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STATUS OF MOUNTAIN SHEEP IN MORGAN CREEK, EAST-CENTRAL IDAHO

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Abstract: Habitat relationships of the Morgan Creek mountain sheep (*Ovis canadensis*) population were observed in 1989 and 1990. The population increased from approximately 100 in 1970 to at least 278 in 1988, the highest level recorded. Rams used areas further from water and frequently-used roads than did ewes. Comparisons of areas subject to grazing by cattle along with a 1417 ha area excluded from livestock grazing show improved grass cover since 1973, with no differences between the excluded area and adjacent grazed areas. Blood chemistry data indicated this population to be in relatively poor condition in late winter. Live-trapping individuals for restoration to vacant habitat could be intensified as a means of recovering the vigor of this population.

Mountain sheep populations and the habitat in Morgan Creek, a tributary to the Salmon River in east-central Idaho, were the subject of a major controversy in the late 1960's between livestock and wildlife interests. Populations of sheep had declined from over 250 in 1963 to approximately 70 in 1970 (Morgan 1970). The resulting management activities included establishment of a rest-rotation grazing system for cattle using the area, closure of hunting, and a continuing population monitoring program by Idaho Department of Fish and Game. Subsequently, sheep populations increased and distributions were probably altered by the changed grazing pattern (Bodie and Hickey 1980). Objectives of this study were to determine sheep population size, distributions, and condition, and to assess vegetative composition and trend.

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STUDY AREA

The Morgan Creek sheep winter range lies approximately 21 km north of Challis, Idaho (Fig. 1). Elevations range from 1450 m at the mouth of Morgan Creek to 2700 m at the top of Red Butte. Soils are granitic and basaltic in origin, shallow and very rocky (Morgan 1970). Annual precipitation at Challis, Idaho, 40 km southeast of the winter range averaged 24 cm from 1968-90, mostly as snow, and averaged 17.5 cm for years 1988-89 (N.O.O.A. 1969-1990).

Sheep habitat is dominated by sagebrush communities. Wyoming big sagebrush (Artemesia tridentata wyomingensis) - bluebunch wheatgrass (Agropyron spicatum) (Arwy-Agsp)occurs on shallow soils at lower southerly aspects. A Wyoming big sagebrush-bluebunch wheatgrass-bluegrass (Poa sandbergii and P. fendleriana) (Arwy-Agsp-Poa) community occurs on more mesic sites on lower slopes and other aspects. A threetip sagebrush (A. tripartita) - Idaho fescue (Festuca idahoensis) (Artr2-Feid) community occurs on higher elevations on deeper soils. A threetip sagebrush-bluebunch wheatgrass (Artr2-Agsp) community occurs on slightly drier sites, and is found with big sagebrush and low sagebrush (A. arbuscula). A low sagebrush community is present on dry flat ridges with poorly developed soils. Cliffs were separated as a unique community and were comprised of mixtures of the above communities and plants representative of more mesic microsites where moisture and shade allowed their development.

In 1973, a 3 pasture rest-rotation grazing system was established in Morgan Creek. Additionally, approximately 1147 ha of primary sheep winter range were fenced to exclude livestock. Most of the Morgan Creek winter range is administered by the U.S. Bureau of Land Management with small portions of private land along creek bottoms, a few sections of state-owned land, and some in the Challis National Forest.

METHODS

Sheep were captured using a helicopter and a net-gun (Jessup et al. 1988). Seasonal distributions of radio-collared sheep were determined from 11 rams and 9 ewes in 1988 and 1989 using ground and aerial search. Each sheep relocation was recorded by Universal Transverse Mercator (UTM), slope, aspect, elevation, group size, and sex/age class throughout winter, spring, and summer of 1989 and 1990. In March 1988 and April 1990, aerial censuses of the winter range made with a Hiller 12E helicopter. Sheep were classified according to sex and age class following Geist (1968). Mean ram:ewe and lamb:ewe ratios and variances were estimated using each group as an observation. Relocations of radio-marked sheep were plotted on a USGS topographic map and distances to water sources and roads were recorded.

Vehicle use of roads on the winter range was monitored daily from January through April, after which roads became too dry and hard for vehicle tracks to be observed. Vehicle traffic was classified as high (>1 time per day) or low (<5 times during Jan through Apr). Fifty random locations were also plotted to determine random distances from roads and water.

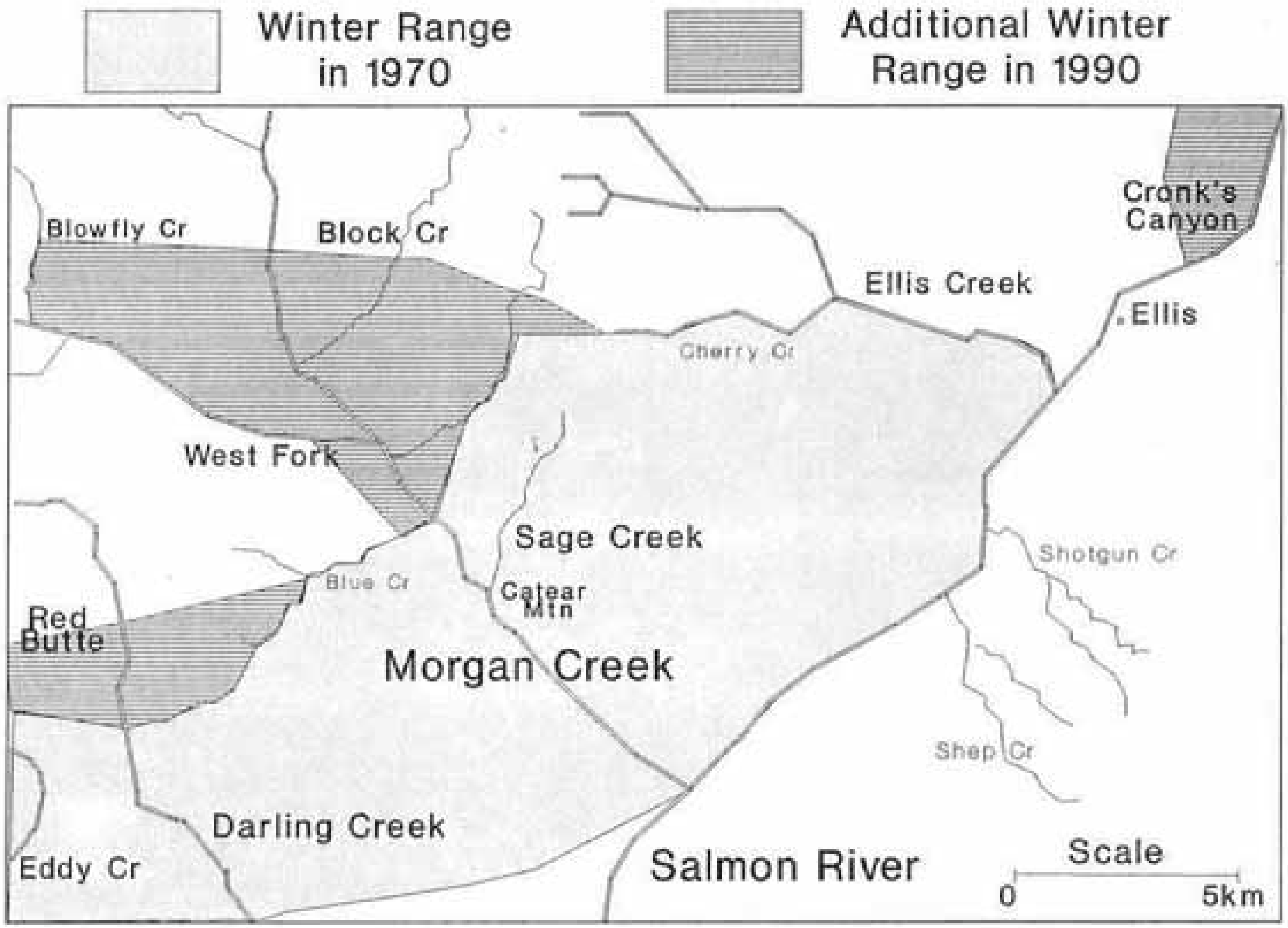

Fig. 1. Morgan Creek bighorn sheep winter range, showing the expansion of area occupied from 1970 to 1989-1990.

Multivariate analysis of variance (MANOVA) was used to test for differences between sheep relocation distances and random distances to water and roads, and least squares means were used to determine where differences existed. A chi-square test was used to test for differences in use of cover types between males and females. Cover types used less than 5 times were dropped from the analysis. After the chi-square indicated overall significance, 90% confidence intervals were constructed to determine where differences existed (Marcum and Loftsgaarden 1980).

Clusters of permanent vegetation transects established by Morgan (1970) were reanalyzed using his techniques. Three transects per cluster were laid in a straight line following the contour of the slope. Three clusters of 3 transects each were analyzed. The cluster sites were Catear Mountain (Cluster 5), Mud Springs Gulch (Cluster 7), and Spring Gulch (Cluster 9). Each transect consisted of 20, 2X5dm plots to determine canopy coverage of all plant species, and percent of bare soil, rock, litter, and moss and lichen at ground level. In addition, the 4 corners of each plot (leg point hits) were recorded as hitting bare soil, rock, litter, moss and lichen, or vegetation. For 1977, cluster 7 data and leg point hit data for all clusters were missing. For 1986 only 19 plots per transect were recorded. MANOVAS tested the null hypothesis that winter range plant species composition was similar among 1968, 1977, 1986, and 1990.

Ten to 40 ml of blood were taken from each sheep trapped in the winter of 1989, centrifuged, and protected from freezing and extreme heat. Levels of blood urea nitrogen (BUN), calcium, phosphorous, and magnesium were determined at the Washington State University Clinical Diagnostic Laboratory in Pullman, Washington. BUN, magnesium, phosphorus, and calcium levels were compared with those from bighorn sheep in the Poudre River area in Colorado (Davies 1976) and to values established as normal in winter for bighorn sheep from Canada, Montana, Wyoming, and Washington by Franzmann (1971a). T-tests were used to compare the data (Sokal and Rohlf 1973).

RESULTS

Numbers

Two hundred and seventy eight sheep were counted in March 1988, including 36 class IV rams, 23 class III rams, 27 class II rams, 5 class I rams, 156 ewes, and 31 lambs. Overall ram:ewe ratio was 58:100 (variance = 0.056) and overall lamb:ewe ratio was 20:100 (variance = 0.003). In April 1990, flights over the winter range recorded 130 sheep, including 13 class IV rams, 12 class III rams, 18 class II rams, 9 class I rams, 66 ewes and 12 lambs. Overall ram:ewe ratio was 82:100 (variance = 0.135) and overall lamb:ewe ratio was 15:100 (variance = 0.004). No significant differences occurred in the ram:ewe ratio or the lamb:ewe ratio from 1988 to 1990 ($\underline{P}$ = .2236 and $\underline{P}$ = .2004, respectively).

Distribution

Relocations totalled 222 in 1989 and 364 in 1990. Most collared ewes wintered in lower Morgan Creek, primarily in the Catear Mountain and Mud Springs Gulch area; a few wintered in Darling Creek (Fig. 1). Rams generally used higher elevations and different areas than ewes.

The mean distance between winter and summer ranges was 37.03 km (SD = 81.02, n = 90). Ewes averaged 24.2 km (SD = 12.6, n = 51) to summer range, while rams averaged 53.8 km (SD = 120.2, n = 39). Movements to summer range began in mid-May each year and continued through June. Some ewes returned to winter range in early August.

Habitat use

Cover type use was significantly different (P < 0.0005) between rams and ewes. The ARWY-AGSP and CONIFER cover types were used more frequently by rams, whereas the ARWY-AGSP-POA and ARAR cover types were used more frequently by ewes (P < 0.01). Both sexes used CLIFF and ARTR2-FEID types similarly.

Rams stayed further from water and high-use roads than ewes. Distance to water and high-use roads was significantly greater for random sites than for sheep relocations (P < 0.05) (Table 1), but there was no significant difference in distance to low-use roads between random sites and sheep relocations. Ewe relocation distances were significantly less than random location distances from both water and high-use roads, but ram relocation distances were significantly less than random distances from high-use roads only.

Vegetation trend

Significant changes in canopy coverage of 9 common species occurred on the permanent transects (Table 2). Wyoming big sagebrush cover remained stable over the 22 year period on both Catear Mountain and Mud Springs Gulch. Low sagebrush increased on Catear Mountain (P = 0.0001), and shadscale did not change on Spring Gulch. Bluebunch wheatgrass increased on Catear Mountain (P = 0.0001), and increased from 1968 to 1986 then declined in 1990 on Mud Springs Gulch (P = 0.0001). Wildrye showed an increasing trend through 1986 and declined from 1986 to 1990 at Spring Gulch, but the changes were not significant. Indian ricegrass slowly increased at Spring Gulch (P = 0.0093). The bluegrasses remained stable on Mud Springs Gulch, and showed an initial decrease in 1977 (P = 0.0033), then increased to 1986 at Catear Mountain (P = 0.0405). Forbs, including lava aster (*Aster scopulorum*), phlox (*Phlox* spp.), rock cress (*Arabis hoelbelli*), and stonecrop (*Sedum lanceolatum*), generally increased from 1968 to 1986 and declined from 1986 to 1990, reflecting the drought. Additionally, mean canopy coverage on all 3 sites of 13 common species is shown for each year of the long term study. Canopy cover of vegetation appeared to increase with increasing precipitation, and decrease with drought. However, because only 4 estimates of canopy cover were made, no statistical analysis was done. Litter generally increased on all three sites over the 22 year period. Mosses and lichens fluctuated, while vegetation increased at Mud Springs Gulch and Spring Gulch, and was stable at Catear Mountain.

Table 1. Proportion of relocations of radio-collared mountain sheep within cover types and proportional availability of these cover types on the Morgan Creek winter range. Least squares means of distances to water and roads for both sheep locations and random sites.

Cover Type	Availability	Rams	Ewes	All Sheep
ARWY-AGSP	0.10a[a]	0.11a	0.06b	0.07a
ARWY-AGSP-POA	0.27a	0.21a	0.28a	0.26a
ARTR2-FEID	0.15a	0.09a	0.06b	0.07b
ARTR2-AGSP	0.01a	0.02a	0.00a	<0.01a
ARTRTR	0.01a	0.00a	<0.01a	<0.01a
CLIFF	0.19a	0.46b	0.45b	0.46b
CONIFER	0.11a	0.09a	0.02b	0.04b
ARAR	0.03a	0.00a	0.11b	0.08b
SHADSCALE	0.06a	0.02b	0.01b	0.01b
RIPARIAN	0.06a	0.01b	0.01b	0.01b
_n_	-	126	320	446
Distances(meters):				
Water:				
LSMean	728.17a	658.41a	469.41b	525.36b
SD	402.63	398.65	398.64	406.58
High use roads:				
LSMean	3041.39a	2165.48b	852.67b	1241.33b
SD	1431.75	1417.40	1417.37	1526.61
Low use roads:				
LSMean	952.47a	853.71a	849.38a	850.66a
SD	532.52	527.15	527.10	526.59
_n_	50	135	321	456

[a]Same letter denotes no significant difference from availability at $P < 0.05$; Comparisons were made between availability and ram locations, availability and ewe locations, and availability and total sheep locations.

Table 2. Mean and standard deviation (SD) of vegetal canopy cover from permanent transects (Morgan 1970) on the Morgan Creek mountain sheep winter range, east-central Idaho.

	1968[a]			1977		1986			1990		
	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch
Agropyron spicatum											
Mean	1.92	6.27	0.00	8.83	0.00	15.92	15.35	0.00	15.79	9.08	0.00
SD	4.13	7.53	-	8.93	-	13.70	14.57	-	12.58	12.59	-
Poa spp.											
Mean	5.71	0.17	0.00	2.75	0.00	4.96	0.18	0.00	4.75	0.54	0.00
SD	5.68	0.63	-	2.38	-	5.27	0.64	-	5.22	2.06	-
Artemisia tridentata wyomingensis											
Mean	4.38	14.19	0.00	3.42	0.00	5.18	16.93	0.00	4.25	16.08	0.00
SD	11.74	24.82	-	14.19	-	15.00	27.83	-	13.99	26.69	-
Artemisia arbuscula											
Mean	0.00	0.00	0.00	6.62	0.00	10.48	0.00	0.00	8.88	0.00	0.00
SD	-	-	-	11.72	-	17.64	-	-	14.25	-	-
Atriplex spp.											
Mean	0.00	0.00	1.67	0.00	2.75	0.00	0.00	5.00	0.00	0.00	3.88
SD	-	-	5.76	-	7.73	-	-	15.48	-	-	11.03

(Table 2 continued)

	1968[a]			1977		1986			1990		
	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch
Phlox longifolia											
Mean	1.88	0.00	0.00	3.12	0.00	4.74	0.00	0.00	0.75	0.00	0.00
SD	1.09	-	-	5.76	-	7.73	-	-	15.48	-	-
Phlox muscoides											
Mean	3.29	0.00	0.00	9.96	0.00	6.58	0.00	0.00	4.00	0.00	0.00
SD	4.05	-	-	12.38	-	7.94	-	-	5.66	-	-
Penstemon spp.											
Mean	0.04	0.00	0.04	0.33	0.12	0.39	0.00	0.75	0.38	0.00	0.04
SD	0.32	-	0.32	0.86	0.55	0.92	-	2.16	0.90	-	0.32
Sedum spp.											
Mean	0.67	0.00	0.00	0.54	0.00	1.01	0.00	0.00	0.17	0.00	0.00
SD	1.11	-	-	1.04	-	1.24	-	-	0.63	-	-
Aster scopulorum											
Mean	0.00	0.00	0.00	0.62	0.00	0.92	0.00	0.00	0.38	0.00	0.00
SD	-	-	-	1.09	-	2.20	-	-	0.90	-	-

(Table 2 continued)

	1968[a]			1977		1986			1990		
	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch
<u>Arabis</u> spp.											
Mean	0.00	0.38	0.08	0.00	0.00	0.00	1.93	0.13	0.17	0.04	0.00
SD	-	0.91	0.45	-	-	-	2.11	0.56	0.63	0.32	-
<u>Elymus ambiguus</u>											
Mean	0.00	0.00	5.50	0.00	8.17	0.00	0.00	6.49	0.33	0.29	6.75
SD	-	-	10.95	-	13.60	-	-	10.53	0.86	1.96	10.37
<u>Oryzopsis hymenoides</u>											
Mean	0.00	0.00	0.25	0.00	1.42	0.00	0.70	3.33	0.00	0.33	3.58
SD	-	-	0.76	-	5.49	-	4.97	8.01	-	1.98	10.81
Bare soil											
Mean	9.29	7.63	32.46	-	-	17.72	21.18	25.66	23.71	14.88	18.79
SD	10.81	9.29	34.36	-	-	15.25	21.80	26.07	16.96	12.62	16.05
Rock											
Mean	6.42	27.08	0.00	-	-	14.12	45.79	55.83	16.88	44.42	19.42
SD	7.34	23.24	-	-	-	11.29	27.48	27.47	11.88	24.14	17.94

(Table 2 continued)

	1968[a]			1977		1986			1990		
	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch	Catear Mtn	Mud Springs	Spring Gulch
Litter											
Mean	0.58	4.07	2.92	-	-	18.64	16.23	4.30	41.21	25.38	13.71
SD	2.08	6.73	7.27	-	-	16.01	13.90	5.38	21.43	18.80	13.56
Moss & lichen											
Mean	0.54	0.00	0.00	-	-	0.39	0.00	0.00	2.46	3.88	0.08
SD	1.04	-	-	-	-	2.05	-	-	3.10	6.25	0.45

[a]1968: clusters 5 and 9 n = 60, cluster 7 n = 59; 1977: clusters 5 and 9 n = 60, cluster 7 data missing; 1986: clusters 5, 7, and 9 n = 57; 1990: clusters 5, 7 and 9 n = 60.

BUN and calcium levels for Morgan Creek sheep were significantly lower than for Poudre River sheep, but phosphorous was not (Table 3). Normal BUN levels (Franzmann 1971a) were greater than levels for Morgan Creek sheep, while levels of calcium, phosphorus, and magnesium in Morgan Creek sheep were greater.

DISCUSSION

The area used as winter range by sheep has increased since 1970 (Morgan 1970) (Fig. 1) probably reflecting a doubling of population size. Movements to and use of summer range were similar to those reported by Morgan (1970), as was mean distance between winter and summer ranges.

The population survey in 1988 was more reliable than in 1990. Deep snows in 1988 concentrated animals on windswept slopes, and no sign was noted in timber. In 1990, very little snow cover occurred, sheep were widely dispersed, and often seen in timber. Signals from several radio-collared animals were heard, but the sheep were not seen in 1990, suggesting that significant numbers of sheep were not counted. Assuming that no sheep were counted more than once, the 1988 total count of 278 sheep is the highest population number ever recorded on the Morgan Creek winter range.

Rams appeared to select only cliff habitats, while ewes selected lower elevation, cliff areas. Geist and Petocz (1977) found that rams preferred open slopes and ewes preferred cliffs.

The main water sources, Morgan Creek and Salmon River, occur adjacent to high-use roads and major cliff areas, so the corresponding use of areas closer to high-use roads may reflect this. MacArthur et al. (1982) found that reactions by sheep to road traffic were minimal. However, the sheep population studied was partially habituated to humans due to recreational activities in the area, and the authors predicted a greater reaction by sheep in less habituated populations such as the Morgan Creek population.

The differences in distance to high-use roads and water sources and in use of cover types between the sexes were not necessarily due to differences in habitat selection. Geist and Petocz (1977) and Shank (1982) found that although both sexes occupy contiguous range, they were concentrated in different areas on that range. Reasons for these differences in spatial use of the range are poorly understood. Geist and Petocz (1977) theorized that rams minimize competition with females and their prospective offspring by segregating spatially and by using different habitat, thereby maximizing their own reproductive fitness. Shannon et al. (1975) found that mountain sheep distribution was only loosely coupled to environmental cues with most of the variation related either to random search or to "occupational" patterns that were strongly shaped by tradition. Environmental variables not yet identified may be important to sheep in determining habitat use.

The greater amount of total canopy cover for cluster 5 in 1986 than all other years may reflect the continuing improvement of the

Table 3. Mean, standard deviation (SD), and sample size (n) of blood chemistry values (mg/100ml) of mountain sheep in Morgan Creek, east-central Idaho and comparisons of these values to other studies.

	Morgan Creek[a]			Poudre River			Franzmann			T-test P values	
	mean	SD	n	mean	SD	n	mean	SD	n	89-PR[c]	89-F
BUN[b]	10.49	3.21	43	13.98	2.89	24	23.50	8.30	65	<0.001	<0.001
Ca	9.80	0.87	21	11.49	1.22	24	8.80	1.69	65	<0.001	0.013
P	6.22	1.28	21	5.85	1.47	24	4.00	1.29	65	0.398	<0.001
Mg	3.12	0.37	21	-	-	-	1.70	1.21	65	-	<0.001

[a]Morgan Creek data collected Dec. 1988-Feb. 1989; Poudre River, Wyoming data collected January, 1975 (Davies 1976); Franzmann data compiled from herds in Wyoming, Montana, and Canada in winter, 1969-1970 (Franzmann 1971a)

[b]BUN = blood urea nitrogen; Ca = calcium; P = phosphorus; Mg = magnesium

[c]89-PR = comparison between Morgan Creek sheep in 1989 and Poudre River herd in 1975; 89-F = between Morgan Creek sheep in 1989 and Franzmann (1971a)

Morgan Creek winter range through the years. The fact that Catear Mountain had less overall canopy cover in 1990 than in 1986 may be attributable to the severe drought that has occurred for the past several years in this area. Generally, there was greater canopy cover and leg point hits of litter in 1990 than other years. Although there were no differences in leg point hits on vegetation between years, the greater amount of litter in 1990 may reflect the greater vegetation availability due to increasing quality of the range, but earlier seasonal senescence of plants due to several years of drought.

Relative changes in canopy cover over the 22-year period were compared for the permanent transects. Cover of Wyoming big sagebrush, the dominant shrub on Catear Mountain (within the exclosure) and at Mud Springs Gulch (grazed), remained stable over the 22-year period. Cover of shadscale, the dominant shrub at Spring Gulch (grazed), also did not change. It appears that the rest-rotation grazing system in this area generally did not affect shrub cover. Bluebunch wheatgrass, the dominant grass species at Catear Mountain and Mud Springs Gulch, increased through time at both places, but decreased with drought only in the grazing system. This may reflect an interaction between drought and grazing effects on this species. It must be noted that these transects were located in different cover types and differences between the sites themselves may explain differences in relative changes over the years. Canopy coverage of bluegrasses remained relatively stable over the 22-year period through both wet and dry years.

These general increases in canopy cover of forage species, especially bluebunch wheatgrass, over the last 22 years provided more forage for sheep. Dissipation of the drought would improve production and possibly foster a continuation of the observed trends in plant composition, until some equilibrium is again reached. Similar changes following establishment of a rest-rotation grazing system in a nearby drainage were documented by Yeo et al. (1990), suggesting that these systems are an appropriate means to improve grass cover on mountain rangeland in east-central Idaho.

Franzmann (1971b) found that differences in quality of forage intake most affected BUN levels, while magnesium, calcium, and phosphorus did not seem to change with either forage quality or excitability. Protein intake is significantly related to BUN levels (Seal et al. 1978, Lewis 1957). However, since protein anabolism may change to protein catabolism during mid-winter to early spring (Hebert 1978), BUN samples taken during this period may or may not be a reflection of forage quality at this time. The relationship between time of year and protein metabolism is highly variable.

Although calcium, phosphorus, and magnesium levels for the Morgan Creek sheep in 1989 are within normal limits (M. R. Dunbar, Cascade, Id., pers. commun.), this could be due to elevated serum levels from depletion of bone reserves. Hebert (1978) stated that previous superior nutrition can maintain a sheep's nutritional status while it is feeding on low-quality winter forage. However, the prolonged drought may indicate the greater amount of calcium, phosphorus, and magnesium, but lower BUN levels in Morgan Creek sheep in 1989 than in sheep sampled by

Franzmann in 1971 is due to body protein catabolism and bone reserve depletions by the sheep because of low quality forage rather than to previous superior nutrition on the fall range. This may explain the overall poor body condition of the herd and the likelihood of poor quality forage at that time period.

No estimation of body condition was given for the Poudre River herd, so we don't know if this herd was catabolizing body protein or depleting bone reserves of calcium and phosphorus. Perhaps they were in better condition than the Morgan Creek sheep in 1989, however, because of high hemoglobin and packed cell volume values of the Poudre River herd (Coles 1967, Franzmann 1971b) in addition to its higher levels of BUN and calcium than the Morgan Creek herd (Davies 1976).

Fecal nitrogen can be used to indicate whether an animal is above or below the protein maintenance level (Hebert 1978). The Morgan Creek herd in 1989 had only 1.26% fecal dry matter nitrogen and body condition was poor in January-February, so it was likely catabolizing body protein. We recommend future studies of nutritional status of sheep determine both blood urea nitrogen and fecal nitrogen levels to better understand herd condition.

The count of 278 sheep in 1988 is the highest number ever recorded on the Morgan Creek winter range. However, the sheep are also in poor body condition and incidence of lungworms is higher than normal (Ballard 1991). Adequate protein appears to be lacking in the diet. It is unlikely that these sheep are limited by the available forage because forage utilizations does not appear to be high. Poor forage quality and early senescence of grasses due to extended drought may be a factor. Signs of pneumonia were evident in this population during the trapping in January and February. This was not surprising due to the very high lungworm loads, and the stress on these animals from poor winter forage quality (due to extended drought), and from being chased by a helicopter during this stressful time period. Overall, the Morgan Creek sheep appear to be in relatively poor body condition in mid to late winter.

LITERATURE CITED

Ballard, G. L. 1991. Habitat relationships and physiological condition of mountain sheep in Morgan Creek, east-central Idaho. M.S. Thesis, Univ. of Idaho, Moscow. 114pp.

Bodie, W. L., and W. O. Hickey. 1980. Response of bighorns to a rest-rotation grazing plan in central Idaho. Bienn. Symp. North. Wild Sheep and Goat Counc. 2:60-69.

Coles, E. H. 1967. Veterinary Clinical Pathology. W.B. Saunders, Philadelphia, Pa. 455pp.

Davies, R. B. 1976. Blood and serum chemistry values of a Poudre River Bighorn sheep herd. Pages 9-13 in E. T. Thorne, ed. Proc. Bienn. Symp. North. Wild Sheep Counc. Wyoming Game and Fish Dep. Cheyenne.

Franzmann, A. W. 1971a. Comparative physiologic values in captive and wild bighorn sheep. J. Wildl. Dis. 7:105-108.

_____. 1971b. Physiologic values of bighorn sheep. Ph.D. Thesis. Univ. of Idaho, Moscow. 30pp.

Geist, V. 1968. On delayed social and physical maturation in mountain sheep. Can. J. Zool. 46:899-904.

_____. and R.G. Petocz. 1977. Bighorn sheep in winter: do rams maximize reproductive fitness by spatial and habitat segregation from ewes? Can. J. Zool. 55:1802-1810.

Hebert, D. 1978. Blood chemistry as an indicator of nutritional condition in bighorn sheep. Bienn. Symp. North. Wild Sheep and Goat Counc. 1:365-387.

Jessup, D. A., R. K. Clark, R. A. Weaver, and M. D. Kock. 1988. The safety and cost-effectiveness of net-gun capture of desert bighorn sheep (Ovis canadensis nelsoni). J. Zool. Anim. Med. 19:208-213.

Lewis, D. 1957. Blood-urea concentration in relation to protein utilization in the ruminant. J. Agric. Sci. 48: 438-446.

MacArthur, R. A., V. Geist, and R. H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. J. Wildl. Manage. 46:351-358.

Marcum, C. L. and D. O. Loftsgaarden. 1980. A nonmapping technique for studying habitat preferences. J. Wildl. Manage. 44:963-968.

Morgan, J. K. 1970. Rocky Mountain bighorn sheep investigations. Idaho Fish and Game Dep., Boise. Proj. W-142-R-1. 155pp.

National Oceanic and Atmospheric Administration. 1969-1990. Climatological Data Annual Summary: Idaho. U.S. Dep. Commer. Vol. 72-93. No. 13.

Seal, U. S., L. J. Verme, and J. J. Ozoga. 1978. Dietary protein and energy effects on deer fawn metabolic patterns. J. Wildl. Manage. 42:776-790.

Shank, C. C. 1982. Age-sex differences in the diets of wintering Rocky Mountain bighorn sheep. Ecology 63:627-633.

Shannon, N. H., R. J. Hudson, V. C. Brink, and W. D. Kitts. 1975. Determinants of spatial distribution of Rocky Mountain bighorn sheep. J. Wildl. Manage. 39:387-401.

Sokal, R. R., and F. J. Rohlf. 1973. Introduction to Biostatistics. W.H. Freeman and Co., San Francisco, Calif., 368pp.

Yeo, J. J., W. T. Wittinger, and J. M. Peek. 1990. Vegetation changes on a rest-rotation grazing system. Rangelands 12:220-225.