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INTERIOR SHEEP STUDIES

By
Wayne E. Heimer

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Project Progress Report
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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Wayne E. Heimer

Project No.: W-21-2 Project Title: Big Game Investigations

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

Period Covered: July 1, 1980 through June 30, 1981

SUMMARY

Comparative studies of high- and low-quality Dall sheep populations were continued to determine whether differences in population quality manifest themselves as differences in population dynamics which should be considered in management planning. Population sizes for both study populations were determined by aerial census and survey; population compositions were calculated in terms of absolute numbers of ewes, lambs, and yearlings. The Dry Creek population consisted of 1,425 sheep following lambing. It included 630 ewes, 422 lambs, and 227 yearlings--the greatest production and recruitment ever recorded in the area. The Sheep Creek population was determined to be 1,050 sheep after lambing. It contained an estimated 500 ewes, 346 lambs, and 146 yearlings. Circumstances suggest the 3% annual rate of increase observed in the ewe component of the Dry Creek population is maximal for low-quality sheep populations; this rate was probably due to mild weather and wolf reductions which occurred during the last 5 years. Ewe harvests should be kept below this level in expanding populations. Ewe harvests may cause or accelerate population declines in areas where sheep populations are not increasing or where wolf management and mild winters do not favor population growth.

CONTENTS

BACKGROUND

Differences in Dall sheep (Ovis dalli) ram horn growth in the populations along the Alaska Range east of Mt. McKinley have been shown by previous Alaska Department of Fish and Game studies (Heimer and Smith 1975). The results of these studies were considered supportive of Geist's (1971, 1979) Quality Hypothesis (now referred to as Geist's 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 (ARE) into 3 areas for purposes of investigating "quality" based on ram horn growth characteristics. These areas, from Mt. McKinley 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 low quality, ARE II was of average quality, and ARE III was of high quality. For these reasons, it was decided to compare Dall sheep ecology in ARE I and ARE III to determine whether different management approaches were necessary in areas of differing sheep quality.

Geist's (1979) Dispersal Theory predicts population dynamics will differ 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 all points of this hypothesis (Heimer 1980, Heimer and Smith 1975). It is not known, however, if high-quality populations are increasing as a result of higher yearling recruitment or whether the postulated higher adult mortality compensates for the greater number of sheep recruited. Population dynamics of the high-quality population (ARE III) are being investigated and compared with those of the low-quality (ARE I) population to answer this question.

OBJECTIVES

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

PROCEDURES

Dry Creek

The Dry Creek mineral lick was observed from 21 June through 2 July 1980 beginning at 0430 hours and ending at 1200 hours daily. Initial lamb production and yearling survival were determined by classifying all sheep entering the lick as ewes, yearlings, lambs, or rams. Classifications were made using spotting scopes at distances <200 m. An aerial census of the sheep populations influenced by the Dry Creek lick was conducted using a Piper PA-18-150 Super Cub piloted by Bill Lentsch on 17, 18, 21, and 22 July 1980. A total of 18.5 hours was spent searching for and classifying sheep. Sheep were classified as legal rams (7/8 curl or greater), sublegal rams, lambs, and "ewes" (a category which includes ewes, as classified above, yearlings, and young rams which cannot be distinguished from ewes while flying).

Survival of the 1980 lamb cohort through its 1st winter was monitored. Foot surveys and classifications were made in the months of October and April. During the intervening months, aerial surveys were flown using a Piper PA-18-150 Super Cub piloted by Bill Lentsch. This work was confined to the mountain mass between Dry Creek and the West Fork of the Little Delta River. Aerial survey time was usually more than 1 hour, and the number of sheep classified during each survey ranged from 130 to 200.

Sheep Creek

The Sheep Creek mineral lick was observed in a manner similar to that used at Dry Creek. Observation dates were 12-14 June and 18-28 June. Observations were made from 0400 through 2000 hours on those dates. Collared sheep were identified and their reproductive status determined by observations of lamb suckling. An aerial census of the sheep populations influenced by the Sheep Creek lick was flown on 23 and 24 July in a PA-18-150 Super Cub piloted by Bill Lentsch. This census covered sheep habitat north of the Tok River between the Robertson River and the Tok-Slana Road. A total of 16.1 hours was spent searching for and classifying all sheep seen in this area. Collar numbers of marked sheep were read whenever possible during these flights.

Using helicopters, additional flights were made during winter to identify collared individuals on winter ranges. A 3-hour flight took place on 18 March 1981 using a Bell 206A Jet Ranger. A 2nd survey lasting 6 hours was made on 15 and 16 April with a Hughes 500 helicopter.

FINDINGS

Estimated Size and Composition of the Dry Creek Population

During the 12-day period of mineral lick observation, 1,346 sheep were classified as they entered the lick. Sixty-seven lambs and 36 yearlings were observed for each 100 ewes entering the lick. In Table 1, these data are compared with historic productivity, survival, and estimated numbers of sheep influenced by the Dry Creek lick. It is important to note that the ratios per 100 ewes presented in Table 1, while accurate data, are only relative numbers. While it is hoped they are indicative of actual production and survival, there is little assurance they are. Population composition is more meaningfully revealed by actual numbers of lambs produced and yearlings recruited. These could be calculated if the actual number of ewes in the study area were known.

The number of ewes is calculable from the percentage of ewes observed among incoming sheep at the mineral lick applied to the total number of sheep in the study area. During the 12-day observation period, a mean of 112 sheep/day entered the lick. Using the nomogram presented in Heimer (1981:4), this average number of incoming sheep predicts a total population size of 1,440 following lambing.

This estimate of total sheep numbers is in agreement with the number of sheep seen in the aerial census conducted approximately 3 weeks later. During this census, 1,417 sheep were counted in 18.1 hours of flight time. If the mineral lick estimate were considered correct, the aerial census resulted in observation of 98% of the sheep present. It is certain the population contains at least 1,417 sheep, but unlikely that all sheep were seen in the census attempt. Past work (Heimer 1981) has established confidence in the mineral lick method. Hence, the population is thought to be between 1,417 and 1,440. I arbitrarily selected 1,425 as the post-lambing population estimate. Ewes composed

Table 1. Productivity, survival, and estimated number of Dall sheep influenced by the Alaska Range Dry Creek mineral lick from 1970 through 1980.

Year	Lambs/ 100 ewes	Yearlings/ 100 ewes	% 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
1980	67	36	55	1425

44.2% of the incoming sheep classified at the Dry Creek lick. This gives an estimate of ewe numbers of 630, an increase of 18 ewes (3%) over last year. When the number of ewes are multiplied by the percentage of lambs and yearlings for each 100 ewes, one arrives at 422 lambs produced and 227 yearlings recruited in spring 1980. Comparable data for previous years are presented in Table 2. Production and recruitment for 1980 were the highest ever recorded in the study area.

A comparison of the survival rates presented in Tables 1 and 2 reveals a difference in the percentage of lambs surviving to yearling age. Table 1 is based on relative ratios while Table 2 is derived from actual production and survival estimates. The differences, of course, are caused by the constantly changing number of ewes present in the population. This variability illustrates the problems inherent in assuming production and recruitment ratios are accurate indicators of population behavior.

Aerial Census, Dry Creek

Data from the aerial census conducted in 1980 are supportive of Heimer's (1981) conclusion that the population changed significantly beginning in 1976. This change coincided with wolf reductions in the area. Fig. 1 shows the study area divided into geographic areas as analyzed for the censuses of 1970 and 1975 (Heimer 1976). Classification of sheep observed at Dry Creek in 1980 is given in Table 3. Table 4 gives flight times and total sheep seen for 1970, 1975, and 1980.

The data in Table 4 indicate that populations in 1980 in areas 1 and 2 have increased to approximately the same levels seen in 1970 after having been considerably lower in 1975. Populations of areas 3 and 4 appear to have decreased from 1975. This pattern may be explained by noting that wolf removal has been centered in areas immediately adjacent to areas 1 and 2 (Gasaway et al. 1981). Areas 3 and 4 are more distant from the centers of wolf reduction, and populations living in these areas may not have benefited from wolf removal to the same extent as those in areas 1 and 2.

Still, total population figures can be misleading. It should be noted that 1975 and 1980 were very different years in terms of lamb production (Table 2). For example, 1980 had the highest lamb production ever recorded in the Dry Creek area. Consequently, in order to make a useful comparison of census results from 1975 and 1980, lambs-of-the-year and rams should be subtracted from the population totals. Table 5 shows the number of "ewes" remaining in each survey area for 1975 and 1980 after these subtractions. These data show the pattern observed for total numbers holds for "ewes" as well. It should be noted the "ewe" category always includes young rams as well as yearlings of both sexes not discernible from ewes in aerial classifications. It appears that populations within the Dry Creek study area may

Table 2. Estimated total postlambing population, % adult ewes observed, calculated numbers of ewes and lambs, % survival to yearling age, and numbers of yearlings in Dry Creek population from 1972 through 1980.

Year	Estimated postlambing population	% adult ewes	Number adult ewes	Number lambs	% survival to yrlg age	Number yearlings
1972	1473	56	823	123	74	132
1973	1423	58	823	313	60	91
1974	1280	59	750	210	78	187
1975	1230	58	709	199	58	163
1976	1310	55	723	260	47	116
1977	1350	53	714	414	43	121
1978	1390	52	721	296	39	180
1979	1340	46	612	398	57	116
1980	1425	44	630	422	--	227

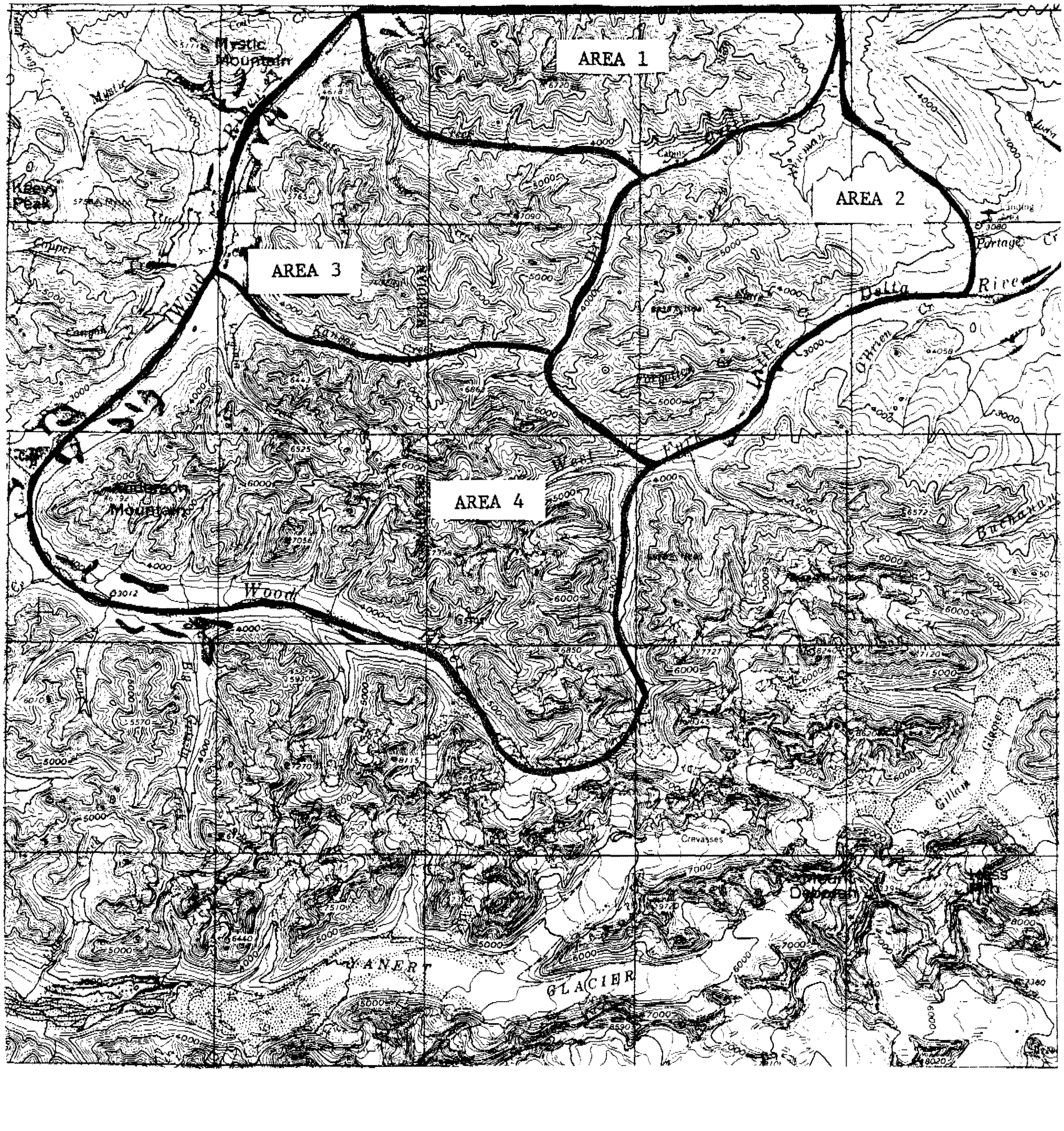

Fig. 1. Dry Creek area divided into subpopulations for the censuses of 1970 and 1975.

Table 3. Classification of sheep observed at Dry Creek in 1980.

Area	Unclassified	"ewes"	lambs	Sublegal rams	Legal (7/8 curl)
1	15	197	90	80	25
2	3	294	125	27	5
3	--	166	75	67	19
4	--	116	49	44	20
	18	773	339	218	69

Table 4. Dall sheep counts from 1970, 1975, and 1980 for Dry Creek, Alaska Range.

Area surveyed	1970		1975		1980	
	Count	Time (hour)	Count	Time (hour)	Count	Time (hour)
1	315	--	250	3.0	407	3.5
2	485	*	347	2.4	454	4.0
3	332	*	341	3.0	327	4.0
4	--	--	294	5.9	229	7.8

* Specific time not available by area; total time 11.0 hours.

Table 5. "Ewe"[1] numbers for survey areas within the Dry Creek vicinity in 1975 and 1980.

Area surveyed	1975	1980	% change
1	183	197	+ 8
2	240[2]	294	+ 23
3	186[2]	166	- 11
4	152[2]	116	- 24

[1] Definition of "ewe": class of sheep not identifiable as lambs or rams during aerial surveys.

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

have differing trajectories dependent upon their proximity to wolf reduction. That is, areas 1 and 2 increased by an average of 15% over the last 5-year period while areas 3 and 4 decreased by 18% over the same timespan.

The rate of increase for populations in areas 1 and 2 is probably maximal for Dall sheep of the population quality found at Dry Creek. The period from 1975 to 1980 has been one of mild winters. These conditions have been reflected in high lamb production and yearling recruitment. In addition, from 1975 to 1980, wolf reduction programs benefited sheep in the immediate area. Consequently, it is unlikely under conditions when weather is favorable and wolf reduction is successfully practiced that annual increases greater than the 3% seen here will be possible. Furthermore, ewe harvests when weather is unfavorable or when predators are not reduced will probably result in lower population numbers. Even when populations are known to be lower than historically observed and all conditions for population growth are favorable, ewe harvests in the Dry Creek population should not exceed 3% of the ewe segment unless additional population reduction is desired.

The high lamb production observed in the study area during recent years has not generally been reflected in overall increased recruitment (Heimer 1981). In light of the knowledge that some populations are increasing while others in the study area are decreasing, this is not surprising. Survival of lambs in area 2 was monitored throughout the winter by ground and aerial surveys. The lamb:ewe ratio did not show a decreasing trend by April (Fig. 2). Mortality could be high between April and June when the annual composition figures are gathered, but it appears likely that yearling recruitment in area 2 will be high.

Estimated Size and Composition of the Sheep Creek Population

During observations of the Sheep Creek mineral lick, 69 lambs and 29 yearlings were found for each 100 ewes ($\underline{N}$ = 821). These data are compared with productivity, survival, and sample sizes from earlier years in Table 6.

To acertain the actual number of ewes, lambs, and yearlings, the percentage of ewes using the mineral lick and the total number of sheep in the population were determined. The size of the population influenced by the Sheep Creek mineral lick was estimated from aerial survey data for collared sheep. Seventy ewes have been marked with colored neckbands since 1977; 48 (69%) of these ewes were seen in 16.1 hours of survey time. Resightings at the Sheep Creek lick before the survey was flown confirmed the presence of all but 15 of 70 possible collars in the population. If it is assumed that all unlocated collars were no longer in the population (due to collar loss or death), 87% (48 out of 55) of the collared sheep were sighted in the aerial survey. Since collars are more difficult to see than entire sheep, it is probable that actual sightability was somewhere

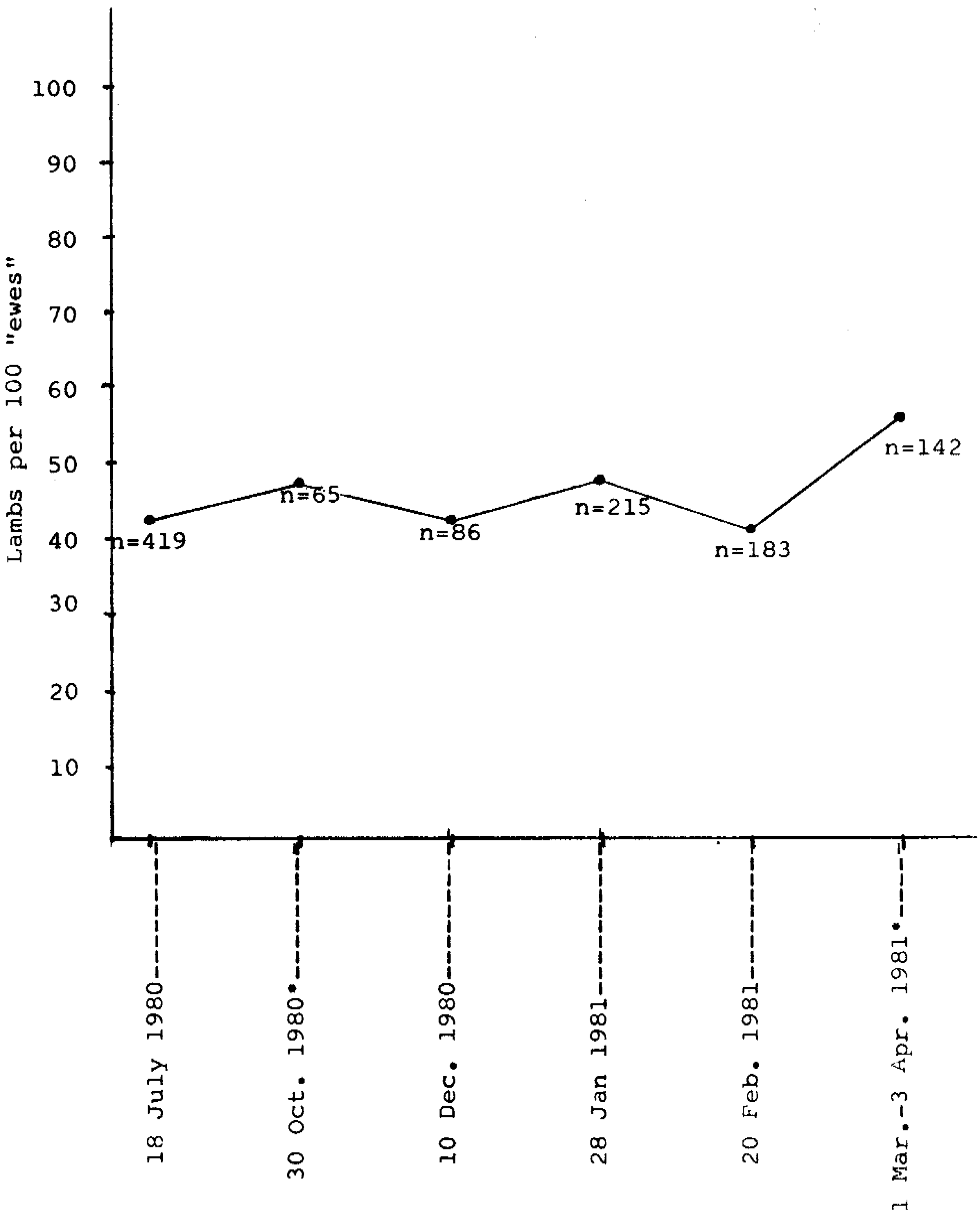

Fig. 2. Lamb:"ewe" ratio as a function of time for survey area 2 during winter 1980-81 in Dry Creek, Alaska Range. Surveys are aerial unless marked * to denote ground survey.

Table 6. Productivity, survival, and sample size of Dall sheep classified at the Sheep Creek mineral lick from 1974 through 1980.

Years	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

between 69 and 87% for the pilot-observer team involved in this survey. This same team saw 97% of the sheep estimated in Dry Creek, so I arbitrarily defined a sighting efficiency for ewes in the survey at the high end of the range at 85% which resulted in a conservative population estimate.

Using 85% as the sightability factor applied to 892 sheep seen (468 "ewes," 218 lambs, 141 rams less than full curl, and 66 rams full curl or greater) gives an estimated sheep population of 1,050 sheep of all sex and age classes. It should be noted that this assumes equal sightability for rams, "ewes," and lambs. This assumption is untested.

Using 1,050 as the total number of sheep present, the number of ewes, lambs, and yearlings was calculated using the percentage of ewes observed at the Sheep Creek mineral lick and the lamb:ewe and yearling:ewe ratios. At the Sheep Creek mineral lick, 48% of the incoming sheep were ewes. If this accurately reflects the population composition, the ewe component of the population contains 503 ewes. Multiplying the lamb:ewe ratio (69 lambs:100 ewes) by the number of ewes yielded an estimate of 346 lambs produced in 1980. Similar calculations using the yearling:ewe ratio (29 yearlings:100 ewes) indicated a recruitment of 146 yearlings.

Resighting Data, Sheep Creek

Resighting data for sheep at the Sheep Creek mineral lick are presented in Table 7. Data on reproductive performance and lactation are also shown. The observed pattern of reproduction has been 1st lambing on the 3rd birthday, with a lamb produced annually thereafter. Only 3 ewes have been observed without lambs in 2 consecutive years; 2 of these showed obvious signs of disease. One had a large lump-jaw lesion on the left mandible and a smaller one on the right. The other ewe had active contagious ecthyma lesions on her udder in 1979 (Smith and Heimer 1981).

Collar resightings in the study area indicated at least 2 separate populations of ewes. Thirteen collars were seen on summer ranges during an aerial survey in late July and early August. During helicopter surveys in March and April 1981, 31 collars were identified on the same ranges. These data are presented in Appendix I and indicate 2 separate populations of ewes. One is found northwest of the Sheep Creek lick during winter and summer. The other is primarily located on Clearwater Creek and the Mt. Neuberger area. The extent of movement of this population is not currently known. Collars have been sighted in summer and winter on upper Shindata and Natahona Creeks, but individuals have not been identified. The individuals that have been identified northwest of the Sheep Creek lick appear to reside in those mountains along the Robertson River, venturing as far "down" the front of the Alaska Range as the Sheep Creek lick

Table 7. Resightings of collared sheep at Sheep Creek mineral lick, 1977-1981. C=Capture date

Sex	Collar number	Collar color	Eartag number	Eartag color	1977	1978	1979	1980	1981	Yrs w/ lambs	Comments
M			07 Blk	Yel		C	X				
M			17 Blk	Yel		C					
M			27 Blk	Yel		C	X				
M			37 Blk	Yel		C		X			
M			47 Blk	Yel		C	X	X			
M			57 Blk	Yel		C					
M			67 Blk	Yel		C					
M			77 Blk	Yel		C					
M			7 Blk	Yel		C					
M			X7 Blk	Yel		C		X			
M			L17 Blk	Yel		C	X	X			1980, lump jaw right side
M			L27 Blk	Yel		C					
M			L37 Blk	Yel		C					
M			L47 Blk	Yel		C	X				
M			07 Wht	Blu		C	X				
M			17 Wht	Blu		C					
M			27 Wht	Blu			C				
M			47 Wht	Blu			C	X			
M			57 Wht	Blu			C	X			
M			67 Wht	Blu			C	X			
M			77 Wht	Blu			C				
M			7 Wht	Blu			C				
M			09 Wht	Grn			C				
M			19 Wht	Grn			C				
M			29 Wht	Grn			C				

Table 7. Continued.

Sex	Collar number	Collar color	Eartag number	Eartag color	1977	1978	1979	1980	1981	Yrs w/ lambs	Comments
M			39 Wht	Grn			C				
M			49 Wht	Grn			C	X			
M			59 Wht	Grn			C	X			
M			69 Wht	Grn			C	X			
M			79 Wht	Grn			C	X			1979, has golf ball size lump jaw both sides
M			9 Wht	Grn			C	X			
M			X9 Wht	Grn			C				
M			29 Wht	Red			C	X			
F			L07 Wht	Red			C				
F			L17 Wht	Red			C				
F	0 Blk	Yel	0 Blk	Yel			C	X	X		
F	1 Blk	Yel	1 Blk	Yel			C	X			
F	2 Blk	Yel	2 Blk	Yel			C	X			
F	3 Blk	Yel	3 Blk	Yel			C	X			
F	4 Blk	Yel	4 Blk	Yel			C		X		
F	5 Blk	Yel	5 Blk	Yel			C	X			
F	6 Blk	Yel	6 Blk	Yel			C	X	X	80	
F	7 Blk	Yel	7 Blk	Yel			C				
F			L08 Blk	Yel		C					
F	0 Yel	Red	0 Wht	Red		C		X			
F	1 Yel	Red	1 Wht	Red		C					
F	2 Yel	Red	2 Wht	Red		C	X				
F	3 Yel	Red	3 Wht	Red		C	X	X		80	
F	4 Yel	Red	4 Wht	Red		C	X	X		80	1978, quite small left horn
F	5 Yel	Red	5 Wht	Red			C	X	X		

Table 7. Continued.

Sex	Collar number	Collar color	Eartag number	Eartag color	1977	1978	1979	1980	1981	Yrs w/ lambs	Comments
F	6 Yel	Red	6 Wht	Red			C	X	X	80	
F	7 Yel	Red	7 Wht	Red			C	X		80	
F	X Yel	Red	X Wht	Red		C	X	X		80	
F	Yel	Red	Wht	Red			C	X		80	
F	00 Yel	Red	00 Wht	Red			C				
F	01 Yel	Red	01 Wht	Red			C				
F	02 Yel	Red	02 Wht	Red			C		X		1979, right horn broken off
F	03 Yel	Red	03 Wht	Red			C	X			
F	04 Yel	Red	04 Wht	red			C	X	X	80	1979, right horn broken off
F	05 Yel	Red	05 Wht	Red			C				
F	06 Yel	Red	06 Wht	Red			C	X		80	
F	07 Yel	Red	07 Wht	Red			C		X		
F	0 Yel	Blu	0 Wht	Blu	C	X	X	X	X	77,78,79,80	
F	1 Yel	Blu	1 Wht	Blu		C	X			78,79	
F	2 Yel	Blu	2 Wht	Blu		C	X	X	X	78,79	
F	4 Yel	Blu	4 Wht	Blu	C	X	X	X		80	
F	5 Yel	Blu	5 Wht	Blu	C	X	X	X		78,80	
F	6 Yel	Blu	6 Wht	Blu		C	X	X	X	80	
F	7 Yel	Blu	7 Wht	Blu	C					77	1977, hunter kill
F	Yel	Blu	Wht	Blu	C	X	X			77,78,79	
F	X Yel	Blu	X Yel	Blu	C	X	X	X		77,78,79	
F	20 Yel	Blu	20 Wht	Blu			C				
F	0 Yel	Grn	0 Wht	Grn			C				1979, hunter kill
F	1 Yel	Grn	1 Wht	Grn			C				
F	2 Yel	Grn	2 Wht	Grn			C	X			1980, had contagious ecthyma (App. II) lesions on udder last year, no lambs

Table 7. Continued.

Sex	Collar number	Collar color	Eartag number	Eartag color	1977	1978	1979	1980	1981	Yrs w/ lambs	Comments
F	3 Yel	Grn	3 Wht	Grn			C	X	X	79	1980, large (50¢ size) black lesion on right maxilla
F	4 Yel	Grn	4 Wht	Grn			C		X	79	
F	5 Yel	Grn	5 Wht	Grn			C	X		79,80	1979, lump jaw both sides
F	6 Yel	Grn	6 Wht	Grn			C	X		80	1979, lump jaw left side
F	Yel	Grn	- Wht	Grn		C		X		78,80	
F	00 Yel	Grn	00 Wht	Grn		C	X	X		78,79,80	
F	01 Yel	Grn	01 Wht	Grn		C	X	X		80	
F	02 Yel	Grn	02 Wht	Grn			C	X		79	1979, small udder and mucoid discharge
F	03 Yel	Grn	03 Wht	Grn			C	X	X	79,80	
F	05 Yel	Grn	05 Wht	Grn			C	X		79	
F	06 Yel	Grn	06 Wht	Grn			C	X		79,80	
F	07 Yel	Grn	07 Wht	Grn			C		X	79,80	
F	0 Blk	Red	0 Blk	Red		C				78	1978, lump jaw
F	1 Blk	Red	1 Blk	Red			C	X		79,80	
F	2 Blk	Red	2 Blk	Red			C	X		79,80	
F	3 Blk	Red	3 Blk	Red			C	X	X	79	
F	4 Blk	Red	4 Blk	Red			C	X	X	79	
F	5 Blk	Red	5 Blk	Red			C	X		79	
F	6 Blk	Red	6 Blk	Red			C	X	X	79	1979, small udder with discolored milk; lamb may have died and milk drying up
F	00 Blk	Red	00 Blk	Red		C	X			78,79	
F	01 Blk	Red	01 Blk	Red		C	X		X		1978, lump jaw both sides, left side severe

Table 7. Continued.

Sex	Collar number	Collar color	Eartag number	Eartag color	1977	1978	1979	1980	1981	Yrs w/ lambs	Comments
F	02 Blk	Red	02 Blk	Red		C	X	X	X	78,79,80	
F	03 Blk	Red	03 Blk	Red			C			79	
F	04 Blk	Red	04 Blk	Red			C			79	
F	05 Blk	Red	05 Blk	Red			C	X		79,80	
F	07 Blk	Red	07 Blk	Red			C	X	X	79	
F	30 Blk	Red	30 Blk	Red			C	X	X	79,80	
F	40 Blk	Red	40 Blk	Red		C	X		X	78,79	
F	41 Blk	Red	41 Blk	Red		C	X	X	X	78,79,80	
F	42 Blk	Red	42 Blk	Red			C	X		79,80	
F	43 Blk	Red	43 Blk	Red			C				
F	44 Blk	Red	44 Blk	Red			C				1979, lump on left jaw
F	45 Blk	Red	45 Blk	Red			C	X	X	80	
F	4 Blk	Red	4 Blk	Red			C		X		

and then returning. Further data are needed to confirm these tentative conclusions.

Appendix II contains data on Dall sheep serology and blood chemistry gathered incidental to trapping efforts in Sheep Creek during 1979.

MANAGEMENT RECOMMENDATIONS

The findings that "ewe" populations are increasing in 2 of the Dry Creek populations during the past 5 years of generally favorable winter weather suggest that a maximal annual increase of 3% can be expected for "ewe" sheep populations of low quality. This figure may be greater for populations of higher quality, but until a greater rate of increase is demonstrated, a conservative approach should be taken and this rate considered maximal. This means harvest of ewes from expanding populations (those benefiting from wolf reductions, mild winters, or recently documented population reductions) should be limited to 3% of the "ewes" if the ewe population is not to be depressed as a result of the harvest. In areas where population levels are unknown with respect to historic fluctuations, predators are abundant, or winter weather is relatively severe with respect to what is "normal," it should be understood that harvests of the same magnitude may cause or accelerate population declines.

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PREPARED BY:

Wayne E. Heimer
Game Biologist

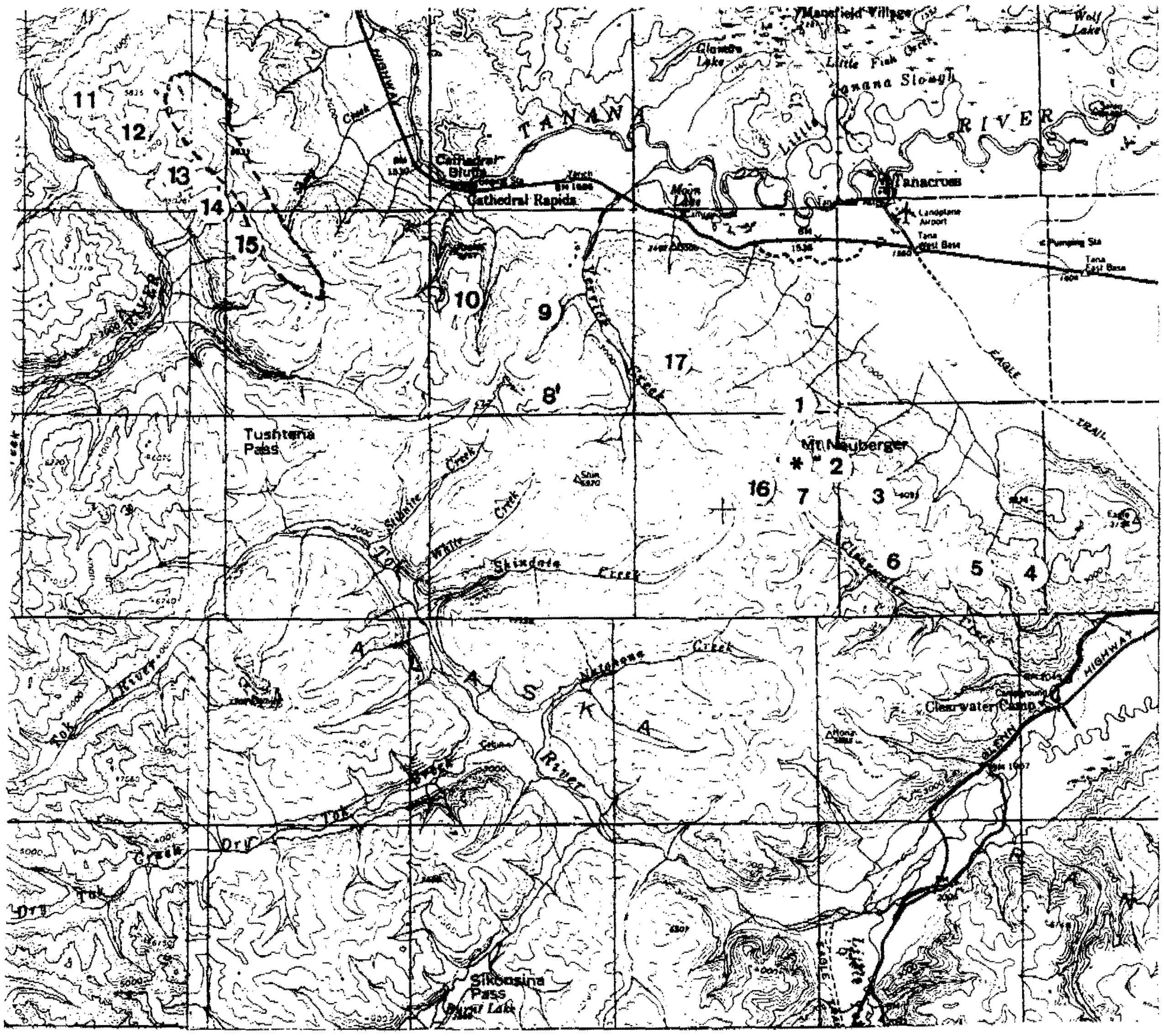
SUBMITTED BY:

John W. Coady
Regional Research Coordinator

APPROVED BY:

Ronald J. Somerville by J. Barnett
Director, Division of Game

Steven R. Peterson by J. Barnett
Research Chief, Division of Game



Appendix I. Resightings of collared ewes in the Sheep Creek study area. The dashed lines refer to the location of ewes sighted on 23-24 July 1980. The * refers to the location of ewes sighted on 18 March 1981. Numbers 1-17 refer to locations of ewes sighted on 15-16 April 1981.

Appendix I. Resightings of collared ewes in the Sheep Creek area.

23-24 July 1980

Red with Yellow 0
Red with Yellow 1
Red with Yellow 5
Red with Yellow 6
Red with Yellow 07
Blue with Yellow 0
Blue with Yellow 2
Blue with Yellow 6
Blue with Yellow 20
Blue with Yellow X
Yellow with Black 0
Green with Yellow 00
Green wih Yellow 07

18 March 1981

Red with Black 6
Red with Black 30
Green with Yellow 07
Blue with Yellow 0

15-16 April 1981

1- Red with Black 3
Blue with Yellow 0
2- Red with Black 34
3- Red with Black 41
4- Red with Black 40
5- Red with Black 6
6- Red with Black 30
7- Blue with Yellow 2
8- Green with Yellow 02
9- Green with Yellow 4
10- Red with Black 02
11- Red with Black 45
Red with Yellow 5
11- Red with Yellow 6
12- Red with Black 07
13- Yellow with Black 0
Yellow with Black 6
Red with Yellow 02
Red with Yellow 07
14- Blue with Yellow 06
15- Red with Yellow 04
16- Red with Black 01
Red with Black 4
Red with Black 4-
Green with Black 03
17- Yellow with Black 4

Appendix II. Hematologic, serum chemistry, and serologic values of Dall sheep (*Ovis dalli dalli*) in Alaska. A. C. Smith, III, W. E. Heimer, and W. J. Foreyt. Journal of Wildlife Disease. (In press)

INTRODUCTION

Normal physiologic values of hematology, blood chemistries, and serology are necessary criteria for disease study of a species. Most domestic species and some wild species have established values. Rocky Mountain bighorns (*Ovis canadensis canadensis*) and Stone sheep (*Ovis dalli stonei*) have published values.[2] [3] [4] This report presents data from 73 wild Dall sheep (*Ovis dalli dalli*) captured in Alaska.

MATERIALS AND METHODS

Dall sheep were captured using either a 60 ft x 40 ft nylon rocket net or a 60 ft x 60 ft nylon drop net at Sheep Creek in the Alaska Range, west of Tok, Alaska during June 1979. Captured sheep were physically restrained, three legs were hoppled, and the sheep were blindfolded. Most sheep (94%) were tranquilized with acepromazine maleate.[a] Adults 2 years or older were injected intramuscularly with 6 mg, yearlings with 4 mg, and lambs were not tranquilized.

Following tranquilization, 60 ml of blood in plain 10 ml vacutainers and a 3 ml EDTA blood sample were collected via jugular venupuncture. The EDTA sample was used to determine the total white blood cell count (Unopette #5856)[b], the total red blood cell count (Unopette #5851)[b], total hemoglobin (Spencer hemoglobinometer)[c], the packed cell volume (Clay Adams microhematocrit method)[d], and total plasma proteins (AO refractometer)[e]. A blood smear was fixed in methanol and stained with Wright's stain for the differential white cell count.

The blood collected in plain vacutainers was allowed to clot, centrifuged, and the serum was pipetted off. Serum was stored in 2 ml Cryotubes[f] frozen in a 30-liter liquid nitrogen tank[g].

Serum chemistries were analyzed with a Technicon Sequential Multiple Analyzer Computer (SMAC)[h].

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a) Ayerst Laboratories, New York
b) Becton-Dickinson Co., Rutherford, New Jersey
c) American Optical, Buffalo, New York
d) Clay Adams, Inc., New York, New York
e) American Optical, Buffalo, New York
f) Vanguard International, Inc., Neptune, New Jersey
g) Linde Tank
h) Treasure Valley Laboratories, Inc., Boise, Idaho

Tests for serum antibodies were completed as indicated in Table 1 by personnel at the Washington State Diagnostic Laboratory, Pullman, Washington (WADDL).

Table 1. Serologic procedures completed by WADDL personnel to detect evidence of antibody response to various domestic animal pathogens.

Organism	Serologic Procedure
Anaplasma spp.	Card agglutination (CG)
Brucella spp.	Plate agglutination (PG)
Campylobacter feti	Tube agglutination (TG)
Leptospira spp.	Plate agglutination (PG)
Bovine viral diarrhea virus	Serum neutralization (SN)
Bluetongue virus	Agar gel immunodiffusion (AGL)
Contagious ecthyma virus	Serum neutralization (SN)
Infectious bovine rhinotracheitis virus	Serum neutralization (SN)
Ovine progressive pneumonia virus	Agar gel immunodiffusion (AGL)
Parainfluenza 3 virus	Serum neutralization (SN)
Toxoplasma spp.	?

Results.

Forty-four sheep were captured with the rocket net, and 29 sheep were captured with the drop net. The mean age of captured sheep was 3.7 years, ranging from lambs to one sheep 13 years of age. The age distribution of captured sheep is given in Table 2. Fifty-four sheep were females and 19 were males.

Table 2. Age distribution of captured sheep, Sheep Creek, 1979.

Age	Number of Sheep
Lamb	2
Yearling	14
2	21
3	8
4	6
5	6
6	6
7	4
8	1
9	1
10	3
13	1

The results of hematological tests are presented in Table 3. A comparison of these Dall sheep mean values with published data for domestic sheep is presented in Table 4.[1 5]

Table 3. Mean hematologic values for 73 wild Dall sheep.

Leucocytic series	Mean/me	SD Standard Deviation
Total white blood cells	7600	3200
Distribution percentage		
Mature neutrophils (%)	49.6	11.9
Bandl neutrophils (7%)	rare	--
Lymphocytes (%)	33.9	11.9
Monocytes (%)	1.3	1.3
Eosinophils (%)	14.5	7.5
Basophils (%)	rare	--
Erythrocytic series		
Total red blood cells (x 10^6)	13.83	2.83
Total hemoglobin (gms/dl)	14.3	1.61
Hematocrit (%)	46	5.2
Total plasma protein (gms/dl)	6.81	.75
Mean cell volume (u^3)	33*	
Mean corpuscular hemoglobin (uug)	10.4*	
Mean corpuscular hemoglobin concentration	31*	

* Calculated from mean values for total red blood cells, total hemoglobin and hematocrit.

Table 4. Comparison of Dall sheep and domestic sheep hematology.

	Dall sheep	Domestic sheep
Total white blood cells (TWBC)	7600/ml^3	7-8000/ml^3
Range of TWBC	2-14 x $10^3/ml^3$	4-12 x $10^3/ml^3$
Differential distribution		
Mature neutrophils (%)	50	30
Lymphocytes (%)	34	62
Monocytes (%)	1	2 - 5
Eosinophils (%)	15	5
Basophils (%)	1	1
Total red blood cells	13.8 x $10^6/ml^3$	12 x $10^6/ml^3$
Total hemoglobin (gm/dl)	14.3	11.5
Hematocrit	46	35
MCV (u^3)	33	34
MCH (uug)	10.4	10
MCHC (%)	31	33

The results of the SMAC analysis for serum chemistries are presented in Table 5. A comparison of the Dall sheep mean values with published data for domestic sheep is present in Table 6.[6 7 8 9 10 11]

Table 5. Mean and standard deviations of blood chemistries for Dall sheep.

	$\overline{X}$	S.D.
Total plasma proteins (g/dl)	6.81	.75
Albumin (g/dl)	3.28	.36
Globulin (g/dl)	3.54	.69
Fe (mg/dl)	200	60
Ca (mg/dl)	9.6	.8
P_i (mg/dl)	4.8	1.6
Na (meg/l)	140	7.1
K (meg/l)	6.9	1.9
Cl^- (meg/l)	100	6.6
BUN (mg/dl)	24	4.7
Creatinine (mg/dl)	1.1	.2
Glucose (mg/dl)	162	56
Triglycerides (mg/dl)	94	45
Cholesterol (mg/dl)	60	15
Gamma glutamyl transpeptidase (IU/L)	26.5	8.8
Lactic dehyrogenase (IU/L)	762	66.8
Aspartate amino transferase (IU/L)	160	37
Alkaline phosphatase (IU/L)	844	374

Table 6. Comparison of Dall sheep and domestic sheep blood chemistry parameters.

		Dall sheep	Domestic sheep
Total plasma proteins	(g/dl)	6.8	6.0 -7.5
Albumin	(g/dl)	3.3	2.7 - 3.9
Globulin	(g/dl)	3.5	3.5 - 5.7
Ca	(mg/dl)	9.6	9.8[6]
P_i	(mg/dl)	4.8	5.2[7]
Na	(meg/l)	140	146.9 ± 4.9[8]
K	(meg/l)	6.9	4.85 ± .37[8]
Cl^-	(meg/l)	100	107 ± 4
BUN	(mg/dl)	24	8 - 20
Creatinine	(mg/dl)	1.1	1.2 - 1.93
Glucose	(mg/dl)	162	54 ± 8
Cholesterol	(mg/dl)	60	64 ± 12[9]
Aspartate amino transferase	(IU/L)	160	164 ± 23[10]
Alkaline phosphatase	(IU/L)	844	14 - 427[11]

The results of serologic procedures to detect evidence of exposure to various domestic animal pathogens are presented in Table 7.

Table 7. Results of serologic procedures to detect evidence of exposure to domestic animal pathogens among wild Dall sheep.

Organism	Test	Results
Anaplasma spp.	CG	73 negative
Brucella spp.	PG	3 positive 1:50 70 negative
Campylobacter feti	TG	2 positive 1:1000 20 positive 1:100 51 negative 1:100
Leptospira spp.	PG	73 negative
Bovine viral diarrhea virus	SN	73 negative
Bluetongue virus	AGI	73 negative
Contagious ecthyma virus	SN	17 positive 56 negative
Infectious bovine rhinotracheitis virus	SN	73 negative
Ovine progressive pneumonia	AGI	73 negative
Parainfluenza 3 virus	SN	1 positive, 72 negative
Toxoplasma spp.	?	73 negative

DISCUSSION

A previous report of all Dall sheep hematology is based on an extremely small sample, and comparison is of little value.[6] Data presented for Dall sheep in this report are similar with few exceptions to normal values for domestic sheep (Table 4).

The most outstanding difference in the leucocytic series is the percentage of eosinophils. Eosinophilia is known to be associated with endoparasites.[5] Dall sheep in other areas of Alaska are known to carry heavy parasite burdens.[12] Fecal samples of the captured population were not evaluated. Considering the differential cell count and evidence showing heavy parasite burdens in other mountain ranges, a moderate to heavy parasite load in the captured population is probable.

In the erythrocytic cell series, Dall sheep show a higher number of red blood cells, more hemoglobin, and a higher hematocrit than domestic sheep (Table 4). Several environmental factors, including stress and elevation, can influence these values.

The elevation at the capture site on Sheep Creek was approximately 3,500 ft above sea level, and it is not likely that this elevation would result in any significant elevation in the observed hematocrit.

Stress of capture can result in splenic contraction with subsequent release of red blood cells into the peripheral vasculature leading to an increased hematocrit. Stress is the most likely explanation for the increased values observed in Dall sheep.

The results of serum chemistry analysis showed Dall sheep values to be similar with few exceptions to normal values for domestic sheep (Table 6). Exceptions to normal domestic sheep values include elevated glucose, potassium, and serum alkaline phosphatase.

The elevated glucose is no doubt in response to the stress of capture which has already been discussed. It is interesting to note that the glucose values remained elevated despite the fact that the serum was not removed from the red blood cells until 18-24 hr after capture. There is little doubt that glucose values would have been significantly higher had the serum been removed from the clot immediately after capture.

Elevated potassium values can occur due to renal disease, hypoadrenocorticism, lactic acidosis shock, and circulatory failure.[13] It is unlikely that the captured Dall sheep population is suffering from renal disease or hypoadrenocorticism. A mild lactic acidosis and mild shock situation due to the stress of capture could well have been present in the majority of sheep captured. Tranquilization of captured sheep with Acepromazine which tended to lower the respiratory rates could have contributed to the mild lactic acidosis and consequently to the observed elevated potassium values.

Serum alkaline phosphatases (SAP) constitute a group of enzymes involved in both the hydrolysis of phosphate monoesters and the transport of glucose and phosphate in the intestinal mucosa, bone, kidney, and placenta. Therefore, SAP are a group of enzymes with low specificity to any one group of cells. Increased values of SAP are found in young animals due to osteoblastic activity, conditions of liver disease and bilary obstruction, kidney disease, gastrointestinal lesions, and the administration of some drugs including corticosteroids. It is not likely that observed increased values were due to any disease conditions nor to the administration of corticosteriods. The stress of capture again and the young age of the captured sheep may be important in explaining increased values.

The average age of the captured sheep was 3.7 yr with 51 percent of all captured sheep 2 yr or less. The 2-year-old sheep were still growing rapidly and had just come off of winter ranges at the time of capture. Osteoblastic activity was no doubt occurring.

Results of serological procedures to detect evidence of exposure to various domestic animal pathogens with few exceptions showed the captured population to lack exposure and hence to be a susceptible population.

All Dall sheep tested were negative for *Anaplasma* spp., *Leptospira* spp., bovine viral diarrhea, bluetongue, *Toxoplasma* spp., infectious bovine rhinotracheitis (IBR), and ovine progressive pneumonia. Of the above disease organisms, only IBR is not reported to occur in domestic sheep.[14]

Vibriosis is an abortive disease of domestic sheep caused by *Campylobacter feti intestinales* and *Campylobacter feti jejuni*. Diagnosis is based on isolation, pathology of lesions, and history of widespread abortion in young unvaccinated ewes.[14] Thirty percent of the captured Dall sheep reacted to the tube agglutination test. It is possible that vibriosis does contribute to decreased herd productivity in Alaska Range sheep.

Ovine brucellosis is a relatively common disease of domestic sheep and results in lowered productivity. Infected ewes may abort; however, more commonly, infected rams develop an epididymitis leading to absecessation and reduced fertility. Of the 73 sheep tested, three sheep showed a positive reaction to the plate agglutination test at a 1:50 titer. No further evidence was gathered to substantiate exposure of

Alaska Range Dall sheep. McCain in a personal communication suggested that beef cattle showing evidence of actinomycosis often reacted positive to the plate agglutination test for *Brucella*. Twelve sheep that were in the capture area had obvious lesions of the lower mandible suggestive of actinomycosis. Despite several attempts, *Actinomycosis* spp. have not been isolated from Dall sheep lesions. Of the three sheep that reacted to the *Brucella* antigen, none had clinically detectable lesions of the lower mandible. The possibility of brucellosis in Alaska Range sheep is unlikely, but investigation should continue.

The Parainfluenza 3 (PI3) virus has been shown to be a pathogen in the upper respiratory tract of domestic sheep[15] and Rocky Mountain bighorn sheep.[16] Serologic evidence of exposure among captured Dall sheep is slight. Only one of 73 sera showed a significant titer. In a sample of seven Dall sheep sera collected in the Brooks Range, some 300 mi north of the Alaska Range, six of seven sera showed significant titers (unpublished data). The evidence suggests exposure to the PI3 virus, but further work is needed to determine the importance of this virus as a respiratory pathogen of Dall sheep.

Contagious ecthyma (CE) is a common disease of domestic sheep. The CE virus has been shown to infect Rocky Mountain bighorn sheep.[17] Contagious ecthyma has been diagnosed in Dall sheep in captivity (unpublished data), and CE has recently been isolated from a mammary gland lesion on a captured wild Dall sheep ewe (unpublished data). Serologic evidence suggests widespread exposure to the CE virus among this population of Dall sheep. The role of this pathogen in contributing to decreased productivity among Alaska's Dall sheep deserves further study.

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