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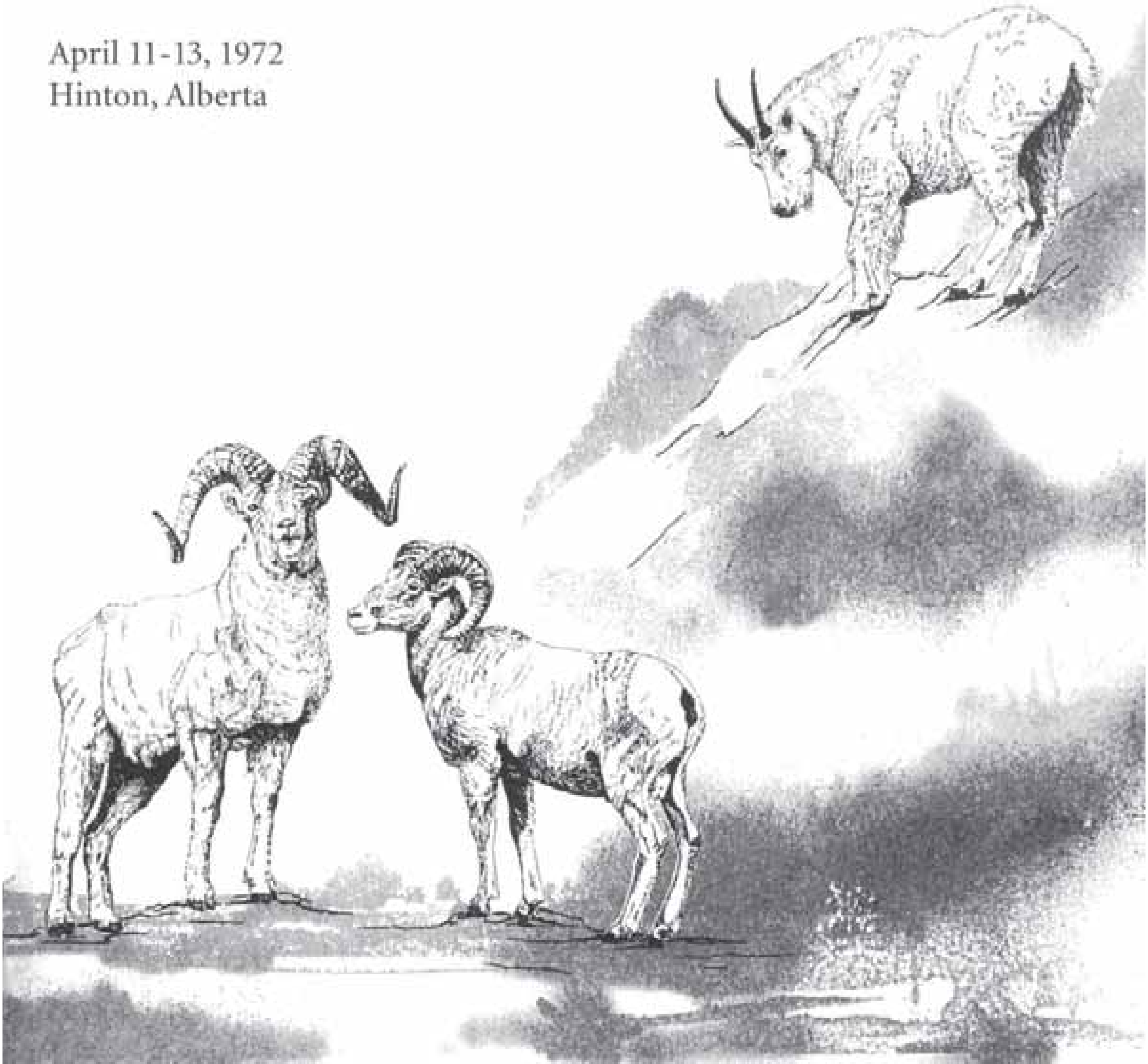

TRANSACTIONS OF THE 1972

NORTHERN WILD SHEEP COUNCIL

held in Hinton, Alberta

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Chairman: E. G. Scheffler

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MANAGEMENT AND RESEARCH ON BIGHORN SHEEP SUN RIVER AREA, MONTANA

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Abstract - Data for harvest by hunters and transplanting are discussed. Condition of ranges are compared to those in Idaho. Harvesting males has not caused the decline in ram populations reported for Idaho and Nevada. Classification data from 1955-1971 also show better lamb and yearling survival ratios than those reported by the above states. Weights for 213 animals are compared by sex and age class. Horn measurements for 145 females and 206 males are discussed for various age classes. Success of transplanting as a management technique is discussed.

Introduction

The Sun River area of Montana supports the largest bighorn sheep herd in the state. Minimum big game populations wintering in the area include 700 bighorn sheep, 2,400 elk and thousands of mule and white-tailed deer. The mule deer are the most numerous species. Domestic livestock including horses and cattle graze portions of the area.

The bighorn sheep hunting season was closed in 1912 and remained closed until 1953 when 15 3/4 curl ram permits were issued. Bighorn sheep populations reached very high levels in the 1920's and die-offs were recorded in 1924-25, 1927, 1929, 1932 and 1936. Elk populations were greater in that period than at present and large die-offs of elk were recorded in 1929. Deer populations reached their highest peak in recorded history during the late 1950's.

In 1929 a large irrigation dam was completed in Sun River Canyon and the filling of the reservoir covered some big game winter range and blocked migration routes. Another result of the dam building was that as many as 5,000 cattle which had formerly grazed the National Forest for six months of the year were banished from the area by 1934.

Major forest fires occurred in 1889, 1910 and 1919. Much of the present bighorn range is found in old burns. Some of the old burns have been restocked with timber, and conifers are also encroaching on other areas and reducing big game range.

Bighorn sheep trapping and transplanting was initiated in 1941 and 125 animals were removed by this method prior to 1967.

The first studies of the Sun River bighorn sheep were accomplished in 1941. (Couey, 1950). I worked on a food habits and range relationships study in the area in 1964 and 1965, and since have been associated with the area as a Game Management Biologist.

Methods

Composition of low growing vegetation was measured by the method of Daubenmire, 1959. Grass utilization was measured by the methods of Cole, 1958.

Bighorns were trapped in corral traps using hay and salt for bait. Both portable net traps and permanent wire and log structures were used. Snowmobiles and a helicopter were used to transport bighorn sheep from roadless areas.

Bighorn sheep were aged in the field with binoculars and a spotting scope. Yearling ratios were determined by classifying yearling males and assuming a like number of females were present. When the animals were handled, they were aged by the methods of Deming, 1952 and Geist, 1966.

Horns were measured around the outside of the curl, around the lowest portion of the horn base and from tip to tip.

Description of the Area

Bighorn sheep habitat in the Sun River area is located on the east face of the Rocky Mountains approximately 80 miles west of Great Falls, (Fig.1) Montana. According to Deiss (1943) the mountains were formed by the Lewis overthrust which moved Proterzoic and Palezoic shales and limestones over younger Mezozoic sediments. Glacial action and water erosion have modified the range to a characteristic series of closely spaced, parallel reefs running in a north to south direction. The reefs have steep east facing sides with vertical limestone cliffs several hundred feet high. West facing sides slope more gradually and are covered by scattered patches of conifer timber. Elevations vary from 4,590 feet at Gibson Lake to 9,392 on Rocky Mountain, the highest peak in the area. Tops of most of the reefs utilized for bighorn sheep winter range are from 6,000 to 7,000 feet in elevation. (Fig.2)

Climatological data recorded at Gibson Dam indicate mean temperature is 41.4 degrees with extremes of 100 and -42. Mean annual precipitation is 17.5 inches (U.S. Dept. Commerce Weather Bureau, 1929-65). Strong southwesterly winds, "chinooks", remove snow cover from southern and western exposures within a few days after snowstorms. Reef tops are also often blown bare.

Major grass species are bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*) and rough fescue (*Festuca scabrella*). Tree species common in bighorn sheep winter habitat include Douglas-fir (*Pseudotsuga menziesii*), limber pine (*Pinus flexilis*) and lodgepole pine (*Pinus contorta*).

Research and Management

Classification surveys have been made since 1955 (Table 1). Ratios of rams per 100 ewes indicate harvesting rams by hunting and transplanting has not caused the decline in ram populations reported by Hanson, 1967 and Morgan, 1970. Survival of lambs to six months of age averaged 47 per 100 ewes for the 1955-1972 period and the range was 34 to 59. This is considerably higher than that reported by the above authors also.

Grass utilization for 1967-71 is presented in Table 2. Use appears excessive in most cases if bunchgrass ranges are to be improved in condition. Because the bighorn sheep population seems to be increasing in size and some of the ranges are in a deteriorated condition, a program of trapping and transplanting has been attempted.

From 1967 through 1971 a total of 333 bighorns was trapped. A total of 235 was transplanted to other areas within Montana and the remaining 98 animals were individually marked and released in the vicinity of the traps. Since 1969, females released have been neckbanded and males have been marked with large numbered eartags for an intensive movements study carried out by a graduate student. Rams were not marked with neckbands because of fear from some quarters that the capes would be damaged. No evidence of damage has been seen on ewe necks. The final report for the summer-winter ecology of the bighorns is due in June of 1972. Another researcher, utilizing marked animals also, will study the spring-fall ecology of the animals with a report due in 1973.

Winter weights for 157 females and 56 males trapped are listed in Table 3. A monthly breakdown of the data showed lambs gained weight and the other age classes lost weight during winters. Extreme weight losses were not noted.

Horn measurements for 145 females are given in Table 4. The measurements indicate difficulty would be encountered in segregating anything except lambs through field observations during the winter period.

Horn measurements for 50 males trapped are listed in Table 5. The data indicate serious overlap in horn measurements for the two and three year old age classes. Two animals from the two year class fell within the range of yearling males. Unless these animals were incorrectly aged, the overlap could bias field observations.

Overall, over 877 bighorns have been removed from the area since 1955 (Table 6). Since 1967, 186+ males have been removed by hunters and 52 by trapping and transplanting. Percentages by age classes for the 52 males transplanted since 1967 are as follows: 50 lambs, 33 yearlings, 11 two year olds and 6 three year olds.

Horn measurements for hunter kills are shown in Table 7. Measurements declined under the pressure from 60 3/4 curl permits combined with transplanting. Hunter success fell from the remarkably high 52 rams for 60 hunters in 1967 to 40 rams in 1969. A reduction to 40 3/4 curl permits in 1970 and 1971 allowed an increase in the ram horn size in 1971. The horns were nearly as large as the 1967 level in 1971.

Comparisons of the horn data for 1971 in the Sun River area and for Idaho bighorn sheep in 1966-67 is shown in Table 8. Horn size for the Sun River bighorns is nearly the same as those in Idaho with average ages of 4.5 and 7.7 years, respectively.

Apparently better range conditions are found in the Sun River area in comparison to the areas studied by Morgan, 1970 in Idaho. In Idaho, nine Daubenmire transect clusters showed a grass coverage of 12.4 per cent and a coverage of soil and erosion pavement of 42.3 per cent. Desirable components - grass, forbs, litter, and moss made up 34 per cent on the area sampled in Idaho. In the Sun River area data were gathered from bighorn sheep winter ranges by 33 Daubenmire transects (Schallenberger, 1965). Observations showed 92 per cent of the bighorn sheep were found on three habitat types. Grasses made up an average of 19.6 per cent of the coverage on these habitat types and ranged as high as 29.3 per cent in the bunchgrass habitat type on which bighorns often grazed. Soil and rock made up 39.6 per cent of the coverage. Low growing vegetation, measured by the Daubenmire system in the Sun River area, made up 41.5 per cent of the canopy coverage. Taller browse species were not measured by the method so the actual vegetative cover was even greater.

Effects of removal of bighorns from two apparently separate winter populations in Sun River Canyon were quite apparent in classification data (Table 9). The herd in upper Sun River Canyon lives under conditions of more deteriorated winter range, competition from elk, and greater snow depths than does the herd wintering in lower Sun River Canyon. In 1969, removal of 52 bighorns was accomplished on the ranges at the upper end of the canyon. Males removed included three lambs, two yearlings and two, two year olds. Females included 10 lambs, 5 yearlings, 7 two year olds, 4 three year olds and 19 which were 4 plus. In the winter following the removal, ram, lamb and yearling ratios were higher than for the two succeeding years in the head of the canyon. As population numbers built up again the ratios declined. In 1971, removal of 74 bighorns from the better range at the lower end of the canyon resulted in an increase in the ram and yearling ratios per 100 ewes. Males removed included 11 lambs, 7 yearlings, 1 two year old and 1 three year old. Females removed included 11 lambs, 6 yearlings, 4 two year olds, 5 three year olds and 25 four plus animals. Perhaps the lamb ratio per 100 ewes didn't increase because of the relatively high previous level and the fact that many one and two year old ewes remained in the population. These age classes may not have produced lambs.

Summary and Discussion

Data for the Sun River area shows that ram ratios per 100 ewes have not been greatly reduced by several years of limited permit hunting for 3/4 curl rams and additional harvest by transplanting. This is in contrast to results reported for Nevada and Idaho. Perhaps the stability in the Sun River area results from the better range conditions and better survival of lambs and yearlings.

Trapping and transplanting is not the final answer to keeping the Sun River bighorn population in balance with the range. As better bighorn habitats have been populated the success of the technique has declined.

Minimum costs of at least $40.00 per animal trapped cannot be justified for many years if transplanting success declines. Other environmental problems demand personnel and money.

The final solution may be to maintain the range in the highest possible condition through reduction of competing animal species, preservation of the wilderness habitat, creation of new range through forest fires and control of excessive bighorn populations through harvest of large rams with limited 3/4 curl or either-sex permits and harvest of ewes with limited ewe permits.

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Table 1. Bighorn sheep classifications 1955-72

Year	Lambs	Ewes	Lambs/100 Ewes	Rams	Rams/100 Ewes	Unk.	Total
1955-56	62	113	55	62	55	38	275
1956-57	54	125	43	61	49	88	328
1957-58	50	89	56	43	48	153	325
1958-59	67	117	57	55	47	25	274
1959-60	52	131	40	77	59	109	369
1960-61	69	117	59	48	41	64	298
1961-62	86	209	41	67	32	55	417
1962-63	0	0	0	0	0	0	0
1963-64	61	117	52	37	32	34	249
1964-65	527	1,306	40	632	48	0	2,465 1/
1965-66	75	138	54	78	56	0	291
1966-67	98	289	34	108	38	0	495
1967-68	78	172	45	66	38	0	316
1968-69	111	281	40	78	28	20	490
1969-70	130	274	47	114	42	69	587
1970-71	150	326	46	111	34	2	588
1971-72	142	311	46	138	44	8	599

1/ Repeated observations of about 400 bighorn

Table 2. Grass utilization on bighorn sheep winter range in Sun River Area 1967-71

	Grass Species								
Year	Feid			Fesc			Agsp		
1967	8	77	60	3	93	74	7	96	77
1968	7	89	71	4	95	76	7	81	64
1969	7	64	49	3	77	60	7	70	54
1970	8	73	57	4	84	66	7	83	66
1971	9 1/	85 2/	67 3/	4	93	74	9	87	69

1/ No. transects examined with 100 plants per transect
2/ No. plants grazed per 100
3/ Per cent weight utilization of plants

Table 3. Winter weights bighorn sheep 1967-71

Sex	1/2 No.	1/2 Ave.	1/2 Range	1 No.	1 Ave.	1 Range	2 No.	2 Ave.	2 Range	3 No.	3 Ave.	3 Range	4+ No.	4+ Ave.	4+ Range
Female	32	61	38-70	19	99	75-115	24	119	91-145	14	120	110-150	68	131	80-155
Male	26	66	48-97	12	111	85-140	10	154	135-175	7	150	125-186	1	190	

Table 4. Horn measurements for female bighorns trapped

Age	No.	Curl Circ. $\bar{X}$	Curl Circ. Range	Basal Circ. $\bar{X}$	Basal Circ. Range	Tip-Tip $\bar{X}$	Tip-Tip Range
1/2	21	3.0 1/	1.3-5.0	2.5	.7-43	4.8	2.6-6.5
1	16	6.6	3.2-8.2	4.5	3.4-4.9	7.8	5.6-12.5
2	23	8.2	5.3-10.3	4.8	3.6-6.4	8.6	6.0-12.0
3	14	9.0	7.3-10.4	5.2	4.8-5.5	9.9	7.5-13.0
4+	71	9.7	5.6-13.5	5.1	4.0-6.1	11.1	6.5-14.5

1/ Inches

Table 5. Horn measurements for male bighorns trapped

Age	No.	Curl Circ. $\bar{X}$	Curl Circ. Range	Basal Circ. $\bar{X}$	Basal Circ. Range	Tip-Tip $\bar{X}$	Tip-Tip Range
1/2	18	4.3 1/	1.6-6.5	3.7	1.6-5.5	6.8	[illegible].5-9.1
1	12	12.6	7.2-17.5	7.8	5.3-9.3	[illegible]	[illegible]
2	11	19.8	12.4-24.8	11.7	7.8-13.4	18.6	16.5-20.5
3	9	21.1	18.0-27.0	12.4	10.7-15.0	[illegible]	17.5-22.0

1/ Inches

Table 6. Bighorn sheep harvested 1955-71

Year	No. 3/4 Curl Permits	Rams Shot	Total Sheep Transplanted	Total
1955	20	12	0	12
1956	20	15	13	28
1957	40	32	7	39
1958	40	30	8	38
1959	40	35	13	48
1960	40	30	10	40
1961	40	32	9	41
1962	40	28	18	46
1963	40	31	0	31
1964	40	27	25	52
1965	40	37	0	37
1966	40	34	0	34
1967	60	52	49	101
1968	60	45	53	98
1969	60	40	57	97
1970	40	29	2	31
1971	40	20+ 1/	84	104+

1/ Hunter questionnaire information not available for 1971.

Table 7. Hunter harvested ram horn measurements from Sun River

Year	Sample No.	$\bar{X}$ Curl Circ. Right	Left	$\bar{X}$ Basal Circ. Right	Left	$\bar{X}$ Tip-Tip	Score $\bar{X}$	Range
1966	25	31.9	31.7	14.9	15.1	19.5	113.5	89.5 122.5
1967	40	31.5	31.3	14.9	14.9	19.5	111.9	83.0 [illegible]
1968	25	31.2	31.2	15.1	15.1	20.0	115.6	92.0 135.1
1969	24	29.0	29.3	14.8	14.9	19.3	107.2	86.3 123.5
1970	22	27.3	28.0	14.6	14.6	19.1	104.1	91.8 120.0
1971	20	30.2[1/]	30.5	14.7	14.6	19.3	109.4[2/]	95.1 [illegible]

1/ Inches
2/ Sum of measurements

Table 8. Hunter harvested bighorn ram measurements

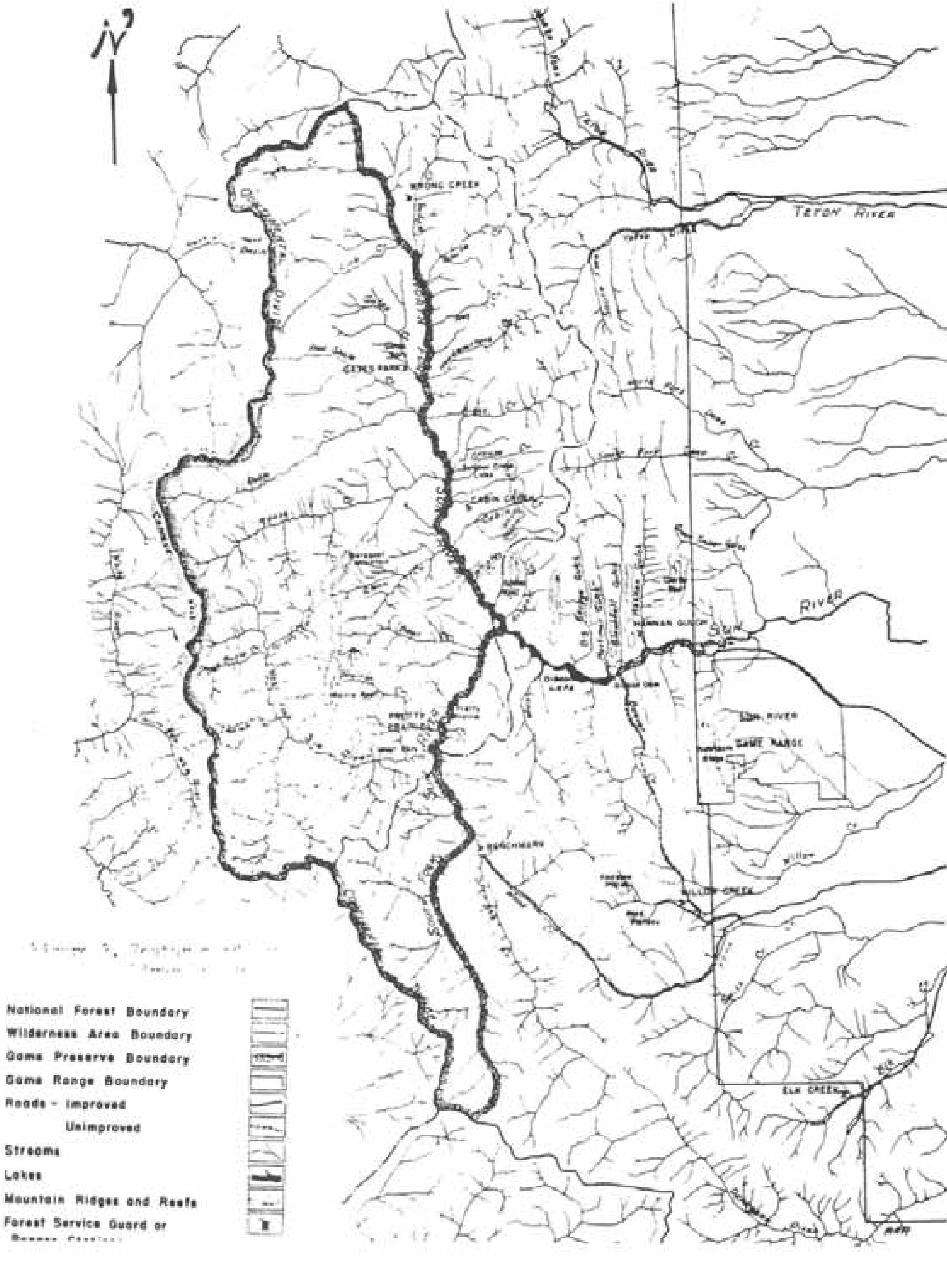
Date and Location	Sample No.	$\bar{X}$ Age	$\bar{X}$ Curl Circ. Right	Left	$\bar{X}$ Basal Circ. Right	Left	$\bar{X}$ Tip-Tip	$\bar{X}$ Score
1966-67 Idaho	29	7.7	31.5[1/]	30.9	14.2	14.0	19.8	110.4[2/]
1971 Montana Sun River Area	20	4.5	30.2	30.5	14.7	14.6	19.3	109.4

1/ Inches
2/ Sum of measurements

Table 9. Ram, lamb, and yearling numbers per 100 ewes

Location	Year	Rams	Lambs	Yearlings	Sample Size
Upper Sun Canyon	1969-70	52	48	39	122
	1970-71	31	34	30	216
	1971-72	39	39	29	233
Lower Sun Canyon	1969-70	36	53	56	191
	1970-71	36	54	49	201
	1971-72	55	51	79	161
Ford-Fairview	1969-70	47	37	46	128
	1970-71	43	55	35	109
	1971-72	58	53	58	84
Deep Creek	1969-70	45	47	41	102
	1970-71	29	51	26	63
	1971-72	34	49	43	126

Figure 1. Sun River Area


TETON RIVER
WRONG CREEK
CABIN CREEK
RIVER
HANNAN GULCH
SUN RIVER
GAME RANGE
BENCHMARK
ELK CREEK
National Forest Boundary
Wilderness Area Boundary
Game Preserve Boundary
Game Range Boundary
Roads - Improved
Unimproved
Streams
Lakes
Mountain Ridges and Reefs
Forest Service Guard or

A. Schallenberger - Question Period

Q. You mentioned about 100 bighorns in a transplant. In how big an area did this take place?

A. This was down on a wildlife refuge on the Missouri River, a former Audobon Sheep Habitat. They built up a pasture of about 2,000 acres and put sheep in there in late 1950. The pasture was protected from cattle grazing but the whole area was overrun with sheep. Last year, three-quarters of the winter range was removed before the bighorn sheep started wintering there. They took hay off the area, cattle grazed part of the area, and we had a lot of snow, 2 to 3 feet deep. Even last fall, after a dry summer, sheep were hacking and coughing, the typical symptoms of lungworm. With the range in bad shape and the sheep down with lungworm, they will suffer with starvation this winter.

Q. When did the ram seasons occur?

A. Generally ran from about the 15th of September to about the 30th of November. A few years ago when we had sixty permits, the season ran to the end of December.

Q. What is the age structure of kill? Toward the tail end of the season are you taking more older rams or younger rams than in the beginning? In order to maintain your 4 1/2 year average, you must be taking 2 1/2 and 3 1/2 year old rams too?

A. No. Most of them were 4 1/2 or so. We had one 2 1/2 year old ram with 27" curl that got shot - an inch less than 3/4 curl standard - from the front horn, through the back of the eye to the horn again. Most of the sheep are taken late in the season - the latter part of November when they move down into accessible areas.

Q. You had a mean age of 4 1/2 years in last year's season?

A. Right.

Q. Where are the big rams?

A. We wiped most of the big rams out with 60 permits. They are just building back up again.

Q. Al, the figures on rams per 100 ewes - you included yearling ewes as well?

A. Right, we included all ewes.

Q. You took all your big rams then; you are averaging 32" 4 1/2 yr. of age - there are no big rams left? All you have left are 4 1/2 year old rams? Don't you think you are over-harvesting?

A. There are big rams left. As I told you, the sheep population is increasing. We have seen a number of real large rams this winter. We are recommending that for this coming year there be 40 either sex permits. We have seen 55 rams which we feel will be legal size next year.

Q. Then do you have a goal - a mean age goal type of thing - in the harvest? In other words, do you have a goal which you would like to reach, e.g. a mean age in the harvest of 4 1/2, 6 1/2 or 8 1/2?

A. No particular age goal. One of our goals is not to go the full curl ram hunting, or something like that. It is getting to be a monetary thing in Montana. We have some outfitters charging as much as $5,000 for a ram.

DIFFERENCE BETWEEN YEARS AND NUTRIENT CYCLES

Daryll Hebert
University of B.C. Vancouver

Sheep, (Ovis canadensis canadensis) along with most other ungulates of the mountainous areas of Canada, undertake seasonal migrations to and from high alpine ranges. The downward migration appears to be weather induced while the motivation for the upward movement appears to be food oriented. The known facts of phenology and the associated changes in the chemical composition of plants suggests that one of the probable advantages to be gained is improved nutrition.

A group of adult ewes (1967-68) were maintained on a variety of forages (ration 36-57, alpine, winter) which changed in quality with season. During 1968-69, two groups of yearling sheep were maintained, one on winter range forage year-round while the other was changed from winter to alpine range to simulate the normal migratory pattern.

The winters of 1967-68 and 1969-70 could be considered mild with a light snowfall and relatively mild temperatures. This resulted in a short critical winter period (January and February) of both years and an early spring green-up. Precipitation was lowered, presumably resulting in lowered productivity and reduced succulence of the forage. The light snowpack of the two years did not knock down over-wintering forage and therefore did not allow ungulates to graze much of the spring growth until it reached 4 to 6 inches in height and in some cases emerged from the previous years growth. Observations showed that considerably less spring growth had been grazed in 1968 than in 1969. This is believed to have reduced the average nutrient intake of sheep grazing on the winter ranges during the early spring. The proportion of old growth to new, available to sheep is shown in Table 1.

The winter of 1968-69, although harsh resulted in many beneficial side effects. The abnormal snow depths produced abundant soil moisture and resulted in greater subsequent forage productivity as compared to the summer of 1968. In June a record rainfall of 6.02 inches caused forage to remain green and succulent later into the summer and greatly aided productivity. The extreme weight and compaction of the winter snow flattened all of the past years growth and allowed spring growth to emerge from old growth when only one to two inches in height (Table 1). This resulted in deer, sheep and elk utilizing the earliest spring growth in late March and early April.

Observations on the grazing habits of a tame bighorn lamb indicated the difficulty of a grazing animal to select high quality feed when old growth protected new growing forage. Bighorns tend to pull

Forage Description	Date				
	1968	1969	1970		
Percent New Growth	July	July	May	June	July
	[illegible]	95-100	[illegible]	[illegible]	[illegible]
Percent Old Growth	41	0-5	60.0	35.4	17.2

Table 1. The proportion of previous year's forage to the current year's growth, using bluebunch wheatgrass as the indicator species. (Percentages based upon field dried weights).

Date	Winter Range	Percent C.P.	G.E. kcal/gm
1968			
June [illegible]	Bull River	7.0	4.11
July 22	Wigwam	5.9	4.31
1969			
June 15	Premier Ridge	10.1	4.45
July 1-20	" "	5.97	4.15

Table 2. A comparison of crude protein and gross energy values, for similar dates, between years, for areas approximately similar in species composition and phenology.

Animal Group	Composition of Diet	Date of Collection	Average Digestibility
Adult Ewes	Agropyron [illegible] percent	1908 June [illegible]	52.3
" "	"	July [illegible]	[illegible]
Yearling Ewes	Agropyron 65-70 percent	June 1-10	71.6
" "	Agropyron 85-90 percent	July 1-10	56.6

Table 5. A comparison of digestibility between years (1908 and 1909) on forages approximately similar in species composition and phenology.

grass blades from their sheaths rather than nip them off. This has recently been supported by Geist (1971, p.268) who suggests that a pulling or plucking type of grazing increases the nutrient content of each mouthful. During 1968 bighorns ingested considerable quantities of old growth while grazing in this fashion but not in 1969 when only new growth was available.

In early June, 1968 and 1970, previous year's growth comprised 65-75 per cent of the standing forage crop (Table 1) while in 1969 it was considerably less. This produced a 2.5 per cent difference in absolute crude protein values between June of 1968 and 1969. In July of both years crude protein content was similar, as current year's growth forms the bulk of the standing crop. Alpine forage sampled at approximately the same date in both years, contained similar quantities of crude protein, since no previous year's forage is present.

Similarly, gross energy of forage cut during June of 1969 is considerably higher (Table 2) than that cut in June of 1968 (difference of .34 Kcal/gm). During July the difference is reduced (.10 Kcal/gm) with the 1968 forage containing more gross energy than the 1969 cut forage. Alpine forage cut in August of 1969 contained approximately .13 Kcal/gm more gross energy than that of 1968.

Another component of the difference between the 1969 spring vegetation and that of 1968 is seen in the comparison of June and July digestibilities of experimental diets. In 1969, the digestibility of the June sample was significantly greater (26 per cent) than that of the July sample. In 1968, on the other hand, (Table 3) the digestibility was the same in June as in July and both were at the level of July 1969.

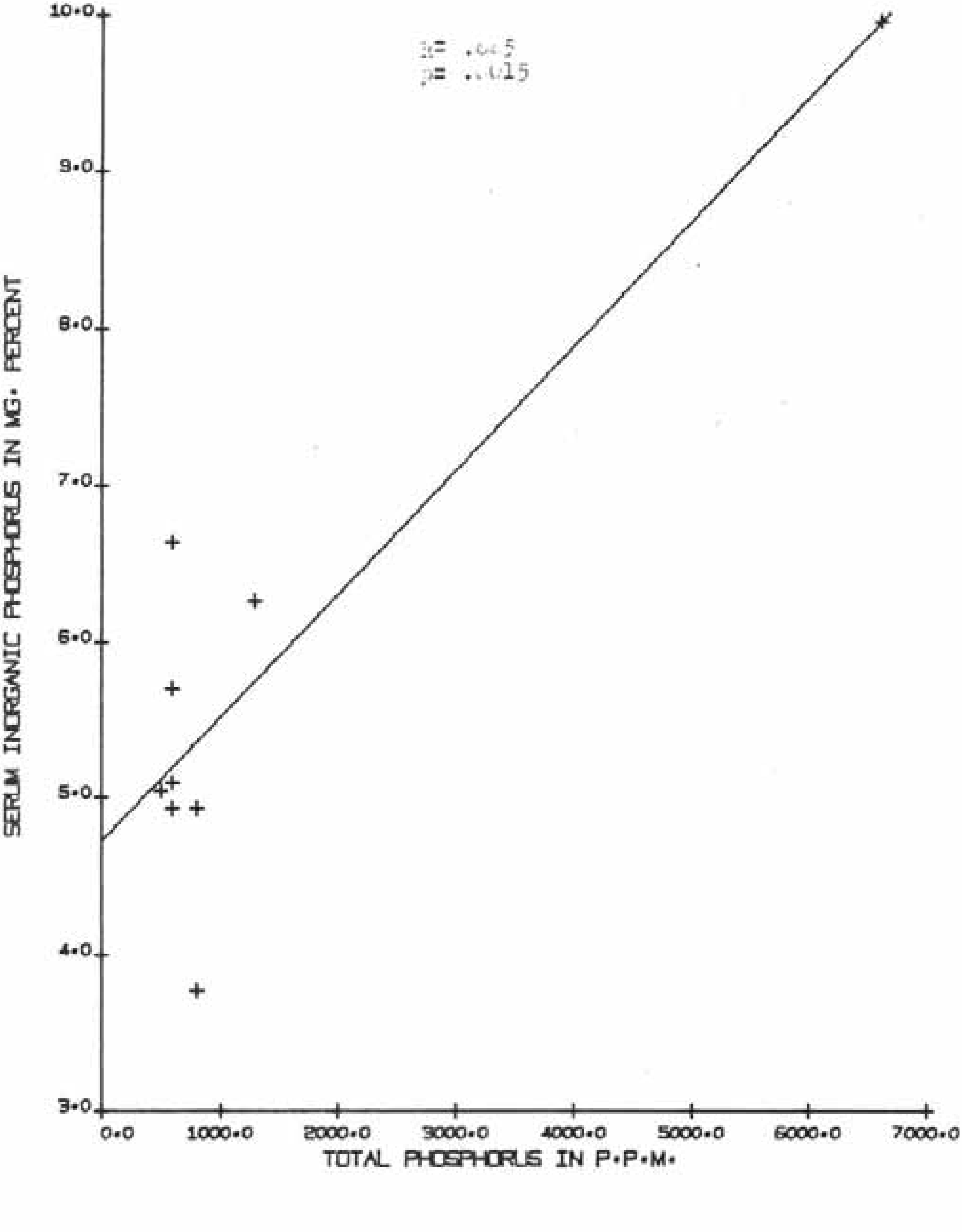
The situation of 1969 is considered "normal" when the proportion of old growth is minimal and does not mask the change in quality. Thus, the drop in digestibility from June to July is a direct result of the reduction in quality of the forage rather than to a change in composition.

Preliminary work during the summer of 1968 indicated definite yearly changes in crude protein and gross energy in winter range plants. Differences between summer and winter range plants indicated sufficient potential benefits to migrating animals to warrant a more extensive investigation in 1969.

In 1969-70, approximately 6,000 pounds of natural winter and summer range forages was selectively cut using hand clippers and in some cases a sickle mower, where the vegetation was sufficiently uniform. Diets were formulated on the basis of field selectivity trials using an imprinted bighorn lamb, pen selection trials, actual observation, availability of the forage and a review of the literature.

Periodic sampling was undertaken to document the course of the change in protein, energy and phosphorus values throughout a 12 month period, from initiation of new growth in April.

This indicated that CP declined from about 18 per cent to 2 per cent on the winter range while GE changed from 4.40 Kcal/gm to 4.1 Kcal/gm. Subsequently, on the summer range CP declined from about 17 to 11.6 per cent from July to October but changed minimally from November to May 18 (9.2 to 7 per cent CP). In contrast GE increased from about 4.44 Kcal/gm to about 4.56 Kcal/gm in the same period.


r= .645
p= .015
SERUM INORGANIC PHOSPHORUS IN MG. PERCENT
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
0.0
1000.0
2000.0
3000.0
4000.0
5000.0
6000.0
7000.0
TOTAL PHOSPHORUS IN P.P.M.

The annual cycle of phosphorus parallels that of crude protein. Maximum phosphorus values of winter range grasses, mainly bluebunch wheatgrass and rough fescue, reached 2,600-2,800 ppm. in April but had declined to 1,600 ppm. by early July. Decline was abrupt between July and September, with a total decline for the period of about 57 per cent. Late winter values of 500 ppm. represented about an 81 per cent loss from maximum values, the previous spring. Declines are minimal from early to late winter, during the period when forage is frozen.

The alpine range, with its later commencement of growth, reached maximum levels toward the end of July (3,000 ppm.) and maintained these throughout August. By freeze-up in late September values had declined 56 per cent to 1,300 ppm.

Serum phosphorus showed minimal change while the sheep were on winter range forage (Hebert, 1972, J. of Range Mgmt. In Press). The relationship between serum and forage phosphorus is given in Figure 1 and is significant.

Winter range forage satisfied the requirements for phosphorus for gestation until June but were below the lactation and winter requirements. In contrast the summer range met requirements year around.

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D. Hebert - Question Period

Q. Did you determine the phosphorus levels in individual species and did you find a correlation between the phosphorus levels you had in the winter time and the percentage of the diet that were forbs? Did you increase the content of your forbs?

A. I didn't look at that aspect. I know that in other work forbs were generally higher in phosphorus than were grasses, and you could manipulate the phosphorus content by changing your forb content. My diets were mainly grass diets. The forb component of the winter range areas was fairly small. On the alpine areas I imagine you could manipulate phosphorus content substantially by changing the forb component of the diet.

Q. Have you any data on protein levels of shrubs on winter range compared to grasses?

A. No. I didn't do individual species. There is a student working in that same area now on individual grass species, so I hope eventually to relate that to what I have done on nutrient changes in the diet.

Q. Did you supplement your lamb when it was on your forage trials?

A. No, my lamb was not supplemented.

Q. Was he strictly on natural forage?

A. Right.

Q. Does pen raising affect selection of forage?

A. From some of the work done by Longhurst I think it probably is very close to that which they would select in the wild. Their pen raised young animals selected virtually the same dietary composition as the adult animals taken in from the wild.

Q. You mentioned last night you were able to keep a sheep alive for a considerable time on a protein level down to 2 per cent - that was for how long?

A. Their diets contained approximately 3 per cent crude protein from October until February and 2 per cent until April.

Q. Have you any information to show changes in productivity with the various protein levels?

A. No, I was strictly interested in nutrition. I noted weight changes in various blood components and differences in digestibility, etc.

Q. Have you seen anything in the literature correlating winter protein levels and production?

A. Some of the work on deer, yes, but not on sheep.

Q. It does show correlation though?

A. Yes, I think so. Other workers used animals prior to the production stage. I think it would complicate things to get into productivity along with nutrition at this stage. A lot of the work done by Ullrey with pregnant white-tailed deer indicates that when he gets some of his animals down to the maintenance level he has the female decreasing its body weight and the fetus increasing its body weight and he may have a situation where the female actually is in negative nitrogen balance prior to what he thinks it is.

Q. Do you have any weights of the lambs you were holding?

A. Yes, I have weights for the whole year. The animals were measured weekly and before and after each trial.

Q. What would be the maximum weight?

A. By the time we reached the end of the alpine forage trial he was just over 100 lb. During the first year I kept him on maintenance and sub-maintenance diets, from weaning throughout the winter. There was considerable compensatory growth through the second summer and he picked up weight quite rapidly. He may have been 10-20 lb. heavier if he had been on a normal diet the first year without the compensatory growth.

Q. What is the lowest level of protein necessary to produce death of an animal.

A. I don't know - I didn't have any animals die. I am sure the group that was on winter range forage year around were pretty well at rock bottom by the end of that winter. We did a lot of blood work on them, such as blood urea, various minerals, hematocrit and hemoglobin. The animals were in extremely poor condition and I am sure if they had been out on the range with any kind of heavy snow or any other stress, they probably would have died, but under the pen conditions they probably stayed alive longer.

Q. You maintained the imprinted lamb at 36 lb. throughout the first winter of his life?

A. Yes. He was weaned at 20 lb. and for about 2 months while the temperature was fairly warm - September and October - he gained weight and then the temperature went down below freezing and he began losing weight for the rest of the winter. They were on maintenance diets. The established maintenance protein diet is about 6-7% and most of the diets I used were 5-6%. The second year he gained about 70 or 80 lb.

Q. Did you have this animal treated for worms or anything else?

A. No, I didn't use any such treatment. I didn't give them any antibiotics and I didn't treat them for any intestinal parasites.

Q. How did you prevent stressing? Did you keep them among people early in life?

A. Right. We kept them in the house for about the first 2 months of their life. He was imprinted so that he would come when he was called. I don't think he underwent too much stress at all. We checked the degree of stress through blood sampling procedures. We stressed some of the other animals and compared their SGOT values to his. There was virtually no change in his blood value, whereas there was a change with some of the other animals.

Q. The older animals - how did you keep them penned?

A. These animals were in metabolism pens at all times. The pens were 6 x 8 ft. in size. I had all the pens connected for purposes of weighing.

POST DIE-OFF RECOVERY OF EAST KOOTENAY BIGHORN SHEEP

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Introduction

Rocky Mountain bighorn sheep suffered severe losses in the East Kootenay of British Columbia during the mid-1960's. Bandy (1966) documented and described the etiology of the die-off which was ascribed to a pneumonia-lungworm-malnutrition complex.

Detailed population composition records have been obtained for most herds of bighorn in the East Kootenay since the early 1960's by the B.C. Fish and Wildlife Branch. The Wildlife Research Section has undertaken a comprehensive analysis of the population data with the objective of describing the dynamics of the area's bighorn population before, during and after the die-off. This paper presents a review of the changes in total numbers as a result of the die-off, a comparison of the post die-off response in two discrete herds and progress in bighorn habitat management and protection.

Methods

Population data was collected by aerial (helicopter) and ground (foot, automobile, snowmobile and horseback) counts by Fish and Wildlife personnel. Population estimates were based on a combination of maximum counts, harvest records and informed estimates.

Acknowledgements

Many people contributed to the organization and collection of the population data between 1960-61 and 1971-72. In some instances the collection of information necessitated physical hardships and personal sacrifices. The list of contributors includes: H. Andrusak, B.E. Clapp, D.A. Demarchi, C.G. Ellis, R.R. Farquharson, T.A. Fraser, B.R. Gates, J.P. Gibault, L.F. Harmsworth, J. Logan, J.V. Mackill, L. Russell, R.A. Seaton, W.G. Smith, C.E. Stenton and J.D. Williams. Helicopter pilot Art Druet piloted all of the aerial surveys, and Daryll Hebert and Frank Phillips contributed classified counts.

Population Estimates

Table 1 shows the estimated numbers of bighorn sheep resident in the East Kootenay herd before and after the die-off and during the 1971-72 winter. Bighorn which summer in B.C. and winter in Alberta are not included.

The total population was estimated at 1,650 in the early 1960's, declined to about 720 at its lowest point and was estimated at 935 during 1971-72 winter. Herds affected by the die-off declined from 1,310 to 380 with a recovery to 595 by 1971-72. This indicates a loss of about 930 bighorn or about 70 per cent of the affected herds and a subsequent recovery by 1971-72 of 215 bighorn or 56 per cent of the survivors.

Losses to individual herds ranged from 95 per cent in the Bull River herd to slightly more than 50 per cent in the Wigwam herd.

Extensive aerial searches were conducted between 1965 and 1971 to locate reported and unknown wintering herds. As shown in Table 1, eight separate herds totalling some 330 bighorn were located. With the possible exception of the McGuire Creek herd which has shown an increase since it was documented in 1967, there is no evidence to suggest that these herds were affected by the die-off. The majority of these herds winter at elevations in excess of 6,500 feet and their apparent numbers and herd structure remained relatively constant since initial discovery.

Recovery

Reproduction and recruitment has occurred annually in all affected herds since the die-off including the Bull River herd which was almost decimated. However, the rate and degree of recovery has varied considerably between herds. As indicated by late winter lamb:ewe ratios, recruitment varied from an average of less than ten lambs per 100 ewes in the Premier Ridge herd to a high of 55 lambs per 100 ewes in the Wigwam herd during the 1966-67 winter. Table 2 compares the lamb:ewe ratios for the Wigwam and Premier herds between the 1962-63 and 1971-72 winters.

TABLE 1. Maximum pre and post die-off and present estimates of separate East Kootenay bighorn herds. (Based on late winter populations).

AREA	HERD	PERIOD OF DIE-OFF	PRE DIE-OFF NUMBERS	POST DIE-OFF NUMBERS	1971-72 NOS.
R.M.T.	Bull River	1964-65	200	10	15
	Columbia Lake	1965-66	100	30	35
	Estella Mtn.	1965-66	130	30	40
	McGuire Cr.*	?	(50)	(30)	50
	Phillips Cr.	N.A.	30	30	30
	Premier Ridge	1965-66	150	50	50
	Radium	1966-67	150	40	60
	Wigwam River	1963-65(?)	300	130	200
	Wildhorse R.	1965-66	(30)	10	(20)
White R.	Coyote Cr.				
Van Nostrand	McLean Pk.	1965-66	(200)	(50)	(125)
Range	Whiteswan L.				
	Nine Mile Cr.				
SUB-TOTALS			1340	410	625
East Elk	Ewin Pass*	N/A	(85)	(85)	85
	Grave Creek*	N/A	(30)	30	30
	Imperial Mtn.	N/A	30	30	30
	Todhunter Cr.*	N/A	(20)	20	20
West Elk	Brule Cr.*	N/A	(15)	15	15
	Crossing Cr.*	N/A	(20)	20	20
	Quarrie Cr.*	N/A	(35)	35	35
Upper	Cross R.	N/A	Unknown	(Extinct?)	Unknown
Kootenay	Simpson R.*	N/A	75	75	75
SUB-TOTALS			310	310	310
GRAND TOTALS			1650	720	935

N/A = Not affected.
Brackets indicate subjective estimates only.
* Herds located since 1965.

TABLE 2. Post die-off late winter juvenile:female ratios in the Wigwam River and Premier Ridge bighorn herds.

	LAMBS : 100 EWES	
WINTER	PREMIER	WIGWAM
1962-63	49(124)	51(238)
1963-64	54(96)	39(112)
1964-65	29(95)	16(112)
1965-66	5(69)	12(110)
1966-67	5(55)	55(164)
1967-68	5(43)	44(148)
1968-69	7(40)	36(193)
1969-70	7(35)	21(147)
1970-71	11(43)	N.S.
1971-72	14(44)	29(161)

Numbers in brackets are total classified including rams.
N/A = not surveyed.

Initial recovery was the most rapid in the Wigwam herd. The high proportions of lambs in 1966-67, 1967-68 and 1968-69 coincided with a marked reduction in the Wigwam River elk herd in 1965 caused by the lifting of a long established elk hunting closure. However, the recruitment rate declined in 1969-70 and the population remained relatively stable between 1969 and 1972.

One explanation for the decline in the lamb component in 1969-70 was the severe winter of 1968-69 which affected most ungulate populations in the East Kootenay.

Recovery in the Premier Ridge herd was negligable over the seven year period following the die-off. The low lamb production and yearling recruitment rates were barely sufficient to maintain the population. A slight improvement was noted in the lamb components in 1970-71 and 1971-72. However, 1971-72 the herd possessed an abnormally old female segment resulting from the low recruitment rates since 1964-65 and unless production improves within the next two or three years, further declines can be expected.

Recovery rates and patterns of the remaining herds fell between the two extremes described for the Wigwam and Premier herds. Generally, all herds increased but, with the possible exception of the McGuire Creek herd, none reached their pre-die-off abundance by 1972.

Management and Protection

Management of the bighorn population has been directed primarily at habitat protection and acquisition and the regulation of the harvest of 3/4 curl males. Efforts have been focused upon protection of the Elk Valley bighorn winter ranges from coal exploration activities. Although no damage has occured to date, most of the ungulate winter ranges on the east side of the valley are under active coal exploration licences and the future of these ranges is uncertain.

In the Rocky Mountain Trench, livestock grazing has been eliminated or reduced on all bighorn winter ranges excepting Phillips Creek.

However, significant numbers of cattle remain on the Bull River and Premier Ridge winter ranges and efforts are being made to improve grazing practices with a view to decreasing the competition with bighorn for winter forage. Two small ranches were purchased to provide land for winter range and to reduce livestock grazing of the adjacent winter range.

No artificial methods of range improvement have been undertaken. Demarchi (1971) documented the rate of forest succession in the Rocky Mountain Trench and concluded that it was a significant cause of range shrinkage for both domestic and wild ungulates. A program of range rehabilitation through controlled burning can only be accommodated by changes in present Forest Service policy.

The regulation of the harvest of rams by the three-quarter curl restriction is presently under active review. A high demand for trophy bighorns and a marked reduction in both population size and the male component of most herds requires further restrictions in the annual harvest of males.

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Ray Demarchi - Question Period

Q. To get a die-off in the alpine, what was the forage like and competition like on that range compared to other ranges?

A. The only area that suffered from the die-off in the alpine situation was the White Swan area. Sheep from this area came into contact with sheep from the Premier area; they appeared to share a common summer range. The White Swan herd winters on high-swept ridges and also utilizes during the spring time a seral shrubland area, which is presently being reinvaded by conifers. Now, we could say that forest succession was a complicating factor and really rationalize this thing, but I would keep my mind open on it and I suspect that once a disease becomes virulent, any population in its path will suffer some loss. Now, this is strictly a hypothesis, but on the other areas there was either a past history of range abuse 15 or 20 years before the die-off, 10 years before the die-off or right at the time of the die-off, or forest succession.

Q. Further to Al's question, do you care to speculate as to why the other alpine herds did not suffer a die-off at the same time. Does that have anything to do with winter nutrition, maybe protein, or is there any livestock use of the alpine ranges?

A. First of all, there is no livestock use of this alpine range and, in fact, there is very little ungulate use of any kind except for some elk use particularly in the spring and summer. In mid-winter the sheep are up on the high ridges. I am not a nutritionist but one thing that comes to my mind when we are talking about high quality alpine forage (and Daryll Hebert has suggested that it is like a deep-freeze and plants maintain high nutritional levels even on the wind-swept areas), is that snow still gets built up in pockets. Around the edges of drifts you can see where the sheep have been feeding on the wind-swept snow covered vegetation. They are exposed to wind velocities up to and probably in excess of 80 miles per hour and in some situations the wind blows constantly 24 hours a day for the entire winter as Al Luckhurst has found on stone sheep range. The small horn size of the rams to my mind at least points out that they are living under some pretty tough conditions and I would suggest that they require that highly nutritious forage just to make it up there on the alpine. If the bacteria would have reached those sheep, I suspect we would have suffered some losses but it is speculation and I have no evidence to support or deny it.

Q. Could it be that winter weather is acting in a density independent manner to prevent population build-up and that it is maintaining or preventing populations from becoming too abundant?

A. No, I don't think it is working in a density independent fashion. I think maybe the reverse is true and I think that some of these alpine ranges may provide some classic study sites for determining just what is the limiting factor. I find that in the Fording River, for instance, and on Sheep Mountain behind Grave Lake, and north of Quarrie Creek in the strip mining country, there are cases where winter ranges are extremely isolated. You are flying over areas of 3, 4 or 5 feet of snow and all of a sudden you locate a small pasture on the side of the mountain in the shape of a triangle in a basin which is completely free of snow for the whole winter because of the wind action and southern exposure. The sheep are confined as if they were surrounded by a 9, 10 or 11 foot fence in that area, exactly like they were on an island. They are almost insular populations during the winter months. If there was any place where any intra-specific competition for forage was occurring, I would suggest that it be on those sites because no matter what type of winter is occurring down in the valley the winter weather up there is almost the same every year. The sizes of those winter ranges appear to be about the same every year. I think if we did meteorological studies we would find fairly constant weather conditions and the range would stay about the same every year. Therefore, I do not think that winter weather acts in a density independent manner but that again is just my own personal opinion.

Q. You said you had about 50 sheep on Premier now for about 7 years, is that right? How small an area? Have you considered inbreeding on that area with small populations?

A. That is a good question and one I didn't want to discuss for a second because I don't know whether anyone has ever shown it or not, but on the whole, inbreeding is probably something that has been created by man rather than something in the wild. Nature is a pretty harsh culler and anything that is defective goes. There may be some inbreeding but I don't think it would be significant and the reason I say that is because of the apparent good health of very very small populations of sheep which have existed since white man first came to the Kootenays. Brule Creek supports no more than 15 sheep and when W. C. Hornaday and company hunted in there in 1908, I believe, and killed two rams, they made an estimate of the population which they said was very small. If you go back into the old B. C. Game Commission Reports on the Elk River Game Reserve, you will see that the population has remained fairly constant and yet I saw four Class '4' rams, and the ewes have anywhere from a 40 to 60 per cent lamb crop, so I think that inbreeding in nature is just practically unheard of. If anyone has any information to the contrary I sure would like to hear it.

ABSTRACT OF NON-TROPHY OR EWE SEASONS IN ALBERTA

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The concept of shooting female sheep in Alberta was first considered seriously in 1956; i.e., the same year that we instigated the protective 3/4 curl law for rams. The inspiration for ewe seasons was primarily due to the die-off in the early 1950's of the protected Tarryall herd in Colorado. I understand at that time the idea of ewe seasons did not go over too well in the United States. Here in Alberta, hunters were in fact ready to hang the man (who still wishes to remain anonymous) for even suggesting the idea of shooting female sheep. Fortunately for us and unfortunately for British Columbia, there was another severe die-off of bighorns closer to home in the mid-sixties. As a result, in 1966 we were able to initiate our first "ewe" season.

Outside of the National Parks we have between 4,000 and 5,000 bighorns. The average legal ram kill is around 150 and the average non-trophy or "ewe" kill is about 110. Thus, the average annual sheep harvest since 1967 has been around 260 animals or about 2% of the available bighorn population. Obviously, the total effect of hunting has been negligible, and our efforts in management will have to be directed to more intensive removal of ewes. At present we have 400-600 applicants for 300-350 non-trophy permits.

In a study area near Nordegg we have a bighorn herd of about 100 head, and at last count there were 33 adult ewes. This particular herd produces between 20-25 lambs per year. This fall we plan to remove about a dozen adult ewes in order to compare the survival of the orphaned

lambs with unorphaned lambs. In other words, it is possible that we are taking two sheep for every adult ewe recorded and our "ewe" seasons may be more effective than we think.

There is a fair amount of controversy over shooting ewes with lambs from an aesthetic point of view. Indications are that shooting an adult ewe with a lamb at heel is not a very pleasant experience, since the lamb tends to stay around in full view of the hunter at the kill site. An alternative proposal would be to encourage the harvest of non-productive ewes; i.e., primarily yearlings and 2 year olds. In any case, the emotional hang-up is a management problem that we still have to face. Since trapping and transplanting sheep is costly and really not necessary in Alberta, I don't know how else we can sustain healthy bighorn populations without "ewe" seasons.

STRESS-INDUCED IMMUNOLOGIC IMPAIRMENT IN ROCKY MOUNTAIN BIGHORN SHEEP

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Rocky Mountain bighorn sheep serve as hosts for a wide variety of parasitic, bacterial and viral pathogens (Forrester, 1971). A major pre-occupation in past years has been the incrimination of each of these agents as a prime etiologic agent in large-scale die-offs. Pneumonia caused by lungworms has been identified as a major pathogen in a number of outbreaks of respiratory disease. Some workers have emphasized bacterial organisms, particularly *Pasturella*, whereas others have postulated the involvement of viruses (Howe et al., 1966) or *Mycoplasma* (Woolf et al., 1970).

On the basis of present knowledge, there does not appear to be one pathogen that can be considered a common denominator. However, environmental stress (nutritional, meteorologic, psychologic or otherwise) is emphasized in a large proportion of disease outbreaks. Perhaps the association is more imagined than real - it may have been adopted in desperation since it is a convenient term accounting for the "all others" category. However, there is probably enough circumstantial evidence to warrant some time and effort in determining the mechanisms by which stress may influence the frequency and severity of such infections.

A good starting point is the development of methods to monitor general immunologic status. With such a tool, the role of a variety of environmental stressors in the respiratory diseases of bighorn sheep can be evaluated.

A number of methods, such as experimental infection or immunization, are available for assessing immunologic status. Such procedures permit a direct evaluation of the ability of animals to resist disease or produce antibody. However, they are obviously impractical for examining free-ranging populations of bighorn sheep. A technique is required which involves only brief handling of animals at a single capture.

Functional characteristics of peripheral lymphocytes have been used successfully in human medicine as correlates of immunologic reactivity (Revillard, 1971). The lymphocyte is a basic cellular element involved in both humoral and cellular immune responses. Phytohemagglutinin (PHA), an extract of the kidney bean (*Phaseolus vulgaris*), acts as a blastogenic agent in cultures of these cells, inducing sequential metabolic changes culminating in morphologic transformation to blastoid cells. This study was conducted to determine whether changes in *in vitro* lymphocyte responsiveness to PHA occurred in bighorn sheep subjected to stress associated with captivity.

Experimental

Six adult Rocky Mountain bighorn ewes were captured in Jasper National Park in November, and were transported to Vancouver for nutritional and immunologic studies. They were offered medium quality hay for the duration of the study.

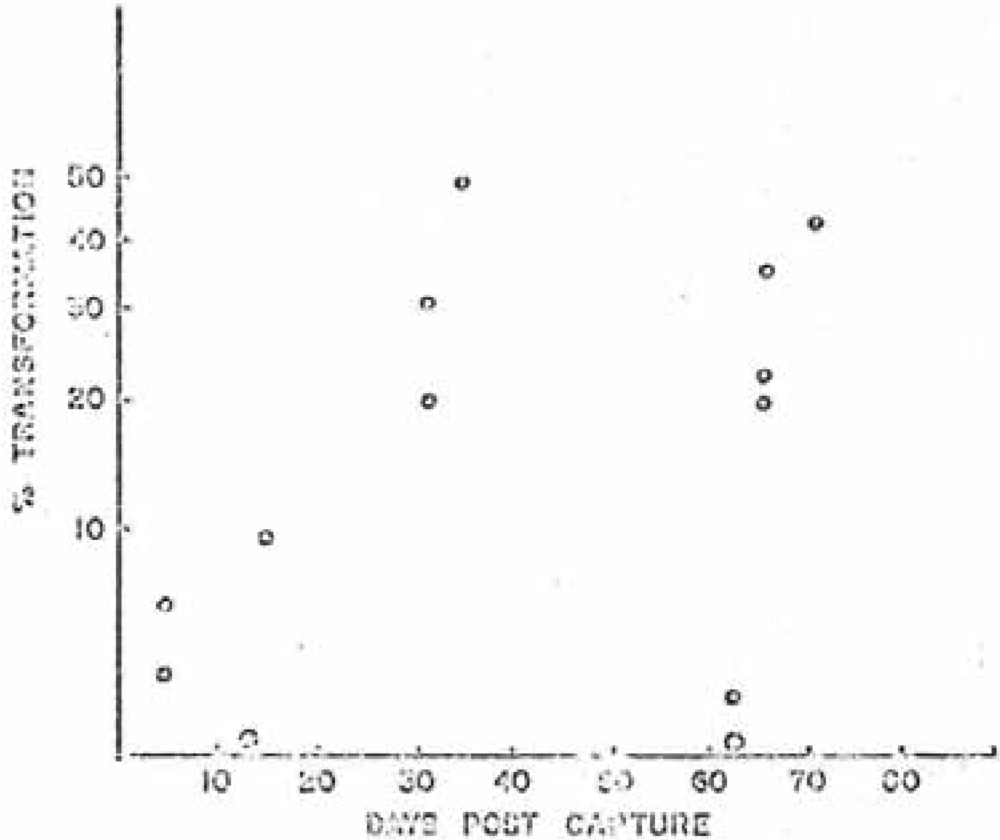
% TRANSFORMATION
50
40
30
20
10
10
20
30
40
50
60
70
80
DAYS POST CAPTURE

Figure 2

The functional activities of lymphocytes were evaluated by culturing blood lymphocytes with PHA, according to a procedure which will be reported in detail elsewhere. Following incubation for 6 days, the cells were stained with acridine orange and examined for morphologic changes by fluorescent microscopy.

Results and Discussion

Lymphocytes responding to PHA were characterized by their large size, bright yellow-green nucleus and red cytoplasm (Fig. 1). In contrast, unstimulated cells were small, with a deep green nucleus and unstained cytoplasm.

In the present study, stress associated with capture, transport and nutritional changes was accompanied by an apparent depression of lymphocyte responsiveness to PHA. Lymphocyte stimulation, measured by per cent transformation, was low during the first two weeks following capture, but increased markedly over the next two months (Fig. 2). Two animals with clinical signs, including slight scouring, loss of condition, and high erythrocyte fragility, exhibited very low levels of lymphocyte transformation. However, one animal sampled 62 days following capture, exhibited a marginal degree of lymphocyte transformation although clinical signs, other than slight loss of condition, were not evident.

Lymphocyte responsiveness to phytomitogens has been subjected to extensive clinical evaluation in man as an *in vitro* correlate of immunologic status. Depressed transformation has been found in malnutrition and in a variety of disease conditions which involve immunologic impairment, including chronic lymphocytic leukemia, Hodgkin's disease, sarcoidosis, and advanced cancer (Naspitz and Richter, 1968, Revillard, 1971). Lymphocyte transformation has also been used, with some success, in the evaluation of immunosuppressive drugs and antilymphocyte globulins (Naspitz and Richter, 1968).

Although alterations of *in vitro* characteristics of peripheral lymphocytes of bighorn sheep were demonstrated during stress associated with introduction to captivity, the actual significance of this observation remains speculative. Since bighorn sheep are particularly susceptible to disease when brought into captivity, it is possible that depressed *in vitro* lymphocyte reactivity reflected impaired immunity. Such an interpretation is consistent with known lymphocyte behaviour in man and laboratory animals. However, further studies are required to establish the actual applicability of this procedure in the assessment of general immunologic status of bighorn sheep.

Acknowledgements

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PREPARATION AND TESTING OF PASTEURELLA BACTERINS ON CAPTIVE BIGHORN SHEEP[1]

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Abstract

Experimental testing was done on two multi-valent Pasteurella bacterins: one a formalinized cell bacterin and the other an extracted cell bacterin. Two groups of captive-penned bighorn sheep were used for the tests. One group consisted of newborn full-blood and hybrid (F_2) bighorn sheep at Rachelwood Wildlife Research Preserve, Pennsylvania. This group received either antibiotics, domestic

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sheep anti-Pasteurella gamma globulins, and/or various doses of the formalinized cell bacterin after birth. The second group consisted of ten captive-penned lambs and yearling bighorn sheep at Sybille Big Game Research Unit, Wyoming. This second group received various doses of either the formalinized cell bacterin or the extracted cell bacterin. Indirect hemagglutination titers were determined as well as ability to survive natural infection following vaccination of the animals when held in pens and handled for the experimental studies. The formalinized cell bacterin and the extracted cell bacterin seem to protect newborn lambs and older bighorn sheep, respectively, from Pasteurellosis when given in multi-doses.

Introduction

Information is needed on Rocky Mountain bighorn sheep such as the physical conditions of individuals, biochemical normals, normal physiological parameters, nutrient requirements, breeding age, gestation period, multiple birth frequency and others. Bighorns must be held in captivity to gather this information. Bighorns are easily injured and readily contract pneumonia while in captivity. Post (1971) related the problems of respiratory diseases in bighorns and described the large variety of causes of pneumonia in bighorn sheep.

The "pneumonia complex" in bighorns is difficult to attribute to one cause. It may be a combination of effects. Problems with feed, crowding, handling, and stress of captivity as well as the microbial agents may be contributors to pneumonia. One organism which is reported most often as the primary cause of death in Rocky Mountain bighorns is Pasteurella. The organisms are found as normal flora in nasal passages (Post, 1962). Recent diagnosis of Pasteurellosis under semi-captive conditions have been reported in bighorns in Utah (Follis et al, 1971) and Wyoming (Thorne, 1971a).

The purpose of the research reported in this paper has been to prepare and test two Pasteurella bacterins for immunological response, ability to reduce the pneumonia caused by natural infection, and to aid in survival of bighorn sheep in captive conditions. Experimental animals were subjected to various stress conditions such as capture, handling, and alteration of feeding as well as close confinement. These are factors which must be overcome in order to hold them in confinement for any purpose. Immunological response was measured in terms of indirect hemagglutination titers.

Material and Methods

Bacterial Cultures - Six Pasteurella sp. isolated from nasal swabs and tissues of bighorn sheep were described previously by Nash (1971).

Bacterins - Formalinized multivalent cell bacterin (Bacterin A) was prepared with stock Pasteurella sp. using techniques given by Nash (1971). Two methods of antigen suspension were used. One suspension was in normal saline the other in mineral oil-lanolin (4:1) adjuvant. The adjuvant was added 1:1 to the saline cell suspensions and mixed to a final concentration of 5 mg dry wt bacterial cells/3 ml dose.

An extracted multivalent cell bacterin (Bacterin C) was prepared using a modified method of Herzberg et al (1972). It consisted of the residue of the living cells of the stock *Pasteurella* isolates after extraction with 2% deoxycholate in 0.2M tris, hydroxymethyl, amino methane buffer at pH 8.0 and 37 C. Suspensions were made in oil adjuvant similar to Bacterin A at 5 mg dry wt bacterial residue/3 ml dose.

Antiserum Production-Anti Pasteurella serum was prepared in domestic sheep using a 3 ml dose series of subcutaneously injected, saline suspended Bacterin A. Blood was taken from the animals six weeks after the last injection. The Gamma globulin fraction was concentrated using precipitation to a final indirect hemagglutination titer of 1:1,024.

Experimental Animals - Experiment No. 1 consisted of six newborn F_2 hybrid bighorn-mouflon lambs and two pure bred bighorn lambs from captive ewes at Rachelwood Wildlife Preserve, New Florence, Pennsylvania. All animals were held in enclosed pens on their mothers from birth.

Experiment No. 2 consisted of ten bighorn sheep captured near Dubois, Wyoming. Five animals (No's. 217, 218, 220, 223 and 224) were live trapped (Helms, 1970). The other five (No's. 215, 216, 219, 221, and 222) were captured with M-99 (Thorne, 1971b). All animals were transported by truck to the Sybille Wildlife Research Unit, Wheatland, Wyoming, confined to pens, and fed hay and protein supplements.

Treatment and Immunization - Experiment No. 1: The newborn lambs were given various treatments after birth. Each received either streptomycin (250 mg), various doses of antiserum, and either 2 or 3 doses of Bacterin A in saline suspension.

Experiment No. 2: Blood samples were taken from the jugular vein and each animal was vaccinated at the site of capture. Live trapped animals received Bacterin A in saline-oil adjuvant. Animals captured with M-99 received Bacterin C in saline-oil adjuvant. Three milliliter doses were given first intra- muscular in the right gluteus muscle. Additional doses were given either subcutaneously under the front legs or I.M. in the gluteus muscles. Two animals were held as experimental controls and received no bacterins, only the adjuvants. Blood samples and rectal temperatures were taken thereafter every two to four weeks.

Ten milliliters of blood were taken from the right jugular vein at each bleeding time, the serum was collected and Pasteurella antibody titers were determined. Indirect hemagglutination titers were determined using formalinized sheep red blood cells and the 0.025 ml microtiter techniques previously described by Nash (1971).

Results

The newborn bighorn and bighorn-mouflon hybrid lambs which received the complete series of antibiotics when needed, antiserum, and three doses of Bacterin A survived the longest (Table 1). One animal survived for almost six months, another survives today (over one year).

The dead animals generally showed chronic pneumonia. Mycoplasma were isolated from animals 6-B and 9-C (bighorn lambs). No causative microorganisms could be isolated from the bighorn-mouflon hybrids at death. No Pasteurella sp. were isolated from any of the animals in Experiment No. 1.

Results obtained from the ten older bighorn sheep captured from the wild are given in Table 2. Body temperatures were not taken at capture to minimize stress. However, the average rectal body temperature at capture of wild bighorns was taken as 101.9° F and used as a reference point (Franzman et al, 1971). Note that Groups 2 and 4 showed a rapid increase in body temperature after capture and dropped after four weeks in captivity. The experimental control group showed a rapid increase in body temperature for the first 4 weeks.

The average indirect hemagglutination titers for the various groups of bighorn sheep are shown by Graph 2. Groups 2 and 4 show the highest average titers over the longest period of time. The experimental controls show little or no titers to the selected Pasteurella sp.

All vaccinated animals showed some degree of pneumonia after five weeks of captivity. Necropsy results showed general consolidation of the apical, cardiac and anterior diaphragmatic lobes of the lungs. There was usually no purulent exudate in these animals. Group 4 lived the longest and showed no Pasteurella sp. or apparent causative agent.

The experimental control animals showed pneumonia with purulent abscesses throughout the lungs as well as collections of edematous fluid in the thoracic cavity. There were numerous adhesions and almost pure cultures of Pasteurella sp. from the lungs and heart blood.

Discussion

Limited data have been published on the treatment and raising of newborn lambs in captivity. Howe (1966) was able to hold three young bighorn lambs taken from their mothers out of the pasture in isolation and free from pneumonia for at least 40 days after birth. These animals all died of pneumonia three to four weeks after being released into pens. Data from Table 1 indicates the Pasteurella bacterin is of some value in the survival of newborns. Time seems to be an important factor as well as the health and physical state of the animal at birth. Those animals in this study which lived to be at least 48 days old and received at least two doses of bacterin lived about twice as long as those receiving no bacterin. Those that received three doses have lived six months to at least one year with one exception, bighorn lamb 6-B received no bacterin, antiserum, or antibiotics, yet survived for 151 days. No Pasteurella sp. were isolated from any of the lambs which died.

Results shown by Experiment No. 1 indicate that antibiotics, antiserum, and bacterin should be given at birth followed by daily doses of antibiotics for at least 7 days. The antiserum is short lived and gives only immediate passive immunity. It takes from 7 to 14 days to stimulate a high antibody response to the bacterins. Additional doses of bacterin should be given at 21 day intervals for two more doses and then repeated every six months if the animals are confined in pens. The three week period is used so that the animals are handled less and placed under as little stress as possible.

Table 1

RECORD OF TREATMENTS AND SURVIVAL OF NEWBORN BIGHORN AND BIGHORN HYBRID LAMBS
(Experiment No. 1)

NUMBER	SEX	BREED	BORN	DIED	SURVIVAL Days*	Treatments Received ANTIBIOTIC Days*	ANTISERUM ml	ANTISERUM Days*	BACTERIN Days*
6-B	F	Bh	5/31/71	10/29/71	151	-	-	-	-
9-C	F	Bh	4/13/71	10/29/71	198	-	0.8	21	49;70;91
H71-2	M	F_2Hy	4/27/71	5/22/71	25	7	0.4	7	-
H71-3	M	F_2Hy	4/25/71	5/31/71	36	9	0.6	9	-
H71-5	F	F_2HY	4/12/71	7/6/71	86	-	-	-	48;70**
H71-6	M	F_2Hy	4/13/71	7/20/71	98	21	0.7	21	47;69
H71-7	M	F_2Hy	4/14/71	7/21/71	98	20	0.8	20	46;68
F27-C	M	F_2Hy	4/7/71	†	365+	13	0.6	13	48;69;90

*Days following birth.
Bh= full-Blood Bighorn.
F_2Hy= F_2 Bighorn-Mouflon Cross.
**= Age of animal at time of vaccinations. The number of Recorded Ages indicates the number of 3 ml S.Q. inoculations of Bacterin A in a saline suspension.
-= No treatment of the given substance was given to that animal.
†= This animal is still living.

TABLE 2

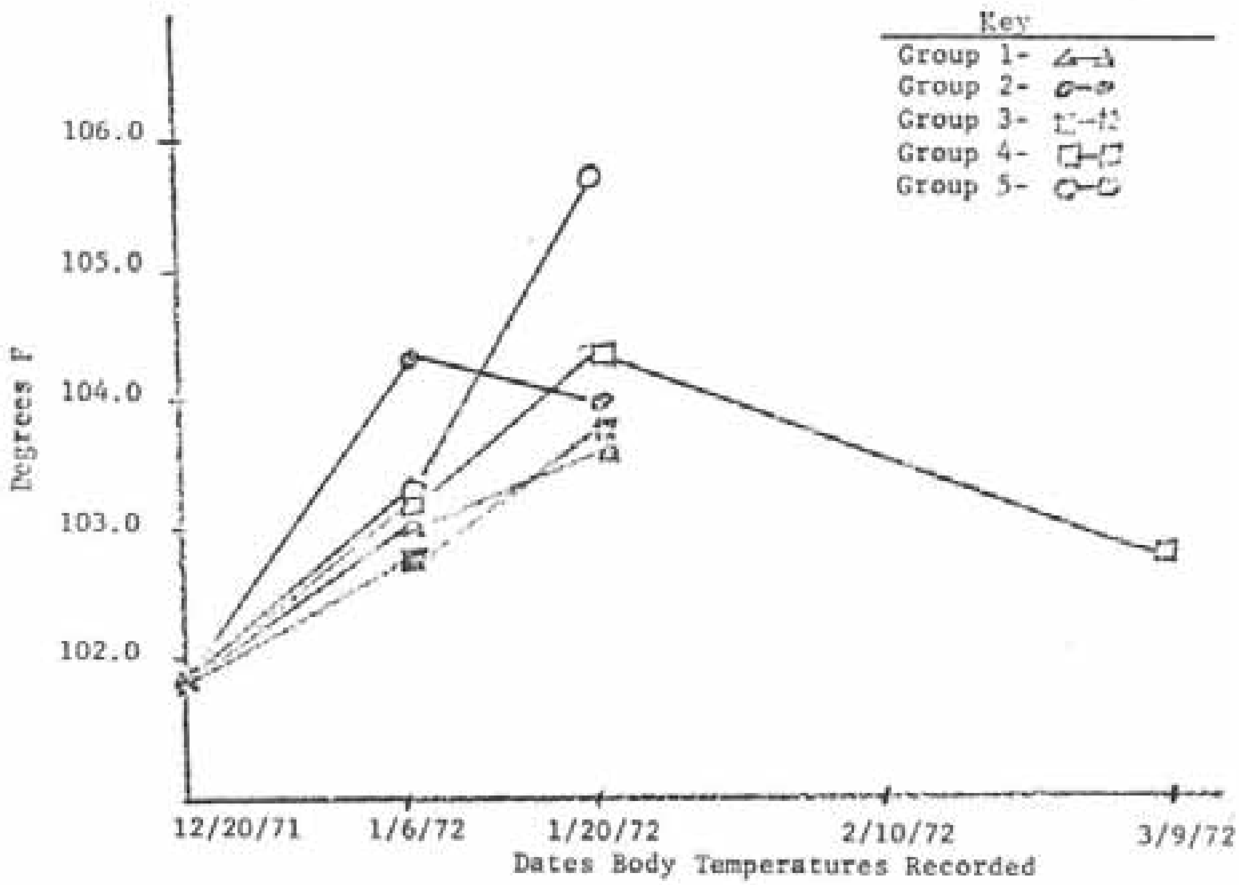
RECORD OF CAPTURE, HANDLING, BLEEDING, TEMPERATURES, AND VACCINATIONS DONE ON BIGHORN SHEEP HELD IN CAPTIVITY IN CONFINED PENS
(EXPERIMENT NO. 2)

GROUP	NUMBER	SEX	WT. LBS.	AGE	BACTERIN	Dates of Various Treatments 12/20/71	1/6/72	1/20/72	2/10/72	3/9/72	Pasteurella Isolated
1	218	M	65	L	A	CBV	HBVT	HBT	-	-	+
1	220	F	100+	1 yr	A	CBV	HBVT	HBT	-	-	+
2	217	M	80	L	A	CBV	HBVT	HBVT	-	-	+
2	224	F	106.5	2 yr	A	CBV	HBVT	HBVT	-	-	+
3	221	F	122.5	1 yr	C	CBV	HBVT	HBT	-	-	-
3	219	F	96	1 yr	C	CBV	HBVT	HBT	-	-	-
4	215	F	100	1 yr	C	CBV	HBVT	HBVT	HBV	HBVT	-
4	216	F	102	1 yr	C	CBV	HBVT	HBVT	HBV	HBVT	-
5	223	M	66	L	Ex.Con.	CBI	HBIT	HBIT	-	-	+
5	222	F	100	1 yr	Ex.Con	CBI	HBIT	HBIT	HB	-	+

L= Less than one year old.
C= Date captured is one of three dates 12/20/71, 12/21/71, and 12/22/71 and are given as one date for east of recording data.
B= Blood samples taken on this date
H= Animal handled on this date.
V= Animal vaccinated on this date.
I= Experimental control animal was given a placebo.
T= Temperatures taken on this date.
Ex.Con.= Experimental Control animal.

Graph 1

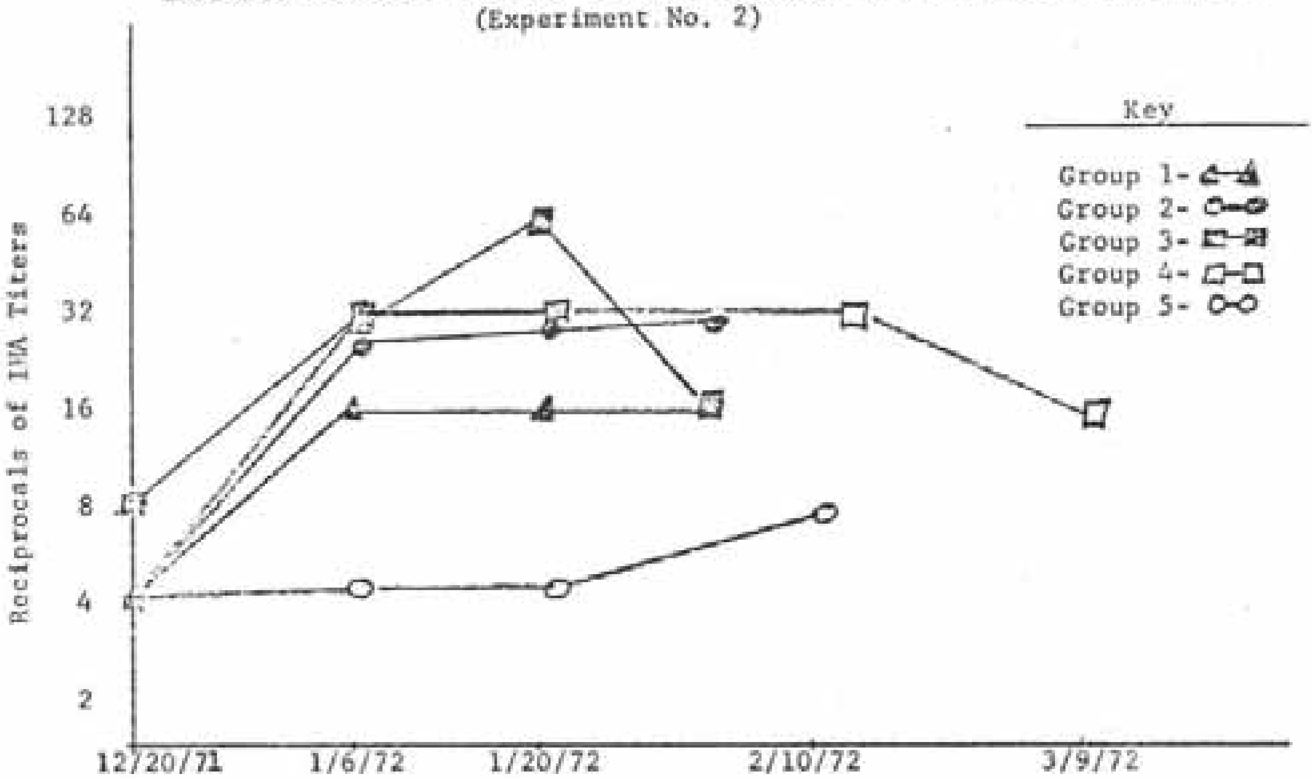
RECTAL BODY TEMPERATURES OF BIGHORN SHEEP
(Experiment No. 2)



* Estimated as 101.9 F (Franzman et al, 1971).

Graph 2

INDIRECT HEMAGGLUTINATION TITERS* RECORDED ON DATES AFTER CAPTIVITY
(Experiment No. 2)



Dates of Blood Sample Collection

* Given as average IHA titers for the two animals in each group or the average for one animal if one animal died before this reading.

There is little available data on the holding of older bighorn sheep taken direct from the wild and held in enclosed pens. Bingham (1962) attempted an experiment to test a Pasteurella bacterin on six bighorn ewes. The animals were confined to pens during the experiment. The experiment had to be discontinued when four animals died. Two animals showed pneumonia with isolation of a Pasteurella sp. The other two died from enterotoxemia. Woolf (1971) reported an influence of lambing and morbidity on body weights of 8 captive bighorn sheep. Franzman et al (1971) held six bighorns for at least two weeks in confinement.

There is no need for a direct challenge of living bacteria to test immunity produced with a bacterin against pneumonia in bighorn sheep when animals are confined to pens. These animals are probably exposed to natural infections while under intense stress conditions of capture, handling, bleeding, vaccination and other treatments. Table 2 shows that the animals in Group 4 were subjected to all of these factors. The use of Bacterin C seemed to lower the intensity of the pneumonic symptoms. This could have been because Pasteurella sp. were not present prior to the time of death to intensify pneumonic symptoms.

Franzman et al (1971) and Thorne (1971b) have shown that the physiological values of bighorns increase quite rapidly when captured. Excitability due to capture, handling, bleeding, taking body temperatures and vaccinations all add to the total stress placed on a wild animal. Significant changes occur to bighorn sheep under these conditions. The animals in Group 4 remained alive and in excellent health with no signs of pneumonia for eighty-two days. Graph 2 shows that the immunological response from the three doses of Bacterin C was the greatest and the titer remained higher for a longer time. The titer drop seen after 62 days may be only a variation in interpretation of tests and not a true reduction in circulating antibody. The continued vaccination may possibly have paralyzed the immune response of the animals.

Graph 1 shows similar results of the other captive bighorn sheep by a rise in body temperature from time of capture and for the first two weeks of captivity. Franzman et al (1971) showed an increase of almost 3° F after holding the animals in pens for two weeks. The body temperature rise in Groups 2 and 4 may have been caused by the handling procedures received by the animals. Group 5, the experimental controls, showed a rapid increase in body temperature which did not drop. This may indicate the chronic pneumonic condition found at death. The use of experimental Pasteurella bacterins seemed to reduce body temperatures over a period of time. Follis et al (1971) showed similar results when a Pasteurella bacterin was used on semi-captive bighorns.

Dalton et al (1971) pointed out that similar problems occur in direct transplants of bighorn sheep without confinement. Stress of capture and handling may weaken the animals and they contract pneumonia. Treatment of these animals should follow the same procedures as for confined animals. Animals should be immobilized with a drug such as M-99 (Franzman et al, 1971, and Thorne, 1971b), to reduce excitability at capture. The authors recommend a broad spectrum antibiotic be given immediately as should Pasteurella sp. bacterin specifically produced from strains of Pasteurella isolated from bighorns. Antibiotic treatment should continue for at least 7 days if the animals are to be held in captivity. Animals should be revaccinated from two to three more times at 2 week intervals. Multi-site vaccination should be used to obtain maximum stimulation of the lymphatic system and to reduce tissue damage in the animals. This procedure may reduce the losses from pneumonia. The same procedure should be followed on direct transplants except that multi-site single vaccination (rump and shoulder) should be used.

The research reported here does not offer an absolute control for pneumonia in captive bighorn sheep. There is an indication, however, that the bacterin may be useful in controlling invasion of Pasteurella sp. in captive animals.

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BIGHORN LAMB MORTALITY INVESTIGATIONS IN COLORADO

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The Sangre de Cristo mountain range in south-central Colorado is a long, narrow chain of rugged peaks and steep rocky slopes. The portion lying in Colorado is over 100 miles long, and rarely more than 12 miles wide at any point along its length. This range contains 8 of Colorado's 54 mountain peaks over 14,000 feet high. Rocks are largely of sedimentary origin, not highly mineralized, and for this reason the area has not suffered the impact of mining activity so common in other parts of the state. Only a very few roads exist, and with the exception of one major east-west highway, all are quite primitive.

The earliest explorers documented the presence of bighorn sheep in this range, and throughout the latter part of the 19th Century, up to the present date, it has been the location of one of the major bighorn herds of the state. At one time, sheep could be found the entire length of the range, but during the past two or three decades, the herd has become more or less concentrated in one portion not over 15 miles long. With this concentration has come a decrease in total numbers, but as recently as ten years ago the herd was judged to be healthy on the basis of population age-class structure.

Starting some time in the early 1960's, a drastic change in age-class structure began to occur. Survival of lambs to reach the yearling age-class diminished to a very low level, resulting in almost no recruitment and replacement. The herd continued to decline in numbers, and of course became dominated by old age-class members. By 1968, it became obvious that the annual lack of herd increment was a persistent and recurrent problem that showed no indication of abatement.

The first investigation aimed at identifying the cause of the problem was a two-year study done by Woodward, then a graduate student in the Dept. of Fishery and Wildlife Biology, Colorado State University, and initiated in the spring of 1969. Objectives of this study were to: (1) ascertain herd composition, (2) determine breeding success in terms of conception and live births, (3) follow the herd from time of lamb drop through the summer and fall, and document lamb survival, and (4) assess the importance of predation, trauma, weather, and disease in mortality of lambs.

It became evident early in the investigation that the problem did not involve lack of conception or failure to bear live lambs. By mid-June of 1969, most breeding-age females in the herd were accompanied by seemingly healthy and active lambs. The same pattern was repeated in 1970. Also, during both years the ewe:yearling ratio was exceptionally low (100:11 and 100:17, respectively) reflecting the lack of lamb survival from the previous year.

Loss of lambs in the herd began to occur generally in late July and early August during both summers. The rate of loss reached peaks in early September of both years, and by mid-September most lambs had succumbed. The ewe:lamb ratio dropped from 100:83 on July 3, 1969 to 100:17 on September 10, 1969; and from 100:72 on June 30, 1970 to 100:22 on September 18, 1970.

At no time during the course of this two-year study could any lamb mortality be ascribed to predation or accidents. Physical appearance and observed coughing in lambs, beginning in late July, 1969, indicated that disease was the most likely factor in mortality and when the pattern was repeated in the summer of 1970, it was decided to collect lambs in an attempt to learn something about this phenomenon. Accordingly, two lambs were collected, one on August 6, 1970 and another on September 9, 1970. The first one collected exhibited early stages of two different types of pneumonia, a verminous proliferative type and a purulent bacterial bronchopneumonia. Although not clinically ill at the time of collection, it appeared to be host to elements that could bring about its eventual demise.

The second lamb collected exhibited the classic pattern of advanced respiratory illness, diagnosed as verminous pneumonia. It was in extremely poor body condition, and at the time of collection appeared not to have the strength to accompany the herd in its flight from danger. It stood without moving while the rest of the herd ran out of sight.

The peak in lamb losses during both summers, but particularly during the summer of 1969, appeared to coincide with a period of cold, wet weather, more or less typical of the Colorado Rockies during August. Critical analysis of the combination of circumstances and conditions encountered by these bighorns, seemed to support the conclusion that high lamb mortality was the result of respiratory disease caused by lung parasitism, enhanced by inclement weather at critical periods, with possible nutritional deficiencies or imbalances contributing.

This general conclusion formed the basis for a greatly expanded research effort, initiated in the spring of 1971, involving a team approach by personnel in the Departments of Pathology, Microbiology, and Anatomy, College of Veterinary Medicine, Colorado State University and personnel of the Colorado Division of Game, Fish and Parks. This investigation aimed at precise identification of the factors or combination of factors responsible for a high rate of mortality of lambs in certain bighorn sheep herds in the state.

A collection schedule, to take lambs from a herd known to have a high rate of lamb mortality, and from a herd known to have a high rate of lamb survival, at two-week intervals through the summer and fall, was established. Initially, the Buffalo Peaks herd, located in approximately the geographic center of the state, was selected as the herd having a high mortality rate. This selection was based on work done three years previously by graduate student Robert G. Streeter, and also on the fact that the terrain lends itself to ease of collection. The herd selected for the control was the Saguache Creek - Trickle Mountain herd, located about 60 miles southwest of Buffalo Peaks. Five animals were taken from the Buffalo Peaks herd, and five from the Saguache Creek - Trickle Mountain herd.

According to previous experience, the classic symptoms of respiratory illness should have appeared by mid-July in lambs from Buffalo Peaks. When they did not appear, it was decided by members of the team that collections should immediately begin in the Sangre de Cristo Range, in spite of the handicap of almost impossibly difficult terrain. Ultimately, all collections made in the Sangre de Cristos in 1971 were done by helicopter. By early August, lamb mortality began to appear on Pikes Peak, approximately 75 miles east of Buffalo Peaks. The Pikes

Peak herd has previously been considered to be a very healthy herd, having a high rate of recruitment and replacement.

The Sangre de Cristo and the Pikes Peak herds thus became the collection locations for sick lambs. By the end of September, five lambs had been taken from each of these two herds, and mortality of remaining lambs was almost complete.

Lambs collected from the Buffalo Peaks and Saguache Creek - Trickle Mountain herds were essentially healthy in appearance and of normal weight for their age. Postmortem examination of these lambs did not reveal any significant pathological changes (Tables 1 and 2). Five of the lambs were infected with *Protostrongylus stilesi*, but the level of infection was quite low and no significant lesions compatible with "verminous pneumonia" were present.

Lambs collected from the Sangre de Cristo and Pikes Peak herds were obviously ill, small for their age and light in color. Coughing and dsypnea were frequently observed. Postmortem examination revealed that all animals, except a yearling accidently killed in the Sangre de Cristo herd, had pneumonia compatible with "verminous pneumonia". *Protostrongylus stilesi* was numerous in all of these animals (Tables 3 and 4).

One lamb from the Sangre de Cristo herd and one from the Pikes Peak herd had a species of *Pasteurella* and a gram negative diplococcus, thought to be a species in the genus *Neisseria*, in their lungs. An additional lamb from Pikes Peak also had this gram negative diplococcus in the lungs. Bacterial results are incomplete as yet, but thus far the results have not revealed any additional lambs infected with pathogenic species.

Virological studies are time-consuming and consequently, incomplete at this time. Low titers (1:2 to 1:64) against bovine PI-3 virus was demonstrated in two lambs from Buffalo Peaks, and four lambs from Pikes Peak.

Gastro-infectional parasitism was not a problem in any of these lambs. Very light infections with *Marshallagia marshalli*, *Nematodirus* spp. and six species of *Eimeria* were found in 10 of 20 lambs.

This research has been and is currently being investigated by a team consisting of William H. Rutherford, Wildlife Researcher; Thomas N. Woodard, Graduate Student, now Senior Research Technician; Ralph J. Gutierrez, Student Assistant; Gene Schoonveld, Wildlife Researcher Candidate; Robert Schmidt, Senior Conservation Aide; George Bear, Wildlife Researcher; Robert Keiss, Wildlife Researcher; Gordon Solomon, Associate Professor of Pathology; John Parks, Assistant Professor of Virology; Harold Breen, Professor of Pathology (Bacteriology); Jerry Adcock, Professor of Pathology; Charles P. Hibler, Professor of Parasitology; and Robert E. Lange, Graduate Student; and Carol J. Metzger, Research Assistant. Considerable assistance has come from George Post, Associate Professor of Microbiology.

Table 1. Bighorn Sheep collected from the Buffalo Peaks herd

DATE	WT. (kg)	SEX	LESIONS Bacterial	Viral	Parasitic
6/16	12.5	F	-	-	Protostrongylus
6/29	9.0	F	-	-	-
7/27	20.0	F	-	-	Protostrongylus
8/10	38.6*	F	-	-	-
8/23	28.2	M	-	-	Protostrongylus

* yearling

Table 2. Bighorn Sheep collected from the Saguache Creek - Trickle Mountain herd

DATE	WT. (kg)	SEX	LESIONS Bacterial	Viral	Parasitic
6/17	4.8	F	-	-	-
6/30	11.5	F	-	-	-
7/28	23.0	M	-	-	-
8/19	27.3	F	-	-	Protostrongylus
9/3	19.1	F	-	-	-
9/3	26.0	M	-	-	Protostrongylus

Table 3. Bighorn Sheep collected from the Sangre de Cristo herd

DATE	WT. (kg)	SEX	LESIONS** Bacterial	Viral	Parasitic
8/26	12.7	M	-	-	Protostrongylus
8/28	-	M	-	-	Protostrongylus
8/30	49.0*	F	-	-	Protostrongylus
9/2	14.6	M	-	-	Protostrongylus
9/2	18.2	M	-	-	Protostrongylus

* yearling
** All animals except yearling had the classical "verminous pneumonia"

Table 4. Bighorn Sheep collected from the Pikes Peak herd

DATE	WT. (kg)	SEX	LESIONS* Bacterial	Viral	Parasitic
9/13	21.0	F	-	-	Protostrongylus
9/13	19.0	F	-	-	Protostrongylus
9/16	17.3	M	-	-	Protostrongylus
9/16	14.0	M	-	-	Protostrongylus
9/16	18.2	M	-	-	Protostrongylus

* All animals had the classical "verminous pneumonia"

Dr. Hibler and Bill Rutherford - Question Period

Q. Did you find any mortality in adults or was it mostly in lambs?

A. I could be wrong, but as far as I recall we had no adult mortality or no adult illness. In fact, I should have pointed this out as I knew someone was going to ask about this. There were a couple of yearlings involved, but there were no gross lesions visible in any of these adults. However, the same type of bacteria was present, lung worm was present, but no pneumonia.

I might just add that we did learn something from those two accidental collection of yearlings which boils down in simple terms -- if they do survive these lesions to the one-year old class, they have it made.

Q. You mentioned that in order for the adults to suffer and to die from the disease these bacteria had to be transmitted?

A. Well, it is true, of course, that the lambs are more susceptible to all types of infection and is generally true, where a virulent or bacterial infection is involved, an animal develops an immunity upon exposure, especially if it is a healthy animal and can ward off the infection. The lungworm is something I would rather hedge upon as to whether an animal with age could really combat. Possibly they could because of the so-called pre-immune response. The presence of the worm in an animal, would insure that no extensive infection will occur in the future. With bacteria, once they have had some exposure to it, antibodies can develop.

BEHAVIORAL DIFFERENCES IN BIGHORN LAMBS (*Ovis canadensis canadensis* Shaw) DURING YEARS OF HIGH AND LOW SURVIVAL

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Introduction

The hypothesis that there are measurable differences between populations in different stages of development, for example growing versus declining, is an old one. According to Chitty (1955) it was Young (1868) who first suggested it.

These differences have been demonstrated using morphological and reproductive characteristics, as Klein did in his work with black-tailed deer (*Odocoileus hemionus sitkensis*) (1964) and reindeer (*Rangifer tarandus*) (1968).

Behavioral parameters have also been considered as indicators of population status. Chitty (1955) recognized their value but was not able to quantify differences. More recently Geist (1971) showed that between populations of different species of mountain sheep (*Ovis* spp.) there were certain aspects of behavior that were quantitatively different and that these differences could be attributed to differences in the 'quality' of a population, i.e. expanding or declining.

This study was undertaken to test the hypothesis that, although there may be a definite trend in a population and therefore it could be classified as either expanding, stable or declining, there may be considerable between year differences in behavior within the population. The study was conducted in the Sheep River area of southwest Alberta during the summers of 1969 and 1970, a period over which the population slowly increased despite heavy hunting pressure.

The objectives of the study were to quantify certain aspects of ewe and lamb behavior and analyze any differences in terms of their possible influence on lamb survival.

Emphasis was on ewes and lambs because they were the 'producing' segment of the population and had not previously been studied intensively. In addition it was thought an analysis of their behavior might provide an efficient means by which to evaluate both the yearly, and as Geist suggested, the longer term status of the population.

In retrospect the choice of years was most fortunate for in 1969 lamb survival was low and in 1970 it was high (Table 1).

The late spring ewe : lamb ratios from the two years represent close to the extremes that might be expected. Wishart (1958), working with this same herd, reported ewe : lamb ratios, in May, of 100:92, 100:77, and 100:70 in 1955/56/57 respectively. The first values indicate exceptionally high lamb survival, much as Woodgerd (1964) found in a rapidly expanding population. He found a ewe : lamb ratio of 100:91 six months or more after lambing. Berwick (1968) whose study population was declining reports ratios of 100:31 and 100:75 in winter and Morgan (1970), who also worked with declining populations, found ewe : lamb ratios as low as 100:8 and 100:12 in mid-winter.

Equally as important as late spring ratios are those from July. These indicate that, in terms of fertility , both years were probably equal (Table 1).

A number of different classes of behavior were quantified in the course of the study. Amongst these were time spent feeding vegetation (FV), intensity of FV, FV effort, time spent 'active' (on their feet) and time spent bedded. This data was collected from both ewes and lambs. Additional observations of events which occurred during suckling interactions were recorded and will be discussed shortly.

Data on FV activity was collected in an effort to get an estimate of the relative abundance and/or quality of forage available to the grazing sheep. In the agricultural literature there are a number of works relating forage quality or quantity to grazing time.

Amongst these works are those of Arnold (1960, 1963, 1964) in which he found that there was a significant negative correlation between the grazing time of domestic sheep and pasture availability measured in pounds of green dry matter per acre. He reported grazing times varied from 7 hours on pasture producing 2250 lbs/acre to 10.5 hrs. on pasture producing about 650 lbs/acre. Increased stocking rates increased grazing time due to decreased forage availability.

Allden (1962) reports a strong inverse relationship between grazing time and the amount of dry green herbage available in a pasture providing less than 3000 lbs of dry matter per acre. In a later paper Allden and Whittaker (1970) conclude that sheep are partially able to compensate for a reduction in the amount of herbage available by increasing grazing time. They found grazing times varying from 6 to 13 hours on pastures producing 2670 lbs and 445 lbs of dry matter per acre, respectively.

It is also commonly reported that grazing times increase with advancing forage maturity, i.e. decreasing quality and availability. Hancock (1954) and Wagnon (1960) report this relationship holds true for dairy cattle and beef cattle in New Zealand and California respectively. A number of other North American investigators have also commented on this while studying the grazing behavior of cattle (Sneva, 1970; Compton and Brundage, 1971) and domestic sheep (Bowns, 1971) although they, like myself, present no quantitative data on forage quality.

It is of course recognized that there are a number of other factors which may affect grazing time indirectly by affecting rate of intake. Some of these factors, which are extremely variable and most difficult to measure, are plant height, physionomy and spacing, the size of bite the animal takes and the rate at which it bites (Arnold, 1963; Allden and Whittaker, 1970). Our understanding of their effects on grazing time is negligible.

Activity of Females

Excluding July, ewes in 1969 spent more time FV than those in 1970. In July the opposite was true but not to the same degree as in other months (Table 2).

In 1970 ewes fed less intently than those in 1969 (Table 3).

Combining the time spent feeding and the intensity with which the animals fed, I calculated FV effort which, in short, gives the percentage of time the animal spent actually ingesting vegetation.

It is obvious from Table 4 that the feeding effort of ewes in 1969 was considerably greater than that of ewes in 1970 -- for that matter approximately twice as great. On the basis of the generalized relationship between forage quality/quantity and grazing time, I concluded that in 1970 forage conditions were more favorable for the bighorns than in 1969.

In addition to differences in FV, there were differences in time 'active' and time spent 'walking'. Ewes in 1970 were generally more 'active' than those in 1969, again excepting July and they spent more time walking (Table 5).

Activity of Lambs

Lambs in 1970 spent less time FV than did lambs in 1969 (Table 6). The former also fed less intently than the latter (Table 7).

The result was a FV effort in 1970 considerably smaller, particularly in July, than in 1969 (Table 8).

In each month of 1970 lambs spent much more time 'walking' than did lambs in 1969. Lambs were also more 'active' in June and August of 1970 than lambs in the same months of 1969 (Table 9). In July lambs in 1969 were more active than those in 1970 but the difference was small compared to the differences, in favor of 1970, in other months. This data on time 'walking' and 'active' suggests to me that lambs in the "high survival" year of 1970, who spent more of their 'active' time 'walking' (Table 10), were more vigorous than lambs in 1969. Walking includes running, most of which occurred during 'play'.

Nursing and Suckling Behavior

A considerable amount of research has been conducted on the effects of nutrition on milk production and lamb growth in domestic sheep (Wallace, 1948; Barnicoat, Murray, Roberts and Wilson, 1956). It is now well accepted that: 1) a low plane of nutrition results in poor milk production, and 2) rate of growth of lambs is largely dependent on the amount of milk consumed.

I had no direct means of measuring milk production and therefore I relied on observations of the duration and frequency of suckling in an effort to determine whether there was a difference between the two years. Ewbanks (1967) has shown that amongst single domestic lambs there is almost a linear relationship between suckling rate (no. of suckles per unit of time) and weight gain. Since, as I have mentioned, weight gain of lambs is directly dependent, at least for the first 6 weeks, on milk consumed, a high suckling rate would suggest high milk production. In addition, I recorded several other events which I felt would indicate to what degree a lamb was being satisfied.

As Table 11 shows suckling durations were longer in 1970 than in 1969 although the only significant difference is in the last two weeks of July. Table 12 shows that, excepting the first two weeks in July, lambs in 1970 also suckled more frequently than those in 1969. Calculations of the total number of seconds suckled per 24 hours (Table 13) shows that, with one exception, lambs in 1970 spent more total time suckling than did those in 1969. Figure 1 shows this graphically.

This data suggests that, in general, lambs in 1970 may have received more milk (assuming total suckling time is related to milk intake) than those in 1969. Perhaps more important than this is the high number of seconds suckled in late July and early August of 1970. The implication is that lactation in 1970 did not drop off as rapidly as it did in 1969, a pattern characteristic of domestic ewes on a high plane of nutrition (Barnicoat, Logan and Grant 1949).

Geist (1971) suggested that lambs in an expanding or growing population, which he termed a high quality population, would attempt to suckle less and be rejected less than lambs from the opposite "type" of population, that is a stable or declining population. He presents data in support of this hypothesis, showing that "low quality" bighorn lambs in their second and third weeks of life were refused an average of 39 per cent of their suckle attempts while "high quality" Stone's lambs of the same age were refused in only 17 per cent of their attempts. The bighorns attempted to suckle 4.3 times/hour of ewe activity at three weeks of age while, at the same age, the Stone's lambs attempted to suckle only 3.5 times/hour of ewe activity.

I found in the high survival year of 1970/71, as opposed to 1969/70, that: a) lambs attempted to suckle more often per hour of ewe activity (Table 14), and b) a greater percentage of their attempts were refused, considering monthly totals only, in all but August. Considering two-week periods however, only in July were lambs in 1970/71 refused a greater percentage of the time than lambs in 1969/70 (Table 15).

This data suggests that the more lambs suckle the more times they will attempt to suckle or conversely, the more they attempt to suckle, the more they do suckle. These findings are contrary to those of Geist (1971).

The type of approach that a lamb makes to a ewe when intending to suckle is another means by which the observer can judge the stage and rate of development of lambs. Lambs use two basic types of approach during successful suckling intereactions: the "run-around" approach, in which the lamb passes immediately in front of the ewe, often rubbing up against her chest. This action often brings the ewe to a stop and the lamb then continues around to the udder.

The second type of approach is the "step-in" during which the lamb does <u>not</u> pass immediately in front of the ewe but instead takes the shortest possible route to the udder. Unlike the "run-around" it does not facilitate suckling by bringing the ewe to a stop, even momentarily.

The "run-around" approach is used more as a lamb grows older and larger (Table 16).

It seems reasonable then, to assume that lamb size is an important factor in the "run-around" approach, a large lamb being more likely to stop or "hold" a ewe than a small lamb. A reflection of the rate of growth of lambs would then be the rate at which the use of this type of approach increases. In 1970 the rate of increase of run-around approaches was greater than in 1969 and, in terms of the point at which this type of approach equals the occurrence of step-in approaches, I judged lambs in 1970 to be from 3 to 4 weeks ahead of lambs in 1969 (Figure 2).

In 1970, the only year for which I have the type of data that follows, the "step-in" approach was used during 58 per cent (n = 81) of 140 unsuccessful suckle attempts while the "run-around" approach was used in only 42 per cent of the unsuccessful attempts, making the latter clearly the more effective.

The last aspect of ewe-lamb relations I will comment on is the method which ewes use to terminate suckling events. Since it is uncommon for a lamb to quit suckling on its own, the initiative to terminate falls on the ewe.

Two main categories of termination were recognized -- contact and non-contact terminations. Contact terminations are those in which the ewe makes physical contact with the lamb. The "step-through" method of termination, in which the ewe simply walks forward and pushes the lamb with its leg, causing it to "break loose" from the udder, composes 98 per cent (n = 240) of all terminations in this group.

Non-contact terminations include those in which the ewe breaks the lamb's grip on the udder without physically contacting the lamb. The "step-over" method, in which the ewe lifts her foot over the lamb and the "turn-away" method compose 81 per cent (n = 335) and 15 per cent (n= 64), respectively, of all non-contact terminations.

I am of the opinion that the frequency of occurrence of contact and non-contact terminations reflects the size of lambs. As I mentioned previously in the "step-through", the ewe simply forces the lamb out of the way. This is possible as long as the lamb is small enough to be moved; however at a "certain" lamb size it becomes difficult for the ewe to move the lamb. It then begins to "step-over" or "turn-away" from the lamb. In Figure 3 the relationship between contact and non-contact terminations can be seen.

The important features of this graph are the points at which non-contact terminations finally equal or surpass contact terminations in frequency. The data show that in 1970 lambs reached that "certain" size about one month before lambs in 1969 did.

Conclusions

The conclusions I have drawn from the observations presented are:

a) bighorns in 1970 expended less energy on foraging due to greater quality and/or quantity of forage, than did bighorns in 1969.
b) that lambs in 1970 may have been more dependent on milk than lambs in 1969 probably because there was more of it available, and
c) that in the high survival year of 1970/71 lambs exhibited certain characteristics that suggested they were larger than lambs in 1969.

Although there are parts of the data that do not support my conclusions the majority of the evidence does and I strongly suspect that the factors I have discussed were associated with the different rates of lamb survival in the 2 years.

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<u>Brian Horejsi</u> - Question Period

Q. Have you any observations on how long nursing continued during these two years?

A. Yes, in both years it continued into January. Mind you, at that stage it is very infrequent but it did continue into January. I also saw yearlings suckling at this time.

Q. Did you make any observation of any dry weight forage, of what was available?

A. No, I didn't make any measurements on the amount of forage available.

Q. Did you make any measurements of what was the difference in spring growth - plants, not grasses?

A. Of course, I am sure that is what caused the effect in the differences in feeding between vegetation, effort and time. In the spring of 1970 there was very heavy snowfall in April and March of that year and temperatures in July of 1970 were significantly warmer than in 1969. I think that there was more moisture available in 1970 and it improved more rapidly in warmer temperatures.

TABLE 1. Lambs per 100 females*, 1969-1970, Sheep River Area.
(n = number of ewe and lamb days).

	1969/70 (n)	1970/71 (n)
June	78 (121)	75 (185)
July	84 (153	85 (242)
August	56 (56)	85 (76)
September	27 (71)	--
October	--	63 (70)
November	23 (163)	--
December	25 (280)	70 (52)
January	38 (36)	--
February	20 (425)	56 (53)
March	12 (171)	--
April	19 (217)	--
May	15 (38)	72 (55)
June + July + August	76 (330)	81 (503)
September to May	21 (1401)	64 (230)

* No correction for 2 yr. old or barren ♀♀.

TABLE 2. Percent of observation time grazing and number of hours spent grazing per 24 hours., females.

	1969		1970	
	%	hours	%	hours
June	28	6.72	16	3.84
July	14	3.36	16	3.84
August	29	6.96	19	4.56
September	32	7.68	--	---
June-July-August	22	5.28	16	3.84

TABLE 3 . Intensity of Feeding Vegetation (FV) by females, 1969 and 1970, in minutes FV per 100 minutes active.

	Feeding Vegetation Intensity			
	1969	(n)	1970	(n)
June	80.3	(13)	65.3	24)
July	----		59.7	(9)
August	61.3	(14)	----	
July-Aug.	----		56.8	(12)
Sept.-Nov.	65.3	(13)	----	

(n) = number of ten minute observation periods

TABLE 4 . Feeding Vegetation Effort (% of time actually spent ingesting vegetation), bighorn ewes, 1969 and 1970.

	Feeding Vegetation Effort	
	1969	1970
June	22.48	11.09
July	----	9.55
August	17.78	----
July-Aug.	-----	9.08
Sept.-Nov.	20.90	----

TABLE 5 Percent of time females were 'active' and the percent of time they spent 'walking', 1969 and 1970.

	Active		Walking	
	1969	1970	1969	1970
June	47	59	6	8
July	67	51	7	7
August	56	69	6	13
September	58	--	7	-

TABLE 6 . Percent of observation time lambs spent Feeding Vegetation and number of hours FV/24 hours.

	% of time FV		Hrs. FV/24 hrs.	
	1969	1970	1969	1970
June	10	8	2.40	1.92
July	13	11	3.12	2.64
August	22	20	5.28	4.80
September	31	--	7.44	----

TABLE 7 . Intensity of Feeding Vegetation by lambs, 1969 and 1970, in minutes FV per 100 minutes active.

	Feeding vegetation Intensity			
	1969	(n)	1970	(n)
June	34.5	(36)	28.0	(40)
July	51.3	(40)	29.8	(45)
August	48.3	(23)	43.3	(9)
Sept.-Nov.	68.7	(17)	-- -	

(n) = number of ten minute observation periods

TABLE 8 . Feeding Vegetation Effort (% of time actually spent ingesting vegetation), bighorn lambs, 1969 and 1970.

	Feeding Vegetation Effort	
	1969	1970
June	3.45	2.24
July	6.67	3.28
August	10.61	8.66
Sept.-Nov.	21.30	----

TABLE 9 . Percent of time lambs were "active" and the percent of time they spent 'walking', 1969 and 1970.

	Active		Walking	
	1969	1970	1969	1970
June	34	47	5	11
July	45	43	6	9
August	50	63	6	11
September	59	--	6	--

TABLE 10. 'Walking'as a percent of time 'active', bighorn lambs, 1969 and 1970.

	1969	1970
June	15	23
July	13	21
August	12	17

TABLE 11 . Duration of suckles by bighorn lambs, 1969 and 1970, Sheep River Area.

		Suckle Duration (sec.) 1969	(n)	1970	(n)	Significance of difference
June	1 - 15	20.2	(102)	----		
	16 - 31	20.1	(48)	21.5	(157)	$p < .10$
	total	20.2	(150)	21.5	(157)	$p < .10$
July	1 - 15	15.6	(87)	16.9	(22)	$p > .5$
	16 - 31	15.3	(11)	17.3	(107)	$p < .01$
	total	15.6	(98)	17.2	(129)	$p < .01$
August		14.0	(22)	14.5	(9)	
September		13.5	(8)	----		
Nov. to Jan.		9.7	(10)	----		

(n) = number of suckles timed

TABLE 12. Frequency of successful suckles and total number of seconds suckles by bighorn lambs per hour of female activity, 1969 and 1970.

	June				July			
	1 - 15		16 - 30		1 - 15		16 - 31	
	1969	1970	1969	1970	1969	1970	1969	1970
suckles/hr. ♀ 'up'	2.08	---	1.14	1.21	.94	.74	.93	1.24
seconds suck /hr. ♀ 'up'	41.93	---	23.72	26.78	15.27	12.60	14.07	21.87

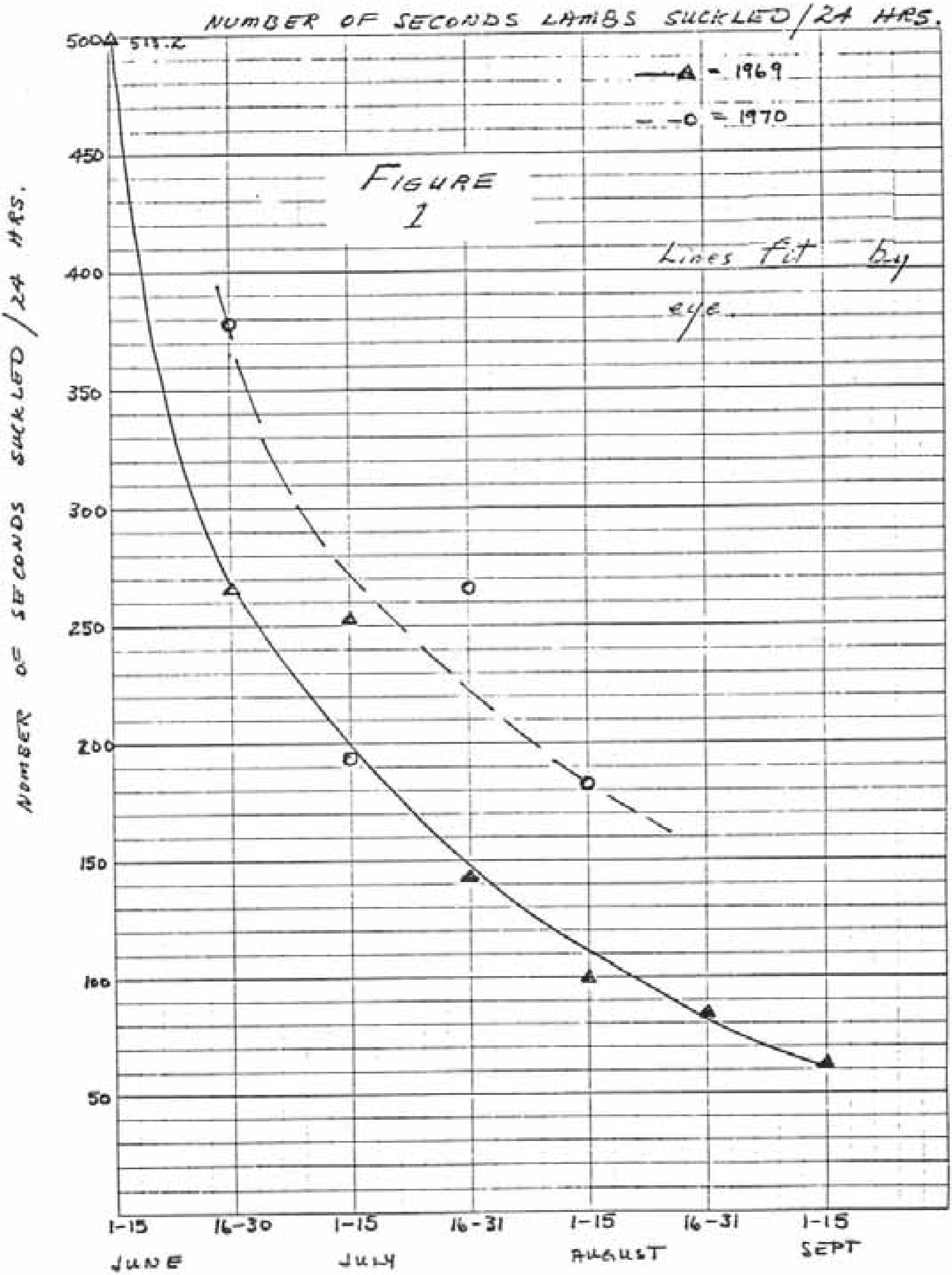
	August				September	
	1 - 15		16 - 30		1 - 15	
	1969	1970	1969	1970	1969	1970
suckles/hr.	.53	.74	.49	--	.34	--
seconds suck	8.92	10.98	5.68	--	4.54	--

TABLE 13 . Calculated total seconds suckled by bighorn lambs per 24 hours, 1969 and 1970.

		seconds suckled/24 hrs.	
		1969	1970
June	1 - 15	513.2	---
	16 - 30	267.6	379.2
July	1 - 15	252.9	193.5
	16 - 31	141.8	267.7
August	1 - 15	100.6	181.8
	16 - 31	85.9	---
September	1- 15	63.2	---

TABLE 14 . Number of suckle attempts per hour of ewe Activity, Sheep River Area, 1969 and 1970

	1969	1970
June	1.44	1.82
July	1.58	1.98
August	1.14	1.61
September	.67	----



NUMBER OF SECONDS LAMBS SUCKLED/24 HRS.
—▲ = 1969
– –o = 1970
FIGURE 1
Lines fit by eye.
517.2
500
450
400
350
300
250
200
150
100
50
NUMBER OF SECONDS SUCKLED / 24 HRS.
1-15
16-30
JUNE
1-15
16-31
JULY
1-15
16-31
AUGUST
1-15
SEPT

TABLE 15 . Frequency of rejection of suckle attempts, bighorn lambs, 1969 and 1970.

		1969 (n)	1970 (n)
June	1 - 15	34 (201)	--
	16 -30	30 (82)	42 (147)
	total	33 (283)	42 (147)
July	1 - 15	39 (174)	30 (33)
	16 -31	55 (33)	51 (136)
	total	41 (207)	47 (169)
August	1 - 15	58 (33)	54 (26)
	16 -31	53 (51)	--
	total	55 (84)	--
September		50 (16)	--
November		79 (24)	--
December		37 (8)	--

(n) = number of suckles attempted

TABLE 15 . Frequency of 'approaches' used by lambs in successful suckling interactions, 1969 & 1970.

		1969			1970		
		SI(%)	RR(%)	(n)	SI	RR	(n)
June	1 - 15	81	19	(113)	--	--	
	16 - 30	80	20	(50)	73	27	(161)
	total	81	19	(163)	73	27	(161)
July	1 - 15	84	16	(96)	64	36	(22)
	16 - 31	67	33	(15)	66	34	(107)
	total	82	18	(111)	66	34	(129)
August	1 - 15	58	42	(12)	45	55	(9)
	16 - 31	50	50	(24)	--	--	
	total	53	47	(36)	45	55	(9)
September	1-15	37	63	(8)	--	--	

SI = 'step-in' approach ; RR = 'run-around' approach
(n)= total number of approaches

FIG. 2 FREQUENCY OF CONTACT AND NON-CONTACT SUCKLING TERMINATIONS

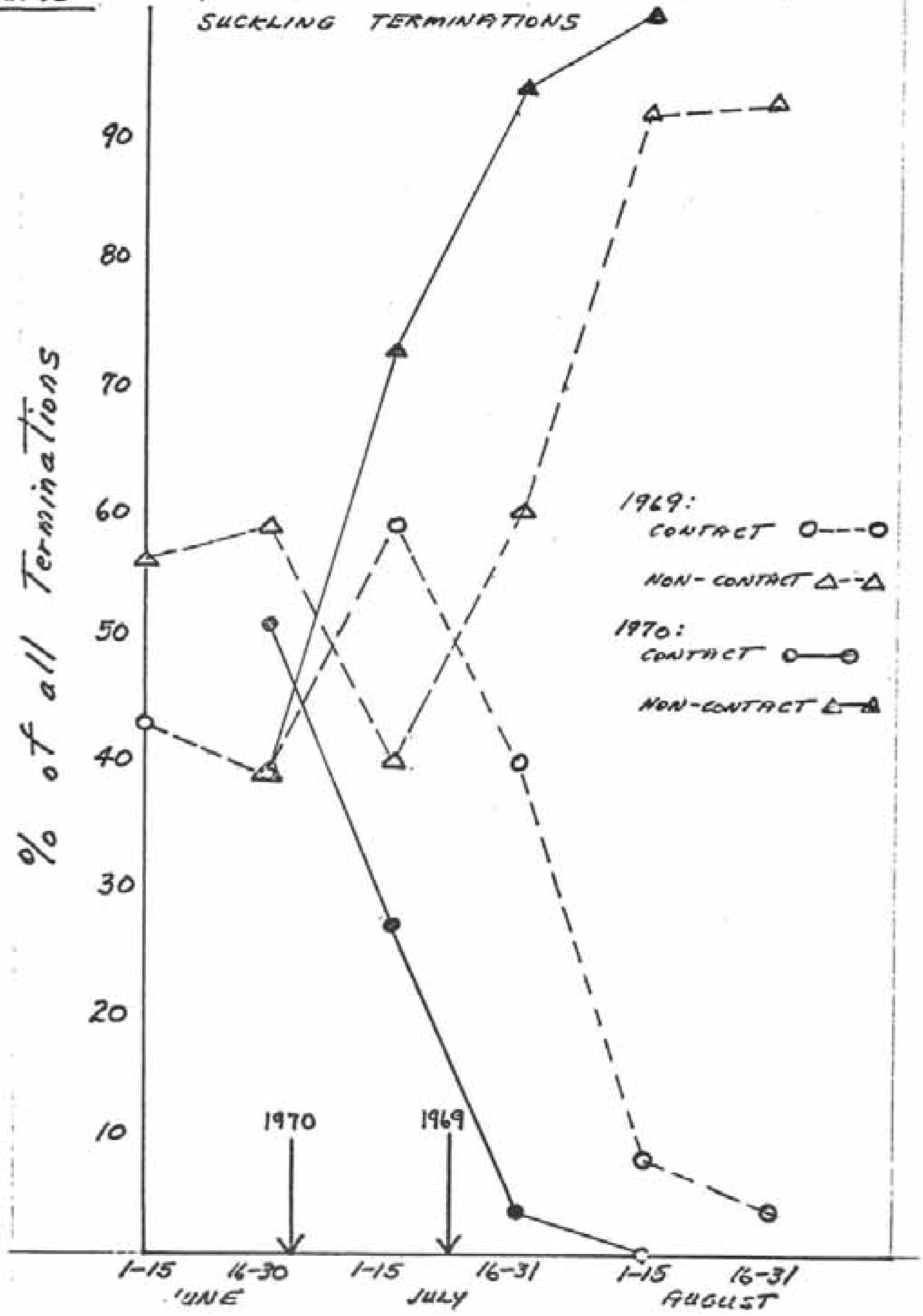
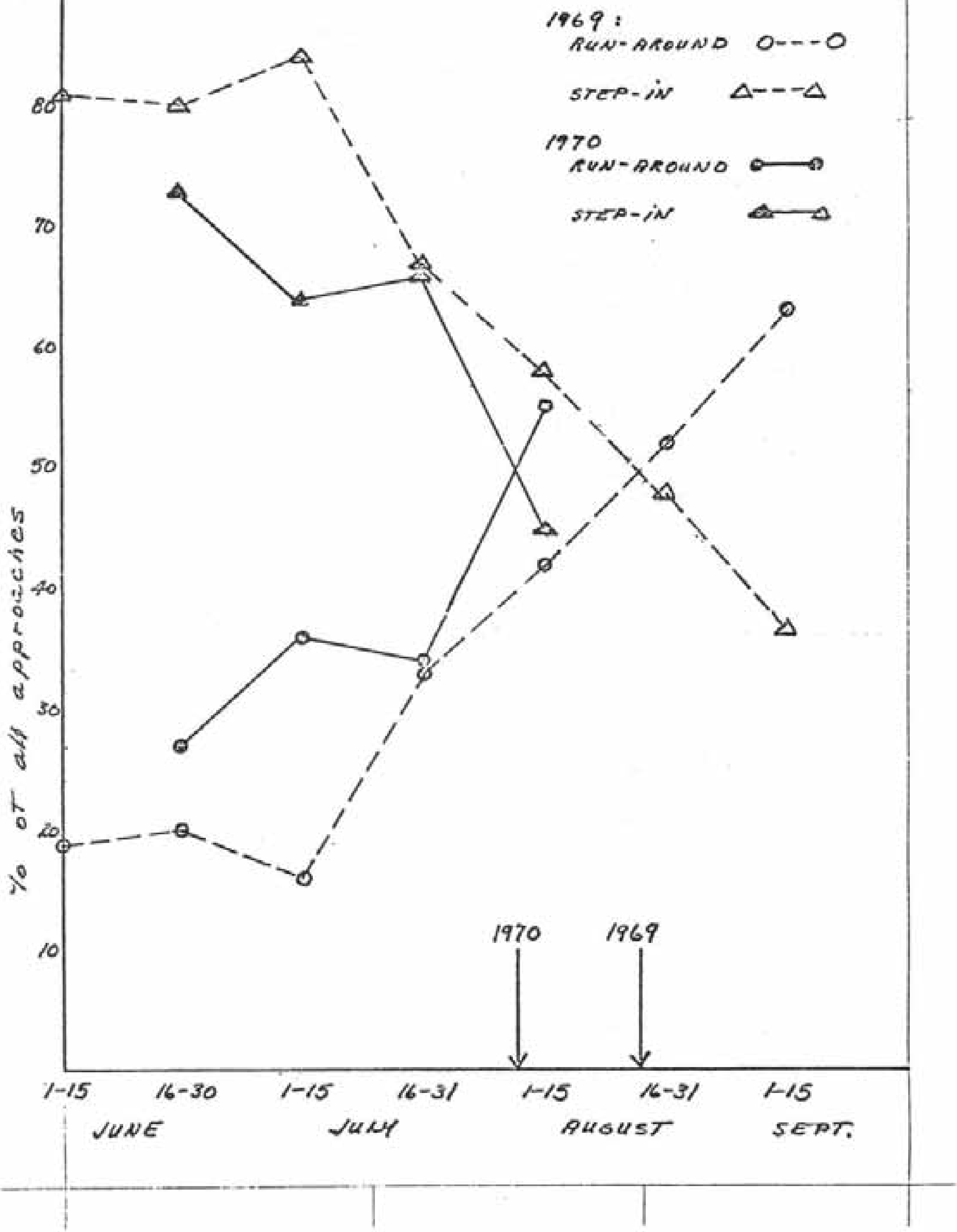


FIG. 3. APPROACHES USED IN SUCCESSFUL SUCKLES



A COMPARISON OF CERTAIN ASPECTS OF THE BEHAVIOUR AND DEVELOPMENT OF LAMBS FROM TWO POPULATIONS OF BIGHORN SHEEP (*Ovis canadensis canadensis* Shaw)

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Abstract

The study was carried out on lambs belonging to two different populations of bighorn sheep in the Canadian Rocky Mountains. The study areas were located at Bare Mountain, Banff National Park, Alberta, and Radium Hot Springs, Kootenay National Park, British Columbia. Information was recorded on all aspects of behaviour related to the nourishment and development of the lambs during their first few months of life. Quantitative data were collected on the durations of suckles, grazing and play bouts, lamb production and development. It was concluded that the lambs from the Bare Mountain population were of poorer quality. The lambs from this population, compared to those from Radium Hot Springs, had a lower milk intake, whilst at the same time relying on a higher forage consumption. Consequently they spent less time in play activities. Bare Mountain lambs also showed markedly poorer growth and development and this appeared to continue into the second year of life. Lamb production also reflected the difference in quality between the two populations, with a lamb to ewe ratio of 33: 100 for the Bare Mountain population, and 70 : 100 for the Radium Hot Springs population. The differences found between these two populations of bighorn sheep are comparable to the results of studies of the effects of high and low plane levels of nutrition on the growth and development of the domestic lamb (*Ovis aries*).

David Shackleton - Question Period

Q. Do you have any figures for the length of grazing by a lamb shown on the slide, and when it began?

A. I observed the first lambs at Banff on 4th June when they were about 2 weeks old, and they were grazing consistently then. The figures as I gave them were mean values and were 2 minutes per lamb and 3 minutes per ewe for grazing bouts. I first observed sustained grazing by Kootenay lambs when they were 7 weeks old, but they could have started two weeks earlier.

Q. Did you collect data on the difference between range qualities here at all?

A. No I didn't. This has been studied quite adequately by John Stelfox, although I don't think he is collecting in the Kootenays. This aspect requires a separate study to itself to do it adequatley. I must add that the rest of my study is concerned with the social behaviour, morphology and taxonomy of the sheep from the two populations.

Q. Although I don't believe you did any work on this, in your reading were you satisfied that there is a constant relationship between the amount of forage available and the amount of milk produced by the females?

A. From the available literature on domestic sheep which I have read, there is good evidence to show that the quality of the forage is very significant, more so than the quantity. The better the quality, the greater the amount of milk produced. This effect is significant whenever the high quality feeding regime is started; whether it is started prior to lactation or up to 4 weeks after its onset.

Comment: On Bill's question about the difference between Banff and Radium (Kootenay), you could probably go back to some of the information on the population at Radium before the die-off in 1966-67 and see that the lambs at that time had the same appearance as the ones at Banff do now, and that the range conditions were similar.

A. Well, John has the information about this and I am also collecting data on the horn growth and development, from rams which are still living and which were alive before the die-off. There is tentative evidence to support your suggestion.

Comment: There is more evidence from the Wigwam herd as well and this almost parallels your findings Dave.

Q. Dave, do you have any differences in the time of weaning or didn't you record this?

A. I guess in domestic sheep weaning occurs around 70 days of age, but I couldn't say for sure in bighorns.

Q. Was the herd structure the same for both parks?

A. In Banff there were: 30 adult ewes, 10 lambs, six 2-year old males, six 2-year old females, 4 yearling males and 5 yearling females, giving a total of 61. In Kootenay there were: 26 adult ewes, 19 lambs (12 male and 7 female), one 2-year old male, two 2-year old females, 3 yearling females, 3 yearling males, and 9 rams of 3-years and older, giving a total of 63.

ON THE SIGNIFICANCE OF THERMOCLINES TO THE BIOLOGY OF WINTERING MOUNTAIN SHEEP

V. Geist
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Abstract

The theoretical significance of why mountain sheep frequent high elevations during mid-winter is investigated. A thermocline is found at high elevations which allows sheep and mountain goats to live at higher ambient temperatures than those occurring in the valleys below. It can be shown that each day-degree in a warmer microclimate saves a significant amount of fat from oxidation, if the animals live below the temperature at which their food intake is insufficient to cover the cost of keeping warm. With the aid of formulas derived from experiments on the bioenergetics of ruminants, it can be shown that each day-degree

saved can also be expressed in terms of food quantity and quality. Thus at high ambient temperatures a sheep may live on poorer forage than at low ambient temperatures. These formulas were tested against digestibility of forage and found to predict accurately. It can be shown that for an identical content of crude fibre and protein, green forages have a higher digestibility than dry forages. Using the formulas and figures derived it can be shown that lambs must have considerably better forage than rams to survive identical climatic conditions. It is predicted that lambs will differ from adults in food habits by being more selective feeders -- taking in forage of relatively low fibre and higher protein content. The highest energy expenditures would be incurred in the valley where ambient temperatures are lower, and temperatures fluctuate more than in the thermocline. Both the high ambient temperatures and the reduced temperature fluctuations in the thermocline are shown to be important for sheep in energy conservation.

Dr. Val Geist - Question Period

Q. How sensitive is forage intake to forage volume requirements in wild populations? It is very good where forage is very high, but in the field can you use forage quality as an estimate of forage intake? Is that with winter range?

A. I would be delighted to have an answer to that question myself. This is exactly why we do these things -- to raise questions that one hopes to be answered.

Q. Suppose you had the opportunity to test these models; where would you start and what would be the first thing you would start to find out?

A. This model assumes the animal is standing, it does not make the assumption at any point that the animal is lying down. The moment the animal lies down there is part of his body in contact with the ground and you do in fact increase the insulation considerably because the ground warms up where the animal lies down. I do not know what percentage touches the ground -- one third or one quarter. This must be worked out. Then you have to know quite accurately how long on the average the animal touches the ground, at what time period he lies down. It would have to be set up as a sub-program. The first thing that I can see is that there are still a lot of details that need cleaning up.

Q. I was wondering why you use protein and fibre as the main base for nutritional computer work here when I believe that carbohydrate energy and Vitamin 'A' and mineral intake are generally considered by nutritionists to be an important year round concern from the standpoint of the animal's welfare and energy requirements. Protein and fibre would generally be one of the last you would like to look at.

A. Quite simply, protein and fibre do predict quite accurately the intake of the animal. So, it tells you how many calories it is going to take in and this has been worked out very well. The amount of Vitamin 'A' and what effect it has on intake per se, I frankly at present am not prepared to say and maybe you have some indication in some of your work, but I am quite sure that it has considerable effect and I am aware that Vitamin 'A' content, at least during the winter time, would very likely derive supplement from the Vitamin 'A' stores in the liver itself. Some of the Russian work indicates that the Vitamin 'A' content in the liver declines during the winter time. I suspect even if the Vitamin 'A' content in winter forage is very low, which it very likely is because green forage is very low in their intake, it will be supplemented fairly adequately in that case. As far as phosphates are concerned, there is work to indicate that they are absorbed from bone during the winter time. This would be true for other minerals as well. It is my present understanding that the animal goes into winter with a store of energy in the form of fat, a store of minerals in the form of dense bone, a store of vitamins in the form of Vitamin 'A' in the liver, and they use these things up during the winter months and that they replenish them at salt licks in the case of minerals and in the case of forage, of course, during the following summer.

Val Geist
University of Calgary
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My main points in sheep management are:

1. The need to conserve unhunted and unmanaged populations of sheep of all races, and ecological types. Thus we need a viable Stone's sheep population under protection. Next, we need not only high-mountain populations under protection but also some lowland sheep, i.e. such as in cliff belts along major rivers, such as the Yukon. These small, but viable populations would be our insurance against mismanagement, since they represent untapped information and a reserve of animals for reintroduction programs.
2. The need to keep unmanaged, unaltered, natural populations in our National Parks so that we can inform ourselves on how the ecological parameters of the habitat translate into the sheep's population dynamics, growth, physiology and behaviour. Sheep that graze fertilized roadbanks and lawns, are fed and salted by tourists, whose population is reduced by trapping programs and highway traffic, do not fit the requirements.
3. Once these requirements are satisfied, we can manage and experiment with new management concepts on populations used for hunting or for recreational, aesthetic, etc. needs, in good conscience.
4. A desirable objective is to rehabilitate areas from which sheep were eradicated in earlier years. This applies to large areas in the Yukon Territory where market hunting destroyed sheep populations.
5. I emphasized that in dealing with social animals we must not apply our knowledge gained from moose or deer, since their adaptive strategies differ too greatly.

Dave Neave
Alberta Fish and Wildlife Division
Edmonton, Alberta

Is sheep management in Alberta affected by the presence of National Parks? Obviously the answer is yes, after looking at the relationship of winter sheep ranges on the East Slope to the location of the Park boundary.

Alberta East Slope Bighorn Range - 50 miles x 450 miles with half in the National Park. But, most (60-70%) of the winter ranges in the Province are within 10 miles of the boundary. There is, therefore, a very marked movement of sheep: Park in summer, outside Park in winter. But the number and availability of winter ranges is the key to bighorn survival and population numbers.

This relationship is important as there has been a tremendous change in sheep numbers in the last Century (well documented by John Stelfox).

Very generally:

1800 - 1866 - high, 10,000 sheep
1860 - 1915 - decline, 2,600 sheep due to heavy hunting and livestock competition
1915 - 1936 - rapid increase to 8,400 sheep through protection
1937 - 1950 - high density and rapid decline - 2,500 sheep not synchronous decline over East Slopes but decline of 75 per cent in Parks - identifying of pneumonia lungworm - relation weather and range.
1950 - 1966 - rapid increase, 10,000 sheep - good range, mild winters. Scattered die-offs in Banff - Bow River
1966 - 1970 - high, but potential for die-off - first showing in the East Kootenay and then Kootenay Park in B.C. due to the pneumonia - lungworm complex and the weather and range conditions. The incidence of lungworm is now low there; however, very high in Jasper and Banff Parks and a decline is predicted.

Outside Parks winter surveys 4,500 sheep - ranges generally fair (incidence of lungworm relatively low), but relatively low production - December 30%; lambs per 100 ewes and yearlings and 2 year olds.

We can accept the philosophy that the population declines in the Parks are natural, but how can we reduce the very real possibility of an effect on adjacent or mutual herds? - with the apparent virulent condition.

Here then is the problem:

1. a mutual herd, partially in the Park (unhunted) and Provincial (hunted), but with considerable movement between.
2. the build-up in sheep populations - perhaps fluctuating between 10,000 - 2,500 in response to range conditions, weather severity and a lungworm - pneumonia complex and with additional stresses including range competition and a lack of predation.

We are at the peak in sheep populations and we are expecting a decline. What are we doing? Look at our present management outside the Park:

1. Trophy Sheep Seasons:
   - originally none, then a minimum 3/4 curl in the early 1960's to 4/5 curl in 1968
   - November seasons were initiated for a short time to catch Park rams
   - 1,200 residents and 200 non-residents = 110 rams killed
     - about 1/3 of the legal rams
     - a reduction from past kills - mid 1960's with November season over 200 rams.

   However, with trophy sheep seasons - only one small segment - rams 6 years and over - affects 5% of population.
2. Non-Trophy Sheep Seasons:
   - initiated in 1966 to reduce sheep populations in order to maintain a lower population level and to increase production. A recent modification was made to protect yearling rams and lambs. The attempt to reduce population on a range basis, is not effective.

- 400 - 450 permits - kill up to 150 sheep (kill probably 5% of the population and therefore not effective in population control.

3. Reduction of Elk and Livestock Competition:
   - late 1950's - introduction of cow elk seasons
   - a gradual reduction in livestock grazing in key areas
   Both these methods only allow more range and less competition for available grass. A short term solution allowing higher carrying capacity for bighorns.
   - estimated loss of elk range at 7% every 10 years.

In Summary: we have a sheep population above or reaching its carrying capacity and although very "refined", sheep management can not retain a desired population level.

What can we do to maintain a high sheep population in Alberta outside of the Parks? - raising rams and yet maintaining adequate production

1. Kill a higher number of non-trophy sheep and maintain a lower population level. Very difficult when there is no demand for present non-trophy licences. It is unpalatable for many sheep hunters, perhaps epidimizing trophy hunting, to kill a ewe at 25 yards.
2. A late sheep season in November to kill more rams and ewes when they are on specific winter ranges. This may delay migration and even breeding behaviour. Unless there are more non-trophy hunters, there would not be a significant increase in the harvest.
3. Same number of non-trophy permits - but only few W.M.U.'s per year - heavy harvest on specific herds.
4. Ray Demarchi - "slaughter house" syndrome in Europe.
5. Remove all competition for bighorn sheep on ranges - more liberal cow elk seasons and elimination of livestock from many allotments.
6. Improving present sheep ranges by burning and fertilizing - but, range improvements only temporarily resolve the problem and only in specific areas due to the animals' innate capacity to increase above their carrying capacity.
7. Protecting predators and allowing their build-up is essential. They alone may maintain a stable population or at least smooth out violent oscillations. But predators are protected in the Parks and have had no effect in Park sheep populations.
8. Possibly the best solution - let any die-offs occur - best for solving land-use problems.

I feel our management may, and certainly could help maintain a more desired level of sheep outside the National Parks. However, we can expect declines in sheep numbers if there are die-offs inside the Park. These die-offs will probably extend through sheep ranges outside the Parks until reaching natural barriers. Hopefully, the response of the sheep that survive and their speed of recovery to high numbers, may be affected with management.

V. P. Rolfson
Head, Resource Conservation
National Parks Branch
Calgary, Alberta

I have been asked as a member of this panel to present the "preservationist" point of view in line with our policy in regard to the wildlife (bighorn sheep) management. In doing this, I would like at the beginning to clarify the word, preserve. To some this term means literally to maintain and protect without change.

Basically in the National Parks we manage normally to two basic objectives

1. to the era concept which means we do manage to preserve a basic resource in such a condition that it will remain static. This may be necessary to preserve a species or to maintain a unique feature or eco-system. Examples could be the wood buffalo in Elk Island or the whooping crane in Wood Buffalo. In these cases nature is not allowed to determine completely the results.
2. for the most part our National Parks are managed on an evolutionary concept, i.e. that nature is allowed to take its course as much as possible and that dynamic changes as in nature are taking place.

With regard to preservation then, we are essentially preserving the Parks under these two management concepts.

The policy states that, with regard to wildlife and nature, "objectives of nature in National Parks are important parts of the national heritage and should be preserved unimpaired for the benefit, education and enjoyment of future generations." The policy further states that "it is part of the National Park purpose to maintain the quality and beauty of wildlife in National Parks, i.e. to maintain healthy populations of native animals in balance with our environment. In a completely natural situation this could be accomplished by the steady pressure and persistent attrition of predators on animals of poorer condition." Modern hunting tends to reverse the natural process of selection by favouring the less fit.

I think no one here would argue that nature, if let alone, would produce the healthiest and best balanced natural population of the various species of flora and fauna. In line with this then, I would say our responsibility in most cases is to preserve that natural and dynamic situation. We must recognize in some cases the value of predators including disease and fire in this category and, with the development of skills to use these predators in our management techniques, we should not be fearful of the cycles which occur naturally affecting population numbers. Population peaks and crashes in nature do occur and do, in various ways, have beneficial effects.

Thus our preservation management needs for all species including sheep are clearly defined and in most cases, as mentioned previously, natural systems requiring no management would be the most desirable. However, because of such things as boundaries which do not encompass complete ecosystems and consequently the lack of some natural predators, the best we can hope for is a quasi system of natural management. Where we as man enter the picture with development and visitor use, some counter acting measures must always be planned and taken. With regard to sheep, the quality and health of their populations can only be achieved if we consider several basic factors. These are:

1. the amount of available range, particularly winter range.
2. the total range or migratory area required has to be considered. If part of the range occurs outside the Park, what are the conditions that prevail there as well as inside.
3. density of animals on the range.
4. other species present. What is the situation with regard to competition.
5. predator conditions including disease.
6. availability of mineral licks.
7. development should not fragment populations.

No single one of these factors can be considered by itself as each is related or dependent on others. Our big problem is perhaps the development of some index which would help us forecase conditions and help us take proper corrective action. In this regard we rely heavily on the Canadian Wildlife Service.

In general we could say that to take preventative measures to natural occurrences such as disease is to go contrary to our policy. In the pure sense, it may be but management requirements may dictate action because National Parks are not, in many cases, pure natural communities.

Pressures outside the Parks and from within often require that counter acting measures be taken. Most of you are aware, for example, that we have in the past reduced our sheep and elk populations in some areas. This, in fact, is in line with the "Leopold" recommendations in Park management of wildlife. The removal of sheep has always been by live transplant and many have gone to other parts of Canada and to the United States. In some cases the reduction has not been because of our management requirements but for the purpose of cooperating with another agency in the establishment of herds.

How do we determine what action should be taken? What are our objectives in wildlife management? Obviously the objectives must differ from Park to Park. For example, the purpose and objectives of managing buffalo would be entirely different between the three Parks of Wood Buffalo, Waterton Lakes and Elk Island. Our management practices and our reduction programs would, therefore, vary. At the present time our specific objectives are not as well defined as we would like them to be. Resource information with regard to environmental requirements and conditions, have, however, started on a very ambitious program which will lead us to achieve them ultimately. We have started an inventory program to give us resource information in all our National Parks. The schedule for this may take 10-12 years before completion. The priority is being given to new Parks. This inventory information will then be used in the preparation of Master Plans. The Master Plan will set out the Park theme and the objectives. These objectives will then be reflected in the Resource Management plan which will follow and, of course, the Resource Management plan will include wildlife management plans. You might be interested to note that we have also embarked on a program of conducting studies regarding the impact on the environment and the eco-systems as a result of development or use in the Parks. These impact studies will be a part of the development process and in some cases may well determine that a development is inadvisable. In the impact studies, wildlife requirements, migratory routes, etc., will be fully considered and I am sure that as a result many of the problems, such as fragmentation of animal populations will be minimized.

On this optimistic note I would close with thanks to the Chairman in asking National Parks to participate in this Conference.

John G. Stelfox
Canadian Wildlife Service
Edmonton, Alberta

"The Parks are hereby dedicated to the people of Canada for their benefit, education and enjoyment, and such Parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations." This statement from the National Park policy lays down two fundamental terms of reference:

1. Parks are set aside so the public may enjoy and learn from the natural features.
2. The natural features are to be preserved intact for all time.

By these natural features are meant all the living things in the Parks, both plant and animal, and their non-living environment.

The concept of wildlife management in Parks is different from that on non-Park lands where management consists of the manipulation of animal numbers and habitat conditions to produce a maximum sustained crop of harvestable game. In Parks all wild animals, birds, reptiles and amphibians as well as plants are protected from destruction. Thus we do not categorize some species as pests (coyotes, skunks, etc.) that must be controlled. Nor do we rate others as more desirable (bighorn sheep, blue grouse, etc.) because they are important game species on provincial lands. In general, all wildlife species are to be given equal importance.

Changes in plant cover occur with plant succession, and there are corresponding changes in wildlife species. Thus the removal of spruce by fires may be followed by aspen poplar growth which favours an increase in moose, beaver and snowshoe hares. However, if no further disturbance occurs the tree cover will gradually revert back to a spruce forest with conditions slowly becoming more favourable for caribou, white-winged crossbills, spruce grouse, etc.

Some animals are capable of reducing their own food supply, thus contributing to population fluctuations. A population of hoofed mammals can increase until it damages the grass and browse forage and changes occur in plant community composition to the detriment of some animal species.

When ranges and forage preferences of animal species overlap (i.e. bighorn sheep and elk), competition for forage occurs and the species that suffers the most is the one with the more restrictive or selective diet (Cowan, 1950, Flook 1964, Stelfox & Taber 1969). For example, bighorn sheep are largely grazers whereas elk seem to have a broader adaptability to feeding and surviving on a wider variety of grass, shrub and tree species and coping with deeper snow conditions. In addition elk are at home on grassland, parkland or forest communities, whereas wild sheep prefer grassland communities in close proximity to rugged escarpment.

Diseases and parasites act as mortality agents especially in the bovids such as bighorn sheep but have less effect on cervids such as elk, thus favoring the survival of cervids. Conversely, predation by large carnivores such as wolves is heavier on elk than sheep thus favoring the latter (Cowan, 1947). However, it is difficult to maintain good wolf numbers in Parks because they also frequent adjacent non-Park lands and prey on livestock to the dissatisfaction of livestock owners.

In order to preserve soil, plant cover, and animal populations in a relatively harmonic but dynamic state within Parks it is sometimes necessary to control populations of hoofed mammals for the following reasons:

1. the wildlife management policy is designed to maintain natural and harmonious communities of plants and animals, with no animal species permitted to increase to a level where they cause:
   a) serious depletion of native plant species.
   b) serious depletion of other native animal species through elimination of their food or cover, or
   c) its own disappearance through destruction of necessary habitat.
2. As most National Parks include, or are on the headwaters of, important watersheds, the maintenance of adequate plant cover, soil stability and water quality are of utmost importance. Uncontrolled populations of hoofed mammals can seriously damage watersheds, especially in the case of elk.
3. Some Parks border farm or ranch lands where an overflow of surplus elk or deer can cause economic losses to landowners which may cause a sufficient uproar in the voting public to force control measures within the Parks.

For the above reasons, management programs of hoofed mammals are implemented to keep populations within the carrying capacities of their ranges. These control measures are sanctioned in Section 7 of the National Park Regulations which states that the Director may authorize the Park Superintendent to take or destroy any game when such action is considered advisable for game management purposes. Elk, bison, moose and deer have been harvested in various Parks. Elk have required the most widespread control for reasons mentioned above.

Sport hunting is prohibited under the National Park Act and justifiably so for two main reasons:

1. it would set a precedent in National Parks exploitation.
2. the behaviour of the wildlife within the Parks is such that hunting or shooting them would not be much of a sport.

What is vitally needed in all Parks is:

1. A broad and effective public education program to inform the public on all natural park values and on the reasons for existing wildlife management or non-management programs.
2. the development of a sound wildlife management policy for each Park determined on the basis of the overall Park objectives and priorities of various wildlife species in relation to other natural features. This actually means placing priorities on each wildlife species as well as desired numbers of each species. For example, it is essential to determine the importance of bighorn sheep compared to elk, caribou, etc. as well as the impact that uncontrolled numbers will have on other important Park features. These priorities must also be determined in consideration of adjacent provincial plans and problems.

Finally, should bighorn sheep management within National Parks be designed to prevent population build-ups in excess of range carrying capacities and the consequent temporary die-off of roughly 75 per cent of the population. In considering the long-term welfare of the range, there is nothing to indicate that temporary range deterioration along the Athabasca Valley in Jasper National Park in the 1940's resulted in permanent range deterioration or reduction of forage production. Unless the contrary can be proven, there is little justification for bighorn sheep control within National Parks. It appears that at this northern latitude, the duration, severity and snowpack conditions of our winters are capable of inducing a reduction in ungulate populations when range carrying capacities are surpassed, before permanent range damage occurs.

Considering the problem of a pneumonia-lungworm disease in over-abundant sheep populations within Parks spreading to sheep herds on provincial ranges thus endangering their survival, this is a definite possibility and must be given serious consideration. However, a review of past die-offs in western Canada indicates that provincial herds suffered declines at the same time or at times even prior to die-offs in adjacent Parks. The heavy use of livestock, or land alienation, on important sheep winter ranges outside the Parks has often been responsible for triggering die-offs as fast if not sooner than has occurred in unhunted herds within the Parks. It is likely desirable to maintain optimum numbers of transient sheep herds by inducing surplus animals to migrate onto provincial lands where they can be cropped by hunters.

Within the Parks it is more important to consider habitat management (perpetuating sufficient grasslands), and to minimize interspecific competition, assuming of course that the Parks objective is to perpetuate large numbers of bighorn sheep.

According to a previous speaker, only about 5 per cent of the bighorn sheep are being harvested annually in Alberta. If the provincial objective is to maintain populations within the carrying capacity of winter ranges this would likely necessitate cropping at least 15 per cent of the presently high population. One of the most damaging programs we could implement either within or without the National Parks would be one designed to harvest less than the optimum number of sheep from a range management standpoint. Such a program would permit over-abundant populations to exist for longer durations before a die-off, thus causing more severe range damage than would occur if no population control existed and populations declined sooner after they exceeded range carrying capacities.

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Question Period

Q. (to J. Stelfox) Does the Park really consider the population of sheep outside the Park to be an important factor in Park sheep management?

A. I will turn that question over to Sandy because the management of all wildlife in natural surroundings in the Park is controlled by Park staff on the advice of the Canadian Wildlife Service. I would say that it definitely should be considered.

S. Rolfson - I think I would start that off by saying that the Park requirements would come first. However, we are in the process of working very closely with the Alberta Fish and Wildlife Division and we are trying to establish joint management on both sides of the boundary.

V. Geist - with regard to the lungworm - pneumonia complex, animals become so heavily infected that at this state of high infection, they will catch pneumonia and die off. I am wondering if we should not identify a virus sweeping through. I do not believe we have the answers.

J. Stelfox - I would like to comment further that I would think that Dr. Holmes and other parasitologists would tend to agree that looking at past die-offs in bighorn sheep we do not want to look just at pneumonia or incidences from virulent strains involved. Looking at the habitat of the animals and the range quality and quantity is the important aspect and we should put less emphasis on pneumonia - lungworm.

Q. I would like to ask Sandy what developments within the Parks he thinks are the key developments that should be considered with respect to wildlife?

A. I do not know if we can answer this. We have studies to understand the impact on changes to animal populations. We have gone into a crash impact study on the Trans Canada highway. We are looking at it closely from an ecological standpoint. I do not know that we are establishing any priorities right now.

Q. Do you have ecologists looking at this?

A. Yes. We are going to the Canadian Wildlife Service, to University graduates, etc. Our priority for special studies are first to the government agency, such as C.W.S., or Forestry people; subsequently we go to Universities. Then we will look to outside consultants and there are a large number of those kind of organizations coming up all over the country.

Q. I do not see very much difference in the concept between the proposal put forth by Mr. Wishart of "shoot them while you have them" and Stelfox's "let them all die".

V. Geist - One of the major reasons why we must have information is indeed to know how and when die-offs occur and what the reason for them is. We are just getting into the age of knowing something about living things. We are at the very early stages. It is imperative that several areas should be that we let nature take its course.

R. Demarchi - In addition to what Val said about establishing animals, one has to restore natural ecological systems in our National Parks as they now exist and if possible try to restore the natural balance. Removal of livestock would not solve the problem and die-offs are most severe when they start. Our goal in British Columbia is to remove all livestock from our bighorn sheep ranges. We are trying to find out what effect cattle have had on sheep as livestock are not part of the natural ecological system. They are not truly a competitor on the same scale. We should examine those ranges that are natural and also those that are mucked up by livestock.

D. Neave - You said your Department's policy was removal of livestock. I think we can say that the Alberta Fish and Wildlife Division feels the same way. We are looking more at livestock on elk and wildlife ranges and I agree that the range would be in better shape if we removed livestock in many areas.

J. Holmes - I would like to comment on some of the parasitological information that has been flying around. We have done some studies in the National Parks on animals that have been made available to us and looking at the species that have been found there. The sheep herds have not had contact with livestock. In the Sheep River herd we have information about parasites and if we look at the species of parasites that are present, we find that the greatest amount of overlap as we might expect is between domestic sheep and wild sheep. The only studies we made have come to the conclusion that there may be different strains involved between wildlife and domestic species. We made no studies in areas where there are overlapping distributions. So far on the bighorn sheep, it does not look as if there is a great deal of inter-action there. Lung worm burdens found at Sheep River had less lung worm in the herds than the lung worm loads in the herds in Jasper but not much difference than Waterton or Banff Parks.

A. Schallenberger - I would like to say that the Alberta Fish and Wildlife Division should shoot more bighorns. Everybody so far has carefully avoided shooting more than 5 per cent of the bighorn herd. I think this is one of the alternatives that can be considered here, if you reduced herds and kept ranges in better condition. Possible reduction of the bighorn herd would not do much good if you have an over-population of elk.

J. Stelfox - By controlling to prevent fluctuations, you do more harm in cropping 5 per cent and maintaining your range in poor condition. What you should take would be approximately **15-25 per cent** harvest to get down to a point where you permit the range to recover to a healthy state and then continue cropping. If we look at Jasper's present population of 2,500 to 3,000, we know we have too many animals on the ranges at present. The 85 per cent die-off in the 1940's in Jasper permitted the range to come back. I am sure it would be essential for us to bring the population down to something in the neighborhood of 1,000-1,500 in order to induce winter range improvement. It would be far worse to pick away at this population. We are looking at other means of control. If it is hard to find a full sized ram outside the Park, then it might be desirable to maintain populations with a top-heavy balance toward rams. Before we get into this control we really have to know what management is required if we are going to maintain good range conditions.

D. Neave - We certainly would like to shoot more non-trophy sheep. We have only 400 permits issued, but do not receive more than 500 applications. The only thing we can do is saturate some areas with more non-trophy sheep hunters and eliminate a large number of sheep in a smaller area.

E. G. Scheffler
Alberta Fish and Wildlife Division
Edmonton, Alberta

Panel members are requested to address themselves to four questions.

1. Are alpine and other bighorn sheep winter ranges in danger of destruction?
2. Should sheep ranges be preserved and/or rehabilitated?
3. What is being done today to achieve a better harmony and to prevent permanent damage to critical ranges?
4. What should and can be done in the future and what are the possibilities for preventing protection and reclamation?

I came to Alberta in 1968 and there was very little work or concern expressed about sheep habitations except for in a few areas and although there was probably more concern expressed, it was known by only a few informed people. In 1969 we got some idea of some of the big coal mining activities going on and in 1971 we learned the extent of exploration plans. We were faced with antiquated legislation at that time. Government mechanisms such as the Environment Conservation Authority have since been created.

The Fish and Wildlife Division was caught in the middle, literally - no staff to handle the situation. There now is a Mineral Surface Rights Committee and the Fish and Wildlife Division have a representative on this Committee. We now have more staff - two biologists on land use and one technician and are in the process of setting up a land-use/habitat section with a section head equivalent to our research and management section heads.

WILDLIFE - MINERAL RESOURCE CONFLICTS

J. B. Kemper
Alberta Fish and Wildlife Division
Edmonton, Alberta

The comparison of the conflict between coal developments and bighorn sheep in Alberta has been based upon sheep winter ranges. Our feeling is that while summer ranges are vast, wintering areas, which occur in light snowfall zones or on wind swept slopes, are in short supply. In addition, sheep appear to be labile enough in the summer to avoid disturbed areas, however they are physically and perhaps behaviorally unwilling to do this during winters.

At present we have some 388,000 acres of bighorn sheep winter range in Alberta, outside of the National Parks. Approximately 80,000 acres, or about 21 per cent of this area, lies within existing coal dispositions. Since about 90 per cent of the mineable coal properties in the Province are now under lease, the general picture reflected by this data should be representative of what we can expect in the next decade.

These sheep winter ranges, which lie within existing coal dispositions, may be referred to as "conflict areas".

The natural sequence which companies follow in developing a mine area, could generally be summarized as follows:

1. obtain mineral lease for the area
2. general surface exploration
3. intense exploration of specific small areas
4. develop mine site, plant and begin mining
5. full operation - strip - spoil areas added underground

Of immediate concern for these conflict areas therefore, is not only their geographic location but also their relative position in this timetable of events. At present, some 3,000 acres of the conflict area have been explored by surface drilling, trenching, addits, or a combination of these methods. This represents about 4 per cent of the sheep ranges within coal leases. In addition, exploration in the near future has been proposed for some 9,000 acres of the conflict area, or 11 per cent of it. Therefore, some form of coal exploration has or will occur in about 14 per cent of the conflict area, or 11,000 acres.

Without a more detailed examination, one is tempted to conclude that the coal industry has really only set it's sights on some 11,000 acres of the Province's 388,000 acres of bighorn winter range. Extrapolating further a 3 per cent loss to our sheep herd of 4,000 animals, represents 120 head. Unfortunately this does not represent a realistic basis for comparison because individual ranges may be completely destroyed in some areas, while other areas are not touched. Compound these losses are range shrinkage due to forest succession, improved access, increasing harassment year-round, and a host of other problems.

We have prepared detailed resource maps of two areas which we have investigated to date. An examination of these small areas in detail may help to clarify the nature of the problem.

The Ya-ha Tinda area is well known for its elk and bighorn sheep populations: the large grassy flats and slopes of this area are the result of an unique microclimatic phenomenon which prevents forest encroachment of the grassland climax.

The first slide shows the physiographic feature of the general area, and depicts the critical range of elk in orange and bighorn sheep in blue. The Federally owned Ya-ha Tinda ranch is outlined in black in the center of the map.

The elk population numbers about 1,500 animals which move through the area during fall, winter and early spring, retiring to the park to the west during the summer. The total area needed by these elk is in the neighborhood of 37,000 acres. Some 200 bighorns reside on the winter ranges (in blue) using about 10,000 acres.

The second slide shows the domestic grazing pattern superimposed on the base map. About 710 head of cattle, and 330 horses use the area annually, however, little conflict with elk and sheep occurs except on the Ya-ha tinda ranch area. The grazing allotment surrounding the ranch property is reserved for big game use. The horse grazing presents the only serious overlap with big game. The ranch area is entirely within the critical area for elk and the Brewser's 110 horses, to the south, also overlap with the elk.

The third overlay projects the existing coal and petroleum and natural gas leases. They overlap with everything - including each other.

The sheep - coal conflict areas include about 5,000 acres or 50 per cent of the critical winter range. The range south and north of the ranch has undergone extensive exploration. If the coal property south of the ranch is developed, this land (the largest in the area) will be total climated. In situations like these, statistics can be misleading when based only on area calculations. If all the coal properties on this map were developed by strip methods, only two isolated and relatively insignificant ranges would remain intact. It is doubtful that sheep could survive at all on these areas.

The conflict between coal and elk is not severe. Some 8,000 of 37,000 acres are involved, or about 27 per cent.

If the oil and coal leases are combined, only 400 acres of sheep range and 4,000 acres of elk range remain unaffected. However, the method of resources' extraction must be considered here.

To the previously mentioned uses may be added:

1. 200 horses on the Ya-ha Tinda ranch, winter and summer require 200+ tons of hay plus grain for over winter.
2. a sulpher gas plant, and two proposed new ones
3. a proposed recreation complex which could include skiing, golfing, motels, snowmobiles.
4. a small logging operation exists in the area.
5. good fishing in the Red Deer River and in Klein and Eagle Lakes.
6. It should be noted that the eastern slope of the Rockies has been designated for watershed conservation.

A second area which involves one herd of sheep and the various dispositions of the land on which they reside, is known locally as the Sheep River area (or refuge).

The Sheep River bighorn sheep and mule deer herds are among the most accessible in the Province. Typically such herds exist on very small critical winter ranges, and at Sheep River these small grassy slopes are linked by the river canyon which the animals use as a travel route. The total winter range acreage is small, about 1,200 acres, of which 200 acres lies within coal leases. Almost the entire sheep range conflicts with petroleum and natural gas leases.

Other major users of the area include grazing by domestic stock, forestry and logging operations on the perifery of the area, and on important highways bisecting the area.

Recreation conflicts are anticipated in the near future as snowmobiles and A.T.V. become more prevalent. In such accessible areas, poaching may become a serious problem.

I hope these examples can serve as a basis for discussion by the other members of the panel. In the past such discussion has been hampered by the lack of comparative data which reflects the magnitude of the various conflicts.

Jim Simpson
Class A Guide & Outfitter
Box 1175
Jasper, Alberta

This may be a little tough for me as I am an outfitter and not a public speaker, but I have learned to tell a few lies in order to survive.

I started in this business down around the Pincher Creek area quite a number of years ago which was the best bighorn country in the world, I think and the Boone and Crockett Word Record Club will vouch for this. At that time the area I hunted was real fine as the fire roads in there were chained off and we thought we had it made. Then the public pressure opened up these roads as they felt we were harvesting all the game and about that time exploration came to that country and put roads up every canyon and I mean to the very top. Due to this there are 3,000 hunters there for the first day or so of the season. I therefore moved to Jasper Park 4 years ago where I bought out a very good man, Mr. Tom McCready. Now I have nothing against coal or gas, but I would like to see some areas kept like they are.

Now there is no non-resident sheep hunting south of the Bow River and up here they must draw for a permit. This is hard to understand when it is not from a shortage of sheep but from too many hunters in the field at one time.

The outfitters may have caused some of this but I feel that when the Fish and Wildlife Division took us out of the Game Act they caused a lot of this as they then got 600 Class A guides or outfitters in one year and I would like to see the outfitters put back in the Game Act so they could control us.

They can talk game management, but they can not do this if they can not police it.

When one of us outfitters talk about these things they always say that we are trying to feather our own nest and I say yes if I can not make a living out of it, I will go into something where I can.

We talk of bighorns and I do believe that anyone who lasted in my business must be an ardent sheep hunter or he would not have stayed in the business and had to fight with everyone; he would have done something where he could make a living better.

As for Jasper Park, I am very pleased to be there as it is a great place with some great fishing and scenery. I take out a number of summer trips with great people like National Geographic and they would like to come back in a couple of years for a complete summer photo trip and we want to be able to do this but won't be able to for long if this mining, gas and oil tears up our mountains.

Now I may get shot before I get out of here, but I have seen these mining towns in the south and the men have too much time off and make too much money so consequently you get a lot of poaching which is hard to police and that is what we will have in the Grande Cache area and more so with more roads.

As far as I am concerned the Willmore is the only Wilderness Area that we have left in Alberta. They talk about Wilderness Areas but to me they aren't if you can walk across them in a couple of hours. When I take people into the wilderness I want to be completely away from roads, towns, etc. We don't want cars or trains keeping us awake at nights and now we could lose this to the coal mining exploration.

I would like my grand children to have some of the things that I have had when they grow up. When someone says to them, your Grandad used to outfit bighorn sheep hunters in the mountains, they may say what is a bighorn and further what is a mountain.

So ladies and gentlemen, lets all try and keep this Willmore Wilderness as it is. Thank you.

PROTECTION AND RECLAMATION OF BIGHORN SHEEP RANGE IN THE FOOTHILLS OF ALBERTA

Harold M. Etter
Northern Forest Research Centre
Canada Department of the Environment
Edmonton, Alberta

Winter Range Ecology

Just as winter often restricts man's movements on the ground, big game animals find themselves confined to rather small portions of their habitat where protection, forage and snow depths are to their advantage. In the foothills of Alberta, this winter range is shared at various times by bighorn sheep, elk, mule deer and perhaps moose, horses or other livestock; it is mainly composed of openings and southerly facing, grassy slopes, bordered by open mixedwood or coniferous forests. The climax grass species in many of these open areas in southern Alberta is Festuca scabrella.

Several ecological factors combine to make winter range quality of great importance for the maintenance of bighorn sheep herds. First, if winter range becomes restricted or deteriorated, malnutrition will occur at a time when climatic factors are the most severe. Secondly, poor winter forage may increase the incidence of lungworm disease and lamb mortality, or cause late breeding by ewes. Thirdly, sheep often have to compete with other grazing animals that use the same range at various times during the year. And, fourthly, these same areas are the first to green up in the spring and thus provide for the recovery of animals from poor winter forage conditions. These ecological relationships combine to determine the carrying capacity of winter ranges, which is a key factor in the management and conservation of wild sheep herds.

Range Protection

The federal government does not have a historical mandate for the protection of wildlife species and habitats outside the National Parks and the Territories, although the proposed Canada Wildlife Act would allow for the designation and protection of rare and endangered animals, and in cooperation with provincial governments, the Act would allow for the federal government to acquire, control and manage lands for conservation and study of wildlife resources. Habitat protection through land-use management is in most cases a provincial responsibility. The two main threats to sheep winter range in Alberta are overgrazing by sheep or competing animals, and encroachment by forests or man into grassy cover types. Sheep, elk and deer can be hunted, horses can be fenced, and trees can be cut or burned; but man's presence in this ecosystem is not so easily dealt with. If our goal is to protect the range, then man must either be excluded from it, or made to act in a manner that is non-destructive to its critical elements.

Impact of Mining

One of man's activities that can completely destroy winter range is surface mining, since all original wildlife, vegetation and soil is lost where open pits, overburden dumps, processing plants and haul roads are located. If surface mining is allowed in areas that are presently used by sheep as winter range, we can expect some effects upon sheep populations for the term of the disturbance and until the habitat is restored. The first effect will be that the animals must move to other locations. If this secondary range is as accessible and as able to support grazing animals as the disturbed land did, then there should be no decrease in sheep numbers. However, if the new range can not support as high animal densities, or greater competition is encountered, then sheep numbers will fall to the new carrying capacity of the range. Rapid reclamation and evacuation of mined land will minimize the impact of these activities on grazing animals by allowing them to return to their original range as quickly as possible, bearing in mind, that if the carrying capacity of the secondary range is too low, there may be no sheep to return.

Reclamation

Our next consideration must be the quality of the original range after mining and reclamation are completed. Methods of reclamation are not known to me that can reproduce the mosaic of topography and native vegetation that we know as high quality wild sheep habitat. Reclamationists who want to restore winter range must be made aware of the intricacy of the habitat that was destroyed.

Hopefully we will be able to restore or duplicate some parts of the range. To attempt this, we start with a list of the preferred foods of bighorn sheep and certain other wild ungulates (Table 1). Grasses, sedges and legumes constitute 80 - 90 per cent of the sheep's diet; and the sheep's closest competitors are probably elk and horses or other livestock. Of the 16 genera listed in Table 1 only 3 are given at the species level. This reflects both a degree of flexibility by sheep within most genera, and our lack of specific knowledge of preferred species. Even if we do designate individual species, there are at least 20 species of *Poa* and *Carex* and 10 legumes that occur naturally in the foothills, none of which are commercially available or which have been grown on disturbed land. We can take two approaches to this situation. Either substitute species that are commercially available, or start a native plant collection and propagation program. The latter option is expensive and usually frought with technical difficulties. A compromise between these two approaches has lead to the list of species in Table 2 which we are now studying in hydroseeding trials at Luscar, Alberta. Additions and deletions in this list may be necessary, and plants in genera such as *Salix* and *Populus* which are more easily planted than seeded, will be considered separately in our experiments. Initial results indicate that several of the plants in the Luscar trials will prove useful for the revegetation of mined land for winter range. However, it will take some time to get the sheep's opinion of this list of candidate species.

Assuming that available species will satisfy wildlife forage requirements, the next step is establishing them on disturbed land in a pattern that will be useful, for example, grasses and forbs on south facing slopes and shrubs and trees on north facing slopes. If the soil mantle that was on these areas can be replaced prior to seeding or planting, then the job of revegetation is within the realm of possibility; however, if the s-o-i-l must be spelled s-p-o-i-l, then the time required to produce a productive range will be decades, perhaps centuries. Since south facing slopes have a potential for use by animals and a risk of drought, limited soil supplies should be placed on these slopes first and immediately stabilized with vegetation during reclamation. Some grass will also be needed on north facing slopes to control erosion. If choices must be made as to the steepness and stability of slopes, the most stable 20 - 40 per cent slopes should be south facing. Hydroseeding techniques, in which a slurry of water, organic mulch, fertilizer, adhesive and seeds are sprayed onto rough ground, appear to be well suited to these revegetation jobs. Certain species will require other planting methods. The main information we lack is the ability of these plants to produce high quality forage and to support wildlife populations.

Conclusion

In conclusion, a conscientious, cooperative effort by mining companies and environmental agencies, will be necessary to apply and refine these basic methods of winter range protection and reclamation, and to assure our continued enjoyment of wild sheep in Alberta. Also, we will have to keep a close watch on the health and distribution of bighorn sheep herds in the coming years to make sure that we are in fact not destroying this unique natural resource.

TABLE 1. PREFERRED FOODS OF BIGHORN SHEEP AS COMPARED TO ELK, MULE DEER AND MOOSE ON FOOTHILLS RANGE IN ALBERTA [a,b]

Plants Eaten	Bighorn Sheep	Elk	Mule Deer	Moose
Grasses				
Agropyron spp.	H	H	L	M
Koeleria cristata	H	M	L	L
Festuca spp.	M	M	H	L
Poa spp.	M	H	H	M
Bromus spp.	L	H	M	L
Sedges				
Carex spp.	H	M	M	M
Forbs				
Astragalus spp.	H	L	L	L
Oxytropis spp.	H	L	L	L
Hedysarum spp.	M	L	L	L
Delphinium spp.	M	L	L	L
Cirsium spp.	M	M	L	L
Shrubs and Trees				
Salix spp.	H	H	H	H
Populus tremuloides	H	H	M	H
Ribes spp.	H	L	L	L
Picea gluca	M	L	L	L
Rosa spp.	L	M	M	L

[a] H, M and L represent high, medium, and little or no utilization of the plant listed.

[b] Sources: W.D. Wishart 1958. The bighorn sheep of the Sheep River Valley. M.Sc. Thesis, Univ. of Alberta, Edmonton; and private communication by Bill Wishart, Wildlife Research Biologist, Fish and Wildlife Div., Alberta Dept. of Lands and Forests, Edmonton.

TABLE 2. PLANTS UNDER STUDY IN HYDROSEEDING TRIALS ON MINED-LAND AT

LUSCAR, ALBERTA

Plants Seeded	Seed Source	Seedlot Quality and Germination[a]
Grasses		
Agropyron cristatum	Commercial	H
Agropyron latiglume	Collected in Alberta	M
Agropyron riparium	Commercial	H
Agropyron trichophorum	Commercial	H
Agrostis alba	Commercial	H
Bromus inermis	Commercial	H
Dactylis glomerata	Commercial	H
Elymus junceus	Commercial	H
Festuca rubra	Commercial	H
Koleria cristata	Collected in Alberta	M
Phleum pratense	Commercial	H
Poa pratensis	Commercial	M
Forbs		
Medicago sativa	Commercial	H
Melilotus alba	Commercial	H
Lupinus sp. (Russel)	Commercial	M
Vicia americana	Collected in Alberta	L
Epilobium angustifolium	Collected in Alberta	M
Phacelia sericea	Collected in Alberta	M
Linaria dalmatica	Collected in Alberta	L
Aster alpinus	Commercial	L
Shrubs and trees		
Amelanchier alnifolia	Commercial	S
Prunus virginiana	Commercial	S
Rosa woodsii	Collected in Alberta	S
Caragana arborescens	Commercial	S
Elaeagnus commutata	Commercial	M
Lonicera tatarica	Commercial	H
Picea engelmanii	Alberta Forest Service	M
Picea glauca	Alberta Forest Service	M
Pinus contorta var. latifolia	Alberta Forest Service	H

[a]H, M and L indicate high, medium and low quality and germination are characteristic of most seedlots; S indicates special germination requirements such as stratification are common.

APPENDIX A - Coal Mining

Before approval is given to the mining operation, the department requires:

1. Assurance that no failures occur in the foundation area on which the spoil material is placed and that no failures occur in the spoil material itself.

2. Sufficient detail of operations to assess the intervening impact as well as the ultimate result on the watershed characteristics with respect to groundwater and overland flow, water quality and quantity, sediment transport, flow diversion, methods of diversion and monitoring and other corrective actions to maintain provincially imposed pollution control standards.

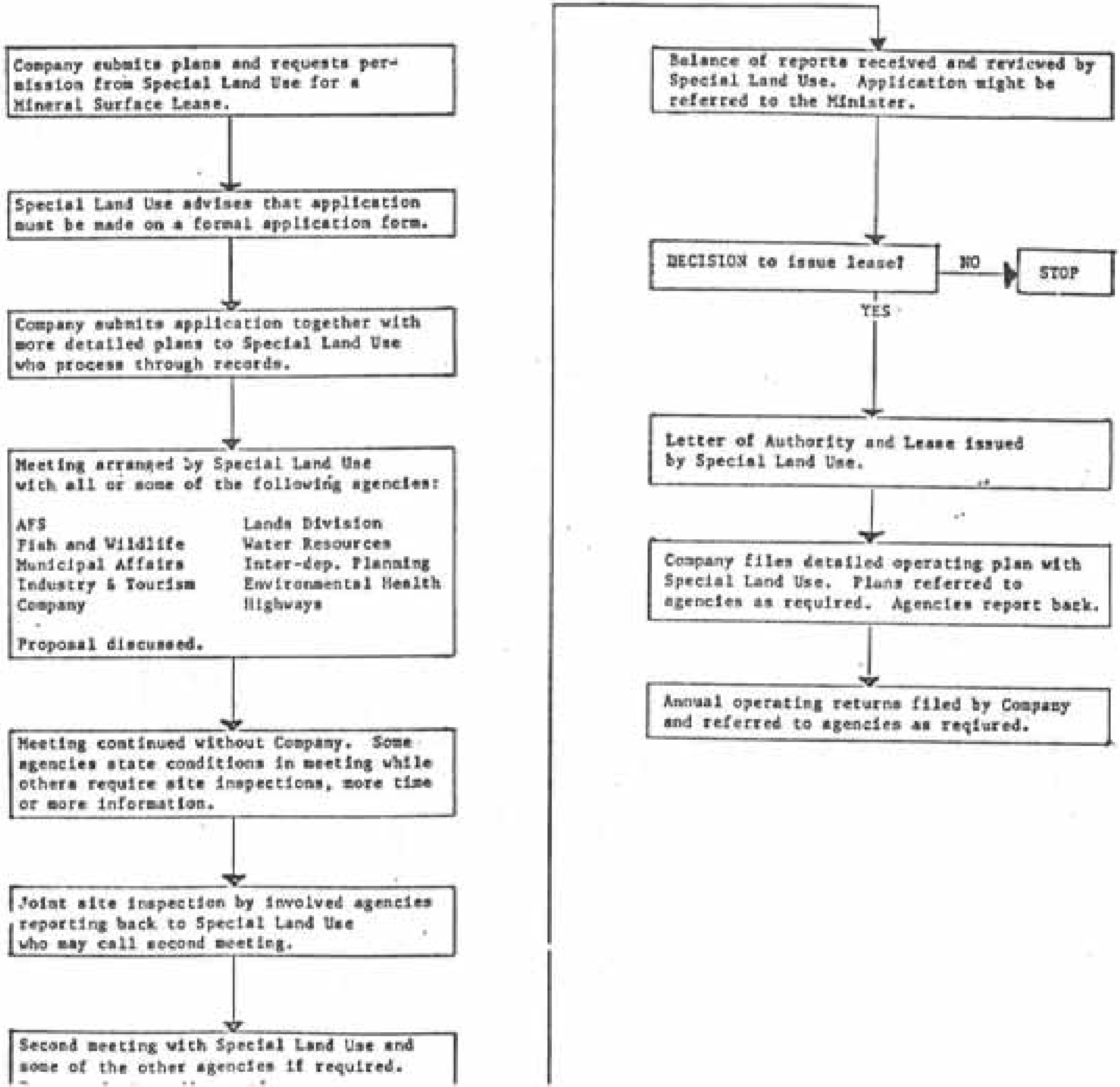
3. Details of your access road location on your own as well as public lands.

4. We require plans submitted under the signature and seal of a professional engineer and in preparing your mining plan, the following should be considered:

(a) Temporary spoil piles shall not be permitted in a location which would result in siltation of any drainage course.
(b) The slopes and location of the spoil material must be such that no failures will occur in either its foundation upon which the spoil material has been placed or the spoil material itself.
(c) Backfilling shall be carried out progressively and shall not be left as the final operation.
(d) The entire mined area is to be backfilled.
(e) No permanent spoil pikes will be permitted.
(f) The surface non-toxic material shall be piled separately to be used as a top layer in completing the reclamation program.
(g) Drainage ditches shall be constructed above and below the spoil and strip areas in order to prevent any surface runoff water from entering the areas disturbed in the mining operation.
(h) Sedimentation ponds may be required and it may be necessary to have the sedimentation ponds operative until revegetation has been totally accomplished.
(i) The area shall be contoured in order that the disturbed areas blend in with the natural areas and that no slope shall exceed 25° 30'.

We will require a reclamation deposit of $500.00 per acre for the area which will be disturbed. The reclamation deposit will be increased as additional areas are approved. This reclamation deposit or portion thereof will be held until vegetation has been re-established and siltation in runoff has been eliminated.

PROCESS SCHEMATIC OF COALMINING SURFACE RIGHTS APPLICATIONS



APPENDIX C - Geophysical Conditions for Seismic Exploratory & Coal Permit Exploratory Work

1. It is the responsibility of the company to determine the ownership or other interests in the land designated in the sketch attached to the request.

2. Access trails shall not exceed sixteen (16) feet in width and shall be constructed with a minimum of surface disturbance. Existing trails shall be utilized wherever possible. New trails must be flagged by the company and their location approved by an officer of the Minister before clearing commences.

3. All necessary precautions to be taken while trails are under construction to prevent the inception of soil erosion and sedimentation to streams. Trails shall be constructed in such a manner that inside ditches are not required unless otherwise directed.

4. All backfilled areas and other areas of bare soil must be reseeded to a suitable mixture and vegetative growth re-established to the satisfaction of an officer of the Minister.

5. Stream crossings shall be kept to a minimum and only one crossing is permitted at any intersection of a trail and stream. Trails shall cross streams at right angles to the stream channel and where necessary, diversion trenches shall be constructed on approaches to streams to prevent siltation.

6. No debris, soil or overburden shall be deposited or allowed to enter any watercourse and the stream courses shall not be diverted or altered in any way. Stream flow shall not be carried in road or trail ditches.

7. Except for crossings, no trail shall be constructed within 150 feet of the banks of any watercourse unless necessitated by the terrain, in which case the requirement may be waived by an officer of the Minister.

8. Drill hole locations shall be approved by an officer of the Minister and shall not be located less than 150 feet from the high water mark of any stream.

9. No campsite may be established without approval of an officer of the Minister.

10. Cleanup of debris shall be conducted to the satisfaction of an officer of the Minister and to be in accordance with The Public Lands Act, and The Forest Protection Regulations.

11. Cleanup and reclamation shall be conducted in progress with the program.

12. The company shall conduct the operation in a manner that will preserve the aesthetic quality of the area and in this regard shall carry out as little clearing as possible.

13. Revisions of the program requiring additional trails, drill holes or substantial changes in location must be resubmitted and approved before construction. Minor changes may be made in the field if approved by an officer of the Minister.

14. Wherever possible, or upon request, berms of debris and soil along trails are to be removed to allow for proper drainage. Unstable areas such as seeps and slump topography shall be avoided. Trails shall be located on ridge tops where possible to avoid heavy cuts.

15. A copy of the monthly plans presently being submitted to the Director of Minerals, should be forwarded to the Director of Lands and the Forest Superintendent of the Forest wherein the program is being conducted.

16. Before a drilling rig is moved away from a drill hole, a tag indicating the company name and drill hole location to be placed facing and in close proximity to the hole but in no case more than thirty (30) feet from the hole location.

17. Total disposal of debris must be carried out for a distance of 300 feet from the high water mark of all rivers and for a distance of 150 feet from high water mark of secondary streams.

18. All vertical cuts made along slopes that are deeper than two feet in depth are to be backsloped to a minimum 1 1/2:1 slope ratio.

19. Continuous liaison shall be maintained with the officer designated by Forest Superintendent   of the   Forest, and these officers will oversee your program.

Lorne Yule
Land Use Section
Department of Lands and Forests
Edmonton, Alberta

In preparing this short talk, I assumed the group would be primarily interested in surface disturbance as it relates to coal exploration and surface mining. I will therefore give a general run down of present governmental procedures and policies with reference to this activity.

In brief, if a company proposed to mine coal, it would normally follow this procedure:

1. request the minerals be offered for sale.
2. obtain an exploration permit to determine location and extent of minerals.
3. once minerals established, obtain a mining permit and a mineral surface lease to mine.
4. after completion of mining and reclamation, obtain a reclamation certificate.

(1) To go into each of these stages more fully therefore, and the various environmental protection measures being utilized, let us consider first Stage 1 - sale or lease of minerals. (Here it should be pointed out that in foothills and mountain areas where coal is likely to occur a large proportion of the minerals have already been disposed of). Where they have not been disposed of, a mineral application or request is referred to the Mineral Referral Review Committee. The committee has representatives from the various resource disciples as well as the Department of Mines and Minerals. Once a request for mineral sale is received, the committee makes recommendations to the Deputy Minister of the Environment as to advisability of sale, of all or part of the area and/or environmental protection conditions which should be attached if sale is approved.

(2) If the mineral sale is approved, the next stage, Stage 2 is normally exploratory. Authority to explore for coal or any other purpose entailing more surface damage than a purely geophysical operation for oil and gas is issued persuant to the Public Lands Act. Once an application is made, it is submitted to an interdepartmental committee (commonly known as the coal committee), consisting of a Biologist, Agrologist and a Forestry representative. Recommendations of approving the project as a whole or in part plus any special reclamation or land use conditions, which should apply are made to the Deputy Minister of Lands and Forests. The Minister

of Lands and Forests makes the final decision as to whether the project will proceed or not. To date, outside of certain selected areas, pretty well all exploration programs have been approved. Exceptions have been select watershed areas and Wilmore Wilderness Park.

Stage 3 - If the company decides to mine, it makes a mineral surface lease application through the Lands Division. This application is referred to the various resource personnel, Fish & Wildlife, Water Resources, Forestry, etc. After comments have been made, a meeting is held with the governmental agencies and company to go over the proposal. If mine location considered is satisfactory, a letter of approval with conditions is issued by the Minister of Lands and Forests. Before development proceeds, however, the company is required to submit a development and reclamation plan. This is again forwarded to the various government agencies for comment. A development and reclamation committee go over the proposed development plan with the company.

As mining progresses, periodic meetings are held with the company to scrutinize and evaluate on a continuing basis on-going development programs.

These procedures have pretty well evolved over the past couple of years, since coal mining became an important industry in the foothills area.

The legislative authority presently for environmental protection rests in the Forestry, Lands, Water Resources and Fish & Wildlife Acts. Enforcement of the land use, reclamation conditions has generally been the responsibility of Lands or Forestry personnel, assisted by Water Resources and Fish & Wildlife. The area of over all inspection and enforcement responsibilities has as yet not been clearly defined.

As far as the outlook for the future is concerned, during the fall and winter 1971-72 five inter-disciplinary task forces were established and reports submitted to the Director of Interdepartmental Planning, Dept. of the Environment, to deal with surface disturbance and reclamation. The task force were:

1) coal exploration and surface mining
2) sand and gravel exploration and development
3) oil and gas exploration and development
4) sanitary landfill
5) stream bank protection

These task forces were established in an attempt to deal with all surface disturbance and reclamation comprehensively, and equitably, whether it is a surface mining, sand or gravel removal, oil and gas activity or what have you. Also, it was felt there was a need to bring together the various and sometimes overlapping environmental protection acts and regulations as they exist within the various departments and divisions. This would streamline both administrative and enforcement procedures which would be an advantage to both government and industry. This amalgamation and streamlining has already been done to some extent by bringing Water Resources, Environmental Health and the Reclamation Council into one department, the Department of the Environment.

The proposed surface disturbance and conservation act, under the Department of the Environment, which is to utilize the reports of the various task forces outlined previously, has not been tabled in the legislature as yet, but is expected to be before the 1972 spring session ends.

G. Stephenson
Assistant General Manager
Canmore Mines
Canmore, Alberta

(Summary Only of Talk Presented)

Comments on Canmore Mines - have been operating in Bow Valley since 1886, surface mining last four (?) years. Nine out of ten coal companies are concerned about the environment, for the following two reasons:

1) public image
2) more conscientious reasons

Concern the company shows for reclamation depends on three things:

1) depends on the personal concern of the individuals in charge of the company
2) attitude of the owners of the company - many are prepared to put money into it
3) depends on the attitude of the average employee, not only the owners but the people working for that company -- a case of educating employees as to what and what not should be done.

I believe that until proven otherwise, you get more things done by talking than by fighting. As an example, to quote Sir Winston Churchill, "Talk, talk, talk rather than war, war, war". My point is in your attitude to coal companies. Give them a chance to explain to you what they are trying to do and retain the cooperation of the coal companies. Unfair criticism by people who do not know the facts of the operations of the coal companies creates adverse reaction.

Showed Slides.

1. Canmore Corridor area.
2. Coal seam.
3. Site after strip mining is completed.
4. Same section of strip mine after reclamation - absolutely impossible to bring area back exactly as it was before strip mining.
5. Bull-dozing.
6. Abandoned mine, showing the worst possible condition.
7. Shows the three separate stock piles - rocks, gravel and soil - located on Mount Rundle strip mine.
8. Recharge pond.
9. View of Mount Rundle strip mine.
10. Strip mine shown earlier - full length of valley - originally covered with dense lumber.
11. Same strip mine taken from exactly the same point, looking the other way.
12. Mulching operation in progress.
13. Closer view, about two weeks after mulching operation.
14. How an area completely covered by dense forest can be opened up a little and possibly create pasture suitable for wildlife.
15. This is the only area for which I have a slide, shows a nine acre experiment plot on which we did establish vegetation.

It is my honest belief that where reclamation is not possible after surface mining, there should be no surface mining.

We have done a wildlife survey of the area where we are strip mining - a summer student surveyed three areas by following cutlines through the forest and just counted tracks - admittedly an amateur way of doing it. . .

Question Period

Q. (to H. Etter) Have you any indication that sheep would not do as well on the species that you have rather than going into the exotic species?

A. It is quite possible from a pasture point of view. It could even do better. It is not very consistent with ecology. What are we really reclaiming for in wildlife habitat? Reclamationists must be made aware of the intimacy of the habitat. It is not so much will they do better, but is it consistent with the principal of ecological protection.

Q. (to H. Etter) I would not be too concerned about the fact that you are bringing in some exotic species that are temporary and will help stabilize the soil, but they should be replanted by native species and the best ones should eventually take over.

A. It is a possibility that the species we put in now will be more successful. I find it difficult in my mind to visualize the kinds of success which we are used to in ranges.

Q. (to G. Stephenson) There are two things that come to my mind. One is the opportunity of strip mining in alpine areas. The other point I would like to make is that in areas where the government has leases in the alpine areas, will these leases be cancelled?

A. Quite honestly, I have not seen a strip mine in alpine areas. If the re-vegetation process is so difficult that it takes 200 years to grow, the government will not allow a strip mine where you can not reclaim the surfaces.

Q. (to L. Yule) Does reclamation apply to explorations only? Also, reclamation is for some reason synonymous with vegetation. A good example is in the Yukon. Various ranges are now devoid of Dahl sheep. Now, is the government to re-establish those sheep at government expense?

A. This is not really government policy. This is sometimes the lack of co-ordination between various agencies of the government. Under the new proposed Reclamation of Surfaces Act this is one of the things that is taken into consideration. If a coal mine company goes in there and say for instance takes a sheep range, it is proposed that they would be required to replace that sheep range in some way or another.

Q. (to L. Yule) Yes, but the range is useless without the sheep. If the government decides we have 100 or 500 sheep there and they decide it is in the best public interest to have these sheep established, the government is forced to do it.

A. The government is not forced to do it.

- Discussion re submitting mine plans prior to exploration -

L. Yule - The people that work with this find it almost impossible to submit mining plans prior to exploration because they have to go in and explore, drill and do a tremendous amount of work to find out where the coal seams are before there is any possibility of submitting a plan.

Q. (to L. Yule) Do I understand that they do not have to or can not submit an exploration plan? Are they required to submit an exploration plan?

A. Yes.

E. Scheffler - We don't know their time schedule as to when they are going to explore. One of the things we have done, is that we have developed guide lines where they have to destroy and close the access roads after they have finished with their exploration.

Q. Where is the coal going?

A. Japan.

Comment - After 17 years with the provincial government agencies I have developed a very pessimistic outlook with regards to your coal development areas in Alberta and the reason for my feeling this way is the government's fragmentary, uncoordinated program. If they do permit exploration they actually determine how the roads will go in if they do go. The way it has been in the past, you have certain individuals in the branch and certain industries that are trying to do the job, but there is no way in which you can get effective multiple use. I have seen nothing yet to indicate that we can expect anything different so that by 1985 when 25,000 acres of the province are stripped, what portion of that is going to be reclaimed? I would like to be optimistic that there were a number of companies like Gerry's that would reclaim it.

Q. (to G. Stephenson) I understand that a lot of the coal seams are relatively small and coal operation will only last for a few years in these mountain ranges and if development was going to occur it would be extensive throughout the sheep range. How large are these seams? Are they quite small? Pursuing the idea of sheep being removed from ranges and there being no way of getting them back, is it possible to build a new range prior to a mine going into operation?

A. The seams that are being worked now are 5 feet high to 150 feet thick. I think the point to remember is of the total coal reserve of 3 to 4 per cent is amendable to surface reclaim. A large strip mine is a very large capital expenditure. Seams near the surface are very limited. In 100 years time we will not want any coal. I think in 50 years time the amount of coal we will need will be dying out.

Establishing a new range adjacent to existing ones - my suggestion to this one would be this -- if you open up a mine the first thing you have to do is to ban all hunting in that area. My experience is that by opening up roads you are very very subject to poaching. The sheep on the mine property are relatively tame. You can get as close as 18 yards from them and they will not move. With an automatic rifle you could eliminate half the herd. Another pet peeve of mine is a lot of your Fish and Wildlife Officers are not covering this. You need more Fish and Wildlife Officers.

Q. (to L. Yule) There seems to be a bit of inconsistency that perhaps Mr. Yule can clear up for us. Earlier, Mr. Stephenson expressed the idea that strip mining could not occur above the timberline because of the fragile ecology. However, as many of you saw in the Grande Cache area, one area is above the timberline. I am wondering how the mining company in Grande Cache could go ahead and develop this for strip mining when in fact they could not reclaim it.

A. I know Grande Cache and Coleman Collieries are mining well above the timberline. As far as I know this is not against any regulation.

G. Stephenson - My feeling is that if you can't re-establish vegetation you should not mine. Maybe mining above the timberline is possible.

Q. Is there a regulation stating that you must reclaim?

A. I do not think there is a regulation but it is a policy that if you can't reclaim you should not mine. Of course this is a very difficult subject because for instance if you are in a rock area where there is nothing growing at the present time, would you say that they should not mine there? Take a particular case of Coleman Collieries which is working at the present time - there is no vegetation (unlike Grande Cache where you have big grassy areas). If there was nothing there in the beginning, and if you say you put it back in its natural state, no reclamation is necessary.

Q. (to L. Yule) Around Coleman Collieries there are all kinds of other companies above the tree line. It brings up a point again which has been brought forth by several people and that is that we must get at things above the tree line. It seems that they issue permits on an automatic basis whether this can be reclaimed or not. It is so inconsistent with the fact that you are issuing permits automatically.

A. I am seeking information on this. What is the objection if, for instance, you have rock basis above the tree or grass line, for issuing coal permits?

M. Quaedvlieg - There are several. In an area which is 4 miles long they have put in over 50 miles of exploration roads. Now, if they do not strip they have already done considerable work in there and the area involved in exploration alone may exceed the area involved in the mining. I think we will probably see a decrease in the area of elk and sheep.

E. Scheffler - The Right of Entry legislation literally prevents us from stopping mining companies as well as other mineral developments. Invariably they get the permit under present legislation. This again is under review.

Comment - Assuming you have a defined criteria for what the responsibilities of a mine site are, what procedures do you plan to use to make sure the company has attempted to rehabilitate? If in fact they do not do it, what penalties are anticipated for the company involved? - Answer. The penalty is not laid down in legislation. It is at the discretion of the Minister under the new Environmental Disturbance Act. I think they should propose a standard which would be more uniformly applied.

J. Stelfox - I think the public and the government are being extremely naive that you must reclaim when it has not even been shown that reclamation is possible. Why even let them go in an area to explore before the government proves that reclamation is possible.

B. Kemper - In many explorations there have been moderate successes in establishing re-vegetation. The agencies have put clauses in all the things that have been brought up. If certain clauses have been removed, we have done the best we can.

Q. (to G. Stephenson) There is an excellent report "Review of the Mining Problems throughout the States" showing results of mining and not reclaiming. I have seen nothing yet in our standards to show that the regulations we have are legally binding. Several companies have done irreparable damage and have left the country. In the Province of Alberta, will repair work be done with taxpayers money?

A. In order to obtain permission to strip mine you have to put forth a deposit towards reclaiming. We have the bonding now - up to thirty thousand dollars.

Q. Despite that bond, if you can't reclaim, thirty thousand dollars does not mean anything.

A. We have attempted to come up with a figure that we thought would reclaim an area. We have researched some American figures and have come up with this figure.

Mr. Chairman, Ladies and Gentlemen, it is indeed a pleasure and an honor for me to be here with you this evening and speak to you about the organized poaching of big game animals, specifically the Desert Bighorn Sheep. The fact that you as game managers invited an Enforcement Officer to your workshop would indicate to me that you are looking at enforcement as a tool of management.

I believe law enforcement will become a very important tool of management as our big game resources become more limited in numbers and areas become less where general hunting can be permitted. You here in Canada still have many such areas but in the United States we only have a few of our Western States where general hunting is permitted. Many species such as the desert bighorn, the moose, the tule elk, the grizzly bear, and other prize trophy animals can only be obtained under special permit. As these conditions increase the value of a real trophy animal of almost any species goes up and up.

Today in the United States, and I expect here in Canada, there are no real trophy animals left in the areas where general hunting is permitted. The hunting pressure is such that these animals just don't live long enough to produce the majestic heads that once could be found among all the big game species.

The demand for these record heads has developed in the United States a rather select group of trophy hunters. The ordinary sportsman can no longer pay the price tag that these trophy hunters place on these big game animals; $10,000 for a desert bighorn and $5,000 for a polar bear. Since many of these animals are now limited to areas where they are afforded protection there has developed another select group of individuals who will provide a guaranteed hunt for a record head and they are made up of a group of unscrupulous guides and taxidermists.

In June 1970 our Seattle agent, Larry Wills, was provided an unsigned letter telling about a taxidermist in Yucaipa, California, who was providing guaranteed hunts for desert bighorn sheep at a cost of $2,500. The letter also indicated that a California Fish and Game Officer might be involved.

Agent Wills provided me with this information and I requested our agent at Pasadena, California, to advise the California Fish and Game at Los Angeles of this information and to make some discreet investigation of the taxidermist involved. I also requested agent Wills to try to uncover the name of the individual who sent the letter.

Both of these officers were very successful in these assignments, and Wills found that the writer of the letter was a guide who had worked with the suspected taxidermist and Parcher found out that desert bighorn were being mounted in a taxidermist shop owned and operated by Gary Swanson of Yucaipa, California. Parcher also found out that Mr. Swanson was an avid photographer of desert sheep and was working with the desert bighorn council and the State of California Fish and Game Department.

The State of California advised us that they had received information that their biologist was involved and they had investigated and concluded that their biologist was being accused because of his relationship with a young woman who worked at the shop.

Agent Parcher also began an exhaustive check of telephone calls that had been made from the taxidermist shop and home to cities across the United States. We also alerted our agents to provide us with names of hunters they knew who had grand slams in bighorn sheep. In September 1970 we arranged for one of our agents in Delaware to place a call to Mr. Gary Swanson, owner of the taxidermist shop, to see if he could arrange a hunt. This agent had been provided a cover by a businessman and was represented as a vice president of a very successful construction company.

This telephone call verified the fact that hunts for desert bighorn were being conducted by Swanson and the cost was set at $2,500, but they were not sure if a hunt could be arranged as they were booked solid. Within two days calls came to the construction company office making inquiry to see if agent Halstead worked there and was in fact a member of the firm. The next day Swanson called our agent and advised that a hunt was available for the 12th day of September. He was advised at this time that he would be told when and where to report in plenty of time for the hunt. He was asked if he knew certain individuals and where he had hunted big game and who with. He was also told that all transactions would be paid for in cash in small bills, tens and twenties.

We made arrangements to send extra agents down to cover this hunt and to provide tracking devices so that we could follow the agent by car or airplane as the need might be. We also made arrangements with California Fish and Game to assist with this undercover operation.

On or about August 12 our agent was called by Mr. Swanson who told him he had located some of the largest sheep he had seen in California and the agent should plan to fly to Ontario, California, on September 3, 1970. He was told that he should come on certain flights and bring the $2,500 in cash, he would not need a gun as a breakdown model would be provided. This unexpected change caused us some concern as we wanted to bring the agent to California and brief him on the type of hunting he would be doing, climate, areas that he might expect to hunt in, etc. The naming of flights to take also prevented us from making contact except in Denver, Colorado.

We arranged for a change in our plans and shifted two aircraft and six agents from Dove Patrol to cover the undercover work. Agent Parcher was sent to Denver with the needed cash and a camera with a tracking device built into the case. Arrangements were made to meet Halstead and transfer equipment and brief him on what we thought would take place.

Agent Halstead arrived in Ontario, California, on the 3rd of September, at 11:45 P.M. He was met by Gary Swanson and a man identified as Ray Pocta. As I was the only person in our region who knew Agent Halstead, except Agent Parcher, I was at the Ontario airport and watched the meeting by the subjects. We had three undercover cars on hand with two agents in each. Our tracking device was operating and we could receive it in the cars and by our planes at about 5,000 feet.

The subjects, with our agent, went to a camper and headed out of Ontario towards Redlands where the taxidermist shop was located. Swanson left the camper and took a second car to his home. Pocta and our agent drove south to the area of Anzo Borriyo State Park where we knew there were some good bands of desert bighorn. As daylight was just about upon us and our tracking devices were working, we felt sure they would hunt somewhere close to this area so we broke contact and planned to fly the Park and locate the subject by plane at about 9 A.M.

Later that morning, much to our dismay, we could not locate the vehicle and our subjects. Both planes were sent out and a systematic search was started to cover the known desert bighorn sheep areas. An allday search failed to locate the group although we did see several parties and individuals in and around the sheep watering areas. We planned to continue the search the following day, September 5.

The next morning just as we were leaving to start our search, we received a call from our agent that the hunt had been concluded and had taken place over 100 miles south from where the camper had parked and we broke contact near the Anzo Borriyo State Park. We were told that the guide, Mr. Pocta, had just been too tired to drive further as he had just returned from a successful hunt that same day that he and Swanson met our agent. Halstead had obtained so much information about the operation that he felt no immediate arrest should be made as it appeared that this was a well organized operation and may well have taken upwards of 100 to 150 sheep in California and others in the Republic of Mexico.

He told us that he would break contact with the subjects in the early afternoon and we could meet him at the Ontario airport. The information he had gathered gave us, along with Swanson and Pocta, the names of Bensley, a tannery operator; the young lady, Pearl Prudholm, who worked as a guide and assisted with mounting the sheep; plus the part Mrs. Swanson played in this Jekyll and Hyde operation.

Halstead had been taken to the Jacumba area of San Diego County on his hunt. He was taken through a private ranch to a sheep area near the Mexican border. He started his hunt soon after they arrived in the area at about 9:30 A.M. He was given a small pack, a canteen of water, and a rifle. The guide, Pocta, was an expert in his field and showed Halstead sheep in less than one hour after leaving the camper. The temperature was near 118° with a twenty mile wind blowing. As planned, Halstead soon became tired and complained that his feet were giving him problems. Pocta asked if he would like him to go ahead and get him a sheep. When he replied that would be a good idea, he was told that it would cost him an extra $100, and if he wanted a record head, it would be $500 more. Halstead told Pocta that he did not have that much cash but if he would take a check, he would like a good head. The guide agreed to this and left Halstead to make his way back to the camper. Before he reached the camper he heard one shot and then in about a half hour, he heard two more shots. Upon his return to the camper he was soon joined by Swanson and another hunter. This hunter claimed to be from New York, but was later found to be from New Jersey. The guide returned with a sheep cape and horns. He told Halstead that he had killed a small ram just to meet the guarantee, and then went on to kill a better one. They remained at the camp until after dark, taking back roads to miss any chance of meeting border patrol personnel. They explained that they knew where the local warden worked, but they did not want to be checked by border patrol personnel.

When Halstead returned to Yucaipa he was taken to the Swanson home, paid for his hunt, and was shown about the home where several desert bighorn and many other trophies were on display. He was advised that if he wanted other species, Swanson had contacts that would guarantee Rocky Mountain, Dahl, and Stone sheep. They could also arrange for polar bear, elk, deer, antelope hunts. He was told that hunts in foreign countries could also be arranged. Much of this information indicated that the only good heads were in such places as the National Parks and game refuges of the States. These men bragged of hunts that cost $10,000 for a single hunt. They also explained that they never would take a hunter out until they checked him out with other guides and taxidermists or hunters who had taken part in these illegal hunts. He was filled in on Mr. Swanson's pending safari to Asia for Marco Polo sheep. Halstead was able to visit with Miss Prudholm as she took him back to the airport. The information from her and from Pocta led us to believe that as many as 30 to 40 desert bighorn were now being processed at the tannery and the taxidermist shop.

Under authority of a search warrant, at 11:30 A.M., September 28, 1970, while Mr. Swanson was out of the United States, an organized search was made of the taxidermist shop, the tannery, and the homes of the four principals in this case. At this time we seized parts of some 30 desert bighorn sheep, one a full mount of a desert bighorn ready for shipment to Calgary, Canada; several head mounts; 75 letters involving correspondence relating to desert bighorn sheep hunts; business receipts; address books with suspected hunters' names; business cards; scraps of paper with names of individuals on; etc. This evidence provided us with some 175 names of persons living in 21 states, two Canadian provinces, and the Republic of Mexico. To date we have processed through the Federal courts 35 individuals plus the four principals on charges of conspiracy to violate the Lacey Act. All have paid the maximum Federal fine of $500. Two cases have been dropped because we could not prove that sheep had been killed although each of these defendants admit hunting in California. We have several cases still pending, one of which involves the full mount belonging to Dr. Oyer of Calgary. The State of California also brought charges against the four principals and they have paid fines of $1,000 for Mr. Swanson and 90 days in the State Hospital for the mentally insane, $750 for Pocta and three months in jail, $500 for Mr. Bensley and three months in jail, $250 for Miss Prudholm plus 30 days in jail. Mr. Bensley was arrested in Wyoming the day following our search of his home and was charged with 21 counts of game violations and paid fines in that State of $1,000. The State of California has a civil suit on file to collect $500,000 in damages to the desert bighorn which have been totally protected in that State since 1890.

We in the Bureau are still working on information obtained on this case that indicates that other parties are involved in selling hunts on all species of big game. Cooperation with the States, the several Provincial Game Departments, and the Republic of Mexico all went into making this investigation a success. We have been successful in starting prosecution against a second group headed by a Mexican National named Castellanos. Warrants are issued for his arrest in two States, Arizona and Maryland.

I would like to pass around a few pictures that will show you some of the highlights of this investigation and show you some of the trophies that were seized. Thank you.

BUSINESS SESSION

Thursday, April 13, 1972

Eike Scheffler asked the meeting for suggestions on where the next sheep meeting should be held. Allen Schallenberger offered Montana State and it was unanimously agreed to hold the next meeting in Montana.

Eike Scheffler asked the meeting: Should we consider at meetings if, as a group, there is an ecological concern with regard to use of bighorn sheep range, or development of Federal-Provincial-State authorities, for example coal industry in Montana and Alberta. I for one am very concerned. I would like to see us make a statement to the governments - some sort of statement to the effect that we express a concern as to the extent of rapid exploitation, and recommend that they look more wisely at sound multiple use. Should we consider this statement or should we avoid such a statement to government?

I think we have to be very careful not to antagonize or embarrass. It would be taken in the right light if presented properly. It might slow down this sort of development.

W. Wishart - We just got over a bunch of hearings on strip mining in Alberta. It might be another shot in the arm toward the protection of the alpine - subalpine areas. There are new regulations that are forthcoming with respect to coal explorations and developments.

J. Stelfox - I haven't read it but have heard many complimentary comments about it. I think we could bring out some strong points which would help to direct the government into doing a better job of managing resources on sheep range. It might also give other areas such as British Columbia and some of the states some support in promoting wise multiple use policies for their sheep range areas.

- Some discussion on the maps presented by Bryan Kemper -

J. Stelfox - I think that (referring to E. Scheffler's suggestion) a statement to the Alberta Provincial Government expressing our concern over the deleterious effects of mining on bighorn sheep in western Alberta would be a very useful function of this group and I would so move. Carried.

E. Scheffler - Any volunteers to help with this? Bryan, John, Bill Wishart -- we could use you as a medium; John Stelfox, would you chair this sort of thing? John Stelfox agreed.

E. Scheffler - Maybe you should have one person from each State and Province look at it. Volunteers: Chuck Lacy, Bill Wishart, Bryan Kemper, Wayne Heimer, Gene Schoenveld, Ron Stoneberg, Ray Demarchi, Blair Rippin.

R. Stoneburg - Prior to the next meeting maybe this same group could get up a policy statement and submit it to the group at the next meeting.

J. Stelfox - I would recommend if we draw this statement up I would be prepared to send copies to each member of the organization and solicit comments from them and get the concensus of their approval and if received to then submit it to the Alberta and B.C. Governments, plus any States that delegates from the United States recommend.

G. Schoenveld questioned the time of the next meeting. It was agreed to hold the next meeting the spring of 1974 in Montana.

A STATEMENT OF CONCERN BY THE NORTHERN WILD SHEEP COUNCIL ON THE EFFECTS OF COAL MINING ON WILD SHEEP POPULATIONS IN WESTERN CANADA AND NORTHWESTERN UNITED STATES

August, 1972

The Northern Wild Sheep Council, comprised of research and management biologists from western Canada and the northwestern United States, wishes to express concern regarding current and future deleterious effects of coal mining, in particular strip mining, within Foothill and Mountain Regions on wild sheep populations. We recognize and advocate multiple-use management of these lands but believe that present coal extraction methods are not following sound multiple-resource management guidelines and if pursued will lead to the depletion of wild sheep populations over extensive areas.

It is our contention that an economical, social, and ecologically accurate evaluation of all important resources on coal/sheep ranges plus the formulation of a multiple-use plan for these lands can result in the desired extraction of coal as well as the maintenance of sheep populations and other important renewable resources associated with these headwaters.

Wild sheep in North America are very selective in their habitat requirements. Their range is restricted almost entirely to semi-open and open ranges near cliffs within the Sub-Alpine and Alpine zones. This animal is one of the least adaptable big game species to habitat intrusion by man. Wild sheep do not survive in neighboring forests as do elk, moose and deer. Therefore, they can not be displaced from their small alpine environments and be expected to survive on neighboring lands where they were not formerly present. If their small critical ranges become unavailable either through removal of vegetation and/or human harassment, then each herd will perish. Reintroduction may not establish ecological parameters of existing herds.

Rehabilitation of destroyed alpine ranges has never been demonstrated. We believe that coal mining with only minor changes required of existing practices, can be conducted so as to cause only slight impairment to wild sheep ranges. In most cases it appears that only small portions of coal leases need be exempt from mining, since these areas are often valuable to wild ungulates such as mountain goats, elk, mule deer and mountain caribou. Where important surface conflicts arise, consideration should be given to using underground mining methods in order to minimize range destruction and animal harassment. In some cases it may be necessary to delete mining where other critical habitat requirements from mining such as natural licks, waterholes, or lambing areas aid in maintaining existing populations.

In summary, we contend that present coal mining practices in Foothill and Mountain Regions, plus the recent frantic acceleration of mining activities are having increasingly deleterious effects on wild sheep populations. We believe that the matter is so serious that the very survival of wild sheep in many areas throughout western Canada and northwestern

United States is threatened by present and contemplated coal extraction programs. The major conflict lies in the increased practice of strip mining of critical portions of Sub-Alpine and Alpine meadows that are specific winter ranges for wild sheep. These vital areas comprise less than 5 per cent of the mountainous area and can not be replaced.

There is an urgent need for governments and coal mining companies to infuse sound ecological reasoning in consultation with wildlife specialists into coal development planning on wild sheep ranges.

We thank you for your consideration of this statement and we hope you will accept our comments and offer of help in the light in which it was intended, namely, as that of a constructive associate.

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NOTE: *Script Type* indicates address change

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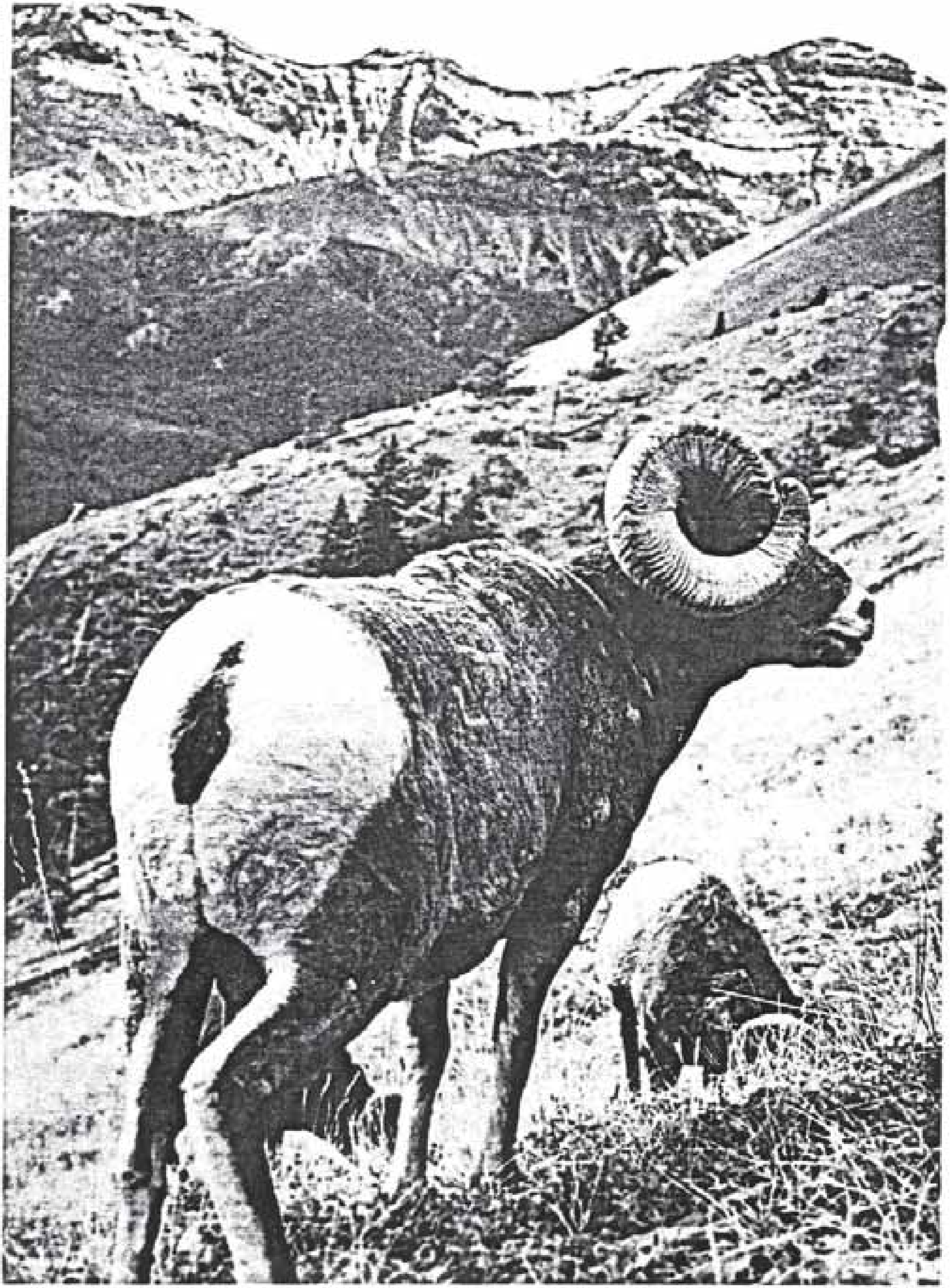

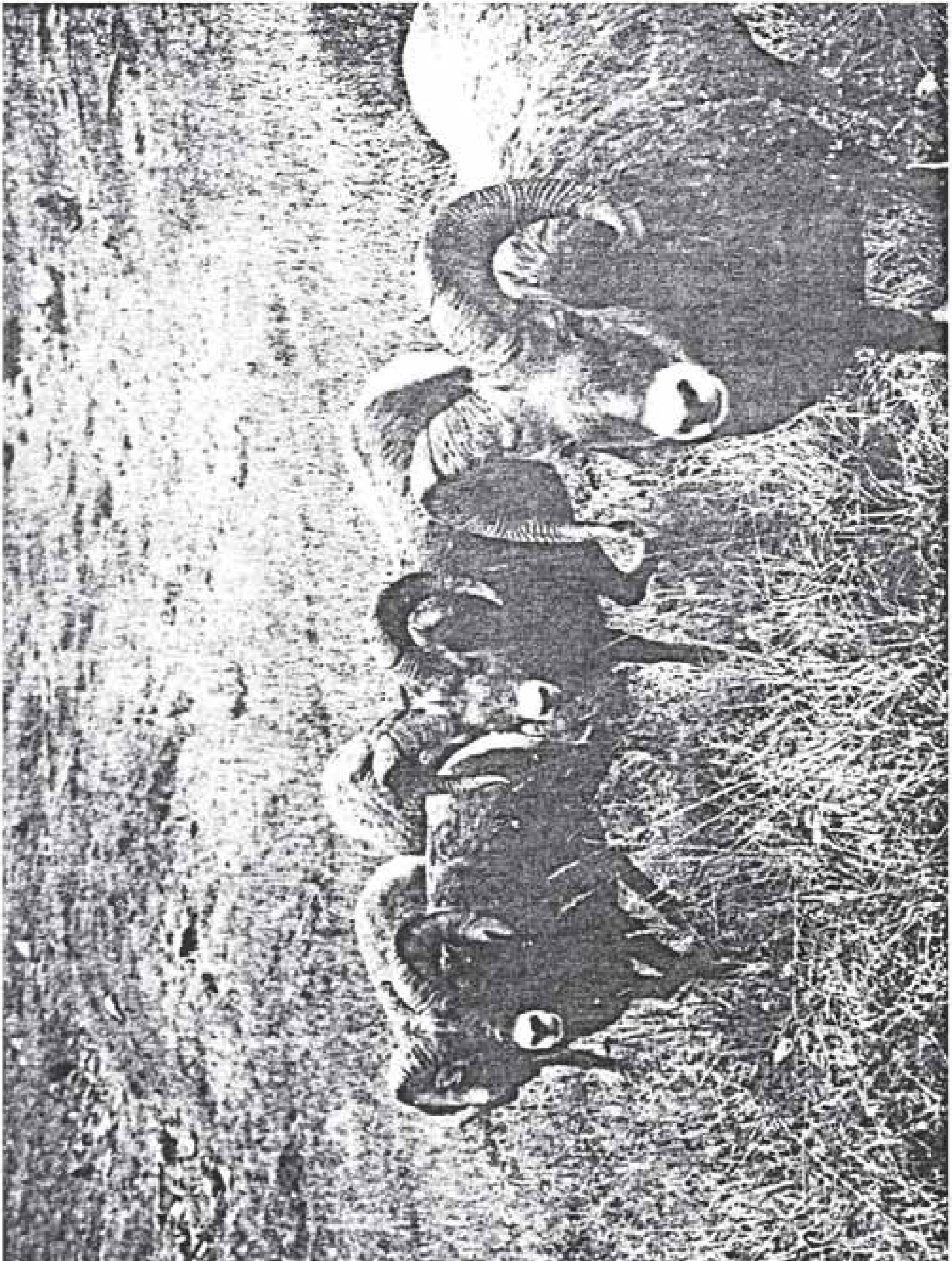

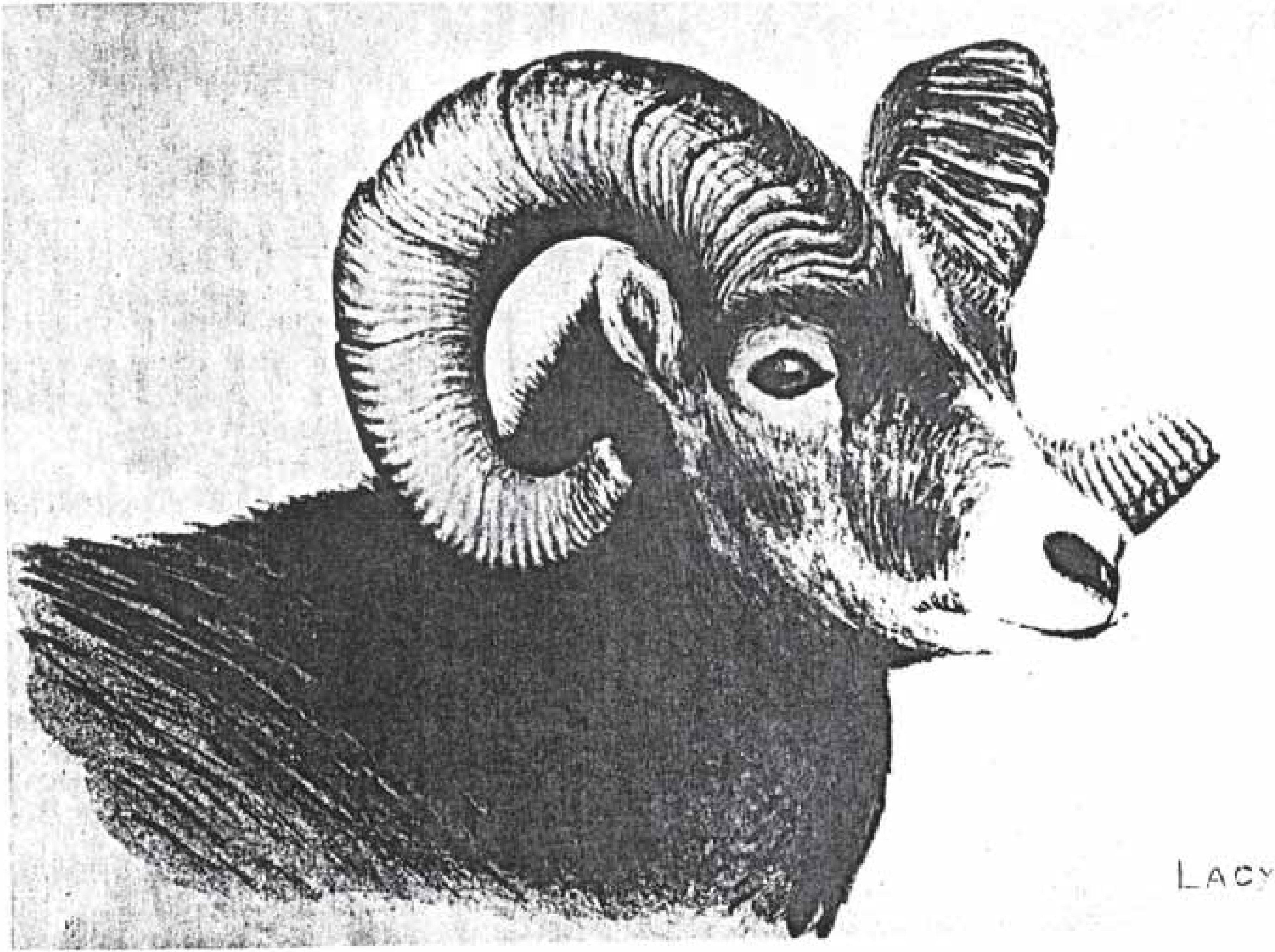
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