CORRELATIONS OF UNGULATE FOOD HABITS AND WINTER RANGE CONDITIONS IN THE IDAHO PRIMITIVE AREA

By

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CORRELATIONS OF UNGULATE FOOD HABITS AND WINTER RANGE CONDITIONS IN THE IDAHO PRIMITIVE AREA

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AUTHORIZATION TO PROCEED WITH THE FINAL DRAFT:

This thesis of James J. Claar for the Master of Science degree with major in Wildlife Management and titled "Correlations of Ungulate Food Habits and Winter Range Conditions in the Idaho Primitive Area" was reviewed in rough draft form by each Committee member as indicated by the signatures and dates given below and permission was granted to prepare the final copy incorporating suggestions of the Committee; permission was also given to schedule the final examination upon submission of two final copies to the Graduate School Office:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The winter range of Big Creek, a major tributary of the Middle Fork of the Salmon River in central Idaho, has been considered in poor condition since the early 1900's. However, mule deer and elk are still abundant, soils are not highly eroded and palatable browse species still occur. This project was designed to quantify and relate ecological factors important to big game species that winter there and to evaluate certain concepts of wildlife management. The project duration was August 1970 to August 1972.

Browse utilization of key species, mountain mahogany (Cercocarpus ledifolius) and antelope bitterbrush (Purshia tridentata), was found usually to exceed the accepted maximum use of 60 percent. Mountain mahogany was utilized in excess of 70 percent practically everywhere it was available. Bitterbrush utilization followed a topographical pattern, ranging from at least 70 percent utilization near ridgetops to less than 25 percent adjacent to creek bottoms. Annual mortality of intensively browsed mountain mahogany and bitterbrush plants was calculated at 2.7 per 100 and 1.0 per 100, respectively.

Rumen samples were collected from ungulates by personnel of the Idaho Cooperative Wildlife Research Unit for three winter seasons, 1969-70, 1970-71 and 1971-72. We collected stomach samples from 116 mule deer (Odocoileus hemionus), 61 elk (Cervus canadensis) and 8 bighorn sheep (Ovis canadensis) killed by hunters, mountain lions and coyotes. Browse (woody tissue) formed the major component of the mule deer diet, averaging at least 65 percent by volume December through March. A variety of browse species was consumed, consisting of mountain mahogany, bitterbrush, Oregon grape (Berberis repens), Douglas fir (Pseudotsuga menziesii) and others. Elk mainly consumed grass

(at least 50 percent by volume) throughout these winters, except during crusted snow conditions that occurred for 1-2 weeks in January or February. It was during these periods that mule deer and elk both selected browse species.

Nutrient analyses of range forage and rumen samples for crude protein and fiber content quantified distinct patterns. Crude protein content of range forage varied almost twofold when values from three collection periods (October, February and May) and from three collection sites were compared. Browse species provided the highest consistent crude protein source (at least 10 percent of total dry weight) throughout the winter, though grasses averaged higher in spring (at least 27 percent of total dry weight). Mule deer rumen contents consistently contained higher crude protein values than elk samples in all months. Crude fiber values usually averaged higher for elk than deer. While crude protein value of range forage decreased down the Big Creek drainage, mule deer and elk dampened this fluctuation by their forage selectivity.

From these data and 7 years of population dynamics information on mule deer and elk, I concluded that this ecosystem is in good condition. It appears that present mule deer and elk population levels are adjusting independent of management operations. In light of these data, there is a need for revision of some management principles, particularly key species and key area concepts. Rather than a set of regionwide standards, we need a flexible system that allows ecological interpretation of our range and population dynamics data.

INTRODUCTION

The assumption that we must balance animal numbers with the range is basic to the philosophy of ungulate game management (Leopold 1939, Dasmann 1948, Gross 1969 and many others). Thus, managers have assigned a carrying capacity to ranges and attempted to keep herds at a particular level. Eabry (1970) defines carrying capacity as "the maximum number (or biomass) of animals of a given species and stated quality which can be sustained in a given ecosystem through the least favorable environmental conditions that occur within a stated interval of time. This number must be sustained without a deterioration of the ecosystem..." In most situations, the objective of management has been to optimize yield and control the harvest to maintain a balance between food and animal numbers (Dasmann 1971). My research in central Idaho, on Big Creek, a major tributary of the Middle Fork of the Salmon River, seeks to quantify certain ecological factors important to big game species that winter there.

Management decisions are usually based on population dynamics data and condition and trend of winter range. It is generally accepted that winter range limits ungulate populations in the northern Rocky Mountain region (Robinette et al. 1952) and range condition indicates carrying capacity. Thus, how we estimate condition and trend will affect our management operation for a particular herd and supply us with information necessary to "balance" animal numbers with food supply. Management agencies typically use key species and key area concepts (Dasmann 1948) to determine condition. They choose one or more forage species they consider critical to the survival of the herd and indicative of trend. Tightly hedged or highlined plants, low percentage of seedlings, and partly dead browse plants are considered evidence of poor range condition and declining forage yield (Dasmann 1948). On these bases, many ranges have been called overbrowsed for years.

Big Creek winter range has been considered in poor condition since the early 1900's (U.S. Forest Service 1968), yet deer and elk are abundant, soils are not highly eroded, and palatable browse species still occur. Thus, standards by which we judge big game winter ranges need to be examined. Our concepts of range condition and carrying capacity, especially when estimated by key species, have failed to provide sound management data. We must look to new interpretations of our range and herd data concerning ungulate-range interactions.

My research on the Big Creek winter range seeks to quantify and relate ecological factors important to big game species that winter there. The objectives are (1) to measure ungulate utilization of mountain mahogany and bitterbrush, (2) to analyze winter food habits of mule deer, elk, and bighorn sheep, (3) to assess range quality on the basis of available plant protein and other related biological and physical factors, and (4) to evaluate the concepts of key forage species, key area, condition and carrying capacity in relation to Big Creek winter range and population data. The project duration was August 1970 to August 1972.

STUDY AREA

Physiography

The Salmon River Basin lies entirely within the central part of Idaho and drains approximately 14,100 square miles (Peebles 1971). Within this system, Big Creek drainage comprises a major tributary of the Middle Fork of the Salmon River. The study area, approximately 180 square miles, was a section on the lower portion of Big Creek drainage (Figure 1). High ridges dissected by deep valleys characterize the topography of this winter range. Winter range extends to 6000 feet elevation on open south-facing slopes. This area has some of the greatest relief of any part of Idaho (Daubenmire 1952).

Soils formed from granitic Idaho batholith parent material. This batholith formed during the Cretaceous period over 55 million years ago. Shallow, coarse soils, interspersed with granitic outcroppings, characterize the ridges (Larson and Lovely 1972). Tisdale et al. (1969) reported the major soil type as brown podzol, revised from Ross and Savage (1967). In a general survey, the U.S. Forest Service classified this area with a high-very high erosion potential and recommended only limited road development (Larson and Lovely 1972).

Climate

Canyons of this area are typically hot and dry in summer. In winter, snow accumulation of 6-18 inches at lower elevations is common from late December through February, and sometimes into March. Southern exposures often are bare, while up to 24 inches of snow may persist on north-facing slopes (Hornocker 1970). The Salmon weather station, some 50 miles east of

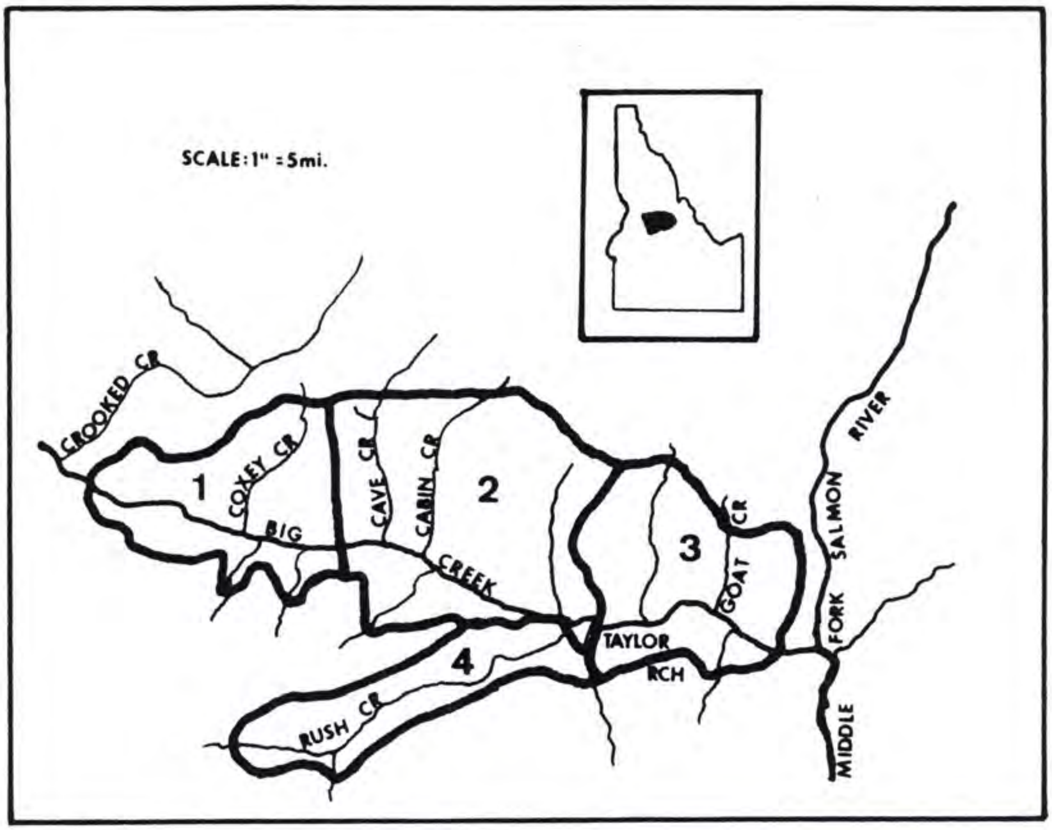

Figure 1: Approximate study area in the Big Creek drainage in the Idaho Primitive Area. Numbered sections 1-4 were delineated for nutrient and food habits analyses. Inset shows the location of the entire Primitive Area in Idaho.

the study area (elevation 3961 feet), recorded a mean annual precipitation rate of less than 9 inches over a 55-year period (U.S. Dept. of Commerce 1966). Weather station records at Big Creek, about 30 miles west of the study area (elevation 5686 feet), indicate an average annual precipitation of about 30 inches. Annual precipitation on the winter range area itself is somewhere between these extremes, probably near 15 inches (Hornocker 1970). Most precipitation falls from late fall to early spring.

History

Large herbivore population levels have changed in this area since the 1800's. Bighorn sheep were abundant at that time; early settlers reported seeing them "by the thousands" (Smith 1954). It seems mule deer numbers were below those of more recent times. Elk were apparently confined to small local populations in the Chamberlain Basin area and nearby drainages such as the Selway.

In the early 1900's, elk were seen occasionally in summer on the Middle Fork, but none wintered there until the late 1930's (Smith 1954). About 1927, a few elk moved from the lower Selway drainage into the upper Selway and Salmon River breaks and became numerous some time after 1934-35 (Schumaker and Dewey 1970). By 1940-46, elk concentrations built up north and south of the Salmon River and caused severe winter range damage to brush fields in such areas as that created by the 1929 fire in Big Squaw-Prospect Ridge-Smith Creek area. Brush was browsed to the "club" stage (Schumaker and Dewey 1970).

Forest Service officers, appointed as deputy game wardens, were concerned about the "need" to increase deer and elk populations as early as 1917. They reported decreasing numbers in some areas and recommended closed seasons and game preserve establishment (U.S. Forest Service 1968). By 1938, there were 35 game preserves on national forest lands in Idaho. Ungulate population buildups in the Salmon River country were probably magnified by the Salmon River Game Preserve established prior to 1933. Hunting was excluded from most of the Primitive Area and part of Bargamin Creek (Schumaker and Dewey 1970, Peebles 1971). The game preserve was effective until 1952 with special permit hunting in 1950 and 1952. The 1950 elk kill was five, but when the area was opened to general hunting in 1952, outfitters became established and increased the kill. Use of power boats on the Salmon River since about 1957 (Peebles 1971) has facilitated access and increased guided hunts.

The Middle Fork Game Preserve, of which Big Creek was the southern boundary, was established in 1925 to increase mule deer herds. However, by 1928 or 1929, records indicate the Forest Service personnel suddenly decided that they had a serious deer winter range problem there (U.S. Forest Service 1968). Apparently, the poor conditions had been in existence for several years and deer populations declined because of starvation on the winter ranges. It seems that this preserve, too, only served to compound the resource problem (U.S. Forest Service 1968). The Middle Fork Preserve was abolished by the 1932 State Legislature due to pressure from the Fish and Game Department and U.S. Forest Service.

In more recent years, mule deer populations increased to high levels in the Big Creek and Middle Fork drainages. Conservation estimates ranged from 12,000 to 15,000 in the Middle Fork area alone (Kindel 1960). Those populations declined in the late 1940's. The best available information indicates that mule deer have returned to intermediate levels, and in some areas of the Middle Fork appear to have stabilized (Wood 1962).

Smith (1954) noted that by 1954 elk were abundant in Cabin and Cow creeks in the Big Creek drainage. Elk are now numerous throughout the Big Creek and Middle Fork drainages, and wintering populations are increasing (Hornocker 1970).

Small numbers of mountain goats (Oreamnos americanus) occur on the study area. White-tailed deer (Odocoileus virginianus) and moose (Alces alces) are found in the Idaho Primitive Area, but none winter on the study area.

Domestic livestock, sheep and horses, have locally overgrazed areas of the Salmon River country. Overuse by trespass horses and river resident horses occurred from about 1940-50 (Peebles 1971). Action by the U.S. Forest Service has reduced this abuse in most areas. Sheep grazing occurred as early as 1917 and has ceased since 1940. Currently, local sites are grazed by horses owned by ranchers and outfitters. Remnants of past overgrazing practices can be seen on high ridges and benches. Supposedly the downward trend toward cheatgrass (Bromus tectorum) range, caused by domestic stock overuse, has been stopped (Peebles 1971).

Larger carnivores inhabiting the Primitive Area are mountain lions (Felis concolor), black bear (Ursus americanus), and coyotes (Canis latrans). Bobcats (Lynx rufus) are common; lynx (Lynx canadensis) and red fox (Vulpes fulva) are present in lesser numbers. Wolverines (Gulo luscus) are reported rarely. Badger (Taxidea taxus) are fairly common. It appears that wolves (C. lupus) never were common in the Idaho Primitive Area (Hornocker 1970).

Characteristics of the Vegetation

Topography on the study area changes sharply. Landforms such as ridgelines and swales often have distinct boundaries. Correspondingly, vegetation responds with abrupt changes on different exposures and landforms. In such country, aspect, slope, and elevation (due to great variance in precipitation) are critical considerations in analysis of vegetation and its use by ungulates.

Daubenmire (1952) recognized 10 vegetation zones in northern Idaho and eastern Washington, distinguished by the climatic associations at different elevations. Of those, the ponderosa pine (Pinus ponderosa) zone, Douglas fir zone, spruce-fir (Pices-Abies) zone and alpine zone occur in the Idaho Primitive Area. The ponderosa pine zone and parts of the Douglas fir zone constitute the winter range along Big Creek. It should be noted that these are major zones described north of the Salmon River. Many vegetative types occur on the study area and some may not fit into these major zones.

Ponderosa pine constitutes the principal zone along the lower Salmon River breaks (Douglas 1964). In some areas, this zone borders the river. Along Big Creek, south-facing breaks are typically grassland. I describe in detail vegetative types of grasslands in a later section. These grasslands are typified by bluebunch wheatgrass (Agropyron spicatum), intermixed on mesic sites with Idaho fescue (Festuca idahoensis), Sandberg's bluegrass (Poa sandbergii), and oniongrass (Melica bulbosa). Cheatgrass has flourished on overgrazed areas and dry, harsh sites such as the understory of mature mountain mahogany stands. Common forbs are balsamroot (Balsamorhiza sagittata), lupine (Lupinus spp.), and yarrow (Achillea millefolium).

Shrubs that occur commonly on southern exposures are mountain mahogany, bitterbrush, big sagebrush (Artemisia tridentata), and rubber rabbitbrush (Chrysothamnus nauseosus). Stands of mountain mahogany occur frequently on the steep, rocky ridges and outcroppings. Bitterbrush and rubber rabbitbrush are densest on open slopes and ridges where soil development is deeper. Other shrub species are Oregon grape, chokecherry (Prunus virginiana), serviceberry (Amelanchier alnifolia), ceanothus (Ceanothus velutinus), and wax current (Ribes cereum).

The Douglas fir zone extends down on the winter range on most northern exposures. Common to this understory is ninebark (Physocarpus malvaceus) and shinyleaf spirea (Spiraea betulifolia). In more open stands, Rocky mountain maple (Acer glabrum) may occur. Pinegrass (Calamagrostis rubescens) and elk sedge (Carex geyeri) are found in the understory.

Creek Bottoms

Creek bottoms are typified by aspen (Populus tremuloides) groves, cottonwood (P. trichocarpa), Red-osier dogwood (Cornus stolonifera), Hawthorn (Crataegus douglasii), willow (Salix spp.), and thimbleberry (Rubus parviflorus). On many sites, fingers of bluebunch wheatgrass-Idaho fescue extend down the hillsides nearly to the streams. A common forb is strawberry (Fragaria vesca).

Burns

The 1939 fire in Doe and Fawn creeks, tributaries of Big Creek, burned north-facing slopes. Now, primarily ninebark covers these slopes, occasionally broken by patches of Douglas fir reproduction. It appears that burning on true northern exposures will not improve this range. However, where finger ridges of northern exposures extend far enough out to receive direct sunlight, mountain mahogany has established. These are primarily older plants, dating back at least 100 years. Over the years, ninebark and Douglas fir have encroached on some of these stands. The lower slopes of Doe, Fawn, and Pioneer creeks demonstrate this type. In this type, fire seems to be essential to set back succession and maintain a seral mountain mahogany-bitterbrush stage. Vegetation response from the 1939 fire indicates that mountain mahogany cannot compete with ninebark on mesic exposures. Mountain mahogany in these areas still occurs primarily on finger ridges, too xeric for ninebark.

I feel that fire has played a role in maintenance of game populations in this area. Since the area has low annual precipitation, we cannot expect low elevation river breaks on these winter ranges to be covered with dense brush fields as seen farther north in Idaho. Grasslands associated with shrubs such as bitterbrush and rabbitbrush are typical for these breaks (Mueggler and Harris 1969) interspersed with mountain mahogany stands where rocky outcrops occur.

The upper elevation of this winter range from 4800-6000 feet is moist enough for Douglas fir types on most exposures, except true south and where soils are shallow and rocky. Many sites can be found where trees are or already have encroached on browse stands. This zone is probably one of the most heavily used areas as it receives intensive use in late fall, mild winters, and spring. Control of fire permits further encroachment of Douglas fir and ninebark. This is a slow process, but it will reduce food availability for ungulates in this important zone. The U.S. Forest Service (1972) recognized the value of this zone and recommended it be monitored.

Range Abuse

Range abuse in Big Creek has changed bluebunch wheatgrass types to sites where *A. michauxiana* and *A. ludoviciana*, cheatgrass and *Rosa* spp. are increasing. Habitually, horses have overgrazed creek bottoms, ridgetops, benches, and even steep hillsides in some fenced areas. Most of these ridgetops and higher elevation benches have pocket gopher (*Thomomys talpoides*) disturbance. Trampling and overgrazing have contributed to soil erosion in these areas. These shallow, granitic soils are especially susceptible to disturbance (Craddock and Pearse 1938, Larson and Lovely 1972) and concentrated livestock use increases erosion potential in these areas.

METHODS AND MATERIALS

Cover Typing

Vegetative types were delineated by species identification, visual reconnaissance, and canopy coverage of selected sites. I followed Hitchcock et al. (1955-69) and Asherin (1973) for plant species notations. Major vegetative types were visually assigned and recorded on aerial photo overlays. These records are available at the Idaho Cooperative Wildlife Research Unit, University of Idaho, Moscow.

Some areas of this winter range are open most winters and are utilized heavily by ungulates. These vegetative sites were sampled intensively by the canopy coverage method (Daubenmire 1959). Specific sampling techniques were patterned after those used by Poulton and Tisdale (1961). I selected large areas of visually similar vegetative types and randomly placed three 50 x 100-foot macroplots within the type. On each macroplot, vegetation was sampled by a random distribution of 40 plot frames, each 8 x 20 in, along four 50-foot transects. I estimated canopy coverage and basal area of plant species and recorded each hit of the pointed frame legs as rock, soil, vegetation, or litter. Yields of live forage for grasses and forbs were obtained by clipping 20 randomly distributed 0.96 ft^2 circular plots on each macroplot. By these techniques, I evaluated vegetation on the bases of frequency of occurrence, canopy coverage of individual species, and forage production of grasses and forbs.

Production of bitterbrush and mountain mahogany was calculated by average number of twigs per plant, mean twig length and mean twig weight (Lauer in prep.). Five hundred twigs of each species were collected, measured to nearest cm, oven dried and weighed so that I could estimate production on a per plant basis. I calculated density of shrubs from macroplot and belt transect (see utilization techniques section) data to estimate production in pounds/acre.

Utilization

I measured ungulate utilization of mountain mahogany and bitterbrush by the "before and after" twig measurement method (Aldous 1944) for the 1970-71 and 1971-72 winter seasons. I located transects in areas available to ungulates most of the winter season. Since Big Creek winter range has such diverse topography, three physical factors, slope, aspect, and elevation, are critical in analysis of plant utilization. These factors were recorded for each transect. Transects were randomly placed through browse stands by a random number of paces along the stand perimeter. The nearest plant within 7 feet of the transect line was taken until I reached 25 plants per transect. Shrub density estimates were obtained from this belt transect, too. Transect locations were marked with rock cairns, metal stakes and on aerial photographs.

I marked plants individually by numbered metal tags backed with 1.5 in^2 fluorescent flagging. The branch systems I measured were marked with colored wire at the base. Position of branch system in relation to slope and average height from the ground was recorded. I collected measurement data with these restrictions: 1) current growth leaders were measured to the nearest 1/20 inch, 2) current growth leaders were considered measurable only if at least 1/4 inch long, and 3) each plant must have at least 15 measurable leaders present.

Utilization was calculated by total inches of growth measured in fall minus inches remaining in spring after ungulates left the lower elevations. Sample size by the formula: $N = \frac{s^2 \cdot t^2}{(\bar{x} \cdot \pm 10\%)^2}$. I sought a 10 percent level of significance on these data. Ten plants per transect usually satisfied this criterion, though I used 25 plants on most transects. These measurements were conducted for 1970-71 and 1971-72 seasons.

Hedging class estimates were taken each spring on measurement transects as well as areas not covered by these transects. In this way, most of the winter range area could be evaluated in reference to utilization zones based on mountain mahogany and bitterbrush. Utilization estimates and shrub age classes were recorded as described by Dasmann (1948) and Cole (1958). I marked transect locations on aerial photographs.

Shrub Aging

To age mountain mahogany and bitterbrush, I cut cross-sections from plants selected from various stands on the study area. I cut plants I felt would offer a range of ages present. Wood faces were polished with a power sander and viewed with a dissecting scope to distinguish annual rings.

In addition, I aged Douglas fir trees where they appeared to be spreading into shrub stands. An increment bore was used for these age estimates.

Mountain Mahogany Regrowth

In an effort to stimulate regrowth of tall, unavailable mountain mahogany plants, I topped plants at heights of 1, 2, and 3 feet on a variety of slopes and exposures. Ten plants were caged to protect any regrowth and 14 were left unprotected. Stumps were marked with numbered metal tags. Plants were cut in November 1970 and August 1971.

Soil Surface Movement

To estimate soil surface displacement on heavily used slopes, I used plumb bob measurement. A pair of stakes were driven 45 inches apart, and oriented across the direction of slope. I suspended 1/2 inch angle iron across them and took a plumb bob distance from the top of the angle iron to the ground at 2.54 cm intervals. I measured these transects five times during the study.

I established three permanent transects in both Coxey and Cave creek drainages. Soil displacement transects are located in proximity to shrub utilization transects.

Food Habits

Personnel of the Idaho Cooperative Wildlife Research Unit collected 186 rumen samples from ungulates killed by hunters, mountain lions, and coyotes throughout the winters of 1969-70, 1970-71 and 1971-72. Samples were taken from 116 mule deer, 62 elk and 8 bighorn sheep. We tried to collect 1000-cc size samples of stomach contents, but not all animals had ingested this much.

I had samples analyzed by volumetric displacement (Greer et al. 1970) and aggregate percentage (Martin et al. 1946). Technicians of the Wildlife Laboratory, Montana Fish and Game Department, washed samples through a 3.2-mm screen and then separated the remainder into similar plant groups. In a 1ℓ graduate cylinder, they measured volumetric displacement of groups to the nearest 0.1 cc. Group displacement of less than 0.1 cc was recorded as trace (Tr). Mr. Earl Murray, a student assistant, and I identified these groups to plant species. Mr. Kenneth Greer supervised these analyses.

Results of these analyses were grouped by months for the three winter periods. I made comparisons on the basis of plant species frequency of occurrence and volume in cc for correlations between food ingested and range composition.

Nutrient Analysis

To assess certain aspects of range forage quality, I selected these critical nutritive components: crude protein and fiber. Protein is considered one of the most important nutrient components (Dietz 1972). The body cannot maintain itself with a serious protein deficiency and even a small deficiency adversely affects reproduction, lactation, growth, and fattening processes. Ruminant animals need protein for rumen microorganisms to digest and metabolize carbohydrates and fats effectively. When protein levels fall below a minimal level, rumen function becomes severely impaired (Dietz 1972).

Crude protein may contain not only the various proteins such as simple proteins, conjugated proteins, and derived proteins, but also other nitrogenous glucosides, and ammonium salts (Maynard and Loosli 1969). Since crude protein is correlated to digestible protein content, determination of the crude protein level of a plant can give a reasonably reliable indication of its feed value (Sullivan 1962).

Plant collections and ungulate stomach contents were analyzed for crude protein and fiber content by proximate analysis (Horwitz 1955). These analyses were supervised by Mr. Frank Parks, Soils Testing Laboratory, University of Idaho.

Volumetric analysis of stomach contents indicated seven plant species are particularly important in the winter diet of mule deer and elk on Big Creek. These species are mountain mahogany, bitterbrush, Douglas fir, rabbitbrush, Oregon grape, bluebunch wheatgrass, and Idaho fescue. I collected twelve 35-g samples of each species from Coxey, Cave, and Goat creek sample sites. I chose three sampling periods in 1971: October 1-3, February 14-17, and May 9-11, to cover earliest arrival of ungulates on the range, mid-winter use, and latest use in spring.

Field collections were air dried 30 days, oven dried 24 hours at 100° C, and then ground at high speed with a Braun blender. Samples were stored in plastic bottles to minimize moisture absorption prior to nutrient analysis.

Samples were collected with these restrictions: 1) Several plants were used in the collection of the 35-g sample. 2) Plant parts taken had to be in an available forage zone of 0-6 feet from ground level. 3) Twigs cut from browse species were from current year's growth. 4) Cuttings from browse species were not to exceed 4 inches in length and the terminal bud or leaf must be present. 5) Grasses were cut from the soil surface and included green as well as cured stems. 6) I utilized the "wandering quarter" technique (Dix 1961) to select plants.

Nutrient values contained small variation. Sample size at the 5 percent level of significance was calculated by this formula: $N = \frac{s^2 \cdot t^2}{(\bar{x} \cdot \pm 5\%)^2}$. Three samples satisfied the restriction in most cases. Since sample values were received on a total weight basis, a moisture correction factor was required. I had 30 samples analyzed for percent moisture at the time of analysis. Moisture content varied slightly between species, but this variance was considered insignificant in my work. All samples contained an average of 2.210 percent moisture by weight. To report nutrient data on a total dry weight basis, I calculated a moisture correction factor. I converted 2.210 percent moisture to its decimal form and subtracted from 1.000. Thus, the correction factor .9779 was derived.

Each rumen sample was oven dried for 24 hours at 100° C, then weighed, and ground in a Braun blender at high speed. Duplicate analyses were run on the first set of 105 rumen samples, but for the remainder I used a single analysis due to small within sample variation.

These data were statistically analyzed by Least Squares Maximum Likelihood General Purpose Program (LSMLGP) and Duncan's new multiple range tests on the IBM computer series 360/40.

RESULTS

Cover Typing

Vegetative types were assigned by the species with the highest canopy coverage of these plant groups: grass-forb-shrub. Table 1 summarizes these vegetative types in relation to aspect and elevation of each site.

Bluebunch wheatgrass is the dominant grass on southern exposures of this winter range. Idaho fescue and Festuca spp. occur in mesic sways and some sites that are southeast and southwest in exposure where more moisture is available. Common forbs are balsamroot, yarrow and lupine. Canopy cover of balsamroot and lupine are under-estimated by sampling in late summer. My purpose was to estimate canopy coverage going into the fall-winter season when animals intensively use the study area. For this reason, I sampled in late summer.

Shrub species encountered most frequently were bitterbrush and rubber rabbitbrush. Mountain mahogany may be associated with bluebunch wheatgrass stands in some areas, but it is usually found on rocky outcroppings where cheatgrass is often common in the understory on dry sites. On moist sites where mountain mahogany occurs, Idaho fescue is often found in the understory.

Specific results from 21 macroplots (Table 2) quantify vegetation as it occurs on slopes available to animals in winter. All plant species that occurred within a macroplot are listed even though their frequency was so low that they did not occur in a plot frame. Shrub species were often missed by the 8 x 20 in sample frame.

Total vegetative coverage for these sites ranged from 10.6 percent (macroplot #19) to 31.0 percent (macroplot #4), averaging 19.6 percent canopy coverage. I feel the low vegetative cover on some sites cannot be entirely

Table 1. Some vegetative types on the Big Creek winter range classified by analysis of 21 macroplots.

Plot No.	Drainage	Elevation (ft)	Forage Production* Grass	Forb	Aspect	Vegetative Type
1	Cave	5400			S	AGSP-ACMI
2	Cave	5400	400	107	S	AGSP-ACMI-CHNA
3	Cave	5400			S	AGSP-LUPIN-CHNA
4	Coxey	5400			S	AGSP-BASA-PUTR
5	Coxey	5400	342	63	S	AGSP-POMA
6	Coxey	5400			S	AGSP-BASA-PUTR
7	Goat-Cougar	5600			S	AGSP-BASA-CHNA
8	Goat-Cougar	5600	455	250	SE	FESTU-BASA
9	Goat-Cougar	5600			S	FESTU-BASA
10	Rush	5500			SW	AGSP-ACMI-ARTR
11	Rush	5500	154	36	SW	AGSP-ACMI-ARTR
12	Rush	5500			SW	AGSP-ACMI-ARTR
13	W.F. Cave	5600			S	AGSP-EROV-PUTR
14	W.F. Cave	5600	238	287	S	AGSP-BASA-PUTR
15	W.F. Cave	5600			S	AGSP-BASA-PUTR
16	E.F. Coxey	5800			S	AGSP-LUPIN-CHNA
17	E.F. Coxey	5800	541	76	S	AGSP-LUPIN-CHNA
18	E.F. Coxey	5800			S	AGSP-LUPIN-CHNA
19	Garden	6000			SE	FEID-BASA-CHNA
20	Garden	6000	171	243	S	FEID-BASA
21	Garden	6000			S	FEID-BASA-PUTR

* Production is presented as pounds per acre, averaged for each set of three adjacent macroplots.

Note: Abbreviations in this table are defined as: S, south; SW, southwest; SE, southeast; W.F., west fork; E.F., east fork; Ft., feet.

Table 2. Vegetative occurrence and canopy coverage on Big Creek winter range, 1972.

Plant Species	Macroplots 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
AGSP	42.5* / 9.8	55.0 / 16.6	70.0 / 20.4	57.5 / 21.8	45.0 / 14.1	55.0 / 13.2	87.5 / 11.4	47.5 / 4.9	40.0 / 4.0	65.0 / 10.3	70.0 / 6.1	42.5 / 4.1	45.0 / 6.9	72.5 / 9.4	65.0 / 11.9	80.0 / 6.6	82.5 / 5.8	87.5 / 7.6	50.0 / 2.5	55.0 / 1.7	60.0 / 1.8
FEID		15.0 / .4	30.0 / 1.1			17.5 / 2.4	2.5 / .1	10.0 / .3	25.0 / 1.3		7.5 / .5	7.5 / .2		7.5 / .2	10.0 / .3	X	10.0 / .3	22.5 / .9	72.5 / 2.8	82.5 / 3.0	87.5 / 3.1
BRTE	90.0 / 2.3	37.5 / .9	37.5 / .9	2.5 / .1	47.5 / 1.2	30.0 / .8	40.0 / 1.0	15.0 / .4	15.0 / .4	80.0 / .2	77.5 / 1.9	85.0 / 2.1	55.0 / 1.4	72.5 / 1.8	15.0 / .4	85.0 / 2.1	97.5 / 2.4	82.5 / 2.1		X	15.0 / .4
MEBU		7.5 / .5												X**							
FESTU								87.5 / 6.6	95.0 / 7.4				5.0 / .1								
ACMI	27.5 / 2.3	22.5 / 2.7	7.5 / .3	2.5 / .1			45.0 / 1.1	20.0 / .5	75.0 / 2.0	35.0 / .9	50.0 / 1.3	30.0 / 1.1	2.5 / .1	7.5 / .2	10.0 / .3					5.0 / .1	
AMSIN							40.0 / 1.0	2.5 / .1				10.0 / .1			5.0 / .3	5.0 / .1	17.5 / .4	10.0 / .3		5.0 / .1	
ANRO 2		2.5 / .1																	2.5 / .1		
ARCA	12.5 / .3	2.5 / .1	5.0 / .1	2.5 / .1	12.5 / .4	17.5 / .4	.0 / .1			7.5 / .2	5.0 / .1	7.5 / .2								X	
BASA				5.0 / 5.3	.0 / .4	2.5 / 3.5	12.5 / 4.0	37.5 / 2.5	30.0 / 2.0		2.5 / .4		.0 / .4	5.0 / 2.6	5.0 / .8				12.5 / 4.1	27.5 / 5.2	30.0 / 14.9
CIRSI		2.5 / .9		.0 / .4		5.0 / 1.9								X		X					
COLLO							27.5 / .7	50.0 / .3	60.0 / 1.5							2.5 / .1	17.5 / .4	45.0 / 1.1		5.0 / .1	
ERIOG																				X	

Table 2 (Continued).

Plant Species	Macroplots 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
EROV								2.5 / .1	5.0 / .1	2.5 / .1	2.5 / .1	X	15.0 / 2.2	15.0 / 1.9	X	2.5 / .1	2.5 / .1	X	2.5 / .1	X	2.5 / .1
ERUM	5.0 / .8	7.5 / 2.3	10.0 / .9			10.0 / .6	5.0 / .1														
GIAG				2.5 / .1																	
LIRU							2.5 / .1	2.5 / .4	5.0 / .1	10.0 / .3	5.0 / .1	X									
LUPIN	2.5 / .4	2.5 / 2.3	.0 / 1.1				.0 / .1	2.5 / 1.3	5.0 / 1.9	2.5 / .1	2.5 / 1.1	.0 / .3		10.0 / .3		5.0 / .5	10.0 / .4	5.0 / .5	2.5 / .1	5.0 / .9	2.5 / .9
PEDE	15.0 / 1.3		5.0 / .1	7.5 / .8	7.5 / .5	5.0 / .5															
PENST			2.5 / .4										22.5 / .6	2.5 / .1		7.5 / .2		2.5 / .1			
PEDIC	10.0 / .3																				
PHGE								7.5 / .5	5.0 / .1				7.5 / .2				2.5 / .1				
PHHA										2.5 / .1	2.5 / .1	5.0 / .1				X					
POMA 2	2.5 / .1	2.5 / .1			22.5 / .6	35.0 / 1.3	10.0 / .3	55.0 / 1.4	65.0 / 1.6							5.0 / .1	7.5 / .2	2.5 / .1		17.5 / .4	2.5 / .1
TRDU							7.5 / .3	10.0 / .3	20.0 / .5	X	X		X	X			2.5 / .1	X		X	
ZIPA									X												
Moss		2.5 / .1					5.0 / .1	5.0 / .1	10.0 / .3	15.0 / 4.0	17.5 / 4.3	37.5 / 5.4	2.5 / .4	5.0 / .4	5.0 / .8	X		2.5 / .1			

Table 2 (Continued).

Plant Species	Macroplots 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ARTR										7.5/6.5	17.5/1.4	2.5/.1									
ARTR 2	15.0/1.9		5.0/.4	10.0/1.2																	
CHNA		2.5/2.1	5.0/.8				2.5/.4				2.5/.1	X				2.5/3.9	5.0/3.8	10.0/5.4	2.5/.9		X
PUTR				2.5/.8		.0/.1				10.0/1.7		5.0/.1	2.5/.4	.0/1.6	5.0/3.3						2.5/.1
RIBES													2.5/.4								
Average Total Canopy Cover	19.5	29.1	26.5	31.0	17.2	24.7	21.0	20.7	23.2	26.3	17.7	14.7	13.1	18.5	18.1	13.7	14.0	18.2	10.6	11.5	21.4

* Value above the line is average frequency of occurrence in macroplot and the value below the line equals average canopy cover of the species.

**Species occurred in macroplot, but not in the sample frame.

explained by intensive animal use. To make a judgment of condition, factors of percent slope, exposure, soil type, and domestic grazing must be considered. These factors will be related in the discussion section.

To estimate the relationship of soil, rock, and litter, I recorded point hits of sharpened plot frame legs. For each macroplot, 160 such hits were recorded (Table 3). The remaining percent represents that of hits on plant basal area. Percentages of soil, rock and litter ranged from 8.1 - 67.5, 0.0 - 75.6, and 8.1 - 40.0 on these harsh sites, respectively (Table 3).

All macroplots need to be remeasured at 2-3 year intervals. In this manner, deviation from current percentages of soil, rock, vegetative cover, species composition, and production can be quantified. These macroplots are placed in sensitive areas that will show change when it first begins to occur. I selected sensitive areas based on observations of ungulates from 7 years of Idaho Cooperative Wildlife Research Unit records and field experience that indicated intensive use each year.

Forage Production

Production (Table 1), on a weight basis, is one of the most variable factors of vegetative description. This is due to seasonal curing and annual variations in rainfall. Production of annual forbs and grasses is particularly dependent on rainfall. To compare production in the future with these data, sampling must be done in late summer and this inherent variation must be realized.

For grasses and forbs, I averaged the production figures from three adjacent macroplots on similar sites. Grass production is basically that of bluebunch wheatgrass, the dominant species. Forb production is composed of

Table 3. Percentages of soil, rock, and litter from the point method.

	Macroplot Number*																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Soil	21.3	8.1	33.8	46.3	29.4	33.1	49.4	55.6	67.5	33.1	38.8	30.0	34.4	31.3	16.3	30.6	22.5	26.3	28.8	22.5	39.4
Rock	46.3	75.6	48.8	31.9	58.1	51.3	1.3	1.9	0.0	30.6	25.6	26.3	46.9	41.9	62.5	45.0	51.9	46.9	53.1	60.0	36.9
Litter	27.5	13.1	10.0	16.9	10.0	10.0	40.0	35.6	23.8	24.4	21.9	31.3	11.3	19.4	12.5	15.6	18.8	18.1	8.1	11.3	13.1

* The line indicates that the macroplots were in a visually similar vegetative type.
Note: The remaining percent for each macroplot is due to basal area of vegetation.

a variety of species, though balsamroot, eriogonums (buckwheat) and yarrow contributed the most.

Browse production for mountain mahogany and bitterbrush was calculated for three sample sites in Coxey, Cave and Goat creeks. On a dry weight, lb/acre basis the results were 15, 16 and 20 for mountain mahogany at Coxey, Cave and Goat creek sample sites, respectively. For bitterbrush, the values were 35 and 32 lb/acre at Coxey and Cave creek sample sites, respectively. Bitterbrush occurs at very low density on Goat Creek slopes and was therefore omitted from the calculations.

Shrub Utilization

Table 4 summarizes percent utilization by before and after twig measurement (Aldous 1944) for 1970-71 and 1971-72 winter seasons. These transects were placed in stands that I considered available to animals and therefore indicative of browse use. They were located at various distances from ridgetops and creek bottoms to measure use intensities in relation to topography. I could do this with some foresight, due to range analyses by Hornocker (1970), U.S. Forest Service (Payette National Forest) range data and information from Idaho Cooperative Wildlife Research Unit field biologists. In this way, I could quantify an overall picture of animal use on mountain mahogany and bitterbrush. It should be noted that some mountain mahogany transects such as numbers 3, 6, and 13 were located near ridgetops since major stands of the drainage to be sampled were associated with rocky finger ridges.

To further substantiate patterns of browse use in relation to topography, I estimated hedging and age classes of shrubs (Dasmann 1948, Cole 1958) on mountain mahogany and bitterbrush plants (Tables 5 and 6). I

Table 4. Browse utilization on 14 shrub transects located on the Big Creek winter range, 1970-72.

Transect No.	Drainage	Elevation (ft)	Aspect	Species	No. Plants	1970-71 Average % Utilization	1971-72 Average % Utilization
1	Cave	5200	S	CELE	16	71.5 ± 13.6*	75.0 ± 13.3
2	Cave	5100	S	PUTR	31	77.5 ± 14.9	79.6 ± 16.8
3	Coxey	5400	S	CELE	19	74.5 ± 13.2	78.0 ± 18.7
4	Coxey	5400	S	PUTR	17	66.3 ± 19.1	69.2 ± 16.7
5	Cave	5250	W	PUTR	25	74.1 ± 12.5	74.3 ± 10.1
6	Cave	5300	SW	CELE	28	54.8 ± 22.6	78.8 ± 12.1
7	Cow	5200	SE	CELE	5	70.5 ± 11.4	63.8 ± 21.7
				PUTR	13	62.1 ± 16.0	83.0 ± 14.5
8	Cow	4900	SE	CELE	16	73.9 ± 12.0	62.4 ± 6.2
				PUTR	2	57.9 ± 10.3	77.3 ± 24.9
9	Cow	4900	SE	CELE	9	80.4 ± 12.0	79.3 ± 27.2
				PUTR	11	86.1 ± 11.3	71.7 ± 5.9
10	Coxey	5200	E	CELE	25	45.5 ± 25.5	76.3 ± 25.8
11	Lime	5000	SE	CELE	28	51.4 ± 15.1	41.0 ± 39.6
12	Lime	5000	SE	PUTR	25	45.1 ± 29.3	21.2 ± 20.7
13	Spring	5300	S	CELE	22	69.7 ± 32.4	70.5 ± 26.5
				PUTR	4	80.0 ± 6.2	83.1 ± 9.0
14	Rush	6000	SE	PUTR	25	---	21.5 ± 20.8

* Standard deviation.

Table 5. Estimated browse utilization on 12 shrub transects located on the Big Creek winter range, 1970-71.

Transect No.	Location	Species	No. Plants	Elevation (ft)	Aspect	% Availability All	% Availability Partially	% Availability Unavailable	% Age Classes Young	% Age Classes Mature	% Age Classes Dead	Ave. % Leader Use*
1	Goat	CELE	100	4100	S	43	39	18	1	81	18	77
2	Lobauer Basin	CELE	50	4600	SE	29	58	13	0	84	16	70
3	Lobauer Basin	PUTR	25	4600	SE	100	0	0	0	100	0	87
4	Brown's Basin	CELE	43	4500	S	49	35	16	0	86	14	88
5	Brown's Basin	PUTR	57	4500	S	78	22	0	0	95	5	89
6	Cave	PUTR	100	5800	S	100	0	0	1	73	26	80
7	W.F. Cave	CELE	35	5600	SE	89	11	0	0	100	0	86
8	W.F. Cave	PUTR	65	5600	SE	98	2	0	6	72	22	73
9	Coxey	CELE	72	5700	S	81	8	11	1	71	28	88
10	Coxey	PUTR	128	5700	S	100	0	0	2	79	19	84
11	Lime	CELE	73	5400	S	78	14	8	0	88	12	90
12	Lime	PUTR	127	5400	S	99	1	0	9	82	9	79

* These hedging class estimates average approximately 12 percent higher than actual use (see page 30).

Table 6. Estimated browse utilization on 20 shrub transects located on the Big Creek winter range, 1971-72.

Tran-sect No.	Location	Species	No. Plants	Ele-vation (ft)	Aspect	% Availability All	Par-tially	Unavail-able	Young	Mature	Dead	Ave. % Leader Use*
1	Goat	CELE	64	4100	S	52	33	15	0	94	6	81
2	Lobauer	CELE	50	4600	SE	28	56	16	0	81	19	78
3	Lobauer	PUTR	25	4600	SE	100	0	0	0	100	0	83
4	Brown's	CELE	50	4500	S	46	37	17	0	84	16	84
5	Brown's	PUTR	50	4500	S	76	24	0	0	96	4	81
6	Cave	PUTR	100	5800	S	100	0	0	2	74	24	74
7	Cabin	PUTR	100	5600	SE	82	14	4	0	86	16	85
8	Cabin	PUTR	81	5600	SE	68	0	32	3	87	10	90
9	Cabin	CELE	62	5700	S	94	6	0	2	77	21	82
10	Spring	PUTR	100	5700	S	92	8	0	4	86	10	88
11	Mile High	PUTR	100	5400	S	95	5	0	3	82	15	73
12	Mile High	PUTR	50	5400	S	100	0	0	2	88	10	71
13	Mile High	PUTR	50	5800	SE	100	0	0	4	90	6	29
14	Coxey	CELE	35	5800	S	33	25	42	0	77	23	90
15	Coxey	PUTR	65	5800	S	100	0	0	10	84	6	76
16	Coxey	CELE	50	5700	SE	68	9	23	0	88	12	84
17	Coxey	CELE	50	5700	SW	37	3	60	0	80	20	90
18	Lime	CELE	87	5500	SW	55	18	27	0	94	6	88
19	Lime	PUTR	60	5500	SW	98	2	0	3	80	17	69
20	Garden	PUTR	50	6000	E	100	0	0	32	66	2	8

* These hedging class estimates average approximately 12 percent higher than actual use (see page 30).

distributed these transects over the winter range at various elevations, slopes and aspects.

I made two changes from techniques as described by Cole (1958) that affect figures in Tables 5 and 6. Cole (1958) recorded plants up to 1/8 inch basal stem diameter as seedlings and similarly, plants 1/8 to 1/4 inch diameter as young. I eliminated the seedling category and classed any plant 1/4 inch diameter or less as young. Next, Cole (1958) tallied plants with a minimum crown decadence of 25 percent as decadent. I raised this figure to 75 percent, so my decadence percent will be lower than other investigators using Cole's methods literally.

To increase accuracy of these hedging class estimates, I determined the average difference between utilization calculated by actual measurement and estimation. I did this by estimating utilization on all plants actually measured. Average deviations for bitterbrush and mountain mahogany were +12.4 percent and +11.7 percent, respectively. Thus, hedging class estimates of utilization for both browse species average approximately 12 percent higher than actual utilization. This error is due primarily to grouping of data, taking mid-point of classes for average, and ocular estimate error. Utilization estimates in Tables 5 and 6, therefore run 12 percent high.

With this utilization pattern quantified, importance of slope location, aspect and elevation became evident. Thus, I looked at a variety of utilization transects before drawing these conclusions about relative intensity of use. In general, mountain mahogany was utilized in excess of 70 percent wherever it was available. Bitterbrush utilization followed a topographical pattern of utilization, ranging from at least 70 percent utilization near ridgetops to less than 25 percent adjacent to creek bottoms.

Browse utilization of mountain mahogany and bitterbrush was similar for the two winter seasons 1970-71 and 1971-72. Eleven transects (Table 4) had higher average use in 1971-72 that ranged from 0.1 to 30.8 percent. However, of these eleven transects showing heavier use, only three had average use at least 20 percent higher than the previous year.

Bunchgrass Utilization

I examined bluebunch wheatgrass plants to get an estimation of their utilization and condition. Two hundred plants in the Mile High area at 5800 feet were 93 percent grazed; however, this use was of low enough intensity that 56 percent of grazed plants examined were producing seeds. Since winds are strong on these high slopes, many of the dried seed culms may have been broken and blown away. Therefore, 56 percent seed production on grazed plants is a minimum figure.

In Coxey Creek, below browse measurement transect #3 and #4, I recorded 200 grazed and ungrazed bluebunch wheatgrass plants and found 91 percent grazed. Four of the 200 plants were seedlings. Of grazed plants, 42 percent had seed culms remaining.

In lower Lime Creek (near hedging class transect #11), I recorded 100 bunchgrass plants as 93 percent grazed. Four of these plants were young and ungrazed.

Comparatively, in spring 1971, U.S. Forest Service wildlife biologist Mr. Dick Welch (Big Creek ranger district, Payette National Forest) recorded 65 percent grazed, 85 percent grazed, and 25 percent grazed on 100 plant transects on Mile High, Cabin and Cliff creeks, respectively.

Shrub Reproduction

Form class structure (Tables 5 and 6) is such that large amounts of mountain mahogany seeds are produced each year by unavailable growth forms. Practically all tall growth form plants examined during two reproductive cycles produced seeds. Of over 500 closely hedged plants examined, less than 15 percent produced seeds each year.

Young mountain mahogany plants were usually found in clumped situations and infrequently scattered in large stands. Many of the low, tightly hedged growth forms are 10-60 years old, indicating reproduction has occurred through years of heavy animal utilization. Dealy (personal communication 1973) stated that annual reproduction is dependent on such factors as weather during a particular season, seed predation by ground insects and rodents, and site competition. Mountain mahogany is very long lived (300+ years) with a low reproductive rate. It does not appear in danger of extermination on the Big Creek winter range due to ungulate use.

Bitterbrush, also intensively used by ungulates, is reproducing in localized areas such as browse measurement transect #12. In this bitterbrush-bluebunch wheatgrass association, young bitterbrush plants get a start under or near bunchgrass clumps. Here they are partially protected by grass clumps and sometimes snow until they reach a height of about 1 foot.

Clumps of chokecherry reproduction are common in bluebunch wheatgrass stands on most of the study area. Chokecherry is a highly palatable species on ranges of deer and elk. Yet, here on a supposedly overstocked and overbrowsed range, young plants are spreading on slopes available practically all winter. Some use occurs, but these young plants are surviving this pressure. Ages of cross-sectioned plants ranged from 1-6 years.

I found similar chokecherry reproduction on the Salmon River winter range study of Mr. Jerry Lauer during a trip in September 1972. These stands were found in Smith Gulch, Chamberlain, Thirsty, Trout and Bull drainages, adjacent to the river.

Young serviceberry plants, another highly palatable browse species, were also noted sporadically on the Big Creek winter range. It was generally less frequent than chokecherry, but reproducing in similar situations.

Shrub Mortality

To estimate an annual mortality rate for mountain mahogany and bitterbrush subjected to intensive utilization, I recorded the number of individually marked plants from browse transects that died over a 2-year period. These plants were all located in areas accessible to ungulates. Of 170 mountain mahogany plants marked in fall 1970, 3 died the first year and 6 the second, averaging 4.5 plants/year or 2.7/100. Of 153 bitterbrush plants marked in fall 1970, 2 died the first year and 1 the second, averaging 1.5/year or 1/100.

Plants were considered dead when green leaves were no longer present. Two mountain mahogany plants called dead in spring 1971 were producing live tissue by spring 1972 so I excluded them from the first year's annual mortality. Perhaps some of the 6 plants tallied as dead in spring 1972 were not dead even though green leaves were not present when examined. Typically, these plants that died were found on what appeared to be drier sites due to very shallow soil or rock outcrops.

Dead, woody tissue persists for many years on these southern slopes. A random sample of living and dead plants in a stand presents higher figures of decadence (Tables 5 and 6) on this basis. Some of these mountain mahogany stands have as high as 28 percent decadence (Table 5), though as shown above this is far from the annual rate of plant mortality. So, in such a dry climate conclusions drawn directly from hedging class methods tend to greatly magnify plant losses. Only by actual calculation of annual mortality can trend be accurately assessed.

Shrub Ages and Related Successional Patterns

Ages of 57 mountain mahogany cross-sections ranged from 2-200+ years. The purpose of these cuttings was to gain a range of plant ages. Since stem diameter is significantly correlated with age I could estimate ages of plants from these results.

Large stands were not evenly aged, but had plants of many different age classes. Young plants occurred in clumps and usually were within or near a large stand. One group of 37 plants in Cougar Creek was in the class of 20-25 years old. Six of these plants were cross-sectioned and the remainder were not visually different in overall size or stem diameter.

Plants that had the tall, unavailable growth form usually were found to be at least 75 years old. These plants occurred throughout the study area on open hillsides as well as in the understory of Douglas fir stands. From this observation, rose the question of which was older, the mountain mahogany or Douglas fir?

I examined 3 such cases of overlap in Coxey, Cave, and Goat creeks and found in each case that mountain mahogany shrubs were older than trees. At the Goat Creek site, shrubs were either dead or had only small branch systems yet alive. Mountain mahogany seedlings were never found in such an understory. Thus, it appears that on more mesic sites where mountain mahogany can initially establish that trees may encroach and stop this shrub from reproducing.

Much of the mahogany, however, occurs on steep ridges and rocky outcroppings where it is too xeric for trees to establish. Some of these sites may occasionally be interspersed with Ponderosa pine, but tree density is usually too low to effect shrubs on Big Creek drainage.

Tree encroachment does seem to have a depressive effect on ceanothus, bitterbrush, and serviceberry stands on the upper winter range area from 4800-6000 feet. Within this elevational range, it is usually moist enough for Douglas fir stands on most exposures, except true south and where soils are shallow and rocky. Numerous sites can be found where trees are or already have encroached on browse stands. Reproduction of palatable shrubs ceases once this occurs and ninebark rapidly spreads through the understory. This upper winter range zone is probably one of the most heavily used areas as it receives intensive use in late fall, mild winters, and spring. Control of fire, as previously discussed on page 9 , permits further encroachment of Douglas fir and ninebark lowering forage production of palatable shrubs.

Mountain Mahogany Regrowth

Tall growth form plants were cut at heights of 1-3 feet in an attempt to stimulate growth within the available browse zone. Ten of 24 topped plants were protected from browsing by metal cages. Since the cuttings in November 1970 and August 1971, resprouting has not occurred at new sites on trunks. Two of the plants appear dead. Photographs were taken for future reference, in case time is a factor in resprouting.

I do not feel this idea should be abandoned without further trial. There are many factors that could affect resprouting. Perhaps cuttings were made at the wrong time of year. It should be noted, however, that wholesale cutting of tall growth form plants on a heavily utilized range will remove most of the seed production, since these plants are major seed producers.

Soil Surface Movement

To quantify soil surface movement on two southern exposures of the winter range, I placed these transects in proximity to browse utilization transects that showed high utilization. I chose two areas where surface movement should be maximum, since the slopes were steep, sparsely vagetated due to harsh exposure, and in areas of intense use by ungulates. As expected for such severe sites, some sheet erosion has taken place, though gulleys and trenches have not formed.

I established transects on 5-26-71 and 5-29-71 in Coxey and Cave creeks, respectively. This first measurement serves as the zero or base line in Figures 2 and 3. Succeeding measurements were taken on Coxey Creek transects on 8-7-71, 10-2-71, 5-13-72, and 7-29-72; and on Cave Creek transects on 8-9-71, 10-1-71, 5-21-72, and 7-24-72.

To simplify presentation of these data (Figures 2 and 3), I used only second and fourth dates measured for each drainage to show departure from the base line. Thus, there is considerable displacement of ground surface. This displacement, however, cannot be completely attributed to surface erosion. Factors such as ungulate trampling of slopes contribute to surface disturbance shown in Figures 2 and 3. Even though these transects do not quantify soil erosion specifically, they do show that the slopes have a high potential for surface displacement as similarly concluded by Larson and Lovely (1972). This fact alone makes it critical to continually monitor range condition and stringently limit use by domestic stock such as horses.

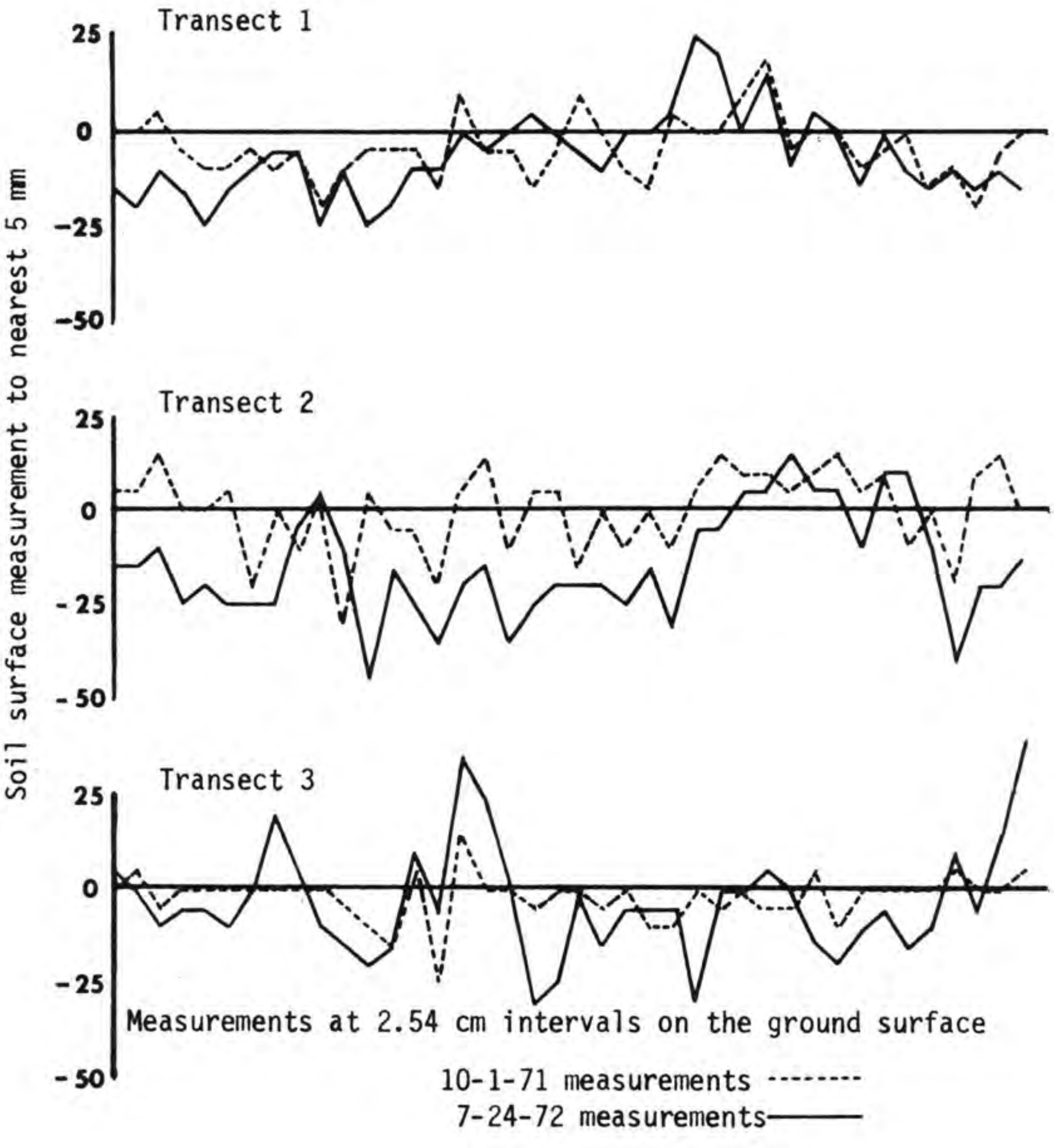

Figure 2. Soil surface movement on a southern exposure in Cave Creek drainage. The abscissa represents the first measurement from which subsequent deviation was plotted.

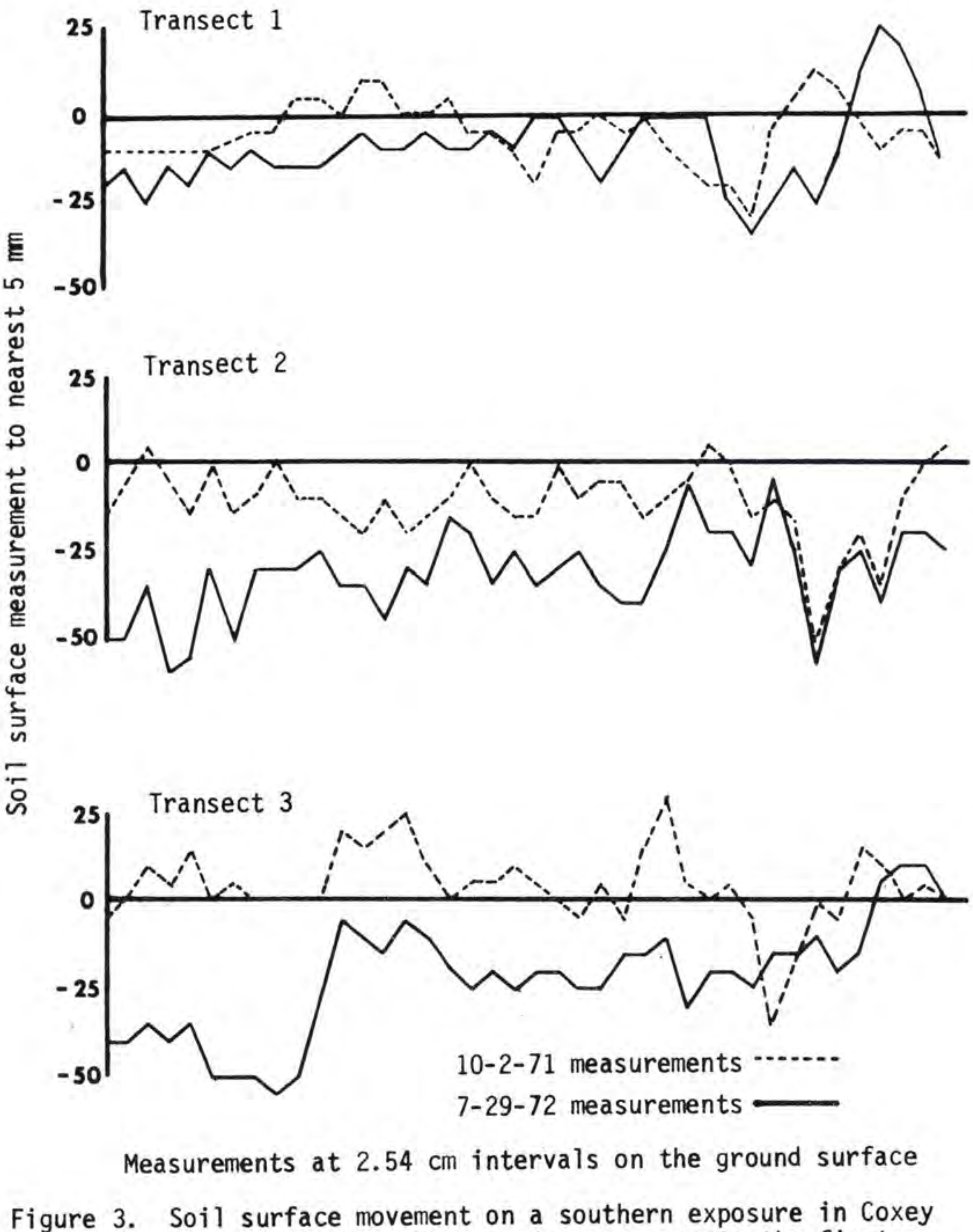

Figure 3. Soil surface movement on a southern exposure in Coxey Creek drainage. The abscissa represents the first measurement from which subsequent deviation was plotted.

Food Habits

Rumen samples were collected for three winter seasons, 1969-70, 1970-71, and 1971-72, from three species (Table 7). Samples were grouped by month for analyses and presentation. Table 7 relates rumen samples to type of kill for these collection periods. It should be noted that none of the samples were classified as winter kills. Only one sample in the collection, a bull elk from February 1972, may have been a winter kill. Thus, the category of unknown kills is primarily due to lack of evidence to distinguish a mountain lion or coyote kill.

Accidental deaths of mule deer and elk were usually due to drowning while attempting to cross Big Creek on soft ice. Accidental deaths of bighorn sheep were so classified since they were found near the base of cliffs. These deaths may have been attributable to a combination of factors such as disease, parasites, and others.

To quantify trends in mule deer and elk food habits on this winter range, I have summarized results of 109 deer and 61 elk rumen samples. I have combined all types of kills (Table 7) for presentation. Predator kills were taken as representative of the population to obtain stomach samples. Hornocker (1970) concluded that physical condition of prey was not a significant factor in determining the makeup of the total kill of either deer or elk by mountain lions. Animals in poor condition were not selected, but were taken proportionately to their occurrence in the population. Of 3 coyote kills, one collected in November and two in February, all were in good condition as classified by femur marrow examination. Hunter kills approximate a random selection, since the first animal sighted was shot. An exception to this is a set of 9 hunter kills of mule deer bucks in area 4 (Table 10 and Figure 1).

Table 7. Chronologic distribution of ungulate rumen samples related to type of kill.

	1969-70								1970-71									1971-72								
	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Se	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Totals
Mule Deer																										
Hunter		1								1	5	4			1				9	3						24
Lion					1			1			1	5	2	4	1	2	2		1		3	4	1			28
Coyote				2	6	5					1		4	1	2						2	8	3			34
Accident														1												1
Unknown				2	3	5						1			1					3	5	1	1			22
Elk																										
Hunter		1									5	3						2	2	3						16
Lion				2	2	1					1	8	4	3	3	2	1	1		3	2	4		2		39
Coyote																										0
Accident							1																			1
Unknown																	1					1		3		5
Bighorn Sheep																										
Hunter									2																	2
Lion		1	1	1																						3
Coyote																										0
Accident														1	1						1					3
Unknown																										0

Tables 8 and 9 relate condition and age of carcasses to month collected. The majority of classified deer and elk were in good condition (Table 8). Young (1/2 to 1 1/2 years) and adult (over 1 1/2 years) deer and elk (Table 9) are represented in the collection. From these summaries, it can be seen that the collection is not weighted to any particular physical condition, age class or type of kill.

Tables 11 and 12 summarize mule deer and elk food habits for three winters by forage classes. These major vegetative classes are browse, conifer, grasses, and forbs. Under browse, I summed all woody tissue except conifer. Forbs include all non-woody and non-graminous tissue. Totals of 109 and 61 samples for mule deer and elk, respectively, were used in computations. Seven more mule deer samples were collected during the 1970-71 winter season that support these data. These samples were not averaged into Table 11, since they could not be assigned to a particular month.

In Figure 4, I present 1969-72 forage class data averaged together for mule deer. Browse comprised at least 50 percent of their diet (Figure 4) December through March. Conifer averages around 15 percent during this period. December through February, grasses average 10 percent, increasing to 30 percent in October-November, and March. In April-May, grasses increase to over 80 percent as spring greenup progresses (Figure 4). At this time, ungulates frequent open ridges and move through upper elevations of the winter range. Forbs comprise a small percent of the diet except in late fall when they averaged as high as 14 percent.

Average forage class data, 1969-72, for elk (Figure 5) show dependence on grasses throughout the winter season. During crusted snow conditions, elk utilize some browse (36 percent), decreasing grass consumption to 45 percent.

Table 8. Chronologic distribution of ungulate rumen samples related to condition of animal.

	1969-70								1970-71									1971-72								
	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Se	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Totals
Mule Deer																										
Good		1		1	1					1	3	3	1	3					4	3	5	3				29
Fair								1														3				4
Poor													1				1			1	1					4
Unknown				3	9	10					4	7	4	3	5	2	1		6	2	4	7	5			72
Elk																										
Good											1	4		1			1		2	1	2	3		1		16
Fair																										0
Poor		1				1																		1		3
Unknown				2	2		1				5	7	4	2	3	2	1	3		5		2		3		42
Bighorn Sheep																										
Good																					1					1
Fair																										0
Poor															1											1
Unknown		1	1	1					2					1												6

Table 9. Chronologic distribution of ungulate rumen samples related to age.

	1969-70								1970-71									1971-72								
	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Se	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Totals
Mule Deer																										
Young (1/2-1 1/2)					1						3	6		2			2		1	1		3				19
Adult (1 1/2+)		1								1	1			1					8	3						12
Unclassified				4	9	10		1			3	4	6	3	5	2			1	2	10	10	5			75
Elk																										
Young (1/2-1 1/2)				1			1				2	7	2	1		1		1	1	1	1			1		20
Adult (1 1/2+)		1		1							2	2	2		1	1	1	2	1	3		2		1		20
Unclassified					2	1					2	2		2	2		1			2	1	3		3		21
Bighorn Sheep																										
Young (1/2-1 1/2)														1												1
Adult (1 1/2+)		1	1	1					2						1											6
Unclassified																					1					1

Table 10. Chronologic distribution of ungulate rumen samples related to location of kill.

		1969-70								1970-71									1971-72								
	Area	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Se	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Oc	No	De	Ja	Fe	Ma	Ap	Ma	Totals
Mule	1		1		2	3	6					1		3	2	1	2	2		1		4	7	2			37
Deer	2				1	3	1						4	2	3	2				2	5	4	5	3			35
	3				1	1			1			1	1	1								1					7
	4					3	3				1	4	4		1	2				7	1	1	1				28
Elk	1		1									1	5	2	2	2	2			1	1		4		4		25
	2				2	1							2	2		1		2			5	2	1		1		19
	3							1				1	2														3
	4					1	1					4	2		1				2	1							12
Bighorn	1																										0
Sheep	2			1											1												2
	3				1					2						1						1					5
	4		1																								1

Table 11. Average percent volume of browse, conifer, grass, and forbs in rumen samples of 109 mule deer collected on Big Creek winter range, 1969-72.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
				1969-70				
Browse	(0)*	17.3 (1)	(0)	83.1 (4)	80.1 (10)	53.2 (10)	(0)	1.8 (1)
Conifer		49.8		0.7	8.9	14.8		3.5
Grass		21.8		15.3	9.4	28.3		94.7
Forbs		11.1		0.9	1.6	3.7		0.0
				1970-71				
Browse	83.2 (1)	48.2 (7)	61.0 (10)	79.3 (6)	50.6 (6)	45.2 (5)	0.2 (2)	16.0 (2)
Conifer	0.0	3.7	18.3	0.1	17.7	9.3	1.9	3.0
Grass	0.0	27.0	14.9	19.9	15.8	38.4	96.7	75.6
Forbs	16.8	21.1	5.8	0.7	15.9	7.1	1.2	5.4
				1971-72				
Browse	(0)	39.1 (10)	58.9 (6)	80.1 (10)	62.2 (13)	53.4 (5)	(0)	(0)
Conifer		1.1	24.8	8.0	26.4	27.6		
Grass		51.1	4.6	5.8	9.9	18.4		
Forbs		8.7	11.7	6.1	1.5	0.6		

*Number in parentheses equals sample size for month.

Table 12. Average percent volume of browse, conifer, grass, and forbs in rumen samples of 61 elk collected on Big Creek winter range, 1969-72.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
				1969-70				
Browse	(0)*	31.9 (1)	(0)	5.4 (2)	14.2 (2)	63.1 (1)	1.6 (1)	(0)
Conifer		0.0		3.3	1.6	0.4	0.7	
Grass		61.0		84.5	37.3	32.0	96.1	
Forbs		7.1		6.8	46.9	4.5	1.6	
				1970-71				
Browse	(0)	3.5 (6)	27.7 (11)	48.8 (4)	28.1 (3)	3.7 (3)	4.8 (2)	0.8 (2)
Conifer		0.3	0.8	3.8	1.5	0.7	1.1	0.4
Grass		94.7	70.9	47.2	58.1	94.3	94.1	97.6
Forbs		1.5	0.6	0.2	12.3	1.3	Tr	1.2
				1971-72				
Browse	6.1 (3)	48.5 (2)	23.5 (6)	40.7 (2)	50.8 (5)	(0)	8.7 (5)	(0)
Conifer	0.1	Tr	1.0	10.5	4.5		0.4	
Grass	91.9	49.7	71.9	47.8	42.9		86.3	
Forbs	1.9	1.8	3.6	1.0	1.8		4.6	

*Number in parentheses indicates sample size for month.

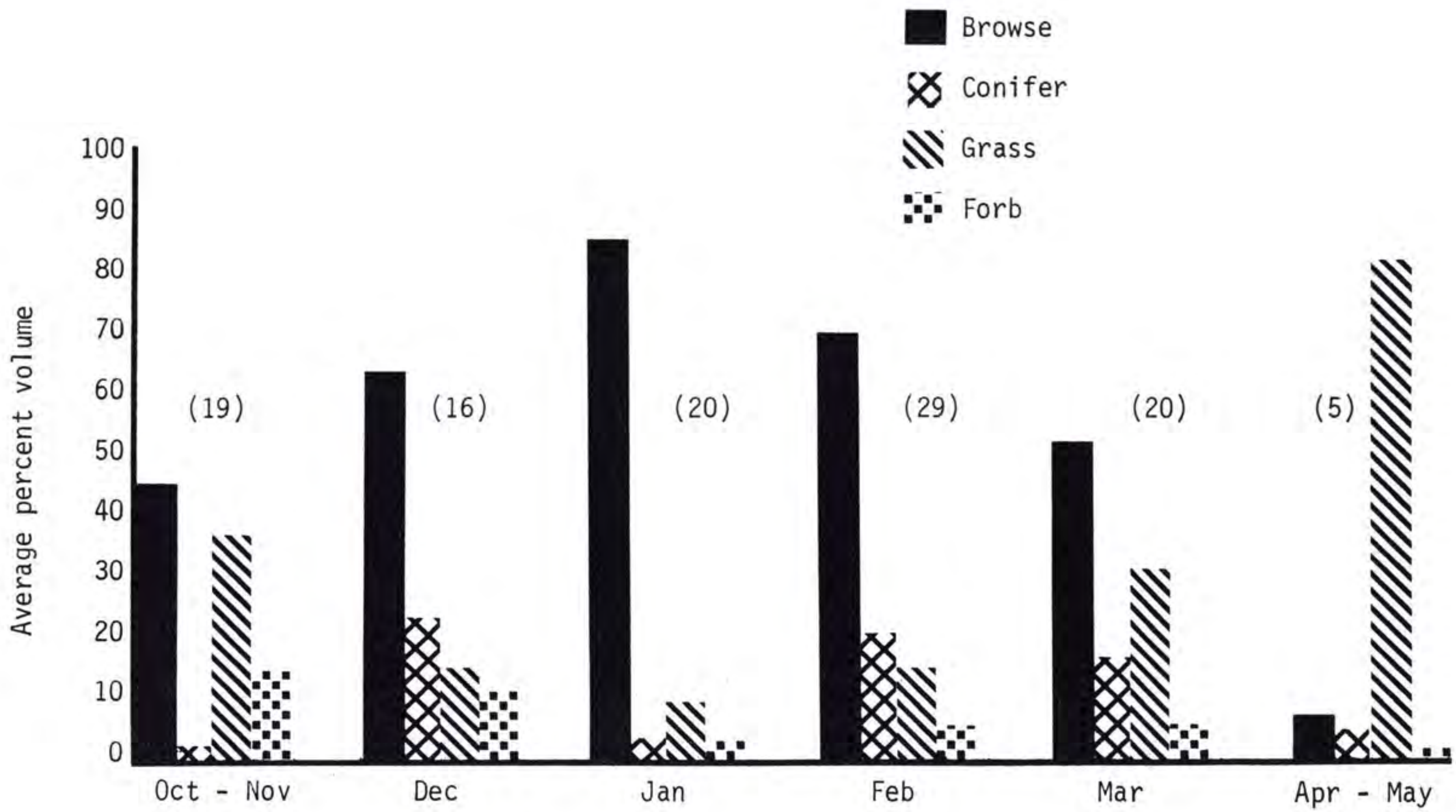

Figure 4. Average percent volume of browse, conifer, grass, and forbs in rumen specimens of 109 mule deer collected on Big Creek winter range, 1969-72. The number in parentheses equals sample size for the month.

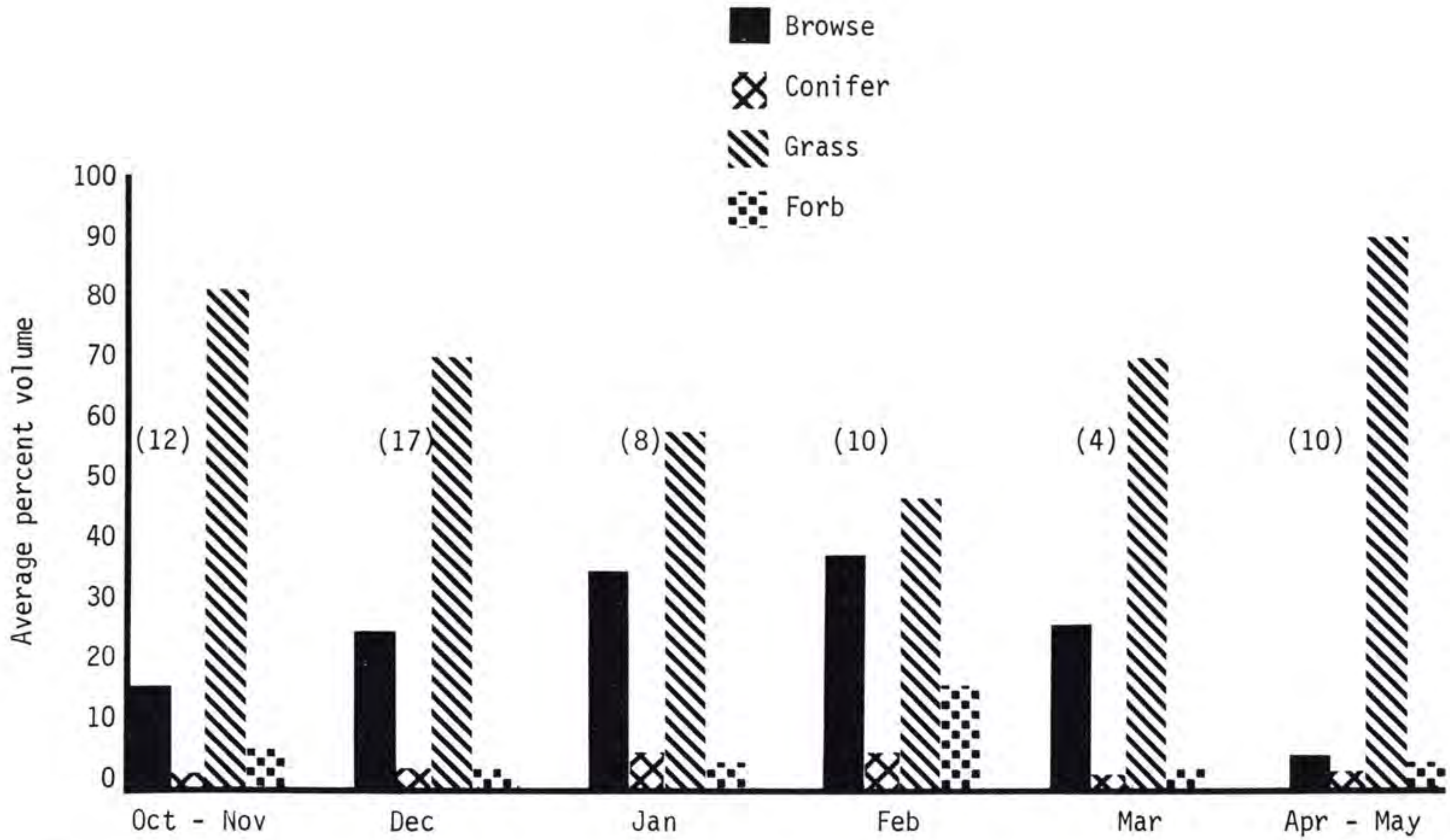

Figure 5. Average percent volume of browse, conifer, grass, and forbs in rumen specimens of 61 elk collected on Big Creek winter range, 1969-72. The number in parentheses equals sample size for the month.

These snow conditions may occur during January or February, but usually persist for only 5-8 days (Wilbur Wiles, personal communication 1971). It is during this time that browse becomes critical to ungulates, and forage competition between deer and elk can occur. Conifer is relatively low by volume in elk diet as are forbs, though dried forbs such as balsamroot stems may be sought in January and February.

Eight bighorn sheep rumen samples were collected, four during September-December and four January-March. Summarized by browse, grass and forb categories, average percentages by volume were 40, 57, and 3 for the time period September-December and 44, 54, and 2 for January-March, respectively.

Mountain mahogany occurred in 7 of the 8 samples, averaging 12 percent and 35 percent by volume for fall and winter time periods, respectively. Douglas fir occurred in 7 of the 8 samples, but comprised less than 2 percent by volume in each sample, except one in February which was 25 percent. Bitterbrush did not occur in any of the samples and Oregon grape was only found in two, measured at 5 percent and a trace. Other woody plants found infrequently were rubber rabbitbrush, snowberry, ceanothus, and Populus spp.

Forbs comprised a small percentage of the samples analyzed. Some of the species taken were Eriogonum ovalifolium, Cryptantha spp., penstemon, and moss.

Table 13 lists particular browse and conifer species important to mule deer on this winter range. Browse comprises more than 60 percent of their diet December through February and into March. Data from three winters indicate that mule deer depend on mountain mahogany, Oregon grape, and Douglas fir during this period when severe weather and crusted snow can occur. Use of bitterbrush by mule deer is heaviest in late fall and drops to less than

Table 13. Average percent volume of mountain mahogany, bitterbrush, Oregon grape and Douglas fir in rumen samples of 109 mule deer collected on Big Creek winter range, 1969-72.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
				1969-70				
Mt. mahogany	(0)*	4.5 (1)	(0)	42.8 (4)	44.8 (10)	8.9 (10)	(0)	0.0 (1)
Bitterbrush		0.0		4.4	2.3	2.4		0.0
Oregon grape		4.5		20.0	10.3	28.5		0.0
Douglas fir		49.8		0.7	8.9	14.8		3.5
				1970-71				
Mt. mahogany	0.0 (1)	12.4 (7)	41.5 (10)	74.6 (6)	32.5 (6)	25.6 (5)	0.0 (2)	0.7 (2)
Bitterbrush	9.0	26.5	1.0	0.3	5.1	0.4	0.0	0.0
Oregon grape	0.2	0.3	9.0	1.4	0.6	16.5	0.1	0.0
Douglas fir	0.0	3.7	18.3	0.1	17.7	9.3	1.9	3.0
				1971-72				
Mt. mahogany	(0)	3.6 (10)	15.6 (6)	42.3 (10)	29.8 (13)	18.0 (5)	(0)	(0)
Bitterbrush		8.2	14.8	7.4	2.1	0.2		
Oregon grape		17.5	9.2	1.6	2.8	13.5		
Douglas fir		1.1	24.8	8.0	26.4	27.6		

* Number in parentheses indicates sample size for month.

10 percent by early January and for the rest of the winter.

Mountain mahogany in deer rumens averaged near or greater than 50 percent December through February (Figure 6). Oregon grape consumption increases in March, when most of the easily accessible mountain mahogany has been removed. Oregon grape does not appear as a last resort forage, since it was important in late fall diets as well (Figure 6). Mule deer ate Douglas fir consistently during the third winter 1971-72, ranging from 8-26 percent by volume December through March. Late fall use of this species indicates that it, too, is taken as a supplement to their diet by choice.

Elk use these four browse species (Table 14) much less than mule deer. This is apparent from the major consumption of grasses (Figure 5). Mountain mahogany composed the majority of total browse consumption (Figure 7). Douglas fir and Oregon grape were taken in lesser quantities, while bitterbrush never averaged more than 1 percent by volume for the entire sampling period.

Accuracy of Volumetric Analysis

A criticism of rumen analysis by volumetric estimate is that plant species digest at different rates (Bergerud and Russell 1964). Easily digestible plants may be volumetrically underestimated, in turn magnifying estimates of persistent woody tissue. This problem is minimal in these data, since my conclusions are drawn by relating species of similar tissue consistency. There is little soft herbaceous or graminous material available in winter. Available forbs and grasses are usually dried and cured. By green-up in April and May, when ungulates seek succulent forage, browse is at such low volume in rumens that error is again minimized.

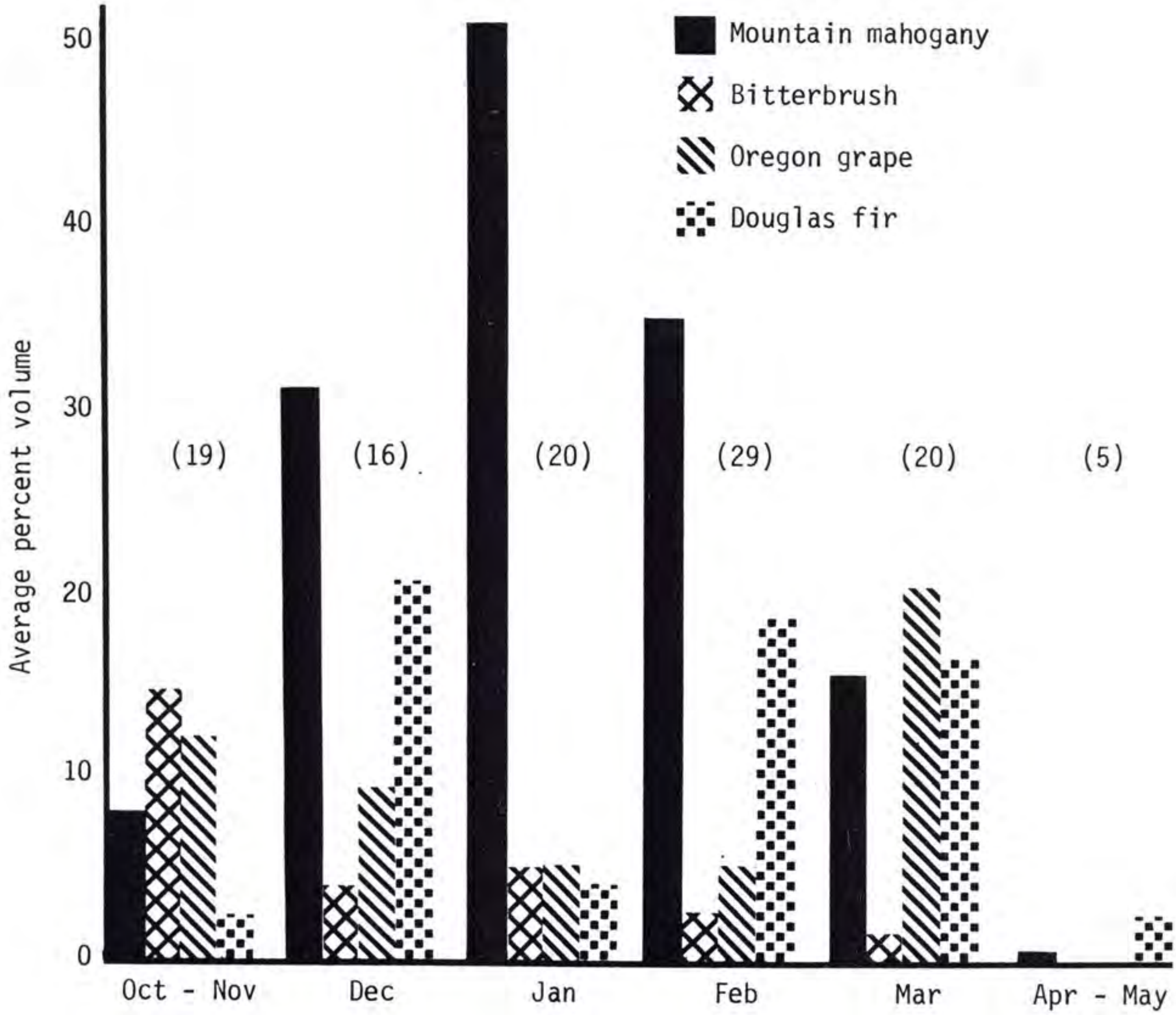

Figure 6. Average percent volume of mountain mahogany, bitterbrush, Oregon grape, and Douglas fir in 109 mule deer rumen samples, 1969-72. The number in parentheses equals sample size for the month.

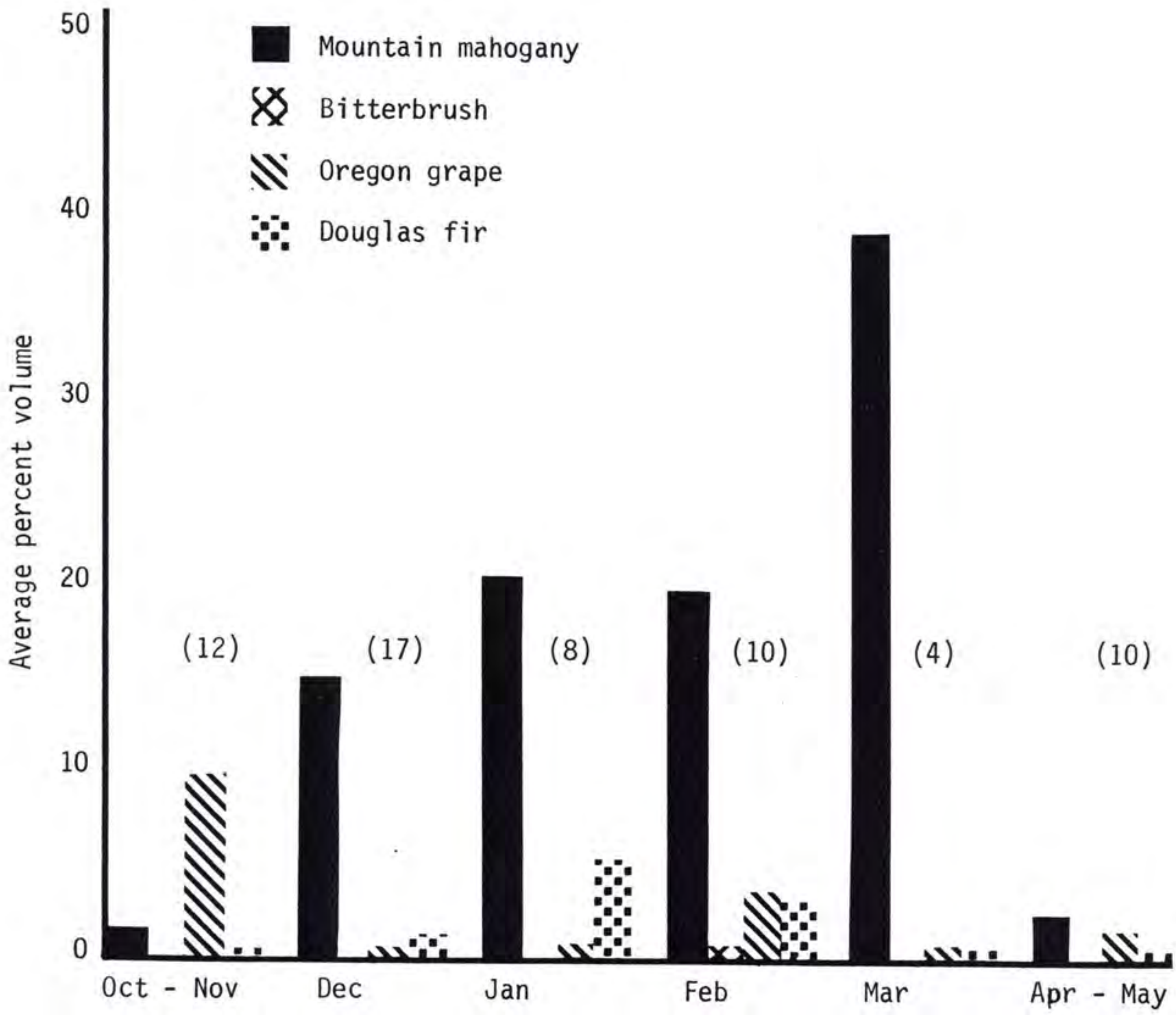

Figure 7. Average percent volume of mountain mahogany, bitterbrush, Oregon grape, and Douglas fir in 61 elk rumen samples, 1969-72. The number in parentheses equals sample size for the month.

Table 14. Average percent volume of mountain mahogany, bitterbrush, Oregon grape and Douglas fir in rumen samples of 61 elk collected on Big Creek winter range, 1969-72.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
				1969-70				
Mt. mahogany	(0)*	4.9 (1)	(0)	0.0 (2)	3.9 (2)	60.5 (1)	0.8 (1)	(0)
Bitterbrush		0.0		0.0	0.0	0.4	0.0	
Oregon grape		25.8		2.7	10.0	0.0	Tr	
Douglas fir		0.0		3.3	1.6	0.4	0.7	
				1970-71				
Mt. mahogany	(0)	1.4 (6)	18.9 (11)	35.2 (4)	21.1 (3)	1.0 (3)	4.6 (2)	0.6 (2)
Bitterbrush		Tr	0.1	0.1	0.2	0.6	0.0	0.0
Oregon grape		0.1	0.8	0.1	4.5	2.1	0.1	0.2
Douglas fir		0.3	0.8	3.8	1.5	0.7	1.1	0.4
				1971-72				
Mt. mahogany	0.0 (3)	2.3 (2)	10.7 (6)	12.0 (2)	25.1 (5)	(0)	2.5 (5)	(0)
Bitterbrush	0.0	0.1	0.3	0.0	0.7		Tr	
Oregon grape	0.7	46.0	0.2	0.5	0.4		2.6	
Douglas fir	0.1	Tr	1.0	10.5	4.5		0.4	

* Number in parentheses indicates sample size for month.

Selectivity

Forage selectivity is generally accepted as an indicator of forage preference. A combination of plant species frequency of occurrence and volume in ungulate rumens can be used to assess forage preference. High frequency and high volume indicate a food of high quality or preference (Korschgen 1969). A high rating by one standard and low for the other may be reason to question quality, quantity, or sampling procedure and analysis.

In these data, volume and frequency comparisons generally coincided for both deer and elk rumens. Frequency of plant species (Table 15) in rumens was usually high when volume was high and vice versa. An exception to this was bitterbrush which had moderately high frequencies (Table 15) in deer and elk rumens in mid-winter, yet consumption on a volume basis was insignificant (Figures 6 and 7). Mountain mahogany, Douglas fir, and Oregon grape generally followed a pattern of moderate use in fall, increasing to heavy use by mid- to late winter in deer rumens. Elk consumed these species comparatively low in volume and frequency, except during severe winter conditions and in March. As previously reported (Figure 5), grass comprises the major portion of the elk diet.

Frequency of occurrence of forbs (Table 15) was high for deer and elk throughout the winter season. Volumetrically, however, forbs comprised a small percentage of ungulate diets, approaching 10 percent for deer in late fall and February for elk at their peaks (Figures 4 and 5). The commonest forbs taken were balsamroot, lupine, yarrow and penstemon.

From the browse utilization data (Table 4), bitterbrush and mountain mahogany were cropped comparatively on similar sites. There is, however, a difference in time of use. Bitterbrush was heavily consumed in late fall

Table 15. Average percent frequency of occurrence of plant species in 109 mule deer and 61 elk rumen samples collected on Big Creek winter range, 1969-72.

Plant Species	Oct-Nov	Dec	Jan	Feb	Mar	Apr-May
	(19/12)*	(16/17)	(20/8)	(29/10)	(20/4)	(5/10)
ACER	/8**	/11	5/	3/10	5/	/10
AMAL 2		12/17	5/25	6/10	10/20	
ARTR	21/	25/11	10/	6/	10/	20/10
ARTR 2	10/	6/5	10/	3/	10/	20/
ARUV	5/		5/			
BEOC				6/	10/	
BERE	63/83	62/47	60/87	41/70	85/50	40/80
CELE	47/50	81/94	95/75	96/80	75/100	20/60
CEVE	26/25	6/	5/	3/	5/	20/
CHNA	10/	12/11	5/	13/	10/	
COST 2				3/		
JUCO 3				3/		
PHMA		/12			5/	/10
PIPO	/33	6/5	10/	10/		/10
POPUL	21/8	6/		6/30	20/	20/
PSME	84/83	100/76	75/100	93/70	100/75	100/80
PRVI		6/5	10/25	17/10	5/	
PUTR	47/16	56/52	90/25	55/20	30/75	/10
RIBES	10/	18/	/12		10/25	20/10
ROSA		12/17	5/12	3/10	5/	20/
SALIX	2/16	12/5	5/25	6/	5/25	/10
SPBE	5/					
SYAL	21/	6/11	5/12	10/20	10/	60/20
VACCI	/16					
ACMI	26/16	25/29	30/12	13/	10/25	20/
ANTEN	10/8					
ASTRA	/8					
BASA	52/16	31/29	10/	3/		
CASTI	10/					
CIRSI		6/23	10/12	13/	5/25	30/
CRYPT					5/	
EQUIS			5/	/30	5/	
ERIGE	5/					
ERIOG	31/		10/	17/10	30/	20/
EUMA	5/					
FRAGA	5/					
GETR	5/	6/				
HEUCH	5/8					
LOMAT				3/	10/	
LUPIN	15/50	18/23	5/12	13/10	5/	40/

Table 15 (Continued).

Plant Species	Oct-Nov	Dec	Jan	Feb	Mar	Apr-May
PEDIC	10/8					
PENST	26/	31/11	20/	13/	10/	60/30
PHHA					20/	20/
PHLOX					/25	
SEDUM	5/					
VIOLA	/8					
CAREX			5/		5/	
ELEOC				3/		
JUNCU					5/	
Lichen Moss	10/	12/17	5/50	6/20	40/25	40/
Browse	52/58	68/94	75/75	79/60	60/75	80/90
Grass	52/58	81/70	60/75	44/70	25/50	40/70
Forb	89/100	75/100	90/100	72/90	95/75	100/100

* The number preceding the slash is the number of mule deer rumen samples for the month and the number that follows the slash is the number of elk rumen samples for the month.

**The numbers preceding and following the slash are the plant species average percent frequency of occurrence per month in mule deer and elk rumen samples, respectively.

and then the animals turned to mountain mahogany in late December or early January. This conclusion is based on late fall observation of my utilization transects, animal observations, and three winters of food habits data. It pertains essentially to deer use, since elk took mainly grasses.

Nutrient Analysis of Range Forage

I collected samples from eight plant species from three tributaries of Big Creek. These areas were located on lower, mid, and upper sections of the study area (Figure 1). Plant samples were collected from each site three different times in 1971: October 1-3, February 14-17, and May 9-11. Crude protein and fiber values are presented on a total dry weight basis (Table 16).

Browse species typically had highest average protein values except in early May when rapid growth of grasses produced higher values (Figure 8). Browse did, however, provide the highest consistent protein source (at least 10 percent) throughout the winter season. Mild winter weather favors plant growth and this could be seen in increased protein content of grasses in February, particularly cheatgrass (Table 16). At this time, new growth of grasses was observed on southern exposures at all three collection sites. Mountain mahogany and bitterbrush were found sprouting in February at Goat and Cave creek collection sites. It is at these sites of rapid growth that protein content will be highest (Klein 1965) and ungulates were frequently observed feeding in these areas.

Fiber content was consistently highest in grasses for all three areas and sampling periods (Table 16 and Figure 8). This may have been due partially to my sampling restriction that required grasses to be cut from ground level, inclusive of new and cured culms. Strictly sampling new growth would lower fiber content values.

Table 16. Average percent* crude protein and fiber in plant collections, 1971.

	October 1 - 3		February 14 - 17		May 9 - 11	
	Protein	Fiber	Protein	Fiber	Protein	Fiber
Area 1						
Coxey Creek, 5200' elev.						
Cercocarpus ledifolius	11.0 ± .12**	25.3 ± 2.21	12.0 ± .63	20.2 ± 1.50	12.2 ± .78	19.7 ± 2.93
Purshia tridentata	9.7 ± .81	19.2 ± .88	9.3 ± .54	24.7 ± .93	12.1 ± .90	22.6 ± .82
Berberis repens	10.9 ± .17	17.7 ± .78	12.0 ± 1.27	19.5 ± 1.74	14.1 ± .77	15.0 ± .55
Pseudotsuga menziesii	6.8 ± .38	20.1 ± 1.09	7.1 ± .57	22.4 ± 2.61	6.9 ± .34	19.6 ± 1.34
Bromus tectorum	4.8 ± .71	35.6 ± 1.41	24.0 ± .42	18.8 ± .71	13.6 ± .60	28.5 ± 2.58
Festuca idahoensis	4.0 ± 1.40	35.5 ± 2.98	8.1 ± .32	28.6 ± 1.33	15.7 ± .23	26.6 ± 1.08
Agropyron spicatum	6.1 ± .17	29.3 ± 1.08	7.1 ± .70	37.4 ± .29	18.0 ± .71	28.7 ± 1.11
Area 2						
Cave Creek, 5000' elev.						
Cercocarpus ledifolius	8.9 ± .79	27.6 ± 2.57	11.0 ± 1.20	22.6 ± 2.73	11.0 ± .25	19.4 ± .72
Purshia tridentata	9.7 ± .48	20.2 ± 2.10	9.6 ± .40	23.6 ± 2.21	12.5 ± 1.39	21.2 ± 1.23
Berberis repens	10.6 ± .90	24.1 ± 2.20	12.0 ± .22	22.1 ± .98	12.1 ± .31	16.7 ± .44
Pseudotsuga menziesii	6.5 ± .65	22.7 ± 1.41	7.6 ± .64	20.8 ± .21	6.4 ± .50	18.7 ± .88
Bromus tectorum	4.9 ± .28	33.6 ± 2.9	16.3 ± .92	21.5 ± .21	15.7 ± 1.87	27.7 ± .50
Festuca idahoensis	5.4 ± .70	29.8 ± 3.40	8.3 ± .50	27.6 ± .42	14.1 ± .25	28.0 ± .49
Agropyron spicatum	3.9 ± .27	36.1 ± 2.11	5.5 ± .07	38.1 ± 1.13	13.1 ± 1.94	32.8 ± 1.93
Area 3						
Goat Creek, 4200' elev.						
Cercocarpus ledifolius	9.2 ± .87	24.1 ± 1.23	11.4 ± 1.10	17.8 ± 1.21	11.9 ± 1.19	19.0 ± .76
Chrysothamnus nauseosus	7.7 ± .67	23.4 ± 1.44	7.6 ± 1.10	30.6 ± 1.60	9.0 ± .75	33.4 ± .75
Berberis repens	9.4 ± .34	22.3 ± 1.99	11.1 ± .81	23.7 ± 2.10	13.7 ± .51	17.3 ± .92
Pseudotsuga menziesii	6.3 ± .56	19.4 ± .91	6.7 ± .62	19.5 ± 1.53	6.7 ± .55	16.9 ± .71
Bromus tectorum	3.2 ± .35	36.0 ± 1.13	22.0 ± 2.62	15.7 ± .21	11.4 ± .32	23.4 ± .44
Festuca idahoensis	3.9 ± .59	32.3 ± 1.31	7.6 ± .80	26.0 ± 1.02	12.6 ± 1.15	29.0 ± .62
Agropyron spicatum	3.0 ± .35	35.7 ± .91	6.4 ± 1.34	36.5 ± 1.56	10.7 ± 1.80	34.7 ± 2.20

* Values presented on a total dry weight basis.

** Standard deviation.

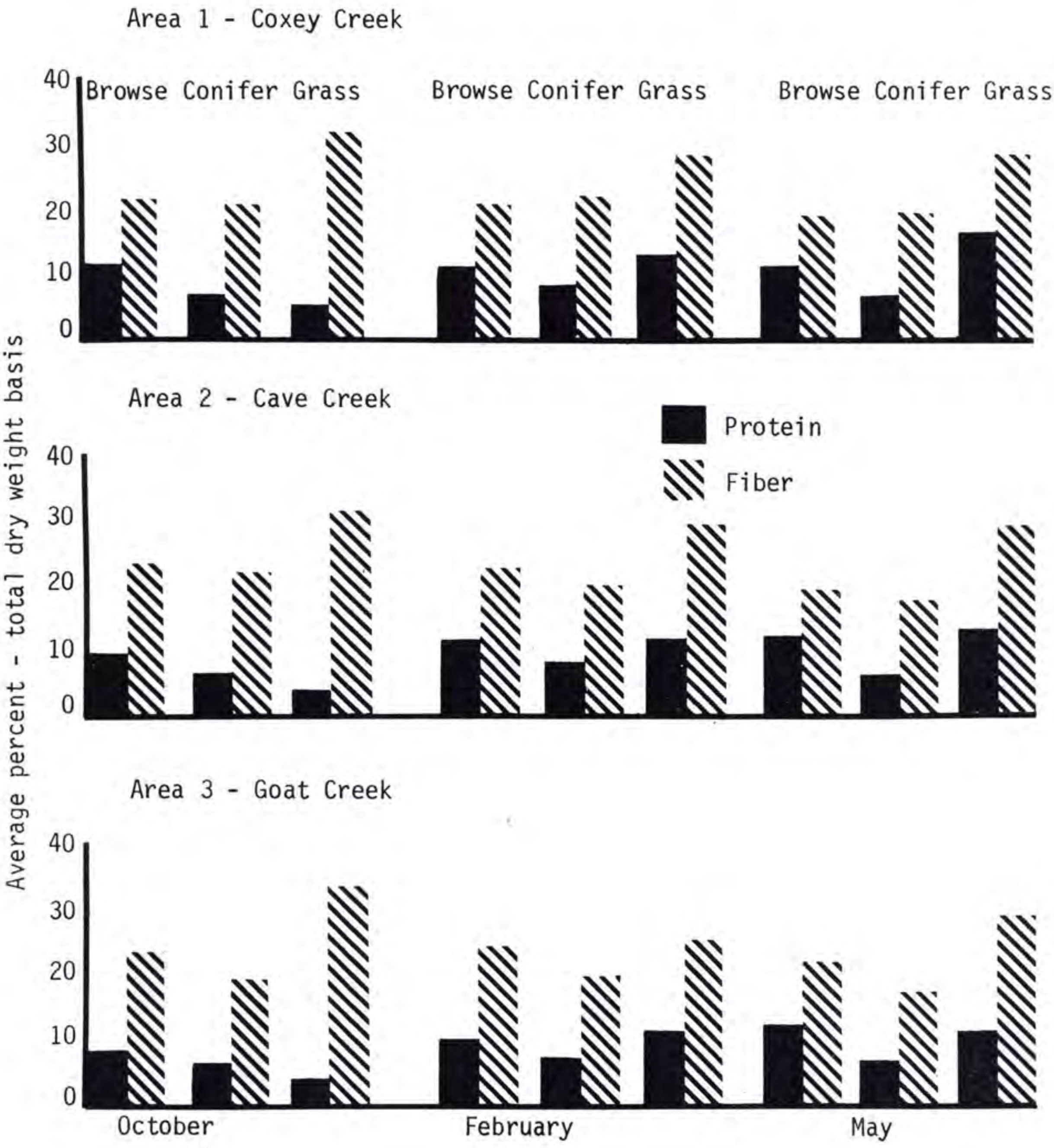

Figure 8. Average percent crude protein and fiber in plant collections, 1971.

Statistical analyses of these data by LSMLGP and Duncan's new multiple range tests indicate that significant differences exist at the 5 percent level between collection sites, collection periods, and most plant species. All nutrient values in the following paragraphs are presented on a total percent dry weight basis.

Crude protein averages for all plant species were 9.22, 9.95, and 10.91 for the collection areas 1-3, Coxey, Cave, and Goat (Figure 1), respectively. All three means were significantly different at the 5 percent level, though it can be seen that the difference between Goat and Cave creek sample sites is small. Total percent fiber means for Goat, Cave, and Coxey creek sample areas are 26.02, 25.99, and 25.04, respectively. In this case, both Goat and Cave creek values were significantly different from Coxey Creek values, but not from each other. In general, this indicates that forage quality based on crude protein and fiber content of these plant species is highest at Coxey Creek and lowest at Goat Creek. Thus, range forage quality decreases down Big Creek drainage.

There is a significant pattern of nutrient values in relation to the three collection periods on this range (Figure 8). Mean protein values for all plant species and areas for October, February, and May were 7.03, 10.76, and 12.25, respectively. Similarly, mean values for fiber were 27.64, 25.15, and 24.26. All of these means differed significantly at the 5 percent level. These values indicate that forage protein content is lowest in October, increases during February, and is highest in May. Change in this pattern is mainly due to rapid growth of grasses in February and May (Figure 8). Crude protein content in woody tissues remained fairly constant at each sampling period (Table 16 and Figure 8).

Crude protein content varies almost twofold (Table 17) when values from all collection periods and areas are averaged together. All crude protein values were significantly different at the 5 percent level, but it can

Table 17. Average percent crude protein and fiber in seven plant species collected on the Big Creek winter range in 1971.

Plant Species	Total Dry Weight Percentage Crude Protein	Fiber
Douglas fir	6.87	20.39
Bluebunch wheatgrass	8.25	35.07
Idaho fescue	8.95	29.81
Bitterbrush	9.85	24.82
Mountain mahogany	11.15	22.29
Oregon grape	11.98	20.21
Cheatgrass	13.13	27.19

be seen that bluebunch wheatgrass-Idaho fescue and mountain mahogany-Oregon grape differences are small. Cheatgrass, an annual, had the highest average crude protein value, probably due to sampling of primarily current growth tissue. All fiber values were significantly different, except Oregon grape-Douglas fir. Thus, three browse species have significantly higher crude protein values than the dominant perennial grasses on this winter range. This difference may be partially due to sampling restrictions as previously reported.

By modification of the computer model, crude protein and fiber values were related to collection areas and periods. Duncan's new multiple range test at the 5 percent level of significance was again used. These results support the patterns previously described and are presented here to show where specific differences occur. Sample areas (Table 18) are listed in order of highest to lowest protein and fiber occurrence for each species. Plant species order is not necessarily indicative of their relative crude protein

Table 18. Collection areas listed in order of highest to lowest average crude protein and fiber values for individual plant species.

Plant Species	Crude Protein	Fiber
Mountain mahogany	Coxey-Goat,* Goat-Cave	Cave-Coxey, Goat
Bitterbrush	Cave-Coxey, Goat**	Goat,** Coxey-Cave
Oregon grape	Coxey-Cave-Goat	Goat-Cave, Coxey
Douglas fir	Coxey-Cave-Goat	Cave-Coxey, Goat
Cheatgrass	Coxey, Cave-Goat	Cave-Coxey, Goat
Idaho fescue	Coxey-Cave, Goat	Coxey, Goat-Cave
Bluebunch wheatgrass	Coxey, Cave-Goat	Goat-Cave, Coxey

* Average crude protein and fiber values of hyphenated areas were not significantly different at the 5 percent level.
** Average crude protein and fiber values are from rabbitbrush, since bitterbrush is rare at this lower elevation.

and fiber value order (Table 17). In a similar fashion, Table 19 lists collection periods ranked by highest to lowest average values of crude protein and fiber for individual species.

Table 19. Collection periods listed in order of highest to lowest average crude protein and fiber values for individual plant species.

Plant Species	Crude Protein	Fiber
Mountain mahogany	May-February,* October	October, February-May
Bitterbrush	May, October-February	February-May, October
Oregon grape	May, February, October	February-October, May
Douglas fir	February-May-October	February-October, May
Cheatgrass	February, May, October	October, May, February
Idaho fescue	May, February, October	October, May-February
Bluebunch wheatgrass	May, February, October	February, October-May

* Average crude protein and fiber values of hyphenated months were not significantly different at the 5 percent level.

Nutrient Analysis of Rumen Contents

Stomach samples from mule deer and elk were analyzed for crude protein and fiber content. I averaged these values on a monthly basis (Tables 20 and 21). Mule deer rumen contents contained higher crude protein values than elk samples in all months (Figure 9). Crude fiber values averaged higher for elk than deer in most months.

Crude protein content of mountain mahogany, bitterbrush and Oregon grape from plants I collected was significantly ($P < 0.05$) higher (Table 17) than grass and these browse species are more commonly eaten by deer (Tables 11 and 12) than elk. Crude protein content of Idaho fescue and bluebunch wheatgrass (Table 17), averaged significantly less than values of these browse species. As reported, the major food item consumed by elk is grass (Figure 4). Thus, generally higher crude protein content in mule deer rumens corresponds with the pattern of crude protein values from collected plant specimens and volumetric rumen analysis. There are, of course, many factors that can affect crude protein levels in stomach contents and these will be considered in the discussion section.

Statistical analyses of crude protein and fiber values from stomach contents (Tables 20 and 21) were performed by use of LSMLGP program and Duncan's new multiple range tests at the 5 percent level of significance. Chronologically, the values were grouped on the basis of similar periodic forage consumption (Figures 4-7). These periods were late October-December, January-February, March, and April-May. Stomach samples were assigned to one of four areas (Figure 1) for comparison with forage value of plants I collected (Table 16).

Table 20. Average percent* of crude protein and fiber values from 103 mule deer rumen samples, 1969-72.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
					1969-70			
Protein	(0)**	11.3 (1)	(0)	10.1 (4)	11.4 (10)	10.7 (10)	(0)	21.8 (1)
Fiber		37.2		43.5	39.1	37.8		30.3
					1970-71			
Protein	(0)	7.9 (6)	11.3 (9)	12.8 (5)	9.8 (6)	11.4 (4)	11.7 (2)	15.7 (2)
Fiber		47.9	40.5	42.4	39.7	41.1	37.0	38.9
					1971-72			
Protein	(0)	9.3 (10)	9.7 (6)	9.3 (9)	8.7 (13)	9.9 (5)	(0)	(0)
Fiber		41.2	43.3	42.6	42.8	40.2		

* Total dry weight basis.
** Number in parentheses equals sample size for month.

Table 21. Average percent* of crude protein and fiber values from 60 elk rumen samples, 1969-72.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
					1969-70			
Protein	(0)**	8.2 (1)	(0)	8.6 (2)	7.5 (2)	6.0 (1)	11.9 (1)	(0)
Fiber		41.8		43.6	39.0	45.8	37.1	
					1970-71			
Protein	(0)	4.4 (6)	6.0 (11)	5.9 (4)	9.2 (3)	7.9 (3)	8.9 (2)	15.7 (2)
Fiber		42.1	44.4	49.3	40.3	39.5	38.1	27.9
					1971-72			
Protein	8.3 (2)	7.7 (2)	6.3 (6)	5.9 (2)	5.5 (5)	(0)	8.0 (5)	(0)
Fiber	38.9	41.4	43.6	48.5	47.7		37.6	

* Total dry weight basis.
** Number in parentheses equals sample size for month.

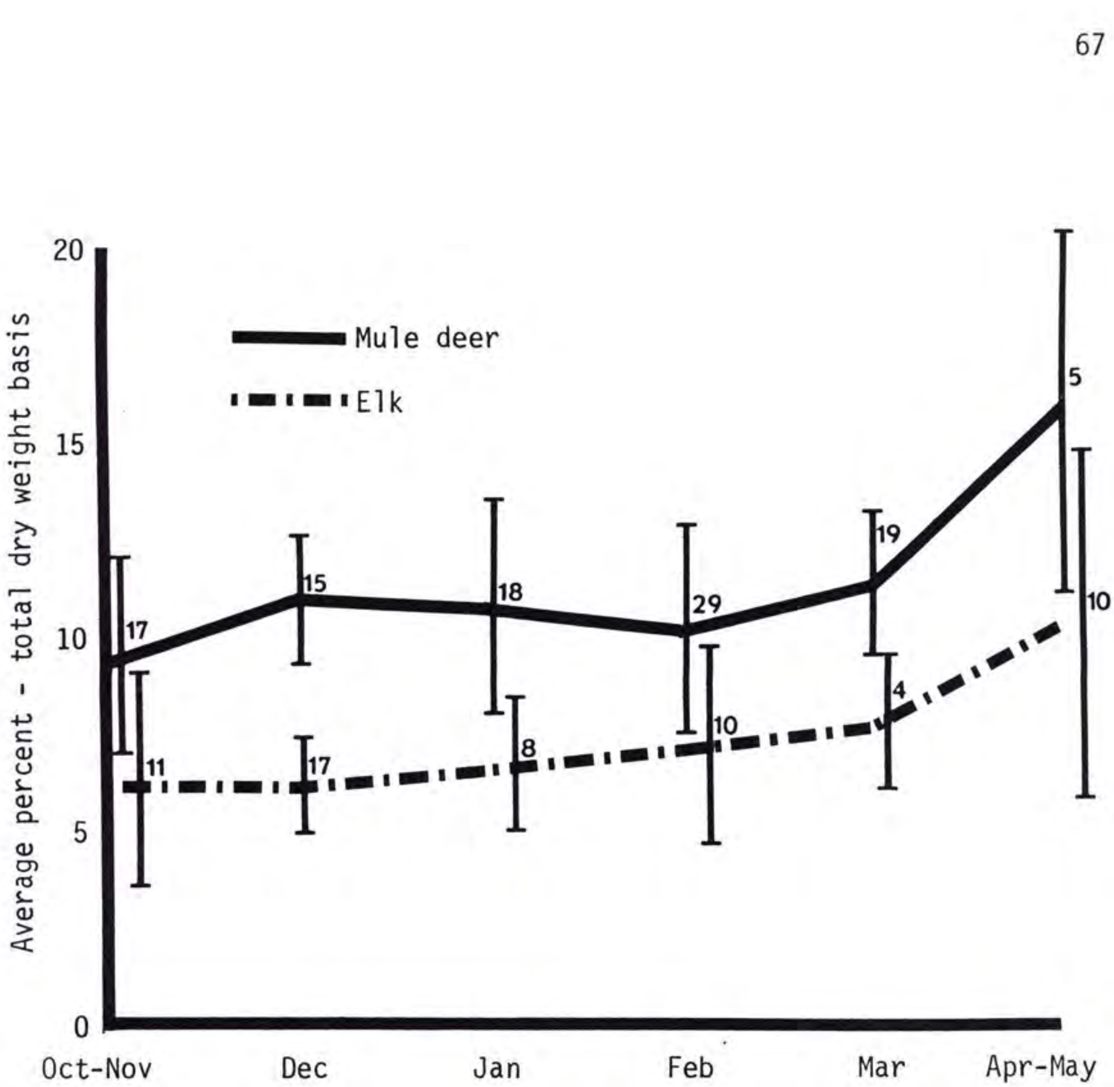

Figure 9. Average percent crude protein content (total dry weight basis) from 60 elk and 103 mule deer rumen samples collected on Big Creek winter range, 1969-72. The number adjacent to the standard deviation bar equals sample size for the month.

For analyses, I combined crude protein and fiber values of rumens from all three years into one set. A pattern somewhat different from collected forage value occurs. For mule deer during the October-December, January-February, March, and April-May periods, crude protein values averaged 10.29, 10.46, 10.58, and 18.77, respectively. The first three values from October through March are not significantly ($P < 0.05$) different, though, the April-May value is. Crude fiber values for these periods averaged 40.72, 40.91, 39.70, and 30.65, respectively. Similar to crude protein values, the first three values from October through March are not significantly different, but the April-May value is. As previously reported, crude protein and fiber values of forage I collected were significantly different at each collection period: October, February, and May.

Similar analyses for crude protein and fiber values of elk rumens during the October-December, January-February, March, April-May periods resulted in crude protein averages of 6.51, 7.23, 7.82 and 10.58, respectively. These values, October through February, are significantly different from April-May values, while March values do not differ significantly for either time period. Crude fiber values for these periods averaged 42.77, 45.19, 41.23 and 34.89, respectively. The first three values from October through March are not significantly different, although the April-May value is.

To summarize, mule deer and elk that winter on this range dampen fluctuation of crude protein and fiber values by forage selectivity. This applies to crude protein and fiber value change in relation to time (late October through early May) as well as to area. I tested crude protein and fiber value differences of rumen samples between areas 1-4 (Figure 1) and found that these differences were insignificant at the 5 percent level for both deer and elk. As previously reported (Table 16 and Figure 8), crude protein and fiber values of forage I collected differed significantly between areas 1-3. So the question arises, if deer and elk can consistently select similar quality forage on a range where time and location affect crude protein and fiber values, then is animal density over the range comparable, too? Seidensticker (1973) concluded that the more rugged terrain of lower Big Creek supports a lower ungulate density than the comparatively gentle terrain upstream.

DISCUSSION AND CONCLUSIONS

Forage Utilization

Major patterns of browse utilization on Big Creek winter range are related to topography. Heaviest use on mountain mahogany, bitterbrush, and rubber rabbitbrush occurs near ridgetops, where ungulates are frequently observed. Percent utilization on plants declines from ridgelines down to valley bottoms. The effect of elevation and aspect on snow cover directly influences forage availability and an assessment of utilization must incorporate these factors. Snow cover on this range is such that browse on southern exposures is available practically all winter, but sharp aspect changes are common and cause snow accumulation rendering forage unavailable.

Specifically, mountain mahogany is utilized intensively (usually in excess of 70 percent) practically everywhere it is available. This species has survived this intensive use on many ranges in Idaho (Smith 1954), Montana (South 1957), and Oregon (Dealy 1971) and has not been eradicated. Reproduction is low, but this appears normal for such a long-lived species (Dealy 1971). Many factors besides intensive ungulate use affect reproduction, such as microsite requirements, seed predation by insects and rodents, fire, and site competition with other plants (Dealy, personal communication 1973). I found young plants scattered on rocky ridges and in clumped aggregations near or within mature mountain mahogany stands.

Bitterbrush is reproducing on this range, particularly where it is associated with bluebunch wheatgrass. It establishes under cover of grass clumps and receives zero to slight use until it is nearly 1 foot tall. Utilization follows a topographical pattern, ranging from at least 70 percent near ridgetops to less than 25 percent adjacent to creek bottoms.

On the basis of current range standards, browse use is generally excessive, that is, greater than the accepted 60 percent utilization of annual growth. This, coupled with low reproductive rates of key browse species indicates the range is overbrowsed and therefore overpopulated. Hornocker (1970) concluded the range was overbrowsed, even in mild winters and shrub reproduction was low. Presby (1963) stated a comparable section of the adjacent Middle Fork winter range was in poor condition due to high use on bitterbrush, inadequate shrub reproduction, and very unstable soils. This range has been considered in poor condition since the early 1900's, yet palatable forage species are still present, supporting large deer populations and increasing elk herds.

Food Habits

Data from three winters indicate that mule deer depend on a group of species for their survival on this range. Bitterbrush is taken in late fall and its use drops to practically zero during the rest of the winter. Heavy use of mountain mahogany does not begin until in January. This use continues through February and into March depending on the winter severity. Douglas fir is readily taken in fall as well as March, indicating it is taken by choice, at least in fall when other forage species are available. Oregon grape is consumed in a pattern similar to Douglas fir. Deer take grass in late fall and in spring it comprises a major portion of their diet.

In contrast, elk prefer grasses throughout the winter period and switch to browse only when forced by crusted snow conditions. This change of diet may occur for short periods in January or February, dependent upon weather conditions. At this time, direct competition may occur for forage and mountain mahogany becomes common in both deer and elk rumens. Some browse use was also recorded in late winter prior to greenup.

In comparison, food habits of 88 mule deer collected on the Middle Fork (Trout, personal communication) of the Salmon River, October through April 1960-62, showed higher use of sagebrush, more common in that area than Big Creek. On my study area sagebrush was only common in Rush Creek (Area 4) and here use was correspondingly higher. In contrast, rumen samples from the Middle Fork contained much less mountain mahogany and at least twice as much grass December through February. Bitterbrush was taken most heavily in fall on both areas and its use dropped for the rest of the winter. April food habits from both areas were similar in that grass became the major item (at least 90 percent). Douglas fir and Oregon grape were consumed similarly on both areas.

Deer select bitterbrush in preference to mountain mahogany in fall for at least two reasons. First, bitterbrush is more common than mountain mahogany on the upper and mid elevations when deer first arrive on the winter range. By late November to early December, though, deer are at low elevations where mountain mahogany is common, yet its consumption is still low. Nutrient data indicate that these species are similar in crude protein content (though bitterbrush was 1 percent higher at the Cave Creek site); however, crude fiber content averaged at least 6 percent higher in mountain mahogany. Perhaps, then, deer are selecting bitterbrush, the more easily digested species, early in the season. By February, bitterbrush consumption has dropped and mountain mahogany consumption is high. At this time, crude protein content of mountain mahogany averages 2 percent higher than bitterbrush and crude fiber content averages 1-4 percent lower in mountain mahogany.

Dietz (1972) analyzed 7 preferred browse species for crude protein content on a Black Hills range and found that preference of deer was directly related to species with the highest protein content. Preference and nutrient quality varied seasonally and deer selected species with higher protein content on a seasonal basis. Thus, deer are capable of selecting the most nutritious species as well as portions of plants that are of highest quality (Klein 1970).

Range Quality

Crude protein and fiber values of forage on this range are similar to others that have been analyzed. Specifically, Bissell and Strong (1955) found 9, 7, and 11 percent crude protein on bitterbrush range of California for October, February, and May, respectively. Corresponding bitterbrush values from Big Creek winter range were 10, 9, and 12 percent. Dietz et al. (1962) stated that mountain mahogany (*C. montanus*) and bitterbrush on a high (8000 ft) winter range of Colorado both averaged approximately 9 percent crude protein. Mountain mahogany (*C. ledifolius*) on Big Creek winter range averaged 11 percent crude protein for the similar period.

Forage value decreases down Big Creek drainage. This corresponds with a decrease in precipitation due to elevation gradient and soil change. Soil analysis of samples from area 1 and area 3 were pH 7.00, sand 73 percent, silt 18 percent, clay 9 percent and pH 6.40, sand 80 percent, silt 16 percent, clay 4 percent, respectively. There is not much difference in these factors; however, soil color change from area 1 to area 3 is apparent. Area 1 has dark colored loamy soils contrasted to lighter colored, more sandy soils on area 3. Parent material (identified by J.G. Bond, Bureau of Mines and Geology, University of Idaho) changes from mestasediments of the Belt

Supergroup broken by volcanic breccia on area 1 to coarser grained granite-quartz monzonite on area 3.

Crude protein and fiber values of plants I collected were significantly different between areas 1-3, especially area 1 and area 3, at upper and lower extremes of the study area. Crude protein and fiber values of mule deer and elk rumen samples did not, however, differ significantly between areas, apparently due to animal selectivity of forage. In general, forbs, grasses and shrubs near maturity tend to have more leaf development on poorer sites than on more favorable sites where stem development is greater. As a result, plants on unfavorable sites are at least or more palatable and nutritious than plants on more favorable sites (Cook and Harris 1950, Cook 1959). Thus, selection of particular plant parts by ungulates would tend to dampen nutrient fluctuation over an area such as Big Creek winter range.

Mule deer rumen contents had consistently higher crude protein values than elk rumen contents and this difference occurred throughout the area and winter season. This difference corresponds with plant species in stomach contents and their relative nutritive value. Basically, deer consumed browse, higher in crude protein content, and elk consumed grasses, somewhat lower in percent crude protein. Rumen content nutrient value between deer and elk was similar only during periods of similar food consumption in February when elk took browse and late April and May when deer switched to grass.

Dietz (1965, 1970) concluded the minimum protein requirement for deer is 7 percent. However, at this level there may be some impairment of reproductive success. Deer on this range averaged at least 8 percent crude protein value in rumens each month. Elk rumen contents averaged at least 6 percent crude protein each month. Browse is available to elk on this range, yet they preferred grass, turning to browse mainly during crusted snow conditions.

Ungulates do not completely digest crude protein content of forage and efficiency decreases with plant maturation. As the cell wall hardens through lignification, protein becomes less available to rumen micro-organisms (Dietz 1972). Crude protein digestion efficiency varies with plant species and time, ranging from 30 percent to at least 70 percent (Cook 1971). In general, browse provides the highest protein content, followed by forbs and then grasses. However, forbs provide higher protein content than grass for only a short period of time during growth and then rapidly decline in quality (Cook 1971). Several shrub species provide good sources of digestible protein during rapid growth and even after they reach full maturity.

Management Implications

Transects are typically placed in key areas to estimate forage utilization. Key areas are defined as areas of heaviest use (Dasmann 1948) that will assure the rest of the range is in good condition if they are. These areas, considered indicative of range condition and trend, will show heavy use under most conditions, independent of herd size. This is especially true when the most highly palatable species on a range, such as bitterbrush and mountain mahogany on Big Creek, are selected as key species. These species will be utilized first, since they are preferred, and animals will not switch to other species as long as they are available.

Mule deer and elk food habits data from Big Creek winter range show that these ungulates depend on a complex of forage species October through early May. Nutrient requirements are met by use on key species as well as supplemental species. So, conversely, we could measure use on supplemental forage species and estimate trends from their use over a period of years. But still we limit our predictions to a small segment of ecological data.

When we examine histories of ungulate-range interactions, present situations are not necessarily what our methods have predicted. Big Creek and Middle Fork winter ranges have been called overbrowsed since the early 1900's. Yet today palatable browse species are still present, soil erosion has not denuded the area, and large ungulate populations exist. Population numbers have fluctuated as a result of food supply, but this is natural for animals that have evolved in unstable habitats (Klein 1970).

Ecosystem components, both biological and physical, of unstable habitats change through time and are not necessarily static or delicately balanced (Ehrilic and Birch 1967). Soil-plant-animal community relationships exist in a state of flux and change on any level affects the others (Cole 1971). Populations of large herbivores may even alter their habitat and its successional trends (Rasmussen 1941, Klein 1968, 1970). Douglas (1964) predicted that overbrowsing on predominantly browse type range of the Middle Fork of the Salmon River is changing them to grass type ranges.

Presently on Big Creek, mule deer populations seem stabilized and elk are increasing. Female to offspring ratios taken throughout the winters of 1964-72 for Big Creek range are 23, 30, 35, 41, 52, 43 and 13, 27, 28, 39, 42, 61 for mule deer and elk, respectively (Hornocker 1970, Idaho Cooperative Wildlife Research Unit files). These ratios are similar to those obtained by Cowan (1947, 1950) on ranges in Canadian parks, classed as overstocked. So, for deer at least, reproduction is impaired probably as a result of high population numbers and forage competition with elk during critical winter periods. We have assumed that low rates of increase in ungulate populations or periodic high overwinter mortality are unnatural phenomena (Cole 1971). Cole (1971), however, feels that these are natural phenomena and can be expected in self-regulated populations. So it appears that present mule deer and elk population levels on Big Creek are adjusting independent of management operations.

Our current definition of overbrowse use (that is, consistent use in excess of 60 percent annual growth) needs to be reviewed in light of these data. These populations, both plant and animal, have evolved together resulting in browse resistant species. Mountain mahogany and bitterbrush can withstand decades of intensive use and still survive. Ungulates can utilize a variety of forage species and adapt to changes in plant composition. Currently, chokecherry (aged at 1-6 years) is reproducing commonly on this range and its use is light so far. In the future, if chokecherry production becomes significant, ungulates will take it in addition to bitterbrush and mountain mahogany. This may even temporarily increase the number of deer and elk that can survive there.

If we accept this heavy use on browse species as normal, then is the range actually overpopulated? Ungulate populations are self-regulating in relation to their food resource and adjust by lowered reproductive and survival rates (Klein 1970, Cole 1971). Ranges can support a finite biomass and if elk increase then other population levels such as those of deer will have to decrease. Current ecological thinking indicates that these processes are natural forces of plant and animal succession (Klein 1970, Cole 1971). During these adjustment periods, vegetation seres may be altered and some soil erosion may occur. These vegetation and soil changes are particularly apparent in areas utilized by domestic livestock and where man has altered wildlife range use patterns.

In the meantime, these ranges of the Salmon River country need to be monitored in relation to ungulate-range interactions, ungulate population levels, and major management policies. Control of fire, for instance, allows unaltered plant succession to proceed to climax stages. This will decrease forage production favorable for ungulates, in turn depressing populations.

The ecological principles I have discussed need to be tested continuously and assimilated into our management programs. These data gathered on Big Creek winter range and related to current management practices show a need for revision of some management principles. Rather than a set of region-wide standards, we need a flexible system that allows ecological interpretation of our range and population dynamics data.

SUMMARY

The winter range of Big Creek, a major tributary of the Middle Fork of the Salmon River in central Idaho, has been considered in poor condition since the early 1900's. However, mule deer and elk are still abundant, soils are not highly eroded and palatable browse species still occur. This project was designed to quantify and relate ecological factors important to big game species that winter there and to evaluate certain concepts of wildlife management.

Canopy coverage data from 21 macroplots indicated that bluebunch wheatgrass was the dominant grass species on most southern exposures of the winter range. Idaho fescue occurred in mesic sways and on some southeastern and southwestern exposures. Common forbs were balsamroot, yarrow, and lupine. Shrub species encountered most frequently were bitterbrush and rubber rabbitbrush. Mountain mahogany was associated with bluebunch wheatgrass stands in some areas, but it was usually found on rocky outcroppings where cheatgrass was the common understory species. Total vegetative coverage ranged from 10.6 percent to 31.0 percent, averaging 19.6 percent canopy coverage.

Browse utilization of key species, mountain mahogany and antelope bitterbrush usually exceeded the accepted maximum use of 60 percent. Mountain mahogany was utilized in excess of 70 percent practically everywhere it was available. Bitterbrush utilization followed a topographical pattern, ranging from at least 70 percent utilization near ridgetops to less than 25 percent adjacent to creek bottoms. Annual mortality of intensively browsed mountain mahogany and bitterbrush plants was calculated at 2.7 per 100 and 1.0 per 100, respectively.

Young mountain mahogany plants were usually found in clumped situations and infrequently scattered in large stands. Many of the low, tightly hedged growth forms were 10-60 years old indicating reproduction has occurred through years of heavy animal utilization. Dealy (personal communication, 1973) stated that annual reproduction is dependent on such factors as weather during a particular season, seed predation by ground insects and rodents, and site competition. Mountain mahogany is a very long-lived (300 years plus) plant with a small annual reproductive rate. Thus, it does not appear in danger of extermination on the Big Creek winter range due to ungulate use.

Rumen samples were collected from ungulates by personnel of the Idaho Cooperative Wildlife Research Unit for three winter seasons, 1969-70, 1970-71 and 1971-72. We collected stomach samples from 116 mule deer, 61 elk and 8 bighorn sheep killed by hunters, mountain lions and coyotes. Browse (woody tissue) formed the major component of the mule deer diet, averaging at least 65 percent by volume December through March. A variety of browse species was consumed, consisting of mountain mahogany, bitterbrush, Oregon grape, Douglas fir and others. Elk mainly consumed grass (at least 50 percent by volume) throughout these winters, except during crusted snow conditions that occurred for 1-2 weeks in January or February. It was during these periods that mule deer and elk both selected browse species.

Mountain mahogany occurred in 7 of the 8 bighorn sheep stomach samples, averaging 12 percent and 35 percent by volume for fall and winter time periods, respectively. Douglas fir occurred in 7 of the 8 samples, but comprised less than 2 percent by volume in each sample, except one in February which was 25 percent. Bitterbrush did not occur in any of the samples and Oregon grape was only found in two, measured at 5 percent and a trace. Summarized by browse, grass and forb categories, average percentages by volume were 40, 57 and 3 for the time period September-December and 44, 54 and 2 for January-March, respectively.

Nutrient analyses of range forage and rumen samples for crude protein and fiber content quantified distinct patterns. Crude protein content of range forage varied almost twofold when values from three collection periods (October, February and May) and from three collection sites were compared. Browse species provided the highest consistent crude protein source (at least 10 percent of total dry weight) throughout the winter, though grasses averaged higher in spring (at least 27 percent of total dry weight). Mule deer rumen contents consistently contained higher crude protein values than elk samples in all months. Crude fiber values usually averaged higher for elk than deer. While crude protein value of range forage decreased down the Big Creek drainage, mule deer and elk dampened this fluctuation by their forage selectivity.

From these data and 7 years of population dynamics information on mule deer and elk, I concluded that this ecosystem is in good condition. It appears that present mule deer and elk population levels are adjusting independent of management operations. In light of these data, there is a need for revision of some management principles, particularly key species and key area concepts. Rather than a set of regionwide standards, we need a flexible system that allows ecological interpretation of our range and population dynamics data.

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