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INTERIOR SHEEP STUDIES

by
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Project Progress Report
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JOB PROGRESS REPORT (RESEARCH)

State:	Alaska		
Cooperator:	Wayne E. Heimer		
Project No.:	W-17-9	Project Title:	Big Game Investigations
Job No.:	6.9R	Job Title:	Dynamics of Selected Sheep Populations
Job No.:	6.10R	Job Title:	Assessment of Sheep Population Occupying Designated Wintering Areas
Job No.:	6.11R	Job Title:	Seasonal Availability of Dall Sheep Range
Job No.:	6.12R	Job Title:	Dall Sheep Condition and Nutritional Profile
Period Covered:	July 1, 1976 through June 30, 1977		

SUMMARY

Comparative studies continued between a dense, low quality sheep population in Dry Creek and a high quality, less dense, more productive population in the Tok Management Area (Sheep Creek). Dry Creek sheep produced 36 lambs per 100 ewes (6 above the mean for the last 5 years) and Sheep Creek sheep produced 42 lambs per 100 ewes. Survival to yearling age was comparable in these populations (57% for Dry Creek and 60% for Sheep Creek). The known population for the Dry Creek study area numbers 350 sheep for a summer density of about 3 sheep per km^2. In Sheep Creek summer density is 0.5 sheep. per km^2. Densities on winter range were about 6 sheep per km^2 in Dry Creek and 3 sheep per km^2 in Sheep Creek. Ewes collected in Sheep Creek had a mean age of 62 months, and those collected in Dry Creek had a mean age of 86 months. Weight loss over winter in both areas was about 20 percent of the fall weight. Ten of 18 ewes collected over a 4-year period in Dry Creek in April were pregnant and the mean fetal weight was 2.26 kg. All six ewes collected in Sheep Creek were pregnant and the fetal weights averaged 2.84 kg. Further analysis on carcasses is yet to be completed. Apparently ewes are somewhat larger at given ages, the pregnancy rate is higher, fetal size is greater, spring lactation is absent and parasite infections are fewer in Sheep Creek than in Dry Creek.

CONTENTS

BACKGROUND

Previous studies by the Alaska Department of Fish and Game (Heimer and Smith 1975) have shown striking differences in Dall sheep (*Ovis dalli*) ram horn growth in populations along the Alaska Range east of Mount McKinley National Park. The results of these studies were considered by the authors to support the "Quality Hypothesis" of Geist (1971). In part, this hypothesis states that differences in population quality exist among sheep populations and that populations of high quality are characterized by individuals with more rapid horn growth and larger horns at any given age than are exhibited by individuals from low quality populations. The studies of Heimer and Smith (1975) also indicated that Dall sheep population quality (as reflected by ram horn growth and size) is inversely related to population density.

Heimer and Smith (1975) divided the Alaska Range east of Mount McKinley National Park (ARE) into three areas for purposes of investigating "quality" based on ram horn growth characteristics. These areas, from McKinley Park to the east, are: ARE I, from the Nenana River eastward to the Delta River; ARE II, from the Delta River eastward to the Johnson River; and ARE III, from the Johnson River eastward to the Tok-Slana Road. In the quality ranking of Heimer and Smith (1975) ARE I was of very low quality, ARE II was of average quality and ARE III was of very high quality. For these reasons it was decided to pursue a comparative study of Dall sheep ecology in ARE I and ARE III to determine whether different management approaches are necessary in areas of vastly differing sheep quality.

The quality hypothesis of Geist (1971) predicts that the population dynamics of high and low quality populations will be different. His hypothesis specifically states that high quality populations will be characterized by individuals with higher reproductive capability and higher survival to yearling age, more rapid body growth and generally shorter life expectancy than individuals in low quality populations. Past observations have supported this hypothesis by indicating higher reproductive rates, yearling recruitment, and greater body and horn size in high quality populations (Heimer 1975). It is still not known, however, whether high quality populations in Alaska are increasing in numbers as a result of high reproductive rates and lamb survival or whether the postulated higher adult mortality balances the greater numbers of sheep produced. To determine what actually occurs in both high quality and low quality sheep populations the population dynamics for the high quality (ARE III) population are being investigated and compared with those of the low quality (ARE I) population.

The hypothesis of Heimer and Smith (1975) that population quality is inversely related to population density in Dall sheep suggests that range quality and/or food availability may be major determinants of population quality. Consequently, the relationship of Dall sheep to their seasonal ranges is being investigated by determining sheep density and forage quality.

Nichols (1974) suggested that Dall sheep winter range was limited by snow depth and hardness. This may result in different winter range carrying capacities from year to year. The number of sheep on winter ranges in the Alaska Range is thought to be fairly consistent from year to year. Numbers of Dall sheep on specific seasonal ranges in the high quality (ARE III) and low quality (ARE I) areas are being determined. Also, availability of winter range will be determined and densities of sheep will be calculated. These measurements will then be correlated with production, survival, range quality and sheep condition to clarify management alternatives.

OBJECTIVES

To determine the composition and productivity of sample sheep populations in ARE I and ARE III.

To determine the numbers of sheep utilizing specific seasonal ranges in ARE I and ARE III.

To determine the availability of winter range to sheep wintering in ARE I and ARE III.

To determine the quality of forage and seasonal body composition of sheep in ARE I and ARE III.

PROCEDURES

Dynamics of selected sheep populations

Mineral lick observations, in which sheep using the mineral lick at Dry Creek were classified by sex and age, have been conducted since 1968 (Heimer 1975). In 1972 continuous observations were made for 24 hours per day from 19 May through 5 July. All sheep entering the lick during this period were classified by age (lamb, yearling, adult) and sex, and the number of sheep attracted to the lick during the period of observation was estimated.

Heimer (1973) reported that during periods of continuous observation marked sheep visited the lick an average of four times per lick-use season. Consequently, the total number of sheep entering the mineral lick was divided by four to estimate the number of sheep attracted to the main mineral lick on Dry Creek. Sex and age composition data allowed calculation of lamb production (lambs per 100 ewes) and survival of lambs to yearling age.

Because it was not practical to make continuous observations each year, data gathered in 1972 were used to estimate the number of sheep attracted to the mineral lick from 12-hour (0400 to 1600) observation days. Sheep entering the lick between 0400 and 1600 during 24-hour observation days between 1 June and 30 June were counted. This total was divided by the estimated population size during 1972, and a correction factor determined. This factor, found to be 2.14, was used to estimate the total population size attracted to the main mineral lick on Dry Creek for the years subsequent to 1972. The calculation was made by dividing the total number of incoming sheep during June by 2.14. I believe this factor is applicable to all years because of the demonstrated high fidelity of sheep to the Dry Creek mineral lick (Heimer 1973).

Because timing of events of the mineral lick use cycle is variable (Heimer 1973), lamb production and survival information was selected from data for incoming sheep from June 19-30 to insure representative sampling. Lambing groups have already disbanded and sex and age classes are more randomly mixed during late June than during other periods of the licking season.

In 1975 observations were made between 0400 and 1600 from June 6-19. On June 20 high water prevented observers from reaching the lick. Observations were then made from 1200 to 1600 on June 22, from 0530 to 1130 on June 23, from 0400 to 1100 on June 24, and from 1100 to 1600 on June 25. From June 26-30 observations were made from 0400 through 1600.

Mineral lick observations at Sheep Creek and the adjacent Tok Glacier were carried out from July 4-6 and from July 10-17, respectively. In 1976 the Dry Creek mineral lick was observed from June 19-28 between 0430 and 1100 hours. These non-standard observation hours do not permit estimation of the total population as detailed above. The 1976 population was estimated by extrapolating a linear regression of the estimated population from 1972 through 1975 on the number of incoming sheep observed during those years using data comparable to the 1976 observation schedule.

Assessment of sheep populations occupying designated wintering areas

An aerial census (Heimer 1976) was used to determine the size of the wintering population of Dall sheep on the Dry Creek study area. Seasonal movements of these sheep are well known (Heimer 1973), which permits an estimate of the winter population size from a summer census. In Sheep Creek the population movements are not known. Consequently, a survey was flown in late August after movement to winter ranges had occurred.

Seasonal availability of Dall sheep range

The extent of winter range in the Dry Creek study area was estimated by making a late winter survey by helicopter to determine areas sheep used during the winter. Feeding sites, tracks and presence of sheep indicated winter range use.

Dall sheep condition and nutritional profile

Five Dall ewes were collected at Dry Creek in late May 1976 and four in November 1976. An additional six ewes were collected in Dry Creek in April 1977. At Sheep Creek nine ewes were taken in November 1976 and seven were taken in April 1977. All collections were made using standard hunting techniques. Rumen samples were collected to determine forage quality and botanical composition. Standard body measurements and weights of all specimens were gathered and carcasses were taken to Fairbanks, autopsied and prepared for determination of gross body composition. The viscera were removed, frozen and stored, and each carcass was divided by a median sagittal section. One half was frozen for later fat, water and protein determination and the other half was boned to determine skeletal weight. Bones were cleaned, boiled and blotted dry before weighing (hooves and horns were not included). Carcass halves and viscera were then separately ground using an Autio 801 B grinder in cooperation with the reindeer research group at the University of Alaska.

Frozen carcass halves were divided into small chunks using a band saw. These chunks were then randomly mixed and fed through the grinder using a cutter with openings of approximately two cm. The pieces were then mixed and fed through the grinder two additional times. A cutter head with 0.7 cm openings was then used and the material passed through two times with mixing after the first grinding. Samples were then randomly selected from the ground carcass to assemble a composite carcass sample. Analysis is underway at this time, and results will be reported in the future.

FINDINGS

Dynamics of selected sheep populations

Estimation of the 1976 total population was made using linear regression of the total population on the number of incoming sheep observed at the Dry Creek lick from June 19-28 from 0430 hrs to 1100 hrs for the years 1972 through 1975. This linear ($y = a + bx$) regression gave a slope "b" of 0.30 and a y intercept "a" of 1023 sheep. These values were substituted in the equation, which was solved for "y." This gave a total population estimate of 0.3 x 727 added to the y intercept value for a total of 1241 sheep.

To test the reliability of the above population estimate, composition, productivity and survival data from 1975 and 1976 were used to model population dynamics for one year. During June 1975, 54 percent (621 animals) of the population consisted of adult ewes. In 1976 this number would have increased by 75 two-year-old ewes to 696 ewes (621 plus 75 two-year-olds). Production in 1976 was 36 lambs per 100 ewes, or 250 lambs. Survival to yearling age from 1975 to 1976 was 57 percent (Table 1), so 81 yearlings would be expected in the population. Adding these figures to the 237 rams observed in 1975 gives:

696 ewes
237 rams
250 lambs
75 male two-year-olds
81 yearlings

This results in a total of 1339 possible sheep, assuming no mortality. The population estimate of 1240 sheep total would be allowable if overall population mortality were approximately 10 percent.

Table 1. Productivity, survival and estimated number of Dall sheep influenced by the Dry Creek mineral lick from 1970 through 1976.

Year	Lambs per 100 ewes	Yearlings per 100 ewes	% of last years lambs surviving	Estimated population
1968*	63	13	--	--
1969*	64	31	49	--
1970*	55	31	48	1500
1971*	50	51	93	--
1972	15	16	32	1473
1973	38	11	73	1315
1974	28	25	66	1270
1975	28	23	82	1150
1976	38	16	57	1240

* Data gathered at mineral lick using observation schedules not described in procedures (see Heimer 1973).

Heimer (1973) reported that a four-year average of ewe mortality under conditions of high predator density and including one extremely severe winter was 16 percent. Most of that mortality was sustained by age classes nine years and above. If these observations are correct it is probable that the mild winter of 1975-76 and the influence of Department wolf (*Canis lupus*) reduction programs could produce a 10 percent overall mortality. Consequently, I consider the estimate of 1240 sheep influenced by the Dry Creek mineral lick acceptable.

If this estimate is accepted it may indicate that the downward trend identified by Heimer (1976) no longer exists. There is little doubt that population numbers have declined since 1970. The mean value for total population estimates from 1970 and 1972 is significantly greater than the mean for total population estimates since 1972 (P 0.025).

The upturn in estimated population in 1976 coincident with a lamb production rate which was the highest since 1973 probably indicates that the population is stable at about 1200 animals. The winter of 1976-77 was considered to be mild; wolf reductions continued; and unless unusually adverse weather affects lamb production, the population should increase during 1977.

In the Sheep Creek area 1976 production was estimated by sampling the population which used the mineral lick in July to determine composition of "ewes" as classified from aircraft (Heimer 1975); then an aerial composition count was performed to determine lambs per 100 "ewes." This figure was subsequently adjusted on the basis of the mineral lick classifications to give a production figure of 42 lambs per 100 ewes in late August. On this count the minimum number of sheep on winter range in Sheep Creek was found to be 380.

Assessment of sheep populations occupying designated wintering areas

Data gathered for the Dry Creek portion of this study were presented in the last progress report (Heimer 1976). This job was completed by an aerial survey (using a Helio Courier 250 hp) of the Sheep Creek populations in late August 1976. All portions of the sheep habitat were not searched intensively, as sheep were concentrated in the upper reaches of major drainages. The survey time was 2.5 hours; and the number of sheep counted was 380 - 163 more sheep than were observed on the best previous survey of this area. The study area and flight route are shown in Fig. 1.

Seasonal availability of Dall sheep range

The density of sheep on summer range in the Dry Creek study area was a minimum of three Dall sheep per map km^2. This figure differs from that given in Heimer (1976) because the previous report was in error. In this calculation it is assumed that all areas within the study unit are suitable sheep habitat, which is an oversimplification. However, even within the constraints of using map km^2 as an index of sheep habitat, the extent of habitat reduction by winter snow can be estimated. A late-April helicopter survey established that during winter 1975-76 available winter range had been reduced from a potential of about 112 km^2 to 62 km^2. This calculates to a sheep density on winter range of about six sheep per km^2. During winter 1976-77 available range was restricted to approximately 81 km^2. The population of sheep was estimated to be unchanged from 1975-76, so the calculated density was 350 sheep per 81 km^2 or 4 sheep per km^2. These figures indicate that winter 1975-76 (judged to be a mild winter) was more severe than winter 1976-77.

The Sheep Creek study area comprises about 350 km^2. The number of sheep using this area during summer is not known, but the best survey of summer numbers was reported in Heimer (1975). On this survey (August 2, 1974) 217 sheep were counted. This suggests that density on summer range was about one sheep per two km^2. After movements to winter range Heimer (this report) observed 380 sheep in 2.5 hours of flying. This is an early winter density of one sheep per km^2. Measurements of

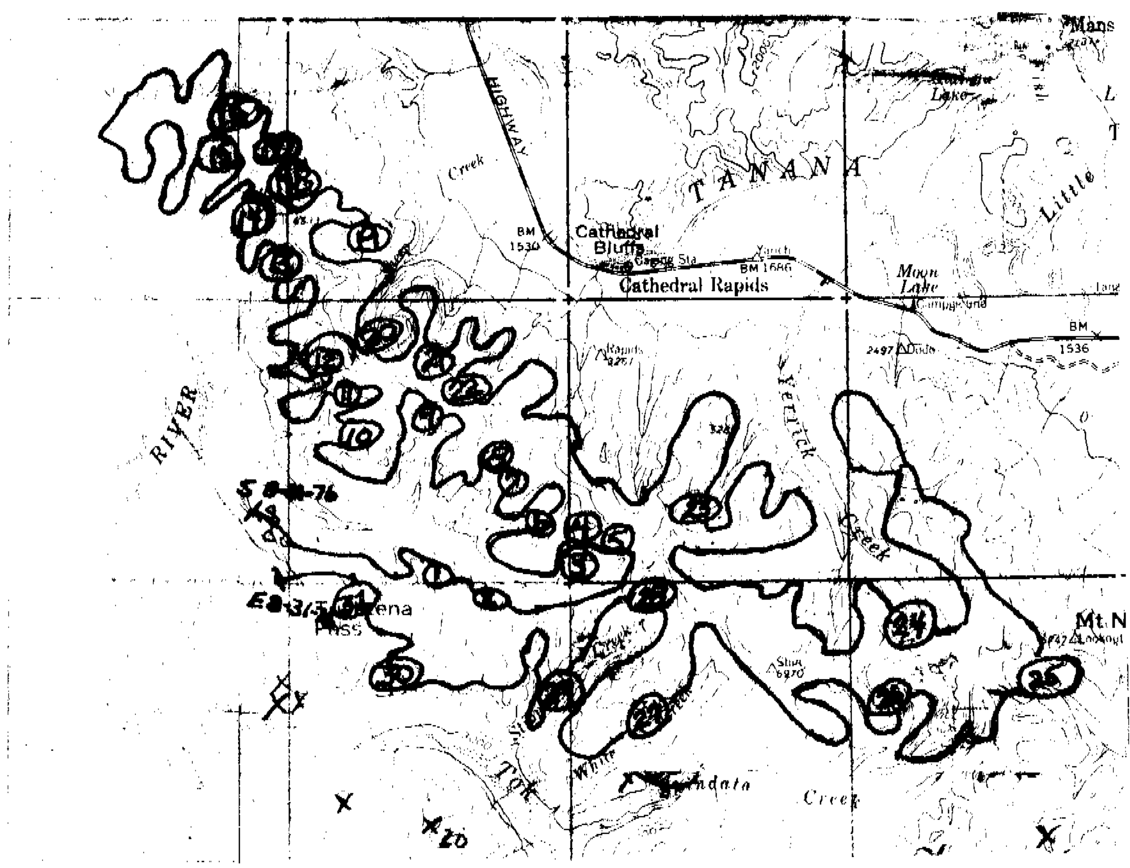

Fig. 1. Sheep Creek study area and survey flight route of August 31, 1976.

sheep habitat size for this area are not available following winter 1976-77, but to equal the density in Dry Creek the habitat would have to have been reduced to 88 km^2, a reduction of 75 percent. Winter 1976-77 in the Tok area was judged to be milder than winter 1975-76. During this period reductions in winter range size in Dry Creek averaged 37 percent. If a similar reduction in winter range size took place in Sheep Creek the density of sheep would have been about two sheep per km^2 as compared with about six sheep per km^2 in Dry Creek. Both winters were considered to be mild and should result in good lamb production unless other factors intervene.

Dall sheep condition and nutritional profile

When results of sheep collections during the last segment are added to those of previous years, certain trends are apparent. However, these trends are based on limited sample sizes and represent preliminary findings. Ewes collected at random in Dry Creek had a mean age of 86 months, and those collected in Sheep Creek had a mean age of 62 months. This may indicate a lower average age of sheep at Sheep Creek and hence reflect a more rapid population turnover. This is consistent with the quality hypothesis of Geist (1971). Body weight was regressed on age in months (Fig. 2) for spring and fall collections from each area to derive a method of estimating weight based on age. Heimer (1973) reported that weight is a function of age in Dry Creek. In plotting the regression all sheep below the age of 22 months were excluded because the relationship between body weight and age is nonlinear below this age. Figure 2 indicates that at any age Sheep Creek ewes are heavier than those of Dry Creek. The corrected weights of sheep collected in Dry Creek during fall averaged 59.4 kg, and those of sheep collected in Sheep Creek averaged 65.5 kg. The corrected average weights of ewes collected in spring were 47.6 kg in Dry Creek and 50.3 kg at Sheep Creek.

Weight loss over the winter of 1976-77 was essentially the same in Dry Creek and Sheep Creek (Dry Creek loss = 20% and Sheep Creek loss = 23% of fall weight). This weight loss does not consider the effects of pregnancy on weight but is rather a gross estimation of general body condition.

Pregnancy rate was higher in Sheep Creek. Ten of 18 ewes collected during spring in Dry Creek were pregnant for a pregnancy rate of 56 percent. All of the six ewes collected in Sheep Creek during spring 1977 were pregnant. These sample sizes are small, but the Dry Creek sample is of particular interest because it represents three different collections over a 4-year period. The pregnancy rate appears to support the observations of Heimer (1976) that ewes produce lambs only in alternate years in this low quality population.

Incidence of early spring lactation is high in Dry Creek. Of 18 ewes collected in Dry Creek during spring, 4 were nonpregnant and lactating. This is a frequency of 21 percent, and it correlates closely with the mean percentage of ewes with yearlings (18%) over the last 5 years. Again, this finding indicates that extended lactation is a cause of alternate year reproduction (Heimer 1976).

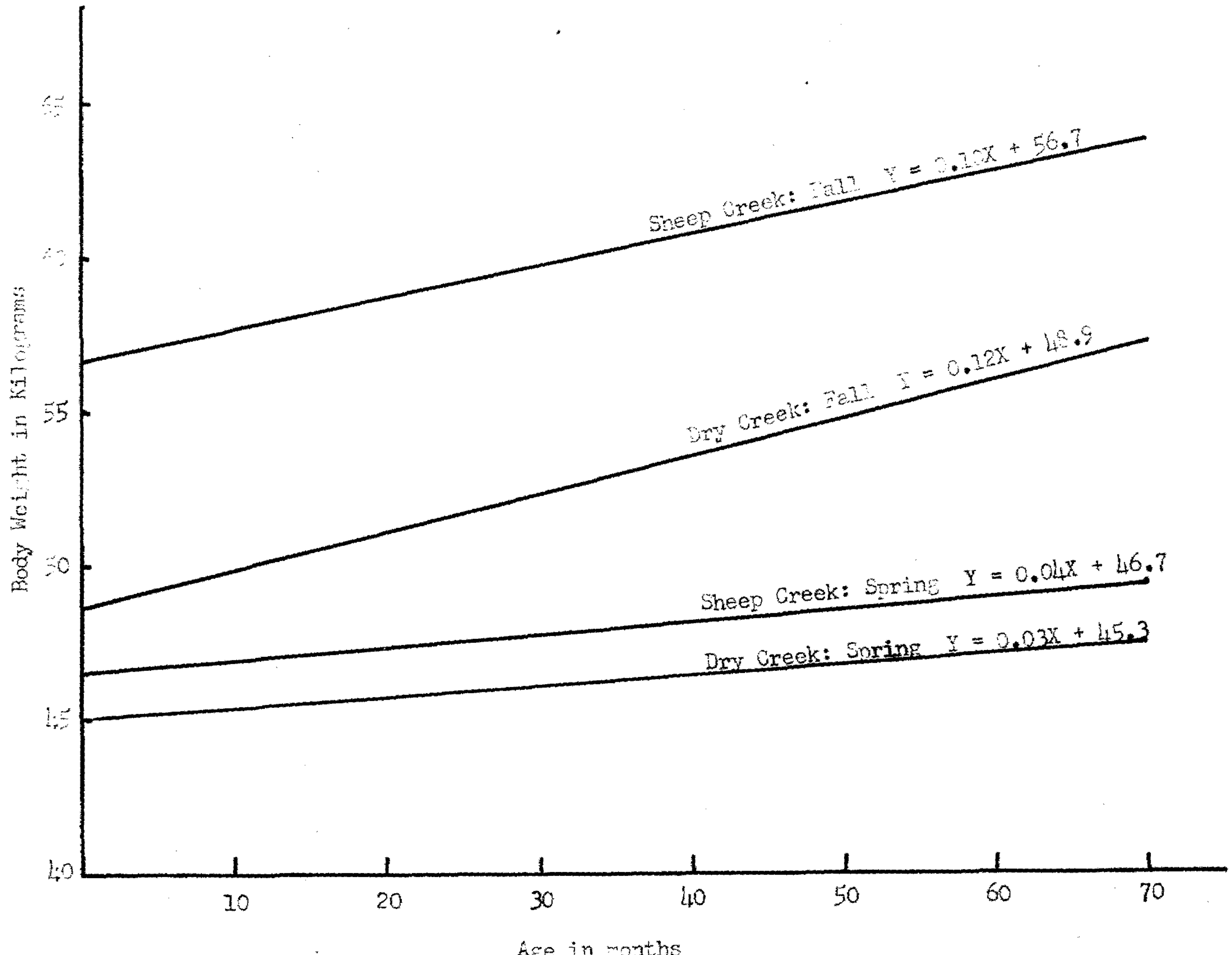

Figure 2. Body weight as a function of age in months. Lines are least squares fits of all ewes 22 months of age or older.

Fetuses recovered from Dry Creek ewes were smaller than those recovered from Sheep Creek ewes. Six fetuses recovered from ewes collected in Sheep Creek area had a mean weight of 2.84 kg and the 10 examined from Dry Creek had a mean weight of 2.26 kg - a difference of 20 percent.

Neiland (pers. comm.) has determined that the incidence of lungworm *Protostrongylus* sp. is greater at Dry Creek than at Sheep Creek. In Dry Creek 98.2 percent of the ewes examined were infected with lungworm, but only 58.8 percent of the ewes collected from Sheep Creek were infected.

In summary, these findings indicate that sheep from the Sheep Creek area are generally of higher quality than those of the Dry Creek area. In Sheep Creek ewes are apparently born larger, grow to greater size, reproduce more frequently, and are less infected by lungworm parasites than ewes of the Dry Creek area. Weight loss is slightly greater over winter in Sheep Creek, although differences are probably not significant. Also, the density of sheep in Sheep Creek is lower than that in Dry Creek. These factors may indicate that the quality of summer range rather than limitations of winter range is the nutritional variable which determines population quality in these areas. Further work will be required to test this hypothesis.

MANAGEMENT RECOMMENDATIONS

The findings suggest that the Sheep Creek population may be of higher quality (greater overall vigor) than that of Dry Creek. However, it is unknown whether this high quality population is expanding or is stable. Preliminary data indicate the population is "turning over" rapidly rather than expanding. It is recommended that ewe hunting be closely regulated until population dynamics are better understood so that overharvest does not occur in any area.

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