Ecology of the mule deer associated with the Brackett Creek winter range in the Bridger Mountains, Montana
by Alfred Ivan Rosgaard, Jr

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University

Abstract:
This study was conducted from June 1979 to December 1980 in the Bridger Mountains of southwestern Montana. The objectives were to describe vegetational characteristics of the Brackett Creek winter range and to monitor the movements, distribution, habitat use, and population characteristics of mule deer associated with that winter range. Grasslands, big sagebrush, agricultural, and skunkbush-limber pine-juniper vegetation cover types comprised 42%, 24.5%, 17.5%, and 5.8% of the Brackett Creek winter range, respectively. Total current annual growth twig production of big sagebrush, antelope bitterbrush, and skunkbush sumac was- determined to be 1,124,907 kg on 3 grass and 8 shrub dominated cover types. Those 3 species made up 96%, 1.9%, and 1.7%, respectively. Mule deer were widely distributed on the winter range throughout the winter of 1979-80. Mean winter home range size for 11 radio-collared deer was'3.06 km2. Big sagebrush, skunkbush-limber pine-juniper, grassland, and agricultural vegetation types accounted for 51%, 16%, 15%, and 11% of the winter habitat use by marked deer. During summer, deer were distributed throughout the herd range in 3 segments. One segment was resident on the winter range.

The other 2 segments were migratory and included 1 group that used open habitats on the periphery of the winter range and another that moved to forested habitats at higher elevations. Summer home range sizes of radio-collared does averaged 3.7 and 3.1 km2 for 1979 and 1980, respectively. Mule deer using the open shrub and grassland types had larger home ranges (7.6 km2) than those that inhabited forested habitats (2.1 km2) Douglas fir, big sagebrush, and swale cover types received, respectively, 47%, 21%, and 14% of the total summer-fall habitat use. Total population estimates of 2,105 and 2,010 were calculated for early and late winter 1979-80, respectively. Adult females, fawns, and adult males comprised 61%, 43%, and 4%, respectively, of the early winter population. Fawn production was 1.56 and 1.64 per radio-collared doe for 1979 and 1980, respectively. Overwinter mortality was low for the 1979-80 winter. Fawn:adult ratios decreased from 76 to 65 fawns/100 adults from early to late winter, representing an estimated loss of only 140 fawns. A minimum of 33 deer in 1979 and 66 in 1980 were killed during the fall hunting seasons. The Brackett Creek mule deer population may be stabilized at about 2,000-2,300 deer without apparent winter range browse deterioration or excessive hunting mortality, and despite high fawn production and survival.

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Approved:

Chairperson, Graduate Committee

Head, Major Department

Graduate Dean

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ABSTRACT

This study was conducted from June 1979 to December 1980 in the Bridger Mountains of southwestern Montana. The objectives were to describe vegetational characteristics of the Brackett Creek winter range and to monitor the movements, distribution, habitat use, and population characteristics of mule deer associated with that winter range. Grasslands, big sagebrush, agricultural, and skunkbush-limber pine-juniper vegetation cover types comprised 42%, 24.5%, 17.5%, and 5.8% of the Brackett Creek winter range, respectively. Total current annual growth twig production of big sagebrush, antelope bitterbrush, and skunkbush sumac was determined to be 1,124,907 kg on 3 grass and 8 shrub dominated cover types. Those 3 species made up 96%, 1.9%, and 1.7%, respectively. Mule deer were widely distributed on the winter range throughout the winter of 1979-80. Mean winter home range size for 11 radio-collared deer was 3.06 km^2. Big sagebrush, skunkbush-limber pine-juniper, grassland, and agricultural vegetation types accounted for 51%, 16%, 15%, and 11% of the winter habitat use by marked deer. During summer, deer were distributed throughout the herd range in 3 segments. One segment was resident on the winter range. The other 2 segments were migratory and included 1 group that used open habitats on the periphery of the winter range and another that moved to forested habitats at higher elevations. Summer home range sizes of radio-collared does averaged 3.7 and 3.1 km^2 for 1979 and 1980, respectively. Mule deer using the open shrub and grassland types had larger home ranges (7.6 km^2) than those that inhabited forested habitats (2.1 km^2). Douglas fir, big sagebrush, and swale cover types received, respectively, 47%, 21%, and 14% of the total summer-fall habitat use. Total population estimates of 2,105 and 2,010 were calculated for early and late winter 1979-80, respectively. Adult females, fawns, and adult males comprised 61%, 43%, and 4%, respectively, of the early winter population. Fawn production was 1.56 and 1.64 per radio-collared doe for 1979 and 1980, respectively. Overwinter mortality was low for the 1979-80 winter. Fawn:adult ratios decreased from 76 to 65 fawns/100 adults from early to late winter, representing an estimated loss of only 140 fawns. A minimum of 33 deer in 1979 and 66 in 1980 were killed during the fall hunting seasons. The Brackett Creek mule deer population may be stabilized at about 2,000-2,300 deer without apparent winter range browse deterioration or excessive hunting mortality, and despite high fawn production and survival.

INTRODUCTION

Mule deer in the Bridger Mountains, Montana are distributed in relation to 7 major winter ranges located around the periphery of the mountains (Mackie et al. 1978). The deer using each winter range appear to comprise discrete populations that occupy fairly distinct and definable yearlong herd ranges located around and within 8 to 16 km of the winter ranges (Mackie and Pac 1980). Previous studies have indicated that each population has a different habitat use pattern and strategy within its range. Population dynamics also vary between ranges. These differences seem to reflect the responses of deer to the entire environmental complex of their particular herd range (Mackie et al. 1980). Individual herd ranges differ in topographical, physiographical, vegetational, climatic, and land use characteristics as detailed by Mackie et al. (1980).

During the winter of 1977-78, studies were initiated to define and characterize the population and habitat of the mule deer associated with the Brackett Creek winter range and to compare results with data for other populations and habitats in the Bridger Mountains. Seasonal distributions, movements, habitat use, food habits, and population characteristics were generally defined by Nyberg (1980). My study was designed to obtain more specific information on the vegetational and forage characteristics of the Brackett Creek winter range and additional data on population characteristics. Deer-habitat interactions

were measured in terms of observed movements and distribution of deer in relation to habitat/environmental features, including topography, vegetation, climate, land use practices, and public access within the Brackett Creek herd range. Comparisons between those data and data obtained from the Armstrong (Bucsis 1974) and Schafer Creek (Steerey 1979) winter ranges on the west slope of the Bridger Mountains portrayed differences in strategy of the deer populations using each range.

Field studies were conducted full time during summer and winter and intermittently during other seasons from June 1979 through December 1980.

DESCRIPTION OF THE STUDY AREA

The Brackett Creek Study Area was located in the east-central portion of the Bridger Mountain Range in Gallatin and Park Counties, Montana (Fig. 1). Nyberg (1980) described the area as including the north end of Bangtail Ridge and its easterly foothills draining into the Shields River. During this study, the northern boundary was extended to encompass the southwest portion of Battle Ridge, including the entire drainages of Horse Creek, Nixon Creek, and Fox Creek, which flow southeasterly into Brackett Creek.

The entire area (Fig. 2) comprised about 34,750 ha. This was 3,250 ha more than recognized by Nyberg (1980). Approximately 7,459 ha (21.5%) of the total were included within the Brackett Creek mule deer winter range. Most of the area (84%), including all of the winter range, was privately owned. Public lands administered by the Gallatin National Forest comprised approximately 5,441 ha (16% of the total) distributed in a checkerboard pattern at elevations above about 1,800 m.

The forest cover of the higher elevations of the Bangtail Ridge was generally Douglas fir (*Pseudotsuga menziesii*) with smaller areas of lodgepole pine (*Pinus contorta*) and subalpine fir (*Abies lasiocarpa*). Plant names follow Hitchcock and Cronquist (1973). Forested areas of Battle Ridge included in the study area were comprised primarily of Douglas fir. The foothills of Bangtail Ridge were characterized by

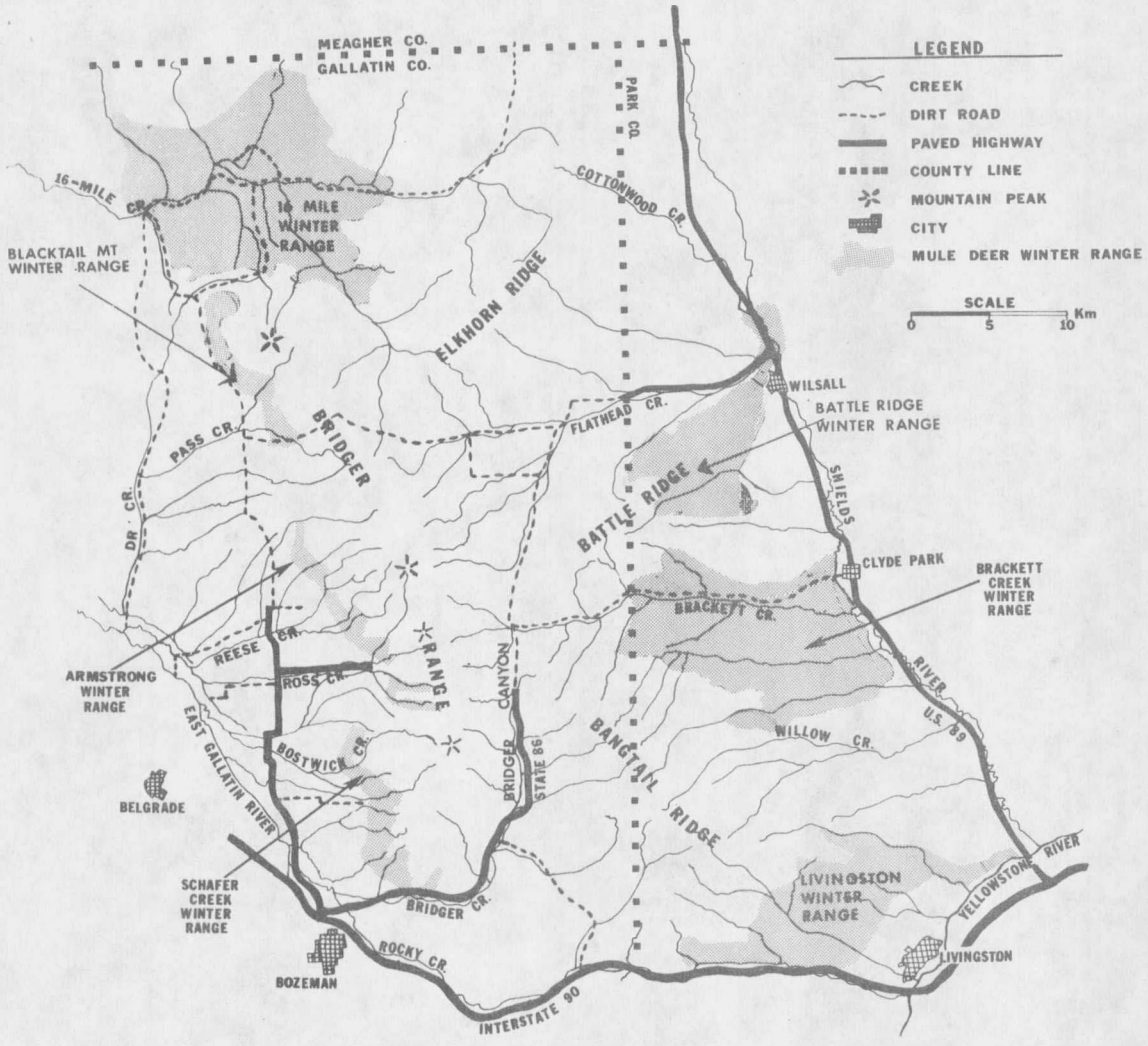

Figure 1. Map of the Bridger Range showing major features and the location of the Brackett Creek and other mule deer winter ranges.

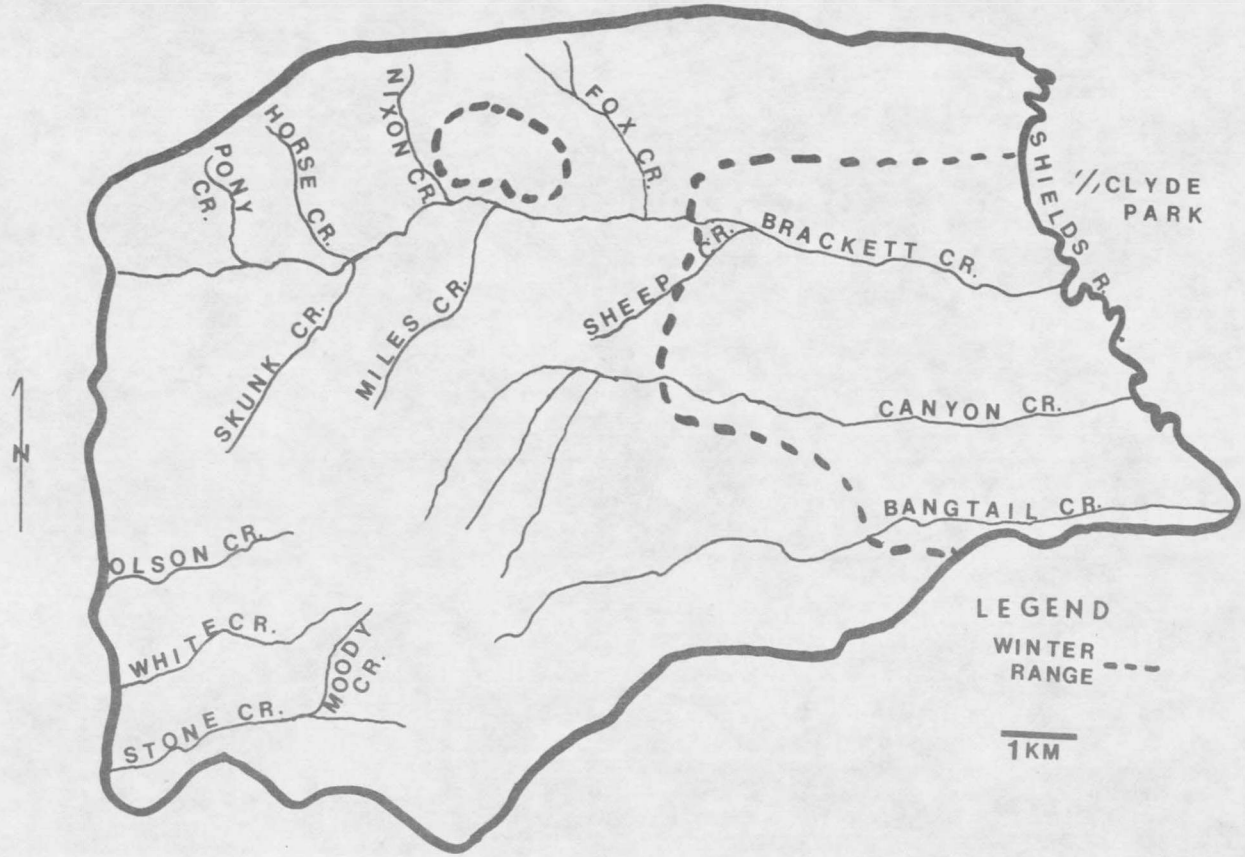

Figure 2. Map of the Brackett Creek study area showing major drainages and winter range.

bare rocky sandstone hilltops and valleys vegetated by big sagebrush (*Artemisia tridentata*), limber pine (*Pinus flexilis*), grasslands and agricultural cover types. Aspen and willow comprised much of the stream bottom cover. The lower elevations of Battle Ridge are characterized by rolling foothills dominated by big sagebrush, antelope bitterbrush (*Purshia tridentata*), and seeded and natural grassland cover types.

Elevations vary from 2,435 m on Bangtail Ridge above the head of Moody Creek to 1,420 m near the confluence of Bangtail Creek and the Shields River. The Brackett Creek winter range is characteristic of a Bridger Mountains east slope winter range in having open, level to rolling sagebrush and grassland valleys (10-20% slope) bisected by south and east facing slopes of 25-35% covered with Rocky Mountain juniper (*Juniperus scopularum*), skunkbush sumac (*Rhus trilobata*), and big sagebrush.

The general climatic characteristics for the Brackett Creek winter range were presented by Nyberg (1980). Climatological data from 2 weather stations on the study area and U.S. Department of Commerce weather stations at Wilsall and Bozeman (Montana State University) (Tables 1 and 2) show that weather conditions were considerably different during the winters of 1978-79 and 1979-80. The winter of 1978-79 was characterized by below average temperatures and above average snowfall. Temperatures were consistently higher from November through

Table 1. Climatological data for 2 weather stations established on the Brackett Creek winter range and for the U.S. Dept. of Commerce weather stations, Wilsall, MT and MSU, Bozeman, MT for the 1978-79 winter.

Month	Station[a]	Temp. °C Mean Max.	Temp. °C Mean Min.	Snowfall cm	Max. snow depth cm	Days on ground
Nov.	Lef.	-0.7	-9.4			
	Peck.	-0.5	-8.9			
	Wil.	1.9	-9.4	43.2	22.9	23
	MSU	1.2	-9.4	82.5	40.6	22
Dec.	Lef.	-5.8	-15.4			
	Peck.	-5.7	-14.8			
	Wil.	-4.5	-15.6	38.1	50.8	31
	MSU	-2.9	-14.0	36.6	25.4	31
Jan.	Lef.	-7.8	-18.2		42.0	31
	Peck.	-8.7	-17.9			
	Wil.	-6.1	-19.4	39.4	40.6	31
	MSU	-8.2	-19.7	45.7	71.1	31
Feb.	Lef.	0.6	-8.9		37.0	28
	Peck.	-0.3	-9.5			
	Wil.	0.9	-11.3	55.9	73.7	28
	MSU	1.3	-9.7	29.3	45.7	28
Mar.	Lef.	5.2	-5.1		51.0	22
	Peck.	4.2	-5.4		26.0	22
	Wil.	5.7	-6.7	33.0	66.0	31
	MSU	6.2	-5.1	25.7	35.6	29
Apr.	Lef.	9.7	-1.3		0.0	0
	Peck.	9.0	-1.8		0.0	0
	Wil.	8.7	-3.3	12.7	45.0	21
	MSU	11.6	-0.4	45.9	2.5	3

[a]Lef. = Leffingwell ranch, Peck. = Peckenpaugh ranch, Wil. = Wilsall, MSU = Montana State University.

Table 2. Climatological data for 2 weather stations established on the Brackett Creek winter range and for the U.S. Dept. of Commerce weather stations, Wilsall, MT and MSU, Bozeman, MT for the 1979-80 winter.

Month	Station[a]	Temp. °C Mean Max.	Temp. °C Mean Min.	Snowfall cm	Max. snow depth cm	Days on ground
Nov.	Lef.	3.9	-6.4		10.2	7
	Peck.	3.9	-6.5		5.1	7
	Wil.	3.8	-8.0	11.4	10.2	13
	MSU	3.6	-7.5	39.1	27.9	13
Dec.	Lef.	6.3	-4.6		0.0	0
	Peck.	5.7	-5.4		0.0	0
	Wil.	4.8	-7.9	30.5	15.2	15
	MSU	6.2	-5.4	19.6	20.3	24
Jan.	Lef.	-1.9	-15.1		17.8	21
	Peck.	-2.1	-15.2		12.7	21
	Wil.	-2.1	-15.9	61.0	38.1	30
	MSU	-2.4	-14.1	53.6	35.6	31
Feb.	Lef.	1.6	-7.2		30.0	29
	Peck.	0.7	-8.1		20.3	29
	Wil.	3.0	-7.8	53.3	55.9	29
	MSU	3.3	-7.2	47.8	25.4	29
Mar.	Lef.	-	-[b]		27.9	31
	Peck.	0.9	-8.2		25.4	31
	Wil.	3.3	-8.2	104.1	76.2	31
	MSU	4.4	-5.8	85.9	50.8	31
Apr.	Lef.	-	-		10.2	11
	Peck.	-	-		12.7	11
	Wil.	13.6	-2.1	5.1	66.0	23
	MSU	15.6	1.4	10.0	33.0	16

[a]Lef. = Leffingwell ranch, Peck. = Peckenpaugh ranch, Wil. = Wilsall, MSU = Montana State University.

[b]Represents no data due to instrument malfunction.

January 1979-80, while those of February and March were more similar to 1978-79 temperatures. Snowfall and maximum snow depth were considerably less for the winter of 1979-80 through February. During March and April 1980, snowfall was greater and the snow cover was more persistent. Winter severity indices (Picton and Knight 1971) for November-April of 1978-79 were 7,766 and 18,114 for the Leffingwell ranch and Wilsall weather stations, respectively. This was about 3.9 times greater than the indices of 1,976 and 4,594 recorded for those stations, respectively, during 1979-80.

METHODS

Vegetational Analysis

Vegetational analysis of the winter range was based on habitat and vegetation cover type classifications and maps developed in studies by Jorgensen (1977), Mackie et al. (1978, 1979, 1980), and Nyberg (1980). Twenty-four different types were recognized and delineated on aerial photographs. The area and percent of the winter range covered by each type were determined by randomly sampling 400 points on a dot grid overlaying the type map. Plant species composition, shrub densities, and current annual growth production of big sagebrush, skunkbush sumac, and antelope bitterbrush were estimated by sampling 51 stands of 12 different cover types known to be important to deer. The sampled stands were selected from aerial photo maps to include (1) areas and types receiving heavy use by mule deer during winter and (2) representation of all shrub types and stands of individual types having varying shrub densities.

Sampling was conducted at 32-48 points, spaced 2-8 m apart, in each stand. Canopy coverage (Daubenmire 1959) of herbaceous and low shrub species was recorded in 2 x 5 dm and 4 x 10 dm plots, respectively, centered on each point. Shrub density was estimated using the point-centered quarter technique (Cottam and Curtis 1956). Mean crown area and volume of shrubs in each type were calculated from measurements of the plant nearest the point in each quadrant. Two

diameters, 1 (a) through the longest axis of the crown, the other (b) through the axis at a right angle to the first, and the height (h) of each shrub were measured. Plant area and volume was calculated as $PA = \pi ab/4$ and $PV = PA(h)$, respectively.

Estimates of browse production for big sagebrush, skunkbush sumac, and antelope bitterbrush on important shrub types and the total winter range were developed from shrub densities and average crown areas using regression equations that related crown area and volume to current annual growth. Those equations were developed by measuring, clipping, and weighing all current annual growth twigs from 20 plants of each species following methods outlined by Lyon (1968), Peek (1970), and Bucsis (1974).

Land Use Practices

Cover type maps of the Brackett Creek winter range were used to determine approximate proportions of cultivated land (grainfields), hayfields, and pasture-rangeland. Individual landowners were then interviewed to obtain current information on the proportions of their land that was hayed, cultivated, and grazed as pasture. Grazing pressure was estimated from information on the grazing period and the number of animal units using the winter range. Proportions of the winter and summer range accessible to the public were determined from maps and landowner contacts. The area covered by subdivisions was

also calculated. A comparison of deer distribution to land use activities aided in analysis of the land use effects on deer distribution.

Distribution, Movements, and Habitat Use

The distribution, movements, and habitat use of mule deer associated with the Brackett Creek winter range were determined by aerial surveys, ground observations, and relocations of radio-collared and neckbanded animals. Aerial observations and relocations were made approximately twice monthly throughout the year, using a Piper Supercub aircraft. Vegetational cover types, slope, aspect, and, when possible, group size and composition were recorded for each observation or relocation. Locations were plotted on aerial photographs. Movements were analyzed using the Xerox Sigma 7 computer and the Telday program developed by Terry N. Lonner, Montana Department of Fish, Wildlife, and Parks.

Additional information on distribution and habitat usage was obtained during helicopter surveys flown for complete coverage of the winter range in January and March (Mackie et al. 1980), 1 fixed wing airplane survey in late March, and intensive ground observations during January-April 1980.

Food Habits

Winter food habits were determined by examining 17 recent feeding sites and recording instances of plant use as described by Wilkins

(1957). Preference was determined by relating plant use to occurrence and availability on the feeding site. Analysis of contents of rumens (Wilkins 1957) collected from 10 deer found dead on the area provided supplementary data.

Population Characteristics

Population estimates for early and late winter 1980 were derived as Lincoln indices from observations of marked and unmarked deer during the helicopter surveys flown for complete coverage of the winter range in January and March and a similarly flown fixed-wing survey in April. Sex and age composition and changes were determined during classification of all deer observed during the winter aerial surveys, radio relocation flights and ground observations during the winter, and sightings of fawns with marked does.

Estimates of winter mortality were derived from the difference in total population estimates for early and late winter, the difference in fawn:adult ratios, and a dead deer survey conducted on 8 May 1980 after most deer had left the winter range. The latter survey employed a stratified random sampling procedure on 7.8 km^2 of the winter range. Two-thirds of this area (5.2 km^2) received moderate winter use by mule deer and one-third (2.6 km^2) received heavy use. Four randomly selected 16 ha plots in each 2.6 km^2 were thoroughly searched by 8 people. Sex, age, and probable cause of death were determined when

possible, for each carcass that was located.

Information on hunting mortality and hunter distribution and success was obtained by field checks of hunters, tag returns, and return of hunter questionnaires during the hunting seasons in 1979 (October 21-November 25) and 1980 (October 19-November 30). Access routes were monitored on weekends, and all hunters encountered were interviewed and informed of the presence of marked deer in the area. Lower jaws were collected to determine age. Basal beam diameters were measured on any harvested bucks. Questionnaires were sent with the 500 either-sex deer permits for hunting district 312. Hunters were asked to provide information on sex of kill, to plot the location of the kill on a map on the back of the questionnaire, and to send the lower jaw to the nearest office of the Montana Department of Fish, Wildlife, and Parks. Since the Brackett Creek study area was within hunting district 312, returned questionnaires provided data on hunting pressure and deer harvest for Brackett Creek relative to other portions of the Bridger Range. Interviews with landowners following the hunting season provided additional information on the harvest.

Deer Trapping

One hundred and twelve mule deer were trapped and marked on the Brackett Creek winter range during 1978 and 1979, including 18 with radio transmitting collars and the rest with neckbands. Six additional

deer were trapped at 2 sites on the study area during March 1980 using a cannon net trap as described by Mackie et al. (1975). Four of these were fitted with radio collars and 2 with neckbands. Neckbands were 4-inch-wide armortite fabric on which individually recognizable symbols were painted using Tufflex marking paint. A maximum of 105 marked deer (89 neckbanded and 16 radio-collared) remained in December 1979. Two of the 16 radio collars were non-functioning by this time. At most, 101 marked animals, including 86 neckbanded and 15 radio-collared deer, were present in summer and early fall 1980.

RESULTS

Vegetational Characteristics of the Brackett Creek Winter Range

Cover Types and Characteristics

Nyberg (1980) recognized and defined 7 broad ecological types, based on general vegetational, physiographic, and topographic similarities, for the study area: grassland, sagebrush, limber pine, Douglas fir, swale, creek bottom, and agricultural. Within those broad categories, 24 specific vegetational cover types were delineated for the winter range (Table 3). The cover types were distributed in 527 individual stands averaging 14.5 ha in size (Table 3). Average stand size varied widely between cover types and between stands of each type.

Almost half (42%) of the winter range was covered by 7 grass-dominated types (Table 3), while 6 types dominated by big sagebrush covered about one-fourth (24.5%) of the area. Most of the remaining area was covered by agricultural lands (17.5% of the total) and 9 other minor types that collectively made up 15.9%. Among the latter, the *Rhus trilobata/Agropyron spicatum/Pinus flexilis/Juniperus scopularum* type (Rhtr/Agsp/Pifl/Jusc), which occurred in 44 stands comprising 5.8% of the winter range, was most important. Cover types dominated or generally characterized by trees and/or tall shrubs occurred on only 1,136 ha (15.2% of the total).

Plant species and their relative abundance, as indicated by mean frequencies of occurrence and canopy coverage, for the 12 cover types

Table 3. Composition, proportion of total area, and stand size for cover types on the Brackett Creek winter range.

Cover type		Area (ha)	Percent of total	No. stands		Mean stand area (ha)
Grassland types						
*Agsp/Feid		1305.3	17.5	83		15.7
*Posa/Arfr/Kocr		984.6	13.2	35		28.1
*Agsp/Chvi/Orhy		395.3	5.3	98		4.0
*Feid/Agsp		156.6	2.1	8		19.6
Agcr seedings		149.2	2.0	6		24.9
Agda/Kocr/Posa		89.5	1.2	8		11.2
Popr/Phpr/Gevi		52.2	0.7	3		17.4
	Total	3132.7	42.0	241	Mean	13.0
Sagebrush types						
*Artr/Agsp		999.5	13.4	53		18.2
*Artr/Feid/Agsp		268.5	3.6	17		15.8
*Artr/Agda/Agsp		216.3	2.9	14		15.5
*Artr/Popr/Phpr		216.3	2.9	39		5.5
*Artr/Feid/Popr		89.5	1.2	14		6.4
*Agsp/Artr/Putr		37.3	0.5	6		6.2
	Total	1827.4	24.5	143	Mean	12.8
Skunkbush-limber pine-juniper type						
*Rhtr/Agsp/Pifl/Jusc		428.9	5.8	44		9.7
Swale types						
*Symph/Popr/Phpr		37.3	0.5	11		3.4
Popr/Phpr/Syal		14.9	0.2	2		7.5
	Total	52.2	0.7	13	Mean	4.0
Creek bottom types						
Salix/Alnus		395.3	5.3	12		32.9
Potr/Salix		74.6	1.0	9		8.3
Crdo/Amal		14.9	0.2	11		1.4
	Total	484.8	6.5	32	Mean	15.2
Douglas fir timber types						
Psme/Feid		193.9	2.6	5		38.8
Psme/Syal/Agsp		14.9	0.2	6		2.9
Agsp/Basa/Psme		7.5	0.1	2		4.3
	Total	216.3	2.9	13	Mean	16.6

Table 3. (Continued.)

Cover type	Area (ha)	Percent of total	No. stands	Mean stand area (ha)
Agricultural types				
Hayfields	842.9	11.3	30	28.0
Grainfields	465.4	6.2	11	42.0
Total	1305.3	17.5	41	31.8
Totals[a]	7447.7	99.9	527	14.5

*Denotes cover types in which sampling was conducted.
[a]Differences in totals is due to rounding.

in which sampling was conducted are presented in Tables 4 and 5. The sampled types comprised 5,136 ha (68.8%) of the total winter range.

Generally, the grass dominated cover types occurred on areas of level to rolling topography and on ridges above sagebrush valleys throughout the winter range. Among the 4 types sampled, bluebunch wheatgrass (*Agropyron spicatum*) was dominant or co-dominant on all but the *Poa sandbergii/Artemisia frigida/Koeleria cristata* (Posa/Arfr/Kocr) type. Other important grasses were Idaho fescue (*Festuca idahoensis*) and Indian ricegrass (*Oryzopsis hymenoides*), which co-dominated some types, and prairie junegrass (*Koeleria cristata*). Forb species were quite similar in the four grassland types. Important forbs included silvery lupine (*Lupinus argenteus*), yellow sweetclover (*Melilotus officinale*), pale alyssum (*Alyssum alyssoides*), western

Table 4. Mean percent frequency of occurrence and canopy coverage of important plant taxa in 4 grass and 2 shrub domintated vegetation cover types on the Brackett Creek winter range. Numbers of sites sampled are in parentheses.

	Grassland types				Skunkbush-limber pine type	Swale type
Taxa[b]	Agsp/Chvi/Orhy[a] (5)	Posa/Arfr/Kocr (4)	Agsp/Feid (6)	Feid/Agsp (2)	Rhtr/Agsp/Pifl/Jusc (8)	Symph/Popr/Phpr (3)
Forbs:						
Achillea millefolium	2/tr[c]	23/2	23/2	18/2	3/tr	22/3
Allium cernuum	1/tr					
Allium spp.			1/tr			
Alyssum alyssoides	30/3	24/5		38/5		
Antennaria rosea	22/2		13/1	6/1	2/tr	
Apocynum androsaemifolium					1/tr	
Arenaria hookeri	17/2		4/tr		tr/tr	
Aster spp.			1/tr		tr/tr	
Astragalus drummondii				1/tr		
Astragalus spp.	26/2		17/3		4/1	
Balsamorhiza sagittata		5/1			3/1	13/2
Castilleja spp.			tr/tr			
Cerastium arvense					tr/tr	
Chrysopsis villosa	12/2					
Commandra umbellata	10/1	9/2	1/tr	1/tr	3/tr	
Crepis atrabarba	1/tr					
Cryptantha celosoides					tr/tr	
Cynoglossum officinale			tr/tr			
Delphinium occidentale						1/tr
Erigeron compositus	1/tr					
Erigeron sp.					tr/tr	3/1
Eriogonum umbellatum	11/1					
Euphorbia maculata					tr/tr	
Gaillardia aristata						1/tr
Gaura coccinea		tr/tr				
Geranium viscosissimum						63/15
Iris missouriensis						3/1
Linum lewisii	1/tr				tr/tr	
Lithospermum incisum						6/1
Lomatium spp.	1/tr				tr/tr	
Lupinus argenteus	14/2	1/tr	17/3	20/4	5/tr	22/4
Malva parviflora	1/tr	13/1		9/1	1/tr	
Medicago sativa		1/tr		1/1	tr/tr	
Melilotus officinale	13/2	42/10	13/3	19/2	70/17	
Monarda fistulosa						9/2
Myosotis sp.	4/1					

Table 4. (Continued).

Taxa[b]	Grassland types: Agsp/Chvi/Orhy[a] (5)	Grassland types: Posa/Arfr/Kocr (4)	Grassland types: Agsp/Feid (6)	Grassland types: Feid/Agsp (2)	Skunkbush-limber pine type: Rhtr/Agsp/Pifl/Jusc (8)	Swale type: Symph/Popr/Phpr (3)
Forbs: (Continued)						
Opuntia polyacantha		1/tr			1/tr	
Oxytropis spp.					1/tr	
Phlox hoodii	33/2	2/tr	27/3	39/5	4/tr	3/tr
Physaria spp.	2/tr					
Potentilla gracillis	2/tr				tr/tr	
Sedum stenopetalum					tr/tr	
Senecio serra						4/1
Senecio spp.			2/tr		tr/tr	
Solidago missouriensis						20/4
Towsendia hookeri	2/tr		1/tr			
Unidentified forbs			2/tr			15/3
Half Shrubs:						
Artemisia frigida	44/6	30/4	5/1	16/2	2/tr	
Gutierrezia sarothrae	2/tr	1/tr	tr/tr	1/tr	1/tr	
Shrubs:						
Amelanchier alnifolia					1/tr	5/1
Artemisia cana			tr/tr	4/tr		
Artemisia tridentata		11/3	24/5	46/15	12/3	50/18
Chrysothamnus nauseosus		1/tr			tr/tr	
Juniperus scopularum					10/3	
Prunus virginianus					1/tr	23/6
Rhus trilobata					9/3	
Ribes spp.					2/tr	
Rosa woodsii		1/tr			5/1	18/3
Symphoricarpos albus						68/17
Trees:						
Pinus flexilis					7/3	
Pseudotsuga menziesii					tr/tr	3/1

Table 4. (Continued).

Taxa[b]	Grassland types: Agsp/Chvi/Orhy[a] (5)	Grassland types: Posa/Arfr/Kocr (4)	Grassland types: Agsp/Feid (6)	Grassland types: Feid/Agsp (2)	Skunkbush-limber pine type: Rhtr/Agsp/Pifl/Jusc (8)	Swale type: Symph/Popr/Phpr (3)
Total grasses	79/13	100/39	99/28	100/31	74/13	99/38
Total forbs	94/18	91/22	87/15	95/18	83/20	95/30
Total shrubs	0/0	13/3	25/5	46/15	43/13	97/39
Selaginella densa	2/tr		15/3	31/5	1/tr	
Bare ground	100/57	100/43	100/44	100/37	96/45	72/16
Rock	89/19	19/5	57/11	44/8	81/18	0/0

[a]See Appendix Table 23 for key to 4-letter plant species abbreviations.
[b]Includes those taxa with a canopy coverage of 0.5% or greater or a frequency of 5% or greater in at least 1 site.
[c]Mean percent frequency of occurrence/mean percent canopy coverage; tr = trace, a value less than 0.5%.

Table 5. Mean percent frequency of occurrence and canopy coverage of important plant taxa in 6 sagebrush dominated vegetation cover types on the Brackett Creek winter range. Numbers of sites sampled are in parentheses.

	Sagebrush shrubland types					
Taxa[b]	Artr/Agsp[a] (13)	Agsp/Artr/Putr (1)	Artr/Feid/Agsp (2)	Artr/Agda/Agsp (1)	Artr/Feid/Popr (1)	Artr/Popr/Phpr (5)
Forbs:						
Achillea millefolium	16/2[c]	28/5	32/3	45/7	15/1	26/3
Agoseris glauca	1/tr[d]					
Allium spp.	2/tr					
Alyssum alyssoides	34/5	90/11		93/9		7/tr
Antennaria rosea	6/tr	3/tr	1/tr	13/1		8/1
Arenaria hookeri	1/tr			3/tr		10/1
Aster commutatus			1/tr		8/1	6/1
Aster spp.				23/4		
Astragalus drummondii	2/1				15/2	9/1
Astragalus spp.	12/2					9/2
Balsamorhiza sagittata	2/tr	3/tr		8/1		1/tr
Campanula rotundifolia					10/1	5/tr
Castilleja spp.	1/tr					
Circium arvense	1/tr					
Commandra umbellata	6/tr	3/tr		8/1	3/tr	11/1
Cynoglossum officinale	tr/tr					
Erigeron compositus	1/tr					
Erigeron sp.						tr/tr
Euphorbia maculata	tr/tr					
Gaura coccinea		10/2				
Geranium viscosissimum						6/1
Linum lewisii	tr/tr					tr/tr
Lithospermum incisum						1/tr
Lomatium spp.	tr/tr	20/5				
Lupinus argenteus	41/10	18/3	80/22	43/8	38/7	32/4
Malva parviflora	3/tr		2/tr			
Medicago sativa						2/tr
Melilotus officinale	33/7		5/2	40/3	40/4	17/2
Myosotis sp.	tr/tr			3/tr		
Opuntia polyacantha	tr/tr	3/tr		3/tr		
Phacelia heterophylla	tr/tr					
Phlox hoodii	16/2	8/1		48/5		18/1
Sedum stenopetalum	1/tr					5/tr

Table 5. (Continued).

Taxa[b]	Sagebrush shrubland types					
	Artr/Agsp[a] (13)	Agsp/Artr/Putr (1)	Artr/Feid/Agsp (2)	Artr/Agda/Agsp (1)	Artr/Feid/Popr (1)	Artr/Popr/Phpr (1)
Forbs: (Continued)						
Senecio spp.	1/tr					1/tr
Townsendia hookeri	1/tr					
Vicia americana	2/tr			3/tr		
Unidentified forbs	3/tr	5/1				1/tr
Half shrubs:						
Artemisia frigida	9/1	3/tr		13/1		3/tr
Artemisia ludoviciana		3/tr				
Gutierrezia sarothrae	3/tr			8/1		
Shrubs:						
Amelanchier alnifolia	tr/tr	5/1				1/tr
Artemisia cana			4/tr			
Artemisia tridentata	72/21	48/10	66/18	98/35	100/37	57/19
Chrysothamnus nauseosus	3/tr		1/tr			
Juniperus scopularum	1/tr					2/1
Prunus virginianus		18/5				
Purshia tridentata		58/15				
Ribes spp.						1/tr
Rosa woodsii		40/8	1/tr			2/tr
Symphoricarpos albus		8/1				
Trees:						
Pinus flexilis						1/1
Pseudotsuga menziesii						1/tr
Total grasses	99/23	100/27	100/45	100/22	98/21	100/32
Total forbs	97/27	95/22	95/26	100/26	85/15	85/17
Total shrubs	74/21	88/30	68/17	98/35	100/37	68/23
Selaginella densa	8/2			15/3	48/13	17/4
Bare ground	99/36	100/36	94/17	100/36	98/26	99/28
Rock	18/3	95/21	0/0	0/0	5/1	22/3

[a] See Appendix Table 23 for key to 4-letter plant species abbreviations.
[b] Includes those taxa with a canopy coverage of 0.5% or greater or a frequency of 5% or greater in at least 1 site.
[c] Mean percent frequency of occurrence/mean percent canopy coverage.
[d] tr = trace, a value less than 0.5%.

yarrow (*Achillea millefolium*), and hairy goldenaster (*Chrysopsis villosa*). Big sagebrush was the only shrub of any significance and was especially abundant in the *Festuca idahoensis/Agropyron spicatum* (Feid/Agsp) type. No shrubs occurred in the *Agropyron spicatum/Chrysopsis villosa/Oryzopsis hymenoides* (Agsp/Chvi/Orhy) type, and and very few were found in Posa/Arfr/Kocr.

The big sagebrush dominated cover types also occurred throughout the winter range, primarily in "valleys" between the grassy ridges. Four of the 6 types were co-dominated by bluebunch wheatgrass. The other 2, *Artemisia tridentata/Festuca idahoensis/Poa pratensis* (Artr/Feid/Popr) and *Artemisia tridentata/Poa pratensis/Phleum pratense* (Artr/Popr/Phpr), which occurred on more mesic sites at higher elevations, were co-dominated by Idaho fescue or Kentucky bluegrass (*Poa pratensis*). Timothy (*Phleum pratense*) and thickspike wheatgrass (*Agropyron dasystachyum*) were other important grasses. Forb composition varied somewhat, but a few species were common on most types. These included silvery lupine, yellow sweetclover, pale alyssum, milkvetch (*Astragalus* spp.), Hood's phlox (*Phlox hoodii*), western yarrow, and rosy pussytoes (*Antennaria rosea*). The *Artemisia tridentata/Agropyron spicatum* (Artr/Agsp) and Artr/Popr/Phpr cover types had the greatest variety of forbs (28+ and 20+ species, respectively), while the fewest were recorded on the Artr/Feid/Agsp and Artr/Feid/Popr (6 and 7 species, respectively). Big sagebrush was

the most important shrub on all types except *Agropyron spicatum/Artemisia tridentata/Purshia tridentata* (Agsp/Artr/Putr), where antelope bitterbrush had slightly greater canopy coverage (15% vs 10%). Chokecherry (*Prunus virginianus*), Wood's rose (*Rosa woodsii*), and common snowberry (*Symphoricarpos albus*) were also common in the latter, but occurred only in trace amounts in all other sagebrush cover types. Rocky Mountain juniper and limber pine occurred as scattered plants in the Artr/Popr/Phpr cover type.

Stands of skunkbush-limber pine-juniper (Rhtr/Agsp/Pifl/Jusc cover type) occurred on steep (30° or greater), south-facing slopes having a very rocky substrate (18% rock coverage) and a high percentage of bare ground (45%). The most important grass was bluebunch wheatgrass, but Idaho fescue and Indian ricegrass were also present. A wide variety of forbs occurred in small quantities. The more important species included yellow sweetclover, milkvetch, and arrowleaf balsamroot (*Balsamorhiza sagittata*). Dominant shrubs were skunkbush sumac, Rocky Mountain juniper, and big sagebrush. Limber pine was also abundant.

The swale types (*Symphoricarpos/Poa pratensis/Phleum pratense* (Symph/Popr/Phpr) and *Poa pratensis/Phleum pratense/Symphoricarpos albus* (Popr/Phpr/Syal) were found in small pockets at the upper elevational edge of the winter range on moderate slopes where deep snow collected in the winter. Vegetation typically was lush during the

growing season. Common grasses included Kentucky bluegrass and timothy. Important forbs were sticky geranium (*Geranium viscosissimum*), silvery lupine, western yarrow, arrowleaf balsamroot, and goldenrod (*Solidago missouriensis*). The dense growth of shrubs included common snowberry, western serviceberry (*Amelanchier alnifolia*), chokecherry, and big sagebrush. Scattered Douglas fir was also present.

Creek bottom types were found along the Brackett, Canyon, and Bangtail Creek drainages as well as some minor drainages. Willow (*Salix* spp.), alder (*Alnus* spp.), quaking aspen (*Populus tremuloides*), and cottonwood (*Populus tricharpos*) generally characterized these cover types. Timbered cover types, found in very small quantities on the winter range, consisted of scattered, sparse Douglas fir stands. Vegetation on the agricultural lands consisted of fields of barley, wheat, alfalfa, and various mixtures of native and exotic grasses.

Distribution and Abundance of Browse Plants

Shrubs occurred on 11 of the 12 cover types sampled. Species composition, density, and plant size of shrubs in those types are listed in Tables 6 and 7. Estimated total shrub densities ranged from 739 plants/ha in the Posa/Arfr/Kocr cover type to 58,785 plants/ha in the Symph/Popr/Phpr type. Lower total shrub densities and/or fewer total shrub species occurred in grass as compared with shrub dominated cover types.

Table 6. Mean density (plants/ha), crown area (cm^2), and crown volume (cm^3) of shrubs in 3 grass and 2 shrub dominated vegetation cover types on the Brackett Creek winter range. Numbers of sites sampled are in parentheses.

	Feid/Agsp[a] (2)	Agsp/Feid (6)	Posa/Arfr Kocr (4)	Rhtr/Agsp/ Pifl/Jusc (8)	Symph/Popr/ Phpr (3)
Amal density				124	1,795
Crown area/vol.				317/6,040	388/21,100
Arca density	19				
Crown area/vol.	590/10,621				
Artr density	5,041	2,643	681	1,280	11,523
Crown area/vol.	3,092/143,666	1,476/45,812	4,038/204,635	2,022/73,120	3,310/200,571
Chna density		7	50	86	
Crown area/vol.		1,009/2,652	1,087/31,020	670/20,145	
Jusc density				332	
Crown area/vol.				32,474/6,459,189	
Prvi density				45	8,973
Crown area/vol.				559/16,079	599/40,972
Putr density				23	
Crown area/vol.				5,213/149,669	
Rhtr density			9	344	
Crown area/vol.			5,730/223,480	5,867/286,942	
Ribes spp. density				94	
Crown area/vol.				3,279/165,728	
Rowo density			0.5	160	3,418
Crown area/vol.			1,317/50,050	562/17,150	427/19,635

Table 6. (Continued).

# Sites	Feid/Agsp[a] (2)	Agsp/Feid (6)	Posa/Arfr/ Kocr (4)	Rhtr/Agsp/ Pifl/Jusc (8)	Symph/Popr/ Phpr (3)
Syal density			0.5		33,077
Crown area/vol.			242/7,257		283/11,997
Total shrub density	5,060	2,651	739	2,572	58,785
Size of cover type (ha)	157.9	89.6	984.5	429.6	35.8

[a]See Appendix Table 23 for key to 4-letter plant species abbreviations.

Table 7. Mean density (plants/ha), crown area (cm^2), and crown volume (cm^3) of shrubs in 6 sagebrush dominated vegetation cover types on the Brackett Creek winter range. Numbers of sites sampled are in parentheses.

	Artr/Feid/Agsp[a] (2)	Artr/Popr/Phpr (5)	Artr/Agsp (13)	Artr/Agda/Agsp (1)	Agsp/Artr/Putr (1)	Artr/Feid/Popr (1)
Amal density		17	5		1,014	
Crown area/vol.		2,592/57,020	190/4,372		207/5,063	
Arca density			2			
Crown area/vol.			3,877/152,380			
Artr density	6,736	9,080	11,705	12,462	6,081	23,898
Crown area/vol.	4,371/279,035	2,292/107,770	2,184/94,005	3,091/145,493	2,463/95,292	2,281/106,972
Chna density	129		269	402		
Crown area/vol.	901/27,945		593/20,054	366/7,975		
Jusc density		58	39			
Crown area/vol.		27,068/2,938,765	15,874/2,752,865			
Prvi density			1		3,909	
Crown area/vol.			7,924/637,869		900/32,305	
Putr density					7,819	
Crown area/vol.					2,854/118,720	
Rhtr density		17				
Crown area/vol.		3,377/96,245				
Ribes spp. density		26				
Crown area/vol.		2,805/171,132				
Rowo density	21	76	1		3,909	
Crown area/vol.	10,754/838,786	785/22,344	11,204/1,157,785		450/15,364	
Syal density	21		0.2		434	
Crown area/vol.	130/2,462		465/23,713		280/4,767	
Total shrub density	6,907	9,278	11,992	12,864	23,167	23,898
Size of cover type (ha)	268.5	214.8	1,002.4	214.8	37.4	89.6

[a]See Appendix Table 23 for key to 4-letter plant species abbreviations.

Big sagebrush was by far the most abundant shrub on the winter range, occurring on all shrubland and most grassland types. It was most abundant (23,898 plants/ha) in the Artr/Feid/Popr cover type where it was the only shrub present. Sagebrush on grasslands ranged from 681 plants/ha in the Posa/Arfr/Kocr cover type to 5,041 plants/ha in the Feid/Agsp cover type. These were lower average densities than occurred in any of the shrubland types except Rhtr/Agsp/Pifl/Jusc.

Antelope bitterbrush occurred on 2 cover types: Rhtr/Agsp/Pifl/Jusc and Agsp/Artr/Putr. It was abundant (7,819 plants/ha) only in the latter, which was found only on the small unit of winter range north of the mouth of Miles Creek (Fig. 2).

Skunkbush sumac was found in 3 cover types (Posa/Arfr/Kocr, Rhtr/Agsp/Pifl/Jusc, and Artr/Popr/Phpr), but was abundant only in the skunkbush-limber pine-juniper type (344 plants/ha). Rocky Mountain juniper occurred at only slightly lower densities than skunkbush in this type. It was also found in Artr/Popr/Phpr and Artr/Agsp cover types but was much less abundant.

Seven other shrubs occurred at low densities on much of the winter range. Most were common or relatively abundant only in the Rhtr/Agsp/Pifl/Jusc, Agsp/Artr/Putr, and Syal/Popr/Phpr cover types. Stands of the skunkbush type supported a diverse shrub community that included 9 of the 11 shrubs found on the winter range, all at moderate densities. Six shrubs occurred in the Agsp/Artr/Putr cover type. Those included

moderate densities of chokecherry, Wood's rose, and western serviceberry, that were of only minor importance elsewhere on the winter range. Five shrub species occurred in the Symph/Popr/Phpr cover type (big sagebrush, common snowberry, Wood's rose, chokecherry and western serviceberry). All but big sagebrush were of minor importance on other types. Common snowberry occurred at a density of 33,077 plants/ha; however, because this cover type made up only 35.8 ha, its mean over the entire winter range was quite low.

Mean size for big sagebrush plants was similar for all cover types except Agsp/Feid grasslands on which relatively small plants were characteristic (Tables 6 and 7). The mean plant size of antelope bitterbrush was quite comparable to that of big sagebrush in the Agsp/Artr/Putr cover type. The mean plant size of skunkbush plants was somewhat greater than the mean plant size of big sagebrush. Rocky Mountain juniper had the largest mean size of all shrubs on the winter range (2.88 m^2).

Production and Yield of Major Browse Species

Statistical relationships between plant size and current annual growth twig (CAGT) production for big sagebrush, antelope bitterbrush, and skunkbush sumac on the winter range are summarized in Table 8. Crown volume provided the best estimate of production for big sagebrush ($r = 0.89$), while crown area appeared to be the best indicator

Table 8. Statistical relationships between plant size and current annual growth twig (CAGT) production in grams for big sagebrush, antelope bitterbrush, and skunkbush sumac on the Brackett Creek winter range.

	Slope	Y intercept	r
Big sagebrush			
Crown area (cm^2)	40.90	622.25	0.86
Crown volume (cm^3)	2,742.43	581.84	0.89
Skunkbush sumac			
Crown area (cm^2)	46.80	283.31	0.96
Crown volume (cm^3)	2,901.88	-55,294.33	0.89
Antelope bitterbrush			
Crown area (cm^2)	40.32	122.52	0.92
Crown volume (cm^3)	2,701.96	-42,777.67	0.92

of CAGT production for skunkbush sumac (r = 0.96) and antelope bitterbush (r = 0.92).

Mean CAGT production estimates and total yields for each of the 3 major browse species on each cover type in which they occurred and for all types combined are presented in Table 9. These data indicate that big sagebrush provided over 96% of the total production and yield for the 3 species in the cover types sampled. Average production was 145.5 kg/ha; the total estimated yield was 1,084,956 kg. The 11 cover types supporting big sagebrush varied in production from 33.9 kg/ha (Rhtr/Agsp/Pifl/Jusc) to 927 kg/ha (Artr/Feid/Popr). In contrast, skunkbush sumac and antelope bitterbush each contributed less than 2% to the total browse produced and available. The average production of skunkbush was 2.5 kg/ha, and the total estimated yield was 18,872 kg

Table 9. Mean current annual growth twig (CAGT) production for big sagebrush, skunkbush sumac, and antelope bitterbrush for grass and shrub cover types on the Brackett Creek winter range.

	Big sagebrush			Skunkbush sumac			Antelope bitterbrush		
Cover types	Prod./Plant[a]	kg/ha	Yield[b]	Prod./Plant	kg/ha	Yield	Prod./Plant	kg/ha	Yield
Agsp/Feid[c]	16.5	43.5	56,957						
Posa/Arfr/Kocr	74.4	50.7	49,919	116.4	1.0	984			
Feid/Agsp	52.5	263.0	41,530						
Rhtr/Agsp/Pifl/Jusc	26.5	33.9	14,545	119.3	41.1	17,652	126.3	2.95	1,269
Symph/Popr/Phpr	72.9	840.9	30,084						
Artr/Agsp	34.1	398.7	399,695						
Artr/Feid/Agsp	101.5	683.9	183,633						
Artr/Agda/Agsp	52.8	658.5	141,443						
Artr/Feid/Popr	38.8	927.1	83,068						
Artr/Popr/Phpr	39.1	354.9	76,228	66.1	1.1	236			
Agsp/Artr/Putr	34.5	210.0	7,855				67.7	529.7	19,809
Overall mean		145.5			2.53			2.83	
Total yield			1,084,956			18,872			21,078

[a] Production is in grams for mean sized shrub of each cover type.
[b] Yield is in kg.
[c] See Appendix Table 23 for key to 4-letter plant species abbreviations.

for the area. For antelope bitterbrush, production averaged 2.8 kg/ha and amounted to an estimated 21,078 kg for the winter range. With both species, however, most of the production and yield was from a single cover type. Most of the skunkbush production occurred on the Rhtr/Agsp/Pifl/Jusc type (41.4 kg/ha), while most bitterbrush was produced on the Agsp/Artr/Putr type (529.7 kg/ha). The total estimated browse production for the 3 species combined was about 1,124,907 kg or 150.8 kg/ha.

Land Use

Of the total 7,459 ha of winter range, 841 ha (11.3%) were hayfields, 465 ha (6.2%) were cultivated grainfields, and the remaining 6,153 ha were pasture-range lands grazed seasonally or yearlong by livestock. Approximately 161.6 ha on the eastern margin of the winter range near the mouth of Brackett Creek was subdivided into twenty 8.1 ha parcels for housing development during the summer of 1980. Other subdivisions occurred on lower summer or transitional range in the Skunk, Horse, and Pony Creek drainages (Fig. 2) where substantial development of homesites and construction had taken place.

During summer and fall, 1979 and 1980, approximately 660 and 500 animal units, respectively, grazed the principal winter range. Most of these animals also were on the area during winters, but were concentrated on feeding areas near ranch buildings. Approximately 1,500

cattle and 1,000 sheep grazed the summer range from July to November during 1979 and 1980.

A small logging operation was active during both summers on a small area of privately-owned land on Bangtail Ridge. Extensive logging had occurred previously on the National Forest lands on Bangtail Ridge, especially in the Skunk, Olson, and Miles Creek drainages (Fig. 2).

Public access to the winter range was limited to the Brackett Creek and Calcite Roads (Nyberg 1980). Access to summer-fall range was limited to seasonal roads through the Jackson, Olson, and Skunk Creek drainages (Fig. 2). A hiking trail provided walking access into the Stone Creek drainage from Highway 86 in Bridger Canyon.

Mule Deer Distribution, Movements, and Habitat Use

Winter

Distribution.—The distribution of mule deer on the Brackett Creek winter range during 1979-1980 was generally similar to that described by Nyberg (1980), though the timing and specific patterns of use differed. In 1979-80, significant use of the winter range by "migratory" deer did not begin until the second week of January, following the first significant snowfall of the winter. All migratory, radio-collared deer moved from summer to winter home ranges within 1 week following the storm. In 1978-79, deer gradually moved onto the winter

range over a 3-month period from early November to late January, and all but 1 of 9 radio-collared animals were on the winter range by the end of December (Nyberg 1980).

Concentrations of deer first appeared on the western edge of the winter range, in Sheep Creek and on hayfields north of the Brackett Creek road. As winter progressed, deer drifted eastward and by mid-February were distributed over the entire winter range. The deer remained widely distributed throughout the winter, apparently in response to the relatively mild conditions that prevailed. During most of the 1978-79 winter, deer were restricted to what Nyberg (1980) described as primary winter range, an area of 3,750 ha or approximately one-half of the total winter range.

Migratory deer spent only 3½ to 4 months on the winter range in 1979-80, compared to 4 to 6 months in 1978-79 (Nyberg 1980). Radio-collared deer began to leave the winter range about 1 May 1980, and all were on their summer home ranges by 23 May. Eight of the 11 telemetered deer moved abruptly from winter to summer home ranges; the others moved more gradually over 2 to 3 weeks. Nyberg (1980) reported that in 1978 deer left the winter range over a 25-day period from mid-May through early June; in 1979 one radio-collared doe left in late April, while a buck did not leave until 15 July.

Movements and Home Ranges.—As radio-collared and neckbanded deer arrived on the winter range, they established home ranges on which they

were consistently observed during the remainder of the winter. The mean size of the winter home ranges of the 11 radio-collared does tracked during 1979-80 was 3.06 km^2 (Table 10). I did not observe the use of 2 or more activity centers as reported by Nyberg (1980) for the winter of 1978-79. Because of this, mean winter home range sizes for radio-collared deer were only about 16% as large as reported by Nyberg (1980): 2.26 km^2 vs 13.74 km^2 (Table 10).

Table 10. Winter polygon home range sizes (km^2) of radio-collared mule deer on the Brackett Creek winter range.

Animal ID #	1978-79[a]	1979-80
2038	19.45	4.35
2068	13.83	3.05
2118	9.42	1.17
2128	8.85	2.96
4088	11.97	1.23
4108	27.39	2.25
4128	5.26	0.79
Mean	13.74	2.26
4049		1.58
4059		6.58
4069		7.80
3129		1.87
Overall Mean	13.74	3.06

[a]From Nyberg (1980).

Two of the 7 radio-collared deer trapped in 1978 used the same home range for the entire winter in both 1978-79 and 1979-80. The others, in 1979-80, used only a portion of the total area on which they ranged in 1978-79. In all cases, the area not used in 1979-80

was that associated with the second or third activity centers used in 1978-79 (Nyberg 1980).

Habitat Use.—Percentages of marked deer observed on each vegetation cover type during the 1979-80 winter are shown in Table 11. Monthly trends in use of 4 major cover type categories appear in Figure 3.

Deer use was recorded on 17 of the 24 cover types that occurred. Sagebrush-dominated types, collectively, received more than half the total use overall and by month, except in March and April. Observed use of the skunkbush-limber pine-juniper type and grasslands was about equal at 15% of the total for the entire winter; highest use of both occurred in March. Eleven percent of the total winter use occurred on hayfields, but most of that occurred in April when 32% of the monthly observations were on that type.

Data in Table 12 show the relative preference or selection by mule deer for major cover type categories, by month and for the entire winter. The chi-square analysis tested the assumption that if deer were randomly distributed, and neither selected for or avoided a given type, they would occur in each type category in approximately the proportion of its occurrence. Selection or preference for a type category would occur if its proportionate occurrence was less than its proportionate use as indicated by confidence limits. Availability proportions within confidence intervals for use would indicate usage

Table 11. Percentages of marked mule deer observed on various vegetational cover types on the Brackett Creek winter range during winter 1980.

Cover types	Jan. N=60	Feb. N=114	Mar. N=111	Apr. N=91	Total N=376
Grassland types					
Agsp/Feid[a]	5	4	20	2	8
Posa/Arfr/Kocr	8	8	3	9	7
Feid/Agsp	0	tr[b]	0	0	tr
Agsp/Chvi/Orhy	0	0	tr	0	tr
Total[c]	13	12	23	11	15
Artr shrub types					
Artr/Agsp	22	12	23	23	20
Artr/Feid/Agsp	20	23	4	3	12
Artr/Popr/Phpr	10	13	3	5	8
Artr/Feid/Popr	18	10	0	0	6
Agsp/Artr/Putr	0	3	9	4	5
Artr/Agda/Agsp	0	tr	3	0	1
Total	70	61	41	35	51
Skunkbush/limber pine/juniper type					
Rhtr/Agsp/Pifl/Jusc	12	13	23	13	16
Creek bottom type					
Salix/Alnus	3	6	5	2	5
Psme timber types					
Agsp/Basa/Psme	0	0	3	3	2
Psme/Feid	2	0	0	0	tr
Psme/Syal/Agsp	0	0	2	0	tr
Total	2	0	5	3	2
Agricultural types					
Hayfields	0	7	3	32	11
Grainfields	0	0	0	2	tr
Total	0	7	3	34	11
Grand total	100	99	100	98	100

[a] See Appendix Table 23 for key to 4-letter plant species abbreviations.
[b] tr = trace; a value less than 1 percent.
[c] Discrepancies in total volumes is due to rounding.

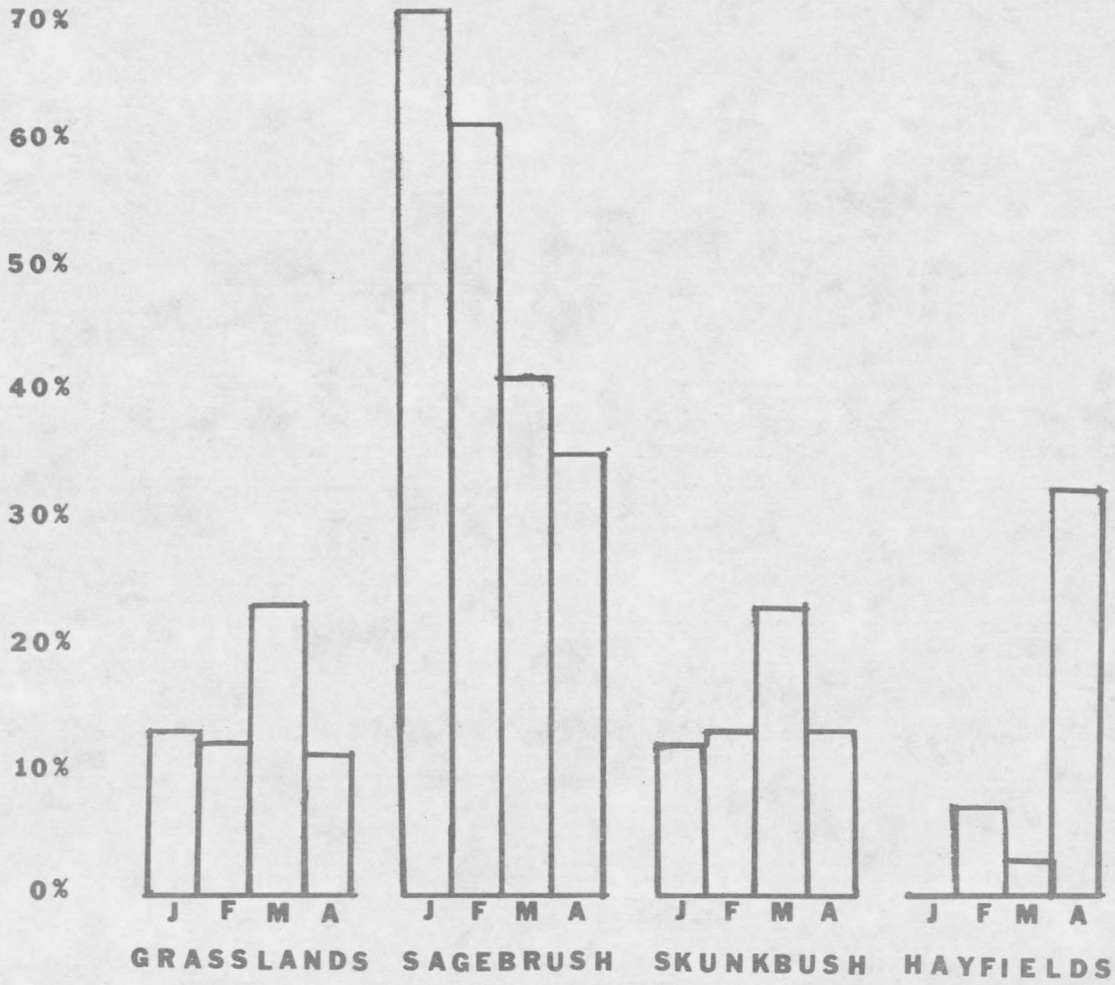

Figure 3. Percent observations of marked mule deer on 4 broad vegetation cover types on the Brackett Creek winter range, January-April 1980.

Table 12. Number and proportion of marked mule deer observed on 7 broad vegetation cover types of the Brackett Creek winter range during winter 1980.

Vegetation type	Area (ha)	Proportion of total area[a] (p_{i_0})	# deer observed	Expected # deer observed[b]	Proportion observed in each type (p_i)	Confidence interval on proportion of occurrence (p_4), $\alpha = 0.10$[c]
Grasslands	3132.8	0.420				
January			8	25	0.133	$0.026 \leq p_i \leq 0.240$
February			14	48	0.123	$0.048 \leq p_i \leq 0.198$
March			26	47	0.234	$0.136 \leq p_i \leq 0.332$
April			10	38	0.110	$0.030 \leq p_i \leq 0.190$
Total winter			58	158	0.154	$0.108 \leq p_i \leq 0.200$
Artr shrublands	1827.4	0.245				
January			42	15	0.700	$0.555 \leq p_i \leq 0.845$
February			70	28	0.614	$0.502 \leq p_i \leq 0.726$
March			46	27	0.414	$0.299 \leq p_i \leq 0.529$
April			33	22	0.363	$0.239 \leq p_i \leq 0.487$
Total winter			191	92	0.508	$0.445 \leq p_i \leq 0.571$
Rhtr/Agsp/Pif1/Jusc	428.9	0.058				
January			7	3	0.117	$0.015 \leq p_i \leq 0.219$
February			15	7	0.132	$0.054 \leq p_i \leq 0.210$
March			25	6	0.225	$0.128 \leq p_i \leq 0.322$
April			12	5	0.132	$0.045 \leq p_i \leq 0.219$
Total winter			59	21	0.157	$0.111 \leq p_i \leq 0.203$
Creek bottom	484.8	0.065				
January			2	4	0.033	$0.000 \leq p_i \leq 0.090$
February			7	7	0.061	$0.006 \leq p_i \leq 0.116$
March			6	7	0.054	$0.001 \leq p_i \leq 0.107$
April			2	6	0.022	$0.000 \leq p_i \leq 0.060$
Total winter			17	24	0.053	$0.025 \leq p_i \leq 0.081$
Psme timber	216.3	0.029				
January			1	2	0.016	$0.000 \leq p_i \leq 0.142$
February			0	3	0.000	
March			5	3	0.045	$0.000 \leq p_i \leq 0.093$
April			3	3	0.033	$0.000 \leq p_i \leq 0.079$
Total winter			9	11	0.024	$0.005 \leq p_i \leq 0.043$

Table 12. (Continued).

Vegetation type	Area (ha)	Proportion of total area[a] (p_{i_o})	# deer observed	Expected # deer observed[b]	Proportion observed in each type (p_i)	Confidence interval on proportion of occurrence (p_4), $\alpha = 0.10$[c]
Hayfields	842.9	0.113				
January			0	7	0.000	
February			8	13	0.070	$0.011 \leq p_i \leq 0.129$
March			3	13	0.027	$0.000 \leq p_i \leq 0.065$
April			29	10	0.319	$0.199 \leq p_i \leq 0.439$
Total winter			40	42	0.106	$0.067 \leq p_i \leq 0.145$
Grainfields	462.5	0.062				
January			0	4	0.000	
February			0	7	0.000	
March			0	7	0.000	
April			2	6	0.022	$0.000 \leq p_i \leq 0.060$
Total winter			2	23	0.005	$0.000 \leq p_i \leq 0.014$

[a] Proportions of total area represent expected deer observation values as if deer occurred in each type in exact proportion to availability.

[b] Calculated by multiplying proportion $p_i \times N$.

[c] p_4 represents theoretical proportion of occurrence and is compared to corresponding p_{i_o} to determine if hypothesis of proportional use is accepted or rejected, i.e., if $p_i = p_{i_o}$, then accept H_o.

proportionate to occurrence (non-selection), while availability proportions greater than the upper confidence limit would represent avoidance. These confidence intervals for the proportions of total animals observed in each type for each winter period followed the formula of Neu et al. (1974).

Deer appeared to avoid grasslands during all months (Table 12). Observed use during 1980 averaged about 12% except for March when about 23% of all observations occurred there (Fig. 3). About 47% of all observations for the 1978-79 winter occurred on grasslands and use of that type was especially heavy in December 1978 (Nyberg 1980).

Big sagebrush types apparently were selected for in all months, except April (Table 12). Observed use of the sagebrush cover types gradually decreased from 70% in January to a low of 36% in April (Fig. 3). Nyberg (1980) reported that sagebrush types received an average of 34% of the monthly observed use for the 1978-79 winter. The monthly range in use was 28-40%.

The skunkbush-limber pine-juniper type was used in proportion to its availability except in March. Greater than expected use in that month could have been due to the occurrence of severe snow storms that caused deer to seek cover provided by juniper. However, skunkbush sites occurred on steep, south-facing slopes where rapid snow melt resulted in greater food availability.

Creek bottom and Douglas fir types were used in proportion to their availability, each averaging about 2 to 5% of the winter use. Usage of these types was also of minor importance in 1978-79 (Nyberg 1980). Agricultural types were divided into hayfields and grainfields since significant differences in use occurred between these 2 types. Marked deer were only seen twice in grainfields; thus, this type was consistently avoided. Hayfields were preferred only during April, when deer selected areas of early green-up. Similar use of agricultural land was described by Nyberg (1980) for the 1978-79 winter.

Food Habits.—Among the 2,421 instances of plant use recorded at 17 feeding sites during winter, 68% were on browse plants, 28% on forbs, and 4% on grasses (Table 13). Plant use at feeding sites during the 1978-79 winter consisted of 48% browse, 19% forbs, and 33% grass (Nyberg 1980). The most important browse species in 1980, in order of importance, were skunkbush sumac, antelope bitterbrush, and big sagebrush (Table 13). Other browse species utilized included Rocky Mountain juniper, chokecherry, and limber pine. Important forbs were Hood's phlox, yellow sweetclover, and silvery lupine. Grass use during winter consisted primarily of dried leaves and stems of western wheatgrass, Idaho fescue and brome grasses (*Bromus* spp.).

Contents of rumens from deer found dead on the winter range during January, March, and April, 1980 (Table 14), indicated relative

Table 13. Instances of use and percent of total use, of plant species, at 17 recently used feeding sites during January-March 1980.

Plant species	Instances of use	Percent of total use
Browse		
Rhus trilobata	739	31
Purshia tridentata	458	19
Artemisia tridentata	176	7
Juniperus scopularum	102	4
Prunus virginianus	67	3
Pinus flexilis	37	2
Chrysothamnus nauseosus	31	2
Pseudotsuga menziesii	21	1
Populus tremuloides	10	tr[a]
Total browse	1641	68
Forbs		
Melilotus officinale	500	22
Phlox hoodii	83	4
Lupinus argenteus	55	3
Aster spp.	11	tr
Opuntia polyacantha	9	tr
Achillea millefolium	7	tr
Antennaria rosea	7	tr
Malva parviflora	2	tr
Total forbs	674	28
Unidentified grasses	60	2
Agropyron spicatum	46	2
Bromus spp.	5	tr
Total grasses	106	4

[a] tr = trace, an amount less than 1%.

Table 14. Percent frequency of occurrence and percent by volume of the plant species in rumens from 10 mule deer found dead on the Brackett Creek winter range during January, March, and April 1980.

Forage species	Percent frequency	Percent by volume
Browse		
Artemisia tridentata	90	23.0
Juniperus scopularum	90	17.0
Rhus trilobata	50	6.8
Pseudotsuga menziesii	40	6.2
Populus tremuloides	50	4.7
Purshia tridentata	10	2.1
Pinus flexilis	20	tr[a]
Salix spp.	10	tr
Ribes spp.	10	tr
Total browse	100	59.8
Forbs		
Melilotus officinale	60	16.3
Medicago sativa	10	3.2
Circium sp.	10	2.9
Antennaria rosea	20	2.8
Alyssum alyssoides	10	tr
Erigeron sp.	10	tr
Phlox hoodii	30	tr
Total forbs	100	25.2
Grasses		
Barley	30	11.4
Other grasses	20	tr
Total grasses	40	11.4
Selaginella densa	10	tr
Unidentified forage	40	1.7

[a] tr = trace, an amount less than 1%.

use of browse, forbs, and grasses similar to that recorded at feeding sites; but species composition and importance were different. Browsed material comprised an average 59.8% of the rumen contents by volume. Much of this (23% of the total volume) consisted of big sagebrush. Rocky Mountain juniper ranked second, followed by skunkbush sumac and Douglas fir. Forbs made up 25.2% of the rumen contents, with yellow sweetclover the single most important item (16.3% of the total volume). Grasses comprised an average 11.4% of the total contents, largely because 1 of the rumen samples contained a high percentage of barley straw.

Rumens examined during the 1978-79 winter (Nyberg 1980), consisted 56% of browsed material, 35% of grass, and 9% of forbs. Big sagebrush and Rocky Mountain juniper were the single most important browse species, comprising 27% and 14% of the total rumen contents, respectively. High use of barley straw by certain individual deer was also noted.

Summer

Distribution.—Marked deer were distributed throughout the 34,750 ha Brackett Creek herd range during the summer. This included about 2,931 ha more than described by Nyberg (1980) due to observations of marked deer in the Fox, Nixon, and Horse Creek drainages of Battle Ridge during the summers of 1979 and 1980.

Significant summer use of the winter range occurred during both 1979 and 1980. One radio-collared doe remained as a yearlong resident of the winter range in 1979 and 1980 and 2 neckbanded deer were observed during 1979. These observations and data from sightings of unmarked deer suggested that about 5% of the winter population (100 animals) were yearlong residents.

A second segment of the population migrated to summer home ranges adjacent to or partially within the upper elevational boundary of the winter range. Those deer included 4 radio-collared and 3 neckbanded does, representing an estimated 25% (500 deer) of the Brackett Creek population.

Eleven of the radio-collared deer moved to summer home ranges at generally higher elevations and within the forested zone of Bangtail and Battle Ridges. I estimated that this segment included approximately 1,500 deer or 70% of all deer using the Brackett Creek winter range.

Movements and Home Ranges.—All but 1 of the radio-collared deer used a summer home range which was separate and distinct from the winter home range. The average distance between winter and summer ranges in 1980 was 9.8 km. This compared to an average distance of 9.4 km calculated by Nyberg (1980) for the previous year. Most migratory, radio-collared deer moved directly and rapidly between winter and summer ranges; specific migration routes could not be determined. When direct movement did not occur, as with use of a transitional

area along the upper margins of the winter range, subsequent movement between transitional and summer range was direct and rapid.

All 10 of the radio-collared animals that were relocated during 2 or more summers used the same general home range area each year. However, there were some differences in the size of individual home ranges between years (Table 15). During 1979, home ranges were either similar in size or larger than those recorded for 1978. In 1980, summer home ranges were generally smaller than those of 1978 and 1979. The mean polygon home range size for 7 radio-collared deer trapped in 1978 and relocated each summer through 1980 increased slightly from 1978 to 1979, then decreased sharply in 1980. Deer trapped in 1979 also showed a decreased home range size in 1980 compared to 1979.

Radio-collared males had considerably larger summer home ranges than most adult females. A yearling male trapped in 1979, had a home range of 29.5 km^2, while a 3-year-old male trapped in 1980 used an area of 10.5 km^2 that included some area outside the Brackett Creek herd range on the north side of Battle Ridge. Both of these males were shot in the fall of the year in which they were trapped.

One radio-collared doe (# 4088) used 2 distinct summer home ranges. In 1978, this doe made several trips back and forth between those 2 units (Nyberg 1980). During 1979 and 1980 she made only 1 trip each summer to the area outside the Brackett Creek herd range, for approximately 6 weeks from early September to mid-October.

Table 15. Summer polygon home range sizes (km^2) of radio-collared mule deer on the Brackett Creek study area.

Animal ID #	1978[a]	1979	1980
2038	1.33	2.6	2.35
2068	0.52	2.02	0.17
2108	2.88	-[b]	-
2118	5.06	9.33	2.23
2128	0.47	1.62	-
4088	1.20	3.63	0.72
4098	12.33	4.10	1.73
4108	1.39	1.29	1.43
4128	1.33	1.26	0.83
3119[c]		29.49	
3129		2.78	
4049		4.19	
4059		4.31	0.31
4069		7.27	4.02
4010			14.10
4020[c]			10.46
4030			6.51
Mean by years for adult females	2.95	3.70	3.13
Mean for adult females trapped in 1978 and followed through 1980	3.30	3.50	1.35

[a] From Nyberg 1980.
[b] - = radio failed.
[c] Adult male.

Records of apparent dispersal of radio-collared and neckbanded deer from the Brackett Creek area included an adult doe that was captured and radio-collared on the Brackett Creek winter range in 1978. This 4½-year-old doe moved approximately 25 km northwest of the Brackett Creek winter range to a summer range on Elkhorn Ridge and subsequently wintered on the Battle Ridge winter range about 13 km north of the Brackett Creek winter range. A yearling male, marked

as a fawn in 1978, was sighted approximately 20 km south of the study area in both December 1978 and March 1979 (Nyberg 1980). A 3½-year-old, radio-collared male trapped in late winter 1979 apparently also dispersed during the summer and was subsequently found dead 8 km north of his wintering area in the Antelope Creek drainage along Battle Ridge.

Other evidence of dispersal included the recovery of a 2-year-old neckbanded doe killed by a motor vehicle on 6 July 1979 approximately 40 km southeast of the Brackett winter range; a neckbanded yearling male that was shot 23 October 1979, 8 km northeast of Clyde Park; and a 6½-year-old neckbanded doe observed in the 1979-80 winter on the Battle Ridge winter range about 10 km north of the Brackett Creek winter range.

Summer-Fall Habitat Use.—Habitat selection during summer and fall (Table 16) was based on availability of cover types across the total herd range in relation to their use by radio-collared does (Neu et al. 1974). Use was determined by aerial relocations and grouped into summer (June-August) and fall (September-December) periods.

Overall, Douglas fir, big sagebrush, and swale types received the greatest use, accounting for 47%, 21%, and 14% of all observations, respectively. Douglas fir types were consistently selected during the summer-fall period, while swale types were preferred in early summer

Table 16. Number and proportion of radio-collared mule deer does located on 7 broad vegetation cover types of the Brackett Creek study area during summers 1979 and 1980.

Vegetation type	Area (ha)	Proportion of total area[a] (p_{i_0})	# deer observed	Expected # deer observed[b]	Proportion in each type (p_i)	Confidence interval on proportion of occurrence (p_i)[c] $\alpha = 0.10^4$
Grasslands	9,957	0.2865				
June-August N=143			13	41	0.091	$0.031 \leq p_i \leq 0.151$
Sept.-Dec. N=173			13	50	0.075	$0.025 \leq p_i \leq 0.125$
Total summer N=316			26	91	0.082	$0.043 \leq p_i \leq 0.121$
Artr shrublands	5,912	0.170				
June-August N=143			22	24	0.154	$0.079 \leq p_i \leq 0.229$
Sept.-Dec. N=173			43	29	0.249	$0.167 \leq p_i \leq 0.331$
Total summer N=316			65	54	0.206	$0.149 \leq p_i \leq 0.263$
Rhtr/Agsp/Pifl/Jusc	777	0.0224				
June-August N=143			0	3	0.000	
Sept.-Dec. N=173			2	4	0.012	$0.000 \leq p_i \leq 0.033$
Total summer N=316			2	7	0.006	$0.000 \leq p_i \leq 0.017$
Creek bottom types	1,215	0.035				
June-August N=143			4	5	0.028	$0.000 \leq p_i \leq 0.062$
Sept.-Dec. N=173			5	6	0.029	$0.000 \leq p_i \leq 0.061$
Total summer N=316			9	11	0.028	$0.005 \leq p_i \leq 0.051$
Psme timber	10,049	0.2892				
June-August N=143			62	41	0.434	$0.330 \leq p_i \leq 0.538$
Sept.-Dec. N=173			86	50	0.497	$0.402 \leq p_i \leq 0.592$
Total summer N=316			148	91	0.468	$0.398 \leq p_i \leq 0.538$
Pico timber	1,630	0.0469				
June-August N=143			6	7	0.042	$0.000 \leq p_i \leq 0.084$
Sept.-Dec. N=173			7	8	0.040	$0.003 \leq p_i \leq 0.077$
Total summer N=316			13	15	0.041	$0.013 \leq p_i \leq 0.069$
Swale type	2,157	0.0621				
June-August N=143			31	9	0.217	$0.131 \leq p_i \leq 0.303$
Sept.-Dec. N=173			12	11	0.069	$0.021 \leq p_i \leq 0.117$
Total summer N=316			43	20	0.136	$0.088 \leq p_i \leq 0.184$

Table 16. (Continued).

Vegetation type	Area (ha)	Proportion of total area[a] (p_{i_o})	# deer observed	Expected # deer observed[b]	Proportion in each type (p_i)	Confidence interval on proportion of occurrence (p_4)[c] $\alpha = 0.10$
Agricultural type	2,346	0.0675				
June-August N=143			5	10	0.035	$0.000 \leq p_i \leq 0.073$
Sept.-Dec. N=173			6	12	0.035	$0.000 \leq p_i \leq 0.070$
Total summer N=316			11	21	0.035	$0.009 \leq p_i \leq 0.061$

[a] Proportions of total area represent expected deer observation values as if deer occurred in each type in exact proportion to availability.

[b] Calculated by multiplying proportion p_i x N.

[c] p_4 represents theoretical proportion of occurrence and is compared to corresponding p_{i_o} to determine if hypothesis of proportional use is accepted or rejected, i.e., if $p_i = p_{i_o}$, then accept H_o.

and for summer-fall overall. During fall, swales were used approximately in proportion to availability just as big sagebrush types were used throughout the summer and fall.

Five other types collectively accounted for 19% of the summer-fall observations; use of each of those types was equal to or less than availability. In order of greatest use, they included grasslands, lodgepole pine timber, agricultural, creek bottom, and skunkbush-limber pine-juniper.

These patterns of use differed somewhat from those calculated for 1978 by Nyberg (1980), who reported that sagebrush, agricultural, and Douglas fir types received the greatest use in summer (27%, 23%, and 18%, respectively), while in the fall agricultural, sagebrush, and grassland types received the greatest use (33%, 31%, and 14%, respectively).

Mule Deer Population Characteristics

Population Size and Composition

A population of 2,105 (Table 17) was estimated from the January helicopter survey in which 579 total deer and 22 of 80 marked deer were observed. This was a 28% increase over the late winter 1979 population estimate of 1,642, but about 10% fewer than the 2,352 estimated for the area in early winter 1979 (Nyberg 1980).

Adult females and fawns comprised 53% and 43% of the population, respectively, while adult males comprised only 4% of the total (Table

Table 17. Lincoln index estimates of the Brackett Creek mule deer population during 1978-79 and 1979-80 winters from aerial survey flights.

Dates	Total # deer observed	Total # marked deer in population	# marked deer observed	Population estimate
Early winter helicopter survey (Dec. 1978)[a]	1,120	21	10	2,352
Late winter helicopter survey (Mar. 1979)[a]	1,057	101	65	1,642
Early winter helicopter survey (Jan. 1980)	517	80	22	2,105
Late winter helicopter survey (Mar. 1980)	1,017	83	42	2,010
Late winter fixed wing survey (Apr. 1980)	758	83	32	1,966

[a]From Nyberg 1980.

18). A low proportion of adult males among the Brackett Creek population has been observed consistently in classifications since 1974-75 (Mackie et al. 1978). On the basis of the above proportions, the projected total population of 2,105 would have included 1,112 adult females, 84 adult males, and 909 fawns.

During the helicopter survey in March 1980, 1,017 deer were counted, including 42 of 83 marked deer known to occur on the area (Table 18). The estimated total population was 2,010, made up of 61% adults (1,226) and 39% fawns (784). A fixed-wing survey conducted 2 weeks later in early April, provided a slightly lower total population estimate of 1,966 deer.

Efficiencies of the surveys, based on percentage of marked deer known to be present and observed, were 28% and 60% using the helicopter for early and late winter, respectively, and 39% for the fixed-wing survey in late winter. In 1978-79, helicopter surveys recorded about 47% and 64% of all marked animals present in early and late winter, respectively. Fixed-wing aircraft surveys in late winter tallied 31-35%. The low efficiency of early winter counts in 1980 was largely due to the slow movement of deer onto the winter range that year.

Fawn Production and Survival

The 9 radio-collared does observed during summer and fall 1979 produced 14 fawns or 1.56/doe (Table 19). In 1980, 8 of those does remained alive and produced 13 fawns (1.63/doe). For all 11 radio-

Table 18. Sex and age classifications of the Brackett Creek mule deer population from early and late winter helicopter survey flights.

Dates of Survey	Total	Adults	Fawns	Ad. ♀	Ad. ♂	Unc.[b]	Fawns/ 100 ♀	Fawns/ 100 Ad.	♂/ 100 ♀
Dec. 1978[a]	1,120	659	447	581	78	14	76.9	67.8	13.4
Mar. 1979[a]	1,057	806	251					31.1	
Jan. 1980	579	329	250	306	23		81.7	76.0	7.5
Mar. 1980	1,017	618	399					64.6	

[a]From Nyberg 1980.
[b]Unc. = unclassified as to sex or age.

Table 19. Reproductive performance of radio-collared does associated with the Brackett Creek winter range.

Animal ID	Date of trapping	Age at trapping	# fawns 1978[a]	# fawns 1979	# fawns 1980
2038	3/15/78	2½	2	2	2
2068	3/29/78	5½	1	2	2
2108	3/21/78	6½	2	2	2
2118	3/21/78	Ad.	1	2	2
2128	4/9/78	4½	1	-[b]	-
4088	3/15/78	4½	-	2	2
4098	3/27/78	3½	1	1	2
4108	3/27/78	6½	-	2	1
4118	4/5/78	6+	2	[c]	
4128	4/9/78	6½	2	-	-[d]
3129	3/8/79	3½		1	
4069	3/8/79	4½		0	0
4049	3/7/79	6½		-	[e]
4059	3/8/79	3½		-	2
4010	3/20/80	Ad.			1
4030	3/19/80	Ad.			2

[a] From Nyberg (1980).
[b] - = not seen during summer or fall.
[c] Died November 1978.
[d] Died April 1980, contained 2 fetuses.
[e] Died June 1980.

collared does observed during the summer and fall of 1980, 18 fawns were produced for an average of 1.64/doe. One dead radio-collared doe, found in April 1980, contained 2 well developed fetuses. Nyberg (1980) found an average of 1.50 fawns/radio-collared doe observed in 1978. In addition to radio-collared animals, fawn production was determined for 3 neckbanded adult does for each summer 1979 and 1980; those produced 4 and 6 fawns, respectively, for the 2 years.

Age ratios from early winter helicopter surveys in 1979-80 (Table 18) were comparatively higher than recorded on the area in previous years (Mackie et al. 1980). Overwinter survival was also quite high in 1980 as indicated by the observed ratio of 65 fawns per 100 adults for the March survey.

Age ratios obtained from ground classifications (Table 20) showed similarly high survival. The January ratio of 78 fawns per 100 adults was not significantly different from February's 83 fawns per 100 adults, ($X^2 = 0.68$, $p = 0.41$). The ratio from the late winter helicopter survey was similar to that from March ground classifications ($X^2 = 1.04$, $p = 0.31$), which was also very similar to the ratio derived from ground classifications in April ($X^2 = 0.04$, $p = 0.95$).

Because of the similarity in ground classifications for January-February and March-April, data were combined for each 2 month period. The resulting ratios, 82.6 fawns per 100 adults for January-February and 70.6 fawns per 100 adults for March-April (Table 20) differed significantly ($X^2 = 3.99$, $p = 0.046$). That difference corresponded to overwinter mortality of about 12 fawns per 100 adults in the population. Using the early winter adult population estimate of 1,196, a loss of approximately 144 fawns was indicated. That number was approximately the same as the 139 difference in total population estimates between January and April (Table 17).

Table 20. Age classification of mule deer on the Brackett Creek winter range from ground observations in 1980.

	Total # observations	Adults	Fawns	Fawns/100 adults
Jan.	531	298	233	78
Feb.	751	404	347	85.9
Jan. + Feb.	1,282	702	580	82.6
Mar.	1,067	625	442	70.7
Apr.	279	164	115	70.1
Mar. + Apr.	1,346	789	557	70.6

Mortality

Winter 1980.—During the dead deer survey in May, 9 fawn carcasses were found on twelve 16-ha plots, randomly located on 7.8 km^2 of moderate-to-heavily used winter range. Two of those 9 were females; both apparently died from malnutrition. Two were males, 1 of which was caught on a barbed wire fence and the other was a possible hunting loss. The remaining 5, unclassified as to sex, included 4 malnutrition losses and 1 possible coyote kill.

Expansion of sampling data to the total winter range indicated as many as 346 deer could have died during the 1979-80 winter. However, when sampling data were applied only to moderate and heavy use areas, approximately 41% of the total winter range, a total mortality estimate of 142 was obtained. That estimate seemed more realistic and compared favorably to the previous estimates of winter mortality.

All but 2 of 13 carcasses found during routine winter ground

observations (Table 21) were fawns. The 2 adults were radio-collared does, 1 of which probably was killed by coyotes and the other possibly by dogs. Five of the 11 fawns appeared to have been killed by coyotes, 1 may have been killed by domestic dogs, 3 apparently died of starvation, and 2 were road kills.

Harvest.—At least 33 deer were harvested within the Brackett Creek herd range during the fall of 1979 (Table 22). Of these 52% were adult males, 30% were adult females, and 18% were fawns. In 1980 at least 66 deer were killed in the fall hunting season. Adult males comprised 61% of those deer, adult females made up 36%, and fawns 3%. In both years, most of the adult males killed were yearlings and 2½-year-olds. The unspecified adults in Table 22 were shot by either-sex permit holders and reported on questionnaires or were reported by landowners. The age structure of the female segment in the small samples varied widely and inconsistently.

The known harvest for the 2 years represented only 1-3% of the total estimated fall populations. This low harvest probably was due to limited public access into the area.

Table 21. Sex, age, and cause of death for 13 mule deer found dead during routine ground observations on the Brackett Creek winter range in 1980.

Sex	Age	Date of death	Cause of death
Unc.[a]	fawn	1/10/80	possible coyote kill
Unc.	fawn	1/20/80	possible coyote kill
Unc.	fawn	1/27/80	possible coyote kill
Unc.	fawn	2/15/80	possible coyote kill
F	fawn	3/3/80	road kill
F	fawn	3/5/80	possible dog kill
M	fawn	3/10/80	malnutrition
M	fawn	3/18/80	possible coyote kill
F	fawn	4/5/80	malnutrition
Unc.	fawn	4/12/80	malnutrition
F	4½ yrs.	4/12/80	possible dog kill
F	fawn	4/24/80	road kill
F	6½ yrs.	5/8/80	probable coyote kill

[a]Unc. = unclassified.

Table 22. Sex and age classification of mule deer killed on the Brackett Creek study area during fall hunting seasons.

	1979				1980			
Age	Male	Female	Unc.[a]	Total	Male	Female	Unc.	Total
½	1	1	4	6	0	0	2	2
1½	7	1		8	20	1		21
2½	4	0		4	1	1		2
3½	0	4		4	1	5		6
4½	0	1		1	0	1		1
5½	0	0		0	0	1		1
6½	0	2		2	0	0		0
7½	0	0		0	0	0		0
8½	0	0		0	1	1		2
10+	0	0		0	0	1		1
Unk.Ad.[b]	6	2		8	17	13		30
Total	18	11	4	33	40	24	2	66

[a]Unc. = unclassified as to sex.
[b]Unk.Ad. = unknown age adult.

DISCUSSION AND CONCLUSIONS

Data from the vegetational analyses show that the Brackett Creek winter range is an extremely open, prairie-type habitat. Grassland, sagebrush, and agricultural cover types predominated (84% of the winter range). Closed-canopy timber cover was lacking, and trees and tall shrubs occurred only in scattered open stands on about 15.5% of the area. This contrasts significantly with the Armstrong and Schafer Creek winter ranges on the west slope of the Bridger Mountains where closed and semi-closed forest comprised about 48% of the vegetation (Bucsis 1974, Steerey 1979).

Vegetational diversity was quite high, at least in terms of the number of different cover types that occurred, the number and size of stands of each type, and the interspersion of stands. The 24 specific cover types occurred as stands ranging in size from 1 to 40 ha and averaging about 14 ha. This diversity appeared to be due in part to farming and grazing practices and in part to the large size of the area (7,459 ha). Fourteen habitat types occurred on the Armstrong winter range (Bucsis 1974) in stands ranging from 1 to 100 ha and averaging about 13 ha in size. That area comprised only about 510 ha, none of which was farmed (Bucsis 1974). Plant species diversity appeared to be much lower on Brackett Creek, where 46 different forbs and 15 trees and shrubs were recorded on the 12 cover types measured. Bucsis (1974) recorded 70 forbs and 15 shrubs on 14 cover types on the

Armstrong range. Many of the cover types on Brackett Creek were very similar in species composition.

Measurements of shrub abundance and production estimates were indicative of the availability of browse on approximately 88% of the winter range. Big sagebrush was by far the single most important browse plant in distribution, abundance, and current annual growth production on the area. The total estimated annual production of 1,085,000 kg of big sagebrush represented an available supply of approximately 517 kg for each of the estimated 2,100 mule deer present in early winter 1979-80. Assuming total availability and a 120 day period of use, big sagebrush could potentially provide 4.3 kg/deer/day. Other browse species were either much less abundant or only locally abundant on the winter range. These included antelope bitterbrush and skunkbush sumac that could provide about 0.08 and 0.07 kg/deer/day, respectively. Each of these species, however, was abundant only on 1 site on the winter range. I did not measure utilization, but general observations indicated that utilization was not excessive on any species or in any part of the area.

Data reported by Bucsis (1974) indicated that big sagebrush was somewhat less available (1.5 kg/deer/day) while antelope bitterbrush was somewhat more available (0.2 kg/deer/day) on the Armstrong winter range. In addition, Rocky Mountain juniper, which I did not measure on the Brackett Creek winter range, provided about 1.6 kg/deer/day.

Approximately 34-40% of available big sagebrush and 53-66% of available bitterbrush were utilized at the time production was measured (Bucsis 1974).

The mule deer population associated with the Brackett Creek winter range was comprised of 3 segments. One, consisting of about 5% of the population, was non-migratory and remained yearlong on the winter range. The other 2 segments were migratory. The smaller of these, comprising about 20% of the population, consisted of deer whose summer home ranges were located adjacent to and, in some cases, partially within the winter range boundaries. The other, which made up approximately 75% of the total winter population, migrated to summer ranges 8-13 km from their winter ranges. Harestad (1979) also observed 1 resident and 2 migratory segments among black-tailed deer (*Odocoileus hemionus columbianus* Richardson) on a winter range in British Columbia. There, 1 migratory group moved altitudinally to higher forested range, and the other moved horizontally to tributary valleys adjacent to the main winter range.

Basic differences in the nature of the habitats occupied by the 3 population segments apparently influenced important differences in habitat use, including selection and use of cover types, home range size, and timing and pattern of interseasonal movements. The 2 segments that ranged on or adjacent to the winter range occurred primarily on and predominantly used big sagebrush, creek bottom and

agricultural types. Deer migrating longer distances and to higher elevations primarily used Douglas fir and lodgepole pine stands, swales, and grassland parks on Bangtail and Battle Ridges. Nyberg's (1980) observations emphasized animals and range areas occupied by those segments most closely associated with the winter range and utilizing the more open sagebrush cover types. Therefore his summer-fall habitat use data are not comparable to my summer-fall habitat use data for migratory deer.

Mule deer in segments using the open shrub and grasslands tended to have larger home ranges (7.06 km^2) than those that used predominantly forested habitats (2.1 km^2). This might suggest that basic food, cover, and spacial requirements were met on smaller areas in the timbered types, due perhaps to greater diversity and complexity of those environments. Generally, the summer home ranges of the Brackett Creek deer were intermediate in size between the smaller home ranges of deer using the extensively timbered west slope of the Bridger Mountains (Pac 1976, Steerey 1979) and the larger home ranges of deer using the more open habitat of the Missouri River Breaks, Montana (Hamlin 1978).

Although data were not conclusive, it appeared that the time and pattern of interseasonal movements of deer migrating long distances differed from that of animals migrating shorter distances. Significant snowfalls at any time during late fall stimulated long distance

migrants, especially those which crossed Bangtail Ridge into Bridger Canyon tributaries, to move rapidly and directly to the winter range. On the other hand, radio-collared deer that summered in drainages adjacent to the winter range moved much more slowly and only as they were forced to by accumulations of snow. Both Steerey (1979) and Nyberg (1980) previously reported that mule deer which crossed major "divides" in migration moved to winter range with the first major snowstorm of winter, before deer which did not have to cross divides. Like Nyberg (1980), I found little evidence of the use of "holding areas" as described by Pac (1976) and Steerey (1979) for mule deer using winter ranges on the west slope of the Bridger Mountains.

The preponderance of big sagebrush on the Brackett Creek winter range was reflected in winter habitat selection and use by mule deer. Big sagebrush dominated cover types received the vast majority of observed use during my study as well as in 1978-79 (Nyberg 1980). Similarly, big sagebrush was most important in the diets of mule deer during both the 1978-79 and 1979-80 winters. In the severe 1978-79 winter, big sagebrush comprised an average of 30% by volume of the contents of rumens of deer found dead and 13% of recorded use at feeding sites (Nyberg 1980). He found some rumens contained more than 60% big sagebrush. Big sagebrush made up a smaller proportion of the winter diet of deer (23% by volume of rumen contents, and 7% of use at feeding sites) during the mild winter of 1979-80, but remained a

relatively important component of the diet.

Wallmo et al. (1977) and Nagy et al. (1964) have suggested that the high concentrations of aromatic oils in big sagebrush may inhibit digestion, especially when the plant comprises more than about 30% of the diet. Welch and McArthur (1979) disagreed, however, and speculated that the 3 subspecies of big sagebrush he analyzed could comprise 50-100% of the deer diet without causing digestive difficulties.

Densities of mule deer on the Brackett Creek winter range during 1979-80 were 28 and 27 deer/km^2 for early and late winter, respectively. For the same periods during 1978-79, Nyberg (1980) estimated densities of 23 and 16 deer/km^2. Nyberg's estimates were based on a much larger (10,200 ha) winter range that included portions of the area in Miles Creek, Canyon Creek, and Bangtail Creek used only in early winter and spring. The 1978-79 population estimates applied to the 7,459 ha winter range that I described yield densities of about 31 deer/km^2 for early winter and 21/km^2 in late winter. Nyberg (1980) estimated a maximum density of about 62 deer/km^2 for the primary winter range on which deer concentrated during mid-winter of 1979. Densities on west slope winter ranges during the same 2 years generally ranged from 30-45 deer/km^2 (Mackie et al. 1980) with much higher densities (150-165/km^2) occurring on primary ranges during periods of concentration. Apparently, differences in deer densities between ranges and between years on the same winter range were influenced by the size of

winter range, the extent to which that range was available and used under prevailing weather and snow conditions, and the numbers of deer in associated populations.

Summer deer densities on the 34,750 ha (350 km^2) Brackett Creek herd range varied from 6 to 10 adults/km^2 during 1979 and 1980. Those deer, however, were not uniformly distributed across that range. Summer densities within the winter range were only about 1-2 adult deer/km^2, while approximately 5 deer/km^2 inhabited open sagebrush-grassland-scattered timber range along and adjacent to the upper boundary of the winter range. Densities as high as 20-25 adult deer/km^2 probably occurred in some of the forested drainages of Bangtail and Battle Ridges. Nyberg (1980) estimated an overall mean summer density of about 12 deer/km^2 for 1978, but his estimate was based on a slightly smaller herd range (31,500 ha).

An estimated 2,000-2,300 mule deer used the Brackett Creek winter range in early winter, 1978-79 and 1979-80. Nearly 2,000, of which about 39% were fawns, remained in late spring 1980. Fawn production estimates for the summer of 1980 were high (1.64 fawns/radio-collared doe). Recent population estimates for the winter of 1980-81 (Unpubl. data, Montana Dept. of Fish, Wildlife, and Parks) indicated a population of approximately 2,100-2,300; and fawn production and survival to late winter was high with a ratio of 97 fawns:100 adults. These data may indicate that mule deer numbers on Brackett Creek have

stabilized at 2,000-2,300. This has occurred without apparent browse forage deterioration on the winter range or excessive hunting mortality, and despite high fawn production and survival.

APPENDIX

Table 23. Key to 4-letter plant species abbreviations.

Acmi	*Achillea millefolium*
Agcr	*Agropyron cristatum*
Agda	*Agropyron dasystachyum*
Agsp	*Agropyron spicatum*
Alnus	*Alnus* spp.
Amal	*Amelanchier alnifolia*
Anro	*Antennaria rosea*
Arca	*Artemisia cana*
Arfr	*Artemisia frigida*
Artr	*Artemisia tridentata*
Basa	*Balsamorhiza sagittata*
Chna	*Chrysothamnus nauseosus*
Chvi	*Chrysopsis villosa*
Crdo	*Crataegus douglasii*
Feid	*Festuca idahoensis*
Gevi	*Geranium viscosissimum*
Jusc	*Juniperus scopularum*
Kocr	*Koeleria cristata*
Luar	*Lupinus argenteus*
Mapa	*Malva parviflora*
Meof	*Melilotus officinale*
Oppo	*Opuntia polyacantha*
Orhy	*Oryzopsis hymenoides*
Phho	*Phlox hoodii*
Phpr	*Phleum pratense*
Pifl	*Pinus flexilis*
Popr	*Poa pratensis*
Posa	*Poa sandbergii*
Potr	*Populus tremuloides*
Prvi	*Prunus virginianus*
Psme	*Pseudotsuga menziesii*
Putr	*Purshia tridentata*
Rhtr	*Rhus trilobata*
Rowo	*Rosa woodsii*
Salix	*Salix* spp.
Syal	*Symphoricarpos alba*
Symph	*Symphoricarpos* spp.

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