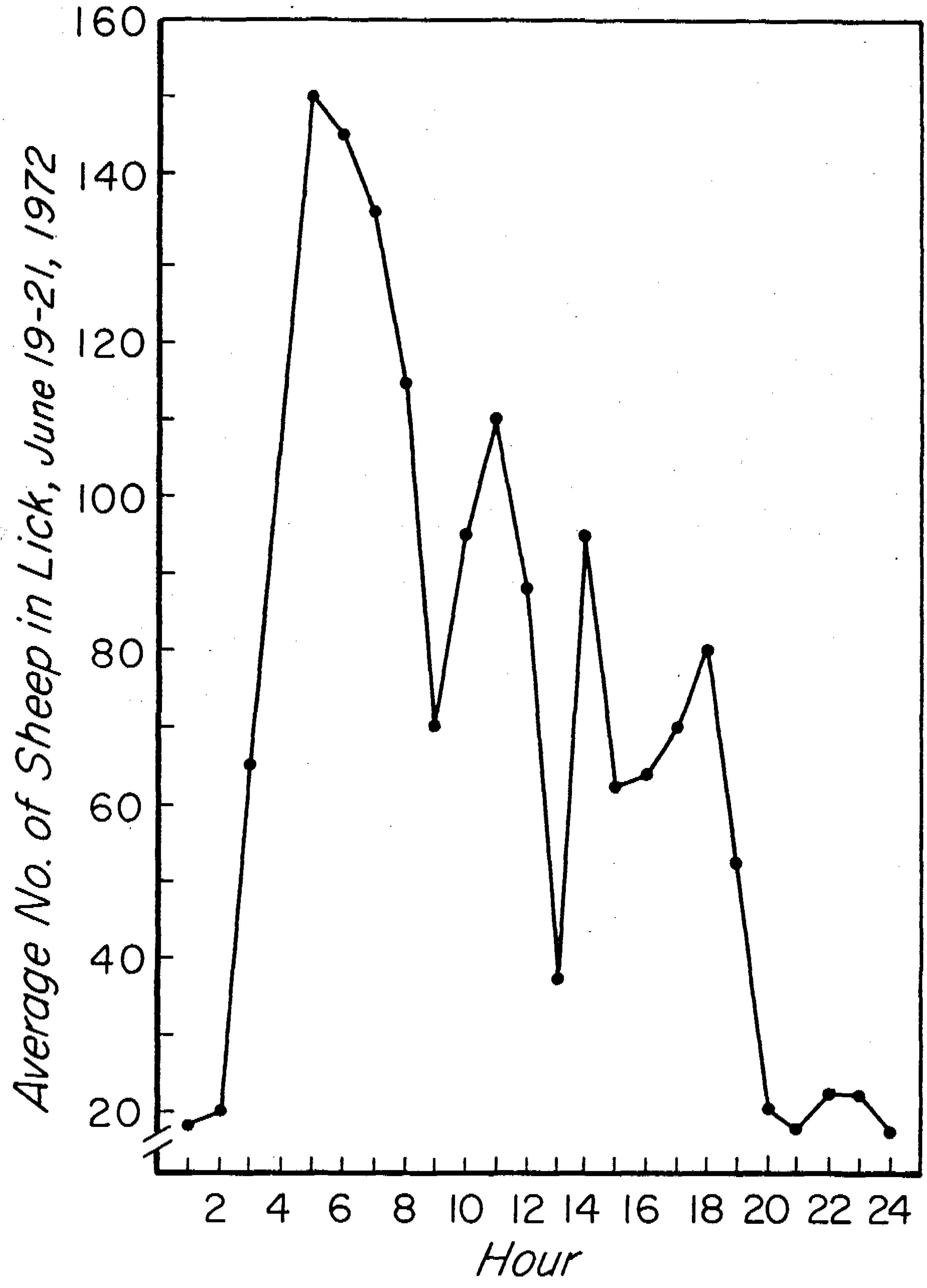

Fig. 22. Hourly lick use at peak of licking cycle, 1972.

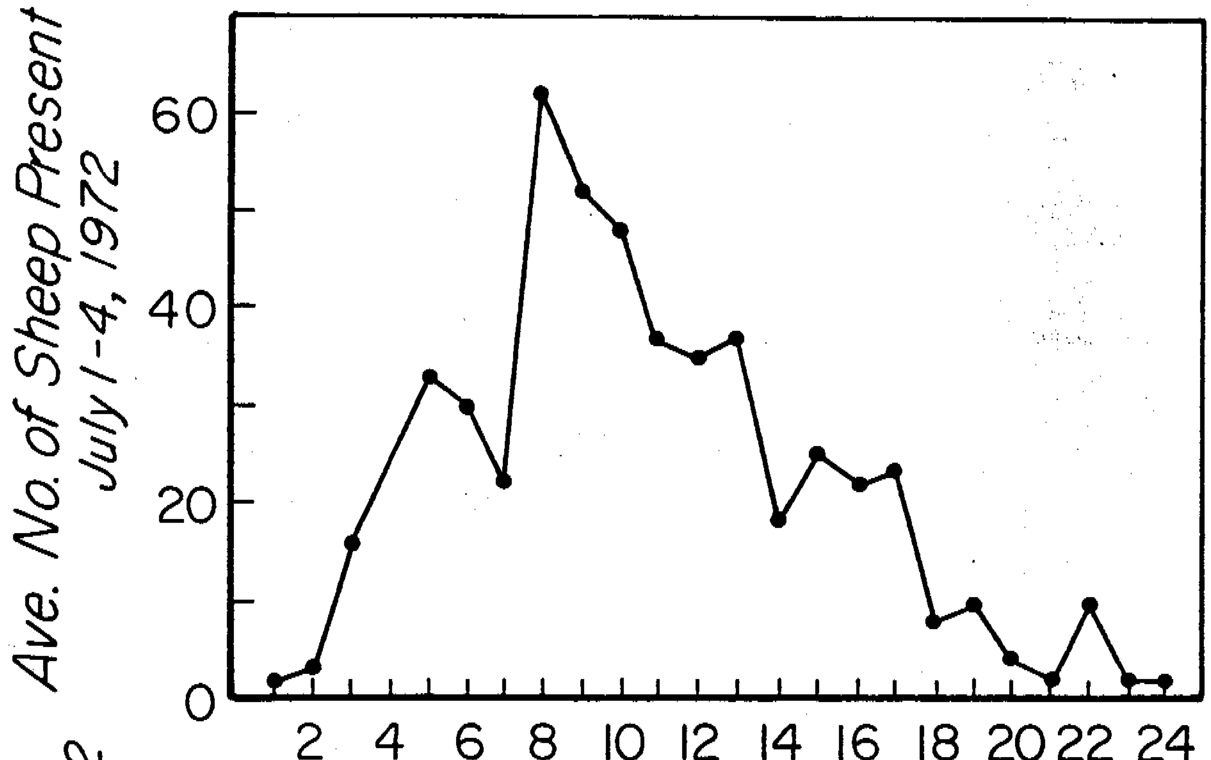

Fig. 23. Hourly lick use late in licking cycle, 1972.

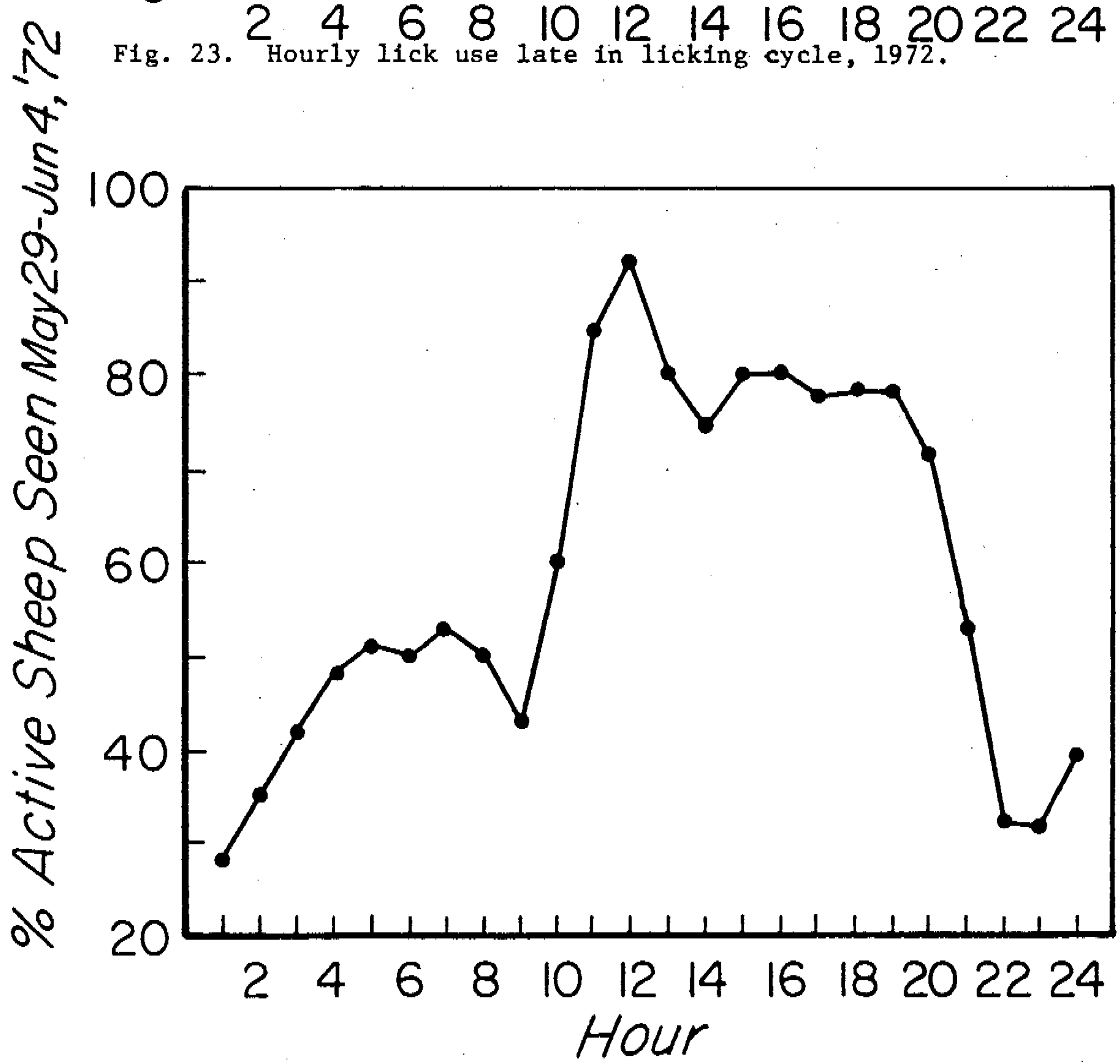

Fig. 24. Daily activity of sheep not involved with the mineral lick.

It appears that daily activity patterns were probably related to those shown by sheep at the mineral lick. It may be, however, that patterns of activity change greatly after movement to summer range, or in response to other factors such as overriding weather events and day length. The statements which were made in the past indicated that there were generally two separate peaks of sheep utilization for any given day at the mineral lick. Since the daily pattern observed is a function of either the time in the lick use cycle or the number of sheep seen, it is unlikely that the two peaks seen in the past represent the total picture, but more probably reflect the situation during the shorter periods of observation. For population composition survey purposes at mineral licks it is important to know temporally where in the "use cycle" one is in order to adjust his schedule to the best advantage.

Cumulative activity from 1972 is summarized in Table 11.

Table 11. Cumulative activity at the Dry Creek mineral lick.

Hours Necessary to Observe	Percent of Daily Activity
0300-1400	67
0300-1430	69
0300-2100	90
0300-1000	50
0300-1600	75

Total sheep counted = 13,451 in 44 days

These data represent cumulative daily activity patterns and may be subject to some variance from those seen early or late in the cycle. However, they may provide a workable guideline for scheduling observations.

Fidelity to the Mineral Lick: Fidelity, as defined by Geist (1971), is the number of identifiable sheep returning to a given seasonal home range in one year divided by the number of identifiable individuals seen there in the preceding year. Of course, corrections must be made for mortality and other factors which affect the number of animals seen in succeeding years after tagging. From the expected fidelity it is possible to calculate population mortality. In the Dry Creek area emphasis was placed on determining fidelity throughout 1972. Mortality was calculated once confidence in the fidelity coefficients had been established.

Heimer (Nichols and Heimer 1972) reported that ewe fidelity was observed to be 78 percent and corrected to 93 percent. Ram fidelity was about 40 percent. During the 1972 observation period 84 marked ewes were seen returning to the lick. Thirty-one of these animals were identified by ear tag numbers only, and six had ear tags which could not be read. This means that of the possible 84 animals with collars only 53 (or 63%) had retained their collars. All animals which had lost collars were collared in 1971 when pendants with engraved numbers were attached to the sheep using polypropylene rope (Smith in Nichols and Smith 1971). Either this is not a good design for sheep collars, or some other factor resulted in loss.

Table 12 lists resightings and observed fidelities since 1969.

Table 12. Resightings and observed fidelity to the Dry Creek mineral lick.

	Ewes	Rams
Seen in 1969	28	26
Resighted in 1970	26	13
Observed fidelity	93%	50%
Seen in 1970	61	28
Resighted in 1971	44	17
Observed fidelity	72%	61%
Seen in 1971	100	55
Identified in 1972	78	37
Seen but not identified 1972	6	4
Total resightings	84	41
Observed fidelity	84%	75%
Seen in 1972	84	41
Identified in 1973	77	27
Seen but not identified	-	2
Total resightings	77	29
Observed fidelity	92%	71%

The observation of 100 marked ewes in 1971 and 78 marked ewes in 1972 means that 22 individuals which visited the lick in 1971 did not visit the lick in 1972. All the marked animals which were not seen in 1972 are listed below:

142 age 3 years 162 age 3 years 191 age 3 years 164 age 4 years 51 age 5 years 147 age 5 years	(Because of their young ages these animals are arbitrarily assumed to be the six ewes seen whose ear tags could not be read.)
14 age 9 years	found dead
26 age 6 years	
33 age 12 years	collar found - no remains
43 age 7 years	

53 age 10 years
63 age 8 years last seen May 1972 with broken leg
64 age 9 years
74 age 10 years
86 age 8 years
G-1 age 9 years
111 age 13 years
114 age 9 years
121 age 10 years
137 age 10 years
180 age 10 years
181 age 8 years

The average age of these missing animals is 8.7 years.

Throughout the study 17 animals which would have been in this age class (9 years) were marked. Of these 17 animals 11 were seen at the lick in 1972, and the average age of the six that were not seen was 10.5 or 11 years. Only one of these six animals can be demonstrated to be dead, but it is assumed that the others are dead because of their absence and advanced age. This means that the calculated, cumulative mortality in 1971 for ewes of the age class nine years and above was 6/17 or 35 percent.

If it is assumed that animals 33 and 63 are dead and that the mortality of the remainder of the unaccounted-for animals listed above was 35 percent then 0.35 x 13 = 4.6 or 5 of the animals were likely victims of mortality. This reduces the number of ewes which were not accounted for to eight and brings corrected fidelity to 78 animals identified, plus six animals seen but not identified, plus three known dead plus five presumed dead to 92 animals accounted for of the 100 seen in 1971. The result was a fidelity of 92 percent for 1972.

Because the winter of 1971-72 was harsh, and because the cumulative mortality calculated was averaged over the last four years I think it is probable that 1971 72 winter mortality was higher than 35 percent in the nine year and older age class for ewes. Because fidelity is so high for ewes and could reasonably be higher, I think it is very reasonable to state that ewe fidelity to the Dry Creek lick is essentially 100 percent.

Assuming 100 percent ewe fidelity, all marked ewes not resighted at the lick in subsequent years would have to be considered absent from the population. Hence, for 1972, overall mortality for ewes in Dry Creek would be 16 percent:

$$\frac{\text{22 ewes not identified in 1972 -6 ewes seen but not identified}}{\text{100 ewes identified in 1971}}$$

Most of this mortality was sustained by the age class nine years old and older.

What?

Consequently, mortality in age classes 9 years and older calculates at 11/17, (11 of the 16 animals not seen in 1972 were in that age class, and there should have been 17 animals if all were alive) or 65 percent.

During 1973 seven ewes were not seen which were observed in 1972. These animals were considered to be no longer in the population. Three of these ewes were less than nine years old, and the number of ewes expected between the ages of 3 and 9 years was 55. Mortality for this group of ewes then calculates at 3/55 or 5 percent.

In summary ~~it appears~~ Heimer assumes that ewe fidelity is 100 percent. Animals which do not visit the lick in subsequent years maybe considered dead. Mortality of ewes between the ages of 3 and 9 years was 5 percent. Once a ewe reaches 9 years of age the mortality of her age class increases to 65 percent. Here it should be noted that the winter of 1972-73 was considered a mild one, but predators were rumored to be abundant.

Ram Fidelity: Table 12 shows that 55 rams were seen at the lick in 1971. Thirty-seven identifiable rams were seen in 1972 as well as four unidentifiable tagged individuals. This brings the number of observed, tagged rams seen to 41. The apparent fidelity then becomes 41/55 or 75 percent.

The rams not accounted for are listed below:

34 age 5 years
40 age 9 years
45 age 9 years
55 age 10 years
65 age 5 years
81 age 4 years
101 age 4 years
108 age 3 years
118 age 3 years
152 age 3 years
157 age 3 years
161 age 5 years
184 age 3 years
195 age 3 years

why?

When the heavy hunting pressure in the study area is considered it is reasonable to predict that rams 40, 45, and 55 had been killed by hunters and not reported. This leaves eight, three-and four-year-old rams which may have changed ranges. Young bighorn *(Ovis canadensis)* rams (2-year-olds) are the most likely sheep to change traditional ranges (Geist 1971). This is thought to occur when they join the ram bands. Young males will follow any larger-horned male when they leave the juvenile and ewe groups. Because Dry Creek sheep grow slowly (Heimer and Smith 1973 unpublished data), the possibility that this could occur among three- and four-year-old Dall rams is most attractive. In any case it must be noted that the fidelity of rams in the younger age classes is less than that of rams which have established home ranges, and that the fidelity of two-, three- and four-year-old rams at Dry Creek lick is low.

If it is accepted that the three old rams not seen in 1972 were probably dead, fidelity could be adjusted to 44/55 or 80 percent for rams. Here it should be noted that the average age of rams resighted in 1972 was less than five years. These animals usually occurred in ram bands, but were not yet legal to hunt. Also, fidelity may change as the animals mature.

When the low fidelity of young rams is considered, and it is known from Geist (1971) that young rams are likely to change ranges as they join ram society, one purpose the Dry Creek lick appears to serve is maintenance of genetic homogenity among the sheep of the study area. All populations of the area appear to come to the lick at approximately the same time each year. Ram band use is apparently not separated from the use by ewes and juvenile (1-4 yrs. old) rams. Consequently, young rams which are ready to join ram society are exposed by chance, it appears, to the opportunity to join any of the four known ram bands in the area depending on the coincidence of their arrival at the lick. This is thought to be of major significance in the prevention of genetic drift among the isolated populations of ewes and the rams which traditionally rut with them and to result in the preservation of genetic stability.

Sheep Use of the Lick by Zone: The lick was arbitrarily divided into physiographic areas. The 30-minute classification counts were recorded by area and give the numbers and composition proportions of sheep use centering on any given physiographic region of the lick. Data for lick use are presented in Table 13.

Table 13. Sheep mineral lick use by zone and time during 1972.

	Percent of Total Use by Rams 1/4 Curl +				Percent of Total Use by Ewes			
Time Period	Zone: A	B	C	D	Zone: A	B	C	D
May 25 - June 6	0.5	57.6	19.8	22.4	0.2	57.6	25.2	20.8
June 9 - 14	3.6	39.3	20.3	36.8	3.9	48.2	24.8	23.1
June 17 - 20	0.9	40.3	14.9	35.3	18.0	45.0	19.5	18.6
June 30 - July 4	1.0	56.3	17.1	16.7	10.5	48.4	30.6	10.5

These data indicate that Zone "B" is the most preferred site for licking and that Zone "A" is the least preferred. Zone "C" is a mud slide formed by material sloughing from the steep side of "B", but is apparently less desirable than the parent material. Zone "D" appears to be about the same material as Zone "B" and could represent the lower reaches of a vein which has been cut by the ravine which forms the lick.

Soil samples from all lick zones were analyzed for ionic content and mineral composition. Mineral composition was determined by X-ray diffraction and sample characteristics. It was found that materials from the high use sites in the lick contained large quantities of clay minerals called zeolites. These are quartz-forming minerals which are said to be of hydrosomic origin and contain the following:

1. quartz
2. crystobalite
3. montmorillonite and possibly mordenite and water-glass

These minerals have in common the occurrence of an imperfect quartz crystal structure. Because of their "immature geological condition" (the mature form of which would be quartz, homogenous sodium silicate) they have cations (other than sodium) of suitable size filling "slots" in the crystal lattice. The possible cations are lithium, sodium, potassium, beryllium, magnesium, calcium, strontium and barium. Of these, sodium, potassium, magnesium, and calcium are of great biological significance. The presence of the others, because of their chemical similarities, would be evident as contamination in analysis for the physiologically important elements. For this reason the ionic content of soil samples was determined for those physiologically important elements. Contaminants were apparently not present.

The elements mentioned above proved to be present and readily available. Analytical techniques involved a cold water leach in which the loosly bound ions were dissolved in water. Because of the ion-exchange properties of the minerals involved, a change in pH such as would take place in the digestive tract of a sheep could probably extract four or five times the quantities liberated by cold water. Consequently, it appears that vast quantities of physiologically important ions are available to sheep in the lick soil of highly preferred areas.

Because the sample compositions were similar from all zones the samples were grouped simply into high use sites, moderate use sites and control areas where little or no licking occurred. Soil samples from high use areas had 7.3 times as much sodium, 3.0 times as much potassium, 3.6 times as much calcium and 14.9 times as much magnesium as did soil from nearby areas which received no attention from sheep. High-use sites also had 9.1 times as much water per unit of soil. Sites receiving intermediate attention had values which were intermediate to these extremes.

It is my speculation that the high phosphorus content of alpine vegetation throughout winter (Herbert 1972) and as it begins to grow in the spring, results in the sheep having an excessive phosphorus load. Excretion of this phosphorus calls for the expenditure of cations (perhaps calcium and magnesium) and may aggravate an already critical situation with respect to low levels of these two essential metal ions. Analyses of the water in the lick and the soil of the lick have revealed that there is little phosphorus present (Linderman, unpublished data). It may be that these sheep come to the lick to attain calcium and magnesium which are free of large accompanying quantities of phosphorus. This is speculative and could only be tested in further work.

Gross observations indicated that the water content may have changed significantly (the surface in some licking sites dried and became quite hard) throughout the course of the licking cycle. This may have caused the change in licking by zone between Zones B and D during mid-June seen for rams, however, the change in ewe preference is less striking. If there is a set of circumstances which renders a licking site desirable or perhaps on a broader scale defines a lick it is probably the following. First, there must be the necessary, sought after mineral or minerals (whether their attraction is physiological or as a condiment). Secondly, there must be a suitable substrate for ingestion by sheep. In the Dry Creek lick this is an extremely fine clay which has been described as bentonite or montmorillonite. Finally, there must be sufficient moisture to allow ingestion of the substrate. It appears that at the Granite Creek lick in the Granite Mountains these conditions are present and the substrate there seems to be a fine sand rather than a clay-like substance. Many dry licks have been reported, but it is not known whether these licks are dry during the times that sheep utilize them.

Miscellaneous Observations: Appendix III presents an observation of attempted predation by a wolf *(Canis lupus)* at the Dry Creek lick.

MANAGEMENT RECOMMENDATIONS

Because of the demonstrated high fidelity of Dall sheep to their seasonal home ranges (in this case specifically the main mineral lick at Dry Creek) and the concentration of animals at this mineral lick immediately after lambing, it is recommended that observations of mineral licks be employed as a method to obtain relative composition data of Dall sheep populations.

It has been demonstrated that all segments of the population utilize this mineral lick, that populations of sheep in the area may travel distances up to 10 air miles (16 km) to visit the lick, that sheep utilize the lick at about the same time every year, that daily and seasonal patterns of use allow scheduling of observations in order to observe maximal numbers of animals with minimal effort, that mortality and population size can be estimated from mineral lick observations involving tagged animals, that extremely accurate classification of ewes, lambs, yearlings, and rams can be made at mineral licks, and that observations can be made with little or no disturbance to sheep. These data are important in the status-assessment of Dall sheep populations.

It has been shown that there is a preferential use of the Dry Creek mineral lick by lactating ewes. This preferential use is reflected in more visits but not in more frequent visits. This could lead to an excessively high estimate of production if observations were prolonged. However, in a survey and inventory situation the observations should be made for four to seven days. This should preclude excessive recounting of lactating ewes. Data gathered during these observations would probably accurately reflect the productivity of sheep populations in the surrounding area.

Even if this set of circumstances did not exist, the relative numbers gathered in this manner should be comparable from year to year, and as a relative index of production and survival, should provide better data than aerial surveys. Furthermore, the danger and expense involved in mineral lick observations are far less than those in aircraft surveys, and the influences of weather on data gathering are much less.

For these reasons it is recommended that wherever feasible, routine survey and inventory information be obtained by the techniques set forth in this report or suitable modifications thereof.

It is further recommended that since this study shows sheep populations are small and discrete groups of sheep, survey and inventory efforts should be devoted to determination of the ranges and movements of sheep populations in areas of heavy exploitation.

Finally, because of the apparent importance of the Dry Creek lick to the sheep it influences, it is recommended that mineral licks be considered critical habitat areas for all Dall sheep populations in Interior Alaska.

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Appendix I. Part 1. Sex, age and measurements of Dall sheep captured 1968, 1969, 1970 and 1971 at Dry Creek, Alaska Range.

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	1	6/14/70			845	45	470	500	18	0	268					70	
M	2	7/17/70			645	35	425	360	10	0	221					70	
M	1	6/17/70			920	45	560	530	25	0	280					70	
M	1	6/20/70			825	40	535	490	20	0	261					70	
M	1	6/8/71		596L	810	55	524	500	25	0	270					71	
M	1	6/17/71		677L	780	41	497	450	15	0	245					71	Weighed in small net, umbilicus still hanging.
M	1	6/18/71		732L	840	43	547	490	19	0	272					71	
M	1	6/9/71		701L	780	38	510	470	15	0	200					71	Weighed in small net, umbilicus still hanging.
F	1	6/14/70			800	35	420	500	18	0	258					70	
F	1	6/14/70			855	50	485	460	18	0	255					70	
F	1	6/15/70			795	50	495	445	15	0	245					70	
F	1	6/17/70			890	50	480	505	21	0	255					70	
F	1	6/18/70			810	50	450	445	16	0	255					70	
F	1	6/19/70			920	50	555	500	25	0	278					70	
F	1	6/18/71		706	870	38	550	510	19	0	268					71	
F	1	6/19/71		706	822	32	512	465	17	0	258					71	Sore on left shoulder.
F	1	6/19/71		740L	705	35	470	390	11	0	235					71	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	12	6/23/68	25	010L												67	
M	12	6/23/68	23													67	
M	12	5/30/69		099						1	340		95	95		68	
M	13	6/1/69	6	027R							360		100	98		68	
M	13	6/3/69		061R							348			78		68	
M	13	6/6/69	46	034L						30						68	
M	13	6/6/69	39	091R						10				104		68	
M	13	6/6/69	35	019R						10				122		68	
M	13	6/6/69	48	017R							348			106		68	
M	13	6/7/69	44	018L						10	358		119			68	
M	13	6/12/70		044L	1230	69	745	792	70	50	361		140	142	127	69	
M	13	6/12/70		510R	1365	65	785	810	75	5	379					69	
M	13	6/12/70		071L 512R	1390	75	740	830	80	15	375		167	181	230	69	
M	13	6/13/70		070L 515R	1270	55	735	810	70	60	363		91	81	250	69	
M	13	6/13/70		066L 516R	1300	60	770	800	70	60	380		175	170	242	69	
M	13	6/14/70		065L 521R	1280	75	700	800	65	50	357		134	132	162	69	
M	13	6/16/70		074L 025R	1320	55	740	790	70	70	350		95	90	100	69	
M	13	6/16/70		527L 530R	1280	60	745	830	78	75	355		145	140	192	69	
M	13	6/18/70		540L	1345	60	715	860		40	367		200	199	270	69	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	13	6/19/70			1125	50	695	735	65	90	333		110	115	175	69	Dead
M	13	6/19/70		562R	1330	70	690	830	46	95	354		152	145	200	69	
M	13	6/20/70		566R	1250	65	695	730	65	95	350		140	136	185	69	
M	13	6/20/70		565L	1280	70	670	790	75	55	355		139	143	215	69	
M	13	6/20/70		570	1290	80	780	780	71	25	360		152	156	206	69	
M	13	6/21/71		734L	1285	72	780	850	75	85	358		138	138	180	70	Lamb Seg. 82mm
M	13	6/21/71		702L												70	Blood sample only
M	13			726L													Blood sample only
M	13	6/7/71		647L												70	Blood sample only
M	13	6/6/71		642L	1270	75	772	865	49	1	362		97	95	142	70	
M	13	6/6/71		643L	1200	60	798	800	52	1	344		37	41	102	70	
M	13	6/9/71	128	630L	1330	77	735	862	62	5	347		103	104	145	70	
M	13	6/11/71		691L	1335	47	752	810	56	30	355		67	66	112	70	Lamb Seg. 30mm
M	13	6/15/71		635L	1300	63	695	810	62	20	360		110	100	160	70	Lamb Seg. 50mm
M	13	6/15/71		640L	1370	60	748	815	64	35	362		140	129	200	70	Lamb Seg. 80mm
M	13	6/27/71		728L												70	Blood & pellet Samples only
F	13	6/4/69	56	057R							389		88			68	
F	13	6/6/69		033						10	334	N	23			68	
F	13	6/6/69		082R							338	N		61		68	
F	13	6/12/70		501 046	1252	60	775	820	70	50	340	N	89	95	102	69	
F	13	6/13/70		518 049	1180	50	642	710	60	60	333	N	42	42	70	69	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	13	6/16/70		068	1210	55	635	740	60		330	N	23	22	70	69	
F	13	6/19/70		545	1315	65	705	790	70	40	348	N	45			69	
F	13	6/20/70		578	1340	60	740	805	75	90	350	N		90		69	
F	13	6/20/70		573	1115	60	655	720	50	30	315	N	26	28	65	69	
F	13	6/20/70		574	1220	55	655	740	58	10	325	N	43	73		69	
F	13	6/2/70		589	1290	60	665	750	67	40	346	N	115	108	132	69	
F	13	6/7/71		666L												70	Blood sample only
F	13	6/3/71		626L	1215	75	747	820	51	0	325	N	40	25	75	70	Art Mtn.
F	13	6/17/71		671L	1309	59	794	795	51	10	328	N	30	57	70	70	
F	13	6/17/71		674L	1295	74	799	823	63	70	355	N	91	94	82	70	
F	13	6/19/71		744L	1310	64	750	780	64	15	340	N	35	41	85	70	
F	13	6/19/71		710L													Blood sample only
F	13	6/23/71		822	1325	68	780	830	66	50	363	N	70	60	110	70	For zoo
F	13	6/23/71		823												70	Blood sample only for zoo
F	13	6/28/71		824	1260	63	735	820		40	355	N	40	44	88	70	For zoo
F	13	6/28/71		825	1190	55	750	760		5	335	N	30	38	84	70	For zoo
M	24	5/31/69	10	100L						1	375		195	200		67	
M	24	5/31/69	8	98							375		270	265		67	
M	24	5/31/69	9	97R							400		297	292		67	
M	24	6/1/69	1	089L						10	390		279	278		67	
M	24	6/2/69	15	087R						15	402		276			67	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	24	6/4/69	18	058L							382		177			67	
M	24	6/5/69	36	032L						20	398		247	242		67	
M	24	6/5/69	34	029L						5	376			211		67	
M	24	6/12/70	59	042L	1400	65	875	880	100	50	400		335	355	434	68	
M	24	6/12/70	G3	048L 508R	1400	80	790	970		-5*	395		405	400	440	68	
M	24	6/13/70	81	040L	1390	65	780	870	95	75	390		282	286	370	68	
M	24	6/19/70	G5	551L	1380	55	752	840	80	60	387		275	282	350	68	
M	24	6/19/70	61	548L	1510	75	775	940	100	10	400		299	300	380	68	
M	25	6/20/70		579L	1340	70	728	845	100	40	375		262	242	331	68	
M	25	6/20/70		580R	1305	80	770	840	90	95	379		280	296	355	68	
M	25	6/20/70		581R	1490	60	770	910	115	95	394		339	336	384	68	
M	25	6/20/70		583R	1460	75	792	960	95	30	392		266	313	389	68	
M	25	6/20/70	87	575L	1380	65	770	870	100	75	386		324	335	418	68	
M	25	6/20/70	85	576R	1530	75	820	980	118	50	405		390	390	470	68	
M	25	6/21/70		590L	1490	90	735	870	107	80	385		383	390	485	68	
M	24	6/10/71	143	617L	1590	85	946	995	104	30	388		352	341	460	69	
M	24	6/9/71	126	619L	1583	70	885	975	86	10	405		354	355	416	69	
M	24	6/9/71	127	615L	1510	75	942	1040	102	2	402		315	389	403	69	Open sore rt. jaw, left clean
M	24	6/11/71	158	700L	1550	80	839	990	89	5	380		293	303	381	69	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	24	6/11/71	156	683L	1490	55	878	1010	96	15	400		290	285	405	69	Brown hair on tip of tail
M	24	6/14/71	149	692L	1565	58	818	970	94	5	410		285	279	382	69	
M	24	6/17/71	165	632L	1550	88	895	940	94	25	397		269	263	326	69	
M	24	6/16/71	144	530R	1582	101	910	965	102	40	352		303	298	398	69	Recapture from 1970
M	24	6/16/71	159	673L	1500	72	905	995	106	25	390		370	361	427	69	Brown hair on tip of tail
M	24	6/18/71	176	741L	1620	67	890	940	99	20	395		305	295	370	69	
M	25	6/20/71	184	715L	1450	80	854	980	100	30	395		324	332	440	69	
M	25	6/27/71	195													69	
M	24	6/7/71	118	624L	1595	97	890	1000	99	1	395		283	254	348	69	
M	24	6/7/71	116	661L	1575	72	928	1005	94	1	403		303	302	425	69	
M	24	6/6/71	108	641L	1510	87	892	1030	109	0	404		255	252	380	69	
M	24	6/7/71	107	645L	1530	82	874	925	83	0	370		267	222	288	69	
M	24	6/5/71	104	629L	1370	85	862	975	86	0	380		246	240	356	69	
M	24	6/4/71	105	628L	1390	80	842	985	94	0	382		337	357	430	69	
M	24	6/10/71	157	684L	1460	66	880	970	94	10	402		292	298	411	69	
M	24	6/10/71	153	687L	1490	78	806	952	87	5	393		244	224	310	69	
M	24	6/10/71	152	681L	1610	80	864	950	91	10	390		285	285	354	69	
F	25	6/23/68	24	008L 007R												66	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	25	6/23/68	22													66	
F	25	6/23/68	26									Y				66	
F	24	5/30/69	7	028L						1	375	N	150	140		67	
F	24	5/31/69	5	026							360		125			67	
F	24	6/2/69	12	095R						10			114	115		67	
F	24	6/3/69	19	077L							360			122		67	
F	24	6/3/69	57	081L							376		121			67	
F	24	6/6/69	51	031						5	357	N	112			67	
F	24	6/13/70	84	514L 092R	1370	75	762	860	75	-5*	360	N	142	134	90	68	
F	24	6/17/70		536R	1370	60	795	850	90	90	365	N	158	135	145	68	
F	24	6/18/70	68	538R	1340	75	770	810	70	-5*	365	Y	142	140	140	68	
F	24	6/18/70	72	539R	1420	75	751	840	85	85	376	N	125	150	150	68	
F	24	6/18/70		544L	1455	60	815	880	95	80	375	N	141	170	180	68	
F	24	6/19/70		553L	1450	75	770	870	90	-5*	365	N	147	140	165	68	
F	25	6/20/70		657R	1480	80	771	890	110	40	378	N	165	160	156	68	
F	25	6/20/70		563L	1320	50	770	860	80	-5*	368	Y	130	165		68	
F	25	6/20/70		569L	1410	70	710	860	81	5	367	Y	145	154	170	68	
F	24	6/6/71	112	518	1350	75	785	950	62	0	356	N	105	77	108	69	Recapture
F	24	6/6/71	110	650L	1490	115	865	980	104	0	387	N	135	180	187	69	
F	24	6/3/71	103	627L	1360	80	820	890	80	2	360	N	138	125	180	69	Art Mtn.
F	24	6/10/71	142	620L	1290	70	875	920	85	30	366	N	120	145	115	69	Both jaws moderate swelling

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	24	6/10/71	145	611L	1450	80	832	905	65	10	370	N	147	149	175	69	
F	24	6/8/71	130	623L	1355	61	870	940	80	0	388	N	157	165	195	69	Both jaws slight swelling
F	24	6/8/71	122	664L	1375	87	880	900	81	1	362	N	157	166	215	69	
F	24	6/17/71	133	679L	1380	85	850	866	70	35	355	N	100	76	92	69	Slight swelling left jaw
F	24	6/17/71	166	695L	1335	74	861	845	81	80	360	N	153	150	192	69	Slight swelling right jaw
F	24	6/18/71	174	737L	1395	85	832	860	73	40	355	N	75	104	122	69	
F	25	6/23/71	191	745L												69	Blood and pellet samples only, two sores left shoulder
F	25	6/23/71	192	703L								Y				69	Blood and pellet samples, only
F	25	6/23/71	162	731L												69	Blood and pellet samples, only
F	25	6/23/71	190	708L												69	Pellet sample, only
M	36	6/17/70	65	537L Q88R	1465	55	818	880	110	30	395		431	435	495	67	
M	36	6/19/70	89	552L	1480	80	870	970	130	90	410		465	468	475	67	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	36	6/21/70		587R	1560	80	835	960	135	90	401		589	582	510	67	
M	36	6/21/70		585	1450	70	825	980	120	75	443		471	463	534	67	
M	36	6/17/71	160	634L	1570	74	997	1009	112	40	408		443	438	432	68	
M	36	6/18/71	171	711L	1415	81	908	980	100	20	400		394	413	470	68	
M	37	6/23/71	177	735L													
M	36	6/2/71	101	622R	1320		1000	1000	115	2	410		465	455	488	68	
M	36	6/6/71	115	648L	1580	95	930	1030	102	3	410		395	377	445	68	
M	36	6/10/71	139	696L	1660	80	946	1080	125	3	405		462	472	530	68	Moderate swelling right jaw
M	36	6/10/71	146	618L	1610	75	932	1050	116	10	393		480	455	520	68	
M	36	6/2/71	100	621R	1620	150	942	1000	130	25	410		600	600	517	68	
M	36	6/14/71	150	682L	1510	82	937	1020	110	5	406		532	522	540	68	Slight swelling right jaw
M	36	6/15/71	151	636L	1665	70	907	1020	125	5	386		585	568		68	Slight swelling right jaw
F	37	6/24/68	27	012R								Y				65	
F	36	6/6/69	54	035L						10	387	N	176			66	
F	36	6/12/70	G2	036L 511R	1480	60	770	900	90	-5*	368	Y	188	220	250	67	
F	36	6/14/70	88	522L 039R	1445	65	800	920	105	-5*	375	N	211	185	175	67	
F	36	6/15/70	96	067L 523R	1485	70	772	890	85	5	385	Y	140	140	115	67	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	36	6/17/70	98	534L	1420	55	780	890	82	-5*	375	Y	195	152	175	67	
F	36	6/19/70	92	546L	1420	70	800	900	90	-5*	355	Y	200	205	275	67	
F	36	6/19/70	97	559L	1445	55	740	900	80	-5*	370	Y	180			67	
F	36	6/6/71	113	649L	1380	83	870	925	67	5	386	Y	134	135	160	68	Slight swelling both jaws
F	36	6/3/71	102	625L	1530	100	910	1010	95	2	385	Y	188	160	177	68	Art Mtn.
F	36	6/10/71	123	614L	1565	70	890	950	93	5	375	N	178	160	180	68	
F	36	6/10/71	125	612L	1545	92	802	950	82	10	385	N	215	185	185	68	Slight swelling right jaw
F	36	6/10/71	138	569L	1435	85	842	920	84	2	370	N	165	175	190	68	Moderate swelling both jaws, recapture.
F	36	6/8/71	129	668L	1550	65	910	1030	95	0	377	Y	183	181	179	68	Slight swelling both jaws
F	36	6/17/71	164	697L	1375	72	878	972	82	10	361	N	160	163	172	68	
F	36	6/18/71	175	750L	1535	94	852	910	95	40	372	N	175	142	107	68	
F	36	6/19/71	136	729L	1450	74	870	1020	93	5	373	Y	165	145	183	68	
F	36	6/19/71	189	748L	1480	80	862	940	97	75	391	N	205	207	170	68	
F	36	6/19/71	187	707L	1420	78	894	990	94	0	395	Y	170	200	185	68	
F	37	6/27/71	210	035												68	Recapture
F	37	6/22/71	178	544L	1445	68	910	920	103	95	380	N	183	212	210	68	
F	37	6/24/71	204	712L												68	
F	37	6/23/71	188	730L	1440	73	890	990		10	382	Y	178	222	177	68	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	48	6/2/69	4	025R						5	421			494		67	
M	48	6/19/70	83	550R	1460	75	880	1000	145	40	402		578	590	535	66	
M	48	6/10/71	124	613L	1755	106	900	1110	132	5	410		542	542	530	67	
M	48	6/17/71	161	676L	1625	92	982	1045	125	30	409		608	605	552	67	
M	48	6/18/71	135	680L	1525	86	940	945	110	60	392		486	487	571	67	Slight swelling right jaw, open sore left shoulder
M	48	6/27/71	193													67	
F	48	6/12/70	G4	045L 502R	1420	75	772	930	95	-5*	368	Y	209	210	250	66	
F	48	6/17/70	78	531L	1380	75	850	920	115	40	370	Y	187	190		66	See photo
F	48	6/7/71	119	662L	1570	60	884	965	97	2	390	N	165	210	257	67	
F	48	6/6/71	120	644L	1460	93	845	927	67	2	382	N	217	213	264	67	
F	48	6/10/71	140	693L	1490	90	830	980	80	4	387	N	212	220	231	67	Recapture #12
F	48	6/14/71	147	619L	1570	95	810	950	94	20	370	N	196	192	152	67	
F	48	6/14/71	115	685L	1510	53	890	950	84	3	384	N	193	182	183	67	Slight swelling both jaws
F	48	6/19/71	186	746L	1395	65	842	940	87	0	375	Y	215	203	212	67	Slight swelling both jaws
F	48	6/21/71	179	546L													Recapture #92

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
M	60	6/28/68	28										640	410		63	
M	60	6/5/69	47	030L						5	402		456			64	
M	60	6/6/69	37	055R						20	411		609			64	Hunter kill 1970
F	60	6/2/69	3	024L						5	360	Y	227	238		64	
F	60	6/2/69	30	023R						15	404	N	234	231		64	
F	*	6/3/69	43	062L							381	N	193	192			Annuli not clear 3, 4 or 5 yrs. old
F	60	6/6/69	41	079L						5		N				64	
F	60	6/6/69	16	021R						10		N				64	
F	60	6/17/70	58	532L	1460	60	795	920	105	-5*	370	Y	210	213	192	65	
F	60	6/18/70	70	541L	1400	60	810	910	100	-5*	375	Y	236	229	266	65	
F	60	6/19/70	79	561R	1475	60	770	900	105	80	366	Y	210	211	213	65	
F	60	6/6/71	109	667L	1630	70	902	1020	100	5	385	Y	210	223	223	66	
M	72	6/2/69	13	078L							460			668		63	
M	72	6/2/69	11	084R							403			697		63	
M	72	6/2/69	29	094R						10	414			668		63	
M	72	6/5/69	45	083L						10	413		617			63	
M	72	6/5/69	44	064L						5	396		731			63	Dead
M	72	6/5/69	40	052R						5	400		782			63	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	72	6/2/69	14	086L							400	Y	211	210		63	
F	72	6/3/69	32							15-20	370	N	259			63	
F	72	6/4/69	20	056L							391		205			63	
F	72	6/6/69	31	011L						5		Y				63	
F	72	6/6/69	38	080R						10		Y				63	
F	72	6/12/70	G6	043L 505R	1525	75	870	960	110	-5*	380	Y	294	326	314	64	
F	72	6/14/70	86	050L 519R	1535	85	789	940	115	-5*	390	Y	225	234		64	
F	72	6/17/70	82	528L	1465	50	815	885	105	-5*	385	Y	215	215	225	64	
F	72	6/18/70	69	542L	1570	70	830	935	120	30	372	Y	215	215	175	64	
F	72	6/18/70	67	543L	1560	60	800	900	100	5	370	Y	199	170	140	64	
F	72	6/19/70	66	547L	1535	65	820	940	101	10	365	Y	240	230	212	64	
F	72	6/19/70	63	560R	1485	50	790	970	115	-5*	380	Y	273	250	395	64	
F	72	6/19/70	75	557L	1405	70	750	850	85	5	343	Y	248	254	190	64	
F	72	6/20/70		564R	1410	65	770	880	95	-5*	360	Y	221	213	155	64	
F	72	6/21/70		586R	1510	80	766	915	111	5	372	Y	217	226	197	64	
F	72	6/11/71	154	699R	1540	55	842	1020	98	2	377	N	236	232	268	65	Major swelling with open sore right jaw Recapture #70
F	72	6/16/71	163	637L	1460	68	920	925	92	20	365	N	210	203	162	65	Large swelling right jaw, open sore

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	72	6/18/71	168	727L	1470	82	844	990	94	2	364	Y	227	214	232	65	
F	72	6/19/71	169	738L	1490	67	875	990	94	10	374	Y	265	269	260	65	
F	72	6/25/71		742L	1520	75	875	920		60	380	Y	230	230	202	65	
F	72	6/27/71	208													65	
M	84	6/2/69	17	076R						10	394			752		62	Hunter kill 1970
M	84	6/7/69	55	015R						50	398			731		62	
M	84	6/12/70	G7	037L	1610	75	800	1000	145	30	400		692	694		63	
				504R													
M	84	6/19/70	99	549L	1680		925	100	185	90	415			816		63	
M	84	6/19/70	93	558R	1635	65	915	1070	150	80	420		735	764	555	63	
M	84	6/20/70	95	582L	1650	80	939	1040	163	99	399		715	702	540	63	
F	84	6/4/69	53	054R							365			208		62	
F	84	6/6/69	52	016L						5		Y				62	
F	84	6/12/70	G1	041L	1520	75	830	915	103	30	367	Y	281	274	195	63	
				503R													
F	84	6/12/70	G8	047L	1515	77	835	1020	100	5	376	Y	255	256	342	63	
				506R													
F	84	6/13/70	60	038L	1560	70	812	940	110	50	382	Y	249	228	307	63	
				513R													
F	84	6/16/70	64	529L	1565	65	830	935	115	10	370	Y	275	232	335	63	
F	84	6/16/70	76	525L	1420	70	830	950	129	-5*	380	N	272	258	165	63	
				069R													

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	84	6/17/70	62	535L	1460	55	845	940		50	380	Y	201	194	212	63	
F	84	6/20/70		571R	1430	70	820	820	106	-5*	365	Y	227	221	307	63	
F	84	6/23/71	181	739L	1565	65	870	990		10	383	Y	207	211	255	64	Large swelling left jaw
F	84	6/14/71	148	689L	1610	62	912	970	110	10	378	Y	272	221	256	64	
F	84	6/15/71		690L	1510	57	900	1000	90	5	410	N	207	226	262	64	Fbks. - Massive swelling both jaws, infection by teat
F	84	6/16/71	141	639L	1430	67	875	990	91	20	366	Y	268	274	267	64	Jaw clean
F	84	6/18/71	172	716L	1490	60	852	980	87	0	373	Y	260	230	347	64	Brown secretion from vagina
M	96	6/7/69	42	020R						20	403			822		61	
M	96	6/19/70	91	554L	1557	80	930	940	140	95	400		678	692	635	62	Hunter kill 1970
M	96	6/18/71	167	631L	1580	78	985	1109	137	15	398	N	769	767	698	63	Slight swelling left jaw
M	96	6/18/71	170	672L	1570	77	981	1035	124	25	409	N	636	665	585	63	Slight swelling right jaw
F	96	6/16/70	80	072L 542R	1530	70	875	1005	125	25	380	N	265	257	242	62	
F	96	6/14/70	74	526L 073R	1470	70	850	920	95	-5*	360	Y	244	210	180	62	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	96	6/23/71	194													63	Recapture #G8
F	96	6/6/71	106	646L	1560	83	903	1000	79	1	379	Y	248	215	191	63	Mod. swelling
F	96	6/7/71	117	665L	1565	77	860	1010	97	2	378	N	280	248	205	63	Lump and open sore on left jaw - photo
F	96	6/7/71	114	669L	1505	78	848	1040	97	0	379	N	240	250	216	63	Jaw clean
F	96	6/15/71		633L	1493		850	1020	90	0	380	Y	238	247	225	63	Trapped for Fbks. but injured self and was killed 6/17/71, skeleton saved
F	96	6/17/71	131	675L	1515	75	827	913	98	20	357	Y	52	151	157	63	Mod. swelling left jaw
M	108	6/21/70		600L	1788	100	925	1100	184	70	416		915	892	624	61	
F	108	6/3/69	50	063L						10		N	206	259		60	
F	108	6/3/69	33	059						10		Y		275		60	
F	108	6/14/70	94	013L 520R	1470	70	755	970	105	-5*	370	Y	310	323	398	61	
F	108	6/17/70	90	533L	1550	60	845	950	120	60	375	Y	239	249	145	61	
F	108	6/20/70		572L	1500	75	810	961	120	30	367	Y	255	246	298	61	
F	108	6/20/70		568R	1450	70	815	940	120	15	383	Y	273	275	342	61	
F	108	6/8/71	121	524R	1680	75	872	1070	110	0	392	Y				62	Recapture #80
F	108	6/14/71	137	694L	1685	70	848	1010		0	390	Y	215	212	210	62	

Appendix I. Part 1 (Continued).

Sex	Age	Capture date	Collar number	Ear tag number	Total contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	% coat shed	Hind foot length (mm)	Lactating	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)	Year class	Remarks
F	108	6/17/71	132	638L	1485	74	925	1004	100	35	377	Y	291	285	204	62	Jaw clean
F	108	6/19/71	185	743L	1610	70	837	1050	97	0	400	Y	310	290	250	62	Lamb captured
F	108	6/27/71	207													62	
F	108	6/27/71	202													62	
F	108	6/21/71	180	716L								Y				62	Blood sample only
M	120	6/18/71	134	678L	1655	101	1000	1125	153	10	395		875	805	540	61	
F	120	6/20/70		571L	1540	60	810	960	120	-5*	370	Y	248	250	217	60	Dead
F	120	6/21/70	71	584L	1559	80	839	1010	125	5	372	Y	229	199	256	60	
F	120	6/22/71	182	714L	1610	65	815	1040	114	0	380	Y	240	250	225	61	
F	132	6/19/70	77	556L	1555	75	793	940	118	-5*	365	Y	275	264	282		
F	132	6/7/71	111	584L	1510	86	838	910	110	2	392	N	232	200	257	60	Yearling w/ewe, recapture #71
F	132	6/18/71	173	749L	1505	54	870	1020	100	0	378	N	236	262	255	60	Mod. swelling right jaw
F	144+	6/23/70		591L	1530	80	800	935	123	30	381	N	223	239	272	57	
F	144+	6/1/69	2	090L							370	N	281	288		56	

-* indicates less than

Appendix I. Part 2. Sex, age and measurements of Dall sheep collected from Crescent Mountain, Kenai Peninsula, from January to April, 1971.

Sex	Age	Collection date	Accession number	Contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	Hind foot length (mm)	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)
M	5	11/13/70	62077	1120	70	700	760	65	330	634	634	
M	5	11/13/70	62080	1110	60	730	830	74	340	760	710	
M	5	11/13/70	62083	1060	60	720	860	60	330	530	510	
M	7	1/14/71	62086	1060	50	710	830	66	325	520	540	
M	9	2/18/71	62096	1090	50	660	730	44	320			
M	11	4/21/71	62117	1110	80	680	730	50	330			
F	7	1/14/71	62085	1150	50	700	870	61	330	67	62	
F	9	3/18/71	62101	1140	80	590	800	55	320			
F	11	4/27/71	62123	1010	70	600	670	34	300			
F	11	4/27/71	62120	1010	60	620	680	34	300			
M	19	1/14/71	62091	1330	110	780	1000	94	385	200	200	
M	19	1/14/71	62087	1400	110	830	1070	103	400	310	315	
M	21	2/26/71	62104	1400	70	890	950	99	390			
M	21	3/18/71	62106	1230	70	770	850	71	360			
M	21	3/18/71	62109	1270	80	680	810	69	365			
M	23	4/27/71	62124	1200	80	710	810	59	350			
M	23	4/27/71	62121	1240	90	800	840	75	380			
F	21	2/26/71	62099	1270	90	810	880	87	370			
F	21	2/26/71	62095	1320	80	820	880	83	360			
F	21	3/18/71	62107	1280	60	770	910	89	360			
F	21	3/18/71	62102	1270	80	710	870	71	360			

Appendix I. Part 2 (Continued).

Sex	Age	Collection date	Accession number	Contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	Hind foot length (mm)	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)
M	33	2/26/71	62094	1420	70	820	960	103	390			
F	29	11/13/70	62082	1140	70	760	910	91	350	110	120	
F	29	11/13/70	62081	1410	90	790	1010	122	370	190	220	181
F	33	2/26/71	62100	1400	80	860	990	110	370			
F	33	2/26/71	62103	1590	100	950	1120	152	400			
F	41	11/13/70	62078	1440	100	860	1040	129	380	199		
F	41	1/14/71	62088	1550	95	840	1040	111	385			
F	45	3/18/71	62108	1420	90	830	950	103	360			
F	59	4/27/71	62125	1440	100	860	930	101	370			
F	59	4/27/71	62119	1370	120	850	890	99	370			
F	69	2/26/71	62100	1460	100	890	1010	121	380			
F	69	3/18/71	62112	1480	90	880	980	121	380			
F	71	4/27/71	62113	1380	100	900	950	114	370			
F	77	11/13/70	62076	1440	70	750	1040	120	360			
F	79	1/14/71	62090	1450	60	890	1090	123	370	230	205	175
F	81	2/26/71	62105	1380	100	910	990	110	370			
F	84	3/18/71	62098	1400	90	860	930	99	370			
F	101	11/13/70	62079	1410	90	880	108	139	370			
F	103	1/14/71	62092	1450	70	870	1020	102	370			

Appendix I. Part 2 (Continued).

Sex	Age	Collection date	Accession number	Contour length (mm)	Tail length (mm)	Shoulder height (mm)	Chest girth (mm)	Weight (lbs.)	Hind foot length (mm)	Left horn length (mm)	Right horn length (mm)	Horn spread (mm)
F	117	2/26/71	62099	1450	80	880	1000	118	350			
F	117	3/18/71	62093	1410	70	850	970	119	380			
F	129	3/18/71	62084	1440	110	850	950	108	380			
F	131	4/27/71	62116	1470	120	860	950	127	370			
F	165	2/26/71	62089	1450	70	870	990	123	380			
F	167	4/27/71	62118	1500	110	900	970	114	380			

Appendix II. Sightings at the lick by year.

Collar Number	Ear Tag Number	Sex	Years Seen (including year collared)						
1	89	M		69	70	--	72	73	
2	90	F		69	70				
3	24	F		69	70				
4	25	M		69					Collar and some remains found May 1972, age 7 years
5	26	F		69	70	71	72	73	
6	27	F		69	--	71	72	73	
7	28	F		69	70	71	72	73	
8	98	M		69					
9	97	M		69					
10	100	M		69	70				
11	84	M		69	70				
12	95	F		69	70				Recollared #140 in 1971
13	78	M		69					
14	86	F		69	70	71			Animal found dead 1972, age 9 years
15	87	M		69					
16	21	F		69					
17	76	M		69					
18	58	M		69					
19	77	F		69	70				
20	56	F		69	70				
21		F		69	70				Recollared #84 in 1970
22		F	68	69	70	71	72	73	
23		M	68	69	70	71			Found dead due to collar in 1971, age 4 years
24	8	F	68	69	70				
25	10	M	68	69	70	71	72	73	
26		F	68	69	70	71			
27	12	F	68	--	70				
28		M	68						
29	94	M		69	70				
30	23	F		69	70				
31	11	F		69	70				
32		F		69	70	71	72	73	Collar unreadable, horns characteristic
33	59	F		69	70	71			Collar found Red Mountain Creek July 1972, snaps were unfastened, ewe would be 12 years old if alive, no remains found with collar
34	29	M		69	--	71			
35	19	M		69	70				
36	32	M		69	70				
37	55	M		69	70				Hunter killed in August 1970 on Slate Creek
38	80	F		69	70				
39	91	M		69					
40	52	M		69	70	71			Likely hunter kill, age in 1972 would be 9 years

Appendix II. (Continued).

Collar Number	Ear Tag Number	Sex	Years Seen (including year collared)					
41	79	F	69	70				
42	20	M	69					Likely hunter kill, age in 1972 would be 11 years
43	62	F	69	70	71			
44	18	M	69					
45	83	M	69	70	71			Likely hunter kill, age in 1972 would be 9 years
46	34	M	69					Collar found lying on ground 1971
47	30	M	69	70				Likely hunter kill, age in 1972 would be 8 years
48	17	M	69					
49	Collar not used							
50	63	F	69	70	71	72	73	
51	31	F	69	70	71			
52	16	F	69	70				
53	54	F	69	70	71			
54	35	F	69	70				
55	15	M	69	70	71			Likely hunter kill, age in 1972 would be 10 years
56	57	F	69	70	71	72		
57	81	F	69	70	--	72		
58	532	F		70	--	72	73	
59	42	M		70				
60	513 & 21 or 38	F		70	71	72		Found dead in April 1973, age 10 years
61	548	M		70				
62	535	F		70	71	72	73	
63	560	F		70	71	72	73	
64	529	F		70	71			
65	537	M		70	71			
66	547	F		70	--	--		Animal found dead with collar nearby May 1972
67	543	F		70	--	72	73	Ear tag only in 1973
68	538	F		70	71	72	73	
69	542	F		70	71	72	73	
70	541	F		70	71	72	73	Animal recollared #154 in 1971
71		F		70				Recollared #111 in 1971
72	539	F		70	--	72		
73		F		70	71	72	73	
74	526	F		70	71			
75	557	F		70	71	72	73	Ear tag only in 1973
76	525	F		70	71	72	73	
77	556	F		70	--	72		Assumed dead 1973
78	531	F		70	71	72	73	
79	561	F		70	71	72	73	
80	72	F		70				

Appendix II. (Continued).

Collar Number	Ear Tag Number	Sex	Years Seen (including year collared)					
81	40	M		70	71			
82	528	F		70				
83	550	M		70	71	72	73	Ear tag only in 1973
84	514	F	69	70	71	72	73	Animal recollared #21 in 1969
85	576	M		70	--	72		Animal identified by ear tag in 1972, collar found in 1971
86	50	F		70	71			
87	575	M		70	71	72	73	
88	522	F		70	71	72	73	
89	552	M		70	71	72		Hunter kill 1972, age 5 years
90	533	F		70	71	72	73	
91	554	M		70				Hunter kill 1970, age 8 years
92		F		70	71	72	73	Recollared #179 in 1971, ear tag only in 1973
93	558	M		70				Likely hunter kill, age in 1972 would would be 9 years
94	520 & 13	F		70				Collar found 1971, age then would have been 11 years
95	582	M		70	71			Hunter kill in 1971, age 8 years
96	67	F		70	71	72		
97	559	F		70	--	72	73	
98	534	F		70	71	72	73	
99	549	M		70				Animal remains found 1972, age 8 or 9 years, collar had been lost, only ear tag remained with skull
G-1	503 & 41	F		70	71			Age in 1972 would have been 9 years
G-2	36	F		70	71	72	73	
G-3	48	M		70	--	72	73	
G-4	45	F		70	71	72	73	
G-5	551	M		70	71	72		
G-6	43	F		70	71	72	73	
G-7	504 & 37	M		70				Likely hunter kill, age in 1972 would be 9 years
G-8	506 & 47	F		70	71	72	73	Recollared #194 in 1971
100	621	M			71	72	73	
101	622	M			71			
102	625	F			71	72	73	
103	627	F			71	72		
104	629	M			71	72	73	Ear tag only in 1973
105	628	M			71	72		
106	646	F			71	72		Killed April 1973, nutritional study, age 10 years
107	645	M			71	72	73	Ear tag only in 1972
108	641	M			71			
109	667	F			71	72	73	Ear tag only in 1972
110	650	F			71	72	73	Ear tag only in 1972
111	584	F		70	71	72	73	

Appendix II. (Continued).

Collar Number	Ear Tag Number	Sex	Years Seen (including year collared)					
112	518	F			71	72	73	Ear tag only in 1972
113	649	F			71	72	73	Ear tag only in 1972
114	669	F			71			
115	648	M			71	72		
116	661	M			71	72		
117	665	F			71	72	73	Ear tag only in 1972
118	624	M			71			
119	662	F			71	72	73	Ear tag only in 1972
120	644	F			71	72		Ear tag only in 1972
121	524	F			71			
122	664	F			71	72	73	Ear tag only in 1972
123	614	F			71	72	73	Ear tag only in 1972
124	613	M			71	72	73	
125	612	F			71	72	73	Ear tag only in 1972
126	619	M			71	72		
127	615	M			71	72	73	
128	630	M			71	72	73	Ear tag only in 1973
129	668	F			71	72	73	
130	623	F			71	72	73	Ear tag only in 1972
131	675	F			71	72		Ear tag only in 1972
132	638	F			71	72		Ear tag only in 1972
133	679	F			71	72		
134	678	M			71			Hunter kill 1972, collar still on, age 11 years
135	680	M			71	72	73	
136	729	F			71	72	73	Ear tag only in 1972
137	694	F			71			
138	569	F			71	72	73	
139	696	M			71			
140	693	M	69	70	71	72	73	Ear tag only in 1972 (formerly collar #12)
141	690 or 639	F			71	72	73	
142	620	F			71			
143	617	M			71	72	73	
144	530	M			71	72		
145	611	F			71	72	73	Ear tag only in 1972
146	618	M			71	72	73	
147	619	F			71			
148	689	F			71	72	73	
149	692	M			71	72		
150	682	M			71	72	73	
151	636	M			71	72		
152	681	M			71			
153	687	M			71	72	73	Ear tag only in 1972
154	699	F			71	72	73	
155	685	F			71	72	73	Ear tag only in 1972

Appendix II. (Continued).

Collar Number	Ear Tag Number	Sex	Years Seen (including year collared)				
156	683	M		71	72		
157	684	M		71			
158	700	M		71	72	73	
159	673	M		71	72	73	
160	634	M		71	72	73	
161	676	M		71			
162	633 or 731	F		71			
163	637	F		71	72	73	
164	697	F		71			
165	632	M		71	72		
166	695	F		71	72	73	
167	631	M		71	72		
168	727	F		71	72	73	
169	738	F		71	72	73	
170	672	M		71			Hunter kill 1971, age 8 years
171	711	M		71	72	73	
172	713	M		71	72	73	
173	749	F		71	72		
174	737	F		71	72	73	Ear tag only in 1972
175	750	F		71	72	73	
176	741	M		71	72		
177	735	M		71	72		
178	544	F		71	72	73	
179	546	F		71	72		Recollared #92 in 1971 see 92
180	716	F		71	72	73	
181	739	F		71			
182	714	F		71	72		Ear tag only in 1972
183	Collar not used						
184	715	M		71			
185	743	F		71	72	73	
186	746	F		71	72	73	
187	707	F		71	72	73	Ear tag only in 1972
188	730	F		71	72	73	Ear tag only in 1972
189	748	F		71	72	73	Ear tag only in 1972
190	708	F		71	72	73	
191	745	F		71			
192	703	F		71	72	73	Ear tag only in 1972
193		M		71	72		
194		F	70	71	72		Formerly G-8
195		M		71			
196	Collar not used						
197	Collar not used						
198	Collar not used						
199	Collar not used						

Appendix II. (Continued).

Collar Number	Ear Tag Number	Sex	Years Seen (including year collared)		
200	Collar not used				
201	Collar not used				
202		F	71	72	73
204	712				

In addition to these resightings in 1972 there were 10 marked animals which entered the lick but whose numbers could not be ascertained with certainty. These animals were composed of 4 rams and 6 ewes.

Appendix III. Part 1. Time spent by collared rams at main mineral lick on Dry Creek.

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Minutes spent in subsequent visits during same day
1	6/1/72	60	60	
1	6/2/72	58	58	
1	6/17/72	96	96	
1	6/18/72	102	102	54
1	6/19/72	22	22	45
36	6/9/72	32	32	
73	6/16/72	62	62	
83	6/3/72	45	45	66
83	6/8/72	69	69	
87	6/3/72	65	65	
87	6/12/72	55	55	65
87	6/13/72	68	68	
G-5	6/2/72	125	125	35, 21, 25, 10
100	6/21/72	--	--	
100	6/22/72	12	12	
104	6/4/72	65	65	10
105	5/30/72	54	54	
105	5/31/72	67	67	
105	6/13/72	81	58	
105	6/14/72	99	55	22
115	6/17/72	60	60	30, 5
115	6/18/72	40	40	
115	6/19/72	57	52	
116	6/11/72	100	100	15
126	6/11/72	65	65	62, 22
126	6/18/72	119	79	
126	6/19/72	30	25	
127	6/18/72	67	32	27, 67
127	6/19/72	137	137	
135	6/12/72	20	20	25, 10, 7, 5
135	6/15/72	60	60	

Appendix III. Part 1. (Continued).

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Minutes spent in subsequent visits during same day
144	6/5/72	131	91	
144	6/6/72	65	65	
144	6/7/72	51	51	
146	6/5/72	58	58	
149	5/24/72	54	54	
149	6/2/72	50	50	
150	6/11/72	40	40	63
150	6/12/72	62	52	50
151	6/14/72	55	55	
151	6/15/72	65	65	16, 20, 15
151	6/16/72	15	15	40
151	6/17/72	40	40	
156	6/15/72	100	100	
158	6/2/72	72	72	
158	6/4/72	34	34	105, 40
158	6/5/72	21	21	12
158	6/9/72	70	70	
158	6/10/72	94	74	
158	6/11/72	25	25	
159	6/17/72	70	70	12
159	6/18/72	--	--	70
160	6/12/72	--	--	
160	6/13/72	37	37	12
160	7/2/72	60	60	27, 48
165	6/11/72	--	--	19, 20, 20, 10, 60
167	6/17/72	69	69	
167	6/18/72	43	43	21
167	6/19/72	40	40	10
171	6/27/72	--	--	
171	7/2/72	80	80	48
176	6/17/72	35	35	46
176	6/19/72	50	50	22
177	6/12/72	87	87	

Appendix III. Part 1. (Continued).

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Minutes spent in subsequent visits during same day
193	6/5/72	79	79	
193	6/12/72	118	118	
193	6/16/72	30	30	21, 20
193	6/17/72	30	30	5
193	6/18/72	10	10	38
Broken tag	6/11/72	33	33	
Broken tag	6/13/72	17	17	22, 5, 30

Appendix III. Part 2. Time spent by collared ewes without lambs at main mineral lick in Dry Creek.

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Total minutes spent in subsequent visits during same day
5	6/13/72	80	80	
5	6/10/72	105	105	
5	6/11/72	35	35	25, 45
7	6/4/72	81	81	183
7	6/5/72	124	124	55, 50
7	6/10/72	177	157	
7	6/11/72	86	86	5, 150, 110
22	6/19/72	--	--	
22	7/5/72	158	158	10
32	5/26/72	203	83	
32	5/29/72	87	87	
32	6/4/72	68	68	50
32	6/6/72	55	55	
32	6/12/72	50	50	45
32	6/14/72	132	44	
32	6/19/72	50	50	
50	6/16/72	41	41	
50	6/17/72	120	70	
56	6/11/72	45	45	
58	6/6/72	105	105	
58	6/12/72	60	60	55, 30
58	6/13/72	10	10	10, 10, 42
58	6/17/72	20	20	10
58	6/18/72	70	70	
60	6/13/72	61	61	47, 30, 32
60	6/15/72	--	--	
62	6/16/72	66	66	18, 40, 70, 30
62	6/17/72	62	62	
62	6/18/72	28	28	
62	7/5/72	89	84	
68	6/20/72	--	--	
68	6/25/72	--	--	
68	7/5/72	152	130	

Appendix III. Part 2. (Continued).

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Total minutes spent in subsequent visits during same day
72	6/19/72	99	99	
72	6/20/72	40	40	
76	6/3/72	10	10	
76	6/13/72	27	27	
88	7/2/72	75	75	
96	6/6/72	70	70	
G-2	6/1/72	150	150	86
G-2	6/2/72	75	75	
G-2	6/3/72	90	90	
G-2	6/5/72	73	73	
G-2	6/15/72	66	66	20, 41, 10, 32
102	6/12/73	83	83	90
103	6/5/72	95	95	
129	5/31/72	88	88	
129	6/13/72	77	77	
129	6/14/72	30	30	
129	6/17/72	230	210	
132	6/12/72	--	--	
133	6/12/72	74	74	45, 30, 20, 60, 14
133	6/13/72	30	20	35
141	6/11/72	25	25	90, 60
141	6/12/72	--	--	26
148	6/13/72	130	90	120
148	6/14/72	140	140	
166	6/13/72	81	81	
166	6/14/72	15	15	58, 40
166	6/15/72	43	43	
166	6/19/72	50	50	

Appendix III. Part 2. (Continued).

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Total minutes spent in subsequent visits during same day
168	6/17/72	--	--	43
168	6/18/72	92	92	
168	6/19/72	57	57	
169	6/28/72	--	--	
169	6/29/72	30	30	90
169	6/30/72	--	--	
169	7/1/72	--	--	
169	7/2/72	--	--	12
169	7/5/72	18	18	26
178	6/11/72	55	55	
185	6/1/72	66	66	
185	6/2/72	131	131	50
190	6/12/72	54	54	
194	6/4/72	129	129	
194	6/11/72	109	109	22, 53
202	6/22/72	--	--	
202	7/5/72	48	48	16

Appendix III. Part 3. Time spent by collared ewes with lambs at main mineral lick on Dry Creek.

Collar Number	Date	Total minutes spent during first visit of day	Minutes spent licking during first visit of day	Total minutes spent in subsequent visits during same day
69	6/16/72	50	50	62
69	6/17/72	90	90	13
78	6/12/72	98	98	15, 80, 85
78	6/13/72	68	38	16
78	6/17/72	50	50	
78	6/19/72	50	50	
79	6/17/72	165	165	5, 60, 10, 15
79	6/18/72	73	73	
79	6/19/72	65	65	31
79	7/2/72	61	61	
79	7/3/72	33	33	5
79	7/4/72	78	78	
90	6/19/72	--	--	
90	6/20/72	40	40	
97	6/17/72	55	55	135, 48, 20
97	6/18/72	70	70	33
G-4	6/17/72	125	125	43, 33
G-4	6/18/72	46	46	55
G-6	6/21/72	--	--	
G-6	6/22/72	--	--	
G-6	7/3/72	103	103	
G-6	7/4/72	50	50	
G-6	7/5/72	50	50	
106	6/17/72	90	90	
106	6/18/72	77	77	
106	6/19/72	78	78	
154	6/17/72	82	82	
154	6/18/72	36	36	
154	6/19/72	55	55	
154	7/5/72	217	217	
175	7/3/72	71	71	
175	7/4/72	31	31	
175	7/5/72	108	108	
182	6/11/72	102	102	120
182	6/12/72	140	140	40
182	6/13/72	63	63	

Appendix IV. June 19, 1972, 2008 hrs. Mark Groves: <u>Account of wolf in the lick at Dry Creek</u>:

The wolf came sprinting down trail #2 and into the lick scattering sheep in all directions, but mostly upward on trails 3, 8, 1, 2 and 7. I first caught sight of the wolf in the grassy area on trail #2 as he was sprinting toward zone "B". As the wolf "dove" into the lick the sheep that were in zone "B" on the wolf's left ran out via trails 8 and 1 and between them. The sheep on the wolf's right started out trail #7.

Sheep that were toward the right edge of zone "B" ran horizontally in the lick into zone "C" then turned up the lick at the foot of the bank at the right edge of "C" and ran out the top of "B" and also out trail #3. Some also ran around the side of the bank and out on trail #3 on the grass. (All this happened when the wolf entered at 2008 hrs.)

As the wolf entered zone "B" he slowed up a bit either to collect his footing or to decide which sheep to catch or both. The wolf selected a lamb which was running toward zone "D". The lamb crossed zone "D", ran around the top of the rock outcropping where the wheather station is situated, down along the right side as we face it, then into the rocks a short distance. The wolf was trailing approximately 25 yards behind. At the moment the lamb ducked into the rocks the wolf would not have been able to see the lamb because the wolf was just reaching the top of the outcropping.

The wolf moved quickly on down around the right side of the outcropping and began hurriedly searching for the lamb in the area where the white talus meets the gray talus below the outcropping then rapidly extended his search through the little ravines of the creek bottom down to the edge of my view of the creek bottom. Upon not immediately finding the lamb the wolf began searching more slowly and throughly as he worked his way back up the creek bottom and along the side of the outcropping. He passed within 15 feet of where the lamb was hiding in the rocks and continued searching up, down and around then up over the top of the outcropping and back into zone "D".

These proceedings covered about 14 minutes. I was watching the wolf most of the time, but whenever I looked the lamb was holding a frozen "point" at the wolf.

The wolf continued across zone "D" (away from the lamb). By this time the wolf seemed to have given up seriously searching for the lamb and was merely sniffing about as he moved on up zone "C" and on out zone "B" which took about another seven minutes.

The wolf exited at the same place he entered and walked on out trail #2. He continued to sidehill below the ridge until he was about 200 yards up from the lick then walked up over the ridge out of sight. (The wolf was seen from the valley bottom at this time heading south about the area of the high trail which becomes #2 as it comes down the ridge to the lick.) Sheep were visible in the area.

At 2145, one hour and 35 minutes later, the lamb was still in the rocks though the tension had eased. The lamb was lying down.

It is strange to me that I have only six sheep recorded in the 30 minute classification as being in the lick when the wolf entered because I remember it looked like more than six when they scattered. Several sheep had just gone over the ridge on trail #2 from the lick before the wolf came and as the wolf came into the grassy area there seemed to be several sheep also in the grassy area. I believe the wolf was chasing a band back down into the lick. There were two lambs present in this band, one of which was singled out as the intended victim.

2310 - The wolf just showed up again in the creek bottom below the rocks where the lamb is still resting, sniffed and looked around for three or four minutes then departed down the creek or around the ridge down from the blind.

Both times the wolf has been here he has looked in the direction of the lamb several times without seeing it.

June 20, 1972 0130 - The lamb is still in the rocks, but is moving around on the outcropping quite a bit now.

0253 - Lamb finally leaves the rocks.