A STUDY OF A RECENTLY INTRODUCED BIGHORN SHEEP HERD

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ABSTRACT

Sixty-eight Rocky Mountain bighorn sheep (Ovis canadensis canadensis) were introduced into the Encampment River Canyon in southcentral Wyoming in 1976 and 1977. Within 2½ years, the herd was estimated to number 85 animals. Reproduction was good and mortality was low. The sheep wintered in the lower canyon and moved up canyon to slightly higher elevations in summer. A few sheep were observed as far as 19 km from the release site. Nearly all bighorn activity on the winter range was confined to 3 areas of similar topographic character. All had flat or gently rolling terrain adjacent to steep hillsides dotted with rock outcrops and cliffs. The black sagebrush (Artemisia nova) and big sagebrush (Artemisia tridentata)-grass vegetation types were most frequently used. Forbs and grasses made up most of the diet of the sheep from late fall through early summer. Most of the last summer-early fall diet was composed of browse. Key food plants were Stipa sp., Carex spp., Antennaria spp., Artemisia sp., Artemisia sp., Cercocarpus montanus, and Purshia tridentata. Elk (Cervus elaphus) were potentially the most serious competitors for forage on the winter range, followed by cattle, which grazed the area in summer. Mule deer (Odocoileus hemionus) were also present on the winter range in fall and winter, and pronghorns (Antilocapra americana) utilized portions of the area in summer, but neither species appeared to pose a competitive threat to the bighorn.

INTRODUCTION

In recent years bighonr sheep transplants have become important management tools for extending existing bighorn sheep ranges and for repopulating ancestral ranges. Introduced bighorn herds have exhibited a range of responses from failure to successful establishment. The reasons for these differing results have not always been apparent. As noted by biologists attending the Workshop on the Management Biology of North American Wild Sheep (Trefethen 1975:176), follow-up and evaluation of bighorn sheep releases is perhaps the weakest aspects of such management programs. A better understanding of the ecology of introduced herds should improve the ability of wildlife managers to effect successful transplants.

The objective of this study was to collect information concerning the activities of a herd of bighorn sheep during the first few years after its introduction. We wished to collect data which may be useful in predicting responses of future transplants, and which could also be used to guide management decisions concerning this particular herd. Specific aspects of the population which were examined included: mortality rates and factors, reproductive performance, movements and range use patterns, food habits, and competition with sympatric ungulates.

The release site was the Encampment River Canyon located on the eastern flank of the Sierra Madre Range in southcentral Wyoming. The Sierra Madre and surrounding foothills were ancestral bighorn sheep range. The native population is believed to have disappeared from the area at about the turn of the century. The introduction was accomplished in a series of 4 releases. Three releases totaling 51 sheep were made on 17 and 23 January, and 3 February, 1976. A final release of 17 sheep was made the following winter on 18 January, 1977. All of the sheep were trapped from the Whiskey Mountain herd near Dubois, Wyoming. Most were weighed at the trap site and received aluminum-strap ear tags and shots of bicillin, an antibiotic. The sex ratio was 25 males:43 females.

Thirty-one (46%) were lambs, and 10 (15%) were yearlings.

This study was begun in February 1976, shortly before the third release. It was funded by the Bureau of Land Management, with additional contributions of funds and equipment from the Hayden District of the Medicine Bow National Forest, the Laramie office of the U.S.F.S. Rocky Mountain Forest and Range Experiment Station, and the Wyoming Game and Fish Department. We wish to thank M. Kniesel, F. Ewing, F. Wolf, and B. Waddell of the BLM; A.L. Ward of the Experiment Station; and J. Newman of the Wyoming Game and Fish Department for their assistance with funding and materials. We also wish to thank D. Hein, P. Lehner, D. Smith, and D. Dilbert for their input during planning and write-up of the study.

STUDY AREA

The study area was located in southcentral Wyoming approximately 1 km south of the town of Encampment. It centered upon the Encampment River Canyon and tributary drainages. The Encampment River runs northward from the Park Range in Colorado and drains the eastern side of the Sierra Madre in Wyoming before emptying into the North Platte River 11 km north of Encampment. Elevation of the study area ranged from 2,230 m at the mouth of the canyon to 2,790 m on the canyon rim near the Colorado-Wyoming border.

The topography of the canyon, particularly the lower portion, is rugged, being dissected by numerous deep drainages. Vegetation of the lower canyon is a variety of shrub and grass communities dominated by big sagebrush and bluebunch wheatgrass (Agropyron spicatum). Other common shrubs include bitterbrush (Purshia tridentata), true mountainmahogany (Cerocarpus montanus), black sagebrush (Artemisia nova), rubber rabbitbrush (Chrysothamnus nauseosus), and Douglas rabbitbrush (Chrysothamnus viscidiflorus).

Lodgepole pine (Pinus contorta) and aspen (Populus tremuloides) forest predominate in the upper canyon, within the boundaries of the Medicine Bow National Forest. The BLM administers a majority of the lower canyon, the remainder being state and privately owned.

The climate is semi-arid with long, snowy winters and cool summers. Annual precipitation averages 30 cm at lower elevations, and may be as high as 114 cm in the upper canyon and on the peaks of the Sierra Madre. The growing season averages 90-100 days long.

Elk and mule deer winter in the lower canyon and disperse onto the National Forest in summer. Pronghorns utilized the lower canyon in summer, and cattle grazed throughout the area from June through October.

METHODS AND MATERIALS

Field work was conducted from February 1976 through August 1976 and from May 1977 through August 1978. During the period from September 1976 to April 1977, the study area was visited at least one weekend a month to locate bighorns and collect fecal samples. The majority of data was collected by direct observation. Counts of bighorn sheep were made on foot from trails and ridgetops or from unimproved roads. A variable power 20-40x spotting scope and a pair of 7x or 10x binoculars were used to locate and observe the sheep and other ungulates on the study area. Four adult ewes had been fitted with radio transmitter collars prior to release. Transmitter signals were monitored with a portable receiver and a variety of hand-held antennas.

Each observation of bighorn sheep, as well as those of mule deer, elk, and pronghorns, was recorded on a field form and plotted on a map. Information recorded at each observation included: time animals were first observed, group size and composition, activity, and characteristics of the location (percent slope, aspect, vegetation type, snow depth).

Observations of sheep sign, telemetric locations, and behavior of the sheep were also recorded.

Vegetation was classified into 10 types based upon dominant plant species. Color aerial photographs were used in conjunction with ground reconnaissance to delineate the types. In order of decreasing area within the study unit, these types were: big sagebrush, coniferous forest, black sagebrush, aspen forest, big sagebrush-grass, mountain shrub-grass, riparian forest, irrigated pasture, clearcut, and mountain shrub. Mountain shrub included true mountainmahogany, bitterbrush, and big sagebrush, and lesser amounts of serviceberry (Amelanchier alnifolia), and Douglas and rubber rabbitbrush. The grass component of the shrub-grass communities was primarily bluebunch wheatgrass, with some needle-grasses (Stipa sp.), and Idaho fescue (Festuca idahoensis). Sedges (Carex sp.) were also relatively abundant.

Fecal samples of bighorn sheep were collected bimonthly during the first 5 months of the study, and monthly thereafter through June 1978. Elk, mule deer, pronghorn, and cattle fecal samples were collected monthly during the periods that they occupied the winter range of the bighorns. This was fall and winter for deer and elk, and spring and summer for pronghorns and cattle. Generally 6 pellets were collected from each of 10 fresh groups and combined to make one sample. Samples were air dried in paper envelopes and sent to the Composition Analysis Laboratory at Colorado State University for microanalysis. One hundred fields per sample were examined (Hansen 1971). Results of microanalysis, supplemented by direct observation of feeding ungulates, snow trailing, and some feeding site examination, were used to determine food habits of the bighorns and deer, elk, pronghorns, and cattle.

RESULTS

Mortality

Only 4 confirmed mortalities occurred during the study period, 3 during the first winter after release, and the remaining 1 during the elk season in Ocotber 1976. All were adult ewes. Of the first 3 discovered mortalitites, the cause of 2 was unknown, and the other was the result of entanglement in a fence. The ewe shot during elk season was recovered because of an eyewitness account. Observations indicated that 3 other ewes could probably be considered dead. Two of these were badly crippled animals, and 1 was an individually recognizeable color-banded ewe which was seen only once subsequent to her release.

Mortality rates were based on herd counts conducted in spring and fall when bighorns were concentrated on the low elevation range (Table 1.). These rates thus represent the maximum mortality that could have occurred. For the 5-month period following the first releases (January-May 1976), the estimated mortality was 13 sheep, or 25%. Four were adult ewes, and 9 were lambs.

Mortality during the following year (June 1976-May 1977) was 11 sheep, or 17%. This included mortality of those sheep introduced in 1976 as well as the 17 additional sheep released in January 1977. Four were adult ewes, 5 were yearlings, and 2 were lambs. The mortality rate for the next year (June 1977-May 1978) was only 8%, or 5 sheep. Four were rams, and 1 was a yearling. The mortality of mature rams in the last year may have been overestimated. Near the end of the study period, rams began to segregate from ewe-subadult groups because they tended to be smaller, and because no rams were radio collared.

No evidence of non-human predation upon bighorn sheep was found. Coyote (Canis latrans) and golden eagles (Aquila chrysaetos) were the most numerous predators on large animals on the study area. Two bighorn lambs

were observed being harassed by dogs on 1 occasion, and a crippled ewe was observed being chased by a coyote. One observation of a bighorn ram chasing a coyote was also made. A golden eagle was seen to dive toward a ewe with a small lamb on 1 occasion, but no contact was made. Bighorns generally ignored eagles which flew or perched in their vicinity.

Table 1. Seasonal estimates of bighorn sheep population in the Encampment River Canyon, Wyoming, from January 1976 through July 1978 based on known sex and age composition of introduced groups and maximum herd counts. (Yearling cohorts of unknown sex composition were considered to be 50% males and 50% females.)

	Season	Year	Female	Male	Yrlg.	Lamb	Adult
Release	Winter	1976	17	2	7	25	51
Max. Pre-lambing count	Spring		13	2	7	16	38
Estimated Recruitment	Summer		15	7	16	9	47
Max. Post-lambing count	Fall		15	7	14	9	45
Release	Winter	1977	7	1	3	6	17
Est. Total population	Winter		22	8	17	15	62
Max. Pre-lambing count	Spring		18	8	14	13	53
Estimated Recruitment	Summer		25	15	13	12	65
Max. Post-lambing count	Fall		25	11	12	12	60
Max. Pre-lambing count	Spring	1978	25	11	12	12	60
Estimated Recruitment	Summer		31	17	12	16	76

Reproduction

Lamb production during the first 2 lambing seasons was at least 9 lambs in 1976 and 12 lambs in 1977. Data on the 1978 lamb crop was not reliable since field work was terminated in August. The best lamb counts were those

obtained in late August through October as sheep gathered on the winter range. As of late July 1978, 16 lambs had been counted. This probably represented a majority of the lambs produced that year since most adult ewes in the population were observed.

Spring population of adult ewes, as determined by maximum counts, were used in calculations of lamb:ewe ratios. This method yielded ratios of 60:100, 48:100, and 53:100 for the 1976, 1977, and 1978 lambing seasons, respectively. The actual productivity was probably somewhat higher than represented by those ratios since the adult ewe age class included 2-year-old ewes, which seldom bear lambs in normal populations. More often the first lamb is produced at the age of 3 (Streeter 1970)

The peak of lambing varied over the 3 summers. In 1976 most lambs were born in the first week of June. In 1977 the peak was later, not until the third week of June. This may have been related to the extremely mild nature of the preceeding winter which may have delayed the rutting season. In 1978 the peak of lambing was in the second week of June.

Observations of ewes with young lambs in June and July revealed 2 major lambing areas. Both were steep slopes on the western side of the Encampment River with extensive areas of cliffs and rock outcrops. One was located on the winter range, just 2 km south of the release site. The other was located on the summer range, about 9 km south of the release site, and was more heavily forested than the lower lambing area.

Movements and Range Use

The annual movement pattern of the Encampment River bighorn herd was a seasonal drift. The sheep wintered on the grass and shrub-covered terrain of the lower canyon and tributary drainages (Fig. 1). They began to drift southward in the canyon in April and May, as snowmelt opened travel routes. Some sheep continued to move onto the summer range throughout June, and July, while some never left the winter range. Only 4 sheep remained on the winter range during the first summer, but 15 remained

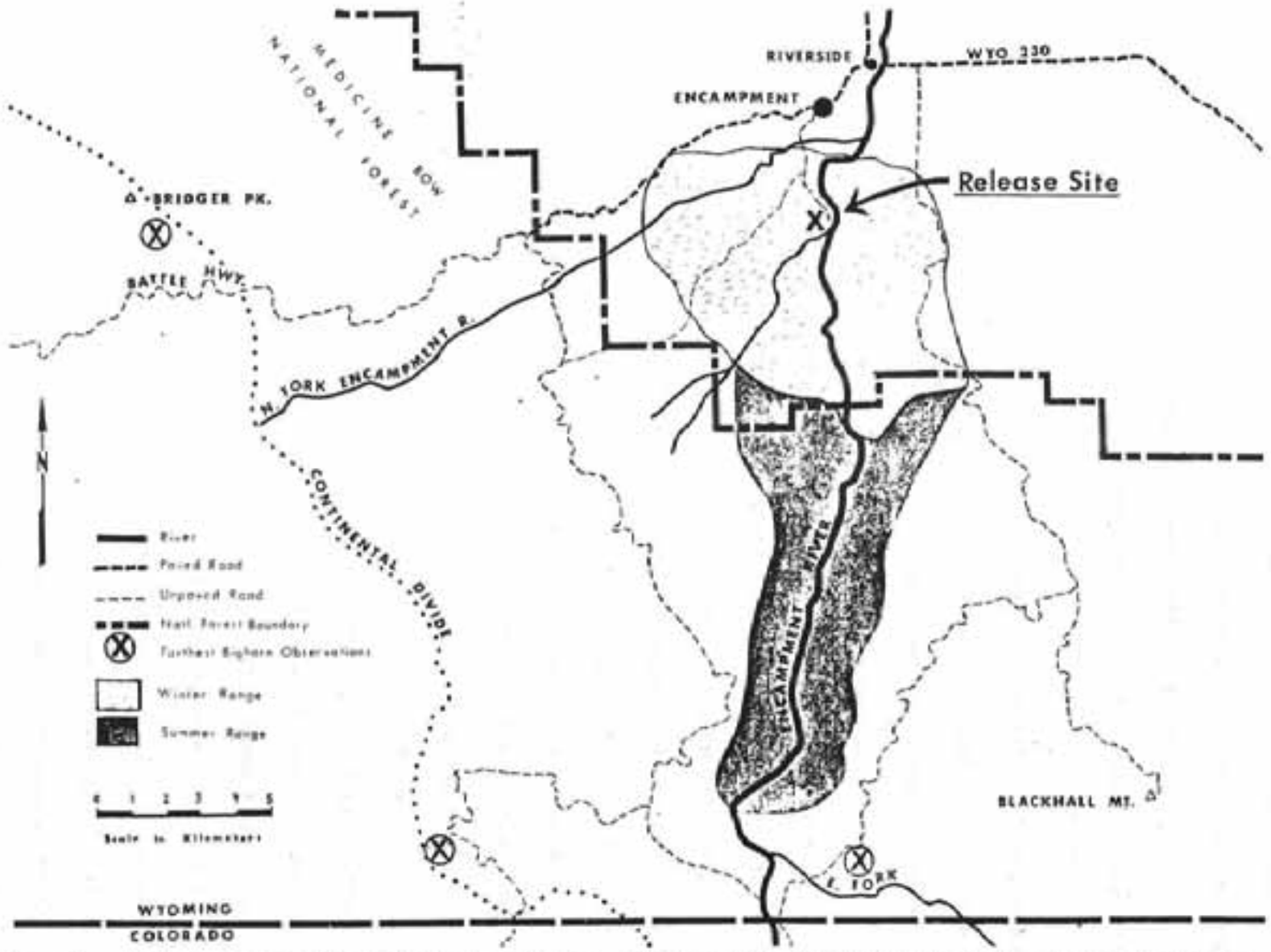

Fig. 1. Summer and winter ranges of the introduced Encampment River bighorn sheep herd, southcentral Wyoming, 1976-1978.

there during the following 2 summers.

The summer range appeared to be largely confined to the upper Encampment River Canyon, however it was difficult to delineate due to the difficulty of observing sheep in forested areas. Some sheep were observed on the alpine range of the Sierra Madre as well as in other distant locations (Fig. 1). The farthest confirmed observation of a bighorn was 19 airline km from the release site. Unconfirmed, but credible, reports were received of small numbers of sheep near Seedhouse Guard Station in Colorado (45 km from the release site) and on Horse Mountain on the western side of the Sierra Madre (40 km).

Some sheep returned to the winter range as early as July, while others remained on the summer range until October or November when deep snows forced them down. During the winter of 1976-1977 snow accumulation on the study area was abnormally low. Consequently, some sheep remained on the lower margin of the summer range for the entire winter.

Home range sizes were determined for the 3 radio-collared ewes whose movements were monitored throughout the study. Home range, as it is used here, denotes that area which an animal learns thoroughly and habitually patrols (Burt 1943). Home ranges were delineated by the polygon method (Mohr 1947).

Ewe #6, which remained on the winter range during the entire study, had a home range of approximately 11 km^2 (N=80 relocations). The home ranges of ewes #5 and #2 while they were occupying the winter range were 13 and 9 km^2 (N=39, 61). The mean fall-winter home range of the 3 ewes over the 3 winters of the study was 6.4 ± 4.69 km^2. Rough estimates of the summer home ranges of ewes #2 and #5 were 26 and 7 km^2.

Three high use areas were identified on the winter range, based on concentrations of bighorn observations. They encompassed approximately 7 km^2. Eighty-seven percent of all bighorn sheep observations were within

these high use areas. The most notable characteristic common to the 3 areas was the topography. All had steep slopes with abundant rock outcrops and cliffs adjacent to flat or gently sloping ridgetops. Slopes which were steep and adjacent to flat areas, but which did not contain rocky cover, were used relatively infrequently.

The sheep displayed a notable preference for ridgetops and steep slopes. Twenty-nine percent of all bighorn observations were on ridgetops. Slightly more than a third of those bighorns observed on slopes were on slopes of 81% or greater, while about 56% were on slopes of 50% or steeper. Bighorns were most often seen on the top third of slopes (61% of all observations on slopes), and least on the bottom third (11%).

The big sagebrush-grass and black sagebrush vegetation types were used most frequently by the sheep, together making up 62% of all observations. The mountain shrub-grass type was the most frequently used (15%). Use of the coniferous forest, aspen forest, and clearcut types was not well represented in these observations. Less field effort was expended in forested areas, and sheep were very difficult to observe while occupying such areas. Undoubtedly, sheep summering in the upper canyon spent a large portion of their time in forested areas, and possibly in clearcuts.

Escape cover was an important component of the habitat. Steep slopes containing rock outcrops and/or cliffs were considered escape terrain for bighorn sheep. Forty-eight percent of all observations of bighorn sheep were in escape terrain. A total of 91% were within 100 m of escape cover. The farthest any sheep was observed from such cover was 1.5 km. All bedded sheep were within 0.8 km of escape terrain.

Food Habits

Investigation of bighorn sheep food habits was concentrated upon the low elevation range. A knowledge of foods consumed on that portion of the range was more important from a management standpoint, since winter forage

Table 2. Mean percent relative densities and frequencies of major plant species in 36 bighorn sheep fecal samples collected from the Encampment River herd, southcentral Wyoming, 1976-1978.

Scientific Name	Mean	Frequency	Highest % one sample
Stipa sp.	20 = 14.8	1.00	56
Carex sp.	6 = 6.5	0.89	24
Agropyron spicatum	5 = 8.6	0.94	38
Koeleria cristata	4 = 4.9	0.75	26
Antennaria sp.	11 = 18.4	0.64	58
Astragalus sp.	5 = 12.2	0.67	61
Potentilla sp.	2 = 3.2	0.44	10
Cercocarpus-Ceanothus	18 = 27.5	0.78	92
Artemisia sp.	9 = 11.4	0.89	55
Purshia tridentata	5 = 8.4	0.86	42

supply is limited. Also, competition for forage between bighorns and mule deer, elk, pronghorns, and cattle was expected to be more of a problem on the winter range than on the summer range where densities of these populations were much lower.

Fragments of true mountainmahogany and ceanothus (Ceanothus velutinus) were indistiguishable in the fecal samples, so they were lumped into one category. Most of this category probably consisted of true mountainmahogany because it was much more abundant on the winter range. Bighorns were observed feeding on true mountainmahogany, but never on ceanothus. All species of the genus Artemisia were also combined into one category since they were not individually recognizeable in the samples. The Artemisia category may thus contain big sagebrush, black sagebrush, fringed sagebrush (Artemisia frigida), and Louisiana sagewort (Artemisia ludoviciana).

On the average, bighorns ate more grasses and sedges than forbs and browse. The mean percent relative densities of the 3 forage classes were 42 ± 23.7% for grasses and sedges, 22 ± 23.2% for forbs, and 35 ± 27.0% for browse. Forage class percentages varied greatly from month to month (Fig. 2). Use of grasses and sedges was greatest in winter and early spring. Forb use was relatively high in spring, and fluctuated erratically during fall, winter, and summer. The most pronounce seasonal trend was the heavy utilization of browse in summer and early fall. Field observations supported these findings. The more important plants in the diet included Stipa sp., Carex sp., Agropyron spicatum, Antennaira sp., Artemisia sp., Cercocarpus montanus, and Purshia tridentata (Table 2).

Numerous studies have reported that grasses and sedges are staples of the bighorn's diet. (Todd 1972), however browse has been found to be an important component of the diets of some populations (Todd 1975, Keiss 1977). Microanalysis of fecal samples from bighorn herds in Colorado

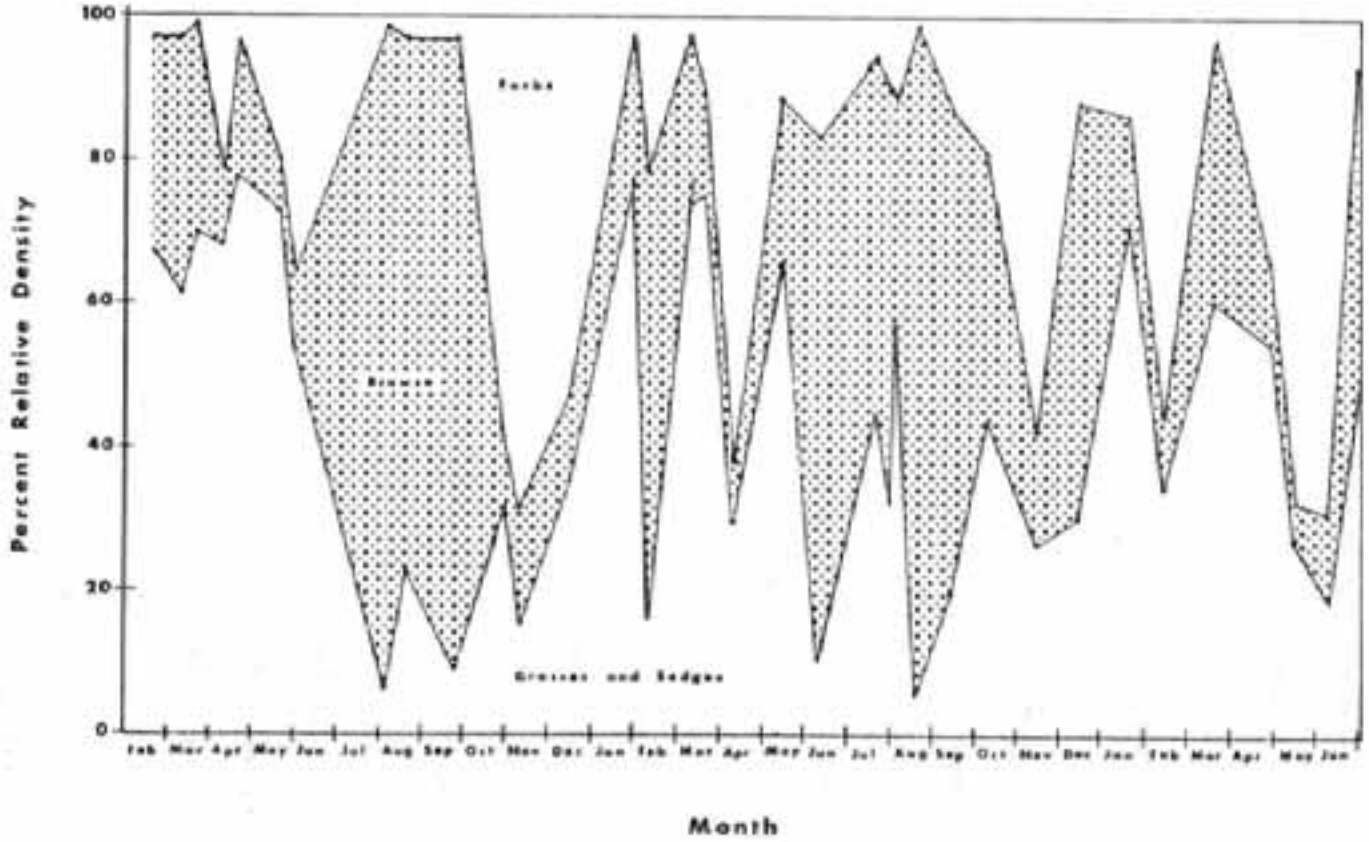

Fig. 2. Percent relative densities of grasses and sedges, forbs, and browse in bighorn sheep fecal samples from the Encampment River herd, southcentral Wyoming, 1976-1978.

indicated that use of browse decreased from summer to winter, and grass use was highest in winter (Keiss 1977). This was the trend observed in the Encampment samples.

The use of Artemisia was highest in the winter, while the highest use of the other 2 major browse species occurred in summer and early fall. Fringed sage probably made up most of the Artemisia category. Bighorns were seldom observed feeding on big sagebrush or black sagebrush, but fringed sage was closely cropped in portions of the bighorn high use areas. It was also observed exposed in feeding craters dug by bighorn in the snow. Heavy fall-winter utilization of fringed sage has been reported in other studies (Honess and Frost 1942, Smith 1954, Moser 1962, Cooperrider 1969, Todd 1975, Keiss 1977).

Competition

Competition may be defined as the active demand by 2 or more species for a common resource that is limiting (Clements and Shelford 1939). Exploitive competition for forage between bighorn sheep and sympatric ungulates was examined in this study. Interference competition did not appear to be a problem. In order to assess levels of competition between these species, their food habits distributions, and habitat preferences were examined.

Distributions of mule deer and elk varied over the 3 winters included in the study period due to differing patterns and schedules of snow accumulation. The first major snowfalls arrived in October and November during the first (1975-1976) and third (1977-1978) winters, and total snow accumulation was about average. In contrast, the second winter (1976-1977) had abnormally low snow accumulation, as the first major snowstorms did not arrive until December, and range unavailable to big game animals in a normal winter was snow-free. The first winter had the greatest

low elevation snow accumulation.

An estimated population of 300 mule deer wintered within the range of the bighorns. A minimum of 90 elk were counted on the range during the first winter, and 150 were counted during the third winter. Elk did not descend to the winter range during the second winter. The greatest overlap of distributions of deer, bighorns and elk occurred in the first winter, however, overlap of concentration areas was small. Deer used the lower extreme of the canyon, while elk used the upper margins adjacent to the summer range. The bighorn high use areas were located between elk and deer concentrations.

Very different distributional patterns were observed during the second winter. The deer ranged widely, so no concentration area could be identified. Most bighorns remained in the same locations as the previous winter, though a few remained south of the regular winter range.

During the third winter deer were distributed over a larger area than that occupied in the first winter, but many once again congregated in the lower canyon. The elk were highly mobile and did not remain in any one area for the whole winter. Overlap of deer and bighorn concentration areas was small. The elk range encompassed all of the bighorn high use areas. For the first time, large numbers of elk and bighorn sheep were observed simultaneously on the same slopes and ridgetops.

Habitat preferences of elk were most similar to those of bighorns. Both made frequent use of steep slopes and ridgetops. Elk were most often observed in the black sagebrush vegetation type (43%), but used the big sagebrush type more frequently than the sheep (31%). Deer were observed on slopes of various steepnesses. They made greater use of less steep slopes and flat or rolling terrain than did the sheep. Deer used the big sagebrush vegetation type much more (47%) and the black sagebrush type (11%) much less than the bighorn sheep.

Diets were compared using Sorensen's community coeffecient (Sorensen 1948) as applied in its quantitative modification by Motyka et al. (1950). The equation is:

$$I = \frac{2MW}{MA + MB} \times 100$$

MW is equal to the sum of the smaller quantitative values of the plant species common to the 2 samples, and MA and MB are equal to the sums of the quantitative values of all plant species in each respective sample A and B. "I" is the index value, which corresponds to the percentage overlap of the 2 samples being compared.

Overlap of elk and sheep samples was generally greater than overlap of deer and bighorn samples. The mean overlap for corresponding pairs of elk-bighorn samples (collected in the same month) was 54 $\pm$ 19.7% (N=7). The overlap of deer-bighorn samples was 28 $\pm$ 16.9% (N=15). Plant species accounting for much of the overlap were Stipa sp., Agropyron spicatum, Antennaria sp., Artemisia sp., Cercocarpus montanus, and Purshia tridentata. Mean percentages of grasses, forbs, and browse in the diets are compared in Figure 3. The amount of overlap of deer and bighorn diets may have been exaggerated due to the lumping of several species in the Artemisia category. Deer appeared to consume primarily big sagebrush, while the bighorns were eating fringed sage.

Numbers of pronghorns summering in the lower Encampment River Canyon appeared to increase during the study period. Approximately 60 were present during the first summer, while at least 80 were present by the third summer. They moved onto the area in late April or early May and remained through September. Numbers of cattle on the study area were not constant since grazing allotments were not entirely included within its boundaries. If cattle were uniformly distributed throughout the allotments, approximately

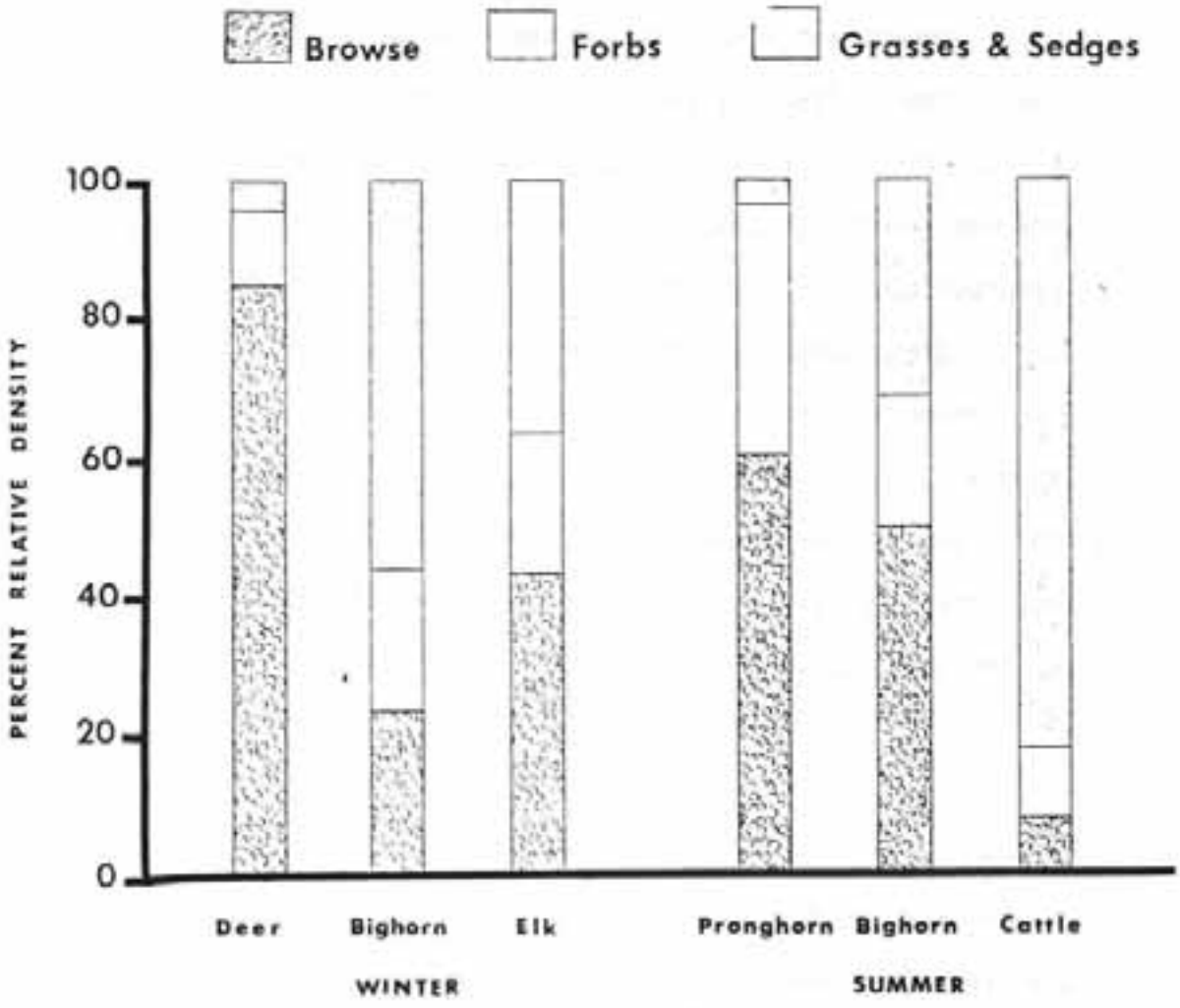

Fig 3. Mean percent relative densities of browse, forbs, and grasses and sedges in fecal samples of bighorn sheep, mule deer, elk, pronghorns, and cattle of the Encampment River Canyon, southcentral Wyoming, 1976-1978.

278 cows with calves would have been present on the bighorn winter range.

Pronghorn distributions varied somewhat over the 3 summers, but the general pattern was the use of broad, flat ridgetop areas and the flat portions of the canyon rim. Cattle made greatest use of ridgetops and drainage bottoms. They utilized the black sagebrush, big sagebrush, aspen forest, riparian forest, and irrigated pasture types the most. Pronghorn activity was restricted almost exclusively to the black sagebrush and big sagebrush types (96% of observations).

Cattle diets consisted mostly of grasses and sedges (82%, N=11), while pronghorns consumed mostly forbs and browse (N=11) (Fig. 3). Mean dietary overlap was greater between cattle and bighonrs (I=36 $\pm$ 15.8) than for pronghorns and bighorns (I=30 $\pm$ 16.7). Plant species involved in the dietary overlap were the same as those indicated for elk, deer, and bighorn samples, with the addition of several forbs in the pronghorn diet.

DISCUSSION

Within the first 3 years after its introduction, the Encampment bighorn sheep herd showed signs of becoming successfully established within the canyon and tributary drainages. Natality and mortality rates compared favorably with population statistics from other thriving bighorn herds (Geist 1971). Mortality rates decreased during the course of the study. The highest rate, occurring during the first 5 months after the release, may have been partially a result of the stress of capture and transport and the unfamiliarity of the sheep with their new environment. At least some of the ewes lost during that period may have been suffering from capture myopathy, as described by Spraker (1976). Sheep which appear

normal soon after handling may subsequently develop symptoms resulting in death or severe locomotor disability.

We speculated that the sudden seperation of lambs and ewes at the trapping site may have contributed to the high lamb mortality observed during the first winter. If each lamb released in 1976 was the offspring of one of the adult ewes, than 8 lambs were released without their dams. In a normal situation, the mother-young bond is not broken until the lamb is at least a year old. Geist (1971) believed that a premature seperation of ewe and lamb could lead to aimless wandering of the lamb and result in an untimely death. During the first 4 months of this study, 14% of all sheep groups observed were all-lamb groups, whereas only 1 of 223 groups observed during the rest of the study was a lamb group. There were also 5 observations of solitary lambs during that initial period and none during the rest of the study. The release of a relatively large number of sheep at one time would appear to be a good strategy so that initial losses do not remove a large percentage of the population.

Based on herd counts, an estimated population of 75 sheep occupied the Encampment River Canyon by the end of August 1978. This was probably a somewhat conservative estimate. The projected population level, counting the 7 "known" mortalities of adult ewes as the only ones that occurred was 98 sheep. The actual population level was probably between these 2 estimates, perhaps about 85 animals. A population of 85 sheep would have been an increase of 25%.

The movements and range use patterns of the Encampment herd were not greatly different from those described for other introduced herds (Drewek 1970, Bear and Jones 1973). Most dispersal is likely to occur along drainages, and some sheep are likely to remain in the vicinity of the release if the terrain is suitably preciptious. Observations of sheep in areas outside the canyon suggest the possibility of future

range enlargement and the establishment of migration routes.

Food habits of the Encampment herd varied seasonally, and a considerable variety of plant species was utilized (Haas 1980). Browse was an important component of the summer and early fall diet. Examination of shrubs utilized by the bighorns revealed that leaves were the principle part utilized. Selection of shrub leaves may have been related to forage succulence, since many grasses and forbs were still green. Use of some plants, such as serviceberry and arrowleaf balsamroot (Balsamorphiza sagittata) may have been underestimated by the microanalysis technique. There was some evidence that fragments of Poa sp. and Stipa sp. were confused in the sample readings. Food habits studies conducted by Arthur (1977) comparing mule deer diets determined by fecal microanalysis and bite count methods also suggested that these 2 genera were being confused in the fecal samples analyzed.

Elk were found to be the most important competitors with the bighorns. Not only did distributions, habitat preferences, and food habits overlap to a great extent, but the number of elk wintering in the Encampment area appeared to be increasing. Cattle were the next most significant competitors because they utilized ridgetop forage which would otherwise be available to bighorns and elk during the winter.

Future considerations for the management of the herd should include regular monitoring of forage condition, and of levels of populations of all ungulates utilizing the lower canyon. Much of the range within the study area was in fair to poor condition in 1978, suggesting that cattle should be reduced on the more critical areas. Human activity may also become an important factor influencing the bighorn sheep. The herd is easily accessible, particularly on the winter range. If the current population growth experienced in Wyoming continues, concomitant with an increased use of off-road vehicles, steps may have to be taken to protect the sheep from harmful disturbance.

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QUESTION - RESPONSES

Jim Bailey: Why do you suspect Poa and Stipa were being used, in the results from the lab?

Wendy Haas: Of the grass component of the diet, Stipa was higher than any other grass during the entire year. Generally, from observations, Stipa wasn't consumed and it developed seed heads; this was mostly needle and thread Stipa comata.