The seasonal distribution and range use of bighorn sheep in the Beartooth Mountains, with special reference to the West Rosebud and Stillwater herds
by Gregory L Pallister

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

Abstract:
A study was conducted in the Beartooth Mountains in south central Montana from July through December 1973, to obtain quantitative data on daily and seasonal movements, range use habits and the population composition of bighorns in the West Rosebud and Stillwater drainages. Vegetation within the study area was classified into 17 vegetation types. Percent canopy coverages and frequencies of occurrence were determined for low growing taxa on 9 types. Range use was determined by recording the locations of 951 observations of bighorns in summer, fall and winter. Observations of bighorns made in the West Rosebud indicated that 43 percent of the summer use occurred on the Douglas Fir-Snowberry type. Thirty-four percent of the fall and 100 percent of the winter use occurred on the Alpine Tundra type. In the Stillwater, 46 percent of the fall observations occurred on the seeded Roadbed type and 85 percent of the winter observations occurred on the Bunchgrass-Forb type. Bighorn affinity to escape terrain lessened as they moved onto winter ranges with 98, 84, and 44 percent of the observations occurring within 150 yards of escape cover in summer, fall and winter, respectively. South and southeast slopes received the greatest overall use. Numbers per 100 ewes for rams and lambs of the West Rosebud were 25 and 64 during summer, 8 and 50 during fall and 14 and 40 during winter, respectively. In the Stillwater, the respective numbers were 35 and 62 during fall and 24 and 36 during winter. The maximum movement of a marked bighorn from the point of capture was 26.5 miles. The average standard diameter of the summer, fall and winter area was 0.36, 4.96, and 0.94 miles, respectively. Winter standard diameters were smaller than fall for each of three bighorns of the Stillwater herd. Summer, fall and winter food habits were determined from the examination of 17 feeding sites involving 5,934 instances of plant use and from the contents of two rumens. Grasses and grasslike plants, forbs and shrubs, respectively, made up 12, 55, and 32 percent of the diet during summer, 99, 1 and 0 during fall, and 98, 2, and 0 during winter for bighorns in the West Rosebud. In the Stillwater, the respective percentages were 85, 11, and 3 during fall and 35, 28, and 38 during winter. Range use and feeding site data obtained for mountain goats, mule deer and livestock indicated that competition with bighorns was minimal at present population levels. Recommendations were made to establish a separate hunting unit and limited hunting permits for the Stillwater herd and to discourage future livestock use of the Stillwater winter area.

Statement of Permission to Copy

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor, or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature Gregory L. Pallister

Date 14 June 1974

THE SEASONAL DISTRIBUTION AND RANGE USE OF BIGHORN SHEEP IN THE BEARTOOTH MOUNTAINS, WITH SPECIAL REFERENCE TO THE WEST ROSEBUD AND STILLWATER HERDS

by

GREGORY L PALLISTER

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Fish and Wildlife Management

Approved:

James M. Pickett
Head, Major Department

Don C. Quimby
Chairman, Examining Committee

R. Goering
Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

August, 1974

ACKNOWLEDGMENT

To the following, the author wishes to express his sincere appreciation for their contributions to this study: Dr. Don C. Quimby, Montana State University, who directed the study and aided in preparation of the manuscript; Drs. Robert L. Eng and Richard J. Mackie, Montana State University, for reviewing the manuscript; Dr. John H. Rumely, Montana State University, for aid in identifying plant specimens from the study area; Mr. Kenneth Greer, Montana Fish and Game Department, for use of lab facilities; Mr. H. O. Compton, Montana Fish and Game Department, for initial project planning, cooperation in supplying equipment and advice on technical matters; Messrs. Floyd Gordon, Kenneth Coop and Ronald Stoneberg, Montana Fish and Game Department personnel, for field assistance and technical advice; personnel of the Beartooth Division, Custer National Forest, for use of facilities and cooperation; Messers. Ray Hertzler, William Henderson, Ted Martin, James Langston, William Russell, Matt Olsen, and Gene Wade, area landowners, for their hospitality and assistance; Mr. Phil Huck, Manager of the Mystic Lake Power Plant, for use of facilities, hospitality and field assistance; and to Larry Goodroad, Bozeman, Montana, for use of photographs. The author would also like to extend special thanks to his brother, Joshua, who accompanied him on the study during July and August, for his company and field

assistance. He would also like to thank his wife, Darlene, for encouragement, assistance and especially for her patience. The author was supported by the Montana Fish and Game Department under Federal Aid Project W-120-R-5.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF FIGURES

ABSTRACT

A study was conducted in the Beartooth Mountains in south central Montana from July through December 1973, to obtain quantitative data on daily and seasonal movements, range use habits and the population composition of bighorns in the West Rosebud and Stillwater drainages. Vegetation within the study area was classified into 17 vegetation types. Percent canopy coverages and frequencies of occurrence were determined for low growing taxa on 9 types. Range use was determined by recording the locations of 951 observations of bighorns in summer, fall and winter. Observations of bighorns made in the West Rosebud indicated that 43 percent of the summer use occurred on the Douglas Fir-Snowberry type. Thirty-four percent of the fall and 100 percent of the winter use occurred on the Alpine Tundra type. In the Stillwater, 46 percent of the fall observations occurred on the seeded Roadbed type and 85 percent of the winter observations occurred on the Bunchgrass-Forb type. Bighorn affinity to escape terrain lessened as they moved onto winter ranges with 98, 84, and 44 percent of the observations occurring within 150 yards of escape cover in summer, fall and winter, respectively. South and southeast slopes received the greatest overall use. Numbers per 100 ewes for rams and lambs of the West Rosebud were 25 and 64 during summer, 8 and 50 during fall and 14 and 40 during winter, respectively. In the Stillwater, the respective numbers were 35 and 62 during fall and 24 and 36 during winter. The maximum movement of a marked bighorn from the point of capture was 26.5 miles. The average standard diameter of the summer, fall and winter area was 0.36, 4.96, and 0.94 miles, respectively. Winter standard diameters were smaller than fall for each of three bighorns of the Stillwater herd. Summer, fall and winter food habits were determined from the examination of 17 feeding sites involving 5,934 instances of plant use and from the contents of two rumens. Grasses and grass-like plants, forbs and shrubs, respectively, made up 12, 55, and 32 percent of the diet during summer, 99, 1 and 0 during fall, and 98, 2, and 0 during winter for bighorns in the West Rosebud. In the Stillwater, the respective percentages were 85, 11, and 3 during fall and 35, 28, and 38 during winter. Range use and feeding site data obtained for mountain goats, mule deer and livestock indicated that competition with bighorns was minimal at present population levels. Recommendations were made to establish a separate hunting unit and limited hunting permits for the Stillwater herd and to discourage future livestock use of the Stillwater winter area.

INTRODUCTION

The Rocky Mountain bighorn sheep *(Ovis canadensis canadensis* Shaw*)*, indigenous to the Beartooth Mountains in south central Montana, inhabits several well known wintering areas throughout this mountain range. Principal among these are the Main Rock Creek, the West Rosebud Creek and the Main Stillwater River wintering areas. Little is known of areas frequented by bighorns in the Beartooth range in other seasons of the year.

Prior to 1971 work on bighorns in this area had been limited to the determination of sex and age of animals on winter-spring ranges and the examination of a few scattered feeding sites. Stoneberg (1973) observed bighorns during the winters of 1971-1972 and 1972-1973 and reported on production, utilization of grasses, and the incidence of lungworm. Unsuccessful attempts to trap bighorns with the aid of bait on the Stillwater and West Rosebud winter areas for the purposes of marking them for future study were made during the winters of 1971-1972 and 1972-1973. During the spring of 1973, area biologists of the Montana Fish and Game Department using a "cap-chur" gun were successful in capturing, marking and releasing 7 and 8 bighorns on the Stillwater and West Rosebud areas, respectively. Each sheep was tagged in the right ear with a metal tag and fitted with a neck band which was color coded as to area of capture. Ewes received 6-inch wide neck

bands whereas rams and lambs were equipped with 3-inch wide bands. Ewes were additionally marked with ear tags embossed with black numerals in the left ear. Each of two ewes from each area was equipped with a radio transmitter (Stoneberg 1973).

To determine daily and seasonal movements, range use and food habits, and the population composition of bighorns in the Stillwater and West Rosebud drainages, I conducted a full time field study from July through December of 1973.

HISTORY

Prior to 1800 the Beartooth Mountains were inhabited by several Indian nations, principal among them were the "Sheep Eaters" or Shoshone, who maintained year around occupancy of this area (Haines 1958). In 1835, Osborne Russell, while leading trappers through the Cooke City area reported killing two bighorns and seeing several scattered bands (Haines 1955). Bighorns in the Beartooths apparently reached their lowest levels around 1928 at which time a U. S. Forest Service bighorn survey of the "Beartooth Forest" revealed only 75 animals (U.S.D.A. Forest Service 1928). From 1928 to 1970, bighorn numbers for the West Rosebud wintering area have remained stable at an estimated 40 animals. The Stillwater herd apparently reached highest densities during the late 1940's and early 1950's when reports of over 100 sheep were common. Since that time bighorn numbers have declined (Koch 1940; Couey 1953 and 1955; Holman 1974).

In 1941 the U. S. Forest Service granted a 30 day grazing allotment for 1,040 domestic sheep on the Fishtail Plateau and West Rosebud Creek. This allotment was continued until 1945 at which time it was sold and converted to a cattle allotment. From 1945 to the present a 30 day grazing season from September 10 to October 10 for 200 cattle has been in effect (Knox 1974). The Stillwater River winter range had a long history of overuse by domestic livestock, chiefly horses,

until 1967 at which time the U. S. Forest Service built a fence below the road and closed the above road portion to livestock grazing. Throughout the study period a few head of cattle and horses and a donkey were present on the area.

METHODS

Emphasis was placed on locating marked and unmarked bighorn sheep in the field. Except for the limited use of horses and a snowmobile, back country travel was limited to hiking on foot. Back country camps were established from which daily observations were made, mainly in the Stillwater and West Rosebud drainages. When sheep were at lower elevations, observations from a vehicle were possible. Sixteen aerial flights in a Super Cub and one in a helicopter aided in locating bighorns. A radio receiver was used on the ground and in the air in attempting to locate sheep with radio-transmitters. This proved unsuccessful due to malfunctioning transmitters and/or receivers. Observation sites of marked bighorns were plotted on a map to establish basic data for evaluating movements between winter and summer ranges, and seasonal home ranges. Bighorns observed were classified by sex, age, and activity. Rams were assigned to one of four categories based on extent of curl of horns as follows: 0-1/4; 1/4-1/2; 1/2-3/4; or 3/4+. Ewes were classified as adults or yearlings. The area occupied by bighorns at each observation site was described as to vegetation type, approximate slope, exposure, elevation, location to the nearest section, and the distance to escape cover and water. Pertinent weather data were also recorded. Observations of mule deer and mountain goats were treated in a similar manner.

Vegetation of representative areas of types used by bighorns was quantitatively sampled using the method described by Daubenmire (1959). Canopy coverages and frequencies of occurrence of plant species less than 1 meter in height were determined within twenty or forty 2x5 decimeter plots spaced at 5 foot intervals along a 100 or 200 foot line transect at representative sites.

Feeding sites were examined to gather information on plant preferences and forage competition among mule deer, mountain goats, domestic livestock and bighorns. An estimation of one bite of a grass species, the use of a single leaf or stem of a forb species and the use of a leaf, fruit or leader of a browse species was considered to be one instance of use (Knowlton 1960). Availability of and preference for plant species on several feeding sites were determined by examination of twenty or forty 2x5 decimeter plots as described above. Botanical nomenclature of plant species collected in the field follows Booth (1950) and Booth and Wright (1959).

A one quart rumen sample was collected from each of two illegally killed ewes during November 1973. Rumen contents were analyzed as described by Wilkins (1957). Analysis of both feeding site examinations and rumen analyses followed the aggregate percentage method of Martin *et al.* (1946).

Data from the files of the Montana Fish and Game Department dating from 1950 were analyzed to establish past range use and population

characteristics. Present population dynamics were determined from ram::ewe, lamb::ewe, and lamb::adult ratios. Ovaries of the two illegally killed ewes mentioned above were collected and examined for structures relevant to reproductive history.

DESCRIPTION OF AREA

The study area of approximately 300 square miles, of which about one-half is in the Beartooth primitive area, is located 75 miles southwest of the city of Billings. Boundaries were the Boulder River, Sheepherder Peak and Cutoff Mountain on the west, the Red Lodge-Cooke City highway on the east, the Montana-Wyoming border and Yellowstone Park boundary on the south, and the West Fork of the Stillwater River and the border of Custer National Forest on the north (Figure 1). Major stream drainages originating within the study area include the Boulder River, West Fork of Rock Creek, Rock Creek, Clarks Fork of the Yellowstone River, Buffalo Creek, Hellroaring Creek, West Fork of the Stillwater River, Rosebud Creek and the Stillwater River. Two prominent features of the area are the Mystic Lake Power Plant on the West Rosebud Creek and the Mouat Mine on the Stillwater River, both of which occur on bighorn winter and/or spring areas.

The area is extremely diverse in topography and landform. Elevations vary from approximately 5,000 feet in the lower Stillwater to 12,799 feet at Granite Peak. Tundra plateaus, unique to the area, are alpine areas, very gentle in topography which rise from approximately 9,800 feet to near 12,000 feet. These plateaus are slashed by numerous glacially carved canyons which commonly drop in excess of 2,000 feet to glacially fed cirques and lakes. To the north and east the canyons

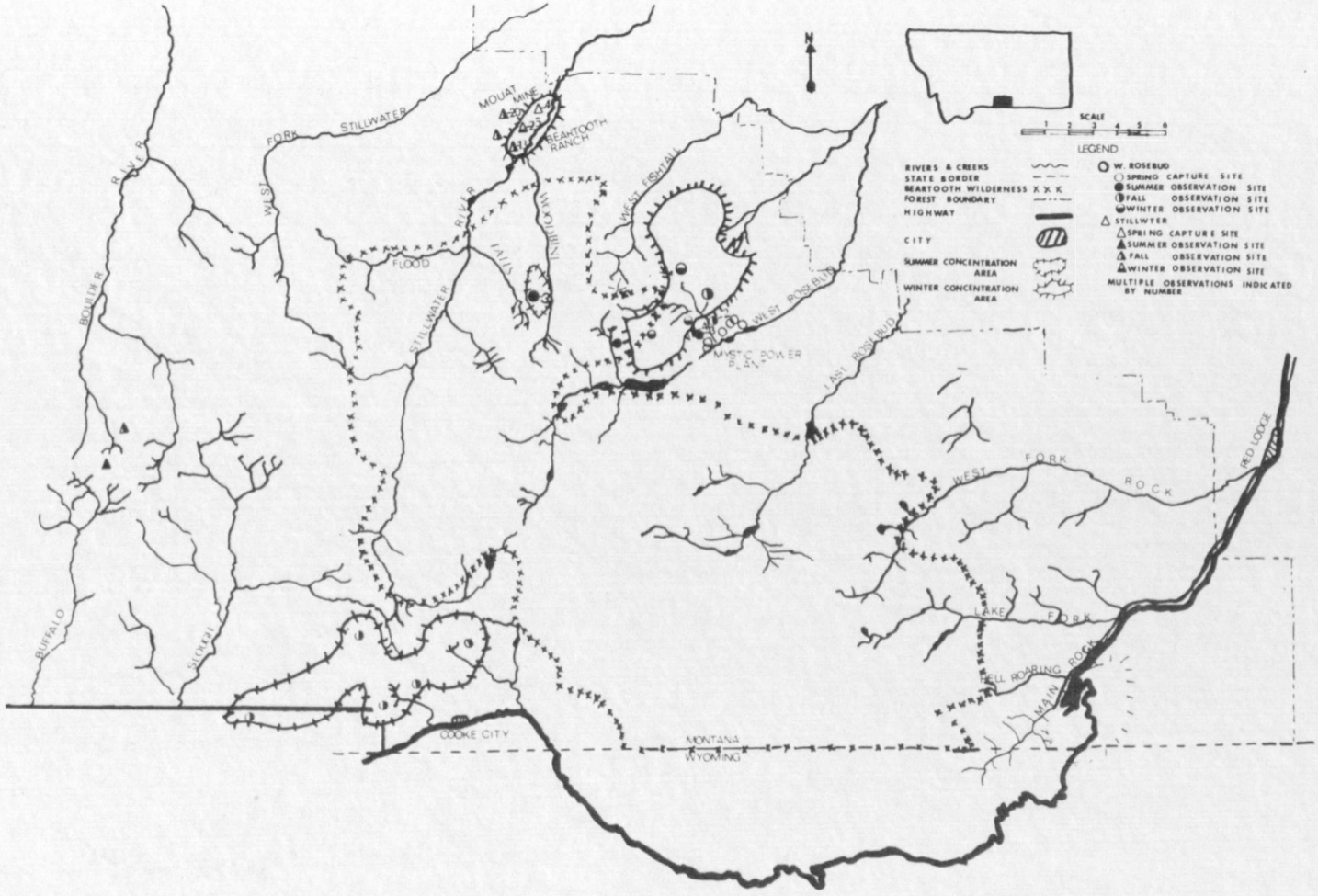

Figure 1. Map of the study area showing the distribution by season of observations of marked bighorn sheep from the Stillwater and West Rosebud drainages.

Figure 2. West Rosebud drainage - characteristic terrain of the Beartooth study area.

and ridges terminate in grass and timber-covered foothills.

The Beartooth block was uplifted as much as 15,000 to 20,000 feet above the adjoining basins along a system of normal faults in late Cretaceous and early Tertiary time (Billings Geological Society 1958). The present rugged terrain (Figure 2) has resulted from fluvial and glacial erosion following regional uplift.

An indication of weather conditions for the area was provided by data recorded at the U. S. Weather Bureau Station at the Mystic Lake Power Plant at an elevation of approximately 6,600 feet. The climatological (U. S. Department of Commerce Weather Bureau 1931-1960) indicate the mean annual temperature and precipitation are 41.9 degrees F and 24.02 inches, respectively. The mean temperature and total precipitation for 1973 was 41.4 degrees F and 20.69 inches, respectively (U. S. Department of Commerce Weather Bureau 1973). Monthly variations during 1973 and normals are recorded in Table 1. January is the coldest month with a mean temperature of 23.9 degrees F while July is the warmest month with a mean temperature of 63.4 degrees F. In 1973, January was the coldest month and August the warmest month with mean temperatures of 23.1 degrees F and 62.0 degrees F, respectively. Extreme temperatures for 1973 were -21 degrees F in January and 88 degrees F in July. Precipitation normals indicate that June receives the greatest amount of precipitation and December the least with means of 3.39 inches and 1.12 inches, respectively. In 1973, April received the greatest amount of precipitation with a mean of 5.38 inches and August received the least amount with a mean of 0.70 inches. Snow accumulations throughout the winter commonly reach 9 feet in the higher elevations.

Topography and climate have interacted to present a subarctic tundra of primarily forbs and sedges on the plateaus, and a semiarid

TABLE 1. CLIMATOLOGICAL DATA GATHERED BY THE U. S. DEPARTMENT OF COMMERCE FROM THE MYSTIC LAKE WEATHER STATION.

	Mean Temperature (Degrees F)												Annual Mean or Total
	J	F	M	A	M	J	J	A	S	O	N	D	
1973	23.1	29.2	29.9	30.0	46.0	56.8	62.4	63.9	51.0	46.7	28.7	29.0	41.4
Normal[1]	23.9	25.1	28.9	38.6	47.5	54.2	63.4	62.0	53.6	45.1	33.0	27.9	41.9
	Mean Precipation (Inches)												
1973	0.83	0.64	2.53	5.38	1.31	2.08	1.24	4.70	2.57	1.14	1.29	.98	20.69
Normal	1.25	1.16	2.34	2.84	3.24	3.39	2.00	1.77	2.01	1.53	1.37	1.12	24.02

[1]Normals computed from 1931-1960 data.

desert of primarily bunchgrasses and sagebrush on the lower foothill regions. The intermediate areas are covered primarily by conifer forests and their associated understory species. Few recent burns are evident.

RESULTS

Vegetation Types

The vegetation within the study area was classified into four major zones; Bunchgrass, Douglas fir, Subalpine and Alpine. Each zone was subdivided into vegetation types. Study units were called vegetation types because they described existing vegetation. They were comparable to the ecosystems of the Beartooth described by South (1971). They were not comparable to the habitat types of Daubenmire (1970) or the U.S.D.A. Forest Service [Pfister *et al.* (1973) and Mueggler *et al.* (1973)] because many of them were subclimax. The species composition of low growing taxa of zones and types for which quantitative measurements were taken are given in Table 2. South's (1971) description of ecosystems was the primary basis for description of types not appearing in Table 2.

Bunchgrass Zone

The Bunchgrass Zone occurred on the foothills and slopes below 6,500 feet on north facing slopes and 7,500 feet on south facing slopes. Recognized were two major types.

Bunchgrass-Forb Type: This type occurred at lower elevations near the Beartooth Ranch. Bluebunch wheatgrass *(Agropyron spicatum)*, fringed sagewort *(Artemisia frigida)*, and skunkbush sumac *(Rhus trilobata)* was the dominant grass, forb and shrub, respectively.

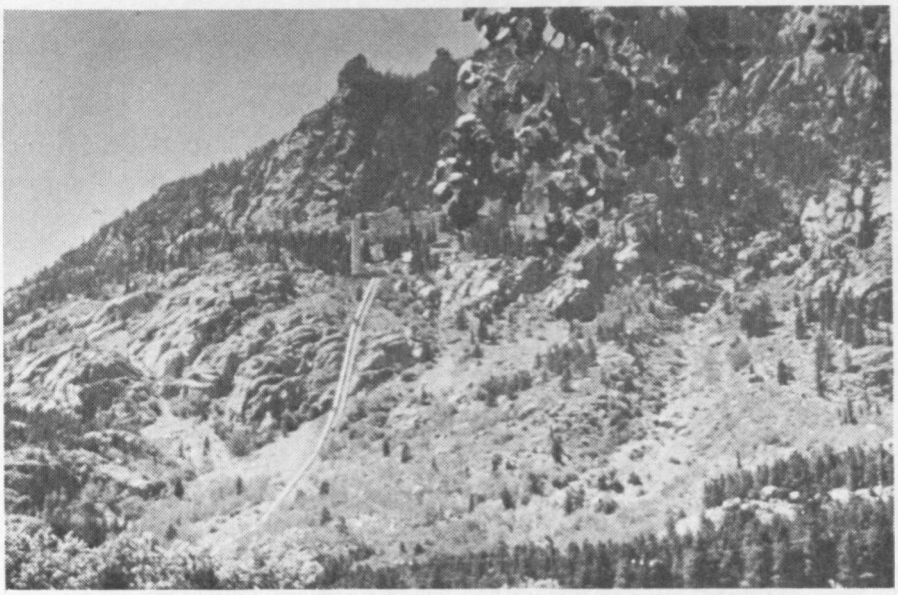

Figure 3. The Douglas Fir-Snowberry Type near the Surge Tower and Rock Outcrop-Forest Type in background within the Douglas Fir Zone.

Other prominent grasses included Idaho fescue *(Festuca idahoensis)* and Junegrass *(Koeleria cristata)*. Sedges *(Carex* spp.*)* were present in moderate amounts. Golden aster *(Chrysopsis villosa)*, chickweed *(Cerastium arvense)* and cudweed sagewort *(Artemisia ludoviciana)* were common forbs. Shrubs of common occurrence included chokecherry *(Prunus virginiana)* and prickly rose *(Rosa acicularis)*.

Bunchgrass-Sage Type: This type occurred on south exposures on the West Rosebud wintering area at elevations up to 7,500 feet. Big sagebrush *(Artemisia tridentata)* and Idaho fescue was the dominant shrub and grass, respectively. Other grasses included needlegrasses *(Stipa* spp.*)* and bluebunch wheatgrass. Characteristic forbs were

TABLE 2. PERCENT CANOPY COVERAGES AND FREQUENCIES OF LOW GROWING TAXA AS DETERMINED BY EXAMINATION OF TWENTY OR FORTY 2X5 DECIMETER PLOTS AT EACH OF 18 SITES.

	Bunchgrass Zone		Douglas Fir Zone			Subalpine Zone		Alpine Zone	
Taxa[1]	Bunchgrass-Forb Type 2 sites	Bunchgrass-Sage Type 2 sites	Douglas Fir-Snowberry Type 1 site	Douglas Fir-Ninebark Type 2 sites	Seeded Roadbed Type 2 sites	Rock Outcrop Type 2 sites	Streamside Forb-Sedge Type 1 site	Rock Outcrop-Snowfield Type 1 site	Alpine Tundra Type 3 sites
GRASS AND GRASS-LIKE PLANTS:									
Agropyron intermedium					8/45[2]				
Agropyron spicatum	14/58	5/42		3/38					
Agropyron trachycaulum			1/9		8/56				
Alopecurus alpinus							2/15		
Bromus anomalus	1/3								
Bromus carinatus			1/11	TR[3]/1					
Calamagrostis montanensis		3/13							
Calamovilfa longifolia		2/13							
Carex albonigra						3/23	7/23		18/56
Carex spp.	5/21	7/43		7/11		TR/3		1/20	
Deschampsia caespitosa									3/14
Deschampsia elongata			1/16						
Festuca idahoensis	6/33	17/82		TR/10					
Festuca ovina				TR/6				1/20	
Juncus tenuis						2/25			
Koeleria cristata	2/15	3/21							
Oryzopsis hymenoides				TR/5	1/16				
Phleum alpinum									
Poa cusickii						5/40	12/33		
Poa juncifolia									
Poa spp.	2/10		TR/6	TR/4				8/35	14/55
Stipa comata		1/5							
Stipa spp.	2/9	6/30							
Trisetum canescens									1/11
Unidentified grasses	7/23			TR/4	TR/1				
FORBS:									
Achillea millefolium				TR/6		TR/3			
Allium spp.				TR/5					
Anaphalis margaritacea			1/8						
Apocynum androsaemifolium			1/14						
Aquilegia flavescens						1/5			
Arenaria congesta				TR/3	1/13				
Arnica latifolia						10/53			
Arnica spp.						1/3			
Artemisia frigida	6/54	2/26							
Artemisia ludoviciana	1/11	3/27	3/21						
Artemisia scopulorum								TR/3	1/8

TABLE 2. (Continued).

Taxa	Bunchgrass Zone		Douglas Fir Zone			Subalpine Zone		Alpine Zone	
	Bunchgrass-Forb Type 2 sites	Bunchgrass-Sage Type 2 sites	Douglas Fir-Snowberry Type 1 site	Douglas Fir-Ninebark Type 2 sites	Seeded Roadbed Type 2 sites	Rock Outcrop Type 2 sites	Streamside Forb-Sedge Type 1 site	Rock Outcrop-Snowfield Type 1 site	Alpine Tundra Type 3 sites
FORBS: (Continued)									
Astragalus spp.	TR/6	3/23							
Balsamorhiza sagittata	1/10	2/17							
Caltha leptosepala									7/66
Campanula rotundifolia			TR/6						
Cerastium arvense	2/28	TR/3			1/8			TR/8	TR/18
Chrysopsis villosa	3/16			1/7					
Cirsium foliosum	TR/3					TR/5			
Dodecatheon pauciflorum						TR/5			
Draba spp.								TR/5	
Epilobium angustifolium							2/15		
Erigeron simplex						2/3			
Glycyrrhiza lepidota	1/19								
Lupinus argenteus	TR/4	TR/11							
Mertensia alpina								2/25	TR/4
Mertensia ciliata						2/8	17/45		
Oxyria digyna								TR/3	
Phlox hoodii	TR/3	1/27							
Polemonium viscosum			TR/4						
Polygonum bistortoides						TR/10	TR/8		3/44
Potentilla concinna		1/11							
Potentilla diversifolia						1/25	TR/5		4/50
Potentilla ovina								1/5	19/48
Ranunculus eschscholtzii									2/35
Sedum rosea								TR/5	TR/8
Senecio canus									8/5
Senecio fuscatus								TR/5	1/11
Solidago canadensis			TR/1	4/16					
Trifolium parryi								12/38	2/11
Unidentified forbs	6/34	TR/1	1/6	TR/5					TR/5
SHRUBS:									
Artemisia tridentata		13/36							
Berberis repens		TR/5	1/15						
Juniperus communis			3/5	6/13					
Juniperus horizontalis				1/1					
Physocarpus malvaceus				4/10					
Prunus virginiana	2/8		2/16	1/1					

TABLE 2. (Continued).

Taxa	Bunchgrass Zone		Douglas Fir Zone			Subalpine Zone		Alpine Zone	
	Bunchgrass-Forb Type 2 sites	Bunchgrass-Sage Type 2 sites	Douglas Fir-Snowberry Type 1 site	Douglas Fir-Ninebark Type 2 sites	Seeded Roadbed Type 2 sites	Rock Outcrop Type 2 sites	Streamside Forb-Sedge Type 1 site	Rock Outcrop-Snowfield Type 1 site	Alpine Tundra Type 3 sites
SHRUBS: (Continued)									
Rhus trilobata	5/8								
Ribes aureum		1/3	7/25	4/27					
Ribes montigenum						16/25			
Rosa aciculariis	1/10			1/3					
Rubus idaeus	TR/1			TR/3		2/3			
Vaccinium scoparium						25/55			
Vaccinium spp.				1/5					
MISCELLANEOUS:									
Mosses						TR/5		4/40	10/31
Selagenella densa		9/50							
Lichen	2/20	3/17				2/5			TR/3
Litter	2/16	1/14	TR/1	20/41	1/16	3/5	4/10		3/13
Exposed Soil	12/39	4/21	18/35	35/66	72/100	10/20		1/5	1/8
Rock	7/38	10/59	5/14	10/50	TR/3	17/38	5/13	20/25	8/42

[1]Taxa not appearing in the above table but which were present in trace amounts were *Bromus tectorum*, *Sitanion hystrix*, *Mamillaria vivipara*, *Opuntia polyacantha*, *Tragopogon dubius* and *Erigeron annuus* in the Bunchgrass-Forb Type; *Melilotus officinalis* in the Seeded Roadbed Type; *Alnus sinuata* and *Ceanothus velutinus* in the Douglas Fir-Snowberry Type; and *Castilleja sulphura*, *Aster foliaceus*, *Gentiana algida*, *Lloydia serotina* and *Salix arctica* in the Alpine Tundra Type.

[2]Canopy coverage (percent of area covered/average frequency (percent occurrence among plots).

[3]TR = trace, a value less than 0.5 percent canopy coverage or 5 percent average frequency.

fringed sagewort, cudweed sagewort, vetches *(Astragalus* spp.), arrowleaf balsamroot *(Balsamorhiza sagittata)* and phlox *(Phlox hoodii)*.

Douglas Fir Zone

This zone included vegetation on the bottoms and sides of glaciated valleys in the lower elevations up to 8,000 feet. Nine types were recognized.

Douglas Fir-Snowberry Type: This type, encountered only in the vicinity of the Mystic Lake Power Plant, occurred on northeast exposures from 6,000 to 7,500 feet elevation (Figure 3). Characteristic overstory vegetation was Douglas fir *(Pseudotsuga menziesii)* in open canopy stands. Lodgepole pine *(Pinus contorta)*, limber pine *(Pinus flexilis)* and ponderosa pine *(Pinus ponderosa)* occurred as scattered trees within the Douglas fir stands. Snowbrush ceanothus *(Ceanothus velutinus)*, although not occurring within the one site examined, was quite common in the understory. Other shrubs within this type were golden currant *(Ribes aureum)*, common juniper *(Juniperus communis)* and chokecherry. California brome *(Bromus carinatus)* and slender hairgrass *(Deschampsia elongata)* were the only important grasses. The most important forbs were cudweed sagewort and dogbane *(Apocynum androsaemifolium*. Occurring in lesser amounts were salsify *(Tragopogon dubius)*, pearly everlasting *(Anaphalis margaritaceae)* and roundleaf

harebell *(Campanula rotundifolia)*.

Douglas Fir-Ninebark Type: This type occurred on south to east facing slopes from 5,200 feet to 7,500 feet. Douglas fir and limber pine occurred in mixed, open canopy stands. Ninebark *(Physocarpus malvaceus)*, golden currant and common juniper were important shrubs. Bluebunch wheatgrass was the dominant grass with Idaho fescue, Indian ricegrass *(Oryzopsis hymenoides)* and sedges occurring in lesser amounts. Canadian goldenrod *(Solidago canadensis)*, golden aster and yarrow *(Achillea millefolium)* were important forbs.

Seeded Roadbed Type: This type occurred in conjunction with the Mouat and Benbow mines and consisted of mine roadbeds that had been artificially seeded and fertilized (Figure 4). Intermediate wheatgrass *(Agropyron intermedium)* and slender wheatgrass *(Agropyron trachycaulum)* were the dominant grasses. Forbs present were yellow sweetclover *(Melilotus officianalis)*, chickweed and ballhead sandwort *(Arenaria congesta)*.

Douglas Fir-Huckleberry Type: This type occurred primarily on north facing slopes from 6,500 to 8,000 feet in closed canopy stands of Douglas fir. Characteristic vegetation included grouse wortelberry *(Vaccinium scoparium)*, thinleaved huckleberry *(Vaccinium membranaceum)*, Canadian buffaloberry *(Shepherdia canadensis)*, ninebark, Oregon grape *(Berberis repens)*, pinegrass *(Calamagrostis rubescens)* and elk sedge *(Carex geyeri)*.

Figure 4. Seeded Roadbed Type in the vicinity of the Mouat Mine.

Mountain Meadow Type: Mountain meadows occurred as isolated openings within the Douglas fir forest stands up to an elevation of 8,000 feet. Characteristic vegetation included blue joint *(Calamagrostis canadensis)*, big bluegrass *(Poa ampla)*, ticklegrass *(Agrostis scabra)*, timber oatgrass *(Danthonia intermedia)*, mountain willow *(Salix monticola)*, broom sedge *(Carex scoparia)*, Hood sedge *(Carex hoodii)*, Mountain bluebell *(Mertensia ciliata)*, Hayden clover *(Trifolium haydenii)*, and largeflower buttercup *(Ranunculus escholtzii)*.

Lodgepole Pine Type: This type was located on the bottom and sides of broad U-shaped glaciated valleys in the lower elevations up to 8,000 feet. Lodgepole pine generally occurred in fairly dense stands with

little or no understory vegetation. The more open stands contained an understory of grouse wortelberry.

Aspen Type: Stands of quaking aspen *(Populus tremuloides)* were interspersed with stands of Douglas fir and lodgepole pine at lower elevations, generally below 7,500 feet, near springs and seeps or where ground water was near the surface. The overstory was composed entirely of quaking aspen. The understory usually consisted of a mixture of snowberry *(Symphoricarpos albus)*, ninebark, prickly rose, sedges, foxtail Muhly *(Muhlenbergia andina)*, blue wild-rye *(Elymus glaucus)*, woodland strawberry *(Fragaria vesca)*, Hayden clover and common angelica *(Angelica arguta)*.

Streamside-Hardwood Type: Stands of this type occurred along stream courses from 7,500 feet to the lower elevations of the Douglas Fir Zone. Characteristic shrubs include thinleaf alder *(Alnus icana)*, water birch *(Betula occidentalis)*, red dogwood *(Cornus stolonifera)*, quaking aspen and Bebb willow *(Salix bebbiana)*. Common forbs were field mint *(Mentha arvensis)*, hemlock water parsnip *(Sium suave)* and Richardson geranium *(Geranium richardsonii)*. Bluegrasses *(Poa* spp.*)* were the most important grasses.

Rock Outcrop-Forest Type: This type was characterized by scattered individual trees and small stands of trees among bare rock outcrops, talus slopes and boulder fields (Figure 3) and occurred throughout the Douglas Fir Zone. Tree species and understory vegetation were similar

to those of the Lodgepole Pine Type and Douglas fir types and made up approximately one-half the coverage, the other one-half being rock.

Subalpine Zone

The Subalpine Zone extended from 7,500 feet to 9,500 feet and was associated with the edges of the plateaus. Slopes were commonly between 10 and 90 percent. Within this zone four types were recognized.

Spruce-Fir Type: This type was found on the plateau edges, ridges, and glaciated valleys and basins between 7,500 feet and 9,800 feet in elevation (Figure 5). The characteristic vegetation of this type consisted of a mixed timber stand which included subalpine fir *(Abies lasiocarpa)*, whitebark pine *(Pinus albicaulis)*, Engelmann spruce *(Picea engelmanni)*, lodgepole pine, Douglas fir and limber pine. At the lower elevations of this type lodgepole pine and Douglas fir occurred in the mixture which graded into stands of subalpine fir, Engelmann spruce and whitebark pine at higher elevations. Characteristic grasses included sheep fescue *(Festuca ovina)*, tufted hairgrass *(Deschampsia caespitosa)*, bluegrasses, and tall trisetum *(Trisetum canescens)*. Common forbs included alpine sage *(Artemisia scopulorum)*, American bistort *(Polygonum bistortoides)* and Parry clover *(Trifolium parryi)*. Sedges and willows *(Salix* spp.*)* were also common.

Subalpine Meadow Type: This type occurred along streams, lakes, and cirques throughout the elevational limits of the Subalpine Zone (Figure 5). It is generally associated with slopes of less than 20

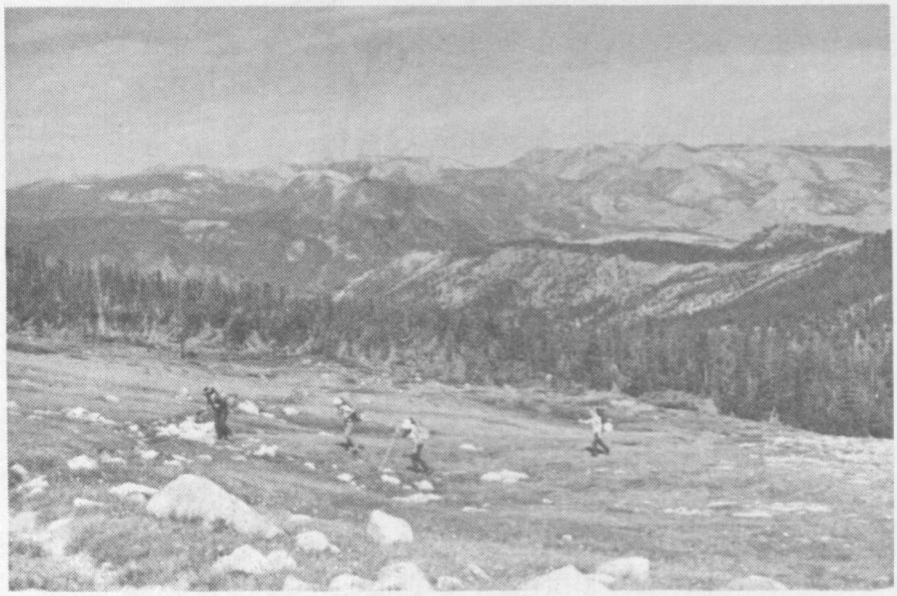

Figure 5. The Subalpine Meadow Type in the foreground and Spruce-Fir Type in the background within the Subalpine Zone.

percent. Vegetation varied from a sedge and willow type in wet areas to a grass and forb type in the drier areas. Characteristic vegetation included sageleaf willow *(Salix barclayi)*, sedges, bluegrasses, alpine foxtail *(Alopecurus alpinus)*, mountain bluebell and prickly gooseberry *(Ribes montigenum)*.

Streamside Forb-Sedge Type: This type occurred along the steep water courses dropping from the edges of the plateaus and gradually graded into the Streamside-Hardwood Type at about 7,500 feet. The dominant forb and sedge was mountain bluebell and *Carex albonigra*, respectively. Other important forbs included fireweed *(Epilobium angustifolium)*, American bistort and varileaf cinquefoil *(Potentilla*

diversifolia). Grasses which occurred in this type included cusick bluegrass *(Poa cusickii)* and alpine foxtail.

Rock Outcrop Type: This type consisted of vegetated terraces on steep slopes and cliffs and small pockets of vegetation among steep boulder fields throughout the elevational limits of the Subalpine Zone. Important shrubs which occurred within this type were grouse whortleberry, prickly gooseberry and raspberry *(Rubus idaeus)*. Arnica *(Arnica latifolia)* was the dominant forb. Other forbs present included varileaf cinquefoil, mountain bluebell, yarrow and yellow columbine *(Aquilegia flavescens)*. *Carex albonigra*, slender rush *(Juncus tenius)* and cusick bluegrass were important sedges, rushes and grasses, respectively.

Alpine Zone

The Alpine Zone extends from approximately 9,500 feet to an excess of 12,000 feet in elevation. Plateaus of gentle topography predominated within this zone. Recognized were two types.

Alpine Tundra Type: This type occurred primarily on the gentle slopes of the plateaus (Figure 6). Forbs were the dominant vegetation. Important forbs present included elkslip marshmarigold *(Caltha leptosepala)*, varileaf cinquefoil, sheep cinquefoil *(Potentilla ovina)*, American bistort, largeflower buttercup, chickweed, Parry clover and groundsel *(Senecio fuscatus)*. The dominant shrub was alpine willow

Figure 6. The Alpine Tundra Type in the foreground and Rock Outcrop-Snowfield Type in the background within the Alpine Zone.

(Salix arctica) which appeared in great amounts in some areas. *Carex albonigra* was a very important sedge and was abundant in wet areas. Grasses present were bluegrasses, tufted hairgrass and tall trisetum. Moss was important in moist areas.

Rock Outcrop-Snowfield Type: This type consisted of mountain tops, cliffs, steep valley sides, and knife ridges above 9,500 feet (Figure 6). Vegetation was sparse and established primarily in small pockets among the rocks. Characteristic vegetation was Parry clover, skunk polemonium *(Polemonium viscosum)*, alpine bluebell *(Mertensia alpina)*, mountain sorrel *(Oxyria dignya)*, moss silene *(Silene acaulis)* and moss.

Use of Vegetation Types

The seasonal distribution of all observations of bighorns, including 18 by personnel of the Montana Fish and Game Department, for the entire study area is presented in Table 3 by vegetation types. Data for the West Rosebud and Stillwater herds are presented separately in Table 4. Observations of marked animals indicated the West Rosebud and Stillwater herds were distinct and that their use of vegetation types was different.

Summer (July-August)

Seven vegetation types were used in summer (Table 3). The Douglas Fir-Snowberry Type received the most usage but all usage was in the West Rosebud (Table 4) and use of the type was biased by the presence of salt blocks. I feel the most important types on the West Rosebud were the Streamside-Hardwood, Streamside Forb-Sedge and Rock Outcrop types which provided both abundant forage and security for bighorns. The two streamside types were also used as travel routes to and from higher elevations. In early September I located an apparent summer concentration area for bighorns of the West Rosebud near Cooke City and evidence from tracks, droppings and vegetation usage indicated extensive summer use of the Alpine Tundra and Rock Outcrop-Snowfield types in that area.

Of 18 bighorns observed in the Stillwater during the summer, 12 were in the Bunchgrass-Forb Type where a salt block was present.

TABLE 3. NUMBER AND PERCENT OF 951 OBSERVATIONS OF BIGHORNS IN EACH OF 13 VEGETATION TYPES BY MONTH AND SEASON.

Type	July	Aug.	Season	Sept.	Oct.	Nov.	Season	Dec.
Bunchgrass-Forb	12/11[1]		12/10		8/3	106/43	114/21	159/58
Douglas Fir-Snowberry	43/38		43/35	19/32	16/7		36/6	
Seeded Roadbed				28/47	111/45	39/16	178/32	10/4
Douglas Fir-Ninebark				5/8	17/7		22/4	
Mountain Meadow					1/TR[2]	23/9	24/4	3/1
Streamside-Hardwood	16/14		16/13		15/6		15/3	
Rock Outcrop-Forest					27/11	29/12	56/10	10/4
Spruce-Fir				6/10	7/3		13/2	
Subalpine Meadow					2/1		2/TR	
Streamside Forb-Sedge	16/14		16/13					
Rock Outcrop	16/14		16/13					
Alpine Tundra	8/7	9/100	17/14	1/2	20/8	51/21	72/13	93/34
Rock Outcrop-Snowfield	3/2		3/2		22/9		22/4	
Sample Size	114	9	123	59	246	248	553	275

[1]Number of bighorns observed/percent of bighorns observed.

[2]TR = trace, a value of less than 0.5 percent.

TABLE 4. PERCENT OF 900 OBSERVATIONS OF BIGHORNS IN EACH OF 13 VEGETATION TYPES FOR THE WEST ROSEBUD AND STILLWATER HERDS BY MONTH AND SEASON.

Type	July	Aug.	Season	Sept.	Oct.	Nov.	Season	Dec.
Bunchgrass-Forb	-/80[1]	-/-	-/66	/	-/2	-/54	-/29	-/85
Douglas Fir-Snowberry	43/-	-/-	41/-	77/-	17/-	-/-	23/-	-/-
Seeded Roadbed	-/-	-/-	-/-	-/82	-/73	-/20	-/46	-/5
Douglas Fir-Ninebark	-/-	-/-	-/-	-/15	-/11	-/-	-/6	-/-
Mountain Meadow	-/-	-/-	-/-	-/-	1/-	-/11	1/6	-/2
Streamside-Hardwood	16/-	-/-	15/-	-/-	17/-	-/-	10/-	-/-
Rock Outcrop-Forest	-/-	-/-	-/-	-/-	6/14	-/15	3/13	-/-
Spruce-Fir	-/-	-/-	-/-	23/-	16/-	-/-	13/-	-/-
Subalpine-Meadow	-/-	-/-	-/-	-/-	2/-	-/-	1/-	-/-
Streamside Forb-Sedge	16/-	-/-	15/-	-/-	-/-	-/-	-/-	-/-
Rock Outcrop	16/-	-/-	15/-	-/-	-/-	-/-	-/-	-/-
Alpine Tundra	8/-	100/100	13/17	-/3	17/-	100/-	34/1	100/-
Rock Outcrop-Snowfield	-/20	-/-	-/17	-/-	25/-	-/-	14/-	-/-
Sample Size	99/15	6/3	105/18	26/34	89/153	36/197	151/384	54/188

[1]West Rosebud/Stillwater.

Twenty to thirty ewes and lambs were observed in July near Flood Creek of the Stillwater drainage (Matt Olsen 1973). Subsequent trips into that area failed to reveal any sheep but tracks, droppings and vegetation usage indicated at least moderate use of the Rock Outcrop-Forest and Streamside-Hardwood types. Rugged terrain and limited visibility contributed to the lack of observations on these types.

Bighorns were first located on the Seeded Roadbed Type near the Mouat Mine in early September and evidence of summer use was present.

I feel that the most important types used by bighorns of the Stillwater during summer were the Seeded Roadbed, Rock Outcrop-Forest, and the Streamside-Hardwood types.

During the summer, rams from both herds preferred the Alpine Tundra Type (Table 5). Forty-three percent of the observations of ewes and lambs were made on the Douglas Fir-Snowberry Type. Summer observations of ewes on the Streamside-Hardwood, Streamside Forb-Sedge and Rock Outcrop types and evidence, such as droppings, gathered in early September on the Seeded Roadbed, Rock Outcrop-Forest, Streamside-Hardwood and the Alpine types indicated that Stillwater ewes and lambs summer at much lower elevations than do those in the West Rosebud.

Fall (September-November)

Thirty-two, 21 and 13 percent of 551 individual bighorn observations made during the fall were on the Seeded Roadbed, Bunchgrass-

TABLE 5. PERCENT OF 745 OBSERVATIONS OF BIGHORNS IN EACH OF 13 VEGETATION TYPES IN EACH OF 3 SEASONS BY SEX AND HERD.

	Summer						Fall						Winter					
	West Rosebud		Stillwater		Aggregate		West Rosebud		Stillwater		Aggregate		West Rosebud		Stillwater		Aggregate	
Type	Ram	Ewes & Lambs[1]	Ram	Ewes & Lambs	Ram	Ewes & Lambs	Ram	Ewes & Lambs	Ram	Ewes & Lambs	Ram	Ewes & Lambs	Ram	Ewes & Lambs	Ram	Ewes & Lambs	Ram	Ewes & Lambs
Bunchgrass-Forb			25	100	6	11			24	27	22	19			81	73	65	48
Douglas Fir-Snowberry		53				43	17	14			2	4						
Seeded Roadbed									56	50	51	36			13	13	10	7
Douglas Fir-Ninebark									6	.4	6	.2						
Mountain Meadow							17			8	2	6				3		2
Streamside-Hardwood		14				16		14				4						
Rock Outcrop-Forest							17	4	12	14	13	11			6	10	5	6
Spruce-Fir								6				.2						
Subalpine Meadow								2				.5						
Streamside Forb-Sedge		14				16												
Rock Outcrop		14				16												
Alpine Tundra	100		75		94		33	44	2		4	12	100	100			20	26
Rock Outcrop-Snowfield							17	19			2	5						
Sample Size	14	90	4	11	18	101	6	111	66	283	72	394	5	49	16	90	21	140

[1]Includes yearling ewes.

Forb and the Alpine Tundra types, respectively (Table 3). As fall progressed the use of the Bunchgrass-Forb, Mountain Meadow and Alpine Tundra types increased as bighorns moved onto their winter range. A corresponding decrease in use of the Seeded Roadbed, Streamside-Hardwood, Spruce-Fir and Douglas Fir-Snowberry types was attributed to snow accumulations in those types making forage unavailable and/or travel perilous. The Rock Outcrop and Streamside Forb-Sedge types used in summer were not used in fall.

Use of the Douglas Fir-Snowberry Type by bighorns of the West Rosebud declined as fall progressed (Table 4). No bighorns were observed in this type in November. The decreased desire for salt and/or snow accumulations along the rims and streamside types used for travel routes to the type may have contributed to the decline in use. By November, 100 percent of the bighorns observed were on the Alpine Tundra Type, which made it the most important type for the season.

With early September snowstorms, bighorns of the Stillwater herd arrived on the Seeded Roadbed Type in increasing numbers. Peak numbers were present on the type in October. Extensive aerial flights from September through December indicated no bighorns of the Stillwater drainage used the higher elevations after the first fall snowstorms. The first use of the Bunchgrass-Forb Type was in late October. As snow accumulated on the Seeded Roadbed Type in November, bighorns moved down to the Bunchgrass-Forb winter range. In November, 54

percent of the observations were on this type, making it second in importance to the Seeded Roadbed Type for the season. The Mountain Meadow and Rock Outcrop-Forest types are in close proximity to the Bunchgrass-Forb Type and were used by bighorns for forage and bedding areas, respectively.

Fall distribution of rams was related to the distribution of ewes (Table 5). Important types for rams and ewes were the Alpine Tundra and Seeded Roadbed types in the West Rosebud and Stillwater, respectively. A greater variety of types were used by the rams during fall as compared to summer and this was attributed to hunter disturbances and the progressing rut.

Winter (December)

The most important types used by bighorns in the winter were the Bunchgrass-Forb and the Alpine Tundra types (Table 3).

Rams and ewes alike wintered on the high wind swept plateaus of the Alpine Tundra Type with 100 percent of the West Rosebud observations occurring on the type (Tables 4 and 5). Tracks and beds indicated the use of the Rock Outcrop-Snowfield and Rock Outcrop types as bedding areas. Extensive observation periods on the lower Bunchgrass-Sage and forest types indicated no bighorns were present on those types as early as 1 January, 1974. Montana Fish and Game biologists (1974) first reported bighorns on the Bunchgrass-Sage Type in mid-March, 1974.

In contrast, all segments of the Stillwater herd winter on the lower Bunchgrass-Forb Type and arrive on the winter range as early as October. Other types were of little importance other than for escape cover and bedding areas. The reason for this difference in wintering habits of the two herds was not apparent. Plateaus on the Stillwater are as extensive as those on the West Rosebud, but no Stillwater bighorns used them. The low south and southeast facing Bunchgrass-Sage Type on the West Rosebud covers perhaps 10 times the area the Bunchgrass-Forb Type covers on the Stillwater, but as discussed above, no sheep used that area until mid-March.

The importance of escape terrain to bighorn sheep has been discussed by Oldemeyer *et al.* (1971), Erickson (1972) and Frisina (1974). Erickson reported 66 percent of the bighorns of Sun River observed during the winter were within 150 yards of escape terrain. In this study I found that as bighorns moved onto their winter ranges their strong affinity to escape terrain lessened (Table 6). Ninety-eight percent of 111, 84 percent of 551 and 44 percent of 275 individual bighorns observed in summer, fall and winter, respectively, were within 150 yards of escape terrain. No sheep were observed more than one-half mile from escape terrain during any season. The lack of affinity to escape terrain in winter was probably due to the winter use of the plateaus on the West Rosebud and the small winter range on the Stillwater which forced bighorns to move away from cover to secure forage.

TABLE 6. PERCENT DISTRIBUTION OF 937 OBSERVATIONS OF BIGHORNS ACCORDING TO PHYSICAL CHARACTERISTICS OF THE HABITAT FOR JULY THROUGH DECEMBER, 1973.

Period	Sample Size	Distance from escape cover		Distance from water		Exposure								Level[3]	% Slope[1]	Elevation[2]	
		150 yds. or less	>150 yds.	150 yds. or less	>150 yds.	N	S	E	W	SE	SW	NE	NW		Mean	Extremes in feet	Mean
July	102	98	2	97	3		36[4]	31		29			3		46	(7,600-10,500)	8,463
August	9	100		56	44		89							11	23	(10,500)	10,500
Season	111	98	2	94	6		41	29		27			3	1	35	(7,600-10,500)	9,481
September	59	100		73	27		17			69	7	7			36	(6,250-10,000)	7,673
October	244	96	4	43	57	7	42	9	3	25		12			38	(5,050-10,700)	7,877
November	248	68	32	43	57		26			44	6	13		11	33	(5,100-10,250)	5,925
Season	551	84	16	46	54	4	32	4	1	38	3	12		5	36	(5,050-10,700)	7,158
December	275	44	56	28	72	6	17		11	59		4	1	2	32	(5,050-12,000)	7,148)

[1]Percent slope by estimate only.

[2]Elevations established with the use of a topographic map.

[3]Level refers to a slope of less than 1%.

[4]Percentage of total observations that occurred on a particular exposure.

Important escape terrains used during the summer were the Rock Outcrop-Forest, Rock Outcrop and Rock Outcrop-Snowfield types. Escape terrains used in both fall and winter were the Rock Outcrop and Rock Outcrop-Snowfield types and the Rock Outcrop-Forest and forest types for the West Rosebud and the Stillwater herds, respectively. The Alpine Tundra plateaus were not considered as escape terrain.

The July through September distribution of bighorns was more closely correlated with the availability of water than during later months. Bighorn affinity to the presence of water during this period is probably related to the green succulent vegetation growing in its vicinity. Streams and lakes are widely distributed over the area at intervals of one-fourth mile or less.

During the summer south, east, and southeast exposures received 41, 29, and 27 percent of bighorn use, respectively. South and southeast exposures received more use by bighorns than other exposures in both fall and winter. Warmer temperatures and minimal snow accumulations probably accounted for these preferences. The use of the north and northeast exposures by bighorns was due to use of the Seeded Roadbed Type in both fall and winter.

Throughout the study period the mean slope used by bighorns was approximately 35 percent. A mean slope of 36 percent used by bighorns in the Beartooth Mountains in fall is low when compared to the 60 percent mean slope used during that season by bighorns in Sun River

(Frisina 1974). Fall use of the Stillwater winter area and the plateaus, both gentle in topography, accounted for this difference.

Summer elevational extremes at which bighorns were observed ranged from 7,600 to 10,500 feet with a mean of 9,481 feet above sea level. This sample represents only three bighorns from the Stillwater herd so best represents the elevational mean and extremes used by West Rosebud bighorns. All bighorns observed above 9,000 feet during the summer were rams. Fall elevational extremes ranged from 5,050 to 10,700 feet with a mean elevation of 7,158 feet. The November mean elevation of 5,925 feet closely represents the mean elevation of the Stillwater winter range since only 15 percent of 248 individual observations of bighorns were from the West Rosebud herd. The mean elevation of the West Rosebud winter area is in excess of 10,000 feet.

Population

Stoneberg's (1973, 1974) population estimates for bighorns of 33, 42 and 47, on the Stillwater based on the maximum count during daily observations for the springs of 1972, 1973, 1974, respectively, indicated increases. His observations on the West Rosebud for the springs of 1972 and 1973 indicated stability at about 60 animals.

The sex and age composition of bighorns of the West Rosebud and Stillwater herds based on my total observations are presented in Table 7. The 64 lambs per 100 ewes for summer in the West Rosebud was

TABLE 7. SEX AND AGE COMPOSITION OF BIGHORN SHEEP AS DETERMINED FROM 745 OBSERVATIONS OF BIGHORNS FROM THE WEST ROSEBUD AND STILLWATER HERDS.[1]

	Sample Size	Males					Females		Lambs	Number per 100 Ewes		
		0-1/4[2] Curl	1/4-1/2 Curl	1/2-3/4 Curl	3/4+ Curl	Total Males	Adult	Yearlings		Rams	Yearlings	Lambs
West Rosebud												
Summer	104	--	1	6	7	14	45	10	35	25	22	64
Fall	117	--	2	4	--	6	74	--	37	8	--	50
Winter	54	--	--	1	4	5	35	--	14	14	--	40
Stillwater												
Summer	15	3	1	--	--	4	9	--	2	44	14[3]	22
Fall	349	27	24	13	2	66	190	--	93	35	36[3]	62
Winter	106	3	5	6	1	16	66	--	24	24	9[3]	36

[1]Includes multiple observations of the same animals.

[2]Yearling males

[3]Assuming a 50/50 ratio of yearling males to yearling females.

slightly higher than that found by Frisina (1974) in the Sun River during June. The number of lambs per 100 ewes for fall and winter for the West Rosebud herd was 50 and 40, respectively, indicating substantial lamb mortality during fall and winter. Sex and age data obtained from the maximum daily count of bighorns in a month (Table 8) suggested lamb mortality occurred between 23 July and 24 December. Reasons for this mortality were not apparent.

The 62 and 36 lambs per 100 ewes observed in the Stillwater during fall and winter, respectively (Table 7), indicated lamb mortality by early winter. Data presented in Table 8 suggested mortality between 11 October and 21 December. However, observations by Stoneberg (1974) on 4 January did not support this conclusion. For a sample of 40, the lamb/ewe ratio was 65/100. The maximum daily count in the Stillwater prior to 11 October was not representative of the population.

The number of rams per 100 ewes observed in the West Rosebud was highest in summer (Table 7). This possibly indicates sampling errors.

The absence of yearling males and the preponderance of older males in the West Rosebud (Table 7) suggested light hunting pressure. Movement of yearling males to other areas may result from population pressure. This seems plausible because survival of lambs should not be greatly affected by sex. Ten observations of yearling ewes were recorded during the summer of 1973.

TABLE 8. NUMBERS OF BIGHORN SHEEP BY SEX AND AGE OBSERVED IN THE WEST ROSEBUD AND STILLWATER DRAINAGES FROM MAXIMUM DAILY OBSERVATIONS IN A MONTH.

Drainage	Dates	Maximum Daily Count	% of Estimated Spring Population	Rams	Ewes	Lambs	No. Per 100 Ewes Rams	No. Per 100 Ewes Lambs
	21-23 July	29	48	--	15	12	--	70
West	26 Sept.	19	32	--	12	7	--	58
Rosebud	19 Oct.	31	52	2	19	10	11	53
	20 Nov.	19	32	1	11	7	9	63
	5 Dec.	25	42	3	14	8	22	57
	24 Dec.	23	38	--	16	7	--	44
	11 Oct.	25	53	4	13	8	31	62
Still-	1 Nov.	32	68	7	16	9	44	56
water	26 Nov.	37	79	5	21	11	24	52
	21 Dec.	30	64	4	17	7	24	41

The 24 rams per 100 ewes observed on 26 November 1973 (Table 8) is considered to be most representative of the Stillwater herd since 79 percent of the estimated population was observed on that day.

The ram population on the Stillwater is indicative of a heavily hunted population. Younger males predominate (Table 7). This population is very vulnerable to hunting due to its habit of arriving on the winter range in November while the hunting season is still in progress. Only two, three-quarter curl rams were observed. One was taken by a hunter during the hunting season. The other was observed once in early December and was thought to be a transient ram in search of ewes.

Group Characteristics

The ram-ewe-lamb group was the largest group seen in summer, fall and winter with mean group sizes of 12, 11.5 and 13.1, respectively (Table 9), but summer data were limited to one observation. As bachelor herds broke up in the fall the ram mean group size decreased as compared to summer. In early winter no rams were seen away from ewes. The decrease in the mean group size of ewe-lamb and ewe groups from fall to winter is related to the increased breeding activity during December.

Frisina (1974) reported that bighorns of the Sun River during fall and spring were found in larger groups as the security of the vegetation type occupied diminished. In this study little difference was noted for average group sizes between seasons (Table 9) although there was a movement to less secure vegetation types (Table 3). The two largest groups observed were on the Alpine Tundra and Bunchgrass-Forb types during winter and numbered 30 and 35 animals, respectively.

Movements

Studies of movements of bighorn sheep were aided by observations of marked individuals. The geographic locations of all observations of marked bighorns are presented in Appendix Table 17 and shown on Figure 1.

TABLE 9. MEAN GROUP SIZE AND NUMBERS OF GROUPS OBSERVED FOR SUMMER, FALL AND WINTER BASED ON 745 OBSERVATIONS OF BIGHORNS.

Season	Ram	Ewe	Yearling	Lamb	Ewe Group[1]	Ram-Ewe-Lamb	Ewe-Lamb	Average Group Size
Summer	3.4/5[2]	1/1	-/-	-/-	9/8	12/1	2/1	6.5/16
Fall	1.3/6	2.3/3	1/1	1/1	6.4/20	10.5/31	7.6/11	7.6/73
Winter	-/-	1/1	3.5/2	1/1	5.1/10	13.1/17	3/8	7.0/39

[1]Includes ewes, yearling ewes and lambs.

[2]Mean group size/number of groups.

A center of activity (Hayne 1949) and a standard diameter (White 1964) were calculated for each of five marked bighorns that were observed three or more times during a season. The standard diameter was calculated using the formula: $SD=\sqrt{\Sigma D^2/N}$, where D equals twice the distance from the center of activity to each relocation and N equals the number of relocations (Harrison 1958). The standard diameter is defined as a circle which contains 68.26 percent of the relocations of the marked animal (White 1964).

Summer

Locations of observations of marked bighorns during the summer (Figure 1) suggested the summer distribution of the West Rosebud and Stillwater herds. A marked ram (S3536) from the West Rosebud moved 9.3 airline miles to the plateau between Falls Creek and Woodbine Creek. The standard diameter for this ram in summer was 0.36 miles

and the average distance between relocations was 0.20 miles (Table 10). Of the four marked ewes observed at the Mystic Lake salt block at an elevation of 7,500 feet during July, only ewe S3540 was relocated again. This ewe was relocated five days later 3.0 airline miles west near Island Lake at an elevation of 9,500 feet. The initial relocation of ewe S3535 on 2 September near Cooke City would indicate a movement in excess of 20 airline miles from spring to summer range. No marked bighorns of the Stillwater herd were observed in this area but this does not preclude the possibility of use by this group.

The only relocation during summer of a bighorn from the Stillwater herd that I was able to document was an observation of ram S4285 on Sheepherder Peak on 9 August. This indicated a movement of 21.3 airline miles between winter and summer range. The band of ewes and lambs observed near Flood Creek by Matt Olsen in July suggested that some of the Stillwater herd summers in that area. My fall observations of bighorn use of the Seeded Roadbed Type indicated that a few bighorns of this same herd summer in the vicinity of the Mouat Mine.

Fall

Ewe S3535 of the West Rosebud herd was observed on five separate occasions during fall between Sheep Mountain and Cutoff Mountain. The standard diameter of the fall area and the average distance between relocations were 6.47 and 4.28 miles, respectively (Table 10). For

TABLE 10. MOVEMENTS, STANDARD DIAMETERS AND AVERAGE DISTANCES BETWEEN RELOCATIONS FOR MARKED BIGHORNS ON THE WEST ROSEBUD AND STILLWATER.

Season	Tag No.	Sex	Drainage Marked	Date Marked	No. of Observations	Date of Observations	Distance from Site of Marking in miles	Standard Diameter in miles	Average Distance Between Relocations in miles
Summer	S3536	♂	West Rosebud	4/26/73	3	7/28/73-8/9/73[1]	9.10-9.30[2]	0.36	0.20
Fall	S3535	♀	West Rosebud	4/26/73	5	9/2/73-10/19/73	17.60-26.50	6.47	4.28
	S3536	♂	West Rosebud	4/26/73	4	10/6/73-10/12/73	2.40-2.60	2.66	1.57
	S4287	♀	Still-water	3/13/73	13	10/10/73-11/27/73	0.25-1.30	1.88	0.60
	S4289	♀	Still-water	4/17/73	9	10/27/73-11/26/73	0.20-1.30	1.47	0.85
	S4285	♂	Still-water	3/12/73	10	9/9/73-11/27/73	0.10-19.5	12.30	2.92
							Average	4.96	
Winter	S4287	♀	Still-water	3/13/73	10	12/7/73-12/27/73	0.25-1.50	1.37	0.52
	S4289	♀	Still-water	4/17/73	7	12/14/73-12/27/73	0.20-0.55	0.47	0.24
	S4285	♂	Still-water	3/12/73	8	12/8/73-12/26/73	0.25-0.90	0.93	0.60
							Average	0.94	

[1]Initial observation - last observation.

[2]Minimum distance - maximum distance.

ram S3536 of the same herd the values were 2.66 and 1.57 miles, respectively, both of which were considerable greater than for summer. Movement of ewes and rams back to the winter area of the West Rosebud was not recorded until late November.

With the first September snowfalls bighorns began arriving on the upper extremities of the Stillwater winter range in increasing numbers. Each of four marked bighorns from the Stillwater herd were present on this area by early November. The standard diameter of the fall area for ewe S4287 and ewe S4289, both of the Stillwater herd, was 1.88 and 1.47 miles, respectively. The average distance between relocations for the same ewes was 0.60 and 0.85 miles, respectively. The standard diameter of the fall area and the average distance between relocations for ram S4285 was 12.30 and 2.92 miles, respectively. By removing the 20.0 mile movement recorded for this ram between 9 September and 24 September, as he moved from summer to fall range, the corrected fall values for standard diameter and average distance between relocations were 1.67 and 0.79 miles, respectively.

Winter

The longest recorded movement from the fall to the winter area on the West Rosebud was 17.5 miles. Of the six marked bighorns from the West Rosebud, four were observed during December on the winter area.

The standard diameter of the winter area for ewe S4287, ewe S4289 and ram S4285 of the Stillwater herd was smaller than that

recorded for each of these animals during fall (Table 10). Values for winter were 1.37, 0.47 and 0.93 miles, respectively, with an average standard diameter of 0.94 airline miles. Erickson (1972) reported pooled (average) standard diameters of 1.48, 1.56 and 1.37 miles for bighorns of the Sun River on three different wintering areas. The smaller average standard diameter for bighorns of the Stillwater as compared to the Sun River area, may reflect the smaller size of the Stillwater winter range.

The average distance between relocations on the winter range for ewe S4287, ewe S4289 and ram S4285 was 0.52, 0.24 and 0.60 miles, respectively. Morgan (1970) reported that movements between relocations within the winter range for ewes and rams averaged 1.59 and 2.25 miles, respectively. This further suggests that the Stillwater winter range is restricted in size.

During the late fall and early winter local elevational migrations by bighorns of both herds in response to snowstorms were recorded. Following a storm the bighorns in the Stillwater moved to the lower elevations. In contrast, bighorns in the West Rosebud that were on the plateaus moved up to secure forage on the higher ridges that were blown clear of snow. Snow blown from the ridges was deposited along the lower edges of the plateaus and restricted bighorn use of those areas.

Food Habits

An indication of summer, fall and early winter food habits of bighorn sheep of the West Rosebud herd was determined from the examination of eight feeding sites involving 3,110 instances of use (Table 11). Fall and early winter food habits of bighorns of the Stillwater herd were suggested by the examination of nine feeding sites involving 2,824 instances of use (Table 12) and the contents of two rumens (Table 13). Canopy coverage and frequency of occurrence of plants were determined at most feeding sites to aid in establishing food preference.

Summer

The examination of five feeding sites, which occurred in four vegetation types in the West Rosebud and involved 2,198 instances of use, indicated that forbs, shrubs and grass and grass-like plants constituted 55, 32 and 12 percent of the summer plant use by bighorns (Table 11). Erickson (1972) reported no usage of browse species during July for bighorns of the Sun River. Forbs were the most important forage class used in all types with the exception of the Douglas Fir-Snowberry Type where browse constituted 72 percent of the diet. The high usage of browse in that type may indicate sampling errors as the feeding site occurred near the power plant salt block. Parry clover, which had a canopy coverage of only two percent on the Alpine Tundra Type (Table 2) received 66 percent of the plant usage recorded on that type indicating preference for that species. Usage of arnica *(Arnica latifolia)*

TABLE 11. BIGHORN SHEEP, MULE DEER AND MOUNTAIN GOAT FOOD HABITS BY MONTH AND SEASON AS DETERMINED FROM 4,721 INSTANCES OF PLANT USE AT 15 FEEDING SITES IN THE WEST ROSEBUD DRAINAGE.

	Bighorn Sheep							Mule Deer		Mountain Goat		
	Summer					Fall	Winter	Summer	Fall	Summer		
	Alpine Tundra Type	Rock Outcrop Type	Streamside Forb-Sedge Type	Douglas Fir-Snowberry Type	Seasonal Average	Alpine Tundra Type	Alpine Tundra Type	Alpine Tundra Type	Streamside-Hardwood Type	Alpine Tundra Type	Rock Outcrop-Snowfield Type	Seasonal Average
	7/30[1]	7/21; 21	7/21	7/24	11/19; 20		12/9	7/30; 8/16	9/1	7/10; 8/28; 28	7/20	
	1 site	2 sites	1 site	1 site	5 sites	2 sites	1 site	2 sites	1 site	3 sites	1 site	4 sites
Taxa	384[2]	759	864	191	2,198	655	257	672	111	510	328	838
GRASS AND GRASS-LIKE PLANTS:												
Alopecurus alpinus			3/100[3]		1/25							
Carex albonigra			14/100		4/25						3/100	2/50
Carex spp.		2/50			TR/25[4]	78/100	22/100			4/33		2/50
Deschampsia caespitosa				2/100	TR/25							
Festuca ovina											1/100	TR/50
Juncus tenuis		TR/100			TR/25							
Phleum alpinum		1/50			TR/25							
Poa cusickii		2/100	18/100		5/50							
Poa spp.	7/100				2/25	16/100	57/100	30/50		60/67	11/100	36/100
Unidentified grasses						5/50	19/100					
Total Grass and Grass-like Plants	7/100	5/100	35/100	2/100	12/100	99/100	98/100	30/50		64/67	15/100	40/100
FORBS:												
Apocynum androsaemifolium				12/100	3/25							
Aquilegia flavescens		20/50			5/25							
Arnica latifolia		20/100			5/25							
Arnica spp.				4/100	1/25				11/100			
Artemisia ludoviciana				4/100	1/25							
Artemisia scopulorum	3/100/1				1/25			1/50		2/33		1/50
Caltha leptosepala	1/100/7				TR/25					5/33		3/50
Cerastium arvense										3/33		2/50
Cirsium foliosum							1/100					
Compositae		TR/50/-			TR/25							
Epilobium angustifolium			16/100		4/25							
Lloydia serotina	1/100/TR				TR/25							
Mertensia alpina										TR/33	40/100	20/50
Mertensia ciliata		11/50	47/100		14/50							

TABLE 11. (Continued).

Taxa	Bighorn Sheep							Mule Deer		Mountain Goat		
	Summer					Fall	Winter	Summer	Fall	Summer		
	Alpine Tundra Type 7/30 1 site 384	Rock Outcrop Type 7/21; 21 2 sites 759	Streamside Forb-Sedge Type 7/21 1 site 864	Douglas Fir-Snowberry Type 7/24 1 site 191	Seasonal Average 5 sites 2,198	Alpine Tundra Type 11/19; 20 2 sites 655	Alpine Tundra Type 12/9 1 site 257	Alpine Tundra Type 7/30; 8/16 2 sites 672	Streamside-Hardwood Type 9/1 1 site 111	Alpine Tundra Type 7/10; 8/28; 28 3 sites 510	Rock Outcrop-Snowfield Type 7/20 1 site 328	Seasonal Average 4 sites 838
FORBS: (Continued)												
Polemonium viscosum				1/100	TR/25						27/100	14/50
Polygonum bistortoides	3/100				1/25			TR/50		11/33		6/50
Potentilla diversifolia	2/100	2/100			1/25	1/50/4		3/50		2/33		1/50
Potentilla ovina	3/100				1/25		1/100	35/100		4/33		2/50
Ranunculus eschscholtzii										2/33		1/50
Senecio canus										TR/33		TR/50
Senecio fuscatus										TR/33		TR/50
Silene acaulis						TR/50						
Trifolium parryi	66/100				17/25			31/50		1/33	18/100	10/100
Unidentified forbs				5/100	1/25	TR/50						
Total Forbs	79/100	53/100	63/100	26/100	55/100	1/100	2/100	70/100	11/100	30/100	85/100	60/100
SHRUBS:												
Alnus sinuata				5/100	1/25				30/100			
Ceanothus velutinus				20/100	4/25							
Prunus virginiana				7/100	2/25							
Ribes aureum				15/100	4/25							
Ribes montigenum		38/100	2/100	19/100	15/75				59/100			
Rubus idaeus		2/50		6/100	2/50							
Salix arctica	15/100				4/25							
Vaccinium scoparium		TR/50			TR/25							
Total Shrubs	15/100	40/100	2/100	72/100	32/100				89/100			
MOSS										6/33		

[1]Date upon which site was examined.

[2]Instances of use.

[3]Percent of plant use/frequency (percent of occurrence among sites).

[4]TR = trace; a value of less than 0.5 percent.

TABLE 12. BIGHORN SHEEP AND DOMESTIC LIVESTOCK FOOD HABITS BY MONTH AND SEASON AS DETERMINED FROM 3,407 INSTANCES OF PLANT USE AT 11 FEEDING SITES IN THE STILLWATER DRAINAGE.

	Bighorn Sheep						
	Fall	Winter			Cow	Donkey & Horse	
Taxa	Seeded Roadbed Type 9/11; 11; 11;[1] 13; 16; 30 6 sites 1,986[2]	Rock Outcrop-Forest Type 12/18 1 site 263	Bunchgrass-Forb Type 12/7; 15 2 sites 575	Seasonal Average 3 sites 838	Bunchgrass-Forb Type 12/15 1 site 277	Bunchgrass-Forb Type 12/15 1 site 306	Seasonal Average 2 sites 583
GRASS AND GRASS-LIKE PLANTS:							
Agropyron intermedium	36/100[3]						
Agropyron spicatum		33/100	18/100	26/100	13/100	25/100	19/100
Agropyron trachycaulum	43/100						
Bromus carinatus	1/17						
Bromus tectorum			15/50	8/50			
Carex spp.					14/100	7/100	10/100
Festuca cristatum	TR[4]/17						
Festuca idahoensis			2/50	1/50	27/100	44/100	36/100
Hordeum jubatum	TR/17						
Juncus drummondii	1/17					3/100	1/100
Koeleria cristata					4/100	2/100	3/100
Oryzopsis hymenoides	3/17						
Phleum pratense	1/33						
Poa spp.					6/100	17/100	12/100
Stipa comata			1/50	TR/50	28/100	2/100	15/100
Total Grass and Grass-like Plants	85/100	33/100	36/100	35/100	92/100	100/100	96/100
FORBS:							
Arenaria congesta	TR/17						
Artemisia frigida			42/100	21/50	5/100		3/100
Artemisia ludoviciana	TR/17		2/100	1/50			
Astragalus miser	3/17						
Brassicaceae	2/33				2/100		1/100
Chrysopsis villosa	TR/33		12/50	6/50			
Cirsium foliosum	TR/17						
Lupinus argenteus	1/17				1/100		TR/100
Melilotus officinalis	4/33						
Phlox hoodii			1/50	TR/50			
Polemonium viscosum	1/17						
Solidago canadensis	TR/17						
Tragopogon dubius	TR/17						
Total Forbs	11/100		57/100	28/50	8/100		4/100
SHRUBS:							
Artemisia tridentata		67/100		33/50			
Rhus trilobata			9/50	5/100			
Rubus idaeus	3/17						
Total Shrubs	3/100	67/100	9/100	38/100			

[1]Date upon which seeding site was examined.

[2]Instances of use.

[3]Percent of plant use/frequency (percent of occurrence among sites).

[4]TR = trace; a value of less than 0.5 percent.

TABLE 13. PERCENT VOLUME OF PLANT SPECIES IN RUMEN SAMPLES FROM EACH OF TWO BIGHORN EWES OF THE STILLWATER HERD COLLECTED DURING NOVEMBER.

Taxa[1]	Bunchgrass-Forb Type	Rock Outcrop-Forest Type	Aggregate Percent
Poaceae	72[2]	73	72.5
Artemisia frigida	2	7	4.5
Chrysopsis villosa	2	-	1.0
Unidentified forbs	4	-	2.0
Total Forbs	8	7	7.5
Berberis repens	16	12	14.0
Ceanothus velutinus	1	-	0.5
Physocarpus malvaceus	1	4	2.5
Pseudotsuga menziesii	2	1	1.5
Rhus trilobata	-	1	0.5
Unidentified shrubs	-	2	1.0
Total Shrubs	20	20	20.0

[1]Taxa with volumes of less than 0.5 percent volume were as follows: *Artemisia tridentata* and *Pinus contorta* from both vegetation types; *Selagenella densa* from the Bunchgrass-Forb Type; and *Prunus virginiana* from the Rock Outcrop Forest Type.

[2]Percent volume of rumen contents.

and prickly gooseberry in the Rock Outcrop Type was in proportion to its occurrence. Bighorn preference for yellow columbine on that type was indicated by the one percent canopy coverage and relatively high percent plant usage of 20 percent (Tables 2 and 11, respectively). Mountain bluebell was the most important plant species used in the Streamside Forb-Sedge Type and constituted 47 percent of the plant usage (Table 11). Grass usage among types was highest during summer on this type and constituted 35 percent of the plant usage. Important

grass and grass-like species were cusick bluegrass and *Carex albonigra*. All plant usage in this type was directly proportional to percent canopy coverages (Table 2).

On all vegetation types bighorns selected for the green leaves on grasses, the flowers on forbs and the upper leaves and flowers on shrubs. The only exception was yellow columbine which was almost entirely consumed.

No feeding sites were obtained during summer for bighorns of the Stillwater herd.

Fall

Both fall feeding sites recorded for bighorns of the West Rosebud occurred on the Alpine Tundra Type and were examined during November (Table 11). Ninety-nine percent of 655 instances of plant use were recorded for grass and grass-like plants. Sedges were the most important species used and comprised 78 percent of the total plant usage. Forbs were of little importance and browse use was not recorded.

All of the fall feeding sites obtained for bighorns of the Stillwater herd occurred on the Seeded Roadbed Type and involved 1,986 instances of plant use (Table 12). Grasses, forbs and shrubs, respectively, constituted 85, 11 and 3 percent of the plant usage. Slender and intermediate wheatgrass, respectively, made up 43 and 36 percent of the bighorn diet on this type. The eight percent canopy coverages

(Table 2) recorded for each of these species was far greater than those for other species and suggests that plant use was in proportion to occurrence. A wide variety of forbs was used, the most important of which was yellow sweetclover which constituted four percent of the plant usage. The only shrub used was raspberry. Analysis of the contents of two rumens collected during November indicated that grasses, shrubs and forbs comprise 72.5, 20.0 and 7.5 percent of the late fall bighorn diet (Table 13). The most important shrub and forb used was Oregon grape and fringed sage, respectively, and they constituted 14.0 and 4.5 percent of the volume of the rumen contents. A much lower fall use of browse species by bighorns was recorded by both Erickson (1972) and Frisina (1974) in the Sun River area. Frisina reported that the only browse species used during fall were Oregon grape and common snowberry. On the Stillwater, snowbrush ceanothus, ninebark, skunkbush sumac, big sagebrush, chokecherry, raspberry, Oregon grape, Douglas fir, and lodgepole pine were used by bighorns during fall (Tables 12 and 13).

At all feeding sites examined during fall, bighorns selected for the lower leaves of grasses, the lower leaves, flowers and fruits of forbs and the terminal twigs, leaves and fruits of browse plants.

Winter

The only bighorn feeding site examined during winter on the West Rosebud occurred on the Alpine Tundra Type and included 257 instances

of plant use (Table 11). Grass and grass-like plants and forbs comprised 98 and two percent of the plant usage, respectively. Bluegrasses and sedges made up 57 and 22 percent of the use, respectively. The only forbs used were elk thistle and sheep cinquefoil. No browse use was recorded. All plant parts that were available were used.

Three feeding sites involving 838 instances of plant use were examined during December on the Stillwater winter area (Table 12). Grass and grass-like plants, forbs and shrubs, respectively, constituted 35, 28 and 38 percent of the plant usage by bighorns. The feeding site examined on the Rock Outcrop-Forest Type involving 263 instances of use, indicated 67 and 33 percent of the plant usage was made up of bluebunch wheatgrass and big sagebrush, respectively. Snow depths in excess of 12 inches were present at the time the site was examined. Both feeding sites obtained on the Bunchgrass-Forb Type during December were examined during conditions of no snow. The percent usage of grass and grass-like plants, forbs and shrubs was 36, 57 and 9, respectively (Table 12). Forty-two percent of the total plant use was on fringed sagewort which had a canopy coverage of six percent (Table 2) and indicated bighorn preference for that species. Important grass species were bluebunch wheatgrass and cheatgrass brome. The only browse use recorded on the Bunchgrass-Forb Type occurred on skunkbush sumac.

The low use of shrubs and the high use of forbs, which included fringed sagewort, during conditions of no snow and the high use of

shrubs during extreme snow depths suggested the importance of browse plants to bighorns in the Stillwater as an emergency forage supply. Schallenberger (1966) indicated a high use of browse species by bighorns of the Sun River and Frisina (1974) indicated this was due to above average snow conditions.

During December bighorns selected for the leaves of big sagebrush, the fruits of skunkbush sumac, the lower leaves of fringed sagewort, the lower leaves and flower parts of forbs, and the green lower leaves of cheatgrass brome and Idaho fescue. All parts of bluebunch wheatgrass were consumed.

Interspecific Relationships

Bighorn Sheep and Mountain Goats

Evaluation of interspecific relationships between bighorns and mountain goats on the study area was limited to the West Rosebud. Only five mountain goats were observed west of the Stillwater River. The percentages of 262 observations of mountain goats recorded in various vegetation types has been presented in Table 14. An indication of summer food habits of mountain goats has been presented in Table 11.

Overlap in range use between bighorns and mountain goats occurred during all seasons and was greatest during each season on the Alpine Tundra Type (Tables 4 and 14). All observations of mountain goats occurred above 8,500 feet in elevation. This usage of the higher

TABLE 14. PERCENT DISTRIBUTION OF 262 OBSERVATIONS OF MOUNTAIN GOATS IN EACH OF 6 VEGETATION TYPES BY MONTH AND SEASON.

Type[1]	July	Aug.	Season	Sept.	Oct.	Nov.	Season	Dec.
Rock Outcrop-Forest					6		4	
Spruce-Fir	1	7	3					18
Subalpine Meadow				50			18	
Streamside Forb-Sedge				40			15	
Alpine Tundra	94	93	94	10	94		63	82
Rock Outcrop-Snowfield	5		3					
Sample Size	133	74	207	10	17	0	27	28

[1]Includes only those types in which goats were observed.

elevations from July through December was closely correlated with that of bighorns of the West Rosebud herd. Four feeding sites involving 838 instances of plant use indicated that forbs and grasses, respectively, constituted 60 and 40 percent of the mountain goats summer diet (Table 11). Forbs constituted 55 percent of the bighorn summer diet. Plant species significant in food habits of both animal species during summer included Parry clover, sedges and bluegrasses. No mountain goat feeding sites were obtained during fall or early winter.

Although the overlap in range use and food habits during summer fulfills Julander's (1958) criteria for potential competition between the two species, competition at present is probably minimal since both

bighorn and mountain goat numbers in the West Rosebud are small. Of 262 observations of mountain goats obtained during the study period only 32 occurred in specific areas inhabitated by bighorns of the West Rosebud herd.

Bighorn Sheep and Mule Deer

As with mountain goats, the evaluation of interspecific relationships between bighorns and mule deer was limited to the West Rosebud as only 15 of 71 observations of mule deer occurred west of the Stillwater River. The percent distribution of mule deer in vegetation types and the evaluation of three mule deer feeding sites involving 783 instances of use has been presented in Tables 15 and 11, respectively.

Overlap of range use between bighorns and mule deer was indicated only during summer on the Alpine Tundra Type (Tables 4 and 15). No mule deer were observed above an elevation of 8,500 feet after August. Two mule deer feeding sites examined during summer which involved 672 instances of plant use indicated that their summer diet constituted 70 percent forbs and 30 percent grasses (Table 11). Important plant species used by both mule deer and bighorns included Parry clover and bluegrasses.

Few mule deer used the Alpine Tundra Type during summer and consisted almost entirely of large males. The small number of bighorns

TABLE 15. PERCENT DISTRIBUTION OF 71 OBSERVATIONS OF MULE DEER IN EACH OF 9 VEGETATION TYPES BY MONTH AND SEASON.

Type[1]	July	Aug.	Season	Sept.	Oct.	Nov.	Season	Dec.
Bunchgrass-Forb								100
Bunchgrass-Sage	3		2		100	40	67	
Douglas Fir-Snowberry	3		2					
Douglas Fir-Ninebark						60	25	
Lodgepole Pine		4	2					
Streamside-Hardwood	3		2	100			8	
Spruce-Fir	3		2					
Subalpine Meadow	6	10	8					
Alpine Tundra	82	86	83					
Sample Size	33	21	54	1	6	5	12	5

[1]Includes only those types in which mule deer were observed.

and mule deer present in the area indicated that competition between the two species was minimal.

Bighorns and Livestock

Bighorn and livestock interspecific relationships were evaluated only on the Stillwater where range overlap occurred on the Bunchgrass-Forb winter area. The examination of two feeding sites involving 583 instances of plant use by livestock indicated that their early winter diet consisted almost entirely of grasses (Table 12).

Data from Tables 12 and 13 indicated that a substantial percentage of the bighorn diet on this type was also made up of grasses. Important species used by both bighorns and livestock during early winter were bluebunch wheatgrass and fringed sagewort.

Gordon and Coop (1973) reported that since the removal of livestock from the Stillwater winter area in 1968, the vegetation had improved. Transects to evaluate usage of grass indicated in 1972 that utilization on Idaho fescue was down from the level of use in 1971. The maximum number of cows, horses and donkeys observed on the area at any one time totaled five. The indicated range improvement as well as the small number of livestock using the area suggested that competition between the bighorns and livestock was minimal.

Livestock usage on the West Rosebud is largely confined to the creek bottoms and adjacent benches during the fall grazing period due to the extreme topography of the area. Bighorns seldom use these areas during fall and when present inhabit the higher areas that are inaccessible to livestock. This suggested that there was no competition between bighorns and livestock on the West Rosebud area.

RECOMMENDATIONS

Of the several herds of bighorns residing within Bighorn Hunting District 501, only limited information has been collected and all is for the Stillwater and West Rosebud herds. Movement and observation data indicated that these two herds are separate entities and suggested they should be managed as such. However, the lack of information concerning fall movements of rams from the West Rosebud herd precludes the establishment of a separate hunting unit for that herd at this time. Movement and observation data from the Stillwater indicated nearly all bighorns of that herd were within one mile of the highway by mid-October, justifying a separate hunting unit. Boundaries of the hunting area should include the area between the Main Stillwater and the Boulder Rivers. The preponderance of younger males and the lack of older males in this herd suggested that the herd is heavily hunted and that a high percent of legal males are harvested. For the above reasons it is recommended that the Stillwater herd be removed from the unlimited permit status of Beartooth Bighorn Hunting District 501 and put on a limited permit basis, and that a separate hunting unit for this herd be established.

Limited data suggested the potential for competition for range and forage between bighorns and livestock on the Stillwater winter area. Although competition at present is thought to be slight, I recommend that efforts to curtail the use of this area by livestock be continued.

LITERATURE CITED

Billings Geological Society. 1958. Beartooth Uplift and Sunlight Basin. 9th Annual Field Conference. 108 pp.

Booth, W. E. 1950. Flora of Montana, Part I - Conifers and Monocots. Research Foundation, Montana State College, Bozeman. 232 pp.

_____. and J. C. Wright. 1959. Flora of Montana, Part II - Dicotyledons. Montana State College, Bozeman. 305 pp.

Couey, F. M. 1953. Are the bighorns doomed? Montana Wildlife. 5(3): 6-8.

_____. 1955. Bighorns are Back. Montana Wildlife. 3(1): 16-18.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science. 33(1): 43-64.

_____. 1970. Steppe vegetation of Washington. Washington Agricultural Experiment Station. Technical Bulletin 62. 131 pp.

Erickson, G. L. 1972. The ecology of Rocky Mountain bighorn sheep in the Sun River area of Montana with special reference to summer food habits and range movements. Unpubl. Master's Thesis, Montana State University, Bozeman. 50 pp.

Frisina, M. R. 1974. Ecology of Bighorn Sheep in the Sun River area during fall and spring. Unpubl. Master's Thesis, Montana State University, Bozeman. 68 pp.

Gordon, F. A. and K. J. Coop. 1973. Big game survey and inventory-deer, antelope, elk, moose, mountain goats and mountain sheep-

Harrison, J. L. 1958. Range of movement of some Malayan rats. J. Mammal. 39(3): 190-206.

Hayne, D. W. 1949. Calculation of size of home range. J. Mammal. 30(1): 1-18.

Holman, R. 1974. Personal communication. Guide and Outfitter, Big Timber, Montana.

Julander, O. 1958. Techniques in studying competition between big game and livestock. J. Range Mgmt. 11(1): 18-21.

Knowlton, F. E. 1960. Food habits, movements and populations of moose in the Gravelly Mountains, Montana. J. Wildl. Mgmt. 24(2): 162-170.

Knox, A. 1971. Personal communication. U.S.D.A. Forest Service, Red Lodge, Montana.

Koch, E. 1940. Big game in Montana from early historical records. Field Notes on Wildlife-Northern Rocky Mountain Region. 1(5): 16 leaves.

Martin, A. C., R. H. Gensch and C. P. Brown. 1946. Alternative methods in upland game bird food analysis. J. Wildl. Mgmt. 10(1): 8-12.

Montana Fish and Game Department Wildlife Biologists. 1974. Personal communication. Region 5. Billings, Montana.

Morgan, J. K. 1970. Rocky Mountain bighorn sheep investigations. Idaho Fish and Game Dept. Research Completion Report. Proj. No. W-142-R-1, Jobs 1, 2, and 3. 155 pp.

Mueggler, W. F. and W. P. Handl. 1973. Preliminary classification of mountain grassland and shrubland habitat types in southwestern Montana. U.S.D.A. Forest and Range Exp. Stat. and Region 1 Progress Rept. 52 pp. Mimeo.

Oldemeyer, J. L., W. J. Barmore and D. L. Gilbert. 1971. Winter ecology of bighorn sheep in Yellowstone Park. J. Wildl. Mgmt. 35(2): 279-290.

Olsen, M. 1973. Personal communication. Guide, Bearcreek, Montana.

Pfister, R. D., S. F. Arno, B. L. Kovalchik and R. C. Presby. 1973. Preliminary forest habitat types of central and eastern Montana. U.S.D.A. Forest and Range Exp. Stat. and Region 1. 82 pp.

Schallenberger, A. D. 1966. Food habits, range use and interspecific relationships of bighorn sheep in the Sun River area of west central Montana. Unpubl. Master's Thesis, Montana State University, Bozeman. 44 pp.

South, P. R. 1971. Ecosystems of the Absaroka and Beartooth Mountains. U.S.D.A. Forest Service Unpublished Report.

Stoneberg, R. P. 1973. Planning Inventory, game-elk, bighorn sheep, mountain goats, mule deer, and grouse-District 5. Montana Fish and Game Dept. Progress Report, Proj. Nos. FW-2-R1 and FW-2-R-2, Job 1-a. 18 pp.

_____. 1974. Personal communication. Montana Fish and Game Biologist, Nye, Montana.

U. S. Department of Agriculture Forest Service. 1928. Census of mountain sheep in the Beartooth Mountains. Montana Wildlife. Vol. 1(2): 6-7.

U. S. Department of Commerce Weather Bureau. 1931-1960. National Oceanic and Atmospheric Administration Environment Data Service Montana Monthly summary.

_____. 1973. National Oceanic and Atmospheric Administration Environment Data Service Montana Monthly summary.

White, J. E. 1964. An index of range activity. Am. Midl. Nat. 71(2): 369-373.

Wilkins, B. T. 1957. Range Use, Food Habits, and Agricultural Relationships of the Mule Deer, Bridger Mountains, Montana. J. Wildl. Mgmt. 21(2): 159-169.

APPENDIX

TABLE 16. PERCENT DISTRIBUTION OF 151 OBSERVATIONS OF BIGHORNS FROM 17 AERIAL FLIGHTS[1] IN EACH OF 13 VEGETATION TYPES FOR SUMMER, FALL AND WINTER.

	Bunch-grass-Forb	Douglas Fir-Snowberry	Seeded Roadbed	Douglas Fir-Ninebark	Mountain Meadow	Stream-side-Hardwood	Rock Outcrop-Forest	Spruce-Fir	Sub-alpine Meadow	Stream-side Forb-Sedge	Rock Out-Crop	Al-pine Tundra	Rock Outcrop-Snowfield	Sample Size
July (3 flights)												40	60	5
Aug. (6 flights)												100		6
Season (9 flights)												73	27	11
Sept. (3 flights)								100						3
Oct. (2 flights)							9	16	5			20	50	44
Nov. (0 flights)														0
Season (5 flights)							9	21	4			19	47	47
Dec. (3 flights)												100		93

[1] Includes one helicopter flight in December.

TABLE 17. RELOCATIONS, SEASONAL CENTERS OF ACTIVITY AND SEASONAL STANDARD DIAMETERS OF 10 MARKED BIGHORNS OF THE WEST ROSEBUD AND STILLWATER HERDS.

Tag No.	Sex	Drainage Marked	Date Captured	Map Coordinates of Capture Location	Date Relocated 1973	Map Coordinates of Relocation	Distance from Site of Capture in miles	Distance from Site of last Relocation in miles	Location of Fall Center of Activity	Standard Diameter of Fall area in miles	Location of Winter Center of Activity	Standard Diameter of Winter Area in miles
S3535	♀	West Rosebud	4/26/73	T6S R16E S36	9/2	T9S R14E S1	17.6		T9S R14E S17	6.47		
					10/4	T9a R14E S21	22.0	4.3				
						T9S R13E S27	26.5	5.6				
						T9S R14E S17	21.3	5.6				
					10/19	T9S R14E S15	20.3	1.6				
					12/24	T7S R16E S5	3.8	17.5				
S3537	♀	West Rosebud	4/27/73	T7S R16E S2	9/26	T7S R16E S3	1.7					
					10/7	T7S R16E S3	1.7	0				
					12/5	T7S R16E S4	2.2	.75				
S3539	♀	West Rosebud	5/3/73	T7S R16E S2	7/6	T7S R16E S3	1.7					
					10/7	T7S R16E S3	1.7	0				
S3540	♀	West Rosebud	5/3/73	T7S R16E S2	11/2	T7S R16E S3	1.7					
					9/26	T7S R16E S3	1.7	0				
S3541	♀	West Rosebud	5/24/73	T7S R16E S3	7/15	T7S R16E S3	.3					
					7/21	T7S R15E S12	4.0	3				
					12/5	T7S R16E S4	1.2	2.6				
S3536	♂	West Rosebud	4/26/73	T6S R16E S36	7/28	T6S R15E S29	9.3		T9S R14E S29[1]	0.36[1]		
					7/30	T6S R15E S29	9.1	.3				
					8/9	T6S R15E S29	9.2	.1				
					10/6	T7S R16E S3	2.6	7.3	T6S R16E S34	2.66		
					10/7	T7S R16E S3	2.4	.2				
					10/7	T6S R16E S27	2.6	2.5				
					10/12	T6S R16E S27	2.6	0				
					12/9	T6S R16E S28	.5					
S4287	♀	Stillwater	3/13/73	T5S R15E S29	10/10	T5S R15E S29	.6		T5S R15E S29	1.88		
					10/11	T5S R15E S20	.6	1.0				
					10/14	T5S R15E S20	.6	.45				
					10/25	T5S R15E S29	.75	.6				
					10/27	T5S R15E S20	1.0	.5				
					10/28	T5S R15E S20	1.0	0				
					11/1	T5S R15E S21	1.3	1.4				
					11/2	T5S R15E S21	1.25	1.25				
					11/7	T5S R15E S28	.55	.75				
					11/19	T5S R15E S29	.25	.25				
					11/25	T5S R15E S29	.45	.65				
					11/26	T5S R15E S29	.45	.25				
					11/27	T5S R15E S29	.4	.15				
					12/7	T5S R15E S32	1.45	1.15			T7S R15E S29	1.37
					12/7	T5S R15E S32	1.5	.25				
					12/8	T5S R15E S29	.5	1.1				
					12/14	T5S R15E S29	.4	.65				
					12/15	T5S R15E S28	.8	.5				

TABLE 17. (Continued).

Tag No.	Sex	Drainage Marked	Date Captured	Map Coordinates of Capture Location	Date Relocated 1973	Map Coordinates of Relocation	Distance from Site of Capture in miles	Distance from Site of last Relocation in miles	Location of Fall Center of Activity	Standard Diameter of Fall area in miles	Location of Winter Center of Activity	Standard Diameter of Winter Area in miles
					12/17	T5S R15E S20	.45	.9				
					12/18	T5S R15E S28	.45	.4				
					12/21	T5S R15E S28	.5	.3				
					12/23	T5S R15E S28	.5	.2				
					12/26	T5S R15E S29	.25	.4				
S4289	♀	Stillwater	4/17/73	T5S R15E S29	10/27	T5S R15E S20	1.0		T5S R15E S29	1.47		
					10/28	T5S R15E S20	1.0	0				
					11/1	T5S R15E S21	1.3	1.4				
					11/2	T5S R15E S21	1.25	.1				
					1/7	T5S R15E S32	.9	1.85				
					11/10	T5S R15E S20	1.0	1.9				
					11/19	T5S R15E S28	.5	1.0				
					11/25	T5S R15E S29	.2	.4				
					11/26	T5S R15E S29	.2	.15				
					12/14	T5S R15E S28	.45	.3			T5S R15E S29	.47
					12/1	T5S R15E S20	.2	.25				
					12/18	T5S R15E S28	.3	.1				
					12/21	T5S R15E S29	.3	.15				
					12/23	T5S R15E S28	.4	.15				
					12/26	T5S R15E S29	.4	.5				
					12/27	T5S R15E S28	.55	.75				
S3534	♀	Stillwater	4/18/73	T5S R15E S29	11/7	T5S R15E S28	.5					
					11/18	T5S R15E S29	.2	.3				
S4285	♂	Stillwater	3/12/73	T5S R15E S29	8/29	T8S R12E S4	21.3					
					9/9	T7S R12E S27	19.5	2.0	T5S R15E S32	12.30		
					9/24	T5S R15E S20	.75	20				
					9/29	T5S R15E S20	.8	.1				
					9/30	T5S R15E S20	.7	.25				
					10/21	T5S R15E S10	1.1	.4				
					11/1	T5S R15E S21	1.3	1.6				
					11/2	T5S R15E S21	1.25	.1				
					11/15	T5S R15E S20	1.1	1.2				
					11/4	T5S R15E S30	1.0	1.8				
					11/27	T5S R15E S29	.4	.9				
					12/8	T5S R15E S32	.9	.5			T5S R15E S29	.93
					12/14	T5S R15E S29	.45	1.25				
					12/15	T5S R15E S28	.8	.5				
					12/17	T5S R15E S29	.25	.8				
					12/18	T5S R15E S29	.4	.6				
					12/21	T5S R15E S28	.5	.4				
					12/23	T5S R15E S29	.3	.2				
					12/26	T5S R15E S29	.25	.45				

[1] = Summer.