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BIG GAME-LIVESTOCK RELATIONSHIPS ON THE BIGHORN SHEEP WINTER RANGE EAST FORK SALMON RIVER IDAHO

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ABSTRACT

An historical record, description of habitat, and outline of winter range use patterns and relationships of bighorn sheep to mule deer and livestock are presented for the East Fork Salmon River, Idaho. Bighorn sheep have undergone two major fluctuations since 1920, with a high in the early 1930s, lows in early 1940s and high again in the early 1950s. The population in winter 1974-1975 was estimated at a minimum of 46 individuals. Three vegetation types and one phase in which big sagebrush dominated were delineated on the bighorn sheep winter range: a Wyoming big sagebrush/bluebunch wheatgrass community, with a Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase, a mountain big sagebrush/bluebunch wheatgrass community, and a Douglas-fir/mountain big sagebrush community. A distinct preference for use of the Wyoming big sagebrush/bluebunch wheatgrass community by bighorn existed during December 1974 through May 1975, and by mule deer from February through June 1975. Mule deer also used riparian and agricultural habitats extensively in late March through June. Competition among bighorn sheep, mule deer, and cattle appeared to exist for bluebunch wheatgrass on the Wyoming big sagebrush/bluebunch wheatgrass plant community, based on assessment of food habits, plant utilization, and range use overlap. Improvement of the current range situation to enhance the bighorn sheep population could be accomplished through modification of current grazing practices and either artificial revegetation of specific sites where grasses are lacking or controlled burning of specific sites where grasses are more prevalent. Such vegetation manipulation should both enhance range condition and promote increased use by bighorn sheep.

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INTRODUCTION

Historical records indicate Rocky Mountain bighorn sheep *Ovis canadensis canadensis* Shaw were abundant in east-central Idaho at the time of initial settlement (Smith 1954). Major declines have occurred until today bighorn sheep are found only in small scattered populations. Maintenance and/or restoration of historic and existing bighorn sheep winter range is a major goal on national resource lands bordering the East Fork of the Salmon River. The bighorn sheep herd that winters there is one of the few populations left in east-central Idaho. These bighorn sheep migrate about 27 km (17 miles) east of the winter range to summer on the Sawtooth National Recreation Area administered by the U.S. Forest Service (Morgan 1970).

Data on habitat characteristics of the winter range and interspecific relations among grazing animals on the winter range are clearly needed to accomplish the management goal. This report covers an investigation conducted from August 1974 to June 1975 designed to provide the data needed for a management plan.

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Methods used in the vegetation sampling were modified after those developed by D. Asherin, J. Claar, and J. Lauer.

STUDY AREA

Location

The study area was located along the East Fork of the Salmon River in east-central Idaho (Fig. 1). We divided the area into two sections, for habitat analysis, to include present and historic bighorn sheep winter range. Specific boundaries of present winter range were taken from Morgan (1970). The historic range included all land administered by the Bureau of Land Management on the East Fork of the Salmon River above Fox Creek. The present winter range contains approximately 8,582 ha (21,207 acres), or 86 km^2 (33 square miles), while the historic winter range further south and east of the East Fork contained an additional 5,443 ha (13,450 acres), or 54 km^2 (21 square miles).

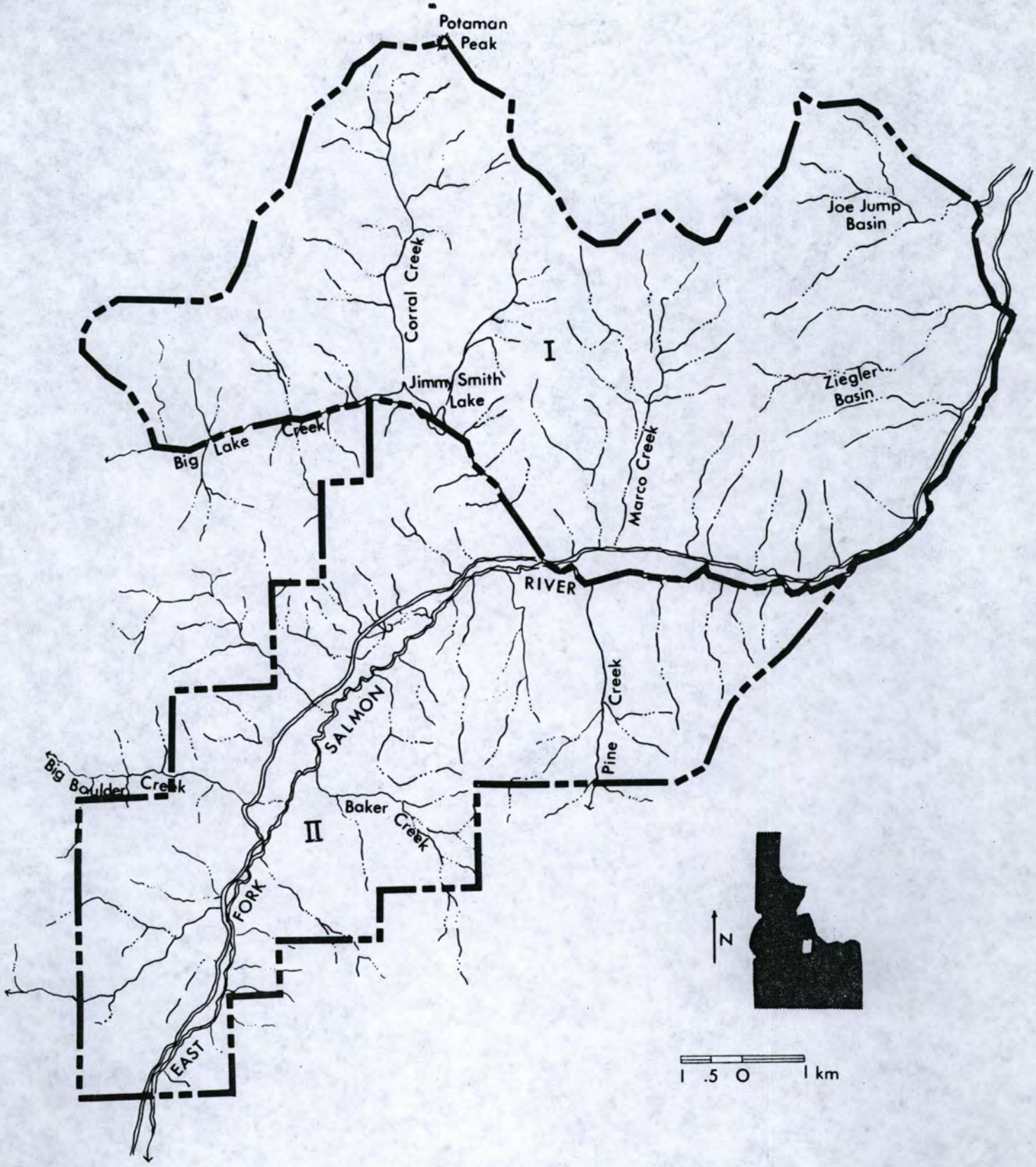

Fig. 1. The East Fork Salmon River study area. I. Present bighorn sheep winter range. II. Historic bighorn sheep winter range not currently occupied.

Land Ownership

Land within the study area is both publicly and privately owned. The public land is administered by the Bureau of Land Management, U.S. Forest Service, and Idaho Department of Public Lands. Primary use of the land has been and continues to be livestock grazing.

Physical Characteristics

The study area is mountainous with elevations ranging from 1,744 m (5,720 ft) to over 2,438 m (8,000 ft). The primary land group based on geomorphic history and geologic character is the Challis Volcanics. These rocks are of Tertiary age and are composed chiefly of andesite flows and flow breccias (Ross and Savage 1967).

The study area lies east of the moutain mass of central Idaho, in a rain shadow. At Challis, approximately 34 km (21 miles) north of the study area, the mean annual temperature is 7°C (44°F) and the annual precipitation is 18 cm (7.1 inch) (Ross and Savage 1967). Much of the precipitation occurs as rain in May and June. Snowpack depths are rarely over 15 cm (6 inch) at lower elevations, but exceed 61 cm (24 inch) at higher elevations.

METHODS

Vegetation Analyses

Study sites were selected in representative areas of plant communities. At each study site, a 15.2x15.2-m (50x50 ft) macroplot was located and staked containing two 15.2-m transects. The reference corner was located using a table of random numbers, any azimuth within 360° and a specified distance between 0.3 m (1 ft) and 3.0 m (10 ft). Along each 15.2-m transect, 10 20x50-cm (7.9x19.7-inch) microplots were systematically located. Microplot placements were at 0.3-m (1-ft), 1.5-m (5-ft), 3.0-m (10-ft), 4.6-m (15-ft), 6.1-m (20-ft), 7.6-m (25-ft), 9.1-m (30-ft), 10.7-m (35-ft), 12.2-m (40-ft), and 13.7-m (45-ft) marks on the tape. Data were collected from 20 microplots per study site.

A species list of all plants about the macroplot was developed according to life form: (1) grasses, (2)grass-likes, (3) forbs, (4) shrubs, and (5) trees. Microplot corner-point hits were recorded for the following ground coverage categories: (1) live vegetation, (2) litter, (3) rock (7.6 cm [3 inch] diameter or greater), (4) erosion pavement (gravel material less than 7.6 cm diameter), and (5)bare ground. Basal coverage for each grass, grasslike, and forb species rooted within each microplot frame was estimated to the nearest whole percent. Canopy coverage for each low-growing shrub rooted within or adjacent to the micro-plot frame was also estimated to nearest whole percent. Frequency of occurrence of each species within the 20 microplots was also obtained.

Line intercept data for tall-growing shrubs and/or trees were recorded for each species intercepted by the tape to the nearest 0.03 m (0.1 ft). Measurements were taken as vertical projections of the outline of undisturbed foliage with interspace included. By dividing the 15.2-m transect into 1.5-m segments, a frequency-of-contact value was obtained as a measure of species distribution.

Density of shrubs and trees was obtained from counts of plants in 10 systematically spaced 9.2-m^2 (100-ft^2) circular plots per site. Plot centers were located every 3.7 m (12 ft) along the two 15.2-m transects.

Current annual growth of the grass-sedge, forb, and shrub vegetation classes were obtained by clipping 5 20x50-cm plots spaced at 3.1-m intervals along the 15.2-m transect. All forage samples were oven-dried at 70°C for 24 hours before weighing.

The vegetation classification was based on species with a frequency of occurrence of 10 percent or more of plots sampled on each site, or 5 percent or more if they occurred on more than one site. Presence-absence data have proven adequate for phytosociological work (Williams et al. 1969).

Scientific plant names follow Hitchcock and Cronquist (1973).

Population and Range Use Analyses

Characteristics of bighorn sheep, mule deer, and cattle populations, and use on the present bighorn sheep winter range were determined by ground and aerial observations from 15 August 1974 through 30 June 1975. Ground surveys were the primary observation method, with nine aerial surveys supplementing the ground surveys. The study area was systematically traveled or retraveled each week, along a predetermined route.

Observations were recorded according to time, location, occurrence by plant community, exposure, percent slope, slope position, and snow depth. Bighorn sheep and mule deer were classified according to sex and age whenever possible. Animals were considered one group if observed within 90 m (300 ft) of each other. A gridded map of the study area was used to record locations to the nearest 0.8km (0.5 mile). Aspect and percent slope were estimated directly from topographic maps. Slope position was recorded as ridgetop, top third slope, middle third slope, bottom third slope, narrow canyon bottom, or wide canyon bottom. Snow depths were estimated from stakes checked at weekly intervals.

Food Habits Analyses

Food habits were determined by recording frequencies of use of each species at feeding sites following Cole (1956) and Knowlton (1960). Use of a culm of grass, leaf

Table 1. Association table based on presence and absence of major species on bighorn winter range.

Species	Areas with *Artemisia tridentata wyomingensis*																	
	Artemisia tridentata wyomingensis-Agropyron spicatum community																	
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
Agropyron spicatum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Festuca idahoensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oryzopsis hymenoides	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Poa sandbergii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sitanion hystrix	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stipa thuberiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antennaria microphylla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster scopulorum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Astragalus spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Castilleja spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepis acuminata	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriogonum umbellatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haplopappus acaulis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lupinus spp.	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-
Penstemon spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artemisia tridentata wyomingensis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Artemisia tridentata vaseyana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysothamnus viscidiflorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron filifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriogonum caespitosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriogonum microthecum	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-
Leptodactylon pungens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phlox spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phlox hoodii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phlox longifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purshia tridentata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudotsuga menziesii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mosses and lichens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1. Continued.

Species	Areas with *Artemisia tridentata wyomingensis*											Areas with *Artemisia tridentata vaseyana*							
	Artemisia tridentata wyomingensis-Agropyron spicatum-Poa sandbergii community											*Artemisia tridentata vaseyana-Agropyron spicatum* community					*Pseudotsuga menziesii-Artemisia tridentata vaseyana* community		
	1	19	22	23	24	25	29	33	36	37	21	26	27	28	34	35	30	31	32
Agropyron spicatum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Festuca idahoensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oryzopsis hymenoides	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	+	+	+	+
Poa sandbergii	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-
Sitanion hystrix	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stipa thuberiana	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Antennaria microphylla	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-
Aster scopulorum	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-
Astragalus spp.	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-
Castilleja spp.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-
Crepis acuminata	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	+	+	-
Erigeron spp.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-
Eriogonum umbellatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Haplopappus acaulis	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Lupinus spp.	-	-	-	-	-	-	-	-	+	+	+	-	+	+	-	+	-	+	-
Penstemon spp.	-	-	-	-	-	+	+	-	-	+	+	-	-	-	-	-	-	-	-
Artemisia tridentata wyomingensis	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Artemisia tridentata vaseyana	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+
Chrysothamnus viscidiflorus	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	+	-	-
Erigeron filifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Eriogonum caespitosum	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	+	+	+	-
Eriogonum microthecum	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Leptodactylon pungens	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-
Phlox spp.	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Phlox hoodii	-	-	-	-	+	+	+	-	+	+	-	+	+	-	+	-	-	+	-
Phlox longifolia	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-
Purshia tridentata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Pseudotsuga menziesii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
Mosses and lichens	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-

or stem of a forb, or leader of a shrub or tree each constituted one instance of use. A minimum of 75 instances of use per site was required for consideration in analysis. Instances of use for various sites were aggregated and averaged within plant communities and time periods.

Forage availability at each feeding site was determined from canopy coverage estimates of each plant species on 10 systematically placed 20x50-cm plots at each site. The 10 20x50-cm plots were placed at 3-m (10-ft) intervals along the path of the feeding animals to eliminate bias associated with animal selection of plant species by sight and smell. Species were considered unavailable when snow-covered if no evidence of pawing by the feeding animals was apparent. If pawing occurred, snow was brushed away on each plot and the canopy coverage of each plant species recorded.

Utilization of Important Forage Species

Utilization of grasses was obtained by recording grazed and ungrazed heights of 100 plants (Smith et al. 1962), examined by the closest plant sampling technique of Cole (1963). Utilization of shrubs was calculated from the measurement of 10 grazed and 10 ungrazed twigs on 15 grazed plants at each site. The nearest plant within 2 ft of a transect line located by the random process described in the vegetation analyses was taken until we reached 15 grazed plants per transect. Twig lengths were converted to weights by using a length-weight regression developed from 50 twigs collected at each site (Peek et al. 1971). The average grazed and ungrazed twig weights were multiplied by total number of grazed twigs and total number of twigs respectively. Percent utilization was calculated by dividing weight removed by total weight produced.

Range Condition

Successional relationships within important plant communities were used as a measure of range condition. Multivariate techniques have proven useful tools in the analysis of vegetation (Goodall 1970). A simple ordination using the Bray and Curtis (1957) method as represented in program CEP4 of the Cornell Ecology Series of Computer Programs (Gauch and Dripps 1973) was used to examine the pattern of secondary succession.

The Sorenson community coefficient is represented by the formula $2W/a + b \times 100$, where W equals the sum of species attributes both stands have in common, and $a + b$ equals the sum of attributes of all species in each stand (Bray and Curtis 1957). Basal coverage of herbs and canopy coverage of shrubs were used for the ordinations.

The ordinations should display the most retrogressed stages of a successional complex on one end of the major axis and a near climax stage of the same complex on the other end. The remaining successional stages should form a pattern similar to a solid cone as there is a greater variability in seral stages than in climax stages (Huschle 1975).

All big sagebrush plants (*Artemisia tridentata*) encountered on density sampling plots during the vegetation sampling were assigned a decadence rating following Asherin (1973).

RESULTS AND DISCUSSION

VEGETATION

Major Plant Communities

We arranged 37 study sites into plant communities on the basis of presence or absence of major plant species (Table 1). Certain species were generally ubiquitous; many others were fairly restricted. These latter species form a somewhat discernible pattern showing major similarities between areas, which could be used to broadly categorize the study sites into four groups.

Eight of the 37 areas contained no measurable amounts of Wyoming big sagebrush *Artemisia tridentata wyomingensis*. Since Wyoming big sagebrush was a dominant species common to the remaining 29 areas, the 8 areas without it were removed from the primary arrangement. The 29 areas can be further subdivided on the basis of presence or absence of Sandberg bluegrass *Poa sandbergii*. For convenience in classification, 18 areas were grouped into a Wyoming big sagebrush/bluebunch wheatgrass *Agropyron spicatum* community, and 11 areas were grouped into a Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase community.

Mountain big sagebrush *Artemisia tridentata vaseyana* was a common dominant on the eight remaining areas, but the areas can be subdivided on the presence or absence of Douglas-fir *Pseudotsuga menziesii*. Five areas were grouped into a mountain big sagebrush/bluebunch wheatgrass community, while three areas were grouped into a Douglas-fir/mountain big sagebrush community.

Species Composition

The Wyoming big sagebrush/bluebunch wheatgrass community included few perennial or annual species (Table 2). Wyoming big sagebrush and bluebunch wheatgrass dominated the vegetation. Indian ricegrass *Oryzopsis hymenoides* was present on grazed areas while cheatgrass *Bromus tectorum* was present on benches near the valley floor. Mountain mahogany *Cercocarpus ledifolius* is sparsely distributed over Wyoming big sagebrush/bluebunch wheatgrass at 7,000 ft and 7,500 ft on the ridge south of Ziegler Basin. Present growth form of these plants precludes their use as forage by mule deer and bighorn sheep.

In contrast, the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase community included more perennials (Table 3). Wyoming big sagebrush and bluebunch wheatgrass were still dominant, but Sandberg bluegrass was also a subdominant. Perennial forbs such as

lupine *Lupinus* spp. and penstemon *Penstemon* spp. were more conspicuous, but still relatively scarce. On certain areas, mat-forming shrubs such as Hood's phlox *Phlox hoodii* may be conspicuous.

The Wyoming big sagebrush/bluebunch wheatgrass and Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase communities appeared related to the Wyoming big sagebrush/bluebunch wheatgrass habitat type described by Winward (1970) and Schlatterer (1972).

The mountain big sagebrush/bluebunch wheatgrass community had mountain big sagebrush and bluebunch wheatgrass as dominants, but Idaho fescue *Festuca idahoensis* joined Sandberg bluegrass as a subdominant (Table 4). Perennial forbs were still scarce.

The Douglas-fir/mountain big sagebrush community was the richest floristically of the four communities (Table 5). Douglas-fir and mountain big sagebrush dominated the vegetation. Bluebunch wheatgrass and Idaho fescue were subdominants.

The mountain big sagebrush/bluebunch wheatgrass community appeared related to the mountain big sagebrush/bluebunch wheatgrass habitat type recognized by Winward (1970) and Schlatterer (1972). The Douglas-fir/mountain big sagebrush community was quite common in the White Cloud area, and is regarded as an ecotone between steppe and forest communities. It is possible that a distinct habitat type phase will be described for this situation (E. Schlatterer pers. comm.). This plant community appeared related to the mountain big sagebrush/Idaho fescue habitat type described by Winward (1970) and Schlatterer (1972).

Density

The density of shrubs and trees was determined for 16 selected species (Table 6). We did not compare density values of each species among communities because of different degrees of disturbance. However, we did compare density values of sagebrush subspecies to provide information on relative shrub densities among the communities. The density of mountain big sagebrush was significantly greater than the density of Wyoming big sagebrush. This difference was conspicuous in the field.

A difference was noticed among the green rabbitbrush *Chrysothamnus viscidiflorus* plants in the Wyoming big sagebrush communities compared to the mountain big sagebrush communities. Lineleaf green rabbitbrush

Table 2. Vegetation from 18 stands in the *Artemisia tridentata wyomingensis/Agropyron spicatum* plant community. Data are presented as follows: grasses and forbs, average percent basal area and average frequency of occurrence; trees and shrubs, average percent canopy coverage and average frequency of occurrence (contact). Presence indicates percentage of stands on which species occurred. T denotes coverage of less than 0.1 percent. Averages were calculated as the aggregate of all stand averages divided by number of stands.

Plant species	Average % cover ±S.D.	Average frequency ±S.D.	Presence
Grasses			
Agropyron spicatum	2.1 ± 1.0	69 ± 13	100
Oryzopsis hymenoides	T	2 ± 6	17
Forbs			
Antennaria microphylla	0	0	17
Astragalus spp.	0	0	6
Chenopodium spp.	0	0	6
Crepis acuminata	T	1 ± 1	28
Lupinus spp.	T	1 ± 3	33
Opuntia spp.	0	0	6
Stephanomeria exigua	T	1 ± 1	11
Shrubs			
Artemisia tridentata wyomingensis	11.7 ± 6.3	42 ± 19	100
Chrysothamnus viscidiflorus	0	0	50
Eriogonum microthecum	T	6 ± 5	28
Leptodactylon pungens	0	0	6
Phlox hoodii	3.6 ± 4.7	8 ± 6	33
Ribes cereum	0	0	6

Table 3. Vegetation from 11 stands in the *Artemisia tridentata wyomingensis/Agropyron spicatum-Poa sandbergii* phase plant community. Data are presented as follows: grasses and forbs, average percent basal area and average frequency of occurrence; trees and shrubs, average percent canopy coverage and average frequency of occurrence (contact). Presence indicates percentage of stands on which species occurred. T denotes coverage of less than 0.1 percent. Averages were calculated as the aggregate of all stand averages divided by number of stands.

Plant species	Average % cover ±S.D.	Average frequency ±S.D.	Presence
Grasses			
Agropyron spicatum	2.5 ± 1.6	75 ± 19	100
Oryzopsis hymenoides	T	1 ± 3	27
Poa sandbergii	0.5 ± 0.6	28 ± 24	100
Sitanion hystrix	0.1 ± 0.2	4 ± 12	9
Stipa thuberiana	0.1 ± 0.3	2 ± 6	9
Forbs			
Allium textile	0	0	9
Amsinckia menziesii	0	0	9
Antennaria spp.	T	1 ± 5	9
Arabis spp.	0	0	18
Arenaria spp.	0	0	18
Aster scopulorum	0.3 ± 0.8	4 ± 9	27
Astragalus spp.	T	2 ± 5	36
Castilleja spp.	T	1 ± 2	27
Cirsium spp.	0	0	9
Crepis acuminata	T	2 ± 4	18
Erigeron spp.	T	4 ± 11	9
Erigeron compositum	0	0	9
Eriogonum ovalifolium	T	3 ± 3	9
Eriogonum umbellatum	0	0	9
Haplopappus acaulis	0.3 ± 1.0	6 ± 18	18
Lomatium spp.	0	0	9
Lupinus spp.	0.1 ± 0.2	3 ± 4	55
Penstemon spp.	0.1 ± 0.2	7 ± 14	36
Stephanomeria exigua	0	0	9
Annual forbs	0.1 ± 0.1	6 ± 12	18
Shrubs			
Artemisia tridentata wyomingensis	14.0 ± 8.3	47 ± 21	100
Chrysothamnus viscidiflorus	0	0	18
Erigeron filifolius	0	0	9
Eriogonum caespitosum	T	1 ± 2	18
Eriogonum microthecum	0.1 ± 0.3	3 ± 3	64
Phlox spp.	0.1 ± 0.3	7 ± 16	18
Phlox hoodii	1.0 ± 1.4	18 ± 23	64
Phlox longifolia	0.2 ± 0.5	6 ± 18	9
Leptodactylon pungens	T	1 ± 2	27
Ribes cereum	0	0	9

Table 4. Vegetation from five stands in the *Artemisia tridentata vaseyana/Agropyron spicatum* plant community. Data are presented as follows: grasses and forbs, average percent basal area and average frequency of occurrence; trees and shrubs, average percent canopy coverage and average frequency of occurrence (contact). Presence indicates percentage of stand on which species occurred. T denotes coverage of less than 0.1 percent. Averages were calculated as the aggregate of all stand averages divided by number of stands.

Plant species	Average % cover ±S.D.	Average frequency ±S.D.	Presence
Grasses			
Agropyron spicatum	2.8 ± 1.4	73 ± 13	100
Festuca idahoensis	1.9 ± 3.8	25 ± 43	60
Oryzopsis hymenoides	0	0	20
Poa sandbergii	0.7 ± 5.8	42 ± 32	100
Sitanion hystrix	0	0	20
Forbs			
Achillea millefolium lanulosa	0	0	20
Amsinckia menziesii	T	1 ± 2	60
Antennaria microphylla	T	1 ± 2	20
Aster scopulorum	0	0	20
Astragalus spp.	0	0	20
Balsamorhiza sagittata	0	0	40
Castilleja spp.	T	1 ± 2	60
Crepis acuminata	0	0	40
Erigeron compositus	0.1 ± 1.1	1 ± 2	20
Eriogonum ovalifolium	0	0	60
Eriogonum umbellatum	0	0	40
Lithospermum ruderale	T	1 ± 2	20
Lomatium spp.	0	0	20
Lupinus spp.	0.2 ± 0.2	10 ± 11	60
Penstemon spp.	0.1 ± 0.3	4 ± 9	20
Sedum stenopetalum	0	0	20
Vicia spp.	0	0	20
Shrubs			
Artemisia tridentata vaseyana	15.5 ± 5.2	58 ± 17	100
Chrysothamnus nauseosus	0	8 ± 12	60
Chrysothamnus viscidiflorus	0.3 ± 0.4	0	100
Eriogonum caespitosum	0.1 ± 0.2	55 ± 7	80
Eriogonum heracleoides	0	0	40
Leptodactylon pungens	T	6 ± 8	80
Phlox hoodii	0.2 ± 0.2	18 ± 3	80
Phlox longifolia	T	4 ± 7	60
Unknown shrub	T	4 ± 9	40

Table 5. Vegetation from three stands in the *Pseudotsuga menziesii/Artemisia tridentata vaseyana* plant community. Data are presented as follows: grasses and forbs, average percent basal area and average frequency of occurrence; trees and shrubs, average percent canopy coverage and average frequency of occurrence (contact). Presence indicates percentage of stand on which species occurred. T denotes coverage of less than 0.1 percent. Averages were calculated as the aggregate of all stand averages divided by number of stands.

Plant species	Average % cover ±S.D.	Average frequency ±S.D.	Presence
Grasses			
Agropyron spicatum	1.5 ± 1.1	60 ± 18	100
Festuca idahoensis	2.5 ± 3.5	48 ± 47	100
Koeleria cristata	0	0	67
Poa sandbergii	T	3 ± 6	33
Grasslikes			
Carex spp.	0	0	33
Forbs			
Achillea millefolium lanulosa	0	0	67
Antennaria microphylla	0.3 ± 0.5	5 ± 9	33
Balsamorhiza sagittata	0	0	67
Castilleja spp.	T	2 ± 3	33
Crepis acuminata	T	3 ± 3	67
Erigeron compositum	0	0	33
Eriogonum umbellatum	0.5 ± 0.8	5 ± 5	67
Lupinus spp.	0.1 ± 0.1	3 ± 6	33
Sedum stenopetalum	0	0	33
Stephanomeria exigua	0	0	33
Unknown forbs	0.1 ± 0.7	10 ± 7	33
Shrubs			
Artemisia tridentata vaseyana	22.8 ± 3.2	43 ± 23	100
Chrysothamnus viscidiflorus	1.8 ± 3.2	8 ± 14	67
Erigeron filifolius	0.2 ± 3.0	3 ± 6	67
Eriogonum caespitosum	1.0 ± 1.6	22 ± 33	100
Leptodactylon pungens	0.1 ± 0.1	5 ± 7	33
Phlox hoodii	1.2 ± 2.1	13 ± 23	33
Phlox longifolia	0.1 ± 0.1	3 ± 6	33
Purshia tridentata	0.5 ± 0.9	3 ± 6	33
Symphoricarpos oreophilus	0	0	67
Trees			
Pseudotsuga menziesii	3.7 ± 3.6	7 ± 8	100

Table 6. Density determinations for shrubs and trees. Figures in parentheses are numbers of stands sampled. A plus (+) denotes occurrence in the plant community but not in any sample plots. For individuals per acre, divide by 2.47.

Plant species	Individuals/hectare ± S.D.			
	Artemisia tridentata wyomingensis/ Agropyron spicatum plant community (18)	*Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii* phase plant community (11)	*Artemisia tridentata vaseyana/ Agropyron spicatum* plant community (5)	*Pseudotsuga menziesii/ Artemisia tridentata vaseyana* plant community (3)
Artemisia tridentata vaseyana	-	-	12,096 ± 4,013	10,369 ± 2,301
Artemisia tridentata wyomingensis	5,202 ± 2,943	8,894 ± 2,811	-	-
Chrysothamnus nauseosus	-	-	+	-
Chrysothamnus viscidiflorus	24 ± 59	10 ± 33	2,066 ± 3,292	251 ± 434
Erigeron filifolius	-	+	-	573 ± 657
Eriogonum caespitosum	-	20 ± 65	409 ± 493	4,664 ± 7,894
Eriogonum heracleoides	-	-	43 ± 96	-
Eriogonum microthecum	251 ± 986	411 ± 869	-	-
Leptodactylon pungens	+	+	1,248 ± 1,200	538 ± 931
Phlox spp.	-	832 ± 2,585	-	-
Phlox hoodii	+	9,208 ± 10,153	7,405 ± 6,776	3,588 ± 6,214
Phlox longifolia	-	411 ± 1,363	1,141 ± 2,004	609 ± 1,056
Purshia tridentata	-	-	-	538 ± 932
Ribes cereum	6 ± 25	10 ± 33	-	-
Symphoricarpos oreophilus	-	-	-	1,704 ± 2,936
Pseudotsuga menziesii	-	-	-	429 ± 186

Chrysothamnus viscidiflorus pumilus was associated with Wyoming big sagebrush communities, while lanceleaf green rabbitbrush *Chrysothamnus viscidiflorus lanceolatus* and tall green rabbitbrush *Chrysothamnus viscidiflorus viscidiflorus* were associated with mountain big sagebrush communities.

Ground Cover

The proportions of litter and erosion pavement varied between the different communities. Areas grouped within the mountain big sagebrush communities had significantly less erosion pavement and more litter than areas grouped within the Wyoming big sagebrush communities (Table 7). Mountain big sagebrush communities possessed greater cover for soil protection.

Forage Production

Total forage production averaged close to 36 g/m^2 (320 lb/acre) over all the sampled communities. This production varied from community to community in the shrub class more than in the grass or forb classes (Table 8). No significant differences in production between communities could be detected.

Minor Plant Communities

Four minor plant communities of limited area were recognized following the classification of Schlatterer (1972), Steele et al. (1974), or Money (1973). We did not sample these communities due to their unimportance to bighorn sheep.

Low sagebrush *Artemisia arbuscula* and bluebunch wheatgrass dominated the low sagebrush/bluebunch wheatgrass community. Idaho fescue and Sandberg bluegrass were subdominants. Common mat-forming shrubs were Hood's phlox and mat buckwheat *Eriogonum caespitosum.*

Heartleaf arnica *Arnica cordifolia* was the dominant forb of a depauperate understory in the Douglas-fir/heartleaf arnica community. Mountain big sagebrush and mountain snowberry *Symphoricarpos oreophilus* persisted as weak depauperate shrubs underneath the dominant Douglas-fir.

Vegetation of riparian plant communities was relatively dense and heterogeneous, with willow *Salix* spp. or black cottonwood *Populus trichocarpa* usually dominating the vegetation. On some areas, Douglas-fir dominated the vegetation.

Agricultural communities as used here refers to irrigated grasslands in private ownership along the valley floor. Several species of grass, including those of brome *Bromus* spp. and bluegrass *Poa* spp. dominated the vegetation. Mule deer *Odocoileus hemionus* made heavy use of this community in spring.

Distribution of Plant Communities

As is typical in mountainous terrain, the different communities reached their best development within fairly definite altitudinal limits but could not be rigidly defined (Fig. 2). In addition, there were often differences in communities between exposures and/or steepness of slope.

Riparian communities reached their greatest extent on the valley floor, but also extended upslope along the narrow side drainages. The Wyoming big sagebrush communities occupied the middle elevations of the study area from the valley floor to the mountain big sagebrush or Douglas-fir communities. The Wyoming big sagebrush/bluebunch wheatgrass community generally occurred on slopes steeper than 40 percent, while Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase community generally occurred on slopes less than 40 per-

Table 7. Percentage of ground cover in four habitat types.

Ground cover	% of microplot corner-point hits ± S.D.			
	Artemisia tridentata wyomingensis/ Agropyron spicatum plant community (18)	*Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii* phase plant community (11)	*Artemisia tridentata vaseyana/ Agropyron spicatum* plant community (5)	*Pseudotsuga menziesii/ Artemisia tridentata vaseyana* plant community (3)
Live vegetation	5.8 ± 2.8	9.2 ± 7.4	8.3 ± 7.4	10.0 ± 9.8
Litter	15.1 ± 9.3	20.3 ± 12.7	30.7 ± 9.4	58.7 ± 10.9
Rock	19.2 ± 8.8	13.7 ± 10.7	10.8 ± 12.1	15.4 ± 12.3
Erosion pavement	44.2 ± 12.2	37.3 ± 14.0	18.7 ± 12.4	3.8 ± 1.3
Bare ground	15.6 ± 12.5	19.6 ± 9.1	31.5 ± 19.0	12.1 ± 10.4

Table 8. Production of grasses, forbs, and shrubs on four habitat types.

Plant community	No. stands	Grams/m^2 ± S.D.		
		Grasses	Forbs	Shrubs
Artemisia tridentata wyomingensis/ Agropyron spicatum	18	15.4 ± 10.1	0.3 ± 0.6	5.3 ± 6.4
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii phase	11	18.0 ± 13.3	4.6 ± 10.0	13.6 ± 7.8
Artemisia tridentata vaseyana/ Agropyron spicatum	5	14.7 ± 13.3	4.3 ± 5.1	19.8 ± 17.5
Pseudotsuga menziesii/ Artemisia tridentata vaseyana	3	13.9 ± 1.7	0.7 ± 0.7	32.1 ± 21.8

cent. These communities reached their greatest altitudinal limit on south-facing exposures.

The mountain big sagebrush and Douglas-fir communities occupied the upper elevations of the study area. The Douglas-fir/heartleaf arnica community occupied moist north-facing exposures. The Douglas-fir/mountain big sagebrush community generally occurred on more north-facing slopes than the mountain big sagebrush/bluebunch wheatgrass community.

The low sagebrush/bluebunch wheatgrass community occupied a limited area on flat to gently sloping terrain. Schlatterer (1972) found low sagebrush communities on shallow and gravelly soils and/or soils with a restrictive clay B horizon.

Table 9 shows acreages of each plant community on the historic and presently occupied ranges. The important communities in which Wyoming big sagebrush is associated comprise approximately one-third of both historic and present ranges.

RANGE CONDITION

Reference point selection was determined by subjective choice to ordinate the 29 individual stands in the Wyoming big sagebrush/bluebunch wheatgrass and Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase plant communities. The data on range use characteristics of bighorn sheep suggested that these communities are the most important to bighorn sheep.

The ordination tends to support the vegetation classification as proposed (Fig. 3). The two plant communities represented by circles and squares are essentially separated in the three-dimensional drawings. Overlap occurs for stands with a small number of species and/or low seral stages. Huschle (1975) demonstrated that seral stages of one successional complex can be more similar to seral stages of another successional complex than they are to seral stages of the same complex.

Stand 21 is consistently below and to one side of the other stands within the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase plant community. The presence of Thurber needlegrass *Stipa thurberiana* suggested this stand may represent an additional plant community not yet recognized. Thurber needlegrass is an indicator species for identification of big sagebrush communities south of the study area (M. Hironaka, pers. comm.).

Suggested successional relationships in the two plant communities are tentative, since a detailed history of the individual stands is lacking. On both plant communities, coverage and density of Wyoming big sagebrush were greater in low seral stages than in climax stages. In contrast, understory components in the two communities responded differently. The loss of bluebunch wheatgrass in the Wyoming big sagebrush/bluebunch wheatgrass plant community occurs without the corresponding increase in mat-forming shrubs such as Hood's phlox and mat buckwheat that occurs in the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase. There was no increase in annuals that are common after disturbance in other big sagebrush plant communities (Tisdale et al. 1969).

Stand 33 was chosen as a climax reference point in the subjective method, but in the other two methods its position is below and to one side of the stand, which indicates climax in the objective methods. This stand may represent a stage of recovery of perennial grasses following protection from initial disturbance because it retains a high coverage of Wyoming big sagebrush.

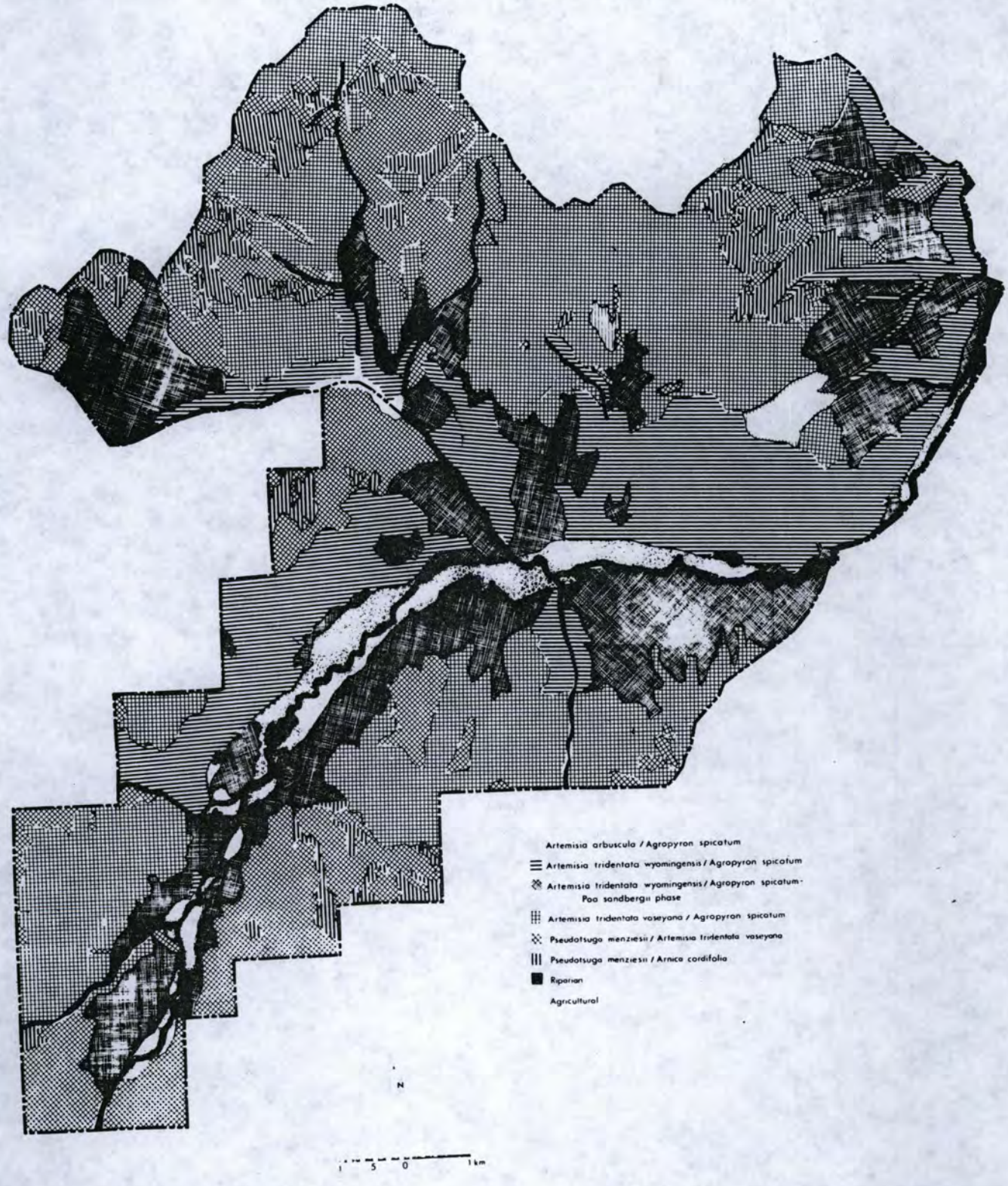

Fig. 2. Vegetation map of bighorn sheep winter range, East Fork Salmon River.

Table 9. Plant communities on current and historic bighorn winter range, East Fork of the Salmon River. For acres, divide by 2.47.

Plant community	Present winter range		Historic winter range		Total study area	
	Hectares	Percent	Hectares	Percent	Hectares	Percent
Artemisia arbuscula/ Agropyron spicatum	102.4	1.2	-	-	102.4	0.7
Artemisia tridentata wyomingensis/ Agropyron spicatum	1,535.4	17.9	735.7	13.5	2,271.2	16.2
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii phase	1,204.8	14.0	1,193.4	21.9	2,398.2	17.1
Artemisia tridentata vaseyana/ Agropyron spicatum	2,656.0	31.0	1,603.0	29.5	4,259.0	30.4
Pseudotsuga menziesii/ Artemisia tridentata vaseyana	2,396.6	27.9	1,068.0	19.6	3,464.6	24.7
Pseudotsuga menziesii/ Arnica cordifolia	502.6	5.9	278.8	5.1	781.5	5.6
Riparian	49.4	0.6	104.0	1.9	153.4	1.1
Agricultural	135.2	1.6	460.1	8.5	595.3	4.2
Total	8,852.4	100.0	5,443.1	100.0	14,025.5	100.0

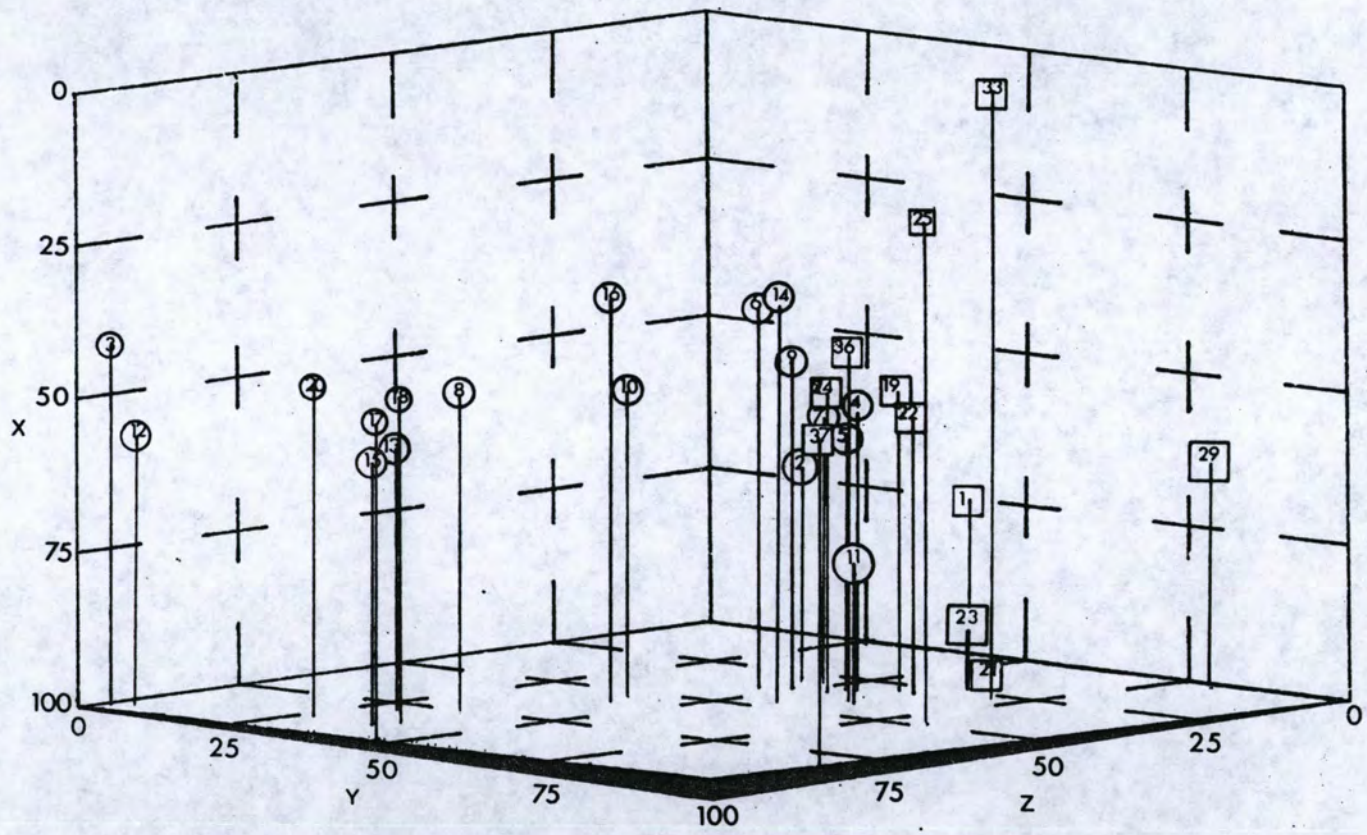

Fig. 3. Three-dimentional drawing of an ordination of stands based on subjective choice of reference points. Top center point of drawing is the lowest value for all three axes. Axes are oriented to position climax stands at the top of drawing. The circles represent stands in the *Artemisia tridentata wyomingensis/Agropyron spicatum* plant community; squares represent stands in the *Artemisia tridentata wyomingensis/Agropyron spicatum-Poa sandbergii* phase plant community. Large-sized symbols represent low seral stages, medium-sized symbols represent seral stages, and the smallest symbols represent climax stands.

Adequate assessment of range quality for an ungulate must consider the successional stages of plant communities and the ungulate's ability to exploit them. Food habits data have shown bighorn sheep and cattle to be dependent on perennial grasses, primarily bluebunch wheatgrass on this range. The loss of grasses represents conditions unfavorable to bighorn sheep and cattle. Food habits data indicate mule deer are dependent on shrubs during late fall and early winter, but make considerable use of grasses in late winter and spring. The intermediate stages of secondary succession are characterized by an increase in Wyoming big sagebrush without a complete loss of bluebunch wheatgrass and Sandberg bluegrass—conditions favorable to mule deer.

The congested orientation of stands within the Wyoming big sagebrush/bluebunch wheatgrass plant community suggests range deterioration is less than on the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase plant community. Much of the latter plant community appears to have retrogressed severely. The steeper slopes on the former community apparently have precluded heavy use by domestic livestock.

Wyoming big sagebrush plants are spread throughout the decadence classes in both communities as were mountain big sagebrush plants in the mountain big sagebrush/bluebunch wheatgrass plant community (Table 10).

POPULATIONS

Bighorn Sheep

Bighorn sheep distribution on the study area by 1920 was much as today except for a small herd wintering in Bowery and Sheep creeks. Shaw (1942) found bighorn sheep still wintering in Bowery and Sheep creeks, but Smith (1954) made no mention of any bighorn sheep wintering in that area.

Bighorn sheep have apparently undergone two major fluctuations since 1920 based on population estimates by the U. S. Forest Service (Fig. 4). Numbers gradually increased in the late 1920's and early 1930's and decreased between 1939 and 1941. Numbers again increased in the early 1950's but decreased in 1956. "Lungworm-pneumonia" may have been responsible as reported for similar crashes in other states and provinces (Moser 1962, Stelfox 1971, Uhazy et al. 1973). Estimates since 1960 have been below 50 individuals.

A minimum of 46 bighorn sheep were present on the East Fork of the Salmon River during an aerial census (fixed-wing) the third week in January 1975. This was the highest number of bighorn sheep observed at any one time. A helicopter census the first week in March located only 10 bighorn sheep.

Age and sex composition for bighorn sheep were based on classifications made during January and May when the greatest number of bighorn sheep was observed on the winter range. Observed ratios of ewes to lambs and rams are given as they occurred in the field. Calculated ratios were derived with the following assumptions: (1) yearling females could not be differentiated from adult females with certainty; (2) yearling males were readily distinguishable from all other age and sex classes and the number of yearling males equalled the number of yearling females. The calculated ewe:lamb ratio was derived by deducting the number of yearling females from total number of females (Table 11).

As Woodgerd (1964) indicated, a 50:50 sex ratio among yearlings may not be representative. However, at

Table 10. Decadence rating determinations for *Artemisia tridentata wyomingensis* and *Artemisia tridentata vaseyana*. Data are presented as percentage of plants ± S.D. Figures in parentheses are number of sites sampled.

Decadence class (%)	*Artemisia tridentata wyomingensis*/ *Agropyron spicatum* plant community (18)	*Artemisia tridentata wyomingensis*/ *Agropyron spicatum*-*Poa sandbergii* phase plant community (11)	*Artemisia tridentata vaseyana*/ *Agropyron spicatum* plant community (5)
0	6.9 ± 9.3	7.0 ± 5.9	15.9 ± 9.5
1-5	10.4 ± 8.6	17.2 ± 8.4	16.5 ± 8.7
6-25	23.1 ± 12.3	21.8 ± 5.6	19.0 ± 7.7
26-50	23.5 ± 9.1	15.0 ± 7.0	16.3 ± 6.2
51-75	12.9 ± 6.1	12.4 ± 4.9	6.7 ± 4.2
76-95	7.3 ± 4.8	8.2 ± 3.7	5.0 ± 4.6
96-99	3.4 ± 4.5	6.4 ± 4.1	6.5 ± 6.8
100	10.6 ± 8.4	11.4 ± 4.6	13.9 ± 8.1

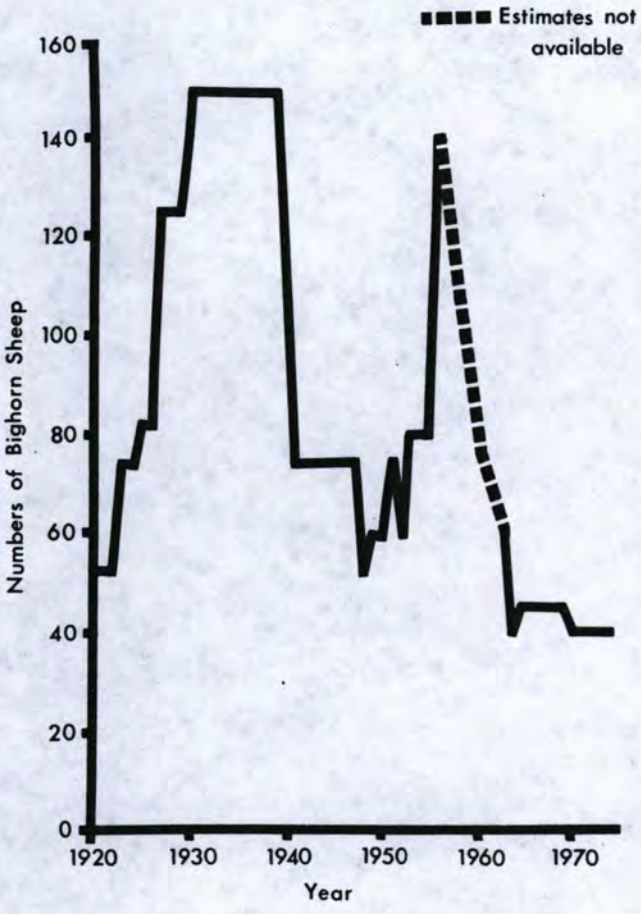

Fig. 4. Population estimates of bighorn sheep along the East Fork Salmon River.

least three different yearling rams and two different yearling ewes were present in the populations. We feel the lamb:ewe and yearling:ewe ratios closely approximated the actual ratios for the herd.

The lamb:ewe, yearling:ewe, and ram:ewe ratios were higher than ratios reported by Morgan (1970). The higher lamb:ewe and yearling:ewe ratios suggest better reproductive success the past two years than during the late 1960's. The yearling:ewe ratio lies between the ratios listed by Geist (1971) for a poor-quality, stable population and a high-quality, expanding population respectively. The higher ram:ewe ratio suggests differential distribution of ram and ewe groups, and was substantiated by the absence of rams from the winter range during much of the winter.

Mule Deer

Mule deer were apparently common at the time of settlement (Grunell and Phillips 1972), but by 1920 were rarely seen in the East Fork. Reports blamed heavy grazing by domestic sheep for the decline (U.S. Forest Service unpublished data, Challis National Forest, Clayton, Idaho). Hunting also likely played a major role in the decline. A rapid build-up of mule deer during the 1930's and 1940's was probably due to protection from hunting and improving range conditions. Peak populations occurred in the 1950's and early 1960's, but have decreased since.

Three consecutive days of ground observation during late February revealed at least 150 to 175 mule deer on or immediately adjacent to the bighorn sheep winter range. A minimum of 260 mule deer were present on historic sheep winter range during an helicopter survey conducted by the Idaho Fish and Game Department the first week in March (W. Bodie, pers. comm.). Some movement between the present and historic winter ranges during the winter months may occur.

Age ratios for mule deer were based on classifications made November through April (Table 12). The ratio of 19 fawns per 100 adults is below that reported by Robinette (1956) and indicated poor survival of fawns.

Elk

Elk *Cervus elaphus* were apparently not present in any numbers on the East Fork of the Salmon River at the time of the first ranching operations (D. Pence pers. comm.), appearing in the late 1950's and early 1960's. Three areas were used by elk in the East Fork all or part of the year: (1) upper East Fork above Bowery Creek, (2) Railroad Ridge-Big Lake Creek, and (3) Herd Creek.

Domestic Livestock

Ranchers and farmers soon followed the miners into the Upper Salmon River Basin (Table 13). Ranching activities started in the Lemhi Valley near Salmon and the Pahsimeroi

Table 11. Sex and age classification of bighorn sheep on East Fork Salmon River winter range, 1975.

Month	Lambs	Adult ♀♀	Yearling ♂♂	Class I ♂	Class II ♂	Class III ♂	Class IV ♂	Unclass. animals	Observed #/100 ewes		Calculated #/100 ewes	
									Lambs	Rams	Lambs	Yrlngs
January	24	40	6	4	7	12	6	16	60	88	70	35
May	50	84	9	20	6	10	6	14	60	65	67	24

Table 12. Age composition of mule deer.

Number classified	Adults	Fawns	Fawns/ 100 adults
2,173	1,826	347	19

and Round valleys near Challis in the 1870's. The first use of any significance on the East Fork of the Salmon River probably developed in the early 1880's.

In the 1890's, large bands of sheep and herds of cattle began grazing the East Fork of the Salmon River and the upper Salmon River, with highest numbers occurring about 1900. Many of these animals were not owned by local stockmen but by outsiders who spent the entire year moving them around on public land. Ketchum became the largest sheep and lamb shipping point in the United States. With the establishment of the Challis and Sawtooth national forests, ownership of base property was required for the issuance of a grazing permit, thus ending grazing by transient livestock (Goodwin and Hussey 1965).

After the establishment of the national forests, local stockmen continued to graze their cattle and sheep for several months of each year on public lands. Livestock were turned loose as early as possible, grazing on the public domain with advent of spring greenup before moving to the national forests for the summer (F. Maraffio pers. comm.). Livestock again grazed the public domain after movement off the national forests.

In addition to cattle and sheep, most ranchers kept a small band of horses. Unnecessary horses were turned loose on public land but were rounded up once a year and branded. After 1930, the U. S. Forest Service moved to eliminate trespass by horses not licensed to graze. The wild horse herd north of the present bighorn sheep winter range descended from horses not rounded up by the ranchers, and became established after 1940. The wild horse herd did not range south of Road Creek to the bighorn sheep winter range (D. Pence pers. comm.).

In 1934, the Taylor Grazing Act was passed and the Grazing Service was established to regulate grazing on the public domain. The Salmon District was established in 1936 pursuant to the Taylor Grazing Act; the first license was issued in 1937 for livestock grazing on the East Fork of the Salmon River. Generally the license was issued according to historical use prior to establishment of the district. In 1941 and 1942, a slight downward adjustment in numbers may have been made, although records are unclear. Adjudication was made in 1957 with no reduction in numbers, although the season was reduced to May 1 though October 17 (Bureau of Land Management, unpublished data on file, Salmon District Office).

Management of national forest grazing allotments has controlled livestock numbers along the East Fork of the Salmon River since the first reduction in 1907. A subsequent build-up never reached previous levels (Fig. 5), and another gradual reduction was initiated in 1950 (U. S. Forest Service, unpublished data, Challis National Forest).

Local stockmen are heavily dependent on public lands and must structure their operations on the number of livestock permitted on public range. Use of range managed by the Bureau of Land Management is limited to

Table 13. History of the Upper Salmon River Drainage.

	Initial Exploration, 1824-1860
1824	Alexander Ross became the first white man to explore the Upper Salmon River drainage.
	Initial Mining Era, 1863-1890
1863	Bayhorse Mining District located, with town of Bayhorse established during 1880's.
1869	Gold discovered on Loon Creek (Middle Fork Salmon River).
1869	Oro Grande established on Loon Creek.
1870	Gold discovered on Yankee Fork of Salmon River.
1876	Bonanza established on Yankee Fork of Salmon River.
1878	Challis established as mining center.
1878	Custer established on Yankee Fork of Salmon River.
1880	Crystal established at mouth of East Fork of Salmon River as freighting center.
1880	Clayton established with the building of a smelter.
	Livestock Operations, 1870-1975
1870's	Livestock-raising and farming began in Round Valley.
1880's	Livestock grazing began on East Fork of Salmon River.
1980's-1907	Large transient bands of livestock grazed Upper Salmon River drainage.
1907-1908	Challis and Sawtooth National Forests established; grazing by transient livestock on National Forests ended.
1934	Taylor Grazing Act passed; Grazing Service established.
1936	Salmon District of Grazing Service established.
1937	Grazing Service issued first license for grazing.
1946	Bureau of Land Management replaced Grazing Service.
1950's	Livestock number declined under more intensive management on National Forests.
1957	Adjudication of national resource lands completed.
1972	Sawtooth National Recreation Area established.

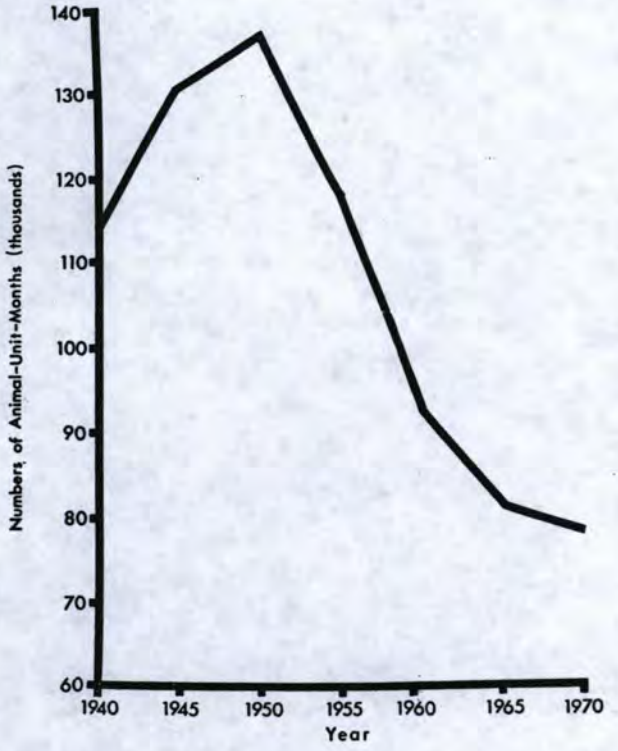

Fig. 5. Number of animal-unit-months use by domestic livestock on Challis National Forest.

a short period before and after summer grazing on the national forests. The class of livestock using the area has also gradually changed from sheep to cattle, as is the pattern for much of Idaho (Godfrey 1972).

Five stockmen held permits to graze 663 cattle (795 AUMs), 50 domestic sheep (45 AUMs), and 5 horses (4 AUMs) within the study area on common open range encompassing part of the East Fork Allotment administered by the Bureau of Land Management. Of these, three with 279 head of livestock (328 AUMs) ran their livestock largely on present bighorn sheep winter range, and one with 186 head of livestock (187 AUMs) partially used the present bighorn sheep winter range.

Four stockmen held permits to graze 133 cattle (265 AUMs) and 6 horses (6 AUMs) on two allotments administered by the U. S. Forest Service within the study area.

RANGE USE

Bighorn Sheep

The small number, irregular distribution, and gregarious behavior of bighorn sheep were reflected in the low number of observations. A total of 142 bighorn sheep observations representing 740 individuals, used in evaluating range use habits, was recorded as follows: November, 3 groups comprising 12 individuals; December, 16 groups comprising 61 individuals; January, 19 groups comprising 115 individuals; February, 25 groups comprising 126 individuals; March, 16 groups comprising 89 individuals; April, 24 groups comprising 123 individuals; and May, 39 groups comprising 214 individuals.

Areas utilized.–Most sightings of bighorn sheep throughout the winter were in an area bordered on the north by Ziegler Basin, on the east and south by the East Fork of the Salmon River, and on the west by Marco Creek (Figs. 6-9). Scattered observations were recorded in Ziegler Basin and Big Lake Creek. The first sightings of bighorn sheep on the winter range occurred on 26 November, but rancher R. Baker reported sighting a small group one week earlier. Most bighorn sheep had moved off the winter range by 27 May, prior to lambing.

The rather abrupt arrival on and departure from the winter range appeared typical for bighorn in central Idaho (Smith 1954, W. Hickey pers. comm.). However, important fluctuations in numbers apparently occurred during the study period. The maximum number of individuals using the study area occurred during late January-early February and late April-early May. The first concentration occurred shortly after a crust formed on the snow, while the second concentration occurred after initiation of growth by grasses. Sightings of bighorn sheep along the main Salmon River near Clayton, Idaho, reported to G. Powers (pers. comm.) coincided with the absence of bighorn sheep near the study area. Similar sightings of bighorn sheep near Clayton were reported by Buechner (1960).

Use of the various parts of the study area varied according to elevation, aspect, slope, slope position, and snow depth. Bighorn sheep gradually moved downward as snow depth increased until March, when melting snow resulted in some upward movement. However, initiation of grass growth in April and May triggered a downward movement to slopes just off the valley floor (Fig. 10). Bighorn sheep showed an affinity for southern aspects (SE, S, SW, W) over northern aspects (N, NE, E, NW) (Table 14) and slopes greater than 30 percent (Table 15). They were also found most frequently on the lowest one-third of slopes (Table 16) and in snow less then 2 inches deep (Table 17).

Plant Communities Utilized.–Bighorn sheep selected the Wyoming big sagebrush/bluebunch wheatgrass community over other plant communities throughout the winter (Table 18).

Mule Deer

A total of 498 mule deer observations representing 3,278 individuals provided data for evaluation of range use habits. These were recorded by month as follows: November, 10 groups comprising 45 individuals; December, 14 groups comprising 132 individuals; January, 47 groups comprising 308 individuals; February 116 groups com-

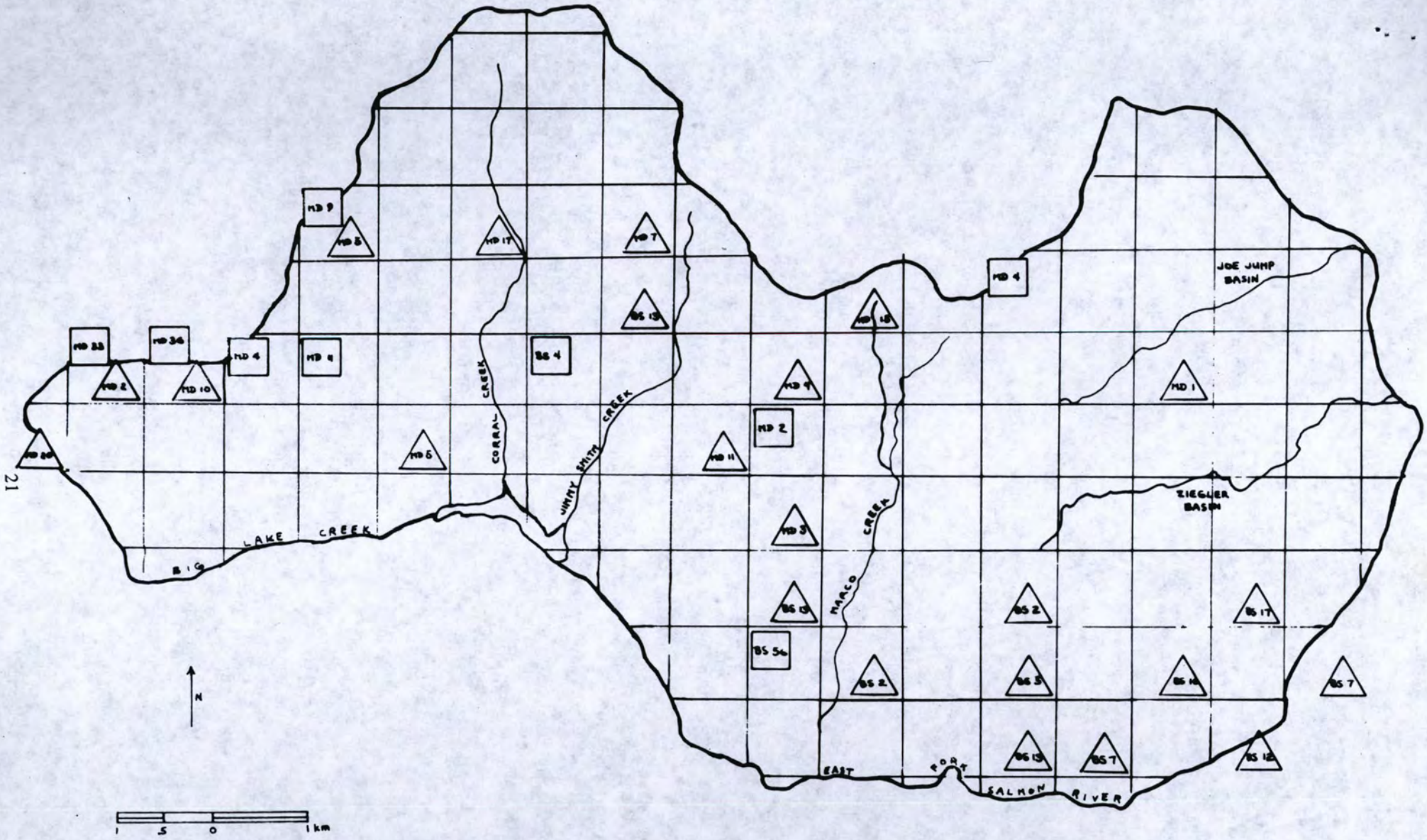

Fig. 6. November (□) – December (△) 1974 distribution of bighorn sheep (BS) and mule deer (MD). Data are expressed as percent of individuals observed in each 0.6 km^2.

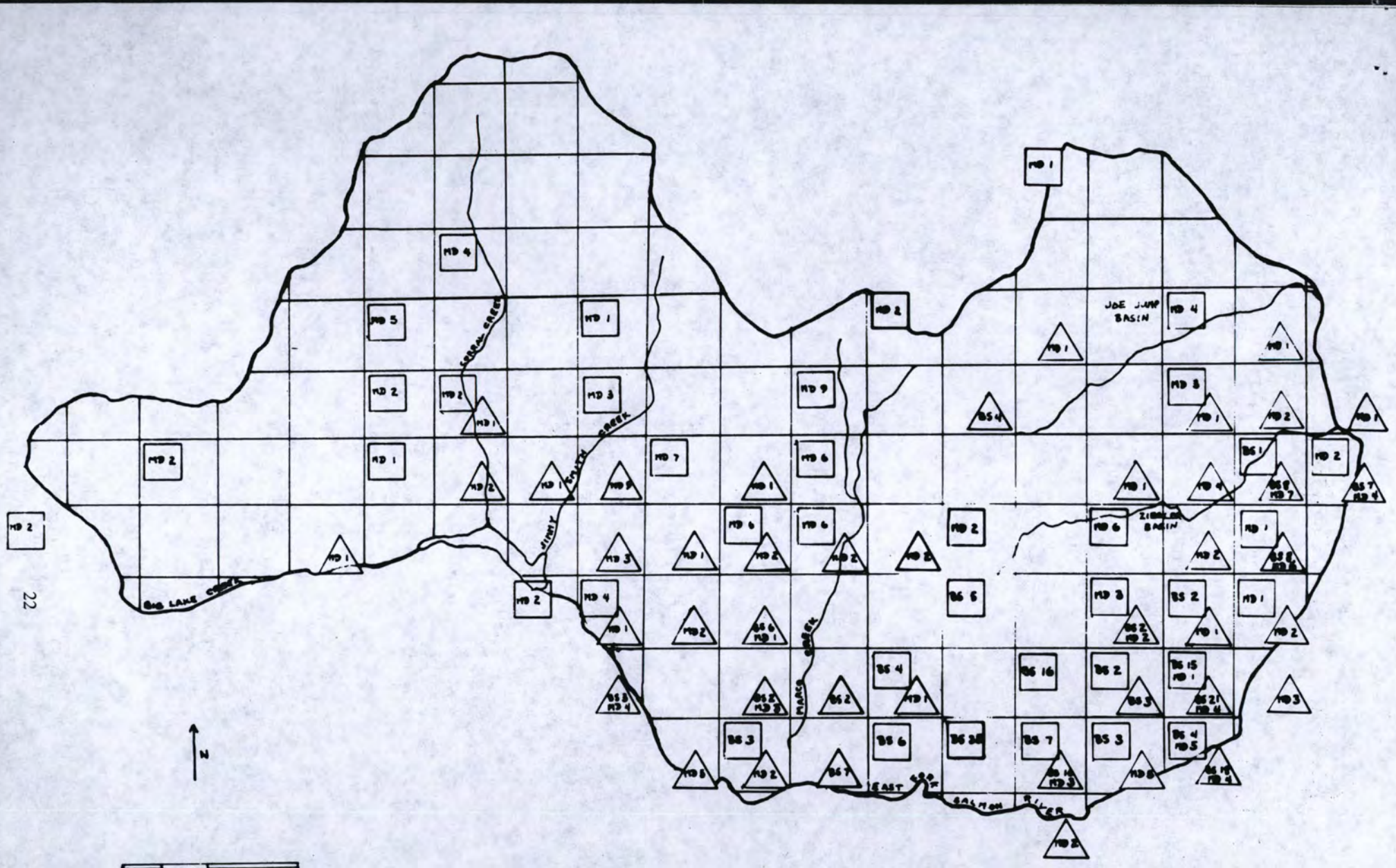

Fig. 7. January (□) – February (△) 1975 distribution of bighorn sheep (BS) and mule deer (MD). Data are expressed as percent of individuals observed in each 0.6 km^2.

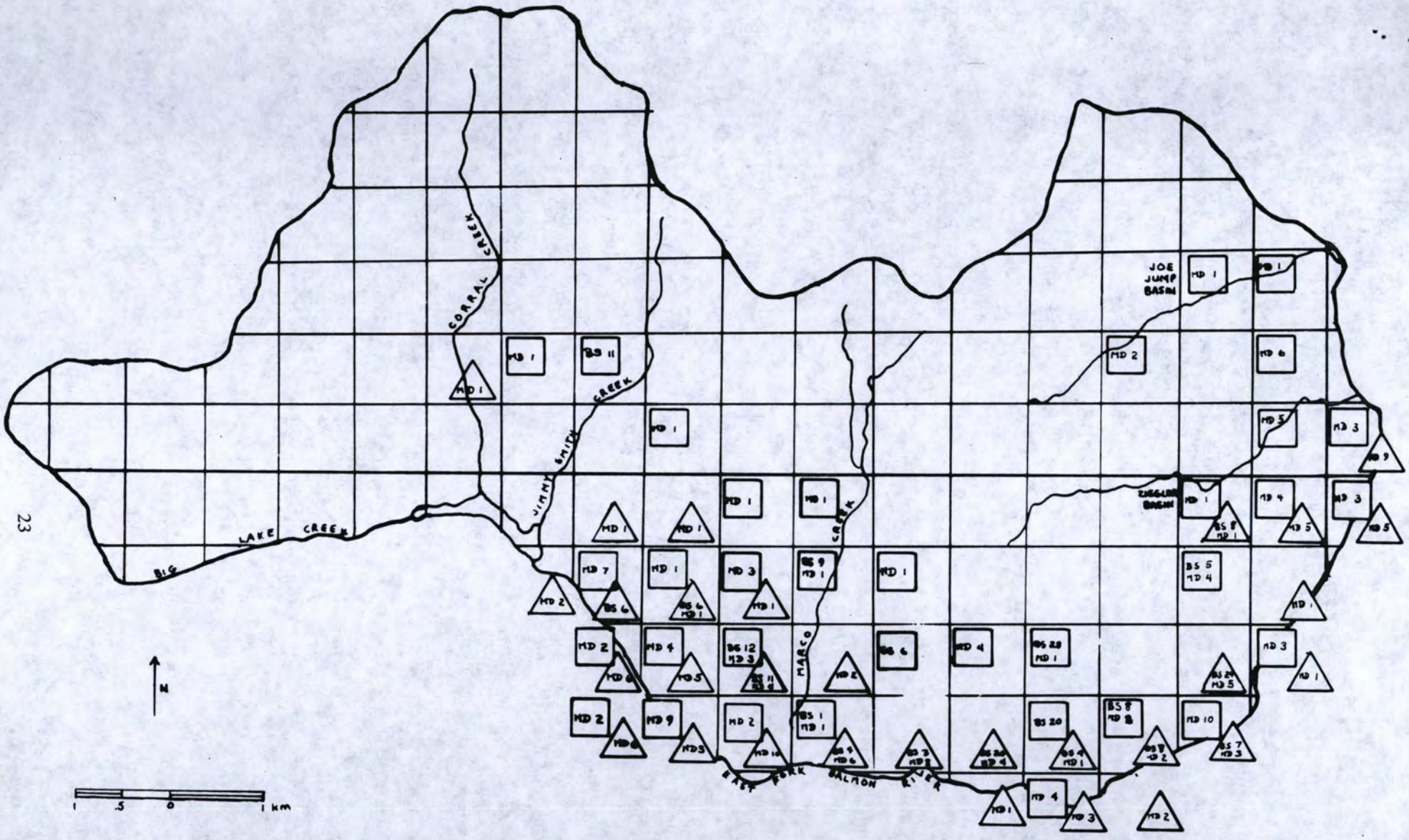

Fig. 8. March (□) – April (△) 1975 distribution of bighorn sheep (BS) and mule deer (MD). Data are expressed as percent of individuals observed in each 0.6 km^2.

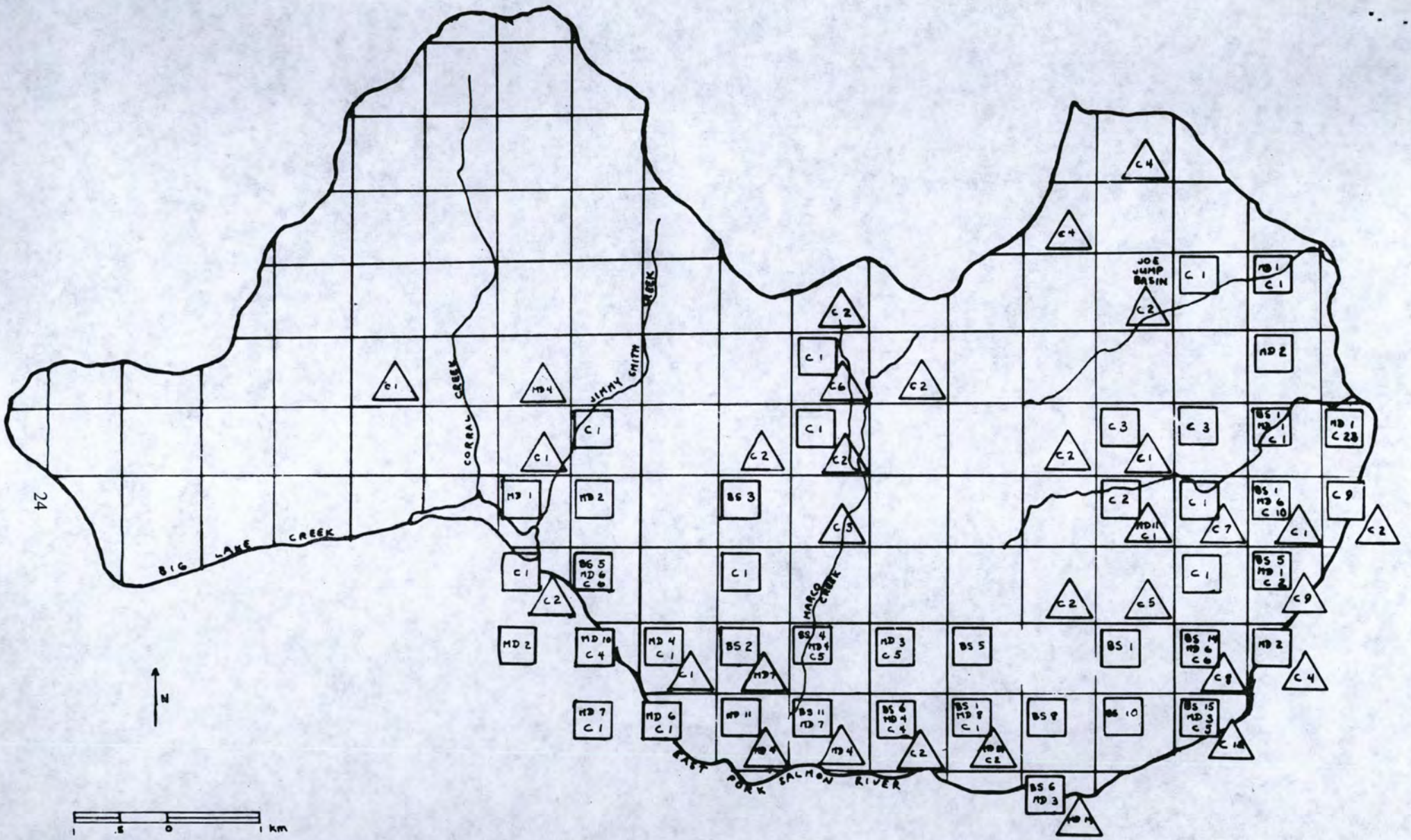

Fig. 9. May (□) – June (△) 1975 distribution of bighorn sheep (BS), mule deer (MD), and cattle (C). Data are expressed as percent of individuals observed in each 0.6 km^2.

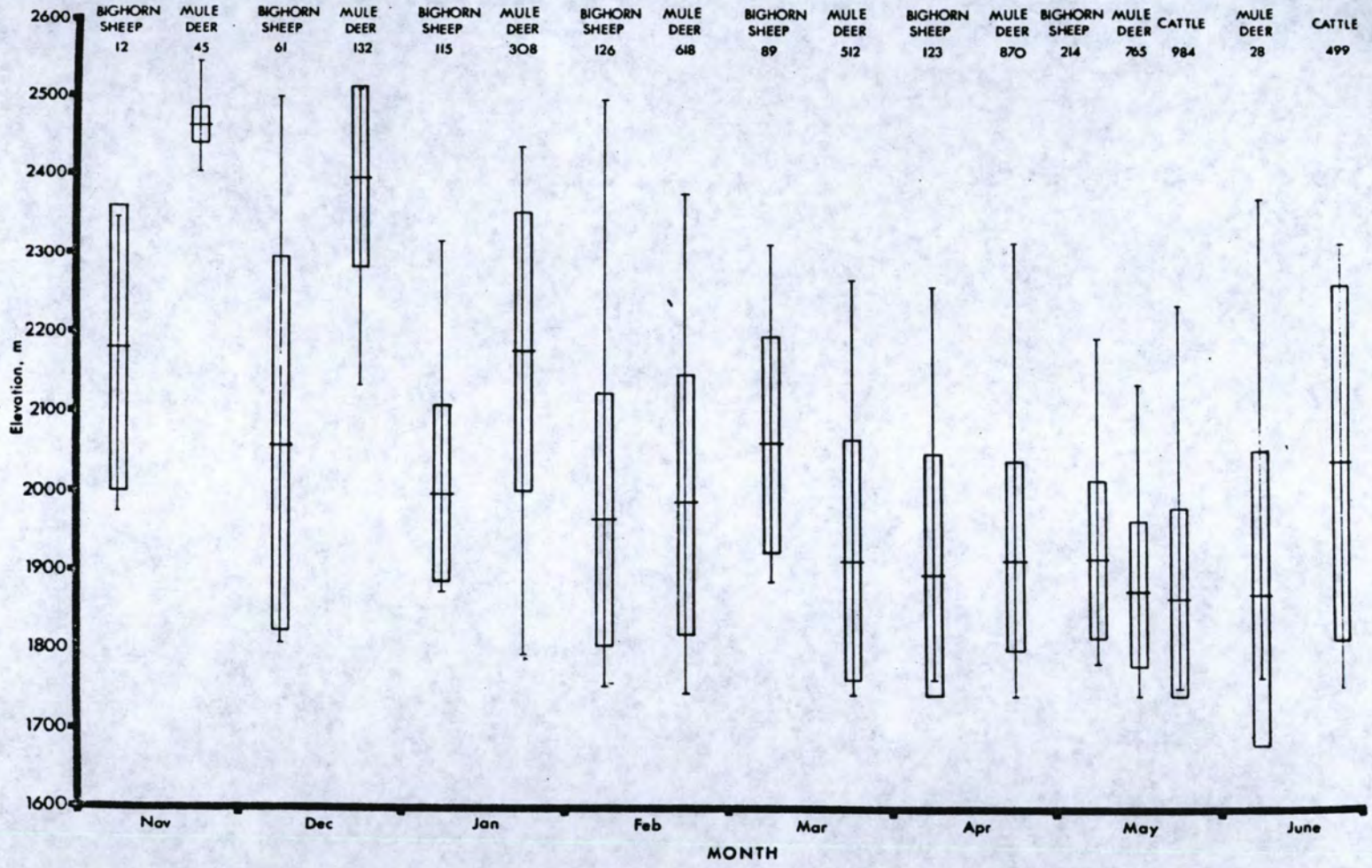

Fig. 10. Monthly elevational distribution of bighorn sheep, mule deer, and cattle, November 1974 through May 1975. Vertical lines represent ranges, and horizontal lines represent means. Rectangles represent one standard deviation about the mean. Numbers represent sample sizes.

Table 14. Percentages of total bighorn sheep observed on various aspects November 1974 through May 1975. Chi-square test: x^2=211.9, x^2 .05, 1 degree of freedom=3.8 for SE,S,SW,W aspects vs. N,NE,E,NW aspects.

Month	Sample size	N	NE	E	SE	S	SW	W	NW
November	12	0	0	0	0	0	100.0	0	0
December	61	0	8.2	11.5	32.8	34.4	13.1	0	0
January	115	0	0	5.2	30.4	28.7	35.7	0	0
February	126	0	3.2	37.3	42.1	13.5	4.0	0	0
March	89	0	15.7	29.2	16.9	27.0	9.0	2.2	0
April	123	0	12.2	10.6	33.3	24.4	19.5	0	0
May	214	5.1	7.9	3.3	52.3	26.7	4.7	0	0

Table 15. Percentages of total bighorn sheep observed on slopes of varying percent steepness, November 1974 through May 1975. Chi-square test: x^2=394.1, x^2 .05, 1 degree of freedom=3.8 for slopes greater than 31 percent vs. slopes 30 percent or less.

Month	Sample size	0-20%	21-30%	31-40%	41-50%	50+%
November	12	0	0	33.3	0	66.7
December	61	0	23.0	70.5	6.6	0
January	115	7.0	0.9	17.4	71.3	3.5
February	126	12.7	15.9	44.4	14.3	12.7
March	89	0	7.9	23.6	56.2	12.4
April	123	0	8.1	48.8	39.0	4.1
May	214	0	11.2	23.8	45.3	19.6

Table 16. Percentages of total bighorn sheep observed on various slope positions, November 1974 through May 1975. Chi-square test: x^2=36.4, x^2 .05, 1 degree of freedom=3.8 for lower one-third slope vs. upper two-thirds slope.

Month	Sample size	Ridge top	Upper third slope	Middle third slope	Lower third slope	Narrow canyon bottom	Wide canyon bottom
November	12	0	33.3	66.7	0	0	0
December	61	18.0	9.8	0	72.1	0	0
January	115	7.8	17.4	26.0	48.7	0	0
February	126	12.7	11.1	11.9	64.3	0	0
March	89	18.0	27.0	32.6	22.5	0	0
April	123	7.3	10.6	0	82.1	0	0
May	214	13.6	11.2	5.1	70.1	0	0

Table 17. Percentages of total bighorn sheep observed on various snow depths, November 1974 through May 1975. Chi-square test: x^2=417.6, x^2 .05, 1 degree of freedom=3.8 for snow depths less than or equal to 5 cm vs. snow depths greater than 5 cm.

Month	Sample size	No snow	0-5 cm	5-15 cm	15-30 cm	30-61 cm	61+ cm
November	12	100.0	0	0	0	0	0
December	61	60.7	21.3	18.0	0	0	0
January	115	33.9	36.5	29.6	0	0	0
February	126	24.6	46.0	21.4	0	5.6	2.4
March	89	75.3	13.5	0	11.2	0	0
April	123	95.1	4.9	0	0	0	0
May	214	99.5	0.5	0	0	0	0

Table 18. Comparison of availability of the various plant communities with use by bighorn sheep, November 1974 through May 1975. "+" indicates preference, "-" indicates avoidance, and "o" indicates neither preference nor avoidance of a particular plant community at the 0.10 level (Neu et al. 1974)

Plant community	Percent study area	% Use by bighorn						
		November	December	January	February	March	April	May
Artemisia arbuscula/ Agropyron spicatum	1.2	0^{o}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}
Artemisia tridentata wyomingensis/ Agropyron spicatum	17.9	41.7^{o}	72.1^{+}	100.0^{+}	86.5^{+}	87.5^{+}	78.0^{+}	92.2^{+}
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii phase	14.0	0^{-}	13.1^{o}	0^{-}	7.1^{-}	1.1^{-}	12.2^{o}	7.8^{-}
Artemisia tridentata vaseyana/ Agropyron spicatum	31.0	58.3^{o}	14.8^{-}	0^{-}	6.3^{-}	11.4^{-}	9.8^{-}	0^{-}
Pseudotsuga menziesii/ Artemisia tridentata vaseyana	27.9	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}
Pseudotsuga menziesii/ Arnica cordifolia	5.9	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}
Riparian	0.6	0^{o}	0^{o}	0^{o}	0^{-}	0^{-}	0^{-}	0^{-}
Agricultural	1.6	0^{o}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}
Total individuals		(12)	(61)	(115)	(126)	(89)	(123)	(214)

prising 618 individuals; March, 77 groups comprising 512 individuals; April, 125 groups comprising 870 individuals; May, 98 groups comprising 765 individuals; and June, 11 groups comprising 28 individuals.

Areas utilized.–Mule deer were widely dispersed over the study area, though local population densities varied from month to month. Concentration areas during late fall and early winter included the north side of Big Lake Creek above Corral Creek, Corral Creek, and upper Marco Creek. During late winter and spring, concentration areas included lower Big Lake Creek, Jimmy Smith Creek, Ziegler Basin, Joe Jump Basin, and the East Fork of the Salmon River (Figs. 6-9).

Mule deer gradually moved downward as snow depth increased, until late January when a heavy snow, followed by subzero temperatures, triggered a rapid downward movement (Fig. 10). Mule deer showed an affinity for southern aspects (SE, S, SW, W) during November and December, but preferred northern aspects (N, NE, E, NW) January through June (Table 19). They also showed an affinity for slopes less than or equal to 30 percent (Table 20). Mule deer showed no preference for slope position November through February, but showed preference for lowest one-third of slopes and canyon bottoms March through June (Table 21). Mule deer were commonly found along the upper one-third of slopes November through February. They did not avoid snow depths up to 60 cm (24 inches) November through February, but did avoid snow depths greater than 5 cm (2 inches) March through June (Table 22). Depths approaching 60 cm (24 inches) and/or formation of a crust seemed to preclude use of an area by deer.

Plant Communities utilized.–Mule deer preferred the Douglas-fir/mountain big sagebrush community during November and December, the mountain big sagebrush/bluebunch wheatgrass community during January, and the Wyoming big sagebrush/bluebunch wheatgrass and the bluegrass phase communities February through May. The increase in use of the agricultural community in March coincided with loss of snow cover in the canyon bottom where it was located (Table 23).

Elk

Approximately 10-15 elk used the ridge between Joe Jump Basin, Marco Creek, and Woods Creek part of the winter. However, the small number and irregular observations of these elk precluded analysis of range use habits. Big Lake Creek above Corral Creek may be an elk calving ground, as approximately 20-25 cows were observed from the air the last week in May.

Cattle

Range use habits of cattle were evaluated from 143 observations representing 1,483 individuals during the May-June grazing season. These were recorded as follows: May, 100 groups comprising 984 individuals; and June, 43 groups comprising 499 individuals. Occasionally, cattle as well as horses used slopes adjacent to the valley floor after snowmelt and prior to the grazing season. Gates in the fences surrounding the fields where the cattle were held through the winter were usually left open. No cattle use occurred on the study area in fall 1974.

Areas utilized.–Cattle were widely dispersed over the study area after snowmelt. Concentration areas were Ziegler Basin, Marco Creek, Big Lake Creek, Jimmy Smith Creek, and Corral Creek. Use of an area bordered on the north by Ziegler Basin, on the east and south by East Fork Salmon River, and on the west by Marco Creek was limited to low areas along the East Fork of the Salmon River (Fig. 9).

Cattle followed snowmelt, moving rapidly upward with initiation of spring growth (Fig. 10). Cattle did not show an affinity for aspect (Table 24) but did prefer slopes less than or equal to 30 percent (Table 25) and the lowest one-third of slopes (Table 26).

Plant communities utilized.–Cattle preferred the Wyoming big sagebrush/bluebunch wheatgrass and Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase communities in May and June. Use of the mountain big sagebrush/bluebunch wheatgrass community increased in June as cattle moved to higher elevations (Table 27).

FOOD HABITS

Bighorn Sheep

A total of 13,220 instances of plant use was recorded at 70 bighorn sheep feeding sites on different plant communities between December and May (Table 28). The number of instances at each site ranged from 78 to 200. Feeding was recorded on 18 taxa including 5 grasses and grasslikes, 5 forbs, and 8 shrubs.

Grasses and grasslikes comprised 82 percent of recorded instances of use overall. This class predominated on all plant communities in all months except the mountain big sagebrush/bluebunch wheatgrass community in December, where shrubs predominated. Bluebunch wheatgrass was the most heavily used species.

Forbs ranked second in total use, with 11 percent. Biscuitroot *Lomatium* spp. was the most important taxon. Bighorn sheep appeared to seek out biscuitroot, using it in greater proportion than its occurrence. Shrub use was of minor importance overall, comprising only about 7 percent. Use of Wyoming big sagebrush was minimal on all sites, but mountain big sagebrush was moderately used on the site where it occurred. Grasses were snow-covered on this site. Use of spiny hopsage *Grayia spinosa* was heavy on sites on which it occurred (Table 28).

Table 19. Percentages of total mule deer observed on various aspects, November 1974 through June 1975. November-December chi-square test: x^2=13.2, x^2 .05, 1 degree of freedom=3.8 for SE,S,SW,W aspects vs. N,NE, E,NW aspects. January-June chi-square test: x^2=80.6, x^2 .05, 1 degree of freedom=3.8 for N,NE,E,NW aspects vs. SE,S,SW,W aspects

Month	Sample size	N	NE	E	SE	S	SW	W	NW
November	45	0	8.9	0	57.8	33.3	0	0	0
December	132	0	17.4	27.3	45.5	9.8	0	0	0
January	308	9.7	13.6	27.9	22.1	13.3	8.1	5.5	0
February	618	20.7	7.8	17.6	17.3	13.4	6.6	14.4	2.1
March	512	15.2	19.1	21.3	12.7	17.9	5.9	2.5	5.3
April	870	10.3	32.9	29.2	9.9	2.4	13.3	2.0	0
May	765	0.5	24.3	24.6	15.3	12.3	23.0	0	0
June	28	0	32.1	60.7	3.6	3.6	0	0	0

Table 20. Percentages of total mule deer observed on various slopes, November 1974 through June 1975. Chi-square test: x^2=28.6, x^2 .05, 1 degree of freedom=3.8 for slopes less than or equal to 30 percent vs. slopes greater than 31 percent.

Month	Sample size	0-20%	21-30%	31-40%	41-50%	50+%
November	45	0	4.4	95.6	0	0
December	132	0	29.6	61.4	9.1	0
January	308	21.1	32.1	39.3	6.2	1.3
February	618	23.1	31.7	21.0	16.2	7.9
March	512	28.1	24.8	35.2	2.0	0
April	870	34.4	29.4	29.6	5.3	1.3
May	765	25.1	20.7	40.4	10.3	3.5
June	28	71.4	3.6	10.7	10.7	3.6

Table 21. Percentages of total mule deer observed on various slope positions, November 1974 through June 1975. November-February chi-square test: x^2=2.7, x^2 .05, 1 degree of freedom=3.8 for lower one-third of slope and canyon bottom vs. upper two-thirds of slope. March-June chi-square test: x^2=1001.9, x^2 .05, 1 degree of freedom=3.8 for lower one-third of slope and canyon bottom vs. upper two-thirds of slope.

Month	Sample size	Ridge top	Upper third slope	Middle third slope	Lower third slope	Narrow canyon bottom	Wide canyon bottom
November	45	4.4	95.6	0	0	0	0
December	132	4.6	75.0	17.4	3.0	0	0
January	308	1.3	40.6	22.4	25.6	10.1	0
February	618	1.8	11.2	11.8	70.9	1.9	2.4
March	512	9.0	7.6	8.0	55.7	1.4	18.4
April	870	0.9	9.1	5.8	54.6	3.7	26.0
May	765	1.8	2.2	6.5	60.5	3.5	25.4
June	28	3.6	17.9	0	7.2	0	71.4

Table 22. Percentages of total mule deer observed on various snow depths, November 1974 through June 1975. November-February chi-square test: x^2=0.81, x^2 .05, 1 degree of freedom=3.8 for snow depths less than or equal to 5 cm vs. snow depths greater than 5 cm. March-June chi-square test: x^2=2054.2, x^2 .05, 1 degree of freedom=3.8 for snow depths less than or equal to 5 cm vs. snow depths greater than 5 cm.

Month	Sample size	No snow	0-5 cm	5-15 cm	15-30 cm	30-61 cm	61+ cm
November	45	6.7	4.4	88.9	0	0	0
December	132	0	0	38.6	29.5	31.8	0
January	308	0	14.0	6.5	2.3	74.0	3.2
February	618	11.2	34.5	15.4	10.7	23.8	4.5
March	512	37.9	48.1	9.7	0.8	3.5	0
April	870	81.0	19.0	0	0	0	0
May	781	94.5	5.5	0	0	0	0
June	28	100.0	0	0	0	0	0

Table 23. Comparison of availability of various plant communities with use by mule deer, November 1974 through June 1975. "+" indicates preference, "-" indicates avoidance, and "o" indicates neither preference nor avoidance for a particular plant community at the 0.10 level (Neu et al. 1974).

Plant community	Percent study area	% Use by mule deer							
		November	December	January	February	March	April	May	June
Artemisia arbuscula/ Agropyron spicatum	1.2	0^{o}	0^{o}	18.8^{+}	1.9^{o}	0^{-}	0^{-}	0^{-}	0^{o}
Artemisia tridentata wyomingensis/ Agropyron spicatum	17.9	0^{-}	0^{-}	5.5^{-}	33.8^{+}	25.0^{+}	27.2^{+}	30.8^{+}	3.6^{+}
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii phase	14.0	0^{-}	0^{-}	17.9^{o}	46.6^{+}	53.1^{+}	44.7^{+}	42.9^{+}	10.7^{o}
Artemisia tridentata vaseyana/ Agropyron spicatum	31.0	2.2^{-}	37.8^{o}	53.2^{+}	11.7^{-}	2.3^{-}	0.7^{-}	0^{-}	14.3^{o}
Pseudotsuga menziesii/ Artemisia tridentata vaseyana	27.9	93.3^{+}	62.2^{+}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}	0^{-}
Pseudotsuga menziesii/ Arnica cordifolia	5.9	4.4^{-}	0^{-}	0^{-}	0.6^{-}	0^{-}	0^{-}	0^{-}	0^{-}
Riparian	0.6	0^{o}	0^{-}	4.6^{+}	2.4^{+}	16.2^{+}	7.6^{+}	1.2^{o}	14.3^{+}
Agricultural	1.6	0^{-}	0^{-}	0^{-}	2.9^{o}	3.4^{o}	19.8^{+}	25.1^{+}	57.1^{+}
Total individuals		(45)	(132)	(308)	(618)	(512)	(870)	(781)	(28)

Table 24. Percentages of total cattle observed on various aspects, May and June 1975. Chi-square test: x^2=2.0, x^2 .05, 1 degree of freedom=3.8.

Month	Sample size	N	NE	E	SE	S	SW	W	NE
May	964	0.6	16.6	41.9	20.4	4.0	16.1	0.5	0
June	499	0	24.4	13.2	49.1	10.0	3.2	0	0

Table 25. Percentages of total cattle observed on various slopes, May and June 1975. Chi-square test: x^2=25.0, x^2 .05, 1 degree of freedom= 3.8 for slopes less than or equal to 30 percent vs. slopes greater than 31 percent.

Month	Sample size	0-20%	21-30%	31-40%	41-50%	50+%
May	984	9.5	57.1	11.3	18.0	4.2
June	499	2.0	34.7	55.5	7.8	0

Table 26. Percentages of total cattle observed on various slope positions, May and June 1975. Chi-square test: x^2=1299.3, x^2 .05, 1 degree of freedom=3.8 for lower one-third of slope vs. upper two-thirds of slope.

Month	Sample size	Ridge top	Upper third slope	Middle third slope	Lower third slope	Narrow canyon bottom	Wide canyon bottom
May	964	1.4	3.8	7.8	81.3	3.3	2.4
June	499	1.0	17.8	25.3	49.5	2.4	4.0

Table 27. Comparison of availability of various plant communities with use by cattle during May-June 1975 grazing season. "+" indicates preference, "-" indicates avoidance, and "o" indicates neither preference not avoidance of a particular plant community at the 0.10 level (Neu et al. 1974).

Plant community	Percent study area	% Use by cattle	
		May	June
Artemisia arbuscula/ *Agropyron spicatum*	1.2	0^-	3.6^+
Artemisia tridentata wyomingensis/ *Agropyron spicatum*	17.9	39.0^+	27.1^+
Artemisia tridentata wyomingensis/ *Agropyron spicatum-Poa sandbergii* phase	14.0	51.8^+	30.1^+
Artemisia tridentata vaseyana/ *Agropyron spicatum*	31.0	14.0^-	30.7^o
Pseudotsuga menziesii/ *Artemisia tridentata vaseyana*	27.9	0^-	2.0^-
Pseudotsuga menziesii/ *Arnica cordifolia*	5.9	0^-	0^-
Riparian	0.6	6.3^+	6.7^+
Total individuals	(984)	(499)	

Table 28. Frequency of occurrence and percent instances of use of plant taxa by bighorn sheep at feeding sites on plant communities, December 1974 through May 1975. Trace (T) amounts are less than 0.1 percent. Numbers in parentheses are number of feeding sites examined and total instances of use on plant communities during month respectively.

Plant taxon	December		January		February		March		April		May	
	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use
Artemisia tridentata wyomingensis/ Agropyron spicatum	(8-1500)		(11-2200)		(9-1467)		(8-1600)		(14-2566)		(13-2494)	
Agropyron spicatum	78.8	65.9	56.4	69.4	61.1	55.3	47.5	74.6	52.1	44.2	66.4	64.1
Bromus tectorum	-	-	0	0	-	-	-	-	-	-	-	-
Oryzopsis hymenoides	12.5	8.5	5.5	12.6	2.2	9.4	2.5	2.7	14.3	41.3	19.1	28.6
Stipa comata	-	-	-	-	0	4.8	-	-	-	-	-	-
Grass total	81.3	74.4	61.9	82.0	63.3	69.5	50.0	77.3	65.0	85.5	80.9	92.7
Crepis acuminata	-	-	-	-	-	-	-	-	0	T	-	-
Lomatium spp.	7.5	7.5	4.6	14.9	3.3	12.1	7.5	19.4	2.1	8.3	0.9	3.0
Lupinus spp.	8.8	6.3	2.7	1.2	1.1	2.9	0	0	1.4	1.1	0	0
Opuntia spp.	-	-	-	-	0	0	-	-	0	0	0	0
Pedicularis spp.	-	-	-	-	-	-	-	-	-	-	0	0
Phacelia spp.	-	-	0	0	-	-	-	-	-	-	-	-
Sisymbrium altissimum	-	-	-	-	-	-	-	-	-	-	0	0
Stephanomeria exigua	0	0	6.4	0.5	5.6	0.3	12.5	0.6	9.3	0.1	0.9	0
Verbascum thapsis	-	-	-	-	-	-	-	-	0	T	-	-
Forb total	16.3	13.8	13.6	16.6	10.0	15.3	20.0	20.0	12.9	9.5	15.4	3.0
Atriplex confertifolia	-	-	0	0	1.1	0	-	-	-	-	-	-
Atriplex spinescens	0.2	5.8	-	-	5.6	12.7	1.3	0	0.7	0.5	7.3	3.4
Artemisia tridentata wyomingensis	28.8	2.0	10.9	1.5	14.4	0.1	5.0	2.6	11.4	2.5	12.7	0.5
Chrysothamnus viscidiflorus	3.8	0.9	3.6	0	0	2.3	3.8	T	0.7	0	2.7	0
Erigeron filifolius	2.5	2.9	-	-	-	-	-	-	2.9	1.8	0.9	0.2
Eriogonum microthecum	0	0	0.9	0	2.2	0.1	0	0	0.7	0	0	0
Phlox hoodii	-	-	-	-	0	0	-	-	0.7	0	0.9	0
Ribes cereum	-	-	0	0	-	-	1.3	0	0.7	T	0	0.1
Browse total	35.0	11.6	15.5	1.5	23.3	15.2	11.3	2.6	17.9	4.8	23.6	4.2

Table 28. Continued.

Plant taxon	December		January		February		March		April		May	
	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii phase	(2-395)		-		(1-200)		(1-200)		(2-400)		-	
Agropyron spicatum	90.0	91.9	-	-	100.0	78.0	90.0	97.0	95.0	39.0	-	-
Oryzopsis hymenoides	5.0	0.3	-	-	0	11.5	-	-	-	-	-	-
Poa sandbergii	5.0	0	-	-	0	0	20.0	0	25.0	10.0	-	-
Grass total	90.0	92.2	-	-	100.0	89.5	90.0	97.0	95.0	49.0	-	-
Carex	-	-	-	-	-	-	-	-	5.0	50.0	-	-
Grasslike total	-	-	-	-	-	-	-	-	5.0	50.0	-	-
Astragalus	0	0	-	-	-	-	-	-	-	-	-	-
Crepis acuminata	0	0.5	-	-	-	-	-	-	-	-	-	-
Lupinus spp.	10.0	3.3	-	-	-	-	-	-	-	-	-	-
Forb total	10.0	3.3	-	-	-	-	-	-	-	-	-	-
Artemisia tridentata wyomingensis	40.0	2.3	-	-	10.0	10.5	20.0	3.0	60.0	1.0	-	-
Chrysothamnus viscidiflorus	5.0	1.3	-	-	-	-	-	-	-	-	-	-
Eriogonum microthecum	5.0	0	-	-	-	-	-	-	-	-	-	-
Leptodactylon pungens	0	0.5	-	-	-	-	-	-	5.0	0	-	-
Phlox spp.	-	-	-	-	-	-	-	-	5.0	0	-	-
Phlox hoodii	0	0	-	-	-	-	-	-	25.0	0	-	-
Phlox longifolia	0	0	-	-	-	-	-	-	-	-	-	-
Shrub total	50.0	4.1	-	-	10.0	10.5	20.0	3.0	80.0	1.0	-	-
Artemisia tridentata vaseyana/ Agropyron spicatum	(1-198)											
Agropyron spicatum	95.0	2.5										
Festuca idahoensis	5.0	30.3										
Grass total	100.0	32.8										
Lupinus spp.	20.0	4.5										
Forb total	20.0	4.5										
Artemisia tridentata vaseyana	30.0	48.0										
Chrysothamnus viscidiflorus	0	13.6										
Leptodactylon pungens	0	1.0										
Shrub total	30.0	62.6										

Mule Deer

A total of 12,248 instances of plant use by mule deer was recorded at 67 feeding sites between December and May (Table 29). The number of instances for each site ranged from 81 to 200. Feeding was recorded on 29 taxa including 4 grasses, 8 forbs, 15 shrubs, and 2 trees.

Year-long, shrubs comprised 62 percent of instances of use, but shrub use sharply decreased in March with a corresponding increase in use of grasses. Use of antelope bitterbrush *Purshia tridentata* predominated in the Douglas-fir/mountain big sagebrush community, while use of big sagebrush predominated on other communities. Mule deer appeared to seek out antelope bitterbrush, using it in greater proportion than its occurrence. Use of associated shrubs on the mountain big sagebrush community was higher than on Wyoming big sagebrush communities.

Grasses comprised 33 percent of overall use, but use was minimal until March, when loss of snow cover resulted in increased use. The exception was moderate grass use on the Wyoming big sagebrush/bluebunch wheatgrass community in January. Snow cover was typically less on this community than on the other plant communities.

Forbs were of minor importance overall, comprising 6 percent of use. Mule deer appeared to seek out lupine, using it more than expected according to its occurrence. Generally, use of forbs and grasses during late fall and early winter was incidental to feeding on shrubs.

Cattle

A total of 5,000 instances of plant use was recorded at 25 feeding sites on different plant communities during the May-June grazing season (Table 30). Two hundred instances of use were recorded at each site. Feeding was recorded on 10 taxa, including 4 grasses, 4 forbs, and 2 shrubs.

Grasses comprised 97 percent of recorded instances of use. Bluebunch wheatgrass was the most commonly used grass. Forbs and shrubs were of minor importance, comprising 1 percent and 2 percent of instances of use, respectively, and appearing to be incidental to that of grasses.

UTILIZATION OF IMPORTANT FORAGE PLANTS

Preliminary analyses of range use patterns suggested that forage competition between bighorn sheep, mule deer, and cattle was potentially greatest on the Wyoming big sagebrush plant communities. We established 10 transects to measure use of grasses by cattle, 6 transects to measure use of grasses by mule deer, and 3 transects to measure use of shrubs by mule deer. Utilization transects were established on forage species indicated by food habits studies to be important, and on sites where overlap in use between species was considered minimal. Utilization transects to measure use by mule deer were completed prior to turnout of cattle, although mule deer were still present on the sites. Forage utilization by bighorns was considered too light and variable to measure.

Mule Deer

Mule deer made considerable use of grasses with initiation of spring growth. Sandberg bluegrass began growth in early April before bluebunch wheatgrass, and received the heaviest use on the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase plant community (Table 31).

Use of Wyoming big sagebrush by mule deer did not appear to be excessive (Table 32). All site regressions of weight on length were significantly different from each other and from a combined site regression (Table 33). The sample of 50 twigs was adequate to give an estimated regression coefficient within 20 percent of the true coefficient at the 95 percent level of confidence. Browsing pressure and specific site relationships may cause significant and practical differences in twig weight-length relationships (Lyon 1970, Peek et al. 1971).

Cattle

Bluebunch wheatgrass had attained about 10-15 cm (4-6 inches) of growth prior to the initiation of cattle grazing. Height reduction generally overestimates weight of foliage removed (Smith et al. 1962). However, we feel mean reduction in height underestimated actual utilization, since regrowth occurred between the end of grazing and establishment of utilization transects. The percent of plants grazed (Table 34) suggests moderate to heavy utilization by weight (Cole 1963).

The higher utilization and higher variability in utilization of bluebunch wheatgrass in the Wyoming big sagebrush/bluebunch wheatgrass plant community versus the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase plant community reflected differences in topography between the two plant communities. The steep slopes of the Wyoming big sagebrush/bluebunch wheatgrass plant community generally precluded use of the upper two-thirds of the slope and concentrated cattle use along the bottom one-third of the slope.

CONCLUSIONS AND RECOMMENDATIONS

Interspecific Competition

Competition between mule deer, bighorn sheep, and cattle was evaluated using Cole's (1958) criteria: (1) extent to which two or more species used the same area, (2) extent to which two or more species used the same forage species,

Table 29. Frequency of occurrence and percent instances of use of plant taxa by mule deer at feeding sites on plant communities, December 1974 through May 1975. Trace (T) amounts are less than 0.1 percent. Numbers in parentheses are number of feeding sites examined and total instances of use on plant communities during month respectively.

Plant taxon	December		January		February		March		April		May	
	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use
Artemisia tridentata wyomingensis/ *Agropyron spicatum*	-		(3-600)		(2-400)		(5-1000)		(5-798)		(5-886)	
Agropyron spicatum	-	-	67.7	27.7	25.0	10.7	62.0	34.1	92.0	49.5	48.0	57.4
Bromus tectorum	-	-	1.0	0	0	0	-	-	-	-	-	-
Oryzopsis hymenoides	-	-	0	2.5	0	3.5	20.0	18.4	4.0	11.4	0	15.7
Stipa comata	-	-	-	-	0	0	-	-	-	-	-	-
Grass total	-	-	70.0	30.2	25.0	14.2	76.0	52.5	94.0	60.9	52.5	73.1
Crepis acuminata	-	-	-	-	-	-	-	-	0	0.3	-	-
Lomatium spp.	-	-	-	-	0	3.8	4.0	9.0	-	-	-	-
Lupinus spp.	-	-	-	-	0	8.7	0	2.0	0	3.3	-	-
Phacelia spp.	-	-	-	-	0	0	-	-	-	-	-	-
Opuntia spp.	-	-	0	0	0	0	0	0	0	0	-	-
Sisymbrium altissimum	-	-	0	0.5	-	-	-	-	-	-	-	-
Stephanomeria exigua	-	-	0	0	10.0	1.0	0	0	0	0	2.0	0
Forb total	-	-	0	0.5	10.0	13.5	4.0	11.0	0	3.6	2.0	0
Artemisia tridentata wyomingensis	-	-	20.0	28.3	40.0	57.2	30.0	32.6	24.0	25.9	18.0	24.8
Atriplex confertifolia	-	-	0	0	-	-	6.0	0.2	0	0	6.0	0
Atriplex spinescens	-	-	20.0	41.0	5.0	7.5	4.0	1.2	-	-	2.0	0.3
Chrysothamnus viscidiflorus	-	-	3.3	0	0	2.8	0	1.9	0	5.3	0	0
Erigeron filifolius	-	-	-	-	5.0	4.8	0	0.5	-	-	-	-
Eriogonum microthecum	-	-	0	0	0	0	2.0	0	0	0	0	1.7
Leptodactylon pungens	-	-	-	-	-	-	-	-	2.0	4.4	-	-
Phlox hoodii	-	-	-	-	-	-	-	-	8.0	0	-	-
Ribes cereum	-	-	-	-	-	-	-	-	-	-	0	0
Shrub total	-	-	43.3	69.3	50.0	72.3	38.0	36.4	34.0	35.6	24.0	26.8

Table 29. Continued.

Plant taxon	December		January		February		March		April		May	
	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii phase	-		(3-600)		(6-1027)		(7-1051)		(6-994)		(6-1200)	
Agropyron spicatum	-	-	40.0	1.7	30.0	10.4	75.7	30.0	78.3	15.4	65.0	60.8
Bromus tectorum	-	-	-	-	-	-	4.3	0	-	-	-	-
Oryzopsis hymenoides	-	-	10.0	3.3	-	-	5.7	T	-	-	11.7	5.6
Poa sandbergii	-	-	-	-	3.3	1.3	18.5	0	28.3	37.1	21.7	11.6
Grass total	-	-	46.7	5.0	33.3	11.7	84.3	30.0	91.7	52.5	80.0	78.0
Astragalus spp.	-	-	-	-	-	-	-	-	-	-	0	0
Crepis acuminata	-	-	-	-	0	0.5	0	0.5	1.7	0.1	-	-
Lomatium spp.	-	-	-	-	0	0.9	-	-	-	-	-	-
Lupinus spp.	-	-	-	-	0	7.1	4.3	6.7	3.3	3.5	0	0
Opuntia spp.	-	-	-	-	-	-	0	0	-	-	0	0
Penstemon spp.	-	-	-	-	-	-	0	0.4	3.3	0	8.3	0
Sisymbrium altissimum	-	-	-	-	-	-	0	0.5	-	-	-	-
Salsola kali tenuifolia	-	-	-	-	-	-	0	0	-	-	-	-
Stephanomeria exigua	-	-	0	8.2	-	-	-	-	-	-	-	-
Taraxacum officinale	-	-	-	-	-	-	-	-	-	-	0	0
Tragopogon dubius	-	-	-	-	-	-	-	-	-	-	1.7	0
Forb total	-	-	0	8.2	0	8.5	4.3	8.1	8.3	3.6	10.0	0
Artemisia tridentata wyomingensis	-	-	36.7	49.0	41.7	75.4	38.6	54.5	38.3	40.8	48.3	21.3
Artemisia arbuscula	-	-	-	-	0	0	-	-	-	-	-	-
Chrysothamnus viscidiflorus	-	-	6.7	18.3	1.7	0	1.4	7.2	0	20.0	0	0.7
Eriogonum caespitosum	-	-	-	-	-	-	-	-	5.0	0.3	-	-
Eriogonum microthecum	-	-	0	14.2	-	-	0	0	-	-	3.3	0
Leptodactylon pungens	-	-	-	-	0	0.2	2.9	0	3.3	0.6	-	-
Phlox spp.	-	-	-	-	-	-	8.6	T	8.3	0	3.3	0
Phlox hoodii	-	-	0	5.3	10.0	2.5	1 .3	0.3	21.7	0.2	25.0	0
Rosa spp.	-	-	-	-	0	0	-	-	-	-	-	-
Populus tremuloides	-	-	-	-	0	1.7	-	-	-	-	-	-
Shrub total	-	-	43.3	86.8	55.0	79.8	55.7	62.0	61.7	43.9	86.7	22.0

Table 29. Continued.

Plant taxon	December		January		February		March		April		May	
	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use
Artemisia tridentata vaseyana/ Agropyron spicatum	(5-1000)		(3-502)		(3-590)		-		-		-	
Agropyron spicatum	50.0	8.2	26.7	1.6	60.0	19.8	-	-	-	-	-	-
Oryzopsis hymenoides	-	-	6.7	1.0	0	0	-	-	-	-	-	-
Poa sandbergii	-	-	-	-	10.0	1.0	-	-	-	-	-	-
Grass total	50.0	8.2	26.7	2.6	66.7	20.8	-	-	-	-	-	-
Astragalus spp.	2.0	1.0	-	-	-	-	-	-	-	-	-	-
Crepis acuminata	2.0	0.4	-	-	-	-	-	-	-	-	-	-
Lupinus spp.	6.0	5.3	0	12.0	0	5.9	-	-	-	-	-	-
Penstemon spp.	0	0.1	-	-	-	-	-	-	-	-	-	-
Stephanomeria exigua	0	0	0	10.0	-	-	-	-	-	-	-	-
Forb total	46.0	6.8	0	22.0	0	5.9	-	-	-	-	-	-
Artemisia tridentata vaseyana	34.0	58.5	40.0	44.2	33.3	51.0	-	-	-	-	-	-
Chrysothamnus nauseosus	8.0	6.0	0	20.3	0	3.1	-	-	-	-	-	-
Chrysothamnus viscidiflorus	24.0	17.2	3.3	3.0	0	10.5	-	-	-	-	-	-
Eriogonum heracleoides	2.0	1.3	0	1.0	0	0.8	-	-	-	-	-	-
Leptodactylon pungens	-	-	-	-	3.3	3.9	-	-	-	-	-	-
Phlox spp.	4.0	2.0	-	-	0	0.9	-	-	-	-	-	-
Phlox hoodii	-	-	-	-	3.3	2.9	-	-	-	-	-	-
Purshia tridentata	-	-	0	7.0	-	-	-	-	-	-	-	-
Shrub total	46.0	85.0	43.3	75.5	39.9	73.1	-	-	-	-	-	-
Pseudotsuga menziesii/ Artemisia tridentata vaseyana	(7-1400)		(1-200)		-		-		-		-	
Agropyron spicatum	50.0	1.1	0	0	-	-	-	-	-	-	-	-
Festuca idahoensis	21.0	1.5	-	-	-	-	-	-	-	-	-	-
Poa sandbergii	10.0	0.8	-	-	-	-	-	-	-	-	-	-
Grass total	60.0	3.4	-	-	-	-	-	-	-	-	-	-
Achillea millefolium lanulosa	3.0	2.2	-	-	-	-	-	-	-	-	-	-
Astragalus spp.	1.0	0.4	-	-	-	-	-	-	-	-	-	-
Lupinus spp.	14.0	1.8	-	-	-	-	-	-	-	-	-	-
Forb total	7.0	4.4	-	-	-	-	-	-	-	-	-	-
Artemisia tridentata vaseyana	64.0	6.2	100.0	75.0	-	-	-	-	-	-	-	-
Chrysothamnus viscidiflorus	2.9	8.4	-	-	-	-	-	-	-	-	-	-
Purshia tridentata	2.7	55.1	20.0	25.0	-	-	-	-	-	-	-	-
Symphoricarpus oreophilus	3.0	1.3	-	-	-	-	-	-	-	-	-	-
Pseudotsuga menziesii	4.0	11.1	0	0	-	-	-	-	-	-	-	-
Shrub and tree total	81.0	92.1	100.0	100.0	-	-	-	-	-	-	-	-

Table 30. Frequency of occurrence and percent instances of use of plant taxa by cattle at feeding sites on plant communities, May and June 1975. Trace (T) amounts are less than 0.1 percent. Numbers in parentheses are number of feeding sites examined and total instances of use on plant communities during month respectively.

Plant taxon	May		June	
	Frequency of occurrence of taxon	% of total instances of use	Frequency of occurrence of taxon	% of total instances of use
Artemisia tridentata wyomingensis/ Agropyron spicatum	(7-1400)		-	
Agropyron spicatum	72.9	89.0	-	-
Oryzopsis hymenoides	7.1	10.9	-	-
Grass total	77.1	99.9	-	-
Lupinus spp.	2.9	0	-	-
Opuntia spp.	0	0	-	-
Stephanomeria exigua	0	0	-	-
Forb total	2.9	0	-	-
Artemisia tridentata wyomingensis	21.4	0.1	-	-
Atriplex confertifolia	0	0	-	-
Atriplex spinescens	4.3	0	-	-
Phlox hoodii	2.9	0	-	-
Shrub total	30.0	0.1	-	-
Artemisia tridentata wyomingensis Agropyron spicatum-Poa sandbergii phase	(8-1600)		(5-1000)	
Agropyron spicatum	51.3	51.1	80.0	79.6
Bromus tectorum	0	0	-	-
Oryzopsis hymenoides	7.5	6.0	-	-
Poa sandbergii	40.0	36.5	32.0	18.1
Grass total	82.5	93.6	86.0	97.7
Arenaria spp.	0	0	0	0
Astragalus spp.	0	0	4.0	0
Castilleja spp.	-	-	0	0
Lupinus spp.	3.8	0.7	10.0	1.3
Opuntia spp.	3.8	0	-	-
Crepis acuminata	-	-	0	0.5
Cirsium spp.	-	-	0	0
Penstemon spp.	-	-	0	0
Annual forbs	6.3	0	-	-
Unknown forbs	6.3	0.6	0	0.5
Forb total	20.0	1.3	12.0	2.3
Artemisia tridentata wyomingensis	53.8	5.1	52.0	0
Eriogonum caespitosum	2.5	0	0	0
Eriogonum spp.	-	-	0	0
Leptodactylon pungens	1.3	0	0	0
Phlox hoodii	8.8	0	14.0	0
Phlox longifolia	-	-	6.0	0
Shrub total	61.3	5.1	64.0	0
Artemisia tridentata vaseyana/ Agropyron spicatum	-		(5-1000)	
Agropyron spicatum	-	-	56.0	52.2
Festuca idahoensus	-	-	24.0	30.1
Poa sandbergii	-	-	18.0	16.4
Grass total	-	-	78.0	98.7
Crepis acuminata	-	-	2.0	0.2
Castilleja spp.	-	-	0	0
Lithosperma ruderale	-	-	2.0	0
Lupinus spp.	-	-	22.0	0.5
Astragalus spp.	-	-	2.0	0
Penstemon spp.	-	-	8.0	0
Collinsia parviflora	-	-	2.0	0
Vicia spp.	-	-	2.0	0.5
Forb total	-	-	40.0	1.2
Artemisia tridentata vaseyana	-	-	34.0	0
Chrysothamnus viscidiflorus	-	-	2.0	0.1
Eriogonum caespitosum	-	-	24.0	0
Leptodactylon pungens	-	-	10.0	0
Phlox longifolia	-	-	16.0	0
Phlox hoodii	-	-	22.0	0
Shrub total	-	-	72.0	0.1

Table 31. Utilization of *Agropyron spicatum* and *Poa sandbergii* by mule deer. Data are presented as percent of plants grazed ± S.D.

Plant community	*Agropyron spicatum*	*Poa sandbergii*
Artemisia tridentata wyomingensis/ Agropyron spicatum (3)	24.3 ± 7.6	-
Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii (3)	25.7 ± 8.5	47.7 ± 11.0

Table 32. Utilization of *Artemisia tridentata wyomingensis* by mule deer.

Site location	Percent of plants grazed	Percent utilization (wt) of plants grazed ± S.D.
Big Lake Creek	46	18.7 ± 17.4
Jimmy Smith Creek	50	36.5 ± 18.6
Marco Creek	50	27.6 ± 7.1

Table 33. Summary of correlation coefficients, twig lengths, and length-weight least squares regression equations from three sites for *Artemisia tridentata wyomingensis*. Analysis of covariance: all regressions were significantly different from each other, and a combined regression for all three sites at .05 level.

Site	Corr. coeff. %	Twig lengths		Regression equation		
		Mean (mm)	Range (mm)	Intercept	Regression coeff.	S.E. regr. coeff.
Combined	87	27	8-100	-0.795	0.162	0.008
Big Lake Creek	89	35	15-100	-1.612	0.172	0.013
Jimmy Smith Creek	87	27	8-86	-0.892	0.172	0.014
Marco Creek	67	25	11-45	-0.234	0.151	0.024

Table 34. Utilization of *Agropyron spicatum* by cattle. Figures in parentheses are numbers of sites sampled.

Plant height (cm)	*Artemisia tridentata wyomingensis/ Agropyron spicatum* (4)		*Artemisia tridentata wyomingensis/ Agropyron spicatum-Poa sandbergii* phase (6)	
	% of grazed plants ± S.D	% of ungrazed plants ±.S.D	% of grazed plants ± S.D.	% of ungrazed plants ± S.D.
0-5	8.3 ± 10.3	0	4.5 ± 5.8	0
5-10	28.8 ± 31.1	0	18.7 ± 12.2	1.6 ± 2.7
10-15	37.1 ± 28.9	7.0 ± 8.7	48.1 ± 9.0	17.9 ± 8.8
15-20	12.8 ± 15.0	8.7 ± 14.3	16.7 ± 8.5	16.5 ± 8.6
20-25	9.7 ± 15.8	47.7 ± 38.5	9.5 ± 7.9	14.4 ± 11.2
25-30	3.3 ± 5.9	19.0 ± 22.0	2.1 ± 2.4	33.5 ± 18.8
30-35	0	17.5 ± 22.1	0.2 ± 0.5	15.7 ± 11.8
Mean % of plant grazed	85.0 ± 16.6		61.5 ± 22.8	
Mean reduction in height	40.2 ± 15.9		27.7 ± 14.6	

and (3) extent to which important forage plants were in limited supply or deteriorating in production as a result of combined use.

Competition between bighorn sheep, mule deer, and cattle appeared to exist for bluebunch wheatgrass on the Wyoming big sagebrush/bluebunch wheatgrass plant community. While bighorn sheep preferred south-facing slopes more than 31 percent, mule deer preferred north-facing slopes less than 30 percent, and cattle preferred slopes less than 30 percent on all aspects. Therefore, slopes of less than 30 percent appeared to be the most critical. Mule deer showed preference for Wyoming big sagebrush during winter but made considerable use of bluebunch wheatgrass during the spring. Competition was greatest at initiation of spring growth, when all three species made considerable use of bluebunch wheatgrass on low-elevation slopes. Competition between cattle and mule deer on the Wyoming big sagebrush/bluebunch wheatgrass-Sandberg bluegrass phase was also suggested.

The fact that these low-elevation communities are composed of relatively few species, are retrogressed by past use, and are adjacent to cliffy escape cover and to privately owned bottomlands makes them readily accessible to both cattle and bighorn sheep, and especially susceptible to competition. On many sites, grasses are so sparse that any grazing inevitably produces circumstances where competition may be potentially severe.

Management Recommendations

The following recommendations are based on our assumption that restoration of natural resource lands to maximum site potential is the primary management goal. This goal should provide conditions suitable not only for maintaining or increasing the current bighorn sheep population, but also for reintroduction of bighorn sheep onto historic range if our hypothesis that existing conditions on the winter range constitute the primary limiting factor is correct. A two-fold approach is indicated by this investigation: (1) the current livestock grazing system should be modified to minimize competition with bighorn sheep, and (2) a program should be initiated to improve range condition, especially on the critical Wyoming big sagebrush/bluebunch wheatgrass community.

Any modification of annual grazing practices should be designed to improve critical forage species. Several alternatives are available, but it is beyond the scope of this study to evaluate the necessary criteria for selection of the most practical one.

Improvement of range condition may also involve: (1) artificial revegetation of specific sites where grasses are lacking, and (2) burning of specific sites where grasses are more prevalent. Artificial revegetation should provide forage currently lacking, and burning should stimulate vigor of grasses, promote increased use by bighorn sheep, and perhaps discourage use by mule deer. It must be recognized that range condition will change very slowly, especially initially, even if grazing by all three species, bighorn sheep, mule deer, and cattle, were to be eliminated, as data from Morgan Creek north of the study area indicate (W. Bodie pers. comm.).

Evaluation of range modification practices should cover the following criteria: (1) remeasurement of esta-

blished vegetation transects to determine composition, production and utilization, and changes in soil erosion due to burning; (2) evaluation of bighorn sheep and mule deer use of treated and untreated areas; and (3) assessment of population size, production, and survival for bighorn sheep and mule deer.

Implementation of these recommendations would serve to help test the hypothesis that winter forage conditions are limiting this bighorn population and that continued evaluation is critical. The increased use of burned areas by mule deer and bighorns suggests that this practice should be evaluated more fully as a range and population improvement technique.

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