Food habits, range use and relationships between elk and livestock in the Gravelly Mountains, Montana by Charles Dean Eustace

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University
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Abstract:
A study of food habits , range use and relationships between elk and livestock was made in 1965-66 on a 130 square mile area of the Gravelly Mountains, Southwestern Montana. The past history of usage of the area by elk, cattle and sheep was discussed. The physiography and vegetation of the area was described. The vegetation was divided into three zones Fescue-Wheatgrass, Douglas-fir and Spruce-Fir. Each zone was divided into several types. Quantitative measurements of canopy coverage and plant density were made for many of the types. Use of each vegetation zone by elk and livestock was evaluated. Food habits were determined from the examination of feeding sites; 79 for elk, 60 for cattle, and 18 for sheep.

The diet in winter for elk consisted of 97% grasses and 2% forbs while in summer it consisted of 67% forbs and 33% grasses. The spring diet for cattle consisted of 70% grasses and 30% forbs whereas the summer diet consisted of 79% grasses and 21% forbs. The sheep diet consisted of 72% forbs and 28% grasses in summer. The canopy coverage of individual plant species was recorded at each feeding site. This provided a measure of abundance. A statistical analysis was conducted to determine the relationship between abundance of individual plant species and their significance in the diets of the animals. Negative, neutral, and positive food preferences were indicated. The summer range data for each of the three animal classes indicated that the average canopy coverage was highest for those plants' for which the animals showed a negative' preference. This may imply that the,abundance of some or all of these plants was so great that it more than satisfied the needs of the animals, and was not an actual indication of a negative preference. Species composition of the vegetation was determined on the winter and summer ranges by the use? of 1,000 feet of basal intercept line transect. Forage utilization was determined by the use of 14 exclosures on the winter range and five on the summer range.

Circular O.96 square foot plots were clipped inside and outside the exclosures. Percent utilization was indicated by the difference in the inside and outside total vegetation weights, air dried. Clipping results indicated an almost equal percent utilization of total vegetation by elk and cattle on the winter range. There appeared to be very little competition between cattle and elk on the winter range and none on the summer range. Similarities of the elk and sheep diets suggested the possibility of competition on summer range.

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CHARLES DEAN EUSTACE

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ABSTRACT

A study of food habits, range use and relationships between elk and livestock was made in 1965-66 on a 130 square mile area of the Gravelly Mountains, Southwestern Montana. The past history of usage of the area by elk, cattle and sheep was discussed. The physiography and vegetation of the area was described. The vegetation was divided into three zones; Fescue-Wheatgrass, Douglas-fir and Spruce-Fir. Each zone was divided into several types. Quantitative measurements of canopy coverage and plant density were made for many of the types. Use of each vegetation zone by elk and livestock was evaluated. Food habits were determined from the examination of feeding sites; 79 for elk, 60 for cattle, and 18 for sheep. The diet in winter for elk consisted of 97% grasses and 2% forbs while in summer it consisted of 67% forbs and 33% grasses. The spring diet for cattle consisted of 70% grasses and 30% forbs whereas the summer diet consisted of 79% grasses and 21% forbs. The sheep diet consisted of 72% forbs and 28% grasses in summer. The canopy coverage of individual plant species was recorded at each feeding site. This provided a measure of abundance. A statistical analysis was conducted to determine the relationship between abundance of individual plant species and their significance in the diets of the animals. Negative, neutral, and positive food preferences were indicated. The summer range data for each of the three animal classes indicated that the average canopy coverage was highest for those plants for which the animals showed a negative preference. This may imply that the abundance of some or all of these plants was so great that it more than satisfied the needs of the animals, and was not an actual indication of a negative preference. Species composition of the vegetation was determined on the winter and summer ranges by the use of 1,000 feet of basal intercept line transect. Forage utilization was determined by the use of 14 exclosures on the winter range and five on the summer range. Circular 0.96 square foot plots were clipped inside and outside the exclosures. Percent utilization was indicated by the difference in the inside and outside total vegetation weights, air dried. Clipping results indicated an almost equal percent utilization of total vegetation by elk and cattle on the winter range. There appeared to be very little competition between cattle and elk on the winter range and none on the summer range. Similarities of the elk and sheep diets suggested the possibility of competition on summer range.

INTRODUCTION

According to records of the Montana Fish and Game Department, numbers of elk (Cervus canadensis nelsoni) have increased greatly in recent years on the Beaverhead National Forest in the vicinity of Wall Creek, Madison County, Southwestern Montana (Fig. 1). Local ranchers reported about 6, 30, and 158 elk wintering on the Wall Creek area in 1935, 1942, and 1950 respectively. Present numbers total nearly 300.

Depredations by elk and mule deer (Odocoileus hemionus) on private lands adjacent to public lands also increased by the early 1950's. To help alleviate the depredation problem and to increase the amount of winter range available to elk and mule deer, 6,467 acres of land adjacent to the public lands were purchased or leased by the Montana Fish and Game Department during 1960-61. This land, known as the Wall Creek Game Range, was reserved exclusively for use by game animals. Forest lands immediately adjacent to the game range are used by cattle in spring as well as by elk and mule deer in winter. There appeared to be localized grazing conflicts between elk and cattle on the forest lands.

An elk range and food habits study was conducted on the Beaverhead National Forest in the southern portion of the Gravelly Mountain Range by Rouse (1956), but observations of competition between elk and livestock were limited. Studies in Montana which included elk-livestock relations were made by Stevens (1965) in the Elkhorn Mountains, and Mackie (1965) in the Missouri River Breaks. Findings were not entirely applicable to the Wall Creek area. The objectives of my study, during the summer of 1965 and the spring and summer of 1966, were to determine seasonal

distributions, movements, food habits, range use and relations to livestock of the elk which winter on the Wall Creek Game Range.

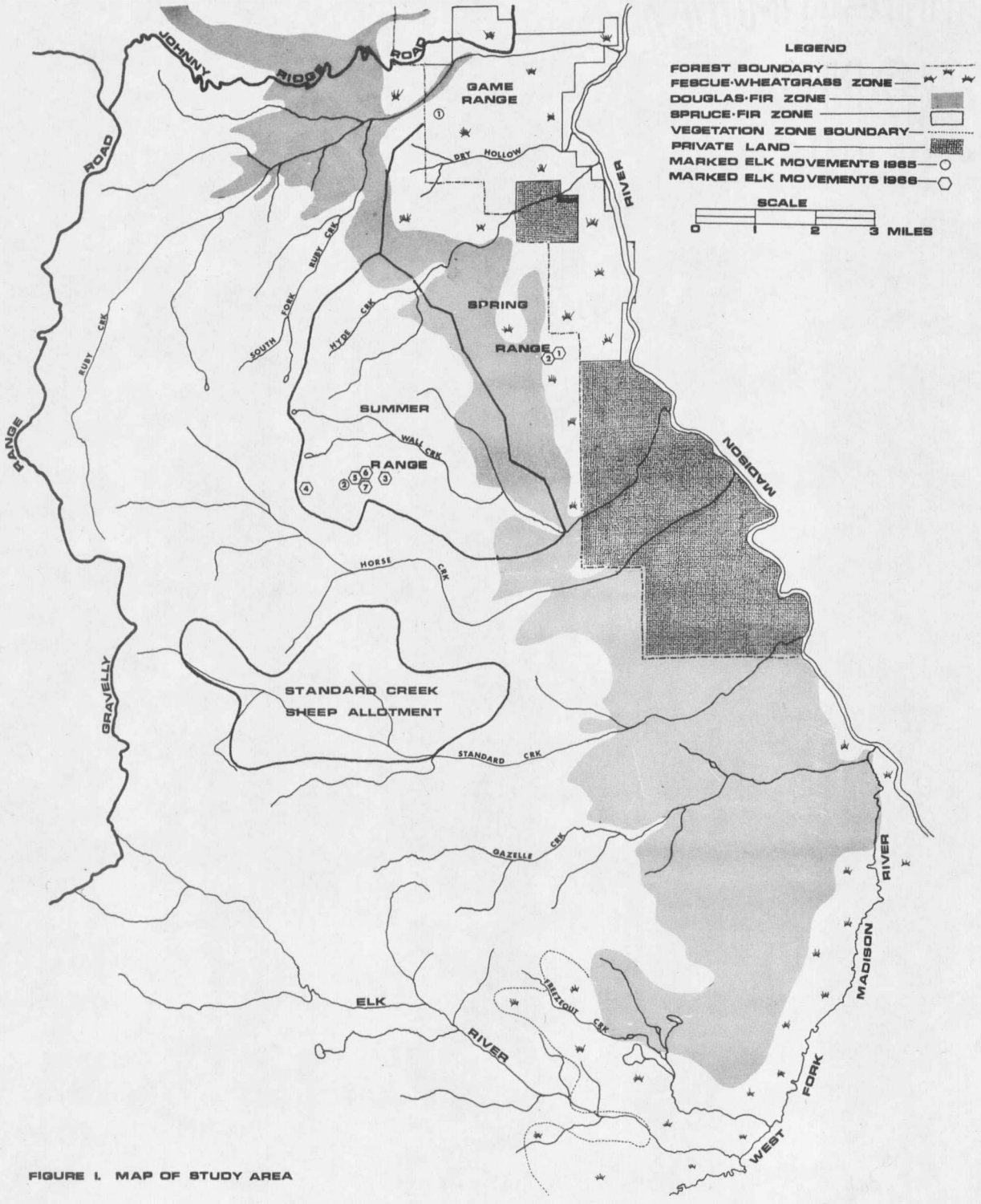


FIGURE 1. MAP OF STUDY AREA

PHYSIOGRAPHY OF STUDY AREA

The Gravelly Mountain Range is a north-south range approximately 32 miles long by 8-20 miles wide lying south of Virginia City. The east slope of the Gravellies is characterized by an initial abrupt rise in elevation of 800 to 1,000 feet followed by gradual elevation increases culminating in moderately rounded mountain tops. The west slope is characterized by long gradual slopes without abrupt elevation changes. Some major drainages have cut deep V-shaped gorges but most drainages are relatively broad. Elevations range from 5,600 feet on the Madison River to 10,545 feet on Black Butte Mountain.

The study area which consisted of approximately 130 square miles on the east slope of the Gravellies, including Wall Creek Game Range, was bounded on the west by the Gravelly Range Road, by Ruby Creek Drainage on the north, Elk River on the south, and the Madison River on the east (Fig. 1).

VEGETATION OF STUDY AREA

Plants were collected from the study area. Identification of species was verified by W. E. Booth. This plant collection aided in identifying plant species in the field. Scientific and common names are from Booth (1950) and Booth and Wright (1962).

Classification of vegetation was influenced by the works of Daubenmire (1943), and Kirsch (1966). The study area was divided into three major zones; the Fescue (Festuca spp.) - Wheatgrass (Agropyron spp.) Zone, the Douglas-fir (Pseudotsuga menziesii) Zone, and the Engelmann spruce (Picea engelmanni) - Subalpine fir (Abies lasiocarpa) Zone. Each zone was subdivided into several types.

Canopy coverage and frequency of occurrence of grasses, forbs, and shrubs on many of these types was measured along 193 transects by the canopy coverage method of Daubenmire (1959)(Table I). Twenty 2x5 decimeter plots with five paces between plots were measured along 74 transects and ten plots with two paces between plots were measured along the others.

On 14 unprotected sites basal intercept of plant species was measured along 50 foot line transects (Canfield, 1941). Measurements were made along a 100 foot line transect in each of four sites protected by exclosure fences to exclude various types of hoofed mammals (see later section). The combined data for all transects are included in Table II.

Vegetation of timber types was studied mainly by direct observation.

Fescue-Wheatgrass Zone

The fescue-wheatgrass zone dominated from 5,800 to 7,000 feet. It was divided into three types.

TABLE I. CANOPY COVERAGE AND FREQUENCY OF TAXA FOR GRASSES, FORBS, AND SHRUBS ON THE FESCUE-WHEATGRASS AND THE SPRUCE-FIR ZONES AS INDICATED BY MEASUREMENTS FROM 2,620 TWO X FIVE DECIMETER PLOTS ON 193 SITES.

Taxa 1/	Fescue-Wheatgrass Zone			Spruce-Fir Zone			
	Fescue-Wheatgrass Type 59 sites 870 plots	Sagebrush-Fescue Type 23 sites 430 plots	Aspen-Willow Type 3 sites 30 plots	Fescue-Wheatgrass Type 59 sites 720 plots	Sagebrush-Fescue Type 22 sites 280 plots	Drainage-Disturbed Type 22 sites 240 plots	Timber-Type 5 sites 50 plots
Grass and Grass-like Plants							
Agropyron spicatum	5/48 2/	3/38	-	-	-	-	-
Agropyron subsecundum	-	-	-	5/42	3/30	2/26	tr/2
Bromus marginatus	-	-	-	1/14	tr/5	3/28	-
Bromus spp.	-	-	1/30	-	-	-	-
Calamagrostis rubescens	-	-	-	-	-	-	15/26
Carex spp.	tr/23	1/18	2/30	8/63	10/73	15/52	1/18
Danthonia intermedia	-	-	-	2/20	1/14	tr/5	tr/2
Deschampsia caespitosa	-	-	-	-	-	3/22	-
Festuca idahoensis	18/80	25/93	-	18/80	11/71	tr/6	2/32
Festuca scabrella	-	-	-	4/19	tr/6	-	-
Hordeum brachyantherum	-	-	-	-	-	1/11	-
Koeleria cristata	3/49	tr/15	-	-	-	-	-
Phleum alpinum	-	-	-	tr/6	tr/3	1/21	-
Poa spp.	8/82	7/84	60/97	5/50	8/72	7/63	2/38
Stipa columbiana	-	-	-	2/16	5/33	3/24	-
Stipa comata	8/52	2/11	-	-	-	-	-
Trisetum spicatum	-	-	-	1/15	1/17	5/51	-
Forbs							
Achillea millefolium	1/18	4/57	2/33	6/69	5/77	5/67	1/38
Agoseris glauca	-	-	-	3/44	3/42	2/29	1/14

TABLE I. CONTINUED

Taxa	Fescue-Wheatgrass Zone			Spruce-Fir Zone			
	Fescue-Wheatgrass Type 59 sites 870 plots	Sagebrush-Fescue Type 23 sites 430 plots	Aspen-Willow Type 3 sites 30 plots	Fescue-Wheatgrass Type 59 sites 720 plots	Sagebrush-Fescue Type 22 sites 280 plots	Drainage-Disturbed Type 22 sites 240 plots	Timber-Type 5 sites 50 plots
Antennaria spp.	6/58	3/42	-	1/10	-	-	-
Arnica cordifolia	-	-	-	-	-	-	6/42
Arnica sororia	1/16	6/43	-	-	-	-	-
Aster canescens	1/8	tr/5	-	-	-	-	-
Astragalus miser	4/44	9/21	-	-	-	-	-
Erigeron compositus	1/20	-	-	-	-	-	-
Erigeron spp.	-	-	-	7/29	2/12	2/15	-
Erythronium grandiflorum	-	-	-	-	-	-	3/46
Fragaria spp.	-	-	-	-	-	tr/3	1/18
Geranium viscosissimum	-	2/15	2/20	2/12	1/17	2/16	tr/16
Geum triflorum	-	-	-	4/31	3/29	-	-
Lupinus sericeus	6/39	7/60	1/23	-	-	-	-
Lupinus spp.	-	-	-	4/24	5/27	tr/8	4/32
Phlox spp.	2/39	1/21	-	2/17	-	-	-
Potentilla spp.	-	1/11	2/27	6/58	7/60	11/64	2/30
Taraxacum spp.	tr/14	6/34	39/100	9/34	24/75	40/93	16/46
Trifolium spp.	-	-	-	4/25	6/37	10/55	10/24
Viola nuttallii	-	-	-	-	-	2/9	-
Shrubs							
Artemisia frigida	1/23	tr/12	-	-	-	-	-
Artemisia tridentata	-	7/34	1/13	-	8/24	tr/4	-
Chrysothamnus spp.	2/15	tr/7	-	-	-	-	-
Rosa spp.	-	-	2/17	-	-	-	-
Tetradymia canescens	tr/2	tr/3	-	-	-	-	-

1/ Includes only taxa with mean canopy coverage values of one percent or more for at least one vegetation type. Exceptions are denoted by tr (trace).

2/ Canopy coverage/Frequency. Mean percentages for the plots evaluated on the vegetation types.

TABLE II. AGGREGATE PERCENTAGES OF BASAL INTERCEPTS FOR TAXA MEASURED ALONG 50 AND 100 FOOT LINE TRANSECTS (1,750 FEET TOTAL FOR FESCUE-WHEATGRASS ZONE, 150 FEET TOTAL FOR DOUGLAS-FIR ZONE).

	Agropyron spicatum	*Festuca idahoensis*	*Koeleria cristata*	*Poa* spp.	*Stipa comata*	Misc. grass	Misc. forbs
Fescue-Wheatgrass Zone							
Fescue-Wheatgrass Type	.7	4.8	.7	2.2	.9	.1	1.2
Douglas-fir Zone							
Sagebrush-Fescue Type	.7	4.2	-	.9	-	1.5	4.2

Fescue-Wheatgrass Type: This type (Fig. 2) was dominant from 5,800 to 6,600 feet. The lower portion was dominated by bluebunch wheatgrass (Agropyron spicatum) and the upper portion by Idaho fescue (Festuca idahoensis). Needle-and-thread (Stipa comata), bluegrasses (Poa spp.), and Junegrass (Koeleria cristata) were common in both segments with needle-and-thread showing local dominance. Miser milkvetch (Astragalus miser), pussytoes (Antennaria spp.), and silky lupine (Lupinus sericeus) were common forbs. Common shrubs were fringed sagewort (Artemisia frigida) and rabbitbrush (Chrysothamnus spp.).

Sagebrush-Fescue Type: This type (Fig. 3) was dominant from 6,600 to 7,000 feet. Big sagebrush (Artemisia tridentata) was the dominant shrub with Idaho fescue, bluegrasses and bluebunch wheatgrass important understory grasses. Milkvetch, silky lupine, dandelion (Taraxacum spp.), and a species of arnica (Arnica sororia) were common forbs.

Aspen-Willow Type: This type (Fig. 4) dominated drainage bottoms and other mesic sites. Kentucky bluegrass (Poa pratensis) and dandelion were the most common grass and forb respectively in the understory. Rose (Rosa spp.) was the most abundant shrub.

Douglas-fir Zone

The Douglas-fir zone dominated from 7,000 to 7,800 feet. It was divided into three types. Vegetation measurements were limited to two 50 foot line transects in the sagebrush-fescue park type. Measurements for both transects were made in 1965 but for only one in 1966.

Timber Type: This was the most extensive type (Fig. 4). It was



Figure 2. Fescue-Wheatgrass Type in the Fescue-Wheatgrass Zone.



Figure 3. Sagebrush-Fescue Type in the Fescue-Wheatgrass Zone.

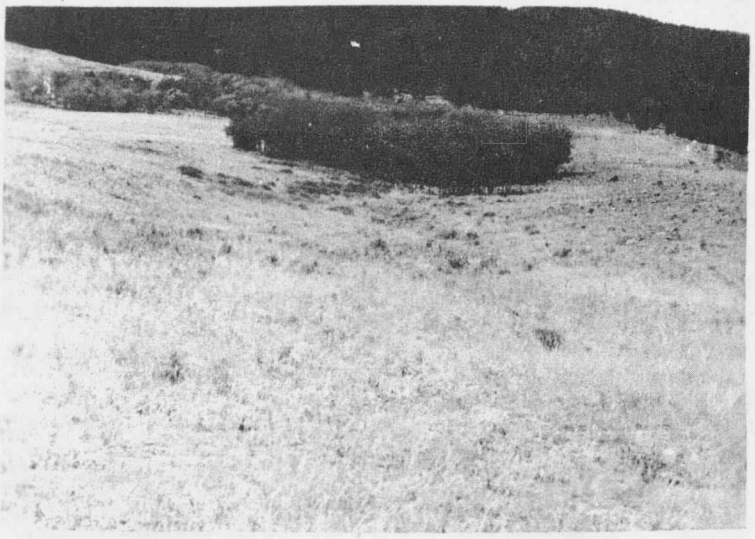


Figure 4. Aspen-Willow Type center, in the Fescue-Wheatgrass Zone with the Timber Type of the Douglas-fir Zone in the background.



Figure 5. Sagebrush-Fescue Type foreground and Aspen Type center in the Douglas-fir Zone.

characterized by a dense overstory of Douglas-fir with occasional whitebark pine (Pinus albicaulis) and limber pine (Pinus flexilis). Common shrubs were roundleaf snowberry (Symphoricarpos oreophilus) and Oregon grape (Berberis repens). Pinegrass (Calamagrostis rubescens) was the predominant grass. Potentilla (Potentilla spp.) and strawberry (Fragaria spp.) were common forbs.

Sagebrush-Fescue Park Type: This type (Fig. 5) was found in open parks throughout the zone. In many areas it was merely an upward extension of the sagebrush-fescue type from the grassland zone. Data in Tables I and II show similarities in the occurrence of certain grasses for the type in both zones.

Aspen Type: This type (Fig. 5) was found in drainage bottoms, rocky outcroppings, and certain side hill exposures. The understory was very similar to the aspen-willow type in the fescue-wheatgrass zone.

Engelmann spruce-Subalpine fir Zone

This zone predominated from 7,800 to 9,200 feet with frequent occurrences at lower elevations on north facing slopes. Four important types were described.

Fescue-Wheatgrass Park Type: This type (Fig. 6) occupied the xeric sites in parks and along ridge tops. Important grasses and grass like plants were Idaho fescue, bearded wheatgrass (Agropyron subsecundum), sedge (Carex spp.), and bluegrasses. Dandelion, daisy (Erigeron spp.), yarrow (Achillea millefolium), and potentilla were common forbs.

Sagebrush-Fescue Park Type: This type (Fig. 7) occupied the mesic

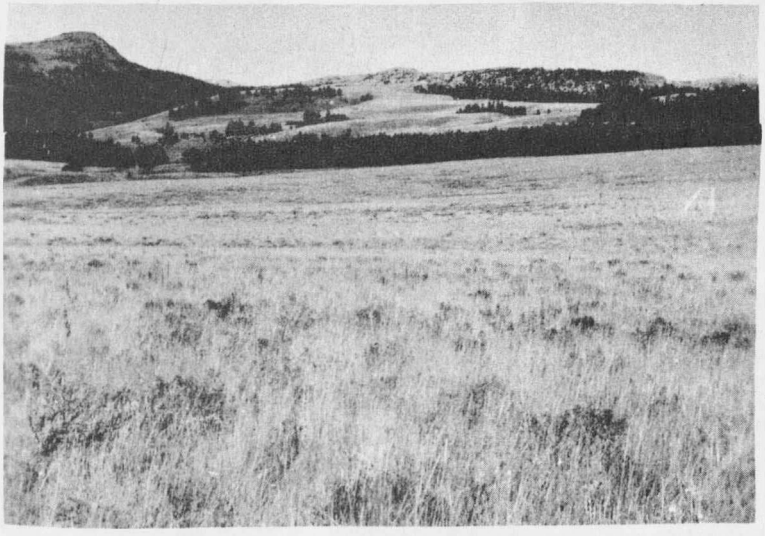


Figure 6. Fescue-Wheatgrass Type in the Spruce-Fir Zone with the Timber Type in the background.



Figure 7. Sagebrush-Fescue Type in the Spruce-Fir Zone.

drainages and small depressions in the fescue-wheatgrass park type. Big sagebrush was the dominant overstory with Idaho fescue, sedge, and bluegrasses important understory grasses and grass-like plants. Dandelion, potentilla, and clover (Trifolium spp.) were common forbs.

Drainage and Disturbed Type: This consisted of two small subtypes at elevations of 8,800 feet and above. Disturbed sites were steep hillsides which were covered by deep snow banks for a considerable portion of the year, greatly reducing the vegetative cover. Drainage sites (Fig. 8) consisted of both low gradient drainages and depressions which received above average moisture. This type was characterized by sedge, bluegrasses, spike trisetum (Trisetum spicatum), and tufted hairgrass (Deschampsia caespitosa). Dandelion, potentilla, and clover were common forbs.

Timber Type: This type (Fig. 6) was characterized by an Engelmann spruce-subalpine fir climax with scattered areas of lodgepole pine (Pinus contorta), whitebark pine, and limber pine. Common understory plants were low red huckleberry (Vaccinium scoparium), meadow rue (Thalictrum spp.), and Heartleaf arnica (Arnica cordifolia). Data in Table I were collected on five elk feeding sites in semi-open whitebark pine bordering the closed canopy timber type, and are not a true representation of the timber type.



Figure 8. Drainage Type in the Spruce-Fir Zone.

RANGE USE AND MOVEMENTS

Elk

During 1965-66, 1,830 observations of individual elk in 78 groups were recorded by vegetation type during 78 observation trips in the study area (Table III). Many elk were observed repeatedly on successive trips.

Elk were observed only on the fescue-wheatgrass zone in April. The fescue-wheatgrass and sagebrush-fescue types received all of the usage noted. Most use was confined to public lands adjacent to the game range but others have observed elk using portions of the game range extensively during mid-winter. Certain south facing slopes and ridges received the most intensive use (Table XI and Fig. 10, Appendix). The timber type of the Douglas-fir zone was used for escape and resting cover. During the third week of April a decreased number of elk was observed on the winter range but the number observed during the fourth week increased. This was probably due to a heavy snow fall at the end of the third week which caused a downward movement of elk. No elk were observed on the winter range after May 6. Picton (1960) reported elk leaving the Sun River winter range in Northern Montana, during the last week in April.

Elk were not observed again until the last week of May. Almost all were in the fescue-wheatgrass and sagebrush-fescue types of the spruce-fir zone. This suggested a rapid upward movement through the intermediate Douglas-fir zone.

During late May and early June two-year olds and calves of the previous spring (yearlings) were observed together in small groups. Cows were generally observed singly or in small groups. Bulls were rarely observed at this time.

TABLE III. PERCENTAGE DISTRIBUTION BY MONTH OF 1,830 OBSERVATIONS OF INDIVIDUAL ELK IN 78 GROUPS ON THE FESCUE-WHEATGRASS AND SPRUCE-FIR ZONES.

Month	Fescue-Wheatgrass Zone		Spruce-Fir Zone				Total
	Fescue-Wheatgrass Type	Sagebrush Fescue Type	Fescue-Wheatgrass Type	Sagebrush-Fescue Type	Drainage-Disturbed Type	Timber Type	
April	55/7[1]	45/11	-	-	-	-	605/18[2]
May	91/8	-	6/3	3/3	-	-	284/14
June	-	-	92/9	8/5	-	-	105/14
July	-	-	27/7	23/4	32/8	18/3	784/22
August	-	-	57/3	-	-	43/6	51/9
September	-	-	-	-	-	100/1	1/1

1/ Percent of individual elk observations/number of groups.

2/ Total number of individual elk observations/number of groups.

In June extensive use was made of the xeric fescue-wheatgrass type by cows. Newborn calves were first observed on the 4th of June. They were in the sagebrush-fescue type. Dense sagebrush was twice observed to be used for concealment of calves temporarily left alone by cows. Cows formed larger groups in mid-June and frequently remained in open parks for the entire day.

In July increased use was made of the timber type during the day with feeding periods restricted to early morning and late evening. This may have been partially caused by the increasing numbers of insects. The greatest numbers of elk were observed during July because of the large aggregations present. Two groups of 106 and one group of 80 were counted. Elk utilized the highest segments of their summer range from early to mid-July feeding on ridge tops and high open parks. In late July elk use decreased on the high ridges and increased on the lower more mesic sagebrush-fescue and disturbed-drainage types. This may have been due to a desiccation of forbs on the more xeric sites.

A sharp decrease in the group size and number of elk observed occurred in August. A similar observation was made by Kirsch (1962) and Stevens (1965). Elk used low heavily timbered areas and timbered drainages in the spruce-fir zone. Vision was extremely limited in these areas.

In January 1965, two elk, a cow and a calf, were individually marked with neck bands to aid in determining seasonal movements. Relocations were recorded only for the cow (Fig. 1). Eight relocations, two on the

winter range and six on the summer range, indicated a yearly movement of at least $6\frac{1}{2}$ airline miles from winter to summer range.

Cattle

Cattle entered the Wall Creek spring range on June 15 during 1965 and 1966. Cattle grazed and rested almost exclusively on the fescue-wheatgrass and sagebrush-fescue types of the fescue-wheatgrass zone during mid-June. In late June and early July considerable use was made of the aspen-willow type of the fescue-wheatgrass zone and the timber type of the Douglas-fir zone for feeding and resting. During this period the fescue-wheatgrass and sagebrush-fescue types were used very early in the morning and late in the evening.

Cattle distribution on the spring range was affected by the Cattleman's Association rider who tried to keep the cattle uniformly distributed.

Cattle entered the summer range by the 15th and 26th of July for 1965 and 1966 respectively. Most of the cattle started at the highest point on the summer range and worked downward as the summer progressed.

During 1965 cattle were fairly evenly distributed over the fescue-wheatgrass and sagebrush-fescue types of the spruce-fir zone. In 1966 the fescue-wheatgrass type was little used through the first week of August. At this time drainages containing the sagebrush-fescue and drainage-disturbed types were used almost exclusively. By mid-August cattle were feeding heavily on the fescue-wheatgrass and sagebrush-fescue types. Timber types were used as resting areas.

Cattle and elk were never observed to use the same area for feeding

simultaneously even though cattle were on the summer range during the period when the largest concentrations of elk were recorded. Elk were observed to run from one feeding site when approached by an Angus cow and calf.

Sheep

Sheep range in the Gravellies is restricted to the higher elevations in the spruce-fir zone. Grazing begins when the Forest Service determines the range is "ready", usually about mid-July. The various sheep bands leave the summer range at different times due to different sized allotments and sheep bands.

All observations on sheep were made on the Standard Creek Allotment. Heaviest use was on the fescue-wheatgrass type with disturbed types receiving moderate use. Grazing occurred in the morning and from mid-afternoon on. Timber types were used for shade and resting during the day. Movements were largely controlled by the herder who followed a plan established by the Forest Service.

FOOD HABITS

A total of 40,661 instances of plant use was recorded on 199 feeding sites to determine the importance of various plant species in the elk, cattle, and sheep diets. Feeding site examinations were conducted immediately after the feeding site had been vacated by feeding animals. Each "bite" from a plant was recorded as one instance of use as described by Knowlton (1960). The percent of the diet constituted by each plant species was computed for each feeding site. These percentages were totaled and averaged using the aggregate percent method (Martin et al, 1946). Daubenmire transects were run in conjunction with each individual feeding site to determine the percent canopy coverage of each species on the feeding site. The average of the differences between the percent of the diet and the percent canopy coverage for each species was tested statistically by a two-tailed t-test at the five percent level of significance (Li, 1965). The hypothesis tested was: there is no significant difference between the percent of the diet constituted by an individual species and its abundance in the plant community (expressed as percent canopy coverage). Each plant species was placed statistically in one of three animal preference categories; (1) a positive preference indicated the plant species was utilized in proportions significantly greater than its abundance, (2) a neutral preference indicated the plant species was utilized more or less in proportion to its abundance, and (3) a negative preference indicated the plant species was utilized in proportions significantly less than its abundance. The results for the two years could not be tested together statistically because of a methods

change the second year. In most cases during the first summer, only those species which were utilized were identified by species on the Daubenmire transect. All other vegetation was lumped under miscellaneous grasses or forbs. This did not take into account plants which were frequently present but seldom utilized. This was corrected the second year by recording all species which could be identified whether or not they had been utilized. Even though the results for both years follow similar trends it is felt that the statistical analysis for 1966 is more meaningful. Therefore only the 1966 data are included in Tables IV, V and VI. The 1965 data are included in Appendix Tables XII and XIII.

Elk

Winter Range: A total of 7,791 instances of plant use was recorded for 38 feeding sites. Usage was divided as follows: grasses 96%, forbs 2%, and browse 1%. A definite preference was indicated for the new spring growth of Idaho fescue and bluegrass. These two grasses formed 89% of the total diet. No preference was shown for either forbs or browse. Browse was of importance only once. This followed a late April snow storm when rabbitbrush formed 22% of the diet on one site.

Summer Range: A total of 8,000 instances of use was recorded for 41 feeding sites. Usage was divided into 67% forbs and 33% grasses. Utilization of grasses decreased sharply in late May and early June when forbs began to appear. No preference was shown for any grass species on the summer range. All were taken in apparent proportion to their abundance or at a level below their abundance.

TABLE IV. ELK FOOD HABITS AS INDICATED BY 15,791 INSTANCES OF PLANT USE AT 79 FEEDING SITES 1966.

Taxa	Winter April-May 38 Feeding Sites				Summer May-August 41 Feeding Sites			
	Number Instances of use	% of Diet	% of Community	t-value 380 plots	Number Instances of use	% of Diet	% of Community	t-value 410 plots
Agropyron spicatum	579	5[1]	4[2]	+1.282[3]	-	-	-	-
Agropyron subsecundum	-	-	-	-	156	2	3	-2.587S
Bromus spp.	-	-	-	-	118	1	1	+0.818
Carex spp.	-	-	-	-	355	4	6	-3.326S
Festuca idahoensis	5433	71	22	+16.965S	432	5	14	-5.155S
Festuca scabrella	-	-	-	-	94	1	3	-5.450S
Koeleria cristata	75	1	1	+0.654	-	-	-	-
Poa spp.	1381	18	11	+4.738S	670	8	9	-0.386
Trisetum spicatum	-	-	-	-	201	3	3	+0.338
Miscellaneous grass	-	-	-	-	601	6	6	+0.315
Total grass	7468	95	-	-	2627	30	-	-
Achillea millefolium	-	-	-	-	206	3	6	-4.347S
Agoseris glauca	-	-	-	-	613	8	4	+4.019S
Arnica cordifolia	-	-	-	-	209	3	tr	+1.867
Delphinium bicolor	-	-	-	-	128	2	2	+0.204
Erigeron spp.	-	-	-	-	90	1	3	-2.318S
Geranium viscossissimum	-	-	-	-	441	6	1	+3.162S
Geum triflorum	-	-	-	-	400	5	5	+0.052
Lupinus spp.	-	-	-	-	190	2	3	-0.129
Pedicularis cystopteridifolia	-	-	-	-	96	1	tr	+0.735
Potentilla spp.	-	-	-	-	505	6	10	-3.439S
Taraxacum spp.	-	-	-	-	1331	17	22	-2.700S
Trifolium spp.	-	-	-	-	195	2	6	-3.678S
Miscellaneous forbs	84	2	4	-5.685S	575	7	11	-4.260S
Total forbs	84	2	-	-	4979	63	-	-

TABLE IV. (Continued)

1/ Only those species which comprised more than one percent of the total diet are included.

2/ As determined by canopy coverage.

3/ S indicates a significant t-value which may be either positive or negative.

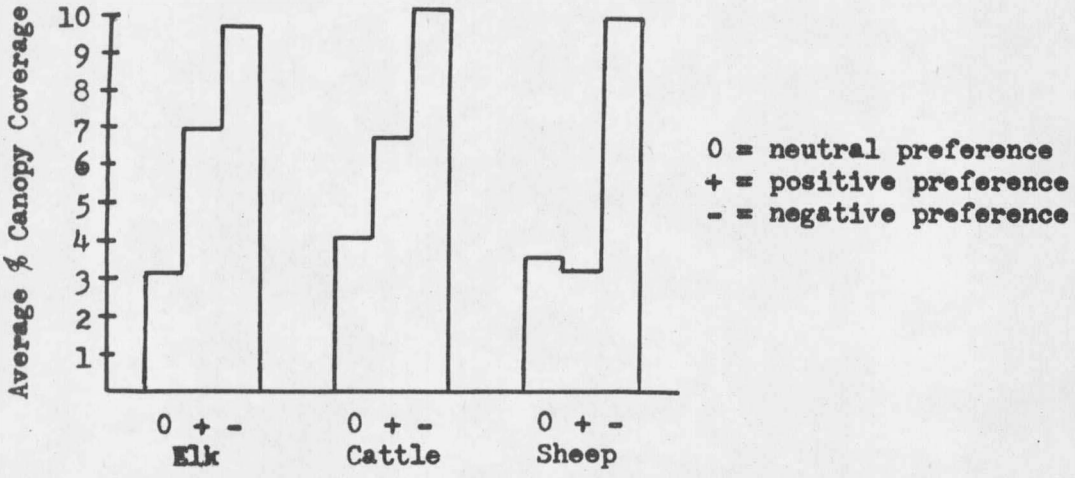


Fig. 9 Forage preference in relation to abundance as expressed by percent canopy coverage on the spruce-fir zone.

Usage of forbs showed a subsequent gain during the summer. A positive preference was shown for only two forbs, pale agoseris (Agoseris glauca) and sticky geranium (Geranium viscossissimum). The data indicate that with the exception of daisy (Erigeron spp.), the forbs for which there was a significant negative t-value were the most abundant species in the forb community. This trend also holds if all canopy coverage values are averaged for grasses and forbs (Fig. 9). This may imply that some or all of these plants were not actually associated with a negative preference, but that their abundance was so great as to more than satisfy the needs of the elk.

Cattle

Spring Range: A total of 7,476 instances of plant use was recorded on 37 feeding sites. Usage was divided into 70% grasses and 30% forbs.

A positive preference was recorded for bluebunch wheatgrass, one-spike oatgrass (Danthonia unispicata), and needle-and-thread. Junegrass was the only grass for which a negative preference was indicated. All other grasses appeared to be taken in amounts fairly close to their abundance. Among forbs, a definite preference was noted for prairie milkvetch (Astragalus striatus) and bastard toadflax (Comandra umbellata). Prairie milkvetch was taken almost to the exclusion of all other species when cattle first entered the range. Arnica was the only forb for which a negative preference was indicated.

Summer Range: A total of 4,652 instances of plant use was recorded on 23 feeding sites. Usage was divided into 79% grasses and 21% forbs. A positive preference was shown for bearded wheatgrass, sedges, meadow barley (Hordeum brachyantherum), and bluegrass. Idaho fescue was also important but was generally taken in proportion to its abundance. A negative preference was shown for the majority of forbs. A decrease in the use of forbs accompanied by a tripling of the average percent canopy coverage for forb species on the summer range may account for these negative preferences. As with elk, it would appear that the abundance of forbs was greatly in excess of the cattle needs.

Sheep

Summer Range: A total of 3,563 instances of plant use was recorded on 18 feeding sites. Usage was divided into 28% grasses and 72% forbs. Most grasses were taken in proportion to their abundance except Idaho fescue for which a negative preference was indicated. Idaho fescue,

TABLE V. CATTLE FOOD HABITS AS INDICATED BY 12,128 INSTANCES OF PLANT USE AT 60 FEEDING SITES 1966.

Taxa	Spring June-July 37 Feeding Sites				Summer July-August 23 Feeding Sites			
	Number Instances of use	% of Diet	% of Community	t-value 370 plots	Number Instances of use	% of Diet	% of Community	t-value 230 plots
Agropyron spicatum	727	10[1]	4[2]	+2.578S[3]	-	-	-	-
Agropyron subsecundum	-	-	-	-	256	5	4	+2.209S
Calamagrostis montanensis	206	3	1	+1.661	-	-	-	-
Carex spp.	81	1	2	-0.452	1052	23	17	+2.712S
Danthonia intermedia	-	-	-	-	94	2	3	-1.830
Danthonia unispicata	108	1	tr	+4.535S	-	-	-	-
Deschampsia caespitosa	-	-	-	-	146	3	3	-0.253
Festuca idahoensis	1109	16	19	-1.905	661	14	10	+0.995
Festuca scrabrella	-	-	-	-	221	5	4	+0.388
Hordeum brachyantherum	-	-	-	-	78	2	1	+25.618S
Koeleria cristata	99	1	4	-4.428S	-	-	-	-
Phleum alpinum	-	-	-	-	62	1	tr	+1.367
Poa spp.	627	9	9	-0.608	466	10	7	+2.122S
Stipa columbiana	-	-	-	-	367	8	7	+1.434
Stipa comata	1858	26	10	+5.951S	-	-	-	-
Trisetum spicatum	-	-	-	-	223	5	2	+1.842
Miscellaneous grass	58	1	1	+0.881	96	2	1	+2.719S
Total grass	4873	68	-	-	3722	80	-	-

TABLE V. (Continued)

Taxa	Spring June-July 37 Feeding Sites				Summer July-August 23 Feeding Sites			
	Number Instances of use	% of Diet	% of Community	t-value 370 plots	Number Instances of use	% of Diet	% of Community	t-value 230 plots
Achillea millefolium	-	-	-	-	68	1	5	-4.650S
Agoseris glauca	-	-	-	-	76	2	1	+1.527
Arnica sororia	66	1	2	-3.670S	-	-	-	-
Aster canescens	117	2	1	+0.447	-	-	-	-
Astragalus miser	343	5	3	+0.847	-	-	-	-
Astragalus striatus	701	10	1	+3.866S	-	-	-	-
Comandra umbellata	220	4	1	+2.963S	-	-	-	-
Erigeron spp.	-	-	-	-	69	2	4	-3.930S
Geum triflorum	-	-	-	-	44	1	1	-0.899
Potentilla spp.	-	-	-	-	72	2	7	-4.178S
Taraxacum spp.	143	3	5	-1.330	383	8	25	-4.799S
Trifolium spp.	-	-	-	-	82	2	6	-5.379S
Miscellaneous forbs	120	2	4	-4.291S	90	2	9	-4.561S
Total forbs	1710	27	-	-	885	20	-	-

1/ Only those species which comprised more than one percent of the total diet are included.

2/ As determined by canopy coverage.

3/ S indicates a significant t-value which may be either positive or negative.

bearded wheatgrass, and sedges were the main grass and grass-like plants in the diet. A positive preference was shown for pale agoseris, potentilla, and sencio (Senecio spp.) which together formed 30% of the diet. When positive, negative, and neutral preferences are averaged for grasses and forbs, they show a pattern similar to that for elk and cattle with the exception of a lower positive preference (Fig. 9).

TABLE VI. SHEEP FOOD HABITS AS INDICATED BY 3,563 INSTANCES OF PLANT USE AT 18 FEEDING SITES 1966.

Taxa	Summer July-August 18 Feeding Sites			
	Number Instances of use	% of Diet	% of Community	t-values 180 plots
Agropyron subsecundum	216	6[1]	6[2]	+0.017[3]
Bromus marginatus	87	2	4	-1.153
Carex spp.	149	4	9	-1.944
Festuca idahoensis	164	5	10	-2.772S
Hordeum brachyantherum	35	1	1	-3.548
Poa spp.	76	2	2	+0.635
Stipa columbiana	83	2	3	-1.129
Trisetum spicatum	80	2	2	+0.100
Miscellaneous grass	62	2	2	-0.441
Total grass	917	26	-	-
Agoseris glauca	576	16	4	+3.188S
Aster spp.	85	2	tr	+2.464
Geranium viscosissimum	73	2	6	-1.793
Helianthella uniflora	334	9	1	+2.431
Potentilla spp.	366	10	5	+2.328S
Senecio spp.	145	4	1	+4.048S
Taraxacum spp.	174	5	3	+0.663
Thalictrum spp.	124	6	1	+1.310
Trifolium spp.	90	3	4	-1.868
Miscellaneous forbs	482	14	9	+1.350
Total forbs	2359	71	-	-

1/ Only those species which comprised more than one percent of the total diet are included.
2/ As determined by canopy coverage.
3/ S indicates a significant t-value which may be either positive or negative.

FORAGE UTILIZATION AND VEGETATION CHARACTERISTICS

To determine the effects of elk and cattle on the elk winter range, personnel of the U. S. Forest Service erected four one-acre exclosures adjacent to Wall Creek Game Range in 1962 as follows: (1) a total exclosure to exclude all grazing animals, (2) an elk exclosure which excluded elk in winter but permitted cattle to graze in spring, (3) a cattle exclosure which excluded cattle in spring but allowed elk to graze in winter and (4) an elk-cattle exclosure which permitted all animals to graze. To measure forage utilization, I clipped and weighed the vegetation from 0.96 square foot circular plots located within the exclosures. Vegetation samples were air dried for at least two weeks before weighing. In 1965, ten plots were clipped in July on each exclosure after the cattle had used the range in spring. In 1966, 20 plots were clipped on each exclosure as follows: (1) in May after elk used the range in winter, (2) in June before cattle used the range in spring and (3) in July after cattle used the range in spring. The vegetation samples were converted to pounds per acre (Table VII) in an attempt to determine utilization and to evaluate the impact of grazing by cattle and elk on the vegetation. To help compensate for any errors possibly due to inadequate sampling, all measurements of the total vegetation on each exclosure were totaled for comparison with similar figures for each of the other exclosures. Figures for the total exclosure, elk exclosure, cattle exclosure, and elk-cattle exclosure were 7,579, 5,588, 5,292, and 4,505 pounds per acre respectively. These figures indicate the greatest impact on areas used jointly by cattle and elk.

TABLE VII. WEIGHTS PER ACRE FOR VEGETATION ON ELK WINTER RANGE AS DETERMINED BY MEASUREMENTS OF TWO HUNDRED EIGHTY 0.96 SQUARE FOOT CIRCULAR PLOTS IN FOUR ONE-ACRE EXCLOSURES.

	Total Exclosure	Elk Exclosure	Elk-Cattle Exclosure	Cattle Exclosure
Agropyron spicatum	132/ 237/ 235/ 534[1/]	170/ 62/ 101/ 82	210/ 234/ 94/ 81	50/ 24/ 132/ 309
Festuca idahoensis	420/ 860/ 817/ 807	250/ 508/ 875/ 877	230/ 361/ 475/ 495	370/ 362/ 587/ 676
Miscellaneous grass	100/ 141/ 122/ 108	50/ 141/ 195/ 197	50/ 97/ 92/ 44	180/ 286/ 290/ 239
Total grass	650/1238/1174/1449	470/ 711/1171/1156	490/ 692/ 661/ 620	600/ 672/1009/1224
Total forbs	1400/ 467/ 474/ 727	640/ 324/ 552/ 564	680/ 300/ 469/ 593	800/ 262/ 502/ 223
Total vegetation	2050/1705/1648/2176	1110/1035/1723/1720	1170/ 992/1130/1213	1400/ 934/1511/1447

1/ All figures indicate pounds per acre in the following sequence: after use by cattle in spring 1965/after use by elk in winter 1966/before cattle use in spring 1966/after cattle use in spring 1966.

They further suggest a greater impact by elk than by cattle. The difference in pounds per acre for total vegetation between the elk and the cattle exclosures is due primarily to the greater abundance of forbs on the former. The difference in pounds per acre between the elk-cattle exclosure and the elk and the cattle exclosures is due primarily to the greater abundance of grass on each of the two latter exclosures.

Forage utilization by elk during the winter amounted to 15 and 33% on the exclosure used jointly by cattle and elk and on the exclosure used only by elk respectively. That the overall intensities of use for both exclosures was similar is indicated by the fact that both contained approximately the same quantity of vegetation when elk left the winter range.

Forage utilization by cattle was masked by continued plant growth during the period they were on the spring range. Data from the total exclosure indicated a total vegetation increase of 32% for this period. If 32% potential vegetation increase is assumed for both the elk and elk-cattle exclosures during this same period then a total percent utilization of 34 and 19% respectively is indicated.

Basal intercept of plant species was measured along a 100 foot line transect in each of the four exclosures in May. This provided an index for plant density and species composition. Plant density as indicated by total basal intercept expressed as a percentage differed between exclosures (Table VIII). The percentage value was greatest for the total exclosure. Values for the others in order from highest to lowest were

TABLE VIII. VEGETATION COMPOSITION OF ELK WINTER AND SUMMER RANGE AS DETERMINED BY MEASUREMENTS OF BASAL INTERCEPT ALONG 1,000 FEET OF LINE TRANSECT.

Taxa	Winter						Summer
	One Acre Exclosures				Three Game Range	Seven Forest Land	Two Forest Land
	Total Excl. 100 ft. of Transect	Elk Excl. 100 ft. of Transect	Elk-Cattle Excl. 100 ft. of Transect	Cattle Excl. 100 ft. of Transect	Excl. 150 ft. of Transect	Excl. 350 ft. of Transect	Excl. 100 ft. of Transect
Agropyron spicatum	0.3[1/]	0.8	0.3	0.3	2.7	0.3	0.7
Festuca idahoensis	8.3	7.3	7.1	6.3	4.4	2.7	2.4
Koeleria cristata	-	0.1	0.3	0.2	3.3	0.3	-
Poa spp.	4.6	3.3	3.0	1.2	3.2	0.5	0.9
Stipa columbiana	-	-	-	1.7	-	-	-
Stipa comata	-	-	-	-	1.3	1.4	-
Miscellaneous grass	0.1	0.1	0.1	0.1	-	0.1	2.0
Antennaria spp.	-	-	0.1	0.3	0.2	0.1	0.3
Phlox spp.	-	-	0.1	0.3	-	0.2	-
Miscellaneous forbs	1.4	1.0	0.7	0.4	1.0	1.1	5.3
Total vegetation	14.7	12.6	11.7	10.8	16.1	6.7	11.6

1/ Percent of total transect intercepted by each species.

elk exclosure, elk-cattle exclosure and cattle exclosure. Most of the difference in plant densities was attributable to Idaho fescue and bluegrasses. Decreases in values for these grasses was accompanied by an increase in values for Junegrass, Columbia needlegrass (Stipa columbiana), pussytoes, and phlox (Phlox spp.).

These data indicate a lower value for plant density on the exclosure grazed by elk alone than for either the exclosure grazed by cattle alone or the exclosure grazed by cattle and elk combined. I do not believe that the indicated differences in plant densities are due to grazing alone. Other ecological factors possibly masked the influence of grazing. The four exclosures are located on a low crested ridge with a slope of four to six percent. The total exclosure is located towards the bottom and the cattle exclosure is located towards the top of this ridge. Distance between exclosures is about 30 yards. The lower portion of the slope originates in a dominant fescue-wheatgrass type and the upper portion terminates in a dominant sagebrush-fescue type. The intermediate area is occupied by an ecotone between the two.

I established fifteen 6x6 foot exclosures by the placement of agronomy cages on the forest and game range as follows: game range three, Forest Service winter range seven, and summer range five. Methods for determining percent utilization were the same as for the larger exclosures. Clippings on the cattle spring (elk winter), and summer range, (cattle and elk), were made as follows: (1) in May after use by elk in winter, (2) in June before use by cattle in spring, (3) in July after use by cattle in

spring, (4) in July after use by elk in summer, (5) in July before use by cattle in summer and (6) in October after use by cattle in summer. Measurements for each individual exclosure are given in Tables XIV, XV, and XVI in the Appendix.

Combined data for the game range exclosures (Table IX), indicated usage values of 24 and 8% for grass and forbs respectively by elk in winter. Total vegetation utilization was 21%. Bluebunch wheatgrass and Idaho fescue were heavily used. The high indicated utilization of bluebunch wheatgrass is probably fairly representative of its use on other areas. However, its relatively high density here (Table VIII), allows more accurate measurement on these three exclosures than on others.

The seven exclosures on the forest winter range were on south, west, and southwest facing slopes and ridgetops which usually remain free of snow during winter and receive heavy use by elk. Elk utilized grass and forbs 33 and 34% respectively with the heaviest use on Idaho fescue, 48%. Total utilization was 33%. Cattle frequently use these same areas during spring. Utilization of grass and forbs was 15 and 57% respectively. Idaho fescue was the most heavily used grass with 48% utilization. Total utilization was 34%.

Three of the five exclosures on summer range were in areas expected to receive heavy elk and cattle use. Elk utilization totaled 18% with 21 and 15% on grass and forbs respectively (Table X). Elk utilization was probably masked somewhat by rapid early growth on the summer range. Cattle utilization totaled 48% with 58 and 33% on grass and forbs respectively.

TABLE IX. FORAGE UTILIZATION BY ELK AND CATTLE AS INDICATED BY WEIGHTS OF VEGETATION FROM TWO HUNDRED THIRTY 0.96 SQUARE FOOT CIRCULAR PLOTS 1/ ON THE FESCUE-WHEATGRASS ZONE.

Taxa	Winter Game Range 3 Exclosures			Winter Range Forest Land 7 Exclosures						
	After Elk Use			After Elk Use			Before Cattle use	After Cattle Use		
	Inside 15 plots	Outside 15 plots	% utilization	Inside 35 plots	Outside 35 plots	% utilization	70 plots	Inside 30 plots	Outside 30 plots	% utilization
	2/									
Agropyron spicatum	297	187	37	38	39	-	37	36	51	-
Festuca idahoensis	365	251	31	201	104	48	125	155	81	48
Koeleria cristata	34	45	-	19	15	21	15	-	-	-
Poa spp.	37	34	8	39	31	21	17	-	-	-
Stipa comata	59	65	-	73	59	19	68	69	87	-
Miscellaneous grass	7	23	-	11	8	27	3	39	34	13
Total grass	799	605	24	381	256	33	265	299	253	15
Total forbs	206	189	8	173	114	34	196	232	100	57
Total vegetation	1005	794	21	554	370	33	461	531	353	34

1/ One-half of the plots were within 6x6 foot exclosures. The others were outside the exclosures.

2/ All figures except % utilization represent pounds per acre.

TABLE X. FORAGE UTILIZATION BY ELK AND CATTLE AS INDICATED BY WEIGHTS OF VEGETATION FROM ONE HUNDRED FORTY-SEVEN 0.96 SQUARE FOOT CIRCULAR PLOTS 1/ ON THE SPRUCE-FIR ZONE.

	Summer Range 5 Exclosures						
	After Elk Use			Before Cattle use	After Cattle Use		
	In-side 20 plots	Out-side 20 plots	% util-iza-tion	25 plots	In-side 41 plots	Out-side 41 plots	% util-iza-tion
Grass	1283 2/	1014	21	1094	1252	523	58
Forbs	809	691	15	597	791	531	33
Total	2092	1705	18	1691	2043	1054	48

1/ One-half of the plots were within 6x6 foot exclosures. The others were outside the plots.

2/ All figures except % utilization represent pounds per acre.

Fifty foot line transects were installed and the basal intercept of vegetation measured in conjunction with 12 of the 6x6 foot exclosures (Table VIII). These data indicate the highest total vegetation index on the game range exclosures. The seven exclosures on key forest land winter range areas show the lowest index of total vegetation density. Individual transect measurements are recorded in Table XVII Appendix.

RANGE RELATIONSHIPS

Four criteria were presented by Cole (1958) and reviewed by Stevens (1965) for determining competition between big game and livestock. These criteria are: (1) that game and livestock use the same range areas, (2) that game and livestock use the same forage plants, (3) that the forage plants are an important source of forage for either game or livestock, and (4) that the forage plants are in limited supply or deteriorating in production as a result of combined use. I used these criteria in an attempt to evaluate competition between elk and cattle as well as between elk and sheep. A meaningful interpretation of the last criterion was difficult because no data on range trends were available for periods previous to my study.

Elk-Cattle

U. S. Forest Service grazing records showed approximately 650 cattle on the Wall Creek spring and summer ranges in 1937. The number of cattle increased to approximately 750 by 1942. These early records showed cattle grazing on the spring range for the entire months of June and October. Grazing on the summer range occurred during July, August, and September. From 1960 on, cattle grazing was restricted to the spring range from approximately mid-June to mid-July. The summer range was grazed from mid-July to mid-October. With the purchase of the Wall Creek Game Range in 1960-61, the Fish and Game Department acquired and retired the grazing rights for 311 head of cattle which had formerly grazed on both the forest spring and summer ranges. Since 1960, cattle animal unit months have been reduced from approximately 1,400 to 500 on the Wall Creek spring range.

Numbers of elk on the Wall Creek Unit have increased from the mid-1930's as was previously noted.

Data in Tables IV and V indicated only three plant species of significance in either diet were used in common by both elk and cattle on the elk winter range. These were bluebunch wheatgrass, Idaho fescue and bluegrass. Data from the seven exclosures on key elk winter range (Table IX), indicated heavy utilization only on Idaho fescue; 48% by both elk and cattle. This probably does not represent excessive use because of the difference in time of use by elk and cattle.

Data from Tables IV and V do not suggest competition between cattle and elk on the summer range. For each grass species for which cattle displayed a positive preference, elk displayed a negative or neutral preference. The same holds true for forbs. Whereas the elk diet consisted mainly of forbs, the cattle diet consisted mainly of grass. It would appear that the food habits of each animal complimented that of the other on the summer range.

Elk-Sheep

An early history of overgrazing by sheep along a sheep driveway in the Gravellies is indicated by the following quotation from a Forest Service report (1926). "Continuous overgrazing for years has been so severe as to kill even the sagebrush. By July 12, 1932 only 12 days after sheep had been admitted to the National Forest, this land had been stripped of practically all usable vegetation. This is public domain land on which no control of grazing is in effect." U. S. Forest Service

sheep grazing records from 1932 to the present indicate a steady reduction in the numbers of sheep, and time spent by sheep on the summer range. This is represented by a reduction of 30 to 60% in the animal unit months on different allotments.

During my study elk were not observed to use areas in conjunction with sheep. Since elk were found in areas directly adjacent to sheep allotments, and were observed on the Standard Creek Allotment before sheep arrived, it is possible that elk and sheep are not compatible. Similar observations were noted by Stevens (1965).

When considering the percent of the diet and the percent of the community constituted by each plant species, the summer food habits of elk and sheep (Tables IV and VI) followed almost identical trends for grasses. Pale agoseris was the only forb for which a mutual positive preferences was indicated. The five forbs used in common by sheep and elk formed 36 and 39% of their diets respectively. Forbs formed 72 and 67% of the sheep and elk diets respectively. This indicated a possibility for competition for forbs.

APPENDIX

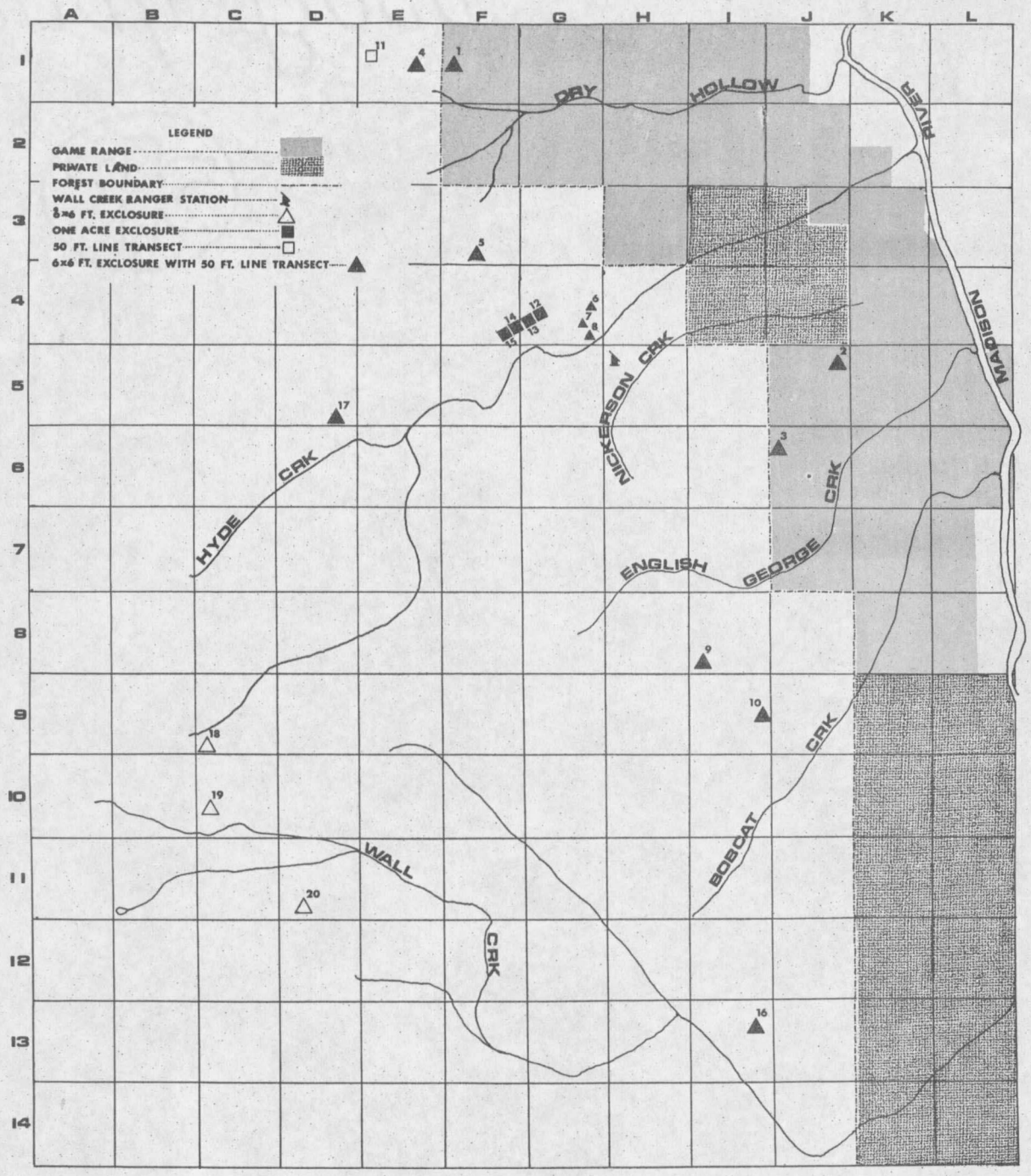


Figure 10. Grid Map of study area for use with Table XVII in showing locations of elk observations. Locations of line transects and exclosures are also shown.

TABLE XI. PERCENTAGES OF 1,170 INDIVIDUAL ELK OBSERVATIONS ON WINTER RANGE, APRIL-MAY 1966, LISTED BY $\frac{1}{4}$ SQUARE MILE.

Location	Percent of Elk	Location	Percent of Elk	Location	Percent of Elk
D5[1/]	0.8	G4	13.8	I11	0.7
E4	1.2	H6	2.9	J7	7.0
E5	8.7	H7	9.4	J8	10.0
F1	1.0	I8	10.9	J9	4.1
F4	19.5	I9	5.8	J11	4.1

1/ See Figure 10 for locations.

TABLE XII. FOOD HABITS OF ELK AS INDICATED BY 3,830 INSTANCES OF PLANT USE AT 18 FEEDING SITES 1965.

Taxa	Summer June-August 18 Feeding Sites			
	Number Instances of use	% of Diet	% of Community	t-value 180 plots
		1/	2/	
Carex spp.	136	3	4	-0.738 3/
Festuca idahoensis	41	1	12	-3.425S
Poa spp.	213	5	5	+0.585
Miscellaneous grass	235	6	10	-2.735S
Total grass	625	14	-	-
Achillea millefolium	108	3	9	-4.143S
Agoseris glauca	296	8	2	+2.664S
Aster spp.	217	5	3	+0.898
Erigeron spp.	106	3	2	+0.309
Geranium viscossissimum	154	4	2	+1.498
Geum triflorum	149	4	2	+1.406
Potentilla spp.	155	4	5	-0.651
Taraxacum spp.	1065	25	21	+2.530S
Trifolium spp.	102	2	9	-3.993S
Viola nuttallii	116	3	1	+2.632
Miscellaneous forbs	477	14	22	-2.522S
Total forbs	2945	75	-	-

1/ Only those species which comprised more than one percent of the total diet are included.

2/ As determined by canopy coverage.

3/ S indicates a significant t-value which may be either positive or negative.

TABLE XIII. FOOD HABITS OF CATTLE AS INDICATED BY 5,349 INSTANCES OF PLANT USE AT 24 FEEDING SITES 1965.

Taxa	Spring June-July 10 Feeding Sites				Summer July-August 14 Feeding Sites			
	Number Instances of use	% of Diet	% of Community	t-value 200 plots	Number Instances of use	% of Diet	% of Community	t-value 280 plots
Agropyron spicatum	383	18 [1]	4 [2]	+1.913 [3]	-	-	-	-
Agropyron subsecundum	-	-	-	-	463	15	5	+2.515S
Bromus spp.	-	-	-	-	37	2	1	+1.268
Carex spp.	56	3	2	+1.044	455	17	11	+3.087S
Danthonia unispicata	59	2	4	+1.338	-	-	-	-
Festuca idahoensis	433	20	23	-0.407	301	10	12	-1.103
Festuca scabrella	-	-	-	-	78	3	2	+1.358
Koeleria cristata	87	4	2	+1.484	-	-	-	-
Poa spp.	258	13	5	+2.719S	380	13	8	+2.425S
Stipa columbiana	-	-	-	-	167	6	3	+1.752
Stipa comata	412	17	4	+2.737S	-	-	-	-
Miscellaneous grass	72	4	1	+2.489	230	9	5	+1.680
Total grass	1760	81	-	-	2111	75	-	-
Achillea millefolium	-	-	-	-	32	1	5	-2.044
Agoseris glauca	-	-	-	-	60	2	1	+1.406
Arnica sororia	30	2	2	-5.250	-	-	-	-
Astragalus spp.	58	3	2	+0.487	-	-	-	-
Taraxacum spp.	131	3	1	+1.238	231	9	19	-2.972S
Trifolium spp.	-	-	-	-	108	4	9	-2.275
Miscellaneous forbs	72	4	1	-1.708	138	5	20	-6.569S
Total forbs	291	12	-	-	569	21	-	-

1/ Only those species which comprised more than one percent of the total diet are included.
2/ As determined by canopy coverage.
3/ S indicates a significant t-value which may be either positive or negative.

TABLE XIV. FORAGE UTILIZATION BY ELK AS INDICATED BY WEIGHTS OF VEGETATION FROM THIRTY 0.96 SQUARE FOOT CIRCULAR PLOTS 1/ ON THE FESCUE-WHEATGRASS ZONE 1966.

Taxa	Winter Game Range After Elk Use								
	Exclosure 1			Exclosure 2			Exclosure 3		
	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization
Agropyron spicatum	118 2/	58	51	424	372	12	348	130	63
Festuca idahoensis	488	352	28	-	-	-	608	402	34
Koeleria cristata	42	34	19	44	86	-	16	14	12
Poa spp.	42	52	-	58	42	28	10	8	20
Stipa comata	56	54	4	106	122	-	14	18	22
Miscellaneous grass	16	34	-	4	10	-	0	26	-
Total grass	762	584	23	636	632	1	996	598	40
Total forbs	136	254	-	190	202	-	292	110	62
Total vegetation	898	838	7	826	834	-	1288	708	45

1/ One-half of the plots were within 6x6 foot exclosures. The others were outside the exclosures.

2/ All figures except % utilization represent pounds per acre.

TABLE XV. FORAGE UTILIZATION BY ELK AS INDICATED BY WEIGHTS OF VEGETATION FROM SEVENTY 0.96 SQUARE FOOT CIRCULAR PLOTS 1/ ON THE FESCUE-WHEATGRASS ZONE 1966.

Taxa	Winter Range Forest Land After Elk											
	Exclosure 4			Exclosure 5			Exclosure 6			Exclosure 7		
	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization
Agropyron spicatum	42 2/	26	38	-	142	-	130	28	78	-	8	-
Festuca idahoensis	154	92	40	146	-	-	244	144	41	188	130	31
Koeleria cristata	42	20	52	66	50	24	6	6	0	16	20	-
Poa spp.	38	66	-	-	8	-	26	6	77	46	54	-
Stipa comata	32	44	-	58	30	48	108	46	57	100	130	-
Miscellaneous grass	-	4	-	10	6	40	-	-	-	-	6	-
Total grass	308	252	18	280	236	16	514	200	61	350	348	1
Total forbs	184	130	29	320	82	74	72	86	-	276	146	47
Total vegetation	492	382	22	600	318	47	586	286	51	626	494	21

TABLE XV. (Continued)

Taxa	Winter Range Forest Land After Elk								
	Exclosure 8			Exclosure 9			Exclosure 10		
	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization
Agropyron spicatum	64	44	31	-	8	-	28	14	50
Festuca idahoensis	34	96	-	476	198	58	168	100	40
Koeleria cristata	-	-	-	-	-	-	4	12	-
Poa spp.	44	38	14	100	38	62	20	8	60
Stipa comata	158	140	11	-	-	-	54	22	59
Miscellaneous grass	38	40	-	26	-	-	-	-	-
Total grass	338	358	-	602	244	59	274	156	43
Total forbs	172	112	35	110	130	-	80	110	-
Total vegetation	510	470	18	712	374	47	354	266	25

1/ One-half of the plots were within 6x6 foot exclosures. The others were outside the exclosures. All plots were clipped in May.

2/ All figures except % utilization represent pounds per acre.

TABLE XVI. FORAGE UTILIZATION BY CATTLE AS INDICATED BY WEIGHTS OF VEGETATION FROM SIXTY 0.96 SQUARE FOOT CIRCULAR PLOTS 1/ ON THE FESCUE-WHEATGRASS ZONE 1966.

Taxa	Spring Range Forest Land After Cattle								
	Exclosure 5			Exclosure 6			Exclosure 7		
	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization
Agropyron spicatum	122 2/	126	-	40	66	-	14	22	-
Festuca idahoensis	-	-	-	170	126	26	182	62	66
Stipa comata	16	16	0	46	82	-	74	60	19
Miscellaneous grass	46	50	-	6	6	0	58	44	24
Total grass	184	192	-	262	280	-	328	188	43
Total forbs	180	86	54	174	54	69	98	170	-
Total vegetation	364	278	24	436	334	23	426	358	16

TABLE XVI. (Continued)

Taxa	Spring Range Forest Land After Cattle								
	Exclosure 8			Exclosure 9			Exclosure 10		
	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization	Inside 5 plots	Outside 5 plots	% utilization
Agropyron spicatum	26	26	0	12	66	-	-	-	-
Festuca idahoensis	18	8	56	384	218	43	174	74	57
Stipa comata	254	342	-	-	-	-	24	20	17
Miscellaneous grass	66	40	39	36	44	-	24	20	17
Total grass	364	416	-	432	328	24	222	114	49
Total forbs	332	112	66	482	92	81	128	88	31
Total vegetation	696	528	24	914	420	54	350	202	42

1/ One-half of the plots were within 6x6 foot exclosures. The others were outside the exclosures. All plots were clipped in July.

2/ All figures except % utilization represent pounds per acre.

TABLE XVII. VEGETATION COMPOSITION OF ELK WINTER AND SUMMER RANGE AS DETERMINED BY MEASUREMENTS OF BASAL INTERCEPT ALONG 650 FEET OF LINE TRANSECT.

Taxa	Game Range Winter			Forest Land Winter							Forest Land Summer	
	Transect # 1 50 feet	Transect # 2 50 feet	Transect # 3 50 feet	Transect # 4 50 feet	Transect # 5 50 feet	Transect # 6 50 feet	Transect # 7 50 feet	Transect # 8 50 feet	Transect # 9 50 feet	Transect # 10 50 feet	Transect # 11 50 feet	Transect # 16 50 feet	Transect # 17 50 feet
Agropyron spicatum	0.1 [1]	7.3	0.8	0.7	0.4	0.3	-	0.5	0.1	0.1	0.2 [2]	0.1	0.7
Danthonia unispicata	-	-	-	-	-	-	-	-	-	-	0.6	-	-
Festuca idahoensis	7.4	-	5.9	2.5	0.1	2.5	1.9	1.5	6.7	4.1	9.1	2.1	13.6
Koeleria cristata	0.3	9.1	0.4	0.2	0.4	0.1	0.4	0.8	0.1	0.1	0.5	-	0.1
Poa spp.	0.8	8.1	0.7	1.4	0.1	0.1	0.6	0.6	1.6	0.5	2.5	-	2.3
Stipa comata	0.5	1.8	1.7	1.3	1.4	1.5	2.0	3.4	0.1	0.1	-	-	-
Miscellaneous grass	0.1	0.1	0.1	0.1	0.3	-	0.1	0.1	0.1	0.1	0.3	3.7	0.3
Total grass	9.2	26.4	9.6	6.2	2.7	4.5	5.0	6.9	8.7	5.0	13.2	5.9	17.0
Total forbs	0.4	1.7	1.1	1.5	2.0	0.8	1.4	1.0	1.3	1.9	1.1	6.1	1.5
Total Vegetation	9.6	28.1	10.7	7.7	4.7	5.3	6.4	6.9	10.0	6.9	14.3	12.0	18.5

1/ Percent of total transect intercepted by each species.
2/ Transect No. 11 was not included in the text.

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