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Steven R. Peterson, Research Chief

INTERIOR SHEEP STUDIES

By
Wayne E. Heimer

Volume VIII

Progress Report
Federal Aid in Wildlife Restoration
Project W-22-2, Job 6.9R

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1982-83b

(Printed July 1984)

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1982-83

PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: None

Project No.: W-22-2 Project Title: Big Game Investigations

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

Period Covered: 1 July 1982 through 30 June 1983

SUMMARY

Comparative studies of high- and low-quality Dall sheep (Ovis dalli) populations were continued to learn if differences in population quality manifest themselves as differences in population dynamics that should be considered in management. Both populations declined due to severe weather during the past year. In the high-quality group, the severe weather acted primarily on old sheep, and lamb production was limited by poor weather at lambing. The low-quality population was less impacted. Reproductive frequency data from the low-quality group indicate a change may be occurring from 1st breeding at 18 months followed by alternate-year reproduction to 1st breeding at 30 months and annual reproduction thereafter. This may be a result of changes in ram age structure since 1979. Winter studies were conducted on snow accumulation. Movement patterns of marked sheep were consistent with past observations.

Key words: Dall sheep, Ovis dalli, population dynamics.

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BACKGROUND

Striking differences in Dall sheep (Ovis dalli) ram horn growth along the Alaska Range east of Mt. McKinley have been reported in previous Alaska Department of Fish and Game studies (Heimer and Smith 1975). The results of these studies were considered supportive of Geist's (1971) Quality Hypothesis. This theory states observable phenotypic differences exist among sheep populations, and populations of high quality are comprised of individuals with more rapid horn growth and larger horns at any given age than individuals from low-quality populations. Heimer and Smith (1975) also found Dall sheep population quality (as reflected by ram horn growth and size) was inversely correlated with population density.

Heimer and Smith (1975) divided the Alaska Range east of Mt. McKinley (ARE) into 3 areas to investigate "quality" based on ram horn growth characteristics. These areas, from Mt. McKinley to the east, are as follows: ARE I, from the Nenana River east to the Delta River; ARE II, from the Delta River east to the Johnson River; and ARE III, from the Johnson River east to the Tok-Slana Road. In this quality ranking, ARE I was of very low quality, ARE II was of average quality, and ARE III was of very high quality. Ecology of Dall sheep populations in ARE I and ARE III was compared to determine if different management approaches are necessary in populations with different horn quality.

Geist's (1979) dispersal theory predicted differing population dynamics between high- and low-quality populations. His hypothesis specifically predicts that high-quality populations will show greater reproductive capability, better survival to yearling age, more rapid growth, and generally shorter life expectancy for individual animals than low-quality populations. Past observations have supported many points of this hypothesis (Heimer and Smith 1975, Horejsi 1976, Shackleton 1973). It is not known, however, if high-quality herds are increasing in numbers as a result of higher yearling recruitment or if the postulated higher adult mortality compensates for the greater number of sheep recruited. Population dynamics of the high-quality (ARE III) population are being compared with those of the low-quality (ARE I) population to answer this question.

OBJECTIVE

To determine initial lamb production, yearling recruitment, survival, reproductive frequency, and mortality in the low-quality Dry Creek sheep population and the high-quality Sheep Creek population.

PROCEDURES

Dry Creek Study Area

Estimated Population Size, Composition, and Trend:

Postlambing population size was estimated using the nomogram developed for this purpose (see Heimer and Watson 1982a). Population size was also estimated using aerial census from 3 of the 4 count areas defined earlier (Heimer and Stephenson 1982). These data were gathered in early July from a PA-18-150 hp Super Cub piloted by Bill Lentsch; Wayne Heimer was the observer. The total population of the study area was extrapolated from percentage distributions of the complete censuses of the study area done in 1975 and 1980.

Composition data were gathered by observing sheep as they entered the Dry Creek mineral lick. The lick was observed daily from 4 June through 10 June and 19 June through 1 July 1982.

Observations started at 0430 and ended at 1200 hours. All sheep were classified as they entered the lick. Classification categories were as follows: ewes, yearlings, lambs, or rams. Rams were classified according to horn size as 1/4 curl, 1/2 curl, 3/4 curl, 7/8 curl, and 4/4 (full) curl. Classifications were made using spotting scopes at distances of less than 200 m.

Population trend was determined by comparing present population size with previous population sizes.

Mortality:

Heimer (1973) found that 93% of marked ewes returned to the lick each year. Hence, mortality was considered highly probable if collared ewes did not appear at the lick after having been observed there in the previous year. This assumption was used to calculate age-specific mortality in the ewe segment of the population. Rams were not studied because of their lower fidelity to mineral licks (Heimer 1973).

Lamb Survival:

No data on lamb survival over winter were gathered during this past year. Observable lamb production was considered poor enough in June that gathering meaningful data using the conventional methods was impractical.

Reproductive Frequency:

Ewe sheep were trapped from 1-10 June 1982 using a rocket net (Heimer et al. 1980). Age and reproductive status of captured sheep were determined by standard techniques (Heimer et al. 1980). Blood and feces were collected for related investigations (Appendix A). All ewes were marked with individual neck bands and ear tags. Lambs were marked with ear tags only. No rams were marked. Marked ewes were subsequently observed when they visited the mineral lick or were located on their various seasonal ranges. Their reproductive status was determined by whether they suckled a lamb. In cases where ewes were not observed to suckle a lamb, the condition of the udder was noted. Ewes with udders characteristic of lactation, but not observed to suckle lambs, were considered reproductively active, but it was noted they had not been confirmed to have a lamb. Ewes with "dry" udders were considered reproductively inactive.

Winter Studies:

Relative winter severity was determined from regional snowfall data recorded by the U.S. Weather Service plus measurements of snow depth along a transect through known sheep winter range.

The transect was established from the 1,007 m (3,300 ft) elevation at the bottom of Slate Creek, and ran along a ridge lying 4 degrees east of geographic north up the south-facing slope to the ridge top at 1,403 m (4,600 ft). The Slate Creek drainage runs from the northwest to the southeast at an angle that is 21 degrees north of true west. Snow depth was measured every 50 m of elevation gained along the transect. At each site, a 0.5 m square grid was located in an area where snow accumulation reflected snowfall during winter. Snow depth was measured at each corner of the half meter square grid. Locations were marked with flagging tape and photographed. Snow depth was measured on 12 April when snow depth was at or near its peak.

Tok Study Area

Estimated Population Size, Composition, Trend, Mortality, and Reproductive Frequency:

The 1982 ewe population size in the Tok study area was estimated using a model that incorporated the 1980 population estimate and herd composition (Heimer 1982), recruitment ratios, and age-specific mortality estimates derived from the return of marked ewes to the mineral lick. The mineral lick on Sheep Creek was observed from 29 May through 3 July 1982. Daily observation hours were from 0400 to 2000 hours. Composition data were gathered as described for the Dry Creek study area. Population trend, mortality, and reproductive frequency were determined using the same procedures and assumptions as in the Dry Creek study area.

Winter Studies:

Relative winter severity was determined from snowfall data as described for Dry Creek. The snow depth transect for this area began at the bottom of Clearwater Creek at 1,007 m (3,300 ft). It ran up a ridge along a line that was 11 degrees east of true north to the 1,373 m (4,500 ft) level. The ridge top is at 1,678 m (5,500 ft), but could not be reached due to difficult terrain. Snow measurements were taken every 50 vertical meters using the same procedure as at Dry Creek. Snow depth was measured on 7 April when the winter accumulation was maximal.

FINDINGS

Dry Creek Study Area

Estimated Population Size, Composition, and Trend:

Population size was estimated using 2 methods. The first was based on the intensity of mineral lick use during a 12-day period in the latter half of June. In this method, the mean daily number of sheep entering the lick is plotted as a function of population size along with similar data gathered over the last 10

years. Population size is then determined from the value at the abcissa (Heimer and Watson 1982a). During summer 1982, the mean number of incoming sheep per day during the sample period was 145, which indicated a population total of 1,550 sheep following lambing.

The other method of estimating population size in the Dry Creek study area was from aerial census data. The entire study area was not censused in 1982 due to weather conditions, so the percentage distribution figures for the surveys of 1975 and 1980 were used to estimate a range of values for the sheep population. Data from the 1975 census (Table 1) show that 76% of the total population was counted in count area 1, 2, and 3 that year. For the 1980 census, the percentage of the total in these areas was 84%. If sheep distribution in mid-July, the time of all 3 surveys, was similar to that in 1975, the calculated countable population in the study area would be about 1,270. If the percentage distribution observed in 1980 is used, the countable population estimate is about 1,150 sheep. The mean of these 2 numbers assumes percentage distribution was intermediate between that of 1975 and 1980. This seems the most reasonable choice, so the number of sheep that would probably have been seen had all 4 count areas been flown in 1982 was somewhat arbitrarily calculated at 1,150. If sightability were between 90 and 95% (as had been calculated for this survey team in the past, Heimer 1982), the estimated total population should be about 1,300 sheep in the study area.

The difference between these 2 population estimates, 250 sheep, or 15 to 20% depending on method of calculation, forces a discussion of both estimates that should provide a basis for selecting the better estimate. Heimer and Stephenson (1982) showed the technique involving estimation of population size from intensity of mineral lick use had reliably predicted the total postlambing population in the past when compared with aerial census results. This pattern did not hold during the past year because it is subject to rather striking variability depending on the timing of the mineral lick use cycle (Heimer 1973). Warm spring weather was late in coming in 1982. The late breakup and extended snowmelt conditions probably delayed mineral lick use in early June and resulted in heavier-than-normal use during our sample period from 19 June through 30 June. This later peaking of the mineral lick use cycle probably caused a deceptively high number of sheep per day to visit the lick during the sample period. Consequently, an unreasonably high population estimate was generated. Any event that seriously distorts the normal course of the mineral lick use cycle will have similar effects.

Consequently, this technique for estimating population size has proven to be of questionable application without supporting data. It would clearly be unwarranted to apply this technique without supporting data on previous population size and recruitment.

Table 1. Productivity, survival, and estimated number of Dall sheep influenced by the Dry Creek mineral lick, 1968-82.

Year	Lambs/ 100 ewes	Yearlings/ 100 ewes	% lambs surviving 1st winter	Estimated postlambing population
1968	63	13	--	--
1969	64	31	49	--
1970	55	31	48	1,500
1971	50	51	93	--
1972	15	16	32	1,473
1973	38	11	73	1,423
1974	28	25	66	1,280
1975	28	23	82	1,230
1976	36	16	57	1,310
1977	58	17	47	1,350
1978	41	25	43	1,390
1979	65	19	46	1,340
1980	67	36	55	1,425
1981	60	43	64	1,450
1982	31	25	41	1,300

Some reliable measure of winter severity (or mortality) should also accompany application of this technique. This past year is the 1st time a significant difference between population estimates by the 2 different techniques has occurred.

I think aerial census was the better of the 2 population estimation techniques. The unusual effects of a late spring should have abated by mid-July when the aerial census was conducted. Flight time was similar to other efforts, and the same pilot/observer team conducted the count. As a result, the likelihood of variability in aerial census technique is less than that of unusually high mineral lick use during our sample period. Hence, the more acceptable population estimate is a total of about 1,300 sheep.

Composition data gathered during the sample period at the main mineral lick on Dry Creek were based on the 1,777 sheep classified. Thirty-one lambs and 25 yearlings were observed for each 100 ewes entering the mineral lick. These data are compared with historic productivity, survival, and estimated numbers of sheep influenced by the Dry Creek lick in Table 2. It appears a significant population reduction occurred from 1981 to 1982. I calculate the magnitude of reduction at approximately 10% (from 1,450 in 1981 postlambing population to 1,300 in 1982 postlambing population).

Mortality:

Some clues about the nature of the population decline can be obtained from examining the population composition. The number of "ewes" (those animals classified as ewes from aircraft, which includes some young rams and yearlings of both sexes) seen during the 1980 censuses was 773 (Table 3). Using the same procedures as we did for the postlambing populations, the percentage distribution figures estimate a total of 675 "ewes" expected had the entire study area been flown. If sightability were 90%, the number of "ewes" would have been 750, and at 95% sightability the number would have been about 700 "ewes." I suspect the mean of these 2 estimates, 725 "ewes," is realistic. If so, the decrease in "ewe" numbers would have come to about 6% (773 - 725 ÷ 773). This is about half of the decrease calculated above. The remainder must have come from other segments of the population.

Table 4 shows the calculated numbers of ewes, lambs, and yearlings in the population based on the total postlambing population figure derived above (1,300 total sheep) and the percentages of ewes, lambs, and yearlings seen entering the mineral lick. It should be noted that composition data gathered during the sample period are not influenced by shifts in timing of the mineral lick cycle. These data indicate a 4% decline in the number of breeding age ewes, a 50% decline in lambs produced, and a 43% decrease in the number of yearlings recruited. Hence, it appears that the population decline resulted from poor

Table 2. Total Dall sheep counts from 1970, 1975, 1980, and 1982 for Dry Creek, Alaska Range.

Area surveyed	1970		1975		1980		1982	
	Count	Time	Count	Time (hr)	Count	Time (hr)	Count	Time (hr)
1	315	[a]	250	3.0	407	3.5	222	3.3
2	485	[a]	347	2.4	454	4.0	353 406[b]	3.3 3.8[b]
3	332	[a]	341	3.0	327	4.0	336	3.8
4	--	--	294	5.9	220	7.8	--	--

[a] Specific time not available by area; total time 11 hours.

[b] Total corrected by sheep/hr figure to equal survey intensity of count areas 1 and 3 for 1982.

Table 3. "Ewe"[a] numbers for survey areas within the Dry Creek vicinity in 1975, 1980, and 1982.

Area surveyed	Year of survey		
	1975	1980	1982
1	183	197	148
2	240[b]	294	237
3	186[b]	166	189
4	152[b]	116	--

[a] Definition of "ewe": sheep not identifiable as lambs or rams during aerial surveys. This class includes yearlings and young rams that cannot be reliably distinguished from adult ewes in July.

[b] Number of lambs not classified in these areas for 1975. The number of ewes is back-calculated using aerial counts, mineral lick data for 1975 for lambs and yearlings, and lick data from 1974 to give a number of 2-year-old rams likely to be present with ewes and classified as such from the air.

Table 4. Population and production estimates for the Dry Creek study population, 1972-1982.

Year	Estimated prelambing population	Estimated postlambing population	% adult ewes	Number adult ewes	Number lambs produced	Number yearlings produced	% survival
1972	1,300	1,473	55.9	823	123	132	--
1973	1,110	1,423	57.9	823	313	91	74
1974	1,070	1,280	58.6	750	210	187	60
1975	1,031	1,230	57.7	709	199	163	78
----------	----------	wolf control begun	----------	----------	----------	----------	----------
1976	1,050	1,310	55.2	723	260	116	58
1977	936	1,350	52.9	714	414	121	47
1978	1,094	1,390	51.9	721	296	180	43
1979	942	1,340	45.7	612	398	116	39
1980	1,003	1,425	44.2	630	422	227	57
1981	1,063	1,450	46.6	646	387	277	66
1982	--	1,300	47.9	623	193	157	40

survival of lambs born in spring 1981 (a survival of only 41%), coupled with a decline in the number of breeding ewes. Unfavorable weather at lambing and a late spring caused even fewer lambs to be produced in 1982. Such results would be expected during a severe winter, such as occurred in 1981-82. Low lamb survival and some loss of adults in the upper age classes are the predictable results of such weather conditions. Heimer (1978) reported the calculated effects of inclement weather on neonatal lamb survival.

The age-specific mortality figures gathered from marked ewe returns to the mineral lick shed little further light on the nature of the population decline at this time. The lick was not observed from 10 June to 19 June, and a significant portion of marked sheep could have been missed. Only 15 of the 26 ewes marked in 1981 were seen during 1982 (Table 5). Of the 11 that were not seen, 4 ewes could be considered "old," 2 would have been 8 years old in 1982, and 2 would have been 11 years old. Twenty-two more ewes were marked in 1982. Neckband data, age, and other data are presented in Table 5.

Lamb Survival:

Lamb production in 1982 was the lowest since 1972. During a foot survey in early April 1983, 68 ewes and 13 short yearlings were observed. This small sample suggested a yearling:100 ewe ratio of 19:100, a survival of 61%. This survival rate is about 10% greater than the average (Table 1) and indicates a relatively mild winter. No systematic winter data on lamb survival were gathered during this report period.

Reproductive Frequency:

Consecutive-year observations of reproductive activity were gathered for 11 ewes (Table 5). Five ewes were reproductively active in both years since capture, and 5 exhibited an alternate-year pattern. One ewe failed to have lambs in either year. These 5 consecutively active females in a sample of 11 observations are in marked contrast to the data gathered between 1972 and 1977 (Heimer and Watson 1982b) that contained only 5 instances of consecutive-year reproduction in 88 paired observations. These data, though sparse, suggest the hypothesis of Heimer and Watson (1982b) may be viable. They hypothesized that early onset of reproduction and alternate-year breeding in Dry Creek were linked, and that both resulted from a distorted ram age structure due to nearly quantitative cropping of 3/4-curl rams. In 1979, the legal horn definition was raised to 7/8 curl. This regulatory action produced a notable change in the age structure of the ram population. When the early data on reproductive frequency were being gathered in 1975, an aerial survey indicated at least 58 of 189 rams seen were legal (at 3/4 curl or greater). These rams should have been at least 4 to 5 years old. Very old rams were scarce because heavy hunting

Table 5. Age, identification data, and reproductive status by year for ewes trapped and marked at the main mineral lick on Dry Creek, June 1982.

Age (yr)	Collar color	Collar number	Number color	Ear tag color		Reproductive status		Comments
				Right	Left	1981	1982	
2	Green	7	Yellow	Green	Green	Inactive	Inactive	
2	Green	X	Yellow	Green	Green	Inactive	Inactive	
2	Green	11	Yellow	Green	Green	Inactive	Not seen 1982	
2	Green	14	Yellow	Green	Green	Inactive	Not seen 1982	
2	Red	-1	Yellow	Yellow	Yellow	Inactive	Not seen 1982	Pink tongue
2	Red	16	Yellow	Yellow	Yellow	Inactive	Inactive	
2	Red	22	Yellow	Green	Red	Inactive	Inactive	
2	Yellow	05	Black	--	--	Caught 1982	Inactive	Ear tag data absent
2	Red	17	Yellow	Red	Red	Caught 1982	Inactive	
2	Red	11	Yellow	Red	Blue	Active	--	Died, necropsy confirmed pregnancy
3	Yellow	24	Black	Yellow	Yellow	Active	Not seen 1982	Seen w/lamb late 1981
3	Red	xx	Yellow	Red	Blue	Active	Inactive	Seen w/lamb late 1981
3	Green	21	Yellow	Green	Green	Caught 1982	Inactive	
3	Green	0-	Yellow	No ear tags		Caught 1982	Inactive	
3	Yellow	03	Black	--	Green	Caught 1982	Active	
3	Green	1X	Yellow	Red	None	Caught 1982	Inactive	
3	Yellow	04	Black	Yellow	Green	Caught 1982	Inactive	
3	Yellow	07	Black	--	--	Caught 1982	Active	Vulval discharge, no milk in small udder
4	Red	25	Yellow	Green	Red	Active	Not seen 1982	
4	Yellow	27	Black	Yellow	Yellow	Inactive	Active	Udder swollen, no suckling observed
4	Red	23	Yellow	Red	Green	Active	Active	
4	Yellow	2-	Black	Yellow	Yellow	Inactive	Not seen 1982	
4	Red	12	Yellow	Red	Red	Caught 1982	Inactive	
4	Red	15	Yellow	Red	Red	Caught 1982	Inactive	
5	Red	21	Yellow	Green	Red	Active	Active	Udder lactating, no suckling observed
5	Yellow	21	Black	Yellow	Yellow	Active	Inactive	

Table 5. Continued.

Age (yr)	Collar color	Collar number	Number color	Ear tag color		Reproductive status		Comments
				Right	Left	1981	1982	
5	Red	2424	Yellow	Green	Red	Inactive	Inactive	
5	Yellow	20	Black	Yellow	Yellow	Active	Inactive	Repro status:question
5	Red	0X	Yellow	Blue	Red	Active	Not seen 1982	
5	Blue	04	Yellow	Red	Red	Caught 1982	Active	Udder empty, vaginal discharge
5	Yellow	06	Black	Yellow	Green	Caught 1982	Inactive	
5	Yellow	--	Black	Yellow	Green	Caught 1982	Inactive	
5	Red	14	Yellow	Red	Red	Caught 1982	Active	Springing, udder large
5	Green	0X	Yellow	Green	Green	Caught 1982	Active	Heavy springing, udder large
6	Red	20	Yellow	Red	Green	Active	Inactive	
6	Red	27	Yellow	Red	Green	Active	Active	Swollen udder, no lamb seen
6	Yellow	23	Black	Yellow	Yellow	Inactive	Not seen 1982	
6	Yellow	2X	Black	Yellow	Yellow	Active	Active	
6	Red	1X	Yellow	Red	Red	Caught 1982	Inactive	
6	Red	13	Yellow	Red	Red	Caught 1982	Active	Swollen udder, no lamb seen
7	Yellow	02	Black	Yellow	Green	Caught 1982	Inactive	Ear tags reversed?
7	Red	2X	Yellow	Green	Red	Active	Active	Udder swollen, no lamb seen
8	Red	0-	Yellow	Blue	Red	Inactive	Not seen 1982	
8	Red	2626	Yellow	Red	Green	Inactive	Not seen 1982	Udder hard and dry
8	Green	16	Yellow	Red	Red	Caught 1982	Active	1 horn (right side)
9	Green	1-	Yellow	Red	Red	Caught 1982	Inactive	Some blood on tail
10	Green	17	Yellow	Red	Red	Caught 1982	Active	No milk, heavy springing
11	Green	20	Yellow	Green	Green	Caught 1982	Active	
11	Green	2-	Yellow	Green	Red	Caught 1982	Inactive	
11	Yellow	22	Black	Yellow	Yellow	Caught 1982	Inactive	

pressure and high harvest had concentrated on the older rams. No further demographic data are available from this period. In 1982, 3 years after the change to 7/8-curl horn as a legal definition, 45 of 114 rams seen during an aerial survey were legal (at 7/8 curl). Cohort sizes (Table 4) had been lower than normal in the years when these legal rams were born (1975-77), so it is not surprising that the number of rams was down somewhat. Still, the 45 (compared with 58) legal rams seen in 1982 should have had a minimum age of 6-7 years.

These changes may be relevant to the hypothesis in 2 ways. First, the age of dominant rams probably averaged about 2 years older in 1982. Consequently, they should have exhibited rutting behavior consistent with their increased horn size and status. Dominant rams should have been Class III rams instead of Class II rams (Geist 1971), as was the situation in 1975. That is, these rams should rut in a more conservative manner (Heimer and Watson 1982b) than the younger individuals that were dominants during the 3/4-curl era. Secondly, the lower total number of rams, from 189 to 114 (as a probable consequence of low recruitment in 1975-77, Table 4), resulted in fewer rams in the population. Since the hypothesis predicts a disorderly rut in the absence of old rams because juvenile rams "run wild," it should follow that decreasing the number (and percentage) of young rams while increasing the age of dominant rams should contribute to an orderly rut. Hence, establishing a minimum harvestable age at behavioral (and horn size) Class III instead of Class II should not have resulted in more conservative rutting behavior alone, but the coincidence of lowered numbers of young rams for the dominants to "keep in check" also should have produced a more orderly rut. The apparent change in age of reproductive onset and subsequent frequency followed the changes in ram age and numbers. Further data are needed to evaluate the suitability of this hypothesis.

Three 2-year-old ewes that were reproductively active in 1981 were marked. One of these died, one was not seen in 1982, and the third was reproductively inactive during her 3rd year after producing a lamb at age 2. Two 2-year-old ewes were trapped in 1982; neither was reproductively active.

Winter Studies:

Snow depth data gathered during the 1st week in April are presented in Table 6. No previous data are available for comparison.

Several marked ewes were located in the course of establishing the snow transect and making the measurements of snow depth. They are listed with their locations, date, and identification in Appendix B.

Table 6. Mean snow depth about station marking stakes for Dry Creek snow transect, 12 April 1983.

Station	Elevation (m)	Mean snow depth (cm) (N = 4)
1	1,007	54
2	1,057	47
3	1,127	57
4	1,147	103
5	1,217	57
6	1,307	32
7	1,357	26
		Average depth = 53.6 cm
		Total depth = 376 cm

Tok Study Area

Estimated Population Size, Composition, Trend, Mortality, and Reproductive Frequency:

The sheep population of this area has not been censused since 1980, and no alternate method for estimating population size (such as in the Dry Creek study area) has been applied. However, it is possible to estimate ewe numbers by reconstructing the dynamics of the ewe segment of the population. This can be done using mortality among marked ewes as an indicator of losses and recruitment from yearling ewes as population gain in this group. Sample sizes appear to be small, with mortalities ranging from 2 to 14 per winter. Still, it should be noted that as late as 1981 the population contained a minimum of 62 marked ewes and was estimated at less than 600 ewes. That is, about 10% of the ewe population was marked with no ewes younger than 3 years old wearing neckbands. As a result, I believe it is worthwhile to model the ewe segment of the study area population. It should be emphasized the model makes 3 assumptions: ewes are dead if not seen at the mineral lick; half of the yearlings recruited were ewes; and the marked ewes accurately indicate mortality percentages among the entire ewe segment of the population.

In 1980, the ewe population was estimated at 500 from a complete aerial census and applied sighting index based on the number of marked individuals known to be present and those seen on the aerial count (Heimer 1982). During the aerial census of 1980, 48 neckbanded ewes were seen. In 1981, 62 marked ewes were observed at the mineral lick. During the previous year (June 1980), only 47 marked ewes were seen because lick observation was discontinuous and many ewes were not identified because no one was watching the lick. Of these 47 ewes identified in 1980, 45 were resighted in 1981. That is, mortality was 2/47, or about 4% among the marked sample. As stated earlier, these 2 individuals were assumed dead. One of them was confirmed dead, having been killed by a ewe sheep hunter the previous October. Hence, half the winter mortality for winter 1980-81 was due to "natural causes" and half to hunting. Two percent of the estimated 500 ewes lost to "natural causes" calculates to 10 ewes. Hunters reported taking 11 sheep that year, for a total overwinter loss of 21 ewes, which leaves an estimated 479 adult ewes in the population.

Of course, more ewes entered the adult ewe class in spring 1981. In 1980, there were 500 ewes and the yearling:ewe ratio was 29 yearlings of both sexes:100 adult ewes. This comes to a total of 146 yearlings present in 1980. Half of these were assumed to be ewes, and I assume mortality over the winter in this age class is equal to the 2% from "natural causes" discussed above. Hence, 500 ewes x 0.29 yearlings/ewe x 1 female yearling/2 yearlings minus 2% gives 72 adult ewes recruited in spring 1981, or a total adult ewe population of 551.

In October 1981, 5 ewes (unmarked) were reported killed by hunters. This left 546 ewes in the population at the onset of winter. Winter 1981-82 was difficult for sheep, and a population decline resulted. Of the 62 marked ewes seen at the mineral lick in spring 1981, only 48 were resighted in spring 1982 (Table 7). This gave an assumed mortality of 14/62, or 23%. Removing 23% of the estimated 546 ewes present at the onset of winter should have left 420 adult ewes at the end of the 1981-82 winter.

Again, some ewes were recruited to the adult ewe class in spring 1982. Calculation of the best figure for recruitment is complicated by the fact that the mortality resulting from the severe winter of 1981-82 was skewed toward old ewes. Eleven of the marked ewes that were presumed dead after winter 1981-82 were 10 years of age or older. Mortality in this age group was 11 of 13 marked ewes, or 85%. Of these 11 ewes, 5 were ages 13 and 14 years, 1 was 12 years, 3 were 11 years, and 4 were 10 years old (Table 8). Mortality among ewes under the age of 10 years was 3/49, or 6%. The yearling:adult ewe ratio from 1981 was 32 yearlings:100 adult ewes, with an estimated population of 551 ewes. Hence, 551 ewes x 0.32 yearlings/ewe x 1 female yearling/2 yearlings gives 88 yearling ewes before winter 1981-82. If we apply the 6% mortality rate for ewes under the age of 10 years for that winter, this indicates that recruitment in spring 1982 should have been 88 - 5 or 83 ewes. This recruitment added to the 420 ewes left at the end of the 1981-82 winter gives 503 ewes estimated in the population in June 1982.

Because of the apparent loss of sheep in winter 1981-82, the ewe season was closed for October 1982. Winter mortality for winter 1982-83 will not be estimated until mineral lick observations are completed beyond the end of this reporting period. The estimated number of ewes entering winter 1982-83 is 503.

In retrospect, it should be emphasized that winter 1980-81 was unusually mild as reflected by low natural mortality among marked ewes (2%) and high lamb production in spring 1981 (Table 8). In addition, there was no mortality among ewes above the age of 9 years that winter. Consequently, the more severe winter of 1981-82 claimed not only the age class of ewes that was "scheduled to die" (those in the 10-12 year old group), but also those which presumably would have died during winter a year earlier (the 12-14 year olds) had the winter not been unusually mild.

The mortality among collared ewes is quite low, ranging from 2% in a mild winter to 6% in a difficult winter (1981-82 was probably more difficult than normal as indicated by loss of older animals and the lowest lamb production on record in spring 1982, 29 lambs/100 ewes). It also appears that this study population is generally stable despite the current level of ewe hunting and weather-induced fluctuations.

Little is known about ram natural mortality. If it is similar to the mortality of ewes, it should follow that few rams above the age of 10 years survived winter 1981-82. Horn size and age among

Table 7. Productivity, survival, and sample size of Dall sheep classified at the Sheep Creek mineral lick, 1974-1982.

Year	Lambs/ 100 ewes	Yearlings/ 100 ewes	% 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
1980	69	29	46	821
1981	52	32	46	5,758
1982	29	36	69	1,481

Table 8. Resightings of collared ewes at Sheep Creek mineral lick, 1977-82. C = Capture date, X = Resighting.

Sex	Age[a] (yr)	Collar Number	Collar Color	Ear tag Number	Ear tag Color	1977	1978	1979	1980	1981	1982	Yrs w/ lambs	Comments
F	4	0	Black Yellow	0	Black Yellow			C	X	X	X	81	
F	4	1	Black Yellow	1	Black Yellow			C	X	X	X	81	
F	4	2	Black Yellow	2	Black Yellow			C	X	X	X	81	
F	4	3	Black Yellow	3	Black Yellow			C	X	X	X	81	
F	5	4	Black Yellow	4	Black Yellow			C		X	X	81, 82	
F	4	5	Black Yellow	5	Black Yellow			C	X	X	X	81	
F	4	6	Black Yellow	6	Black Yellow			C	X	X	X	80, 81, 82	
F	4	7	Black Yellow	7	Black Yellow			C					
F	4			LO7	Black Yellow		C						
F	5	0	Yellow Red	0	White Red		C		X	X	X	81, 82	
F	5	1	Yellow Red	1	White Red		C			X	X	81	
F	5	2	Yellow Red	2	White Red		C	X		X	X	81, ?	
F	5	3	Yellow Red	3	White Red		C	X	X	X	X	80, 82	
F	5	4	Yellow Red	4	White Red		C	X	X	X	X	80, 81, 83	1978, quite small left horn
F	5	5	Yellow Red	5	White Red			C	X	X	X	81, 83	
F	5	6	Yellow Red	6	White Red			C	X	X	X	80, 81, 82	
F	5	7	Yellow Red	7	White Red			C	X	X		80	Assumed dead 1982
F	5	X	Yellow Red	X	White Red		C	X	X	X	X	80, 81	
F	5	-	Yellow Red	-	White Red			C	X	X	X	80, 81	
F	--	00	Yellow Red	00	White Red			C					Dead?
F	--	01	Yellow Red	01	White Red			C					Dead?
F	5	02	Yellow Red	02	White Red			C		X	X	81, 82	1979, right horn broken off
F	5	03	Yellow Red	03	White Red			C	X	X	X	81	
F	5	04	Yellow Red	04	White Red			C	X	X	X	80, 81, 82	1979, right horn broken off
F	5	05	Yellow Red	05	White Red			C		X	X	82	
F	5	06	Yellow Red	06	White Red			C	X	X	X	80, 81, 82	
F	5	07	Yellow Red	07	White Red			C		X	X	81, 82	
F	8	0	Yellow Blue	0	White Blue	C	X	X	X	X	X	77, 78, 79, 80, 81, 82	

Table 8. Continued.

Sex	Age (yr)	Collar Number	Collar Color	Ear tag Number	Ear tag Color	1977	1978	1979	1980	1981	1982	Yrs w/ lambs	Comments
F	7	1	Yellow Blue	1	White Blue		C	X		X	X	78, 79, 82	
F	7	2	Yellow Blue	2	White Blue		C	X	X	X	X	78, 79, 81	
F	7	4	Yellow Blue	4	White Blue		C	X	X	X	X	80	
F	--	5	Yellow Blue	5	White Blue	C	X	X	X			78, 80	Dead, hunter kill
F	6	6	Yellow Blue	6	White Blue			C	X	X	X	80, 81, 82	
F	--	7	Yellow Blue	7	White Blue	C						77	1977, hunter kill
F	--	-	Yellow Blue	-	White Blue	C	X	X				77, 78, 79	Assumed dead 1980
F	8	X	Yellow Blue	X	Yellow Blue	C	X	X	X	X	X	77, 78, 79, 81, 82	
F	6	20	Yellow Blue	20	White Blue			C		X	X	81, 82	
F	7	0	Yellow Green	0	White Green			C					1979, hunter kill
F	7	1	Yellow Green	1	White Green			C		X	X	81	
F	7	2	Yellow Green	2	White Green			C	X	X	X	81	1980, had CE lesions on udder last year, no lambs
F	7	3	Yellow Green	3	White Green			C	X	X		79, 81	Assumed dead 1982
F	9	4	Yellow Green	4	White Green			C		X	X	79, 81	
F	7	5	Yellow Green	5	White Green			C	X	X		79, 80, 81	Assumed dead 1982
F	7	6	Yellow Green	6	White Green			C	X	X	X	80	1979, lump jaw left side
F	8	-	Yellow Green	-	White Green		C		X	X	X	78, 80, 81	
F	8	00	Yellow Green	00	White Green		C	X	X	X	X	78, 79, 80, 81	
F	8	01	Yellow Green	01	White Green		C	X	X	X	X	80, 81, 82	1982, big udder, no lamb seen
F	--	02	Yellow Green	02	White Green			C	X			79	Assumed dead 1980
F	9	03	Yellow Green	03	White Green			C	X	X	X	79, 80, 81	
F	9	05	Yellow Green	05	White Green			C	X	X	X	79, 81	
F	9	06	Yellow Green	06	White Green			C	X	X	X	79, 80, 81	
F	9	07	Yellow Green	07	White Green			C		X	X	79, 80, 81	
F	--	0	Black Red	0	Black Red		C					78	1978, lump jaw assumed dead 1979

Table 8. Continued.

Sex	Age[a] (yr)	Collar Number	Collar Color	Ear tag Number	Ear tag Color	1977	1978	1979	1980	1981	1982	Yrs w/ lambs	Comments
F	8	1 Black	Red	1 Black	Red			C	X	X	X	79, 80, 81, 82	
F	8	2 Black	Red	2 Black	Red			C	X	X	X	79, 80, 81	
F	8	3 Black	Red	3 Black	Red		C	X	X	X		79, 81	
F	8	4 Black	Red	4 Black	Red			C	X	X	X	79, 81, 82	
F	8	5 Black	Red	5 Black	Red			C	X	X	X	79, 81	
F	8	6 Black	Red	6 Black	Red			C	X	X	X	79, 81	1979, small udder with discolored milk; lamb may have died and milk drying up
F	--	00 Black	Red	00 Black	Red		C	X				78, 79	Assumed dead 1980
F	11	01 Black	Red	01 Black	Red		C	X		X		81	Assumed dead 1982
F	11	02 Black	Red	02 Black	Red		C	X	X	X	X	78, 79, 80, 81, 82	
F	10	03 Black	Red	03 Black	Red			C		X		79, 81	Assumed dead 1982
F	10	04 Black	Red	04 Black	Red			C		X		79, 81	Assumed dead 1982
F	10	05 Black	Red	05 Black	Red			C	X	X		79, 80, 81	Assumed dead 1982
F	10	07 Black	Red	07 Black	Red			C	X	X		79, 81	Assumed dead 1982
F	11	30 Black	Red	30 Black	Red			C	X	X	X	79, 80, 81	
F	14	40 Black	Red	40 Black	Red		C	X		X		78, 79, 81	Assumed dead 1982
F	14	41 Black	Red	41 Black	Red		C	X	X	X		78, 79, 80, 81	Assumed dead 1982
F	13	42 Black	Red	42 Black	Red			C	X	X		79, 80, 81	Confirmed dead 1982
F	12	43 Black	Red	43 Black	Red			C		X			Assumed dead 1982
F	--	44 Black	Red	44 Black	Red			C					1979, lump on left jaw; assumed dead 1980
F	13	45 Black	Red	45 Black	Red			C	X	X		80, 81	Assumed dead 1982
F	13	4- Black	Red	4- Black	Red			C		X		81	Assumed dead 1982

[a] Age in 1982.

rams harvested from the surrounding Tok Management Area (TMA) in 1982 were unchanged (age = 8.7 years and horn length = 36.0 inches) compared with earlier years. However, the number of unusually large (horn length ≥39 inches) rams taken during fall 1982 was down from an average of about 20% of the reported ram harvest to about 9%. This could be a result of random selection by hunters or the absence of old rams in the population. The management scheme in the TMA selects heavily against old rams (by a full-curl regulation), and it is likely a large percentage of rams in these age classes had already been harvested. It is premature to suggest the size/age of rams available for harvest next year will be compromised because of winter 1981-82.

Winter Studies:

Snow depth data gathered during the 1st week in April are presented in Table 9. During the course of establishing the snow transect, 2 marked ewes were located on their winter range. Data are present in Appendix B.

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Joe and Steve DuBois established the Sheep Creek mineral lick camp this year. Ruth Gronquist and Diane Preston did their usual fine job of watching both mineral licks while the regular sheep staff was alternately trapping at the other study area. Cathie Harms assisted with the winter studies in Dry Creek. Brian Lawhead assisted with trapping at Dry Creek along with Steve Peterson. Wayne Regelin helped establish the Dry Creek Camp and assisted with early trapping there. Wayne also edited this manuscript--the least glamorous job of all. Sarah Watson assisted with all phases of data gathering, trapping, and incessant brainstorming.

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Table 9. Mean snow depth about station marking stakes for Clearwater Creek snow transect, early April 1983.

Station	Elevation (m)	Mean snow depth (cm) ($\underline{N}$ = 4)	Comments
1	1,007	43	
2	1,037	8	Windblown spot
3	1,057	54	
4	1,160	28	
5	1,217	49	Accumulation zone
6	1,287	67	No crust on snow
7	1,357	24	
		Average depth = 39 cm Total depth = 273 cm	

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Appendix A. Cross-transmission of coccidiosis between wild and domestic alaska sheep.

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Coccidiosis, an intestinal infection caused by protozoan parasites of the genus Eimeria ("coccidia"), is found in domestic sheep throughout the world. Heavy infections cause diarrhea, weight loss, and death, particularly in feeder lambs 3 to 5 months old. Sheep from various locations in interior Alaska have light coccidial infections and shed the oocysts (infective states) of a number of Eimeria species in their feces. Alaskan Dall sheep, Ovis dalli, are also commonly infected with coccidia and shed oocysts of what appear to be some of the same species as domestic sheep. In addition, Dall sheep shed a few other Eimeria species not seen in Alaskan domestic sheep.

There is a definite potential for cross-transmission of Dall sheep coccidial species to domestic sheep that graze on a pasture contaminated with Dall sheep feces. This was demonstrated by giving an oral innoculum (of known number and species composition) of Dall sheep oocysts to 3-month-old domestic lambs that were free of coccidial infection. Developmental stages were observed in their intestinal tracts, and mature oocysts were shed by these lambs. A negative control group of lambs received no oocysts and shed none in the same time period, and a positive control group received domestic sheep oocysts and shed these oocysts appropriately. The Eimeria species composition of the Dall sheep oocysts innoculum and of the resulting oocysts shed by the lambs can be compared to determine if Eimeria species-specific immunity in previously infected domestic sheep could protect them from acquiring severe coccidiosis when grazing Dall sheep pastures.

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Proceedings 33rd Alaska Science Conference, September 1982, Fairbanks, Alaska (AAAS: Arctic Division) page 49.

Appendix B. Resighting data for neckbanded ewes in the Alaska Range.

Dry Creek Study Area[a]

Date	Identification data	Location
24 Feb 1982	Red collar-yellow #22	No Name Creek, south-facing slope in Sect. 7 at 1,220 m (4,000 ft)
24 Feb 1982[b]	Yellow collar-black #20	Same as R/Y #22 above
24 Feb 1982	Red collar-yellow #0	North of Forgotten Creek in Sect. 21 on small peak at 1,556 m (5,100 ft)
3 Jun 1982[a]	Red collar-yellow #27	Sect. 19 between Exclosure and Bigfoot Creeks at 1,220 m (4,000 ft)
3 Jun 1982[a]	Red collar-yellow #16	Same as R/Y #27 above
3 Jun 1982[a]	Red collar-yellow #XX	Same as R/Y #27 above
7 Apr 1983[b]	Yellow collar-black #20	Intersection of Sect. 11, 12, 13, 14 on south fork of No Name Creek, 2.4 km WSW of location on 24 Feb 1982
8 Apr 1983	Red collar-yellow #12	Southwest quarter of Sect. 22 just north of lower Forgotten Creek
8 Apr 1983	Red collar-yellow #13	Southeast quarter of Sect. 21 just north of Forgotten Creek at 1,373 m (4,500 ft)
8 Apr 1983	Yellow collar-black #21	Same as R/Y #13 above

Appendix B. Continued.

Tok Study Area

Date	Identification data	Location
3 Apr 1983	Red collar-yellow unreadable number, red tag in right ear, right horn "off line" being pushed "back" beyond left horn	Clearwater Ridge
3 Apr 1983[c]	Red collar-black #30	Clearwater Ridge

[a] These sightings not previously reported. Sightings from Tok study area for earlier years were depicted graphically in Heimer 1982 and Heimer and Watson 1982a.

[b] This individual resighted in consecutive years. Distance between sightings = 2.4 km (1.5 mi).

[c] This individual seen 0.8 km from this spot in April 1981.