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INTERIOR SHEEP STUDIES

By
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Volume VI

Project Progress Report
Federal Aid in Wildlife Restoration
Project W-21-1, Jobs 6.9R and 6.12R

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Wayne E. Heimer

Project No.: W-21-1 Project Title: Big Game Investigations

Job No.: 6.9R Job Title: Dynamics of Selected Sheep Populations

Job No.: 6.12R Job Title: Dall Sheep Condition and Nutritional Profile

Period Covered: July 1, 1979 through June 30, 1980

SUMMARY

Comparative studies of two dissimilar Dall sheep populations continued. The population dynamics of the low quality Dry Creek population were examined in detail, and it was discovered that post-lambing population size is a poor indicator of population trend. The population is not expanding as had been previously stated, but the decline of the early 1970's has slowed. This is probably due to decreased adult mortality resulting from wolf control. Sheep in the high quality Sheep Creek population were marked, and data on age specific reproductions were gathered. Data are also listed for the final collections made to determine body composition and nutritional profile.

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BACKGROUND

Striking differences in Dall sheep (*Ovis dalli*) ram horn growth in the populations along the Alaska Range east of Mt. McKinley National Park have been shown by previous Alaska Department of Fish and Game studies (Heimer and Smith 1975). The results of these studies were considered by these authors as supportive of Geist's (1971, 1979) Quality Hypothesis (now referred to as Dispersal Theory). This theory predicts that observable phenotypic differences exist among sheep populations and that populations of high quality are composed of individuals with more rapid horn growth and larger horns at any given age than 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 correlated with population density.

Heimer and Smith (1975) divided the Alaska Range east of Mt. 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.

Geist's (1979) dispersal theory predicts population dynamics of high and low quality populations will differ (also see Geist 1971 on population quality). His hypothesis specifically predicts a high quality population will show greater reproductive capability and better survival to yearling age, more rapid growth, and generally shorter life expectancy for individual animals than in low quality populations. Past observations have supported this hypothesis indicating higher yearling recruitment and greater horn size in high quality Dall sheep populations (Heimer 1980a, Heimer and Smith 1975). It is not known, however, if high quality populations are increasing in numbers as a result of higher yearling recruitment or whether the postulated higher adult mortality balances the greater number of sheep recruited. Population dynamics for the high quality population are being investigated and compared with those of the low quality (ARE I) population to answer this question.

The hypothesis suggested by the data of Heimer and Smith (1975), which relate ram horn growth to sheep density per mi^2, is that range quality and/or food availability may be major determinants of population quality. Consequently, the relationship of Dall sheep to their energetic resources is being investigated. Heimer (1980a) detailed the rationale for a comparative study of body composition and nutritional profile for both study populations.

OBJECTIVES

To determine initial lamb production, yearling recruitment, survival, and reproductive frequency in the low quality Dry Creek sheep population (ARE I) and the same parameters for the high quality Sheep Creek population (ARE III).

To determine the quality of forage available to and seasonal body composition of these two sheep populations of greatly differing population quality.

PROCEDURES

Initial lamb production and yearling recruitment were determined using composition counts made at major mineral licks in each study area. Classifications were made using spotting scopes at distances of less than 200 meters. The Dry Creek (ARE I) lick has been observed from 19 June through 30 June from 1972 through 1979 from 0430 to 1200 hours daily. In 1979, 914 sheep were classified as they entered the mineral lick. The Sheep Creek lick was watched from 0400 to 2000 hours each day from 15 June through 23 June and from 27 June to 3 July 1979. It was also observed from 26 July through 1 August 1979. During these periods 465 sheep were classified as they entered the Sheep Creek lick. Lick use and composition data were also used to estimate sheep numbers in Dry Creek. They were supplemented with aerial surveys whenever possible to determine population size and trend, both in total numbers and numbers of producing ewes. Survey techniques have been reported elsewhere (Heimer 1976).

Population estimates for the Dry Creek study area were made in a variety of ways. The earliest estimate was based on data from a 1970 aerial survey but was not made until after Heimer (1976) flew a complete survey of the area. The area was not completely surveyed in 1970, and Heimer (1976) assumed distribution in 1970 and 1975 was similar and estimated a population of 1,500 for 1970. In 1972 the mineral lick at Dry Creek was observed 24 hours per day for 6 weeks. The return frequency for collared sheep in each age/sex class was then used to estimate the number of sheep in that group. Using this technique the population was estimated at 1,473 sheep. After 1972, various sampling methods were used to estimate the population size using the data base gathered in 1972. Heimer (1976) conducted an aerial census in 1975 and counted 1,232 sheep. Since 1975, population estimates have been made from a nomogram constructed by plotting the mean number of incoming sheep from 0430 to 1200 hours for a sample period beginning 19 June and ending 30 June as a function of population size (Fig. 1). The 1972 estimate based on collared sheep return frequency (Heimer 1973) and results of the aerial census of 1975 (Heimer 1976) were used to describe the line relating mean number of incoming sheep per day during the sample period to population size. Estimates of population size made from this nomogram were generally greater than those derived by other sampling methods with only results from 1977 being lower (by 3.7%). Nomogram estimates averaged higher than other estimates by 3.2 percent, and the standard deviation about the mean equals 4.7 percent.

Collection and preparation techniques for the body composition work have been described by Heimer (1980a).

FINDINGS

Tables 1 and 2 show the composition and total post-lambing population trend data gathered in Dry Creek and Sheep Creek, respectively. These tables are representative of the way production and survival data have been traditionally presented in mountain sheep literature. It is important to stress that the ratios reported are relative numbers, and while it is hoped they are indicative of actual production and survival, there is little assurance they are. It is more revealing to deal with actual numbers in an effort to determine the dynamic characteristics of populations. Table 3 gives data on actual numbers of lambs produced, their survival to yearling age, yearling recruitment, the post-lambing population, and the number of adult ewes estimated from 1972 through 1979. The population, including lambs, declined from 1970 through 1975 and then began an upward trend (Table 3). This was coincident with wolf (*Canis lupus*) control in the area which began in 1976 before the lambing season. Wolf control in the area adjacent to the main sheep ranges has continued since that time. Gasaway et al. (1981) reviewed the history, magnitude, and apparent results of the continuing wolf reduction program for other species.

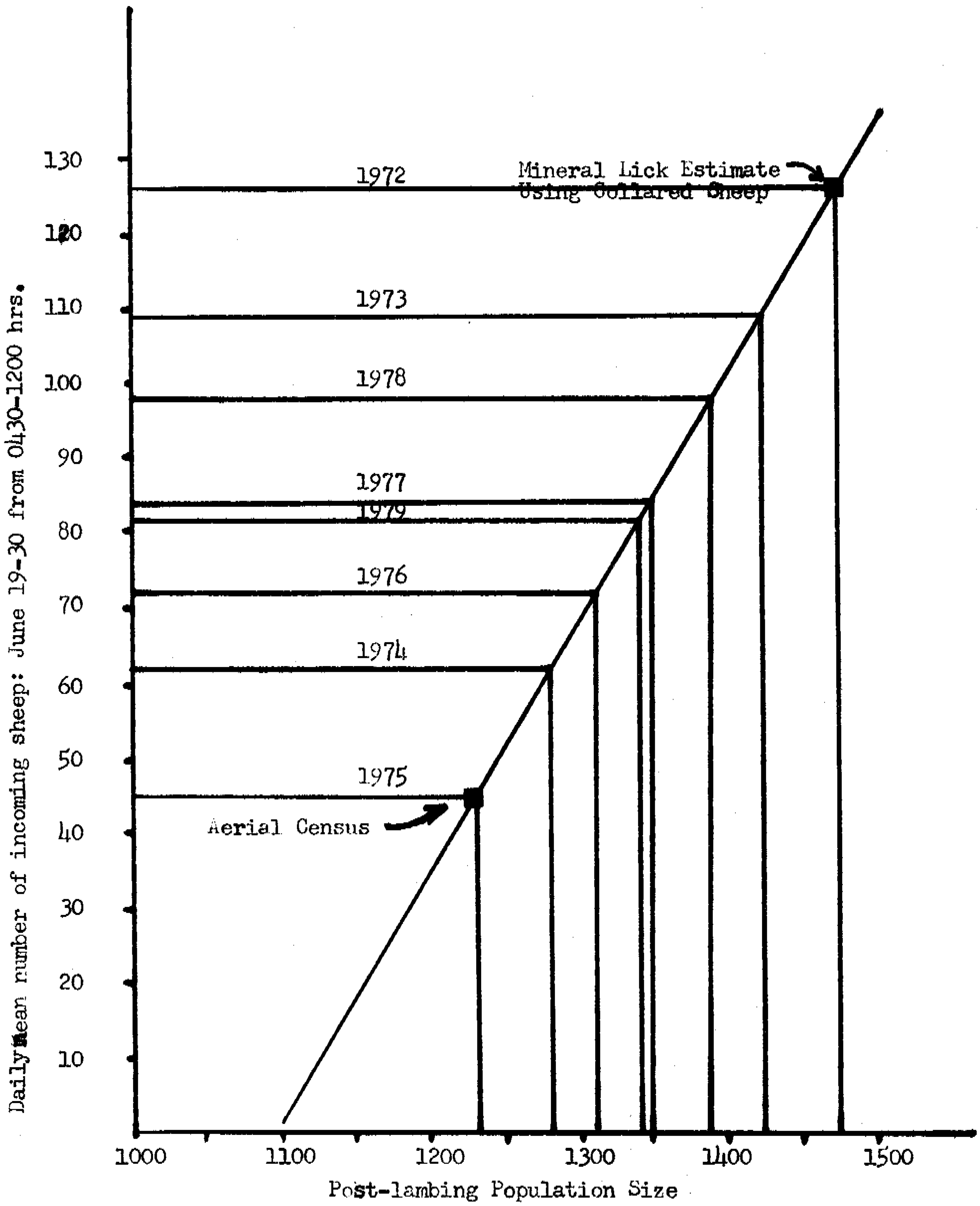

Figure 1. Nomogram for estimating population size from daily mean number of incoming sheep to Dry Creek Lick during sample period in late June.

Table 1. Productivity, survival, and estimated number of Dall sheep influenced by the Dry Creek mineral lick from 1970 through 1979.

Year	Lambs per 100 Ewes	Yearlings per 100 Ewes	Percent of Lambs Surviving 1st Winter	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	1423
1974	28	25	66	1280
1975	28	23	82	1230
1976	36	16	57	1310
1977	58	17	47	1350
1978	41	25	43	1390
1979	65	19	46	1340

* Data gathered at mineral lick using observation schedules not described in procedures (see Heimer 1975).

Table 2. Productivity, survival, and sample size of Dall sheep classified at the Sheep Creek mineral lick from 1974 through 1979.

Years	Lambs per 100 Ewes	Yearlings per 100 Ewes	Percent of Lambs Surviving 1st Winter	Sample Size
1974	56	21	--	116
1975	43	37	66	273
1976	35	26	60	257
1977	52	18	51	593
1978	57	35	67	757
1979	63	25	44	465

Table 3. Estimated total post-lambing population, percent of breeding ewes observed, and calculated numbers of ewes, lambs, percent survival to yearling age, and numbers of yearlings in Dry Creek population from 1972 through 1979.

Year	Estimated Post-lambing Population	Percent Adult Ewes	Number Adult Ewes	Number Lambs	Percent Survival to Yrlg Age	Number Yearlings
1972	1473	55.9	823	123	--	132
1973	1423	57.9	823	313	74	91
1974	1280	58.6	750	210	60	187
1975	1230	57.7	709	199	78	163
1976	1310	55.2	723	260	58	116
1977	1350	52.9	714	414	47	121
1978	1390	51.9	721	296	43	180
1979	1340	45.7	612	398	39	116

The data in Table 3 will be divided into the periods before and after 1976 (the onset of wolf reduction) for further analysis. Data were divided into pre- and post-treatment groups, and the method of least squares was used to determine the equation describing the best straight line through the data. The slope of this line (with units of sheep gained or lost per year) over the 4-year period was then used as an index of population response for that time. The equation for total post-lambing population before 1976 is $y = 1570 - 87x$; for the period after 1976 the equation is $y = 1263 + 13x$. These data indicate a reversal in population trend because the coefficients of x (the slopes of regression lines) differ in sign. It indicates a net population gain after 1976 of 13 sheep per year instead of the 87 sheep per year loss prior to that date.

To decrease variability resulting from differences in lamb production (range = 123 to 414), the lambs produced were subtracted from the total population estimate to give a pre-lambing population. The equation for the period before 1976 is $y = 1,390 - 100x$, and the equation for the period after 1976 is $y = 1,113 - 17x$. These equations indicate a loss of 100 and 17 sheep per year for periods before and after 1976, respectively.

The adult ewe population data were analyzed in the same manner. This analysis revealed a decrease in adult ewe numbers prior to 1976, averaging 42 ewes per year ($y = 880 - 42x$) while the decrease in ewe numbers following 1976 was lowered to 33 per year ($y = 904 - 33x$). In the pre-1976 period an average of eight ewes per year was removed from the population by research collections (19% of the annual decrease); following 1976, research collections accounted for a mean loss of 6 ewes per year (18% of the observed decrease).

Lamb production after 1976 was greater than before 1976. The 8-year mean is 277 lambs, with a pre-1976 mean of 211 and a post-1976 mean of 342. This suggests an inverse relationship between the number of ewes in the population and the number of lambs produced. When lambs produced is plotted as a function of the ewe population size and the best straight line fitted through the data, the resulting equation is $y = 897 - 0.84x$. The regression coefficient is 0.575. According to the significance table given by Simpson et al. (1960), this regression coefficient falls just short of statistical significance at the $P = 0.10$ level. It is probably inappropriate to justify ewe harvests with the expectation of increasing lamb production because of the great fluctuations in lamb numbers from year to year when ewe numbers are constant. For example, when the ewe population was between 700 and 750 (1974 through 1978), the number of lambs produced varied by a factor of 2 from 414 to 199. Obviously, factors other than the number of ewes are involved in determining the number of lambs produced. Also it should be noted that the slope of the regression line and the regression coefficient are greatly influenced by the data from 1979. Note from Table 3 that lamb to yearling survival from 1978 to 1979 was the lowest on record (39%). This usually indicates severe winter conditions which depress the number of lambs produced the subsequent summer. Yet in 1979 there were almost 400 lambs produced. These data suggest that lambs and ewes (presumably those mothering the lambs through the winter) (Heimer 1978) may have experienced mortality resulting from some unknown factor which did not act on pregnant females or result in failure to give birth to healthy lambs.

An inverse relationship is also seen between the number of lambs produced and their survival to yearling age. Fig. 2 is a plot of percent survival as a function of lambs produced. The regression coefficient for this line is indicative of significance at the P = 0.10 level. The apparent mechanisms for this relationship may be selective predation which is effective to a given level, or habitat limitation on the number of yearlings recruited into the population. In either case the number of yearlings recruited over the 8 years of study has averaged 138 per year. Before 1976 it was 143 yearlings per year, and after 1976 the recruitment has averaged 133 yearlings per year.

Given an essentially fixed yearling recruitment of about 140 yearlings per year, the population decline of the early 1970's (which was discernible in pre- and post-lambing populations and overall ewe numbers) was not reversed as I stated in earlier reports. This conclusion was mistakenly based on post-lambing population sizes. Instead, it appears that given fixed yearling recruitment the decline may have slowed to virtual stability, but numbers of ewes and total pre-lambing population size are not currently increasing.

Since the greater initial lamb productions after 1976 did not increase yearling recruitment, the decrease in the rate of decline must have resulted from decreased adult mortality. This could reasonably have occurred as a result of wolf control in the area. About 80 sheep per year have been added to the pre-lambing population since 1975; 10 of these have been producing ewes. I expect that curtailment of research collections will contribute approximately six additional ewes per year. Consequently, if the lowered adult mortality is a function of wolf reduction, I expect the population to stabilize and eventually increase. It is possible the changes are a result of variations in population age structure. This seems unlikely in view of the stability of yearling recruitment over the last 8 years. Necessary data on population age structure are not available so this possibility cannot be evaluated at this time.

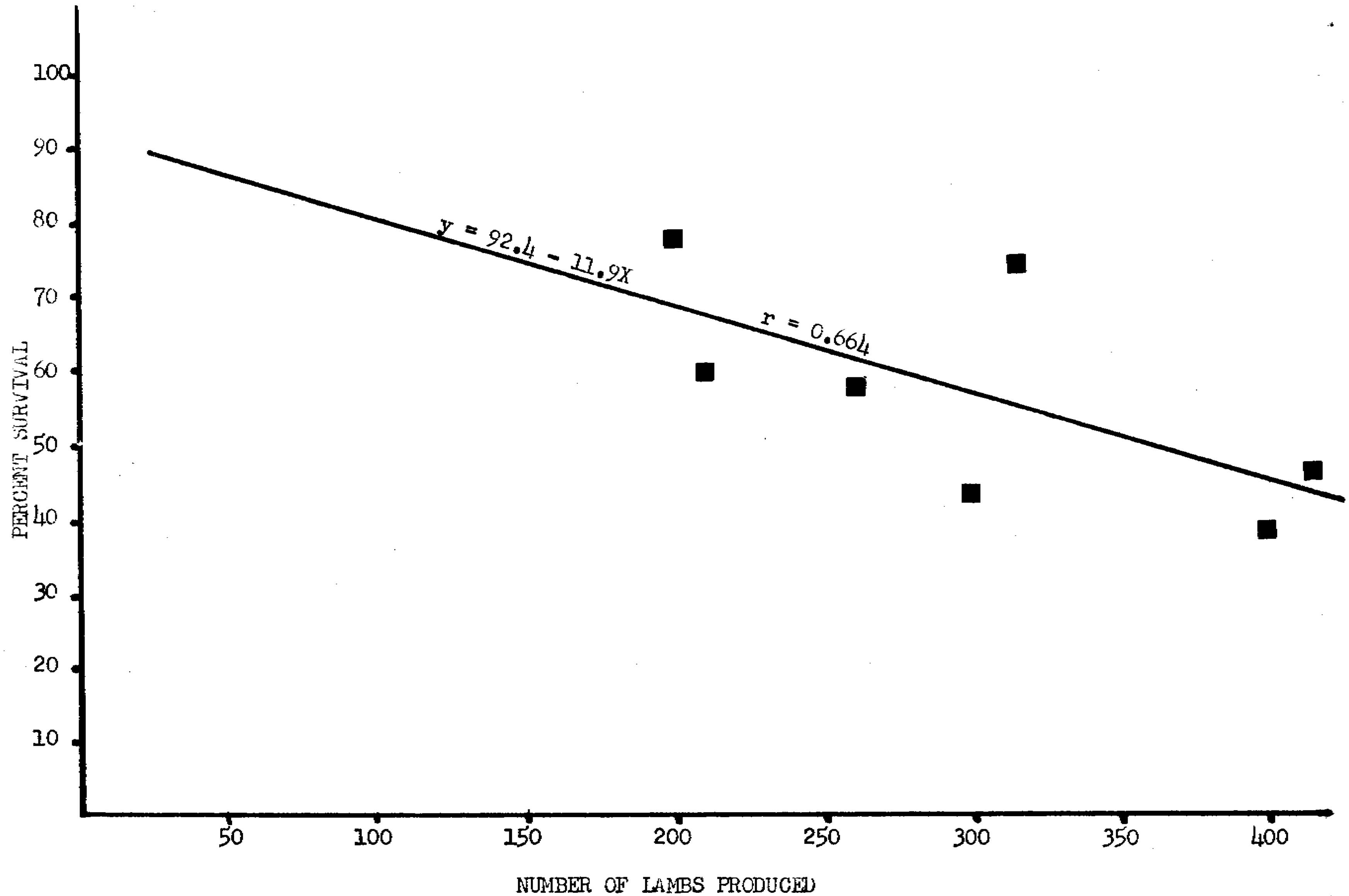

Figure 2. Percent survival of lambs in Dry Creek as a function of lamb crop size.

If the decline in total ewe numbers was reduced by 9 ewes per year after 1976 (from -42 to -33 ewes/year) while the pre-lambing population decline slowed to 83 sheep per year (pre-1976 losses = 100 sheep per year and post-1976 loss rate = 17 sheep per year), the major change must have involved the ram segment of the population. The ram segment was declining by 69 rams per year prior to 1976 and 17 rams per year after 1976, a net change of 52 rams per year. This gain may be attributable to lowered human harvest. When these 52 added rams are subtracted from changes in the pre-lambing population (a post-1976 mean annual loss of 17 sheep per year), a 35 sheep per year gain is indicated. This gain has not been realized. It is possible that rams immigrated into the study area, but there is no evidence supporting this hypothesis (Heimer 1973).

Time precludes further searching for the causes of this error because of reporting deadlines. Harvest will be investigated more thoroughly in the future as this model is refined with additional data.

In summary, lamb production is extremely variable at any given population level of ewes. Lamb survival throughout the first year is also quite variable and correlates inversely at the P = 0.10 level with the number of lambs produced. This suggests a selective predation which is uniformly effective, or that some habitat related factor limits the yearling recruitment to about 140 each year in Dry Creek. The population decline of the early 1970's has not been reversed as I previously reported. The decline has, with essentially fixed yearling recruitment, slowed to virtual stability in the pre-lambing population, but producing females continue to decline. The slowing decline with constant input of yearlings suggests that adult mortality has decreased or population age structure has changed. Reduction of predator numbers in the area is the most likely cause of the population response. This is contrary to my (Heimer 1980b) oversimplified comparison with McKinley Park where a similar post-lambing trend has been observed. I have already discussed the fallacy of post-lambing numbers as indicators of true population trend. Further study is required to understand these complex problems.

Table 4 gives data for sheep trapped in the Sheep Creek mineral lick during the reporting period. These data will eventually be compared with data gathered earlier in Dry Creek (Heimer 1973). Comparisons will focus on the morphological measurements because end of winter weight is a function of winter severity.

It should be noted that Table 4 reveals 13, 2-year-old ewes were trapped and marked. None of these ewes was lactating or showed any signs of having borne a lamb. Additionally, 3, 2-year-olds marked as yearlings in 1978 were resighted.

Table 4. Sheep capture and morphology data from Sheep Creek mineral lick June-July 1979.

Age (mo)	Sex	Collar Number	Color of Collar	Eartag Number	Eartag Color	Capture Method	Contour	Girth	Hindfoot	Shoulder Height
.5	F	-	-	L07 Wht	Red	Rocket	79	52	22	44
.5	F	-	-	L17 Wht	Red	Rocket	-	-	-	-
13	M	-	-	49 Wht	Green	Rocket	119	78	30.5	64
13	M	-	-	59 Wht	Green	Rocket	117	72	31	68
13	M	-	-	69 Wht	Green	Rocket	-	-	-	-
13	M	-	-	79 Wht	Green	Rocket	-	-	-	-
13	M	-	-	09 Wht	Green	Drop	128	92	33	77
13	M	-	-	-9 Wht	Green	Drop	123	84	33	74
13	M	-	-	47 Wht	Blue	Drop	128	82	35	69
13	F	0 Black	Yellow	0 Blk	Yellow	Drop	-	-	-	-
13	F	1 Black	Yellow	1 Blk	Yellow	Drop	120	76	31	64
13	F	2 Black	Yellow	2 Blk	Yellow	Rocket	107	76	29	59
13	F	3 Black	Yellow	3 Blk	Yellow	Rocket	114	84	31	67
13	F	5 Black	Yellow	5 Blk	Yellow	Rocket	123	81	29.5	71
13	F	6 Black	Yellow	6 Blk	Yellow	Drop	129	78	31.5	67
13	F	7 Black	Yellow	7 Blk	Yellow	Rocket	125	84	32	68
25	F	4 Black	Yellow	4 Blk	Yellow	Rocket	128	84	32	68
25	F	5 Yellow	Red	5 Wht	Red	Drop	141	88	33	79
25	F	6 Yellow	Red	6 Wht	Red	Drop	136	90	34	78
25	F	7 Yellow	Red	7 Wht	Red	Drop	138	89	33	79
25	F	- Yellow	Red	- Wht	Red	Drop	132	94	33	82
25	F	00 Yellow	Red	00 Wht	Red	Drop	126	90	32	75
25	F	01 Yellow	Red	01 Wht	Red	Rocket	-	-	-	-
25	F	02 Yellow	Red	02 Wht	Red	Drop	131	90	28	77
25	F	03 Yellow	Red	03 Wht	Red	Drop	129	92	34	82
25	F	04 Yellow	Red	04 Wht	Red	Drop	124	90	31	80
25	F	05 Yellow	Red	05 Wht	Red	Drop	131	86	33.5	76
25	F	06 Yellow	Red	06 Wht	Red	Rocket	140	96	32	78
25	F	07 Yellow	Red	07 Wht	Red	Rocket	132	88	33	70
25	M	-	-	67 Wht	Blue	Drop	143	92	34	71
25	M	-	-	57 Wht	Blue	Drop	144	96	34.5	81

25	M	-	-	77 Wht	Blue	Drop	134	90	36	81
25	M	-	-	-7 Wht	Blue	Drop	132	-	36	81
25	M	-	-	19 Wht	Red	Rocket	-	-	-	-
25	M	-	-	X9 Wht	Green	Drop	137	94	34	84
37	F	6 Yellow	Blue	6 Wht	Blue	Drop	137	94	34.5	81
37	F	20 Yellow	Blue	20 Wht	Blue	Drop	141	95	31	80
37	M	-	-	19 Wht	Green	Drop	147	94	35	79
37	M	-	-	29 Wht	Green	Drop	146	96	36.5	85
37	M	-	-	39 Wht	Green	Rocket	143	105	37	75
37	M	-	-	29 Wht	Red	Rocket	147	96	36	84
37	M	-	-	27 Wht	Blue	Rocket	165	106	41.5	93
49	F	0 Yellow	Green	0 Wht	Green	Drop	148	98	34	83
49	F	1 Yellow	Green	1 Wht	Green	Rocket	143	98	33	86
49	F	2 Yellow	Green	2 Wht	Green	Rocket	132	98	32	80
49	F	3 Yellow	Green	3 Wht	Green	Rocket	138	100	33	68
49	F	5 Yellow	Green	5 Wht	Green	Rocket	148	104	33	79
49	F	6 Yellow	Green	6 Wht	Green	Rocket	145	92	33	83
61	F	1 Black	Red	1 Blk	Red	Drop	146	98	35	81
61	F	2 Black	Red	2 Blk	Red	Rocket	148	98	34	74
61	F	3 Black	Red	3 Blk	Red	Rocket	-	-	-	-
61	F	4 Black	Red	4 Blk	Red	Rocket	143	106	33	86
61	F	5 Black	Red	5 Blk	Red	Rocket	155	92	32	81
61	F	6 Black	Red	6 Blk	Red	Rocket	148	96	35	72
73	F	02 Yellow	Green	02 Wht	Green	Rocket	150	100	33	80
73	F	03 Yellow	Green	03 Wht	Green	Rocket	128	96	32	79
73	F	4 Yellow	Green	4 Wht	Green	Rocket	140	94	35	74
73	F	05 Yellow	Green	05 Wht	Green	Rocket	-	-	-	-
73	F	06 Yellow	Green	06 Wht	Green	Drop	145	100	32.5	82
73	F	07 Yellow	Green	07 Wht	Green	Rocket	140	102	33.5	81
85	F	03 Black	Red	03 Blk	Red	Rocket	147	92	35	83
85	F	04 Black	Red	04 Blk	Red	Rocket	138	98	32	74
85	F	05 Black	Red	05 Blk	Red	Rocket	141	86	34	81
85	F	07 Black	Red	07 Blk	Red	Rocket	152	108	35	88

97	F	30 Black	Red	30 Blk	Red	Drop	146	96	33	84
109	F	42 Black	Red	42 Blk	Red	Rocket	-	-	-	-
109	F	43 Black	Red	43 Blk	Red	Rocket	152	108	36	86
121	F	45 Black	Red	45 Blk	Red	Drop	144	106	33	86
121	F	4- Black	Red	4- Blk	Red	Rocket	142	96	32	75
157	F	44 Black	Red	44 Blk	Red	Rocket	156	104	34	84

None of these ewes was accompanied by lambs or had enlarged or pigmented udders characteristic of lactation. This brings to 16 the total number of 2-year-old ewes examined with none having lambs. This is in marked contrast to Dry Creek and the Kenai (Nichols 1978) where most 2-year-olds give birth to lambs. If Heimer (1980a) is correct in the conclusion that there is little energetic difference between the two study populations, the only identifiable difference between the two populations which could account for the apparently differing reproductive strategies is the age composition of the ram component.

It is possible that the lack of mature rams in Dry Creek in the early 1970's, when alternate year reproduction was documented in Dry Creek (Heimer 1978), may have resulted in a disorderly rut wherein young rams bred physiologically mature, but behaviorally immature, 18-month-old ewes which would likely have been ignored by mature rams. Geist (1971) and Nichols (1971) both observed that young rams were more likely to court anaestrous (as signaled by behavioral keys to both men and sheep) ewes. If this courtship resulted in breeding, it subjected these young ewes to the stresses of a first heat pregnancy and may have thrown them into an alternate year reproductive pattern.

Appendix I lists carcass and forage data received from the laboratory too late for analysis to be included in this report.

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Appendix I. Composition of Dall sheep homogenates and rumen contents. Collected from both study areas in 1977 and 1978.

DALL SHEEP HOMOGENATES

No.	% Protein	% Water	% Fat
4744 fet.	19.0	71	6
4763 fet.	17.0	70	9
4764 fet.	16.0	72	7
4765 fet.	15.5	78	4
4766 fet.	19.0	73	6
4767 fet.	15.5	76	6
4992 visc.	18.0	63	14
4992 carc.	20.0	57	19
4993 carc.	21.5	62	16
4993 visc.	20.0	63	13
4994 carc.	19.5	56	20
4994 visc.	21.5	58	18
4995 carc.	19.0	62	18
4995 visc.	22.5	51	22
4996 carc.	23.0	56	19
4996 visc.	23.5	46	25
4997 visc.	20.5	59	17
4997 carc.	19.5	59	18
5009 carc.	18.0	64	15
5009 visc.	19.0	60	19
5010 carc.	18.0	58	18
5010 visc.	16.0	70	10
5011 carc.	18.0	82	5
5011 visc.	19.5	60	17
5012 carc.	18.5	58	18
5012 visc.	17.5	62	14
5013 carc.	18.0	63	14
5013 visc.	20.0	59	15
5034 carc.	22.0	54	20
5034 visc.	20.5	59	18
5034 fet.	17.0	65	13

Appendix I. Continued.

No.	% Protein	% Water	% Fat
5035 visc.	16.0	74	7
5035 fet.	17.0	71	9
5035 carc.	15.5	73	8
5036 carc.	18.0	69	9
5036 visc.	19.5	62	16
5036 fet.	17.5	73	7
5037 visc.	18.0	69	10
5037 carc.	16.5	72	8
5037 fet.	16.0	75	7
5038 visc.	16.0	73	7
5038 carc.	19.0	68	11
T-1 carc.	23.5	51	16
T-1 visc.	19.5	67	11
T-2 carc.	23.5	55	21
T-2 visc.	18.0	66	13
T-3 carc.	17.5	69	10
T-3 visc.	18.0	67	12
T-3 fet.	21.0	55	22
T-4 carc.	24.0	51	26
T-4 visc.	19.0	60	17
T-5 fet.	16.5	60	19
T-5 carc.	21.0	53	22
T-5 visc.	21.5	57	21
Analytical Error	(± 0.5%)	(± 1.0%)	(± 1.0%)

RUMEN CONTENTS

No.	% Lignin	% Protein
#1 11-18-78	18	6
#2 11-18-78	23	5
#3 11-18-78	15	3
#4 11-18-78	16	4
#5 11-18-78	14	6
T-1	20	6
T-2	24	9
T-3	20	8
T-4	22	9
T-5	23	7

Appendix I. Continued.

Ram Nov 8 '78	14	6
#2 11-08-78	20	7
#3 11-08-78	15	7
#1 Nov 7 78	16	7
5035	17	8
4992	12	4
4996	23	6
5037	18	8
5038	24	8
Analytical Error	(± 1%)	(± 1%)