Behavior and environmental selection by elk (Cervus canadensis nelsoni) during summer and fall in the first and second Yellow Mule drainages, Madison County, Montana
by Gayle Lynne Joslin

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Zoology
Montana State University

Abstract:
A study was conducted in the First and Second Yellow Mule drainages of southcentral Montana during the summer and early fall of 1973 and 1974 to investigate ecological aspects of elk (Cervus canadensis nelsoni). The study area was divided into park, broken park, and timber cover types covering 31, 13, and 56 percent of the area, respectively. Six habitat types were delineated on the timbered regions. Large mixed sex bull-cow groups observed in late July dispersed to form small single sex bull groups and cow groups which increased in size to late August. Environmental features recorded to compare areas selected by each elk group type were cover type, habitat type, timber type, distance to water, distance to the next closest cover type, downfall, sight distance, location, topography, elevation, aspect, and slope. Significant differences existed between preferences of group types for topography and aspect ($P<.05$) and location.($P<.01$). Selection of other environmental features were not statistically different. Bulls abandoned their environmental preferences in late summer to join cow groups in their preferred habitat.

Canopy cover of tree and shrub species, general ground cover, and the three dominant species in each of nine 2X5 decimeter frames were recorded at 21 feeding and 28 bedding sites. Ground cover at both types of sites was similar. Each group was observed in one of five basic activity patterns and in one of three response states. Elk in the restless response state were significantly more common during weather phase one (Landsberg, 1969). The "head jerk" and "humped back" postures and other dominant and subordinate gestures were observed. Rut-related activities began with velvet shedding, followed by herding, wallowing, bugling, and sparring.

Dry weight standing crops and percentage moisture contents were determined for forbs and grasses which were clipped every two weeks from elk feeding sites and from established timber and meadow plots at three elevations. Forbs at elk feeding sites had significantly greater moisture contents than forbs in all meadow and most timber sites; standing crops of forbs at feeding sites were also significantly greater than forbs at all timber and most meadow sites. Percentage moisture content of forbs fell below that of grasses during October, which was also the only time that moisture content of grasses at established plots exceeded that of grasses at feeding sites. However, elk moved into the timber in September, coincident with the rut, and reappeared in high open parks in October. Based on relative percentage moisture content, movement into the timber solely for succulent vegetation would not be founded; therefore, during this study it appeared that security requirements of elk were involved in this fall movement into the timber.

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BEHAVIOR AND ENVIRONMENTAL SELECTION BY ELK *(CERVUS CANADENSIS NELSONI)* DURING SUMMER AND FALL IN THE FIRST AND SECOND YELLOW MULE DRAINAGES, MADISON COUNTY, MONTANA

by

GAYLE LYNNE JOSLIN

A thesis submitted in partial fulfillment
of the requirements for the degree

of

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in

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ABSTRACT

A study was conducted in the First and Second Yellow Mule drainages of southcentral Montana during the summer and early fall of 1973 and 1974 to investigate ecological aspects of elk *(Cervus canadensis nelsoni)*. The study area was divided into park, broken park, and timber cover types covering 31, 13, and 56 percent of the area, respectively. Six habitat types were delineated on the timbered regions. Large mixed sex bull-cow groups observed in late July dispersed to form small single sex bull groups and cow groups which increased in size to late August. Environmental features recorded to compare areas selected by each elk group type were cover type, habitat type, timber type, distance to water, distance to the next closest cover type, downfall, sight distance, location, topography, elevation, aspect, and slope. Significant differences existed between preferences of group types for topography and aspect ($P<.05$) and location ($P<.01$). Selection of other environmental features were not statistically different. Bulls abandoned their environmental preferences in late summer to join cow groups in their preferred habitat.

Canopy cover of tree and shrub species, general ground cover, and the three dominant species in each of nine 2 X 5 decimeter frames were recorded at 21 feeding and 28 bedding sites. Ground cover at both types of sites was similar. Each group was observed in one of five basic activity patterns and in one of three response states. Elk in the restless response state were significantly more common during weather phase one (Landsberg, 1969). The "head jerk" and "humped back" postures and other dominant and subordinate gestures were observed. Rut-related activities began with velvet shedding, followed by herding, wallowing, bugling, and sparring.

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INTRODUCTION

The Rocky Mountain elk *(Cervus canadensis nelsoni)* is an integral part of many Montana ecosystems, and because elk are valuable animals from the standpoint of economics, recreation and aesthetics, knowledge of the relationship of the species to the environment is essential. Elk consistently select certain aspects of various environmental features (Lonner, 1974) such as slope, aspect, topography, and cover type.

The size, composition, and habitat preferences of elk groups change with time and environmental conditions (Knight, 1970). Large early summer migratory groups become smaller dispersal groups of mid summer which become larger bull-cow groups once again with the onset of rut (Martinka, 1965). Behavioral patterns and hierarchical systems change with the season and hormonal development (Struhsaker, 1967). Matriarchal group control is the rule throughout the summer (Cole, 1969), but aggressive mature males join already formed large cow groups during the rut and assert their dominance in the new association (Altmann, 1952). According to Darling (1937), red deer stags move from their summering areas to join hind groups in their preferred habitat in the late summer, but similar movements have not been noted for elk. Seasonal movements of elk have been attributed to the phenological development of vegetation (Brazda, 1953; Picton,

1959; Kirsch, 1962; Martinka, 1965; Stevens, 1966; Knight, 1970; Coop, 1971; Day, 1973), but though this may be a cause of such seasonal movements, it may not be the only cause (Cole, 1969; Ream *et al.*, 1972).

During the summer and fall of 1973 and 1974, elk were studied in the Yellow Mule drainages of southcentral Montana. The purpose of the study was to describe some of the environmental features of the elk's summer habitat and various daily and seasonal social interactions and group changes. This information may help to shed additional light on the ecological requirements of elk and provide some baseline data for future monitoring of the elk in the Yellow Mule area.

The National Science Foundation RANN Program provided support for the Gallatin Canyon Case Study team to assess the impact of the Big Sky development on the Gallatin Canyon region. My project was an offshoot of this endeavor and was funded in part by the NSF RANN Program grant numbers GI-29908x and GI-29908x1.

METHODS

Field work was conducted from July 24 to October 5, 1973, and from July 6 to October 15, 1974. Travel within the area was unrestricted in 1973, but in 1974 the area was closed to all but two wheeled motorized vehicles which were restricted to authorized trails. Travel to and from the area was by motorcycle, and travel within the area was on foot.

Elk observed with the aid of a 32X spotting scope and 7 X 35 binoculars were classified into one of three elk group types. Bull groups consisted of bulls and spikes, alone or in association with each other. Cow groups included cows, calves and spikes, alone or in association with each other, but lone spikes were classified as bulls. Bull-cow groups always included at least a bull and cow, but might also include calves and spikes. The size, composition, activity, response state and behavior of groups were recorded. Aerial observations in 1973 and 1974 were made over the area during 12 flights in a light plane.

Environmental characteristics recorded for each group were cover type, habitat type, timber type, distance to water, distance to next closest cover type, downfall, sight distance, location, topography, elevation, aspect, slope and weather conditions. Relative tree densities and distribution ascertained from aerial photos and

topographic maps were used to determine the park, broken park and timber cover types. Forest areas were classified and mapped by habitat type according to Pfister *et al.* (1974). Points along systematically traveled routes were habitat-typed and plotted on topographic maps. Habitat type boundaries were mapped by delineating areas of similarly habitat-typed points. Notes were made at each point on understory and overstory vegetation composition. Associations of five tree species comprise four timber types present in the overstory. Identification and distribution of each timber type was determined from ground reconnaissance, aerial photos, and U.S.D.A. Forest Service timber inventory maps. Measurements of distance to free surface water and next closest cover type were grouped in categories of less than 100 meters, less than 500 meters, and more than 500 meters. Downfall in the nearest timber stand was recorded as none, light (scattered fallen trees which do not appear to deter elk movement), moderate (fallen trees which retard movement), and heavy (thick downfall in which movement is extremely difficult). Sight distance in the timber stand where elk were observed, or with which elk were most closely associated, was recorded as less than 20 meters, less than 50 meters, and more than 50 meters. Location was noted by drainage. The topography of the immediate area where a group was observed was recorded as ridge, upper slope, mid slope, lower slope, bench or flat, or stream bottom. Elevation was recorded

to the nearest 30.5 meter interval using a U.S. Geological Survey 15 minute topographic map. Aspect of each site was categorized as north, northeast, east, southeast, south, southwest, west, and northwest. Slope categories included 0-15 percent, 16-25 percent, 26-35 percent, 36-45 percent, and over 45 percent. Aspect and slope were measured with a Brunton transet. Wind direction and velocity, cloud cover, and temperature were estimated in the field for each observation. Barometric pressure for each day was later derived from records kept in Bozeman by Harold D. Picton. Various combinations of wind velocity, cloud cover, temperature and barometric pressure comprise six weather phases as described by Landsberg (1969) (Appendix Table 12). One of the six weather phases was ascribed to each observation of elk.

Use of the terms significant and highly significant indicate statistical significance at the five and one percent levels, respectively.

Selected feeding and bedding sites from each two week period in 1974 were sampled with a 141.5 square meter circular plot centered on the spot of most intense elk activity. In it a species list was compiled; scientific and common names follow Booth (1950) and Booth and Wright (1959). General ground cover including grass, forbs, litter, rock and bare ground was recorded by the canopy coverage method (Daubenmire, 1959) in nine 2 X 5 decimeter frames. Frames

were arranged in three concentric circles within the circular plot. The outer circle of four frames circumscribed the perimeter of the plot: the inner circle of four frames located half way between the edge and center alternate with those in the outer circle; a single frame was placed in the center. The three low growing species with the greatest aerial coverage per frame were recorded as dominant species. Overall dominance values were assigned to each dominant species to indicate the percentage of frames it occurred as a dominant species in 189 and 252, 2 X 5 decimeter frames analyzed at feeding and at bedding sites, respectively. Data recorded for each site indicated whether a species was present, and if it was a dominant, in what percentage of nine frames it occurred as a dominant. Shrub cover was measured with the line intercept method of Canfield (1950), along two perpendicular lines each bisecting the plot. Tree species, size classes in four centimeter increments (dbh), and canopy coverage classes as described by Daubenmire (1959) were recorded for each site plot.

In 1974, six 10.5 square meter permanent plots were established east of the study area boundaries, near the Doe Creek road, to monitor the phenological development of vegetation. Pairs of plots were located at each of three elevations: 2200, 2500, and 2800 meters. One of each pair of plots was located in a meadow and the other was located in the timber. Ten 2 X 5 decimeter frames were clipped in

each plot every two weeks from mid July to mid October, 1974. Vegetation from each plot was separated into grasses and forbs, put in plastic bags, labeled, weighed in the laboratory on a Mettler balance scale to the nearest 0.25 gram, transferred to paper bags, labeled, dried for at least 24 hours at 90 C, and reweighed. Percentage moisture content was calculated for grasses and forbs from each plot according to the formula, $\frac{\text{Wet Weight-Dry Weight}}{\text{Dry Weight}} \times 100$.

Vegetation from five of nine 2 X 5 decimeter frames at each of 21 elk feeding sites was clipped and separated into grasses and forbs and similarly weighed, dried and reweighed. A maximum of four feeding sites was clipped each two week period.

THE STUDY AREA

The Yellow Mule study area (Figure 1) is located about 4.8 kilometers south of Meadow Village of Big Sky, Montana, in the Madison Mountain Range of the Gallatin National Forest. The 24.1 square kilometer area is bisected from north to south by the Madison-Gallatin County line and encompasses the First and Second Yellow Mule Creeks and the bordering ridges from the Buck Creek ridge at 2865 meters to the 2195 meter level near the South Fork of the West Fork of the Gallatin River. In 1973 the area boundaries were not well defined, and observation trips were also made to Buck Creek, Beaver Creek, McAtee Basin, Muddy Creek and Third Yellow Mule Creek.

The large amphitheater basins of Muddy Creek, the First, Second, and Third Yellow Mule Creeks are indicative of possible glacial action during the Bull Lake glacial stade. There are no interlocking spur creeks between drainages, and the valleys are wide straight troughs providing evidence of glacial activity, although mass gravity action in the region has largely obscured glacial evidence. Extensive alluvial deposits occur in the basins at the heads of these drainages. They are derived from sedimentary parent material of sandstone, shale and limestone (Walsh, 1971).

The Gallatin Gateway 26 SSW weather station is located 4.8 kilometers northeast of the study area in Beaver Creek at 2012 meters and provides the nearest record of climatological data. The seven year

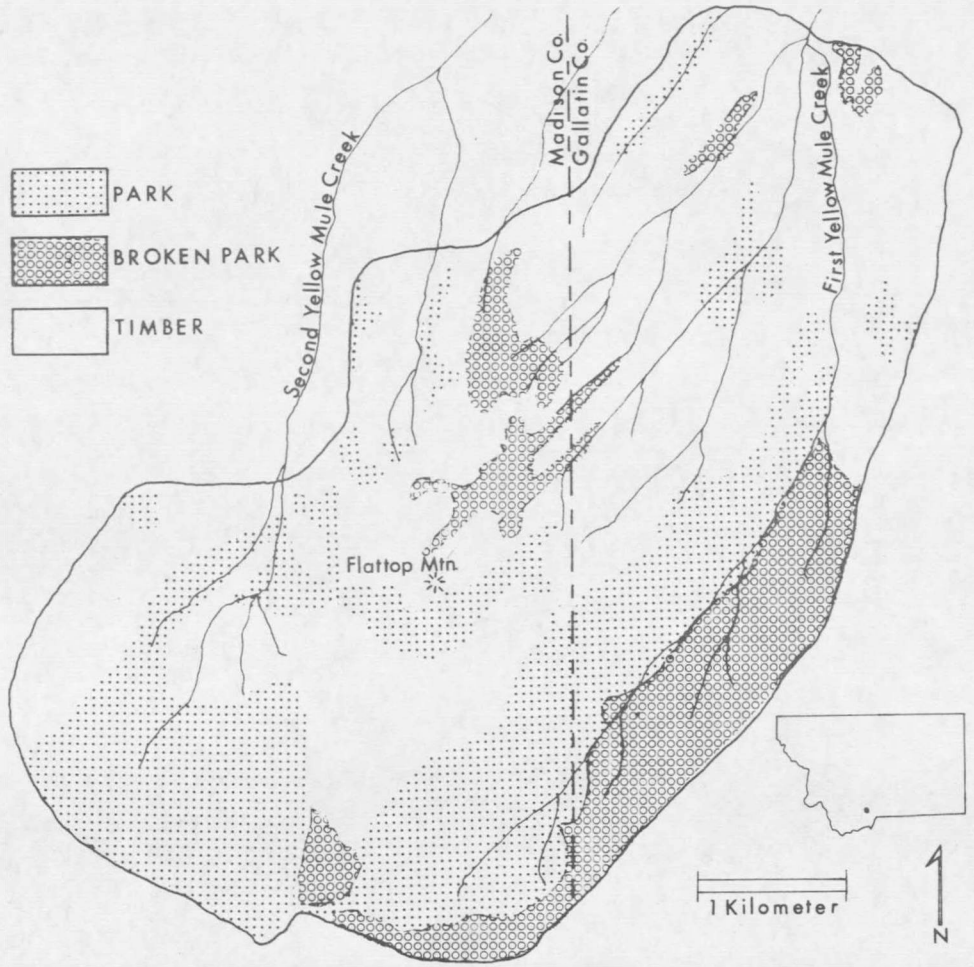

Figure 1. Map of study area showing cover types.

record (U.S. Weather Bureau, 1973 and 1974) indicates an average annual temperature of 2.6 C and an average annual precipitation of 56.95 centimeters. The study area is from 240 meters to 850 meters above the weather station and receives substantially more precipitation and experiences colder temperatures. According to the U.S.D.A. - S.C.S. (1974) precipitation map, from 76.2 to 127.0 centimeters of moisture falls annually, and Caprio (1965) indicates that less than thirty frost free days occur per year on the study area.

The area is part of a cattle grazing allotment leased by the Forest Service from July 1 to October 15. Cattle did not arrive on the area until September 9, 1973, but they were present at high elevations within the area from July 11 until after October 15, 1974.

The study area was divided into three general cover types as seen in Figure 1. The park cover type covers 31.0 percent (7.5 square kilometers) of the area. It consists of terraced benches with long bands and island-like clumps of subalpine fir *(Abies lasiocarpa)*, Engelmann spruce *(Picea engelmannii)*, and whitebark pine *(Pinus albicaulis)* (Figure 2). The large basins of both the First and Second Yellow Mule Creeks contain 67 percent of the park cover type and have a highly heterogeneous nature with interspersed creeks, willow flats, tree islands, meadows, rock piles and bare ground.

The broken park type is composed of small meadows separated by interconnecting tree stands (Figure 3). It covers 13.3 percent (3.2

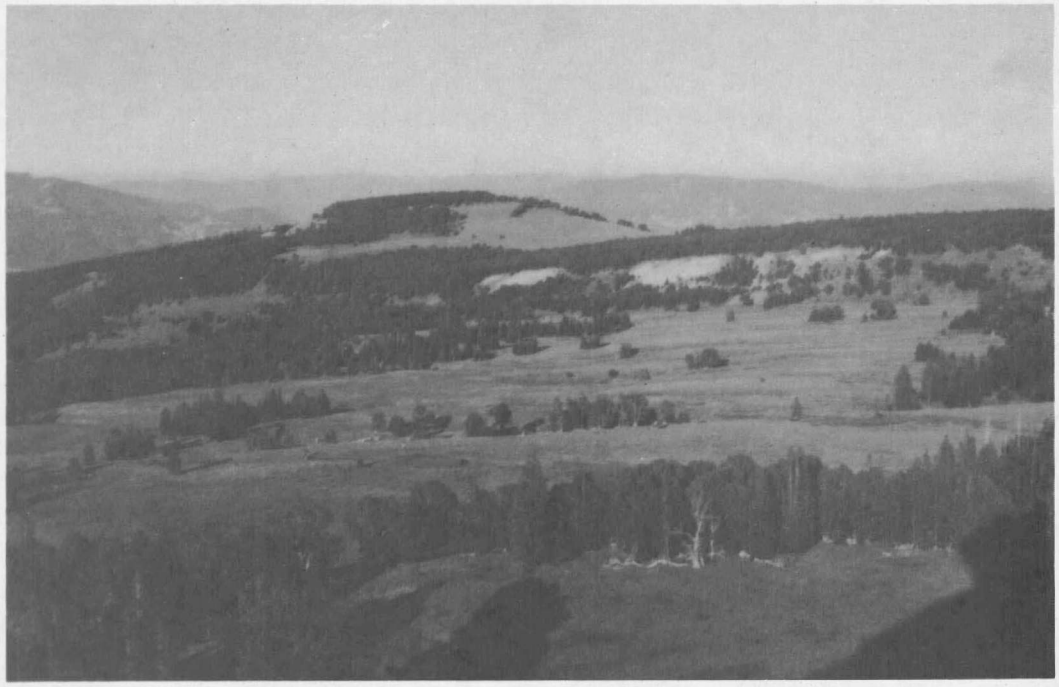

Figure 2. Terraced basin of the upper Second Yellow Mule Creek.

Figure 3. Broken park cover type.

square kilometers) of the study area and is located primarily on the southeast border, but broken park areas heavily used by elk are centered below Flattop Mountain (Figure 1). These cover 0.8 square kilometers, or less than one percent of the study area.

The timber cover type covers 55.7 percent (13.4 square kilometers) of the area. Six of Pfister's *et al.* (1974) forest habitat types, along with seven phases, were recognized within the timber cover type. The area was mapped on a gross scale according to the following four major habitat types; *Abies lasiocarpa (Pinus albicaulis)/Vaccinium scoparium, Abies lasiocarpa/Vaccinium scoparium, Abies lasiocarpa/Linnaea borealis, Abies lasiocarpa/Calamagrostis rubescens* (Figure 4). All habitat types fell within the *Abies lasiocarpa* series which is composed of three elevational categories: temperate, subalpine and timberline. There were no timberline habitat types on the area.

Abies lasiocarpa(Pinus albicaulis)/Vaccinium scoparium habitat type *(AF(WBP)/Vasc):* This is the highest and most extensive subalpine habitat type covering 48.5 percent of the forested area (6.5 square kilometers) from approximately 2560 meters to 2865 meters (Figure 5). It is the only subalpine type to occur on the area. Subalpine fir is the climax tree species, but whitebark pine is a long lived seral dominant which is a conspicuous feature along the dry windy rims of

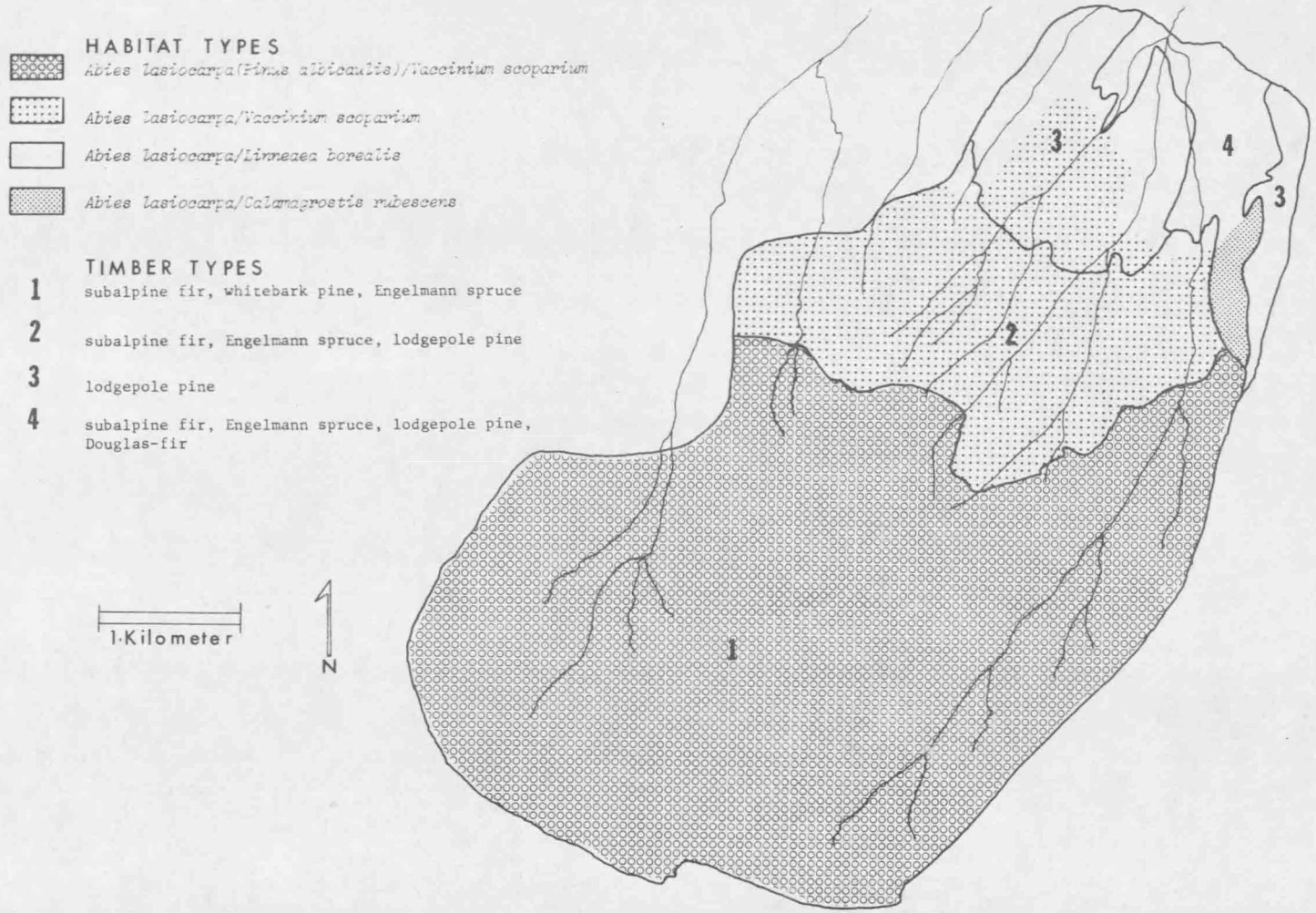

Figure 4. Map of study area showing habitat types and timber types.

Figure 5. *Abies lasiocarpa(Pinus albicaulis)/Vaccinium scoparium* habitat type.

the amphitheater basins. Varying proportions of subalpine fir, whitebark pine and Engelmann spruce comprise the single timber type which occurs on this habitat type (Figure 4). The understory has a paucity of species but consistently includes grouse whortleberry *(Vaccinium scoparium)* which often forms a thick mat in the more open stands where whitebark pine is highly represented. Elk sedge *(Carex geyeri)* may replace grouse whortleberry on the dry upper ridges. Where the canopy is closed, bare ground, litter and scattered *Arnica cordifolia* are most common.

Abies lasiocarpa/Vaccinium scoparium habitat type *(AF/Vasc):* This temperate habitat type forms the lower border of the *Abies lasiocarpa(Pinus albicaulis)/Vaccinium scoparium* type, generally ranging from 2316 meters to 2560 meters and covers about 32.9 percent of the forested area (4.4 square kilometers). It includes portions of two timber types as shown on Figure 4. Subalpine fir is the climax species, and Engelmann spruce is a major component on one of the three phases. Lodgepole pine *(Pinus contorta)* is widely distributed in stands of varying size classes and densities.

The three phases of this habitat type occur on distinct areas but often intermix to form complicated mosaics. The *Vaccinium scoparium* phase apparently occupies cold dry sites on relatively flat ground, usually in the upper regions of the habitat type (Figure 6), however, it does occur along the northern edge of the

type to 2316 meters under lodgepole pine stands or under heavy downfall. Other understory species are sparse but include elk sedge and *Arnica cordifolia*.

Shady, cool, moist sites appear to support the *Thalictrum occidentale* phase, characteristic of inclines and swales, whereas the *Vaccinium scoparium* phase occupies flat areas. Engelmann spruce is typical of this phase. Understory species include western meadow rue *(Thalictrum occidentale)*, grouse whortleberry, pine reedgrass *(Calamagrostis rubescens)*, elk sedge, *Arnica cordifolia* and *Arnica latifolia*.

Probably the least extensive of the three phases is the *Calamagrostis rubescens* phase which occurs on warmer, more open areas. These sites are characterized by an association of pine reedgrass and Oregon grape *(Berberis repens)* or kinikinnick *(Arctostaphylos uva-ursi)* and are most common along the lower edge of the type around 2260 meters. The *Calamagrostis rubescens* phase becomes increasingly interspersed with the *Thalictrum occidentale* phase to 2350 meters. Only this phase occurs in association with Douglas-fir *(Pseudotsuga menziesii)*. Pine reedgrass occurs at higher elevations but without the other necessary indicator species.

Abies lasiocarpa/Linnaea borealis habitat type *(AF/Libo)*: This habitat type covers 17.1 percent (2.3 square kilometers) of the forested regions and forms the northern boundary of the study area.

It extends beyond the lower boundary where logging operations are in progress. The lower elevational limits were not determined. On the west side of the First Yellow Mule Creek this type extends up to 2320 meters where it merges with the *Abies lasiocarpa/Vaccinium scoparium* habitat type *Calamagrostis rubescens* phase. Small isolated patches occur at 2440 meters on the west side of the area, but east of the First Yellow Mule Creek, along the Beaver Creek-First Yellow Mule ridge, the type is continuous to 2440 meters. Lodgepole pine and Douglas-fir are the most common tree species on this type, but subalpine fir and Engelmann spruce occur on wet sites, and subalpine fir is the indicated climax.

Two phases are present in this habitat type. The *Abies lasiocarpa/Linnaea borealis* habitat type *Vaccinium scoparium* phase often occurs in conjunction with the *Calamagrostis rubescens* phase of the *Abies lasiocarpa/Vaccinium scoparium* habitat type. Where stands of Douglas-fir and lodgepole pine form a mosaic pattern it appears as though the *Abies lasiocarpa/Linnaea borealis* habitat type *Vaccinium scoparium* phase is associated with the Douglas-fir, while the *Calamagrostis rubescens* phase of this habitat type occurs under the lodgepole pine. The *Vaccinium scoparium* phase of the *Abies lasiocarpa/Linnaea borealis* habitat type is more common than the *Linnaea borealis* phase because it occupies the more abundant dry areas. Along with twin-flower *(Linnaea borealis)* and grouse whortleberry, western baneberry

(Actea rubra), Oregon grape, kinikinnick, *Arnica cordifolia, Arnica latifolia*, wintergreen *(Pyrola asarifolia)* and western meadow rue occur as some of the major understory species.

The *Linnaea borealis* phase is minor and usually is limited to the cool wet buffer zone between the dry *Vaccinium scoparium* phase of the timber and the wet *Abies lasiocarpa/Galium triflorum* habitat type of creeks. Pfister *et al.* (1974) indicated that the *Vaccinium scoparium* phase was commonly found on the Beaverhead and Deerlodge National Forests and in the Little Belt Mountains between 1920 and 2225 meters elevation.

Abies lasiocarpa/Calamagrostis rubescens habitat type *(AF/Caru)*: This uncommon open canopy habitat type occurs on dry, warm, steep slopes below 2380 meters. It covers 1.5 percent (0.2 square kilometers) of the forested area. The most extensive sites are on the west slope of the Beaver Creek-First Yellow Mule ridge. Its presence coincides with the southern limb of the timber type in which Douglas-fir occurs (Figure 4). Douglas-fir and lodgepole pine dominate the stand although subalpine fir and Engelmann spruce are present. Heavy litter is common in the understory and grouse whortleberry is conspicuously absent. Elk sedge, western meadow rue and Oregon grape are some of the major understory species which occur along with pine reedgrass (Figure 7).

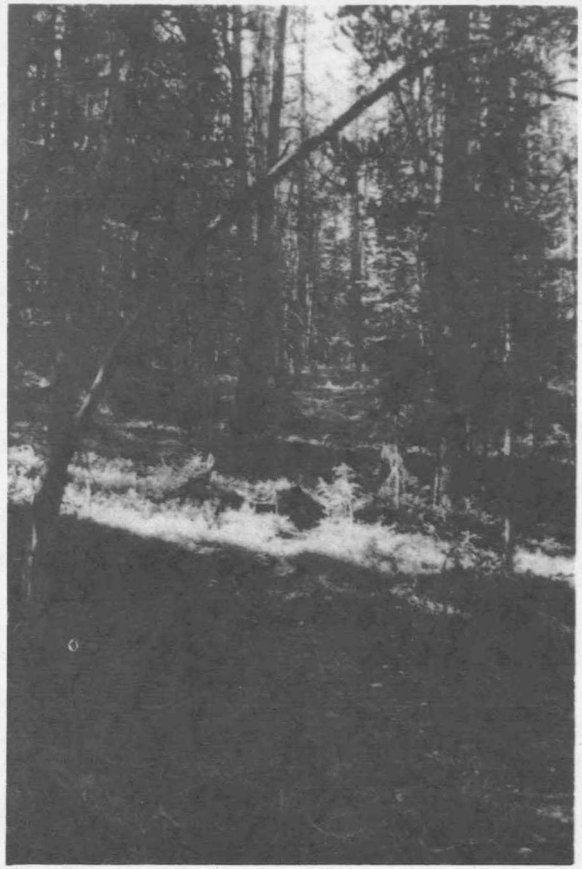

Figure 6. *Abies lasiocarpa/Vaccinium scoparium* habitat type, the *Vaccinium scoparium* phase.

Figure 7. *Abies lasiocarpa/Calamagrostis rubescens* habitat type.

Abies lasiocarpa/Calamagrostis canadensis habitat type *(AF/Caca):* Occupying cool, poorly drained seep areas or creek banks, this local habitat type is the most extensive "wet" type occurring at all elevations within the *Abies lasiocarpa(Pinus albicaulis)/Vaccinium scoparium* and *Abies lasiocarpa/Vaccinium scoparium* habitat types. It is replaced on the eastern ridge of the study area by phases of the *Abies lasiocarpa/Galium triflorum* type. Engelmann spruce is always present, often as the dominant tree because of the wet edaphic conditions. Associated species include bluejoint reedgrass *(Calamagrostis canadensis)*, arrowleaf groundsel *(Senecio triangularis)*, American globeflower *(Trollius laxus)*, horsetail *(Equisetum arvense)* and occasionally Labrador tea *(Ledum glandulosum)* and American mannagrass *(Glyceria grandis)*. This type was often identified in the broken park cover type as "stringers" (Figure 8).

Abies lasiocarpa/Galium triflorum habitat type *(AF/Gatr):* Because *Abies lasiocarpa/Galium triflorum* is the warmest of the wet-site *Abies lasiocarpa* habitat types, it is confined to lower elevations of the study area. Both of the *Abies lasiocarpa/Galium triflorum* habitat type phases were present, but a distributional dimorphism exists. Because the *Galium triflorum* phase is the warmer of the two phases (Pfister, *et al.*, 1974), it was located exclusively on the Beaver Creek-First Yellow Mule ridge, which seems to possess

Figure 8. *Abies lasiocarpa/Calamagrostis canadensis* "stringer" surrounded by the *Abies lasiocarpa(Pinus albicaulis)/ Vaccinium scoparium* habitat type.

a somewhat warmer climate than the rest of the study area as expressed by the other warm climate habitat types found there. It was always associated with Engelmann spruce and Douglas-fir. The *Calamagrostis canadensis* phase is transitional to the cooler *Abies lasiocarpa/Calamagrostis canadensis* habitat type and was located west of the First Yellow Mule Creek, often in areas surrounded by lodgepole pine, but Engelmann spruce always occupied the immediate site. In contrast to the "stringer" nature of *Abies lasiocarpa/Calamagrostis canadensis* habitat type, *Abies lasiocarpa/Galium triflorum* habitat type is a restricted condition characteristic of swales. The indicator species, western baneberry, is found in association with sweetscented bedstraw *(Galium triflorum)*. Other species common to both phases in this type are twinflower, horsetail, wintergreen, western meadow rue and swamp currant *(Ribes lacustre)*. Arrowleaf groundsel and bluejoint reedgrass are found only in the *Calamagrostis canadensis* phase.

RESULTS

Elk Group Characteristics

During the course of this study, a total of 976 elk were observed from the ground. Of these, 281 were observed in 1974. Eighty-eight percent of all elk were observed in parks. If the total number of elk using the area did not vary from year to year, it is assumed that a large portion of elk in 1974 were utilizing the broken park and timber cover types in which observation was difficult. Although fewer elk were observed from the ground in 1974, more were observed from the air. Ninety-two elk were observed in 1973 and 162 elk were observed in 1974 from the air.

The study area boundaries were redefined in 1974 to make the area smaller, but when all elk observed outside the 1974 boundaries were excluded, more than twice as many elk were still observed in 1973 as in 1974. More time was also spent looking for elk in 1974, so the area covered and time spent in the field were not factors in the numerical discrepancy.

Although the observed number of elk varied from one year to the next, those animals observed appeared to exhibit similar activities both years and provided a basis for analysis of interactions of elk with other elk and with the environment.

Group Size and Composition

The sizes of mixed sex bull-cow groups were greatest during the second half of July. As the size of these groups decreased in August, bull and cow groups increased in size; bull groups in 1974 were an exception (Table 1). Large bull-cow groups of early summer dispersed in mid summer to form single sex cow and bull groups. Bull-cow groups reformed in late August and early September, but moved into the timber during September and became unobservable. They reappeared in October after rut. In 1974, more bull-cow groups were observed in October than in any other month, and although no bull-cow groups were seen from the ground in October, 1973, several groups were observed in high parks from the air. A total of 181 elk were observed in bull-cow groups on parks above 2560 meters during flights made in October 1973 and 1974 in drainages of the South and Middle Forks of the West Fork of the Gallatin River.

The number and size of elk groups were compared under six possible weather phases to determine whether either of these group characteristics were influenced by weather. Elk were equally as likely to be observed during each phase since an equal number of observation trips made during each phase were successful and unsuccessful. The number of groups seen during each phase was proportionate to the time spent in search of elk during each phase.

TABLE 1. PERCENT OF ELK GROUPS AND MEAN NUMBER OF ELK PER GROUP OBSERVED IN SEVEN TWO WEEK PERIODS DURING 1973 AND 1974.

	All Elk		Bull Groups		Cow Groups		Bull-Cow Groups	
	1973	1974	1973	1974	1973	1974	1973	1974
	96/695[1]	74/281	42/102	42/81	32/248	21/95	22/345	11/105
July 1-15	--	11/4.0[2]	--	12/3.2	--	14/5.3	--	--
July 16-31	16/13.4	35/4.6	17/2.4	36/2.0	16/11.2	43/4.6	14/43.0	18/23.5
August 1-15	31/5.4	12/3.1	24/1.4	17/2.3	41/6.8	5/2.0	32/8.6	9/10.0
August 16-31	23/7.1	10/5.0	24/4.6	5/1.5	31/9.1	14/6.3	9/9.5	18/6.5
September 1-15	24/7.3	11/3.0	21/1.9	10/1.0	13/4.3	14/4.3	45/13.8	9/7.0
September 16-30	6/1.3	9/2.1	14/1.3	13/1.5	--	--	--	10/6.0
October 1-15	--	12/3.1	--	7/1.0	--	10/1.5	--	36/5.5

[1]Total number of elk groups/total number of elk.

[2]Percent of elk groups/mean number of elk per group.

Largest group sizes were observed during phase three (Table 2), the period prior to a storm, yet the differences in group sizes were not significantly different (t-test). Large group size cannot be attributed to time of year because groups observed during phase three appeared to be nearly equally distributed throughout the summer.

TABLE 2. PERCENT OF ELK GROUPS AND MEAN NUMBER OF ELK OBSERVED PER GROUP DURING SIX WEATHER PHASES. (Weather phases follow those of Landsberg, 1969).[1]

Weather Phase	1	2	3	4	5	6
Elk[2]	14/5.0[3]	22/4.8	10/9.2	11/5.6	22/6.5	21/4.9

[1]See Appendix Table 12.
[2]Elk observed in 1973 and 1974 combined.
[3]Percent of 170 groups observed/mean number of elk seen per group.

Sites Used by Elk

Twelve environmental features of elk activity sites were tested with a Chi Square test against cow, bull and bull-cow group categories to assess differences among group preferences, with regard to each feature (Table 3). Observations for 1973 and 1974 were combined.

Groups exhibited differential selection with regard to topography, aspect and location. Table 4 shows group differences with regard to topography. All three group types utilized the bench or flat areas heavily, but bull groups were observed often on lower slopes while cow groups and bull-cow groups were observed on upper and mid slopes

TABLE 3. CHI SQUARE VALUES CALCULATED FROM COMPARISONS OF THREE ELK GROUP TYPES FOR EACH OF TWELVE ENVIRONMENTAL FEATURES.

Environmental Feature	Calculated Chi Square Value	Degrees of Freedom
Cover type	3.824	4
Habitat type	2.529	8
Timber type	5.792	6
Distance to water	4.479	4
Distance to next cover type	4.906	4
Downfall	4.307	6
Sight distance	1.719	4
Location	35.103*	2
Topography	20.743**	10
Elevation	6.978	6
Aspect	28.091**	14
Slope	8.254	8

*Significant at the .01 probability level.
**Significant at the .05 probability level.

and only rarely on lower slopes. All groups were commonly observed on the north aspect (Table 5); however, cow and bull-cow groups were most often observed on the northeast aspect, and bull groups were most often observed on the west aspect. Bull groups selected the Second Yellow Mule while cow and bull-cow groups selected the First Yellow Mule (Table 6). The differences in distribution are highly significant. Only observations made in the upper basins of the First and Second Yellow Mule were used in the Chi Square test because sample sizes were too small in other areas for testing.

Table 7 is a summary of all environmental features in which the preferences of different elk group types did not significantly vary;

TABLE 4. PERCENT OF ELK GROUPS AND MEAN NUMBER OF ELK PER GROUP IN THREE GROUP TYPES OBSERVED ON SIX TOPOGRAPHICAL AREAS.

Topography	Bull Groups 84/183[1]	Cow Groups 53/343	Bull-Cow Groups 33/450
Ridge	10/2.1[2]	11/11.3	3/7.0
Upper Slope	12/1.4	19/6.0	24/14.0
Mid Slope	17/12.1	26/6.6	37/14.0
Lower Slope	24/2.1	5/1.7	3/7.0
Bench or Flat	31/3.3	28/6.6	27/16.6
Stream Bottom	6/1.2	9/3.6	6/4.0

[1]Total number of elk groups/total number of elk.
[2]Percent of elk groups/mean number of elk per group.

TABLE 5. PERCENT OF ELK GROUPS AND MEAN NUMBER OF ELK PER GROUP IN THREE GROUP TYPES OBSERVED ON EIGHT ASPECT CLASSES.

Aspect[1]	Bull Groups 84/183[2]	Cow Groups 53/343	Bull-Cow Groups 33/450
North	27/2.9[3]	26/6.4	24/14.0
Northeast	13/1.7	21/8.9	28/17.2
East	8/2.1	13/2.7	15/7.4
Southeast	4/1.0	13/6.6	9/13.3
South	--	4/7.0	--
Southwest	6/2.8	9/11.2	3/26.0
West	30/1.7	10/2.4	18/10.0
Northwest	12/1.5	4/1.5	3/22.0

[1]Each class spans an arc of 45 degrees, with 22.5 degrees on either side of center.
[2]Total number of elk groups/total number of elk.
[3]Percent of elk groups/mean number of elk per group.

TABLE 6. PERCENT OF ELK GROUPS AND MEAN NUMBER OF ELK PER GROUP IN THREE GROUP TYPES OBSERVED IN TWO LOCATIONS.

Location	Bull Groups 65/152[1]	Cow Groups 32/183	Bull-Cow Groups 29/354
Upper First Yellow Mule	28/1.5[2]	84/5.6	76/12.1
Upper Second Yellow Mule	72/2.6	16/6.3	24/12.6

[1]Total number of elk groups/total number of elk.
[2]Percent of elk groups/mean number of elk per group.

TABLE 7. PERCENTAGES OF 170 ELK GROUPS RELATED TO VARIOUS ENVIRONMENTAL FEATURES, MEASURED DURING 1973 AND 1974.

Cover Type[1]			Habitat Types[2]			
P	BP	T	*AF(WBP)/Vasc*	*AF/Vasc*	*AF/Caca*	*AF/Caru*
80	11	9	81	10	7	2

Timber Types[3]				Distance to Water in Meters		
AF-WBP-ES	AF-ES-LPP	AF-ES-LPP-DF	LPP	100 or Less	500 or Less	500 or More
81	12	6	1	39	33	28

Distance to Next Closest Cover Type in Meters			Downfall[4]				Sight Distance in Meters		
100 or Less	500 or Less	500 or More	N	L	M	H	20 or Less	50 or Less	50 or More
78	21	1	4	25	50	21	52	38	10

Elevation in Meters				Slope in Percent				
Less Than 2530	2530-2650	2651-2772	2773-2865	1-15	16-25	26-35	36-45	Over 45
12	40	23	25	54	19	9	14	4

[1]P - park, BP = broken park, T = timber.

[2]See Study Area description, page 8.

[3]AF = subalpine fir, WBP = whitebark pine, ES = Engelmann spruce, LPP = lodgepole pine, DF = Douglas-fir.

[4]N = none, L = light, M = moderate, H = heavy.

data from all groups were pooled. Although not significantly different, environmental preferences of bull groups were consistently different from the similar preferences shown by cow and bull-cow groups. Elk were most often observed in the park cover type associated with the *Abies lasiocarpa(Pinus albicaulis)/Vaccinium scoparium* habitat type. Elk were not observed in close association with water, but they were usually close to an adjacent cover type. Nearby timber stands had moderate downfall and sight distances of less than 20 meters. They utilized slopes of less than 15 percent and were often seen between 2530 and 2650 meters elevation. Because an environmental feature may have been distributed in unequal proportions in the landscape, elk may have used it in proportion to its occurrence, and the percentages listed in Table 7 may be a reflection of this. The objective was not to determine the type of habitat elk prefer, but to assess differences in site characteristics selected by different elk group types.

Elk bedding sites were analyzed separately from elk activity sites. A bedding site had from one to 106 beds. Data for bed sites were collected during the 1974 season (Table 8). Beds were most often found in the broken park cover type, north of Flattop Mountain, less than 100 meters from water and cover, in areas associated with light to moderate downfall. Sight distance in adjacent timber stands was usually less than 20 meters. Sites were usually located

TABLE 8. PERCENTAGES OF 83 ELK BEDDING SITES AS RELATED TO VARIOUS ENVIRONMENTAL FEATURES, MEASURED DURING 1974.

Cover Type[1]			Habitat Types[2]				
P	BP	T	*AF(WBP)/Vasc*	*AF/Vasc*	*AF/Caca*	*AF/Gatr*	*AF/Libo*
31	45	24	35	16	44	4	1

Timber Type[3]				Distance to Water in Meters		
AF-WBP-ES	AF-ES-LPP	AF-ES-LPP-DF	LPP	100 or Less	500 or Less	500 or More
63	30	5	2	73	16	11

Distance to Next Closest Cover Type in Meters		Downfall[4]				Sight Distance in Meters		
100 or Less	500 or Less	N	L	M	H	20 or Less	50 or Less	50 or More
98	02	8	28	51	13	55	34	11

Topography[5]						Aspect[6]								Slope in Percent				
R	US	MS	LS	B/F	SB	N	NE	E	SE	S	SW	W	NW	1-15	16-25	26-35	36-45	Over 45
12	7	29	2	25	25	48	21	7	1	1	5	12	5	75	19	4	1	1

[1]P = park, BP = broken park, T = timber.

[2]See Study Area description, page 8.

[3]AF = subalpine fir, WBP = whitebark pine, ES = Engelmann spruce, LPP = lodgepole pine, DF = Douglas-fir.

[4]N = none, L = light, M = moderate, H = heavy.

[5]R = ridge, US = upper slope, MS = mid slope, LS = lower slope, B/F = bench or flat, SB = stream bottom.

[6]Each aspect class encompasses a 45 degree arc.

in moist areas characterized by the *Abies lasiocarpa/Calamagrostis canadensis* habitat type, Engelmann spruce trees, the stream bottom or flat topographies on gentle north slopes.

Vegetation Analysis of Elk Feeding and Bedding Sites

General characteristics of ground cover on 21 feeding and 28 bedding sites were analyzed by the canopy coverage method of Daubenmire (1959) as shown in Table 9. While grass and forb coverage of feeding and bedding sites are nearly equal, bedding sites have more litter coverage and feeding sites have more rock and bare ground coverage.

TABLE 9. MEAN PERCENT CANOPY COVERAGE OF GENERAL VEGETATION GROUPS AT TWENTY-ONE FEEDING AND TWENTY-EIGHT BEDDING SITES AS DETERMINED BY EXAMINATION OF NINE 2 X 5 DECIMETER FRAMES AT EACH SITE.

	Grass	Forbs	Litter	Rock	Bare Ground
Feeding Sites	27.8	46.7	19.1	2.2	13.7
Bedding Sites	28.7	42.9	29.3	0.7	6.7

Table 10 and 11 list species with greater than 20 percent constancy along with the dominance value of each and a presence list of all species at each feeding and bedding site. Eighty percent of the forb species over 20 percent constancy occurred in common on feeding and bedding sites, which had 44 and 43 forb species, respectively. Eighteen grass species over 20 percent constancy

TABLE 10. VEGETATION ASSOCIATED WITH TWENTY-ONE FEEDING SITES EXAMINED OVER A FOURTEEN WEEK PERIOD WITH REGARD TO CONSTANCY, OVERALL DOMINANCE VALUES, AND PRESENCE, MEASURED IN NINE 2X5 DECIMETER FRAMES WITHIN A CIRCULAR PLOT AT EACH SITE. Only species with twenty percent or greater constancy are listed.

			Individual Bedding Sites																			
	C[1]	D[2]	Mid July				Late July				Mid August				Late August				Mid September			Mid October	
FORBS																						
Achillea millifolium	100	20	+[3]	56[4]	22	33	11	11	11	33	+	11	11	+	33	11	22	44	11	22	+	44	56
Agoseris glauca	91	8	-[5]	22	33	11	11	-	11	22	11	+	11	11	+	+	11	+	+	+	11	+	+
Potentilla gracilis	91	13	11	11	+	44	11	33	+	+	22	33	+	33	-	+	11	-	22	+	22	+	11
Taraxicum officianale	86	17	+	+	-	11	67	11	+	44	+	33	+	22	22	-	-	11	22	11	56	+	33
Solidago multiradiata	81	1	+	56	22	44	+	11	+	1	+	22	+	11	-	+	-	+	+	-	-	44	11
Erithronium grandiflorum	71	1	+	+	22	-	+	-	+	+	+	+	+	+	+	+	-	-	+	+	-	+	-
Aster foliaceus	67	24	-	-	-	-	-	11	-	22	22	+	89	+	-	89	89	+	22	67	22	56	22
Senecio crassulus	67	5	-	-	-	-	-	11	+	+	11	+	44	+	33	11	+	-	+	+	+	11	-
Geranium viscosissimum	67	10	-	+	+	-	22	11	44	67	+	-	56	+	-	-	11	-	+	+	-	+	+
Lupinus argenteus	67	6	+	11	11	+	11	+	-	+	-	11	-	56	+	+	11	22	+	-	-	-	-
Helianthella quinquinervis	62	7	-	-	-	-	11	-	11	+	44	+	33	+	+	-	11	-	11	33	+	-	+
Thalictrum occidentale	62	2	+	-	+	-	+	-	+	+	11	-	+	33	-	+	+	-	+	-	+	-	+
Arabis drummondi	52	1	+	+	-	-	-	-	-	+	+	+	+	-	+	-	+	-	+	+	-	11	-
Epilobium angustifolium	52	-	+	-	+	-	-	-	+	-	+	+	+	+	+	+	-	-	-	+	+	-	-
Fragaria virginiana	52	7	-	-	-	-	+	+	-	+	+	+	-	+	+	-	-	-	+	-	11	+	33
Mertensia ciliata	52	6	-	-	-	-	+	+	+	33	+	11	+	33	-	+	-	-	33	-	22	-	-
Pedicularis bracteosa	52	2	-	-	+	-	+	+	-	+	11	11	11	-	+	+	-	-	11	-	+	-	-
Polygonum bistortoides	48	-	-	+	+	+	-	+	+	+	+	+	+	-	+	-	-	-	-	-	-	-	-
Allium schoenoprasum	43	1	-	-	-	+	+	+	+	+	+	11	-	-	-	+	-	-	-	-	+	-	-
Astragalus alpinus	43	4	-	-	-	-	11	11	22	+	-	-	-	-	33	-	-	+	+	+	+	-	-
Arnica cordifolia	38	3	11	-	11	-	-	-	+	+	-	-	-	+	11	+	-	-	+	-	-	-	-
Collomia linearis	38	-	-	-	-	-	-	-	-	-	+	+	-	+	-	-	+	-	+	+	-	+	+
Dodecatheon pauciflorum	38	-	-	+	-	+	+	+	-	-	-	-	+	-	-	+	-	-	+	-	-	+	-
Epilobium glandulosum	38	1	-	-	-	-	+	+	+	+	-	+	-	-	-	+	-	-	11	-	+	-	-
Thlaspi fendleri	38	1	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	-	+	+
Valeriana occidentale	38	2	-	-	11	-	33	+	-	+	+	+	+	+	-	-	-	-	-	-	-	-	-
Viola nuttallii	38	3	44	11	+	-	+	-	+	-	11	-	+	+	-	-	-	-	-	-	-	-	-
Delphinium bicolor	33	-	+	+	+	+	-	+	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-
Delphinium occidentale	33	1	-	-	-	-	-	-	+	-	+	-	11	+	+	-	+	-	-	+	-	-	-
Geranium richardsonii	33	1	-	-	+	-	22	-	-	+	-	+	-	-	+	-	-	+	-	-	+	-	-
Lupinus sericeus	33	5	-	-	-	-	-	-	44	-	-	-	11	11	-	-	+	+	-	33	+	-	-
Myosotis sylvatica	33	-	-	+	+	+	-	+	-	-	-	-	+	+	-	-	-	-	-	+	-	-	-
Ranunculus escholtzii	33	3	+	-	44	-	+	-	-	-	-	+	-	-	11	+	-	-	+	-	-	-	-
Rumex paucifolius	29	1	-	+	11	+	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-
Equisetum arvense	29	8	-	-	-	-	+	-	-	33	-	-	-	-	56	-	-	56	22	-	+	-	-
Geum triflorum	29	3	-	+	+	22	-	-	+	-	-	-	-	-	-	-	-	44	-	-	-	-	+
Heracleum lanatum	29	1	-	-	-	-	11	-	-	+	+	+	-	+	+	-	-	-	-	-	-	-	-
Polygonum douglasii	29	1	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	+	+	-	+	11
Eriogonum umbellatum	24	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	+	+	-	+	-	-	-
Lychnis drummondii	24	-	-	-	-	-	+	-	-	-	+	+	-	+	-	-	-	-	-	-	+	-	-
Phlox multiflora	24	1	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	11	-	-
Plantago tweedyi	24	1	-	-	-	-	-	11	-	+	-	-	-	-	+	-	-	-	+	-	+	-	-
Senecio triangularis	24	3	-	-	-	-	-	+	-	-	-	+	-	-	+	22	-	-	33	-	-	-	-
Trollius laxus	24	5	-	-	-	-	-	22	-	-	-	+	-	-	-	33	-	-	56	+	-	-	-
GRASS AND GRASS-LIKE PLANTS																							
Phleum alpina	91	13	11	22	22	33	+	+	+	+	+	+	+	+	+	-	+	-	+	+	+	33	33
Agropyron caninum	86	18	-	+	-	-	33	+	44	11	22	22	+	+	11	22	+	67	+	44	22	22	67
Festuca idahoensis	71	25	89	89	22	44	-	+	44	+	33	11	67	22	-	-	-	78	-	-	11	11	11
Bromus carinatus	67	15	-	-	-	-	11	-	56	11	+	11	+	44	+	+	44	-	22	33	-	33	+
Melica spectabilis	62	2	11	-	-	-	+	-	+	+	11	-	+	+	-	-	+	1	+	+	+	11	+
Trisetum spicatum	62	2	-	-	-	-	+	-	+	+	11	+	+	+	-	+	-	-	11	+	+	11	+
Poa reflexa	52	1	-	-	-	-	-	-	-	-	+	+	+	+	+	+	11	-	+	11	+	+	-
Carex spp.	43	9	-	11	11	-	-	-	56	11	-	33	-	-	+	56	-	-	+	-	11	-	-
Deschampsia caespitosa	43	3	-	-	-	11	-	33	-	+	-	11	-	+	-	11	-	-	+	-	+	-	+
Poa alpina	29	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	+	-	+	+	-

[1]C = Constancy, percent occurrence among all sites.

[2]D = Dominance Value, percent occurrence of the species as a dominant within 189 2X5 decimeter frames analyzed on bedding sites.

[3]+ = Present on the site but not occurring as a dominant.

[4]Percent occurrence as a dominant in nine 2X5 decimeter frames analyzed on each site.

[5]- = Not present on the site.