POPULATION CHARACTERISTICS, MOVEMENTS, AND DISTRIBUTION PATTERNS OF THE UPPER ROCK CREEK BIGHORN SHEEP

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Abstract: A 1975 re-introduction of 31 bighorn sheep (Ovis canadensis) to the Upper Rock Creek, Montana, Drainage was studied from April 1977 to mid-August 1978. Data from 257 observations of groups with marked and unmarked sheep provided information on population size, sex and age composition, group size, group fidelity, seasonal key use areas, home range size, and movements. The population had increased to approximately 100 by June 1978. Mortality was very low. Mean group size was 10.2. Lamb/ewe ratios were between 70 and 80 lambs per 100 ewes both years. Eight of 10 2-year-old ewes had lambs in 1977. The sheep were expanding their range yearly. Ram summer range was 11km from the winter range in 1977; at least 17 in 1978. Most ewes lambed 4-6km from the winter range though a small contingent migrated 16km to lamb. Seasonal mean standard diameters for collared ewes ranged from 0.35km during lambing,1978, to 1.9km after lambing,1978. Group fidelity was highest during lambing. Mean seasonal cohesion coefficients for collared ewes ranged from 0.11 to 0.35.

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INTRODUCTION

A native population of bighorn sheep (Ovis canadensis) inhabited the Upper Rock Creek Drainage of Granite County, Montana. A die-off began in 1965, and, despite the work of 3 researchers (Berwick 1968, Cooperrider 1969, and Aderhold 1972), no sheep survived.

On 28 January 1975, 31 bighorns were transplanted from the Sun River, Montana, herd to the Upper Rock Creek range by the Montana Department of Fish, Wildlife, and Parks (then the Montana Department of Fish and Game). All 19 adult and yearling ewes were released with individually color-coded collars; rams and lambs were not collared.

Transplanting of bighorns onto new and historical ranges has been practiced in many western states with varying success. Wishart (1975) stated that transplanting "is probably the best management practice known to increase sheep distribution and populations throughout bighorn ranges." He continued, "Perhaps the weakest program associated with trapping and transplanting activities has been the evaluation of transplant success. Many releases have been made with inadequate followup and evaluation of permanent establishments."

The objectives of this study were to (1) estimate herd population and composition, (2) identify key use areas, (3) document daily and seasonal movements, and (4) estimate lamb mortality.

Support for the study was provided by the National Rifle Association, the Bureau of Land Management, the Montana Cooperative Wildlife Research Unit, and the Montana Department of Fish, Wildlife

and Parks.

STUDY AREA

The study area was in Granite County, Montana, approximately 30 km west of Philipsburg. The area was characterized by a series of alternating steep-sided ridges and narrow valleys, trending northeast from Rock Creek. The ridges terminated in steep cliffs and talus slopes 150-200 m high along Rock Creek. Elevations ranged from 1500-2100 m.

Generally, the south- and west-facing slopes and benches on the study area supported the intermountain grassland type of vegetation described by Stoddart et al. (1955).

North slopes, ridgetops, and high elevation slopes were generally forested. Large expanses were dominated by the Douglas-fir/pinegrass habitat type (Pseudotsuga menziesii/Calamagrostis rubescens) (Pfister et al. 1977). Steep west-facing slopes with shallow, rocky soils were dominated by Douglas-fir with a mosaic of understory associates. Steep south- and southeast-facing slopes were characterized by mosaics of scree and Douglas-fir/bluebunch wheatgrass habitat types.

Ownership of land within the study area was distributed among several private individuals, the Bureau of Land Management, the United States Forest Service, and the State of Montana. Fifty-six percent of the 3200 ha within the primary study area was privately owned.

METHODS

Much of the primary sheep range was visible from the Rock Creek Road or from several locations along 2 logging roads to the south and west of the sheep range. An observation route was established using these roads and travelled a minimum of once in the early morning and once in the late afternoon, the times of greatest sheep activity. Most observation points were preselected, though when any sheep were observed they were recorded. A minimum of 10 minutes was spent at each site looking for sheep.

The use of a vehicular route allowed maximum coverage of the study area and minimized disturbance to the sheep. Approximately 80% of the grassland and open timber types were visible from that route. Routes were also travelled on foot into the study area to observe locations not visible from the road; to search for evidence of sheep use such as trails, bedding sites, and pellet groups; and to collect data on the vegetation. These hikes were made at least twice a week. Whenever sheep were encountered, every effort was made not to disturb them.

Rams were classified by degree of horn curl as yearlings, ¼, ½, 3/4, or full curl. Ewes were classified as yearlings, or as collared or uncollared adults. Collars were identified if possible. The sex of lambs was not determined. Group types were recorded as ewe, lamb, ewe/lamb, yearling, ram, mixed, or ewe/lamb/yearling.

Each sighting was located on a 7.5 minute USGS topographic map overlaid with a 0.4 km grid. A 4-digit coding scheme was used to

identify each location as described by Tilton (1977).

The "best count method," where the maximum number of sheep in any category observed without duplication is a minimum estimate of the animals in that category (Smith 1978, Van Dyke 1978), was used to estimate numbers of each cohort. A maximum number predicted in each age class was calculated from known sex and age structure at the time of release.

Monthly ewe/lamb ratios were estimated by totalling all ewes and lambs observed in groups with no unclassified sheep, regardless of duplication. A ratio was also estimated using the "best count" of ewes and lambs for the period considered. Lamb mortality was estimated by comparing ewe/lamb ratios from month to month, and by comparing "best counts" monthly and seasonally.

Minimum seasonal home ranges (Hayne 1949), seasonal centers of activity, and standard diameters (Harrison 1958) were calculated and mapped for all collared ewes. A seasonal cohesion coefficient was calculated for each pair of collared ewes as an index of fidelity to specific groups.

RESULTS

Herd Numbers and Composition

Nineteen ewes ranging in age from $1\frac{1}{2}$ to over 4 years of age, and 12 rams, including 5 lambs, 2 yearlings, 4 $2\frac{1}{2}$-year-olds, and 1 $4\frac{1}{2}$-year-old, were transplanted. Two rams died shortly after release

and 1 ewe was poached in 1976. All other collared ewes were alive during the 1977 field season.

Two-year-old ewes were easily identified in 1977 as they were the only adult-appearing ewes on the range without collars. The minimum number of 2-year-old ewes observed in 1977 was 10.

The maximum number of lambs seen in 1 band in 1977 was 15. Five ewes known to have lambs were not in that band. A minimum estimate of lambs during June 1977 was 20. Four ram and 4 ewe yearlings were identified in 1977. The total number of bighorns in the Upper Rock Creek population during midsummer 1977 was estimated at 75. Estimated sex and age composition at that time is shown in Table 1.

In February 1978, 76 sheep were observed on 1 day. I feel this was the total population at that time. On 7 April 1978, 76 sheep were again observed including 20 lambs of 1977.

One collared ewe seen in 1977 was not observed in 1978; all others were accounted for. The minimum estimate of lambs in 1978 was 24. The Upper Rock Creek sheep population was estimated at approximately 100 in midsummer 1978. Sex and age composition of the population is shown in Table 2.

Sheep were defined as lambs from birth until 1 May of the following year, after which they were classified as yearlings. Totals of ewes and lambs observed that were not in groups with unclassified sheep were used to estimate monthly ewe/lamb ratios (Table 3). A second method was used during June of 1977 and 1978. Based on nearly

Table 1. Estimated sex and age composition, June 1977.

Age	Male	Female	
Lamb	10	10	
1	4	4	
2	9	10	
3	5	0	collared ewes
4	2	3	
5	2	1	
6	0	2	
7	1	11	
8	0	0	
9	0	0	
10	0	0	
Total	33	41	
	74		

Table 2. Estimated sex and age composition, June 1978.

Age	Male	Female	
Lamb	12	12	
1	10	10	
2	4	4	
3	9	10	
4	5	0	collared ewes
5	2	3	
6	2	1	
7	0	2	
8	1	10	
9	0	0	
10	0	0	
Total	45	52	
	97		

exact ewe numbers and best counts of lambs, the estimates are felt to be very accurate. In 1977, 28 ewes, 2 years old or older, and a minimum of 20 lambs were present. The ewe/lamb ratio was 100:71. In 1978, 31 ewes of lamb-bearing age were seen with a minimum of 24 lambs. The ewe/lamb ratio was 100:77 (Table 4).

Two-year-old ewes were the only adult-appearing uncollared ewes in 1977. Ten were observed and 8 had lambs. In 1978, 2- and 3-year-old ewes were difficult to differentiate with certainty. Fourteen ewes were 2 or 3 years of age, and at least 8 were seen with lambs at 1 time. No evidence of twinning was observed.

Distribution and Movements

Data from 257 observations of groups with marked and unmarked sheep, made during 155 days of observation, provided information on movements and distribution patterns of the Rock Creek sheep.

Pooled standard diameters for all collared ewes were smallest during lambing season 1978 (0.3 km) and largest during the 1978 post-lambing season (2.8 km). The average distance between seasonal centers of activity were: 1977 lambing to post-lambing, 4 km; 1977 post-lambing to 1978 pre-lambing, 7 km; 1978 pre-lambing to lambing, 6.5 km; and 1978 lambing to post-lambing, 8.5 km.

One collared ewe migrated 17.6 km between the winter range and her lambing area. Most ewes used the steep, cliffy areas adjacent to the winter range for lambing, which began in late May 1977, mid-May 1978, and late April 1979.

Table 3. Monthly ewe/lamb ratios using the total ewes and lambs method.

Month	Total number observed		Lambs per 100 ewes
	Ewes	Lambs	
1977			
Apr	6	2	33
May	3	2	67
Jun	147	129	88
Jul	68	57	84
Aug	15	9	60
1978			
Jan	14	2	14
Apr	121	103	85
May	102	58	57
Jun	225	170	76
Jul	165	114	69
Aug	20	8	40

Table 4. June ewe/lamb ratios using the best count method.

June 1977	June 1978
100:71	100:77

Until lambs were 1-1½ months old, they remained in the steep, cliffy areas near where they were born. The ewes would leave the lambs with a few adults and venture onto open grassland to feed, returning to their lambs within several hours. Yearlings were often associated with the ewe/lamb groups at that time.

Ewes without lambs and young rams that had not joined the older rams formed their own bands separate from the ewe/lamb bands. They wandered throughout the range.

Rams ½ curl or larger migrated 5 km to a separate late winter range in February. In 1978 they travelled 6.5 km to summer range from late spring range. During 1979 they migrated at least 8 km further, crossing a large, deep drainage and traversing several stretches of unbroken timber. They were thus summering approximately 19 km from their winter range.

Minimum home range size was calculated for several collared ewes (Hayne 1949). The average home range size used by 6 ewes in 1977 was 343 ha, ranging from 151 to 732 ha. During 1978 average home range size for 5 collared ewes was 424 ha and ranged from 355 to 581 ha.

Ewes and lambs stayed fairly close to Rock Creek for a month following lambing. Ewes were seen drinking water during early mornings and late evenings. They usually left the lambs on nearby cliffs. The ewes would then descend rapidly to the Creek, and rarely spend more than 10 minutes there.

By late summer, sheep use was concentrated in the timbered areas of the larger gulches that contained ample shade and water.

Four mineral licks received heavy use, particularly by ewes for a month or more following lambing. Ewes were observed pawing and licking the soil at the lick sites most frequently, lambs and yearlings on occasion, and $\frac{1}{4}$ or $\frac{1}{2}$ curl rams rarely. Adult rams were never seen using a lick. Use of licks took place most frequently within 2 hours of sunrise or sunset, though use was observed at all daylight hours.

Barbed-wire fences divided the primary study area into several large pastures. No restriction of travel was observed. Adult sheep were seen jumping over fences with apparent ease, and all classes of sheep were seen either crawling under or through them.

Group Characteristics

Between 19 April 1977 and 10 August 1978, 257 groups of bighorns were recorded, accounting for 2612 observations of individual sheep. Groups ranged from 1 to 50. More than 60% of the groups contained between 2 and 10 individuals. Mean group size was 10.2.

From April through August mean monthly group size varied from 7.0 to 14.4. The largest groups were generally ewe/lamb or ewe/lamb/yearling groups observed during June while still on the lambing grounds. By late June sheep began dispersing, and were in smaller groups. The lowest group size, in May, reflected the tendency

of ewes to leave other sheep just before lambing and to stay separate until the lambs were several days old.

The largest mean group size by group type was 16.8 for ewe/lamb/yearling groups. Most groups of this type were observed in late June or early July and were often large. Two groups were composed of 43 sheep. Mixed groups were observed at all seasons. Ewes without lambs were often seen with 1- to 2-year-old rams. The mean size of ewe/lamb groups was 9.3; that of rams was 7.2; mixed groups averaged 14.1.

Horn Growth

The only ram horns measured were those of a 5½-year-old ram killed illegally during September 1979. That ram was a lamb when transplanted in 1975. He was almost a full curl at death, with a few inches of horn broomed off. His horns measured more than 90 cm in length on each side and were each approximately 38 cm in circumference.

Mortality

Mortality during the study was apparently low. No carcasses were found. One ewe was killed before the study began, 1 lamb apparently died during late June 1977, and a collared ewe seen in 1977 was not observed in 1978.

Though ewe/lamb ratios varied substantially, a complete count made in February and again in April 1978 indicated no lamb loss since the previous June.

In 1979, after the study, several deaths were reported. A collared ewe, at least 9 years old, was found dead in May. She had a deformed lower jaw and possibly starved to death. Several lambs and a yearling were found in July. No determination as to cause of death was possible because the carcasses were too old and scattered. A 5½-year-old ram was killed illegally during September.

DISCUSSION

Population Dynamics

Buechner (1960) derived an approximate maximum rate of increase for bighorn sheep of $r = 0.258$. He used the growth equation (Odum 1959), $N_t = N_o e^{rt}$, and a mathematically derived breeding potential table from Leopold (1933). The necessary biological assumptions were: (1) 1 lamb per ewe per year, (2) birth of first lamb when ewe is 3 years old, (3) a negligible number of ewes living beyond breeding age, (4) an equal ratio of ewes and lambs, and (5) no mortality.

Buechner discussed 3 populations that apparently approached or exceeded the theoretical maximum growth rate, r, or the breeding potential. One assumption he overlooked when calculating the rates of growth for these populations was that there must be a stable age distribution (Conley 1978). The calculation of a maximum intrinsic rate of increase, r_{max}, is inappropriate to use across a finite interval during which that rate changes (Metzgar, personal communication).

Many populations, when beginning with unstable age distributions

and/or unequal sex ratios, may exhibit temporarily high growth rates. Of the 3 examples Buechner discussed, the beginning age structures were unreported. The sex ratios were known in 2 cases, but apparently not in the third. In the Fort Peck Game Range herd, 3 times more ewes than lambs were introduced. Buechner did point out that the growth rate for the herd was high because of the greater proportion of ewes to rams and a higher natality rate than that of the model. The age distributions of the 3 populations considered were apparently not stable, at least during the beginning of the intervals considered. The comparisons to the theoretical biotic potential, r_{max}, were not appropriate.

Buechner's (1960) assumption that lambing by ewes first occurred at 3 years of age was based on the conclusions of most of the studies at that time. He cited some examples of lambing by 2-year-olds but concluded it occurred too infrequently to consider in the growth potential model. Geist (1971), studying stable sheep populations in Canada, found no evidence of breeding by yearlings but speculated that it may occur under ideal conditions. Wishart (1978) stated that both male and female bighorns were capable of breeding at 18 months of age but most did not do so.

Evidence is accumulating that indicates lambing by 2-year-old ewes may occur more frequently than once suspected. Woodgerd (1964) reported a high incidence of lambing by collared 2-year-olds. Brown (1974) found 1 positive and 1 probable case of 2-year-old ewes producing

lambs. Van Dyke (1978) speculated that ewe/lamb ratios approaching 100:100 indicated either twinning or breeding by yearling ewes. He felt both were occurring on his study area in Oregon.

During 1977, 8 of 10 2-year-old ewes on the Rock Creek study area had lambs. As this cohort was the only adult-appearing group without collars, there was no question about identification. The locations of all 10 ewes were known on several days. The determination of whether a specific ewe had a lamb was made after several hours of observation, during which close association and periodic suckling of the ewe by the lamb was considered as evidence that the ewe had a lamb. During 1978, 2- and 3-year-old ewes were difficult to differentiate. At least 8 of the 14 2- or 3-year-old ewes had lambs.

Further research will probably reveal that lambing by 2-year-old ewes is the rule rather than the exception for high quality populations living on good forage. A maximum rate of increase, using the formula $N_t = N_o e^{rt}$ and Leopold's (1933) breeding potential table for animals that have 1 young per year and bear first young at 2 years of age is: $r = 0.311$.

No twinning was verified during the study. Buechner (1960) and Geist (1971) both argued that twinning may be possible under very favorable conditions, but was probably rare enough to be ignored in calculating rates of growth.

Ewe/Lamb Ratios

Ewe/lamb ratios are often used to estimate lamb mortality (Ogren 1954, Woodgerd 1964, Morgan 1970, Frisina 1974, Klaver 1978). Most ratios are presumably calculated by totalling all ewes and lambs observed in a given period, regardless of repeated observations of the same individuals. Few researchers have specified whether they used groups with unclassified sheep in their classifications. For this method to be valid, several assumptions are made. These are: (1) an equal probability of seeing all ewes and lambs exists; (2) an equal probability exists of seeing ewes that have lambs and ewes that do not; and (3) an adequate sample size is observed during the specified time interval. Frequently, not all of these assumptions are met. Van Dyke (1978) discussed a number of potential problems in using ewe/lamb ratios as indicators of production and mortality.

Monthly ewe/lamb ratios estimated for the Rock Creek sheep during the study, using the total count method, fluctuated between 14 and 88 lambs per 100 ewes. Ratios consistently dropped both years from a high in June to lower ratios by August. The January low of 14 was followed by a ratio of 85 lambs per 100 ewes in April. Because of larger sample sizes during the months of June and July 1977 and April, May, June, and July of 1978, the ratios from these months were probably more indicative of the actual ratios.

Accurate estimates of the numbers of lambs and adult ewes were possible during June 1977 and 1978 using the best count method. June

ratios were estimated at 71 and 77 lambs per 100 ewes in 1977 and 1978, respectively. These compare favorably with the estimates for these months derived by the other method.

The steady decline in lambs per 100 ewes between June 1977 and January 1978 suggested a high lamb mortality. The high ratio in April 1978, and best counts of lambs, indicated otherwise. In June 1977, I estimated a population of approximately 74 sheep were on the study area, based on observations of collared ewes, best counts of lambs, yearlings, and 2-year-old ewes, and transplant data. On 1 day in January 1978, 76 sheep were observed. Many were not classified, so were not included in the January ewe/lamb ratio estimates. In April 1978, a large sample of ewes (n = 121) and lambs (n = 103) was used to calculate the ewe/lamb ratio. In addition, on 7 April 1978, 76 sheep were again observed, including 20 lambs of 1977. It is apparent that little or no mortality occurred between June 1977 and 1978. Declining ratios calculated using the total classified ewes and lambs per month method cannot be explained. Sample sizes were smaller, which may account for some discrepancies, though the decline appears too patterned. Whatever the reason for the apparent decline of ewe/lamb ratios, the April 1978 lamb count demonstrates the possible pitfalls of relying on ewe/lamb ratios alone, from limited numbers of samples, to infer lamb mortality rates.

Dispersal Upon Reintroduction

Geist (1971) stated that mountain sheep do not disperse to occupy nearby suitable habitat as some animals (moose, deer) do. If traditional migratory patterns are lost, substantial portions of a population's habitat may be lost. He commented that reintroduced sheep populations behave much like native, relict populations, remaining small in number and usually failing to spread far from the release site (Geist 1967). The sheep Geist (1971) studied exploited a mosaic of numerous small patches of habitat separated by extensive forests. In an article on sheep management (Geist 1977), he noted that the argument that the loss of older rams in a population exploiting patchy habitat would reduce the area exploited by the population, and thus their numbers, does "not apply to populations living in mountain ranges with very little forest or shrub cover and with long, continuous ridges. Here, sheep will surge and reoccupy habitat, even if the population is severely reduced." This statement should apply to reintroductions, or new transplants, into similar habitats.

After release, most Rock Creek sheep stayed within 2 km of the release site during the first 6 months. Some were reported more than 30 km from the release site during the year following release. Most ewes lambed near the release site the first year, within 2 km the second summer, and 3 km the following years. A small contingent established a lambing ground 17 km south of the release site by the second year and were using the area during the present study. The

rams were expanding their range annually, and by 1979, they appeared to be using patches of habitat separated by deep canyons and dense forest, something Geist (1967, 1971) stated they would not do.

Home Range and Standard Diameters

Calculation of home range and standard diameters was biased because ewes were not always observable. Some were rarely seen. Sheep using dense, timbered areas, remote ranges, and any area not visible from the road, were located infrequently. The use of radio-collared sheep was considered, but rejected because of adverse public response to the suggestion.

Home ranges calculated for the Rock Creek sheep included relocations from late winter, spring, lambing, and summer ranges.

Distance between centers of activity are comparable to those reported by Brown (1974) and less than those of Frisina (1974) and Klaver (1978), reflecting the contiguity of seasonal ranges for the Rock Creek ewes. Seasonal mean standard diameters are smaller than those reported by Brown (1974), Tilton (1977), and Klaver (1978).

Group Size

Average group size was larger than that reported by most studies. The steady decline in group size from midwinter to lambing, followed by large groups after lambing, then another decline until the rut reported by Klaver (1978) was duplicated by the present Rock Creek

sheep. Blood (1963) found groups were largest after lambing. Group size appears to be inversely related to the degree of mobility exhibited by the sheep, except during lambing. Ewes segregate themselves during lambing, so group size is low, but immediately after lambing they congregate in large, sedentary groups with their lambs.

Horn Growth

Horn growth has been used as an index to population quality. Geist (1971) and Klaver (1978) compared ram horn growth rates for stable or declining populations (low quality) and growing populations (high quality). They found pronounced differences.

Berwick (1968) reported that the original Rock Creek rams had exceptionally small and tight curls. He attributed that to lack of phosphorous (P), calcium (Ca), and other minerals, though he pointed out that horn size was larger shortly before the population crash. The horns of a 5½-year-old ram, poached in 1979, were measured. They compare favorably with horns from high quality populations discussed by Geist (1971) and Klaver (1978). The availability of minerals on the Rock Creek range has probably not changed since the mid-1960's. The forage quality and the genetics of the population have changed.

CONCLUSIONS

The reintroduced Rock Creek sheep exhibited rapidly maturing individuals, a high rate of lambing by 2-year-old ewes, a high natality

rate, low lamb mortality, and rams with large, rapidly growing horns. Geist (1971) described these as characterizing high quality sheep populations. The Rock Creek sheep were evidently a high quality population.

The present Rock Creek sheep have expanded their range annually. The rams completely left the winter range and the company of other sheep at least 7 months a year, reducing competition for forage. Ewe, yearling, and lamb movements were frequent and extensive. Reports of sheep well beyond the study area indicated more exploration and wandering than bighorns are generally credited with. The population had not behaved like relict sheep, remaining small in number and failing to spread far from the release site, as Geist (1967) had suggested.

The condition of much of the sheep range was poor in the mid to late 1960's (Berwick 1968). By the mid-1970's, range trend was up and condition was generally good to excellent (BLM range personnel and local residents). Since the late 1960's, mule deer numbers had declined substantially (Janson and Neal, personal communication), domestic sheep were removed, and cattle allotments were reduced and placed on a rest-rotation grazing system.

Geist (1971) stated "a high quality population would tend to perpetuate itself, or change to a low quality population only slowly. Conversely, a population of low quality females with a low death rate would cause low birth rate and low birth weight, and would lag or

perpetuate itself in the face of improving range conditions. Clearly, the same resource base could support sheep populations of different characteristics, composed of individuals of entirely different quality." The Rock Creek transplanted sheep were from the Sun River herd, the largest in Montana (Constan 1975). Other transplants from the Sun River herd were the Wildhorse Island (Woodgerd 1963), Thompson Falls (Brown 1974), and Anaconda (Hartkorn, personal communication) herds, all healthy, expanding populations that exhibited high natality and low lamb mortality rates after their introduction. The Sun River sheep population was characterized by large, vigorous sheep with high natality rates and rapid horn growth (Frisina 1974, McLucas personal communication); in all probability this is a high quality population.

The success of a transplant depends on several factors. Wishart (1975) recommended the following factors be considered before transplanting: (1) determination of the site as an ancestral range, (2) evaluation of competing land uses, (3) availability of desired forage species and land status, and (4) determination of optimum numbers of animals, age, sex, family composition.

If the establishment and growth of a high quality bighorn population indicate a successful transplant, the Rock Creek sheep transplant was a success. The site was an ancestral sheep range. Though potential conflicts with deer and livestock existed, efforts were made to minimize these through elimination of domestic sheep from the area, the establishment of a rest-rotation grazing system, and the

establishment of a USFS livestock exclosure. Human disturbance was minimized by establishing and enforcing a road closure and restricting hunting until the herd was well established. Forage quality had improved considerably since the die-off of the original sheep in the mid-1960's. An ample number of sheep (31) were transplanted, including a few medium-aged rams, several ram lambs, and 19 ewes between 1 and 4 years old. The transplant stock was from a high quality population with a reputation for producing successful transplants.

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QUESTIONS - RESPONSES

Tom Thorne: Tom, you mention the ewe that went 10 or 12 miles to this remote place to have her lamb and she re-did that 3 or 4 years in a row before she finally died. Did her lambs or any other sheep go with her?

Tom Butts: Yes, they did, that's right. In 1977 she had a 2 year old ewe with her, an uncollared ewe, which was perhaps her own; I have no way to prove it, from 1975. They both had lambs there. The next year, they went back and the following year there were more and more; plus, in 1978 there were some young rams going down there, it looked like she had start.....

Tom Thorne: And after she died they kept this up?

Tom Butts: Right.