Ecology of the West Rosebud and Stillwater bighorn sheep herds, Beartooth Mountains, Montana
by Shawn Thomas Stewart

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

Abstract:
A study was conducted in the West Rosebud and Stillwater drainages of the Beartooth Mountains, southcentral Montana, during the summer of 1974 and the winter and spring of 1975 to obtain quantitative data on populations, range use, food habits and movements of bighorn sheep in these areas. Eleven major habitat types and twelve subtypes were recognized. Canopy-coverages and frequencies of occurrence were determined for low growing plant taxa in each habitat type and/or subtype. Recent trends in total numbers of bighorn sheep on both the West Rosebud and Stillwater ranges during spring appeared directly related to the numbers of lambs produced and surviving through winter. Lamb:ewe ratios were 64:100 during the summers of 1973 and 1974 on the West Rosebud, but lamb mortalities in excess of 80 percent during the subsequent winters resulted in a declining population. The Stillwater population has generally increased since 1972 with lamb:ewe ratios ranging from 41:100 to 60:100 during winter and spring. West Rosebud bighorns appeared to lamb during the last week of June and the first week of July, nearly one month later than is thought to be "normal" for bighorns. During winter West Rosebud bighorns ranged on high alpine plateaus and were restricted to small windswept areas of the Cavex/Podi h.t. where relatively little forage of low nutritional value was available. In April these bighorns migrated down to the steep valley slopes along West Rosebud Creek, dominated by the Avtv subtype (Pipo/Feid h.t.), where forage of high nutritional quality was available. Stillwater bighorns spent the winter and spring in the valley bottom using various habitat types where forage of high nutritional quality was relatively abundant. Inferior horn growth, higher lungworm larval output and high lamb mortality on the West Rosebud probably reflected these differences in range use and forage conditions on the two areas. Food habits were determined from feeding site examination and supplemented by rumen analyses. Dried forbs dominated the bighorns diet on the primary West Rosebud winter range. On the Stillwater preferred grasses comprised most of the winter diet, though forbs and browse plants were also used. Grasses dominated the spring diet on both areas. Grasses, forbs and browse was the order of importance of forage classes used by West Rosebud bighorns during summer and fall. Mule deer generally used the same habitat types as bighorn sheep on the two areas, but there was little overlap in food habits between these two species. Mountain goats generally used the same habitat types and forage species as bighorns. Food habits of horses, cattle and domestic sheep overlapped significantly with those of bighorn sheep.

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Fish and Wildlife Management

Approved:

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Bozeman, Montana

December 1975

ACKNOWLEDGMENT

To the following, among others, the author wishes to express his sincere appreciation for their contributions to this study: Dr. Richard J. Mackie, Montana State University, who aided in the preparation of the manuscript and who, along with Dr. Don C. Quimby, Montana State University, directed the study; Drs. Robert L. Eng and William R. Gould, Montana State University, for reviewing the manuscript; Dr. John H. Rumely, Montana State University, for aid in identification of plant specimens; Dr. David E. Worley, Montana State University, for lungworm larvae analyses; Dr. James A. Heimbach, Montana State University, for use of equipment; Mr. H. O. Compton, Montana Department of Fish and Game, for initial project planning, technical advice and assistance; Messers. Ronald P. Stoneberg, Greg L. Pallister and Jeff Denton, Montana Department of Fish and Game personnel, for use of their data of October and November 1974, and for field assistance and technical advice; Mr. Floyd Gordon, Montana Department of Fish and Game, for technical advice and assistance; Mr. Kenneth R. Greer, Montana Department of Fish and Game, for use of lab facilities; personnel of the Beartooth Division, Custer National Forest, for use of facilities; Messers. William Henderson, Glenn McKenzie, Thomas Frost, Charles Scherzberg, Dewey Whited and Henry Bedford, area landowners, for their hospitality and assistance; and to Messers. Phil Huck and Rudy Williams, Managers of the Mystic Lake Power Plant, for advice and assistance.

The author would also like to extend a very special thanks to his wife, Cheryl, for her constant field companionship and assistance, and for her encouragement, understanding and patience. The author was supported by the Montana Department of Fish and Game under Federal Aid Project W-120-R during this study.

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ABSTRACT

A study was conducted in the West Rosebud and Stillwater drainages of the Beartooth Mountains, southcentral Montana, during the summer of 1974 and the winter and spring of 1975 to obtain quantitative data on populations, range use, food habits and movements of bighorn sheep in these areas. Eleven major habitat types and twelve subtypes were recognized. Canopy-coverages and frequencies of occurrence were determined for low growing plant taxa in each habitat type and/or subtype. Recent trends in total numbers of bighorn sheep on both the West Rosebud and Stillwater ranges during spring appeared directly related to the numbers of lambs produced and surviving through winter. Lamb:ewe ratios were 64:100 during the summers of 1973 and 1974 on the West Rosebud, but lamb mortalities in excess of 80 percent during the subsequent winters resulted in a declining population. The Stillwater population has generally increased since 1972 with lamb:ewe ratios ranging from 41:100 to 60:100 during winter and spring. West Rosebud bighorns appeared to lamb during the last week of June and the first week of July, nearly one month later than is thought to be "normal" for bighorns. During winter West Rosebud bighorns ranged on high alpine plateaus and were restricted to small windswept areas of the *Carex/Podi* h.t. where relatively little forage of low nutritional value was available. In April these bighorns migrated down to the steep valley slopes along West Rosebud Creek, dominated by the *Artr* subtype *(Pipo/Feid* h.t.), where forage of high nutritional quality was available. Stillwater bighorns spent the winter and spring in the valley bottom using various habitat types where forage of high nutritional quality was relatively abundant. Inferior horn growth, higher lungworm larval output and high lamb mortality on the West Rosebud probably reflected these differences in range use and forage conditions on the two areas. Food habits were determined from feeding site examination and supplemented by rumen analyses. Dried forbs dominated the bighorns diet on the primary West Rosebud winter range. On the Stillwater preferred grasses comprised most of the winter diet, though forbs and browse plants were also used. Grasses dominated the spring diet on both areas. Grasses, forbs and browse was the order of importance of forage classes used by West Rosebud bighorns during summer and fall. Mule deer generally used the same habitat types as bighorn sheep on the two areas, but there was little overlap in food habits between these two species. Mountain goats generally used the same habitat types and forage species as bighorns. Food habits of horses, cattle and domestic sheep overlapped significantly with those of bighorn sheep.

INTRODUCTION

Populations of Rocky Mountain bighorn sheep *(Ovis canadensis canadensis* Shaw) winter in several distinct areas in the Beartooth Mountains of south central Montana. The principle wintering areas include main Rock Creek, West Rosebud Creek, and the main Stillwater River. Until recently, available information on these bighorns was limited to occasional counts on winter ranges and examination of a few scattered feeding sites (Pallister 1974).

Coordinated studies of bighorns in the West Rosebud and Stillwater drainages was initiated in 1971. Stoneberg (1973, 1974) studied reproduction and the incidence of lungworm among bighorns as well as utilization of grasses on winter range from 1971 to 1974, while Pallister (1974) studied population composition, movements, range use and food habits during the summer and fall of 1973.

The present study extended the latter investigation through the summer of 1974 and the winter and spring of 1975. In addition, total standing crop of forage and the protein content of principle forage species were determined to evaluate possible effects on the bighorn sheep populations.

METHODS

Twenty-seven bighorn sheep were individually marked between the spring of 1973 and the spring of 1975 by Montana Department of Fish and Game biologists using a "cap-chur" gun. Sixteen were marked on the Stillwater River and 11 on West Rosebud Creek. Each sheep was fitted with a neckband which was color-coded as to area of capture, and tagged in the right ear with a numbered metal tag and in the left ear with a plastic cattle tag embossed with black numerals.

Several methods were used to locate marked as well as unmarked bighorn sheep. During summer, most observations were made by backpacking to back country camps from which daily observational trips were made. When sheep were at lower elevations, observations were made from a vehicle. Nine and five flights in fixed-wing aircraft, were made during summer and winter, respectively. In addition, one helicopter flight was made during the winter period to gain access to the otherwise inaccessible West Rosebud winter range, and two helicopter flights were made during the spring period in an effort to locate lambing areas.

Information recorded at each bighorn observation site included the location, time of day, temperature, estimated wind velocity, habitat type, distance to escape cover, elevation as determined from U.S.G.S. quadrangle maps, and an estimate of degree of slope. The bighorns were classified as to age, sex, activity and whether marked or unmarked.

Similar data were recorded for all observations of mule deer *(Odocoileus hemionus)* and mountain goats *(Oreamnos americanus)* to evaluate possible interactions between these species and bighorn sheep.

All bighorn rams were classified as to the degree of horn curl (1/4 or less, 1/4 to 1/2, 1/2 to 3/4, or 3/4+). Whenever possible, I attempted to further "age" rams with less than 3/4-curl by counting horn segments (Geist 1966).

Vegetation of the study area was classified by habitat type and/or subtype. Vegetation of representative areas within each type used by bighorn sheep was quantitatively sampled using the canopy-coverage method (Daubenmire 1959). Canopy-coverage and frequency of occurrence of plant species less than one meter tall were obtained by examination of twenty 2x5 decimeter plots located at five foot intervals along a line transect. A plant collection was compiled to aid in recognition of species. Plant nomenclature follows Booth (1950) and Booth and Wright (1966).

The amount of forage available to the sheep at the end of the winter period was determined for each habitat type or subtype. Estimates were made by clipping all herbaceous plants to ground level and stems up to five mm. in diameter of all browse species from twenty 2x5 decimeter plots in each habitat type. Forage collections were made at the same time as the canopy-coverage transects were read. An equal number of plots was clipped from each of the transects within a

habitat type for the total of twenty plots. Forage was oven dried and the standing crop calculated on a dry weight basis.

Food habits of bighorn sheep were determined by examination of feeding sites (Cole 1956). Similar data were gathered for mule deer, mountain goats and domestic livestock to determine if forage competition existed between these species and bighorns. An estimation of one bite was considered to represent one instance of use. Rumen samples collected from bighorns killed in tagging operations as well as from one illegally killed bighorn ram provided supplementary data. Analysis of data of both feeding site examinations and rumen analyses followed the mean percentage method of Martin et al. (1946). A preference index of each forage species was calculated according to the method described by Peterson (1970).

One-gram samples of each major bighorn sheep forage species were collected from each of the most important habitat types and/or subtypes for determination of crude protein content. The two periods of sample collection were mid-winter (late February) and late winter (mid-April). Chemical analyses were conducted by the Montana State University Analytical Chemistry Laboratory, Bozeman.

Fecal samples were collected throughout the winter and spring periods to determine the incidence and intensity of lungworm (*Protostrongylus* spp.) infestations. Analyses were conducted by the Montana State University Veterinary Laboratory, Bozeman.

DESCRIPTION OF AREA

The study was conducted on a 300 square mile area located approximately 75 miles southwest of Billings, Montana (Pallister 1974). Boundaries were a line including 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 National Park boundary on the south, and the West Fork of the Stillwater River and the border of the Custer National Forest on the north (Fig. 1). Approximately one-half of the area was within the Beartooth Primitive Area.

Topographically, the study area was extremely diverse. Elevations ranged from approximately 5,000 feet on the Stillwater winter range to 12,799 feet at Granite Peak, the highest peak in Montana. A large part of the area consisted of alpine plateaus, rising gradually from 9,800 feet to nearly 12,000 feet. The plateaus are broken by numerous glacially carved canyons which commonly drop 2,000 feet or more to snow fed lakes and streams. Slopes along these canyons vary from 50 to more than 75 degrees. To the north and east the canyons and ridges terminate in grass and timber covered foothills; to the south and west they are continuous with the more gentle alpine areas adjoining the timbered plateaus of Yellowstone Park described by Meagher (1973).

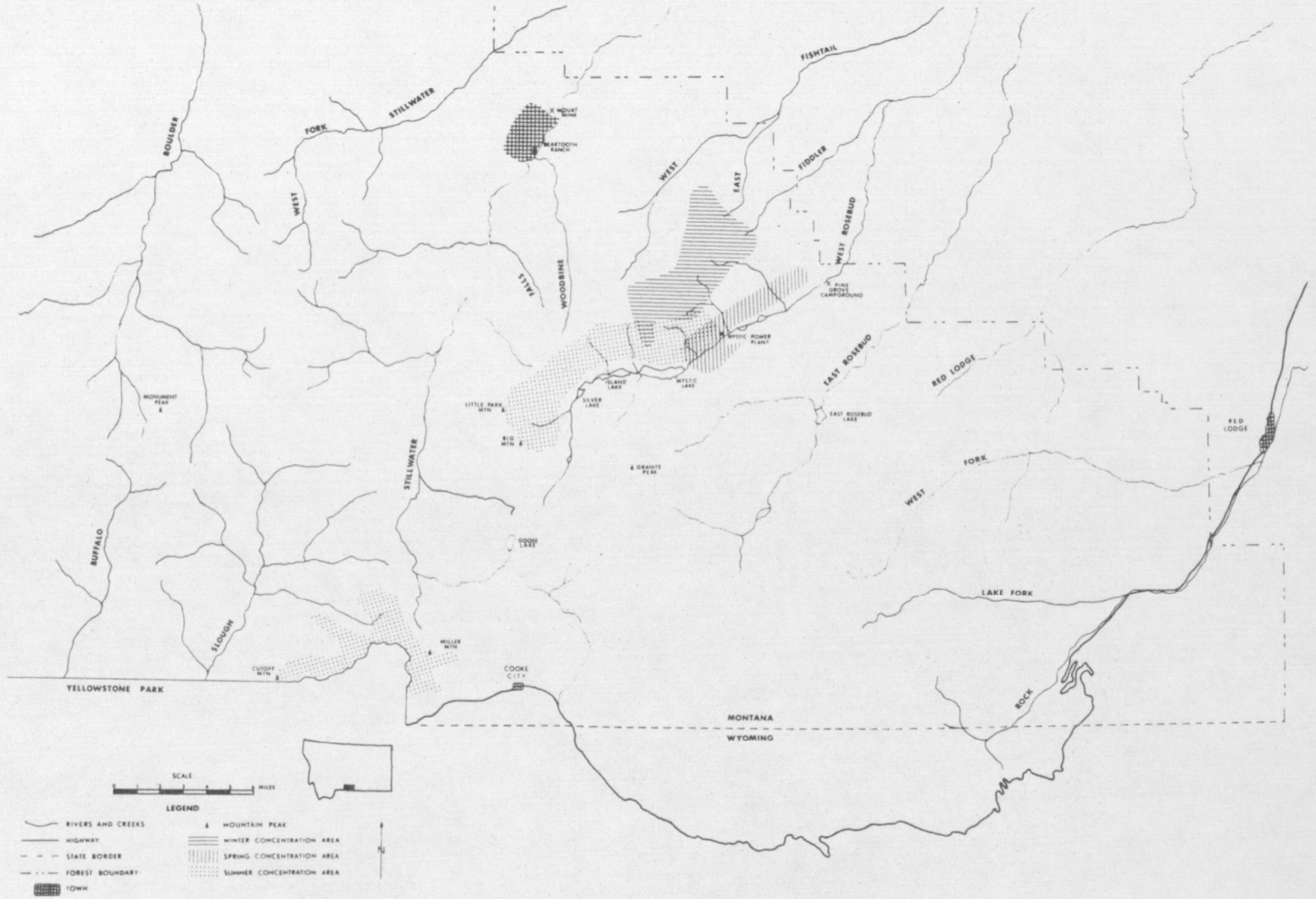

Figure 1. Map of the study area showing the distribution of bighorn sheep of the West Rosebud and Stillwater areas by season.

The geology of the Beartooth block is described in detail in studies published by the Billings Geological Society (1958).

Weather data, generally indicative of weather conditions of the area (Table 1), were obtained from the U. S. Weather Bureau Station at the Mystic Lake Power Plant at an elevation of 6,558 feet in the West Rosebud drainage. In addition, I recorded temperatures at an elevation of approximately 5,250 feet in the Stillwater drainage using a hygrothermograph. The mean temperature of 42.1 F. at Mystic Lake during 1974 was only slightly higher than the normal 41.6 F. (U. S. Department of Commerce Weather Bureau 1974). There were no consistent differences from the normal in monthly trends. Mean temperatures for each of the first six months of 1975 were consistently lower than normal (U. S. Department of Commerce Weather Bureau 1975). Mean monthly temperatures in the Stillwater for early 1975 were generally warmer than the corresponding temperatures of the West Rosebud, probably due to the lower elevation of the Stillwater area. Total precipitation at Mystic Lake in 1974 was 31.32 inches, or considerably more than the normal 25.67 inches (Table 1). All of the first six months of 1975, except April, showed greater than normal precipitation. Although total monthly precipitation in 1975 was greater than that of 1974 for only three of the first six months, total snowfall during 1975 was substantially greater in all months except March and June (Table 1). Snowfall

Table 1. Temperature, precipitation, and snowfall of the West Rosebud and Stillwater Drainages[1] during 1974 and 1975.

	Temperatures (°F)				Precipitation (Inches)			Snowfall (Inches)	
	Mystic Lake Normal[2]	Mystic Lake 1974	Mystic Lake 1975	Stillwater 1975	Mystic Lake Normal	Mystic Lake 1974	Mystic Lake 1975	Mystic Lake 1974	Mystic Lake 1975
January	24.0	20.0	22.3	26.4	1.53	1.44	3.01	14.0	39.1
February	26.4	30.2	22.6	28.6	1.20	0.56	1.36	9.0	18.0
March	28.4	29.4	26.2	31.2	2.28	3.37	2.37	43.0	32.0
April	37.9	41.2	29.6	37.4	3.07	3.30	2.60	23.5	33.5
May	46.7	42.8	42.7	47.4	3.47	4.93	4.46	19.5	58.0
June	53.7	59.0	52.2		3.57	3.62	4.41	10.0	Tr
July	62.6	64.9			1.97	2.74			
August	61.8	56.9			1.81	2.45			
September	52.7	51.0			2.34	1.88		10.0	
October	45.0	47.0			1.55	5.64		29.5	
November	32.9	33.7			1.70	0.62		6.5	
December	27.2	28.6			1.18	0.77		9.5	
Annual Mean or Total	41.6	42.1			25.67	31.32			

[1]Only temperature data available for Stillwater drainage.
[2]Normals computed from 1941-1970 data.

in 1975 was also greater than 1974 in the Stillwater drainage (R. Stoneberg pers. comm.).

Average monthly wind velocities (Table 2), as recorded with anemometers, were considerably greater in the Stillwater area than on the West Rosebud. This probably was a major reason why the Stillwater winter range was generally free of snow while the West Rosebud canyon consistently held at least some snow cover.

Table 2. Average monthly wind speeds (in miles per hour) of the West Rosebud and Stillwater drainages in 1975.

	West Rosebud	Stillwater
January	9.58	13.76
February	9.81	13.69
March	6.11	8.54
April	5.16	19.88
May	4.63	5.60

Although wind data collected previously (1971-74) at the Mouat Mine in the Stillwater drainage (Richmand and Adler 1974) were not comparable to my data, residents of the area considered the winter of 1974-75 to be less windy than normal (B. Dowd, W. Henderson, and R. Stoneberg pers. comm.).

The combination of lower than average temperatures, higher than average snowfall and less wind than normal resulted in greater than normal snow depths on the winter ranges during 1974-75.

Vegetation

General characteristics of the vegetation of the Beartooth Mountains have been described by South (1971), who recognized 17 ecosystems on the basis of characteristic flora and fauna, and Pallister (1974), who quantitatively described the plant communities important to bighorn sheep.

To evaluate and describe habitat usage by bighorn sheep, I divided the study area into habitat types (hereafter abbreviated h.t.) following recent classifications and descriptions of climax forest types of Montana (Pfister et al. 1974) where vegetation appeared to be climax. Alpine, subalpine and river bottom types not considered by Pfister et al. (1974) were designated on the basis of characteristic or "dominant" plant species as determined by canopy-coverage. Seral stages of the habitat types, as well as areas specifically important to bighorns, were recognized as subtypes.

Eleven types and 12 subtypes were recognized on the study area. Because the West Rosebud and Stillwater winter ranges were comprised of totally different habitat types (Tables 4 and 5), vegetational characteristics of these two areas are described separately. Species composition, canopy-coverage, and frequencies of occurrence of grasses, forbs and low shrubs for these types on the West Rosebud summer range, the West Rosebud winter range, and the Stillwater winter range are presented in Tables 3, 4 and 5, respectively.

Table 3. Mean percentage canopy coverage and frequency of grasses, forbs and low shrubs present in greater than trace[1] amounts on habitat types and subtypes on the West Rosebud summer range as determined by examination of twenty 2x5 decimeter plots in each site. Numbers of sites examined are in parentheses.

Taxa	*Carex/Podi* Climax (4)	*Carex/Podi* Rock (2)	*Abla/Vagl*[2] Climax (1)	*Abla/Vagl*[2] Rock (3)	*Abla/ Vasc* (1)	*Pial/ Acmi* (2)	*Poa/ Trifo* (1)
Grasses and Grass-like Plants							
Agropyron caninum				3/35[3]			
Agropyron scribneri	Tr/11					1/20	
Agropyron spicatum				2/ 8			
Agrostis scabra				2/10			
Bromus spp.				Tr/ 5			
Carex spp.	10/42	1/15		3/18	10/70	8/45	
Dactylis glomerata							4/70
Deschampsia atropurpurea					4/55		
Deschampsia caespitosa	1/ 6						
Equisetum arvense			1/20				
Festuca ovina	Tr/10				1/25	Tr/12	
Juncus balticus					3/50		
Koeleria cristata	3/51	Tr/Tr				Tr/18	
Luzula wahlenbergii	Tr/Tr				1/40		
Melica spectabilis					Tr/ 5		
Phleum alpinum					Tr/10	Tr/Tr	
Phleum pratensis			1/20				
Poa spp.	5/61	10/75		1/13	5/60	6/62	33/100
Unknown		1/15		1/15	1/10		
Forbs							
Achillea millefolium	2/21	3/48		Tr/10		8/78	
Agoseris glauca	1/10				Tr/15	3/72	

Table 3. Continued

Taxa	*Carex/Podi* Climax (4)	*Carex/Podi* Rock (2)	*Abla/Vagl* Climax (1)	*Abla/Vagl* Rock (3)	*Abla/ Vasc* (1)	*Pial/ Acmi* (2)	*Poa/ Trifo* (1)
Forbs (cont.)							
Antennaria spp.	1/16			Tr/Tr	2/50	1/12	
Apiaceae	Tr/Tr					1/22	
Apocynum androsaemifolium				1/10			
Arnica latifolia					6/20	Tr/Tr	
Artemisia scopulorum	1/ 6						
Aster alpigenus					Tr/ 5	1/Tr	
Astragalus vexilliflexus	7/50						
Brassicaceae	Tr/Tr	Tr/ 5		1/23	1/45	Tr/ 5	
Castillega cusickii	1/10						
Cerastium arvense	5/71	Tr/Tr				1/30	
Cerastium vulgatum							1/ 6
Cirsium foliosum		1/ 5					
Epilobium angustifolium		Tr/15					
Erigeron spp.	2/39	Tr/Tr			3/55	9/68	
Eriogonum umbellatum				1/10			
Fabaceae	2/24					2/15	
Fragaria virginiana					6/75	3/32	
Geum rossii		2/15					
Lloydia serotina	Tr/Tr	1/20					
Lupinus argenteus	4/29					14/72	
Mertensia alpina	1/20	1/ 8					
Mertensia oblongifolia		1/ 5					
Oxyria digyna					1/ 5		
Plantago spp.							6/55
Polemonium viscosum	3/16						
Polygonum bistortoides	1/19	1/20				Tr/15	

Table 3. Continued.

Taxa	*Carex/Podi* Climax (4)	*Carex/Podi* Rock (2)	*Abla/Vagl* Climax (1)	*Abla/Vagl* Rock (3)	*Abla/ Vasc* (1)	*Pial/ Acmi* (2)	*Poa/ Trifo* (1)
Forbs (cont.)							
Potentilla diversifolia	4/46	4/48			1/25	1/32	
Potentilla spp.			Tr/ 5	Tr/Tr			
Sedum spp.	3/64	1/28		Tr/ 8		Tr/18	
Senecio canus				Tr/ 5			
Senecio crassulus	Tr/Tr	Tr/Tr				Tr/ 5	
Silene acaulis	5/28						
Smelowskia calycina	2/31						
Solidago missouriensis				1/12			
Solidago spp.	1/10						
Taraxacum officinale	Tr/Tr	Tr/ 5					23/100
Trifolium parryi		6/50					
Trifolium spp.							51/100
Veronica wormskjoldii					1/40		
Viola spp.				Tr/ 7		1/32	
Unknown	3/49	8/68	3/35	Tr/ 5	3/30	Tr/ 8	
Shrubs and Low Trees							
Abies lasiocarpa					1/ 5		
Alnus incana			Tr/ 5				
Arctostaphylos uva-ursi				2/ 3			
Berberis repens			1/15	3/27			
Ceanothus velutinus				13/17			
Juniperus communis			2/15	2/Tr			
Juniperus horizontalis				1/Tr			
Penstemon fruticosus				3/10			
Phyllodoce glanduliflora		1/ 8			10/40		
Physocarpus malvaceus			1/ 5	3/ 7			

Table 3. Continued.

Taxa	*Carex/Podi* Climax (4)	*Carex/Podi* Rock (2)	*Abla/Vagl* Climax (1)	*Abla/Vagl* Rock (3)	*Abla/ Vasc* (1)	*Pial/ Acmi* (2)	*Poa/ Trifo* (1)
Shrubs and Low Trees (cont.)							
Pinus albicaulis		1/ 5			Tr/ 5		
Potentilla fruticosa		6/25					
Prunus virginiana				3/ 8			
Ribes setosum				2/Tr			
Rosa acicularis				1/ 7			
Rubus idaeus				Tr/ 5			
Salix spp.		1/20			4/55		
Vaccinium globulare			21/65				
Vaccinium scoparium					9/40		
Unknown				1/10			
Fern		Tr/ 8	1/10	Tr/ 5			
Lichen	Tr/Tr		1/ 5				
Mosses	3/20	Tr/Tr		2/ 8	5/60		
Selaginella densa	Tr/Tr			1/Tr			
Unknown	3/19	Tr/Tr		1/ 5	5/60		
Litter		11/58	75/100	1/Tr			
Rock	14/29	27/88	3/ 5	21/30	10/10		1/ 5
Soil	16/46	3/12		25/53	12/65	38/92	
Grasses and Grass-like Plants	19/94	21/90	2/30	13/73	25/95	16/92	38/100
Forbs	47/98	38/98	4/40	6/65	24/95	44/100	82/100
Shrubs and Low Trees		3/28	25/80	32/67	25/75		

[1]Trace (Tr) = Canopy coverage less than 0.5 percent or frequency less than 5 percent.
[2]First two letters of generic and specific name, e.g. *Abla/Vagl=Abies lasiocarpa/Vaccinium globulare*, of those species used in naming the habitat type. See text.
[3]Canopy coverage/Frequency.

Table 4. Mean percentage canopy coverage and frequency of grasses, forbs and low shrubs present in greater than trace[1] amounts on habitat types and subtypes on the West Rosebud winter and spring range as determined by examination of twenty 2x5 decimeter plots in each site. Numbers of sites examined are in parentheses.

Taxa	*Carex/ Podi* Winter (1)	*Pipo/Feid* Climax Winter (1)	*Pico* Winter (1)	*Artr* Winter (4)	*Artr* Spring (5)	*Artr* Rock Spring (1)	*Artr* Burn Spring (1)	*Zola/ Vagl/* Rock Spring (3)	*Potr/ Syal* Spring (2)
Grasses and Grass-like Plants									
Agropyron spicatum		2/25[2]	Tr/Tr	5/45	4/44	2/20	4/50	3/33	Tr/ 8
Agropyron spp.									1/12
Carex spp.	18/100			2/44	3/38	Tr/ 5	3/60	2/32	
Deschampsia caespitosa	Tr/ 5								
Festuca idahoensis		3/15		3/29	5/43	3/40	14/90	3/45	
Festuca ovina	3/ 55								
Hesperochloa kingii		6/20		6/44	3/23	6/25	5/45		
Koeleria cristata	Tr/ 5				Tr/Tr				
Poa spp.				2/ 5	Tr/Tr			3/15	9/45
Forbs									
Achillea millefolium					Tr/Tr	Tr/ 5		Tr/Tr	Tr/Tr
Agoseris glauca					Tr/Tr		Tr/ 5		
Anemone patens					Tr/Tr			Tr/10	
Antennaria spp.			Tr/Tr		Tr/ 7			1/13	
Apiaceae									1/12
Apocynum androsaemifolium									1/12
Artemisia campestris							Tr/15		
Artemisia frigida		Tr/10		Tr/ 6	1/13	Tr/15	1/25		
Asteraceae				Tr/Tr	Tr/ 8	Tr/ 5		Tr/12	
Balsamorrhiza sagittata			Tr/Tr	9/26	6/17		10/25		10/12
Brassicaceae					Tr/ 5	Tr/10		Tr/Tr	
Cerastium arvense	1/ 15			1/19	Tr/ 5		1/ 5	Tr/15	
Chrysopsis villosa					Tr/ 7			Tr/Tr	
Comandra umbellata					Tr/ 7				
Delphinium bicolor				Tr/ 8	Tr/ 5		1/20	Tr/Tr	
Dodecatheon conjugens					Tr/Tr			Tr/ 8	
Geum rossii	34/ 95								
Heuchera cylindrica						Tr/ 5			
Lupinus argenteus				3/18	4/26		5/45		5/12
Monarda fistulosa									4/22
Musineon divaricatum					Tr/ 5				
Phlox hoodii				Tr/ 8	Tr/Tr		2/50		
Saxifraga spp.	1/ 45								

Table 4. Continued

Taxa	*Carex/ Podi* Winter (1)	*Pipo/Feid* Climax Winter (1)	*Pipo/Feid* *Pico* Winter (1)	*Pipo/Feid* *Artr* Winter (4)	*Pipo/Feid* *Artr* Spring (5)	*Pipo/Feid* *Artr* Rock Spring (1)	*Pipo/Feid* *Artr* Burn Spring (1)	*Abla/ Vagl/* Rock Spring (3)	*Potr/ Syal* Spring (2)
Forbs (cont.)									
Silene acaulis	2/ 10								
Tragopogon dubius				Tr/Tr	Tr/ 5			Tr/Tr	Tr/Tr
Viola nuttallii					1/13	1/30			
Unknown	1/ 40			Tr/Tr	Tr/ 8		1/25	Tr/10	
Shrubs									
Amelanchier alnifolia					Tr/10			Tr/12	1/ 8
Arctostaphylos uva-ursi								Tr/ 5	
Artemisia tridentata		6/20		32/62	25/49	9/30			1/Tr
Berberis repens									1/ 8
Juniperus communis			2/Tr					2/Tr	
Physocarpus malvaceus								20/52	
Populus tremuloides									3/10
Prunus virginiana				Tr/Tr		3/15			12/42
Symphoricarpos albus									5/28
Fern					Tr/Tr			1/18	Tr/Tr
Moss	1/ 25				Tr/Tr	4/35		16/50	
Selaginella densa	1/ 25					4/35		16/50	
Litter		73/100	87/95						11/30
Rock	16/ 20	12/ 50	9/25	8/26	9/30	49/75	8/50	47/87	44/78
Soil	8/ 40			39/74	40/78	19/40	33/90	6/17	4/32
Grasses and Grass-like Plants	21/100	12/ 50	Tr/Tr	19/84	15/76	11/55	27/100	11/68	10/52
Forbs	39/ 95	Tr/ 10	Tr/ 5	14/64	14/68	2/50	20/100	3/50	20/55
Shrubs and Low Trees		6/ 20	3/ 5	32/62	25/55	12/45		22/58	22/68

[1]Trace (Tr) = Canopy coverage less than 0.5 percent/Frequency less than 5 percent.
[2]Canopy coverage/Frequency

Table 5. Mean percentage canopy coverage and frequency of grasses, forbs and low shrubs present in greater than trace[1] amounts on habitat types and subtypes on the Stillwater winter range as determined by examination of twenty 2x5 decimeter plots in each site. Numbers of sites examined are in parentheses.

	Feid/Agsp			*Psme/Agsp*					*Psme/ Feid*	*Potr/ Syal*	*Potr/Salix*	
	Grazed		Ungrazed	*Phtr*	*Artr*	Rock	*Agsp*	Climax			Climax	*Syla*
Taxa	Summer (1)	Winter (4)	Winter (4)	Winter (7)	Winter (4)	Winter (4)	Winter (2)	Winter (2)	Winter (2)	Winter (1)	Winter (1)	Winter (1)
Grasses and Grasslike Plants												
Agropyron spicatum			8/58[2]	12/59	18/74	3/26	28/90	7/32	15/92			
Agrostis scabra											16/100	
Bromus tectorum	7/20	6/22	Tr/Tr	1/10	3/26	Tr/10	Tr/Tr					
Calamovilfa longifolia		Tr/Tr	Tr/Tr	2/15	2/10		2/20		Tr/12			
Carex spp.	3/40	5/54	3/49	4/40	6/32	Tr/Tr	3/48	1/20	7/45		16/95	
Equisetum arvense											2/65	
Festuca idahoensis		2/38	17/86	2/19	1/ 5	Tr/Tr	1/22	1/ 8	12/78			
Juncus balticus											2/80	
Koeleria cristata	5/65	1/35	1/39	Tr/13			2/25		2/42			
Phleum pratensis										Tr/ 5	7/75	
Poa spp.		14/75	10/49	30/37				Tr/Tr	Tr/18	87/100	2/50	
Stipa comata	5/70	Tr/14	Tr/ 8	1/10			4/35					
Typha latifolia												97/100
Unknown	1/10			Tr/Tr			1/15					
Forbs												
Allium spp.				Tr/ 6			1/58		1/32			
Antennaria spp.	1/10	6/39	1/14	Tr/Tr					Tr/Tr			
Artemisia campestris	2/15	2/26	Tr/ 8	Tr/Tr		Tr/Tr	Tr/ 5		1/22			
Artemisia frigida	16/85	8/79	2/45	2/36	Tr/Tr	Tr/Tr	2/55	Tr/Tr	5/85			
Artemisia ludoviciana	2/20	Tr/Tr	1/22	1/26	1/21	Tr/ 5	Tr/Tr					
Asteraceae			Tr/ 5	Tr/Tr					Tr/Tr		1/30	
Astragalus spp.	6/35											
Balsamorrhiza sagittata			2/10	Tr/Tr				1/ 5				
Brassicaceae	2/35	Tr/ 5										
Cerastium arvense	2/15	7/45	2/68	Tr/11	1/21		1/15	Tr/ 5	1/42			
Chrysopsis villosa	1/10	1/32	4/59	Tr/ 9			2/12		2/48			
Comandra umbellata					Tr/ 6							
Delphinium bicolor				Tr/Tr	Tr/Tr		Tr/Tr		Tr/12			
Erigeron caespitosus	1/ 5								1/10			
Fabaceae	Tr/ 5		Tr/Tr						Tr/ 8			
Liatris punctata	5/20	Tr/Tr	2/25	Tr/Tr			Tr/ 5					

Table 5. Continued.

Taxa	Festuca/Agropyron Grazed Summer (1)	Festuca/Agropyron Grazed Winter (4)	Festuca/Agropyron Ungrazed Winter (4)	Festuca/Agropyron Agro Winter (7)	Festuca/Agropyron Artr Winter (4)	Festuca/Agropyron Rock Winter (4)	Festuca/Agropyron Agro Winter (2)	Festuca/Agropyron Climax Winter (2)	Pseudo/Festuca Winter (2)	Pseudo/Stipa Winter (1)	Pseudo/Salix Climax Winter (1)	Pseudo/Salix Stipa Winter (1)
Forbs (cont.)												
Lupinus argenteus	2/10											
Opuntia polyacantha				Tr/Tr	1/Tr		Tr/ 8					
Phlox hoodii	4/40	7/58	2/52	Tr/Tr					1/18			
Plantago spp.											Tr/15	
Trifolium spp.											4/50	
Unknown	4/55	1/25	Tr/ 9	Tr/Tr	Tr/14	Tr/Tr			Tr/Tr			
Shrubs and Low Trees												
Artemisia tridentata			Tr/Tr	1/Tr	22/34	2/Tr	Tr/Tr					
Berberis repens										Tr/15		
Cornus stolonifera						1/Tr						
Juniperus communis				Tr/Tr		1/Tr		2/Tr				
Juniperus horizontalis				1/Tr		1/Tr						
Physocarpus malvaceus								1/Tr				
Populus tremuloides				Tr/Tr	Tr/Tr					3/ 5		
Prunus virginiana			1/Tr	1/ 9	1/ 6	1/Tr		1/ 5		3/25		
Pseudotsuga menziesii						1/Tr						
Rhus trilobata		5/ 5		11/14	3/ 5	2/ 6						
Ribes cereum					Tr/Tr	1/Tr						
Ribes spp.								2/Tr				
Rosa acicularis		4/25	2/ 6	1/11	Tr/Tr			Tr/Tr		10/35		
Salix spp.											4/30	
Symphoricarpos albus				1/Tr				Tr/ 5		3/25		
Unknown				1/19	Tr/ 8		Tr/ 5					
Lichen	1/ 5	3/64	1/41	Tr/ 8			1/20		1/38			
Mosses	11/60	11/39	15/51	8/28	Tr/Tr	Tr/Tr	11/50	1/ 8	20/70		10/100	
Selaginella densa	11/60	11/38	15/51	8/28	Tr/Tr	Tr/Tr	11/50		20/70			
Unknown		Tr/ 8						1/ 8			10/100	
Litter								76/90		6/40		
Rock	6/25	5/18	7/26	8/34	24/56	79/88	10/32	12/35	4/32	Tr/ 5		1/ 5
Soil	20/70	35/89	5/35	17/53	18/46	10/12	30/75		21/70		14/90	
Grasses and Grasslike Plants	20/100	30/100	40/96	53/97	30/84	4/32	42/98	9/50	36/100	87/100	46/100	97/100
Forbs	46/100	31/96	18/95	5/68	4/50	Tr/11	8/88	1/18	13/100		5/65	
Shrubs and Low Trees		8/60	3/ 9	14/36	26/52	11/22	1/ 8	7/20		19/70	4/30	

[1]Trace (Tr) = Canopy coverage less than 0.5 percent or frequency less than 5 percent.
[2]Canopy coverage/Frequency.

West Rosebud Area

Carex spp./*Potentilla diversifolia (Carex/Podi)* h.t.

This type was restricted to the alpine plateaus generally in excess of 9,600 feet in elevation. Herbaceous vegetation dominated, with sedges *(Carex* spp.*)*, and varileaved cinquefoil *(Potentilla diversifolia)* being the distinguishing species. Important grasses included bluegrasses *(Poa* spp.*)*, junegrass *(Koeleria cristata)*, and tufted hairgrass *(Deschampsia caespitosa)*. Other important forbs included yellow avens *(Geum rossii)*, milkvetch *(Astragalus vexilliflexus)*, silvery lupine *(Lupinus argenteus)*, moss silene *(Silene acaulis)*, skunk polemonium *(Polemonium viscosum)*, stonecrop *(Sedum* spp.*)*, and field chickweed *(Cerastium arvense)*. Marsh marigold *(Caltha leptosepala)* was extremely abundant in moist areas. The sparse shrub growth, which occurred only where protected from the severe wind, included willows *(Salix* spp.*)*, and yellow mountain heath *(Phyllodoce glanduliflora)*. This type was comparable to Pallister's (1974) alpine tundra type, and probably included his rock outcrop-snowfield type.

Rock Outcrop Subtype: This type comprised the lush vegetation occurring at the bases of cliffs and in crevices of the large expanses of rock along the plateau edge. Bluegrasses dominated while sedges occurred in lesser amounts. Characteristic forbs included yarrow

(Achillea millefolium), yellow avens, varileaved cinquefoil and Parry's clover *(Trifolium parryi)*, as well as alpine lily *(Lloydia serotina)*, oblongleaved bluebell *(Mertensia oblongfolia)*, and stonecrop. Willows and yellow mountain heath were present only in sheltered areas.

Abies lasiocarpa/Vaccinium globulare (Abla/Vagl) h.t. (Pfister *et al.*)

This type occurred at elevations from 6,600 to over 9,000 feet over much of the West Rosebud drainage south of the Mystic Lake power station. Extensive fires within the last 80 to 100 years apparently have eliminated most climax stands below 7,500 feet elevation (U. S. Forest Service records). In burned areas lodgepole pine *(Pinus contorta)* was dominant forming a continuous canopy. Subalpine fir *(Abies lasiocarpa)*, spruce *(Picea* spp.*)*, and Douglas fir *(Pseudotsuga menziesii)* also occurred in the overstory. The sparse herbaceous layer was dominated by timothy *(Phleum pratensis)*; and horsetail *(Equisetum arvense)* occurred extensively in moist areas. Forbs were not important. Characteristic shrubs included huckleberry *(Vaccinium globulare)*, ninebark *(Physocarpus malvaceus)*, Oregon grape *(Berberis repens)*, and common juniper *(Juniperus communis)*. General observations in stands above 7,500 feet indicated that subalpine fir was the dominant overstory species while huckleberry and ninebark dominated the understory. This type probably included the Douglas

fir-ninebark, Douglas fir-huckleberry, Douglas fir-snowberry and lodgepole pine types of Pallister (1974).

Rock Outcrop Subtype: Vegetation associated with large masses of rock occurring within the *Abla/Vagl* h.t. was classified as a separate subtype. Conifers, principally subalpine fir and lodgepole pine, were scattered throughout, though no continuous canopy was formed. Major grasses and grass-like plants included bluebunch wheatgrass *(Agropyron spicatum)*, Idaho fescue *(Festuca idahoensis)*, bluegrasses, sedges, and slender wheatgrass *(Agropyron caninum)*. Pussytoes *(Antennaria* spp.*)*, goldenrod *(Solidago missouriensis)*, and fireweed *(Epilobium angustifolium)* were the most important forbs with lesser amounts of field chickweed, stonecrop, and yarrow. Ninebark and snowbrush ceanothus *(Ceanothus velutinus)* were dominant shrubs with Oregon grape, shrubby penstemon *(Penstemon fruticosus)*, chokecherry *(Prunus virginiana)*, common juniper, and kinnikinnick *(Arctostaphylos uva-ursi)* well represented.

Abies lasiocarpa/Vaccinium scoparium (Abla/Vasc) h.t. (Pfister *et al.*)

This was a subalpine type found near Cooke City, Montana, generally on north exposures above 9,000 feet. Subalpine fir was dominant though whitebark pine *(Pinus albicaulis)* occasionally occurred in the overstory. Sedges, bluegrasses, wire rush *(Juncus balticus)*, and mountain hairgrass *(Deschampsia atropurpurea)* were

important grass and grass-like plants. Principal forbs included arnica *(Arnica latifolia)*, fleabane *(Erigeron* spp.*)*, and Virginiana strawberry *(Fragaria virginiana)*. Yellow mountain heath and low red huckleberry *(Vaccinium scoparium)* were the only important shrubs. A rock outcrop subtype of this type was generally recognized though no representative sites were sampled.

Pinus albicaulis/Achillea millefolium (Pial/Acmi) h.t.

This type was also found only in the vicinity of Cooke City, where it generally occurred on ridgetops at elevations above 9,500 feet. Whitebark pine was the dominant overstory species although subalpine fir occasionally occurred. Sedges dominated among grass-like species, with bluegrasses and spreading wheatgrass *(Agropyron scribneri)* occurring in lesser amounts. Yarrow, fleabane, and silvery lupine were the principal forbs. Shrubs did not occur on the one site sampled. A rock outcrop subtype of this type was generally recognized though no representative sites were sampled. The spruce-fir type described by Pallister (1974) probably represented a composite of this and the *Abla/Vasc* h.t. described above.

Poa spp./*Trifolium* spp. *(Poc/Trifo)* h.t.

This type was limited to the lawn surrounding the Mystic Lake power plant which was used as a feeding area by bighorns. Bluegrasses and orchard grass *(Dactylis glomerata)* were the only grasses. Forbs

included big chickweed *(Cerastium vulgatum)*, clover *(Trifolium* spp.*)*, common dandelion *(Taraxacum officinale)*, and plantain *(Plantago* spp.*)*.

Pinus ponderosa/Festuca idahoensis (Pipo/Feid) h.t. (Pfister *et al.*)

This type, together with several subtypes, occurred extensively along the West Rosebud canyon. It was found on southeast exposures at elevations from 6,500 to more than 7,200 feet. Sites on which ponderosa pine *(Pinus ponderosa)* occurred on the grasslands and shrublands of the canyon were considered subtypes. In climax stands, ponderosa pine was dominant with lesser amounts of limber pine *(Pinus flexilus)*, and lodgepole pine also occurring in a closed overstory. The restricted understory growth included limited amounts of king spikefescue *(Hesperochloa kingii)*, Idaho fescue, and bluebunch wheatgrass. Fringed sagewort *(Artemisia frigida)* was the only forb on the one site examined, and big sagebrush *(Artemisia tridentata)* was the only shrub.

Pinus contorta (Pico) Subtype: This subtype most commonly occurred above 7,200 feet. Its upper elevational extreme was not determined. Its occurrence seemed to be related to burning within the last 100 years. An extremely dense stand of lodgepole pine with a continuous canopy was characteristic. The very sparse herbaceous layer included trace amounts of bluebunch wheatgrass, pussytoes, and arrowleaf balsamroot *(Balsamorrhiza sagittata)*. Common juniper was

the only important shrub species. Low red huckleberry occurred in trace amounts. This subtype corresponded to Pallister's (1974) lodgepole pine type.

Artemisia tridentata (Artr) Subtype: This subtype was the most extensive in the *Pipo/Feid* h.t. Individual trees of ponderosa pine and limber pine were scattered throughout. The understory was characterized by big sagebrush with canopy coverage of 25 to 30 percent. Idaho fescue, bluebunch wheatgrass, and king spikefescue were important grasses. Sedges occurred in lesser amounts. Arrowleaf balsamroot and silvery lupine were the dominant forbs; those of lesser importance included fringed sagewort, Hood's phlox *(Phlox hoodii)*, field chickweed, and Nuttall's violet *(Viola nuttallii)*. The bunchgrass-sage type described by Pallister (1974) was similar to this subtype.

Artemisia tridentata/Rock Outcrop *(Artr*/Rock Outcrop) Phase: This phase was comprised of vegetation associated with rock outcrops in the *Artr* subtype, and was especially important to bighorns. Important overstory and herbaceous species were similar to the *Artr* subtype, except that silvery lupine, Hood's phlox, and field chickweed were not present. Big sagebrush and chokecherry were the major shrub species.

Artemisia tridentata/Burn *(Artr*/Burn) Phase: This phase comprised a single stand within the *Artr* subtype which has burned,

probably within the last 20 years. This site was also important to bighorns. Only herbaceous plants occurred. Idaho fescue was the dominant grass, though king spikefescue, bluebunch wheatgrass, and sedges were also common. Arrowleaf balsamroot, silvery lupine, Hood's phlox, fringed sagewort, and field chickweed were the characteristic forbs.

Populus tremuloides/Symphoricarpos albus (Potr/Syal) h.t.

Quaking aspen *(Populus tremuloides)* stands occurred at the base of most southeast facing slopes in the West Rosebud canyon north of the Mystic Lake power plant. Bluegrasses were most important among the few grasses present. Arrowleaf balsamroot was a major forb while silvery lupine and horse mint *(Monarda fistulosa)* occurred in lesser amounts. Characteristic shrubs included snowberry *(Symphoricarpos albus)*, chokecherry, and Oregon grape.

Stillwater Area

Festuca idahoensis/Agropyron spicatum (Feid/Agsp) h.t. (Pfister *et al.*)

This type occurred at elevations below 5,300 feet on the Stillwater winter range. Idaho fescue and bluebunch wheatgrass were the dominant and distinguishing species with bluegrasses locally abundant. Junegrass and sedges occurred in lesser amounts. Major forbs included golden aster *(Chrysopsis villosa)*, fringed sagewort,

arrowleaf balsamroot, field chickweed, and Hood's phlox. A few shrubs, including chokecherry, skunkbush sumac *(Rhus trilobata)*, and prickly rose *(Rosa acicularis)* were also present. The bunchgrass-forb type described by Pallister (1974) was comprised primarily of this type together with the *Rhus trilobata* and *Agropyron spicatum* subtypes of the *Pseudotsuga menziesii/Agropyron spicatum* h.t.

Grazed *Festuca idahoensis/Agropyron spicatum* Phase: Due to its somewhat different vegetational characteristics (Table 5) and importance to bighorns, that portion of the *Feid/Agsp* h.t. which occurred below the Forest Service fence on the Stillwater winter range was considered to be a phase of that type. This area was heavily grazed by horses, especially during the summer and fall. Major grasses included bluegrasses and downy chess brome *(Bromus tectorum)*. Sedges were moderately abundant. Fringed sagewort, Hood's phlox, field chickweed and pussytoes were common forbs. Skunkbush sumac and prickly rose were scattered throughout the phase.

Pseudotsuga menziesii/Agropyron spicatum (Psme/Agsp) h.t. (Pfister *et al.*)

This type, along with several subtypes, dominated the Stillwater winter range. The latter included all grass and shrublands on which Douglas fir occurred. Climax stands occurred at elevations above 6,000 feet on southeast exposures and 5,000 feet on northern exposures. Here Douglas fir, lodgepole pine, and limber pine occurred as the

characteristic overstory species in a closed canopy. Bluebunch wheatgrass and arrowleaf balsamroot were the most important grass and forb, respectively. Common juniper and currant *(Ribes* spp.*)* were the most important shrubs.

Rhus trilobata (Rhtr) Subtype: This subtype, the most extensive within the *Psme/Agsp* h.t., generally occurred between 5,200 and 5,500 feet elevation on southeast exposures. Douglas fir trees were scattered throughout. Dominant grasses included bluebunch wheatgrass and Idaho fescue, with bluegrasses dominating moist swales. Fringed sagewort and cudweed sagewort *(Artemisia ludoviciana)* were the only important forbs. Skunkbush sumac was the dominant shrub with big sagebrush and chokecherry being locally important. Prickly rose occurred in limited amounts throughout the subtype.

Artemisia tridentata (Artr) Subtype: Small stands of this subtype occurred at elevations between 5,000 and 6,000 feet. Bluebunch wheatgrass was the dominant grass with downy chess brome and sedges occurring throughout. Characteristic forbs included cudweed sagewort, field chickweed and plains prickly pear *(Opuntia polycantha)*. Big sagebrush was the dominant shrub with chokecherry and skunkbush sumac commonly present. The bunchgrass-sage type of Pallister (1974) was comparable to this subtype.

Agropyron spicatum (Agsp) Subtype: This subtype consisted of two small stands on which bluebunch wheatgrass was the dominant plant species and shrubs were rare. Sedges, prairie sand reedgrass *(Calamovilfa longifolia)*, junegrass, and needle-and-thread *(Stipa comata)* were also important. Major forbs included fringed sagewort and golden aster as well as field chickweed. Chokecherry and big sagebrush were rare shrubs.

Rock Outcrop Subtype: This type was characterized by expansive rock outcroppings on which vegetation was sparse. Bluebunch wheatgrass was the only important grass. Few forbs occurred, of which cudweed sagewort was the most important. Dominant shrubs included big sagebrush and skunkbush sumac, though chokecherry, squaw currant *(Ribes cereum)*, common and creeping juniper *(Juniperus horizontalis)*, and red dogwood *(Cornus stolonifera)* also occurred. Pallister's (1974) rock outcrop-forest type was comparable to this subtype.

Pseudotsuga menziesii/Festuca idahoensis (Psme/Feid) h.t. (Pfister *et al.*)

Toward the southern end of the Stillwater winter range bluebunch wheatgrass became less abundant while Idaho fescue increased in importance, such that these two grasses co-dominated the understory beneath an open canopy of Douglas fir. Sedges and junegrass were of some importance in these stands. Common forbs included fringed sagewort, golden aster, Hood's phlox, and field sagewort *(Artemisia*

campestris). Shrubs were rare.

Populus tremuloides/Symphoricarpos albus (Potr/Syal) h.t.

Quaking aspen stands occurred on moist sites below 7,500 feet throughout the Stillwater winter range. These stands differed from those in the West Rosebud area in that grasses were more abundant and forbs were less common. The herb layer of the one site sampled was comprised mainly of bluegrasses, with a coverage of 87 percent, and trace amounts of timothy. Characteristic shrubs included chokecherry, prickly rose and common snowberry. The aspen type of Pallister (1974) was comparable to this type.

Populus trichocarpa/Salix spp. *(Potr/Salix)* h.t.

Black cottonwood *(Populus trichocarpa)* was the dominant overstory species, and formed a relatively open canopy where it occurred along the Stillwater River bottom. Stands were subjected to heavy grazing by horses and a few cattle, probably causing considerable change in species composition from what might be expected with undisturbed conditions. Grasses and grass-like plants dominated the understory, with ticklegrass *(Agrostis scabra)* and sedges the dominant species. Other major grasses and grass-like plants included horsetail, wire rush, timothy and bluegrasses. Clover was the major forb. Willow was the dominant shrub. This type was similar to the streamside-hardwood type described by Pallister (1974).

Typha latifolia (Tyla) Subtype: River bottom sites with shallow depths of standing water supported a lush growth of common cattail *(Typha latifolia)*. Horsetail was occasionally found and bluegrasses were common near the waters edge, though neither species occurred on the site sampled.

Historical Bighorn Sheep Populations and Trends

Early history of the bighorn herds of the Beartooth Mountains was described by Pallister (1974), who stated that bighorn numbers on the West Rosebud winter range apparently had remained stable at about forty animals from 1928 to 1970. This estimate supported previous estimates by Couey (1950) and personnel of the Mystic Lake power station near the head of the West Rosebud drainage (P. Huck pers. comm.).

Pallister (1974) also reported that peak numbers for the Stillwater winter range were reached in the late 1940's and early 1950's when reports of over 100 sheep on the area were common. Re-examination of the basis for these reports indicated that such a high population might be questioned.

Reports of 135 to 150 sheep during the 1944-46 period were based on Forest Service estimates for the Stillwater "district", not on actual counts. During that period, the Stillwater "district" included both the Stillwater and Boulder River drainages so population estimates did not refer exclusively to bighorns wintering in the Stillwater

valley. A 1954 Forest Service estimate of 90 bighorns applied only to the Stillwater winter range, but apparently was based on the single observation in November, 1953, of "approximately" 80 bighorns on the Beartooth Dude Ranch. This observation was made by ranch owner Edward Ickerman and reported in Buechner (1960) together with another observation of 36 bighorns, classified as to age and sex, by Mr. Ickerman in January, 1954. It seems likely that residents of the area extrapolated the Forest Service estimate to a population of over 100 sheep.

The reported drastic decline of sheep in the Stillwater during the mid-to-late 1950's was apparently based on the Forest Service estimate of 90+ bighorns and actual counts by Fish and Game personnel of 55 and 36 sheep in 1956 and 1957, respectively. As described above, the estimate of 90 sheep in 1954 seems questionable at best. A count by Fish and Game personnel in 1952 (Appendix Table 33) showed only 39 bighorns while a population estimate in 1953 showed "about" 70 sheep. Two counts in 1954 tallied only 32 and 55 bighorns. These figures are not significantly different from Fish and Game counts made from 1956 through 1958 which ranged from 27 to 55 bighorns. Although it is unlikely that all sheep using the Stillwater winter range were seen during these counts, it is equally unlikely that large numbers of bighorns escaped observation or that greatly different proportions of the population were observed before and after 1955.

Observations by two longtime residents of the upper Stillwater, Henry Bedford and Dewey Whited, supported the lower counts. Mr. Whited arrived in the Stillwater valley in January, 1908, and has observed the bighorns each year since that time, while Mr. Bedford has watched the sheep since arriving in the area during the early 1930's. Both gentlemen worked on game counts in the Beartooth Mountains for the U. S. Forest Service in the late 1930's and are considered highly reliable observers. Mr. Bedford reports having seen no more than 35 to 40 bighorns on any one day while Mr. Whited places his maximum count at 40 to 45 animals. Both men maintain that estimates of 90 or more bighorns on the Stillwater winter range during the late 1940's and early 1950's are excessive.

On these bases, I can only conclude that numbers of bighorns wintering in the Stillwater valley have remained relatively stable in recent times. Normal populations probably consisted of from 25 to 50 bighorns with a maximum of 55 to 65 animals. Also, it seems apparent a drastic decline of bighorns in the Stillwater probably did not occur but was hypothesized to reconcile the differences between the population estimates prior to 1954 and the actual counts of 1956.

Hunting Seasons

Prior to 1915, seasons and limits for sheep in the Beartooths were the same as for the rest of the state (Mussehl and Howell 1971). The

hunting of bighorn sheep was closed from 1915 to 1953 when permits were issued to harvest five 3/4-curl rams in the Stillwater - West Rosebud area. The number of permits was increased to eight for the 1954 and 1955 hunting seasons. Because of the extreme ruggedness of the terrain and low hunter success, an unlimited number of permits were allowed for 3/4-curl or larger rams in 1956. This policy remains in effect at the present time; although in 1975 the total harvest will be limited to 14 sheep. Appendix Table 34 summarizes the history of hunting regulations and hunter harvest for the Beartooth Mountains.

Land Use

From the early 1900's until 1944 many of the alpine plateaus in the Beartooth Mountains were grazed by large numbers of domestic sheep under allotments granted by the U. S. Forest Service. As many as 600 domestic sheep grazed Lake Plateau until 1954. Appendix Table 35 summarizes the history of the various grazing allotments on what is considered to be important bighorn range.

Portions of the West Rosebud bighorn winter range were included in two allotments: the Mount Wood allotment, active from 1930 to 1944, and the West Rosebud Canyon and Plateau allotment, active from 1911 to 1946. The relative amounts of grazing on each portion of the West Rosebud allotment is not known except for the 1921-1925 period when equal numbers were allowed in the canyon and on the plateau. The Canyon portion of the West Rosebud allotment was converted from

domestic sheep to cattle in 1947. The cattle do not presently use the adjacent slopes which are important as bighorn spring range. This may be due to the abundance of forage in the valley bottom and the short grazing period (approximately one month). Whether or not cattle grazed the slopes in the late 1940's and early 1950's is unknown.

Three grazing allotments occurred within the area believed to be summer range for the Stillwater population. These included the Lake Plateau allotment active from 1922 to 1954, the West Stillwater Plateau allotment active from 1922 to 1944, and the Verdigris Creek allotment active from 1922 to 1942. The Verdigris Creek allotment was for cattle and horses rather than domestic sheep. The West Stillwater Plateau allotment and the Verdigris Creek allotment were probably less important to bighorns than the Lake Plateau allotment because of limited use of these areas by bighorns.

The Stillwater winter range has had a long history of severe overuse by domestic livestock, mainly horses. In 1967 the U. S. Forest Service, in cooperation with owners of the Beartooth Ranch, built a fence across the winter range to restrict livestock to the lower portions of the range and leave the adjacent slopes ungrazed for use by game species. Trespass livestock still occasionally graze these restricted areas.

The Stillwater winter range lies in a highly mineralized stip of land known as the "Stillwater complex". This area has been subjected

to intensive mineral searches and considerable mining activity. The Mouat Mine, the largest mine in the area, is located on historical bighorn winter range. Present use of the mine lands by bighorns is restricted to peripheral roads which have been reseeded with desirable grass species (Pallister 1974). A comprehensive report on the effects of mining operations on wildlife populations is presently being prepared by Montana Fish and Game personnel (R. Stoneberg pers. comm.).

RESULTS

Population Trends and Dynamics

West Rosebud Area

Population Trends. -- A maximum of 38 different bighorn sheep was counted on the West Rosebud winter range during winter and spring, 1975 (Table 6). Previous spring population estimates on the area were 58 and 59 bighorns during 1972 and 1973, respectively (Stoneberg 1973), and 48 in 1974 (J. Denton pers. comm.). These data suggested a substantial decline in numbers from 1973 to the spring of 1975.

Although it is possible that not all bighorns on the area during the spring of 1974 were seen (J. Denton pers. comm.), it is unlikely that large numbers of sheep were missed during both aerial and intensive daily ground observations in the spring of 1975. Also, it seems unlikely that large numbers of bighorns left the area to winter elsewhere during 1974 and/or 1975. Geist (1971) reported a strong fidelity of bighorn sheep to traditional seasonal home ranges.

Lamb Production and Survival. -- Sex and age composition of bighorns observed in the West Rosebud drainage from June 1974 through July 1975 are summarized in Table 6. Observed lamb:ewe ratios changed little during summer and early fall, ranging from 64 lambs:100 ewes in July to 61:100 in October. Thereafter this ratio declined progressively

Table 6. Sex and age composition of the West Rosebud bighorn sheep population, as determined from 1,355 multiple observations and monthly maximum unduplicated observations.

		Males					Females			Number Per 100 Ewes		
	Sample Size	0-1/4[1] Curl	1/4-1/2 Curl	1/2-3/4 Curl	3/4+ Curl	Total Males	Adult	Yrlg.	Lambs	Rams	Yrlgs	Lambs
1974												
June	85/27[2]	10/2	2/1	5/3	5/2	22/8	54/16	8/2	1/ 1	41/50	15/12	2/ 6
July	135/58	1/1	8/4	3/3		12/8	75/30		48/20	16/27	3/ 7[3]	64/67
Aug.	42/25		4/3	1/1		5/4	22/12		15/ 9	23/33		68/75
Sept.	77/26		3/2	5/3	2/1	10/6	41/12		26/ 8	24/50		63/67
Oct.	45/30						28/20		17/10			61/50
Nov.	98/45		6/2	2/2	3/2	11/6	58/25		29/14	19/24		50/56
1975												
Jan.	23/14		2/2		1/1	3/3	15/ 8		5/ 3	20/38		33/38
Feb.	29/24	1/1	3/2		2/2	6/5	18/16		5/ 3	33/31	11/12[3]	28/19
Mar.	37/28	2/2	1/1			3/3	29/20		5/ 5	10/15	14/20[3]	17/25
Apr.	109/27		14/2	1/1	6/2	21/5	74/17		14/ 5	28/29		19/29
May	306/32	6/1	17/2		5/1	28/4	240/25		38/ 3	12/16	5/ 8[3]	16/12
June	356/38[4]	12/1	22/2	3/1	0/1	37/5	293/29	22/3	4/ 1	13/17	8/10	1/ 3
July	13/ 9			1/1		1/1	4/ 3	4/2	4/ 3	25/33	100/67	100/100

[1]Yearling males
[2]Total number of animals observed during month/Maximum unduplicated count during month
[3]Assuming a 50/50 ratio of yearling males to yearling females
[4]Maximum June observation is 1975 population estimate

from 50:100 in November to approximately 30:100 in January and February, 1975, and to 8:100 in June. Assuming no mortality among adult ewes, the change in lamb:ewe ratios indicated lamb mortality of about 85 percent from the summer of 1974 through the spring of 1975. On the basis of the July lamb:ewe ratio and the 43 ewes (including yearling ewes) observed on the spring range in 1974 (J. Denton pers. comm.) 28 lambs should have been produced. Only three lambs were observed on the spring range in 1975, a difference of 89 percent.

The same pattern of lamb mortality apparently occurred on the West Rosebud area from the summer of 1973, when Pallister (1974) observed 64 lambs:100 ewes, to the spring of 1974 when my observations showed only 15 yearlings:100 ewes; a decrease of 77 percent. The 40 ewes (including yearling ewes) present on the spring range in 1973 (Stoneberg 1973) should have produced 26 lambs. However, only two yearlings, one male and one female, were present the following June, suggesting a possible loss of 92 percent of the previous summer's lambs. The presence of only one male and one female two-year-old on the area in the spring of 1975 further supported the accuracy of the 1974 spring count.

In contrast, Stoneberg (1973) reported lamb:ewe ratios of 41:100 and 36:100 on the West Rosebud during the springs of 1972 and 1973, respectively, indicating much lower winter-spring mortality of lambs in those years. These data might also indicate that the recent trend

in total numbers of bighorns on the West Rosebud winter-spring range was directly related to lamb mortality. Relatively high and stable populations were experienced during 1972 and 1973, years when relatively high numbers of lambs survived the winter. Decreases in total numbers of bighorns on the area during 1974 and 1975 were associated with extremely high (75-90 percent) lamb mortality.

The lamb:ewe ratios of about 64:100 observed on the summer range during 1973 (Pallister 1974) and 1974 were relatively high for bighorn sheep. Frisina (1974) reported 63 lambs:100 ewes in a rapidly increasing sheep population on the Sun River area of Montana. However, the ratio was not as high as those reported by Wishart (1958) and Horejsi (1972) who found 83 and 75 lambs:100 ewes, respectively, on the high quality Sheep River population in Alberta, and Woodard et al. (1974) who reported 72 lambs:100 ewes among bighorns in southern Colorado.

The occurrence of similarly high lamb:ewe ratios in 1973 and 1974 indicated that the factor affecting lamb survival apparently did not affect the number of lambs produced on the area.

Sex Composition. — Twenty nine ewes were counted on the West Rosebud range in the spring of 1975 (Table 6). Stoneberg (1973) reported counts of 33 and 36 ewes on the area during 1972 and 1973, respectively; while Denton (pers. comm.) counted 42 in the spring of 1974. Apparently, lamb recruitments in 1971-72 and 1972-73 was sufficient to provide at least some increase in ewe numbers during 1973 and

1974, respectively. High lamb mortality during 1973-74 was followed by a decline in ewe numbers in 1975. However, some additional mortality of yearling or older ewes also must have occurred during 1974-75 to account for the 33 percent decline.

Only six rams were observed on the West Rosebud during the spring of 1975, two of which were larger than three-quarter curl (Table 6). One of the large rams was illegally killed that spring leaving only one "legal" ram in the population. Younger rams included one coming-two-year-old, two three-year olds, and one four-year-old. Stoneberg (1973) reported ten rams, including three with 3/4-curl or larger horns on the area in 1972 and 14, of which nine were 3/4-curl or larger, in 1973. Denton (pers. comm.) counted ten rams in 1974. Three of these were 3/4-curls.

Because rams occupy somewhat different areas than ewes on the West Rosebud during spring, it is possible that some rams were missed during spring counts. Known hunting losses accounted for only half of the decline in ram numbers from 1973 to 1974. Also, seven legal rams were killed on the West Rosebud area during the fall of 1974; four more than were counted the previous spring. However, rams from Yellowstone Park, which lies immediately south of the West Rosebud (Fig. 1), probably range into the area during the rut and may be included in the harvest.

In contrast to Pallister's (1974) description of a ram segment dominated by older adult males, data for 1974 and 1975 from the West

Rosebud indicated a progressively younger age structure and a population similar to that found in the Stillwater River area. The difference may reflect increased hunting pressure and/or increased hunter success during these two years though few data are available. The decline in numbers of young rams on the West Rosebud from 1974 to 1975 probably reflected the high lamb mortality during 1973-74 and to a lesser extent mortality of young rams which had been recruited into the population in 1973 and 1974.

Stillwater Area

Population Trends. — A maximum of 46 different bighorns was counted on the Stillwater winter range in 1975 (Table 7). Previous population estimates were 33, 42, and 47 in 1972, 1973, and 1974, respectively, (Stoneberg 1973, 1974).

Lamb Production and Survival. — The sex and age composition of bighorns observed in the Stillwater drainage during the winter and spring of 1975 is shown in Table 7. The calculated winter lamb:ewe ratio was 41:100. Ratios of approximately 60 lambs:100 ewes were recorded on the area each winter since 1972 (Stoneberg 1973, 1974) indicating extremely high recruitment. Other investigators have reported winter lamb:ewe ratios ranging from 25:100 to 56:100 (Horejsi 1972, Frisina 1974, Smith 1954, Stelfox 1974, Morgan 1970).

Although comparable ratios for the summer period were not obtained in the area, lamb mortality through the winter of 1975 appeared to be

Table 7. Sex and age composition of the Stillwater bighorn sheep population, as determined from 4,159 multiple observation and monthly maximum unduplicated observations.

	Sample Size	Males					Females	Lambs	Number Per 100 Ewes		
		0-1/4[1] Curl	1/4-1/2 Curl	1/2-3/4 Curl	3/4+ Curl	Total Males			Rams	Yrlgs[3]	Lambs
1974											
Sept.	11/ 9[2]			3/3	1/1	4/4	6/ 4	1/ 1	67/100		17/25
Oct.	31/12	1/1	2/1	1/1		4/3	19/ 5	8/ 4	21/60	11/40	42/80
Nov.	135/26	7/2	9/2	1/1	3/1	20/6	86/15	29/ 5	23/40	16/27	34/33
Dec.	143/41	4/1	9/2	3/2		16/5	94/26	33/10	17/19	9/ 8	35/38
1975											
Jan.	843/46[4]	78/4	38/2	36/2		152/8	492/27	199/11	31/30	32/30	40/41
Feb.	771/46	70/4	40/2	32/2		142/8	467/27	162/11	30/30	30/30	35/41
Mar.	674/43	52/4	14/2	18/2		84/8	443/25	147/10	19/32	23/32	33/40
Apr.	841/41	46/3	33/2	40/2		119/7	559/25	163/ 9	21/28	16/24	29/36
May	687/40	25/2	23/2	25/2		73/6	459/25	155/ 9	16/24	11/16	34/36
June	23/23	1/1				1/1	13/13	9/ 9	8/ 8	15/15	69/69

[1]Yearling males
[2]Total number of animals observed during month/Maximum unduplicated count during month
[3]Assuming a 50/50 ratio of yearling males to yearling females
[4]Maximum unduplicated January observation is 1975 population estimate

minimal. Lamb:ewe ratios remained nearly constant throughout the winter and spring periods (Table 7). Known or assumed losses included only two lambs, one in mid-February and another in early March, and two yearling ewes in early March.

Lamb:ewe ratios based on multiple observations of the same individuals of a population were similar to those based on maximum unduplicated monthly counts (Table 7).

The constancy of the lamb:ewe ratio on the Stillwater winter range was evidence that no differential movement of ewes and lambs occurred during winter and spring.

Sex Composition. — The 27 different ewes observed on the Stillwater winter range in 1975 (Table 7) was the highest number recorded since studies were initiated in 1972. Similarly, the total of eight rams in 1975 was the largest count since 1972.

Numbers of rams of various age classes on the Stillwater winter range each year since 1972 are shown in Table 8. No rams over five years old were observed. Pallister (1974) believed the absence of older rams was due primarily to hunter harvest of all legal rams that return to the area each fall. Large rams were reported wintering in the Stillwater prior to and for a few years after the area was opened to hunting in 1953.

Table 8. Age classes of all rams present on the Stillwater winter range from 1971 to 1975. (Table modified from Stoneberg 1974).

	Age (Years)					
	0.5[1]	1.5	2.5	3.5	4.5	5.5+
1971-72	5	1	3	0	0	0
1972-73[2]	7	5	2	1	0	0
1973-74[3]	7	2	3	2	1	0
1974-75[4]	5	4	2	2	2	0

[1]Assuming a 50/50 ratio of male to female lambs.

[2]Includes one yearling and one 2½ year old found dead.

[3]Includes one 4½ year old that was taken by a hunter.

[4]Includes one 3½ year old and one 4½ year old that were taken by hunters.

Geist (1971) reported that movements of rams are generally rigidly established by the age of 4½ years. Thus, all 4½-year-old or older rams on the Stillwater winter range would be expected to return in subsequent years. At present relatively few 4½-year-old rams occur

on the Stillwater (Table 8). Apparently most rams in this age class attain 3/4-curl horns and are taken by hunters before or upon returning to the winter range.

There was no significant or consistent decline in numbers of rams of any year class between 1½ and 4½ years of age (Table 8), indicating few if any rams leave the area to winter elsewhere before reaching four years of age. Geist (1971) observed that young rams rarely leave ewe groups until their third summer and may or may not return to the maternal winter range in either or both of the following two winters depending upon the habits of other rams they may be associated with in early winter.

Comparisons between numbers of lambs on the Stillwater area one year and the numbers of yearlings the next year (Table 8) indicated that many of the rams which left the winter range as yearlings failed to return as expected (Geist 1971) the following winter, suggesting some mortality during the summer or fall. Similar mortality of rams between their first and second winters may be inferred from the data of Smith (1954) and Wishart (1958) as well as from data from Montana's Sun River herd (M. Frisina pers. comm.). The latter two areas, at least, held high quality increasing populations in which survival of lambs was high. Yearling mortality was not evident in the findings of Geist (1971), Murie (1944), or Morgan (1970) for static or declining populations with low lamb survival. This might suggest that high survival

of lambs through their first winter may be followed by relatively higher mortality of yearlings during the following summer and fall. Conversely, low over-winter survival of lambs may be compensated for by relatively high survival during the following summer and fall, perhaps as a result of increased mothering from ewes bearing inviable lambs (Geist 1971).

Seasonal Distribution and Movements

Centers of activity (Hayne 1949) and standard diameters (White 1964), indicative of seasonal home ranges, were calculated for each of 21 marked bighorns observed three or more times during a season. Standard diameters were calculated as: $SD = \sqrt{\Sigma D^2/N}$, 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).

The seasonal distribution of bighorns within the study area, is shown in Figure 1. Monthly and seasonal centers of activity and standard diameters are given in Appendix Tables 36 and 37 for the West Rosebud and Stillwater areas, respectively.

West Rosebud Area

Winter. — During winter, most marked bighorns were located on plateaus between the Mystic Lake power plant and Mystic Lake. No sheep

were observed south or west of the upper end of the lake. Unmarked bighorns, believed to be part of the West Rosebud population, were seen on Fishtail Plateau, at the heads of the Middle Fork of Fiddler Creek and the East and West Forks of Fishtail Creek, as well as on Stillwater Plateau above Woodbine Creek and between Woodbine and Falls Creeks.

The pooled standard diameter of individual home ranges for the area during winter was 1.53 miles (Table 9). The average distance between successive relocations was 0.88 miles; and the average maximum distance individuals were relocated from their center of activity for the period was 1.18 miles. These data included migrational movement from the alpine plateaus to slopes along the West Rosebud Canyon in late winter. Movements on the plateaus or in the canyon were more restricted than indicated by averages for the winter. The pooled standard diameter and average distance between successive relocations was similar to that reported by Erickson (1972) for bighorns in the Sun River area of Montana, though the latter measurement was much smaller than that reported by Morgan (1970) for bighorns in the Salmon River area of Idaho.

Spring. — During this period, bighorns on the West Rosebud were distributed between Pine Grove Campground and Mystic Lake along the west side of the Rosebud drainage and from the Mystic Lake power plant to the dam on the east side. Only rams were seen as far north as the campground. Bighorns freely crossed West Rosebud Creek only between

Table 9. Pooled standard diameters, average distances between consecutive relocations and average maximum distances from winter range centers of activity of bighorn sheep on the West Rosebud and Stillwater areas during the study period.

	West Rosebud					Stillwater		
	Winter	Spring 1974	Spring 1975	Summer	Fall	Winter	Spring	Fall
Pooled Standard Diameter in Miles	1.53	2.22	1.54	9.23	-	0.78	0.93	1.76
Range of Individual Standard Diameters	0.44-1.92	0.25-3.46	0.82-2.36	0.58-18.39	-	0.50-1.01	0.57-2.23	0.98-2.81
Average Distance Between Relocations in Miles	0.88	1.15	0.41	2.44	-	0.37	0.50	0.75
Number of Animals	4	5	5	7	-	11	11	3
Number of Observations	20	26	48	49	-	684	193	17
Average Maxiumum Distance from Winter Range Center of Activity in Miles[1]	1.18	1.59	1.83	6.83	8.38	1.03	1.06	1.29
Range of Maximum Distances in Miles	0.5 -1.6	0.3 -3.0	0.8 -3.8	0.8 -21.8	2.4 -21.8	0.5 -1.6	0.55-1.8	0.5 -3.0
Number of Animals	6	8	5	8	8	11	11	5
Number of Observations	23	32	48	50	17	684	193	20

[1]Five of the West Rosebud bighorns were not observed a sufficient number of times to calculate winter range centers of activity. In these cases spring range centers of activity are used for this calculation.

the power plant and the dam. Movement across the creek was not known to occur below the power plant.

Data on movements of marked sheep during spring were obtained in both 1974 and 1975. Because movements appeared to be much more extensive in 1974 than 1975, data for the two years are presented separately (Table 9).

The pooled standard diameter for the spring was 2.22 miles in 1974 as compared with 1.54 miles in 1975, while the mean distance between consecutive relocations in 1974 and 1975 was 1.2 and 0.41 miles, respectively. These differences probably reflected the severe climatic conditions during 1975. However, the pooled standard diameters for both years were within the range of those reported by Frisina (1974) for various areas of the Sun River.

During the spring bighorns were an average maximum of about 1.5 miles from their individual winter range centers of activity though some sheep had moved nearly four miles from those areas by the end of the season.

Summer. — In late June, ewes were located on the lambing grounds. Lambing was not concentrated as described by Pitzman (1970) but rather occurred over an area of nearly eight square miles from the power plant to near the head of Mystic Lake. Exact locations of five lambing areas are given in Appendix Table 38.

Throughout July and August, most ewes and lambs ranged between the Mystic Lake power plant and the head of Mystic Lake along the north side of the canyon. Many of these animals regularly visited a salt block at the power plant surge tower. Geist (1971), Heimer (1973), and Brown (1974) have all described the desire of bighorn sheep for salt during mid-summer.

Three marked sheep migrated in July to the vicinity of Cooke City where they ranged from Miller to Cutoff Mountains, as was also reported by Pallister (1974). One of these, a two-year-old ram, returned to the power plant area in mid-August but was back in the Cooke City area by mid-September.

The large pooled standard diameter and average distance between successive relocations for summer (Table 9) reflected migrational movements from spring to summer range. Bighorns were widely scattered during summer. Some animals remained within one mile of their winter centers of activity while others migrated more than twenty miles. Similar patterns of summer dispersal were described by Smith (1954) and Morgan (1970) for bighorn sheep in Idaho. The migration route of over twenty miles from winter to summer range was similar to that found by Morgan (1970), but much longer than that reported by Couey (1950) or Erickson (1972).

Mature rams could not be located during the summer of 1974 and apparently did not use the area in which they were observed by Pallister (1974) during 1973.

Fall. — Marked sheep were only rarely observed during fall. Bighorns which spent the summer in the West Rosebud drainage apparently drifted away from the Mystic Lake power plant in late August to use several basins located north and west of Island and Silver Lakes as well as the Big Mountain and Little Park areas (R. Stoneberg pers. comm.).

Sheep summering in the Cooke City area utilized the same range until mid-October. By early November these animals were seen in the vicinity of Goose Lake (R. Stoneberg pers. comm.) and shortly thereafter were tracked to the Island Lake area (J. Denton pers. comm.).

Stillwater Area

Winter. — During winter, Stillwater bighorns concentrated on the two square mile winter range near the Beartooth Ranch. No bighorns were seen north of the Mouat Mine or south of the rocky reef above the Woodbine Trail Head.

The pooled standard diameter of 0.78 miles for the winter period on the Stillwater (Table 9) was much smaller than that on the West Rosebud and those reported by Erickson (1972). As suggested by Pallister (1974) this was probably due to the small size of the Stillwater winter range. The average distance between consecutive relocations was only 0.37 miles, much less than reported by Erickson (1972) and Morgan (1970). Throughout the winter the average maximum distance from the individual winter range centers of activity was 1.03

miles; similar to that on the West Rosebud.

Spring. — Bighorns occupied the same area in spring as they had throughout the winter.

The pooled standard diameter of 0.93 miles was slightly larger than that observed in the winter. The average distance between consecutive relocations increased to 0.50 miles indicating that the bighorns may be moving farther in response to lighter snow conditions.

Range Use

Use of Habitat Types

The monthly and seasonal distributions of bighorns according to habitat types for the West Rosebud and Stillwater are given in Tables 10 and 11, respectively. Because rams generally occupied the same habitat types as ewes and lambs, data for all sex and age classes of bighorns were combined.

West Rosebud Area

Winter (January-April). — The *Carex/Podi* h.t. on the alpine plateau was the single most important type in use by bighorns throughout the winter (Table 10). Usage of this type was greatly underestimated because of my inability to observe it regularly. The *Artr* subtype *(Pipo/Feid* h.t.) ranked second, though actual use was light or only occasional until April, when usage gradually increased as the sheep moved down from the alpine plateau. This movement coincided with

Table 10. Percent of 1,343 observations of bighorn sheep of the West Rosebud herd in various habitat types by month and season.

	Jan.	Feb.	Mar.	Apr.	Winter	May	June 1-14	Spring	June 15-30	July	Aug.	Summer	Sept.	Oct.	Nov.	Fall
Sample Size	34	29	37	109	209	306	284	590	167	148	42	357	77	45	65	187
Carex/Podi h.t.	59	79	100	31	55					33	2	14	36	4	88	47
Rock Subtype	9			10	7				2	29	9	14	52	56	5	36
Abla/Vase h.t.											43	5				
Rock Subtype										11		4				
Abla/Vagl h.t.																
Rock Subtype						29	41	35	96	27	17	58			6	2
Pial/Acmi h.t.											29	3		13		3
Rock Subtype													12	27		11
Pipo/Feid h.t.						3	2	3								
Rock Subtype						4	2	3							2	1
Artr/Subtype	32	21		56	37	56	39	48								
Artr/Burn Phase						8	12	10	2			1				
Artr/Rock Phase				3	1											
Poa /Trifo h.t.							3	2								

Table 11. Percent of 3,920 observations of bighorn sheep of the Stillwater herd in various habitat types by month and season.

	January			February			March			April			Winter			Spring[1] (May)		
	Total	<3" Snow	>3" Snow	Total	<3" Snow	>3" Snow	Total	<3" Snow	>3" Snow	Total	<3" Snow	>3" Snow	Total	<3" Snow	>3" Snow	Total	<3" Snow	>3" Snow
Sample Size	878	542	336	771	588	183	707	538	169	841	699	142	3,197	2,367	830	700	604	96
Feid/Agsp h.t.	24	26	21	21	25	8	20	26	-	34	38	14	25	29	13*	27	31	-
Grazed Subtype	13	10	19	26	29	16	14	18	-	30	34	13	21	24	13*	12	14	-
Pome/Agsp h.t.																		
Rhtr Subtype	19	23	13	21	14	46	32	21	65	22	17	46	23	18	36	36	38	27
Artr Subtype	24	22	28	8	10	-	6	8	1	5	1	25	11	10	16	6	3	21
Rock Subtype	14	11	18	13	17	-	19	15	33	9	10	3	14	13	15	8	8	4
Agsp Subtype	2	3	-	11	5	31	9	12	-	Tr	Tr	-	5	5	7	11	6	48
Pome/Feid h.t.	3	5	1	-	-	-	Tr[2]	Tr	1	-	-	-	1	1	Tr	-	-	-

[1]Does not include 23 bighorns observed in June on unclassified habitat types, which are included in other tables.
[2]Trace = (Tr): less than 0.5 percent.
*Difference in habitat use at these snow depths significant ($p < .01$).

sharp increases in snow depths on the plateau following late winter and early spring storms.

The rock outcrop subtype *(Carex/Podi* h.t.) provided important escape cover for the bighorns on the alpine plateaus. As usage of the *Artr* subtype *(Pipo/Feid* h.t.) increased in late winter, the *Pico* subtype *(Pipo/Feid* h.t.) provided the primary escape cover.

Spring (May 1 - June 15). — From May until early June the *Artr* subtype *(Pipo/Feid* h.t.) was used most heavily (Table 10). Use of the rock outcrop subtype *(Abla/Vagl* h.t.) gradually increased throughout the spring as snow disappeared. By June it was the most important type used by bighorns. The rock outcrops appeared to provide both increased security and highly palatable and nutritious green forage in the new growth which appeared shortly after the snow melted from these steep south exposures. The tendency of sheep to follow the snowline to higher elevations was also reported by Smith (1954).

Summer (June 15 - August 31). — By June 15, pregnant ewes began to move into the most rugged areas of the rock outcrop subtypes of the *Abla/Vagl* and *Carex/Podi* h.t. for lambing (Table 10). These areas were characterized by nearly vertical rock walls broken occasionally by small terraces which provided the ewe with forage during her period of isolation. Usage of similar areas by bighorn ewes during lambing has been described by Couey (1950), Smith (1954), Pitzman (1970), and Geist (1971). Ewes and lambs were later joined by barren adult ewes

and yearlings. Most of these bighorns apparently continued to occupy and use the less rugged portions of these subtypes throughout the summer and early fall.

Some ewes and lambs, as well as yearlings of both sexes and two-year-old rams, migrated to the Cooke City area. This group appeared to use the *Carex/Podi* h.t. along with its rock outcrop subtype almost exclusively through July. Although the *Carex/Podi* h.t. also occurred in the West Rosebud drainage, areas included in this type provided very little escape cover as compared to areas around Cooke City where *Carex/Podi* sites were interspersed with substantial amounts of escape terrain required by bighorns with young lambs. The importance of interspersion of rocky terrain with various habitat types in the distribution of bighorns in the Sun River area of Montana was discussed by Erickson (1972).

Use of the *Carex/Podi* h.t. declined sharply during August as sheep in the vicinity of Cooke City moved from the alpine plateaus to use the subalpine *Abla/Vasc* and *Pial/Acmi* h.t.'s. This shift followed dessication of the alpine plants in late July and early August, and enabled the animal to continue to obtain succulent and highly nutritious forage (Klein 1965, Hebert 1973) from the more mesic subalpine areas. Similar movements have been described by Picton (1960) for elk *(Cervus canadensis)*, and by Mealey (1975) for grizzly bears *(Ursus arctos)*.

Fall (September - November). — In September, bighorns in the Cooke City area resumed heavy usage of the *Carex/Podi* h.t. and its rock outcrop subtype, though the subalpine *Pial/Acmi* h.t. was also used (Table 10). Usage of the *Carex/Podi* type may have been influenced by a fall "green-up" or resumption of growth of some alpine plants.

The *Carex/Podi* h.t. and its rock outcrop subtype continued to be most important in use by bighorns during October and November. Most bighorns observed in October were using the rock outcrop subtype. During late October, those bighorns which had spent the summer in the Cooke City area returned to the West Rosebud. By mid-November, these sheep as well as those which had summered in the area were using characteristic winter habitats. Rock outcrops were rarely used after this time except as escape terrain.

Stillwater Area

Winter. — The *Feid/Agsp* h.t., including its grazed phase, and the *Rhtr* subtype *(Psme/Agsp* h.t.) were used most heavily during this period (Table 11). Characteristically, the bighorns bedded in the *Rhtr* or rock outcrop subtypes on the valley slopes, fed for up to an hour during early morning in the general vicinity of the bedding area, then moved down to the *Feid/Agsp* h.t. in the valley bottom where their feeding usually was concentrated on the grased phase. Toward evening the animals gradually moved back up into the *Rhtr* subtype, fed for one to two hours, then bedded for the night.

During heavy snowstorms, or when three inches or more snow was present on the winter range, use of the *Feid/Agsp* h.t. declined significantly (Table 11). Use of the *Rhtr* and *Artr* subtypes *(Psme/Agsp* h.t.) increased, though the change was not significant. During heavy storms the bighorns generally either restricted themselves to the *Rhtr* subtype or moved into the more sheltered rock outcrop, *Artr,* and *Agsp* subtypes *(Psme/Agsp* h.t.) within the Stillwater canyon. Use of the canyon habitat types appeared to increase with severity of the weather.

The *Psme/Agsp* h.t. and its rock outcrop subtype were most important as escape cover.

The very limited *Psme/Feid* h.t. was seldom used, while alpine areas which comprised the primary winter range for the West Rosebud were not used. Pallister (1974) also found no use of alpine areas by the Stillwater herd. The alpine areas adjoining the Stillwater winter range were snow covered throughout the winter while little snow accumulated on the valley floor. The opposite was true of the West Rosebud area. From this, as well as selection of habitat types, it appeared that bighorns selected areas and/or habitat types where desirable forage was available or could be obtained with minimal expenditure of energy. Similar observations have been reported by other investigators (Geist 1971, Erickson 1972).

Spring. — Habitat usage during spring was generally similar to winter, though the relative importance of the grazed phase

(Feid/Agsp h.t.) appeared to decline while use of the *Rhtr* subtype *(Psme/Agsp* h.t.) increased (Table 11). Increased usage of the *Rhtr* stands probably was related to the green-up of major forage grasses on the steeply sloping sites as well as greater availability of important forbs.

Differences in use of the various habitat types in relation to weather conditions were similar to those described for winter.

Distribution of Bighorns According to Physical Characteristics of Habitat

The average elevation of the West Rosebud winter range was over 9,000 feet with bighorns commonly observed between 10,500 and 11,000 feet (Table 12). Most of the summer range was lower than the winter range, varying from 6,600 to 10,500 feet. These sheep used relatively low elevations only in the spring, when they ranged from 6,500 to 8,400 feet. Bighorns on the Stillwater area ranged about 5,000 feet lower during winter and nearly 2,000 feet lower during the spring (Table 13).

In the West Rosebud, bighorns were predominantly observed on south, southeast, and southwest exposures throughout the year (Table 12), though this preference became less distinct during the summer when all exposures were used. West exposures were relatively important during the winter period, although these slopes appeared to accumulate more snow than southerly exposed sites. Usage of northerly exposures increased sharply during August, probably in relation to

Table 12. Percent distribution of bighorn sheep observations according to physical characteristics of the habitat based on multiple observations of individuals of the West Rosebud population.

Period	Distance from Escape Cover						Exposure								Mean Degree Slope	Elevation (in Feet)			Sample Size
	<150 Yards			150+ Yards												Mean	Lower Extreme	Upper Extreme	
	Total	Bedded	Feeding	Total	Bedded	Feeding	S	SE	SW	N	NE	NW	E	W					
January	100	-	100	0	-	0	9[1]	32	47	-	12	-	-	-	23	9,147	7,000	10,400	34
February	100	-	100	0	-	0	7	21	41	-	-	-	-	31	12	9,728	6,900	10,600	29
March	100	-	100	0	-	0	13	41	13	3	-	-	-	30	12	10,463	9,300	11,000	37
April	100	100	100	0	0	0	-	56	21	5	3	3	-	12	27	8,304	6,800	10,500	109
Winter	100	100	100	0	0	0	5	45	27	3	3	1	-	16	22	9,022	6,800	11,000	209
May	96	100	95	4	0	5	-	84	-	-	6	-	10	-	40	7,230	6,500	7,400	306
June 1-14[2]	95	100	95	5	0	5	-	61	3	1	2	4	22	6	39	6,865	6,500	8,400	284
Spring[2]	96	100	95	4	0	5	-	73	2	1	4	2	16	3	39	7,054	6,500	8,400	590
June 15-30[2]	100	100	100	0	0	0	10	31	5	6	-	21	10	17	51	7,683	6,700	10,000	167
July[2]	100	100	100	0	0	0	30	28	17	2	5	1	17	-	43	9,268	6,600	10,500	148
August	100	100	100	0	0	0	31	19	-	-	43	7	-	-	42	9,257	6,700	10,100	42
Summer	100	100	100	0	0	0	21	28	9	4	7	11	11	8	47	8,525	6,600	10,500	357
September	100	-	100	0	-	0	44	8	17	21	3	8	-	-	25	9,944	9,000	10,400	77[3]
October	-	-	-	-	-	-	29	-	4	4	-	-	22	40	42	-	-	-	45
November	-	-	-	-	-	-	37	42	8	2	-	3	6	3	13	-	-	-	65
Fall	100	-	100	0	-	0	38	18	11	10	1	4	7	11	25	9,944	9,000	10,400	187[4]

[1]Percentage of total observations for a particular month or season that occurred on a particular exposure.

[2]Data from June 1974 and 1975, and July 1974 and 1975 are combined.

[3]Mean slope determination has a sample size of 75.

[4]Mean slope determination has a sample size of 185 and distance from escape cover determination has a sample size of 77.

Table 13. Percent distribution of bighorn sheep observations according to physical characteristics of the habitat based on multiple observations of individuals of the Stillwater population.

Period	Distance from Escape Cover						Exposure								Mean Degree Slope	Elevation (in Feet)			Sample Size
	<150 Yards			150+ Yards													Lower	Upper	
	Total	Bedded	Feeding	Total	Bedded	Feeding	S	SE	SW	N	NE	NW	E	W		Mean	Extreme	Extreme	
January	61	100	59	39	0	41	4[1]	88	-	2	1	-	3	1	28	5,334	5,000	6,250	878
February	52	87	49	48	13	51	17	76	-	-	3	-	4	-	24	5,345	5,000	7,000	771
March	70	78	70	30	22	30	19	69	-	-	8	-	4	Tr[2]	29	5,392	5,000	7,500	707
April	43	100	37	57	0	63	12	85	-	-	2	-	-	-	17	5,241	5,000	6,000	841
Winter	56	90	53	44	10	47	12	80	-	1	3	-	3	Tr	24	5,325	5,000	7,500	3,197
May	70	94	67	30	6	33	8	90	-	-	2	-	-	-	20	5,256	5,000	6,250	700
June 1-15	100	-	100	0	-	0	-	87	-	-	13	-	-	-	39	5,659	5,620	6,000	23
Spring	71	94	68	29	6	32	8	90	-	-	2	-	-	-	21	5,269	5,000	6,250	723
September	-	-	-	-	-	-	10	90	-	-	-	-	-	-	29	-	-	-	10
October	-	-	-	-	-	-	60	-	-	40	-	-	-	-	48	-	-	-	15
November	-	-	-	-	-	-	21	70	-	-	-	-	9	-	37	-	-	-	63
Fall	-	-	-	-	-	-	26	60	-	7	-	-	7	-	38	-	-	-	88

[1]Percentage of total observations for a particular month or season that occurred on a particular exposure.

[2]Tr = trace: less than 0.5 percent of the total number of sheep observations occurring on an exposure during a month or season.

feeding in the *Abla/Vasc* and *Pial/Acmi* h.t.'s on mesic north slopes. Similar use of north-facing slopes by bighorns in late summer was reported by Smith (1954).

Over 90 percent of all sheep observations on the Stillwater winter and spring range were recorded on south and southeast facing slopes (Table 13). Warmer temperatures, together with minimal accumulations of snow, may account for the preference (Pallister 1974), though these exposures were also preferred during the fall.

The mean slope used by bighorns on the Stillwater range during winter and spring varied from 17 to 29 degrees while that used by the West Rosebud bighorns during the same period ranged from 12 to 40 degrees (Tables 13 and 12). Much of the alpine winter range on the West Rosebud was relatively level, and slopes steeper than about 20 degrees were rarely used until the sheep moved to lower elevations and slopes ranging from 30 to 60 degrees in April. The steepest slopes were used in late June and early July when the pregnant ewes moved to lambing areas. This usage of nearly 45 degree slopes continued throughout the summer. Progressively gentler slopes were used during the fall as bighorns returned to their alpine winter ranges.

The importance of escape terrain to bighorns has been discussed by Oldemeyer et al. (1971), Erickson (1972), Frisina (1974) and Pallister (1974). Pallister (1974) suggested that a strong affinity for escape cover may lessen as bighorns move onto winter range. My

data seemed to confirm this only for the Stillwater winter range. Only 56 percent of all bighorns observed in that area during winter were within 150 yards of escape terrain (Table 13). Sixty-six and 44 percent of all wintering bighorns observed by Erickson (1972) and Pallister (1974), respectively, were within 150 yards of escape terrain. Pallister's (1974) suggestion that use of open areas away from cover was related mainly to a need to secure forage was supported by the fact that bedding rarely occurred more than 150 yards from cover (Table 13). Similar observations were reported by Oldemeyer et al. (1971).

In contrast, sheep on the West Rosebud area appeared to be closely associated with escape terrain during all seasons (Table 12). However, the wind-blown areas most used by bighorns in winter also occurred largely along edges of the plateau in close proximity to escape terrain or cover.

Group Characteristics

Mean group sizes appeared to vary inversely with the security levels, as determined by availability of escape cover, in the areas used by bighorns (Tables 14, 15, and 16). Group sizes increased dramatically when bighorns were further than 150 yards from escape cover (Table 14). The difference in group size for areas over 150 yards from escape cover as compared to areas less than 150 yards from cover was highly significant ($p < .005$) for the period January through May.

Table 14. Relationship of mean bighorn sheep group size and distance from escape cover by season on the Stillwater and West Rosebud areas.

Season	Stillwater		West Rosebud	
	Less than 150 yards to escape	150 or more yards to escape	Less than 150 yards to escape	150 or more yards to escape
Winter	7.1/255[1]	14.7/95	4.0/ 52	-
Spring	7.9/ 62	8.5/25	3.8/149	13.0/2
Summer	-	-	4.4/ 81	-
Fall	-	-	5.9/ 38	-

[1]Mean group size/Number of groups observed.

Table 15 lists mean group sizes for bighorns observed in the Stillwater by habitat type and/or subtype. Types are listed in order of increasing thresholds of security, except that the last two types listed were seldom used by bighorns. Groups sizes increased as the apparent security level of the habitat types decreased. The largest groups were observed on the grazed phase of the *Feid/Agsp* h.t. where a much traveled road separated the sheep from escape cover.

Table 15. Relationship of mean bighorn sheep group size and habitat type occupation on the Stillwater area during winter and spring, 1975.

Habitat Type or Subtype	Winter	Spring
Grazed Phase *Feid/Agsp* h.t.	20.2/33[1]	29.0/ 3
Feid/Agsp h.t.	10.5/76	11.6/16
Psme/Agsp h.t.	-	-
Rhtr Subtype	8.9/83	5.9/43
Artr Subtype	7.1/51	8.3/ 7
Rock Subtype	5.6/78	4.5/13
Agsp Subtype	7.9/21	9.9/ 8
Psme/Feid h.t.	4.1/ 8	-

[1]Mean Group Size/Number of Groups Observed.

Group sizes were relatively small on the West Rosebud area during all seasons and in all habitat types (Table 16). All habitat types used by bighorns in this area were relatively secure with escape cover in close proximity.

Similar relationships between group size and the cover or escape value of vegetation used by wild ungulates have been previously discussed for bighorns (Frisina 1974) and elk (Picton 1960).

Table 16. Relationship of mean bighorn sheep group size and habitat type occupation by season on the West Rosebud area.

Habitat Type or Subtype	Winter	Spring	Summer	Fall[1]
Carex/Podi h.t.	4.8/24[2]		5.0/10	6.2/14
Rock Subtype	4.7/ 3		5.6/ 9	7.6/ 9
Abla/Vasc h.t.			18.0/ 1	
Rock Subtype			16.0/ 1	
Abla/Vagl h.t.				
Rock Subtype		3.4/61	3.6/57	4.0/ 1
Pial/Acmi h.t.			6.0/ 2	6.0/ 1
Rock Subtype				4.2/ 5
Pipo/Feid h.t.		3.0/ 5		
Rock Subtype		2.2/ 8		1.0/ 1
Artr Subtype	3.2/24	4.6/62		
Rock Phase	3.0/ 1			
Burn Phase		4.8/12	4.0/ 1	
Poa/Trifo h.t.		3.3/ 3		
Overall	4.0/52	3.9/151	4.4/81	6.0/31

[1]Does not include 7 groups in unclassified habitat types which were included in Table 15

[2]Mean Group Size/Number of Groups Observed

Food Habits

The year long food habits of bighorn sheep in the West Rosebud drainage were determined by examination of 36 feeding sites involving 28,597 instances of use (Table 17), and the contents of four rumens (Table 18). Examination of 80 feeding sites involving 46,471 instances of use (Table 19) and the contents of two rumens (Table 18) indicated the winter and spring food habits of the bighorns in the Stillwater area. Preference indices, calculated as the ratio of percentage use on feeding sites in a habitat type to percentage canopy-coverage in that type (Peterson 1970), were determined for all plants with greater than 1.0 percent use (Tables 17 and 19). The larger the index number for a given food item, the greater the preference. Monthly summaries of bighorn food habits for the West Rosebud and Stillwater areas are listed in Appendix Tables 39 and 40, respectively.

West Rosebud Area

Winter (March - April). — Three feeding sites were examined on the *Carex/Podi* h.t. on the alpine plateau in mid-March and six on the *Artr* subtype *(Pipo/Feid* h.t.) during April (Table 17).

Dried forbs comprised two thirds of the plant use on the alpine plateau. Important species included yellow avens and moss silene. Sedges and sheep fescue *(Festuca ovina)* constituted most of the remaining use.

Table 17. Mean percentages of use (U) and preference indices (P) by habitat type and/or subtype for each plant species used by bighorn sheep in greater than trace amounts in at least one type during each season in the West Rosebud area. Trace (Tr) amounts are less than 1.0 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

	Winter		Spring					Summer					Fall	
	Carex/ Podi (3) (2302)	*Pipo Feid/ Artr* (6) (6800)	*Pipo Feid/ Artr* (6) (6550)	*Pipo Feid/ Artr/ Rock* (1) (1299)	*Pipo Feid/ Artr/ Burn* (1) (1610)	*Abla/ Vagl/ Rock* (3) (2206)	*Poa/ Trifo* (1) (650)	*Carex/ Podi* (3) (640)	*Carex/ Podi/ Rock* (1) (244)	*Abla/ Vagl/ Rock* (3) (3797)	*Abla/ Vasc* (1) (526)	*Pial/ Acmi* (1) (460)	*Carex/ Podi* (4) (983)	*Carex/ Podi/ Rock* (2) (530)
Taxa[1]	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P
Grasses and Grass-like Plants	33.2/1.6	47.0/2.5	78.2/5.2	98.5/9.0	98.6/3.7	58.7/5.3	87.8/2.3	44.5/2.3	32.0/1.5	71.1/5.5	47.9/1.9	24.8/1.6	74.9/-	94.9/-
Agropyron caninum										7.9/2.6				
Agropyron scribneri											1.7/-	2.4/2.4	1.0/-	11.1/-
Agropyron spicatum		4.4/0.9	27.5/6.9	18.9/9.5	16.9/4.2	22.6/7.5				12.9/6.4				
Agropyron spp.								Tr/-		Tr/-		1.1/-	6.2/-	
Agrostis scabra										1.6/0.8				
Carex spp.	28.5/1.6	11.5/5.8	12.0/4.0	4.2/33.9		12.4/6.2		10.2/1.0	2.5/2.5	25.0/8.3	28.5/2.8	Tr/-	39.1/-	
Dactylis glomerata							6.0/1.5							
Deschampsia atropurpurea											3.2/0.8			
Deschampsia caespitosa	Tr/-							11.9/11.9					19.8/-	37.7/-
Festuca idahoensis		16.9/5.6	19.3/3.9	54.2/18.1		6.2/2.1				1.2/-				
Festuca ovina	4.6/1.5							3.6/8.9			Tr/-		1.6/-	
Hesperochloa kingii		14.2/2.4	17.6/5.9	21.2/3.5	81.7/16.3	1.1/-								
Koeleria cristata			1.8/7.2					5.3/1.8			1.3/-	3.3/7.5	1.1/-	2.3/-
Luzula wahlenbergii											3.2/3.2			
Poa spp.			Tr/-			16.3/5.4	81.8/2.5	13.4/2.7	29.5/3.0	21.7/21.7	8.8/1.8	17.8/2.9	6.0/-	43.8/-
Forbs	66.8/1.7	12.7/0.9	21.7/1.6	Tr/-	1.4/0.1	11.6/3.9	12.2/0.2	55.5/1.2	61.9/1.6	13.0/2.2	31.6/1.3	75.2/1.7	24.9/-	5.1/-
Achillea millefolium										Tr/-		2.2/0.3		
Agoseris glauca					Tr/-						1.7/4.5	27.4/9.1		
Anemone patens			Tr/-			1.3/2.8								
Antennaria spp.			1.3/4.3			Tr/-					Tr/-			
Apocynum androsaemifolium										1.4/2.1				
Aquilegia flavescens											3.6/-			
Arnica latifolia											15.4/2.6			
Artemisia frigida		3.9/13.0	Tr/-	Tr/-										

Table 17. Continued.

	Winter		Spring						Summer					Fall	
			Pipo/Feid												
	Carex/ Podi	Pipo/ Feid/ Artr	Artr	Artr/ Rock	Artr/ Burn	Abla/ Vagl/ Rock	Poa/ Trifo	Carex/ Podi	Carex/ Podi/ Rock	Abla/ Vagl/ Rock	Abla/ Vasc	Pial/ Acmi	Carex/ Podi	Carex/ Podi/ Rock
	(3)	(6)	(6)	(1)	(1)	(3)	(1)	(3)	(1)	(3)	(1)	(1)	(4)	(2)
	(2302)	(6800)	(6550)	(1299)	(1610)	(2206)	(650)	(640)	(244)	(3797)	(526)	(460)	(983)	(530)
Taxa	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P
Forbs (cont.)														
Aster alpigenus											Tr/-	1.1/1.8		
Asteraceae														3.0/-
Astragalus vexilliflexus								15.3/2.2						
Balsamorrhiza sagittata		5.6/0.6	Tr/-		Tr/-									
Castilleja cusickii								8.6/15.3						
Comandra umbellata			6.5/37.1											
Erigeron spp.			Tr/-					1.3/0.6				34.1/3.8	2.2/-	
Fabaceae		Tr/-						7.2/3.6				2.2/1.1		
Geum rossii	62.1/1.8								1.6/0.8				13.8/-	
Heuchera cylindrica			Tr/-	Tr/-		7.5/-				Tr/-				
Lloydia serotina									32.4/39.9					
Lupinus argenteus			8.7/2.2									1.1/0.1	5.7/-	1.9/-
Mertensia alpina								Tr/-			2.5/-			
Oxyria digyna											1.3/1.7			
Phlox hoodii		2.2/7.3	1.4/6.0									1.3/20.8		
Polygonum bistortoides								1.6/1.6	1.2/2.4		Tr/-			
Potentilla diversifolia								1.1/0.3			Tr/-		2.3/-	
Senecio canus										4.8/14.4				
Senecio crassulus												4.1/9.4		
Silene acaulis	3.7/1.8							17.8/3.6						
Solidago missouriensis										4.3/6.1				
Trifolium parryi									26.6/4.4					
Trifolium spp.							11.5/0.2							
Veronica wormskjoldii											2.1/2.1			
Unknown	Tr/-	Tr/-	Tr/-		Tr/-	Tr/-		Tr/-		Tr/-	2.5/0.8	Tr/-	Tr/-	Tr/-

Table 17. Continued

	Winter		Spring					Summer					Fall	
	Carex/ Podi	*Pipo/ Feid/ Artr*	*Pipo/Feid Artr*	*Artr/* Rock	*Artr/* Burn	*Abla/ Vagl/* Rock	*Poa/ Trifo*	*Carex/ Podi*	*Carex/ Podi/* Rock	*Abla/ Vagl/* Rock	*Abla/ Vasc*	*Pial/ Acmi*	*Carex/ Podi*	*Carex/ Podi/* Rock
	(3)	(6)	(6)	(1)	(1)	(3)	(1)	(3)	(1)	(3)	(1)	(1)	(4)	(2)
	(2302)	(6800)	(6550)	(1299)	(1610)	(2206)	(650)	(640)	(244)	(3797)	(526)	(460)	(983)	(530)
Taxa	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P
Shrubs		40.3/1.3	Tr/-	Tr/-		29.7/1.4			6.1/2.0	16.0/0.5	20.5/0.8			
Arctostaphylos uva-ursi										1.4/0.7				
Artemisia tridentata		39.2/1.2	Tr/-			3.1/-								
Phyllodoce glandaliflora											1.0/0.1			
Physocarpus malvaceus						5.0/0.2				4.6/1.5				
Prunus virginiana		1.1/17.6		Tr/-		18.5/-				2.9/1.0				
Ribes setosum						3.1/-				Tr/-				
Rosa acicularis										5.3/5.3				
Salix spp.									6.1/6.1		Tr/-			
Vaccinium scoparium											19.4/2.2			

[1]Taxa not appearing in this table because of utilization in only trace amounts but of possible local importance included: *Allium* spp., *Cerastium arvense*, *Dodecatheon pauciflorum*, *Liliaceae*.

Table 18. Mean volume percentage of each plant taxon and forage class which occurred in bighorn sheep rumen samples collected in fall, winter, and spring since 1972 for the West Rosebud and Stillwater areas. Trace (Tr) amounts are less than 1.0 percent. Numbers of samples are shown in parentheses.

	West Rosebud			Stillwater
	Fall (1)	Winter (1)	Spring (2)	Winter (2)
Taxa	November 1974[1]	April 1975	May 1973 and 1974	1973
Poaceae & Cyperaceae	85	99	72	77
Forbs	2	Tr	3	16
Antennaria spp.	1			6
Artemisia frigida				9
Artemisia ludoviciana				Tr
Cerastium arvense		Tr		Tr
Chrysopsis villosa				Tr
Fabaceae	1			
Heuchera cylindrica			2	
Phlox hoodii				1
Unknown Forbs			1	Tr
Shrubs	11	1	25	5
Arctostaphylos uva-ursi			1	
Artemisia tridentata	4	1		1
Berberis repens			1	1
Penstemon fruticosus			14	
Physocarpus malvaceus			5	
Pinus contorta			3	1
Pseudotsuga menziesii				Tr
Unknown Browse	7		1	2
Selaginella densa		Tr		Tr
Unknown	2			1

[1]Collection dates

Table 19. Mean percentages of use (U) and preference indices (P) by habitat type and/or subtype for each plant species used by bighorn sheep in greater than trace amounts in at least one type during winter and spring,1975, in the Stillwater area. Trace (Tr) amounts are less than 1.0 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

	Winter										Spring				
	Fest/Agsp[1]		*Pamc/Agsp*				*Pame/ Fest*	*Potr/Salix*		*Fest/Agsp*		*Fame/Agsp*		
	Grazed (10) (2662)	Ungrazed (15) (7050)	*Phtr* (14) (9873)	*Artr* (8) (6997)	Rock (10) (5800)	*Agsp* (2) (749)	(3) (1296)	Climax (1) (802)	Tvla (3) (1483)	Grazed (2) (779)	Ungrazed (5) (3386)	*Phtr* (4) (3359)	*Artr* (2) (1178)	*Agsp* (1) (1057)
Taxa	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P	U P
Grasses and Grass-like Plants	9.9/0.3	47.5/1.2	70.0/1.3	35.1/1.2	33.5/0.4	71.7/1.7	52.9/1.5	91.6/2.0	100/1.0	92.8/-	96.2/-	82.2/-	66.0/-	51.3/-
Agropyron spicatum	Tr / -	3.9/0.5	19.3/1.6	31.1/1.7	21.1/7.0	35.8/1.3	25.8/1.7			4.0/-	55.7/-	52.2/-	65.6/-	51.0/-
Calamovilfa longifolia		1.8/4.8	Tr /-			1.2/0.6	1.5/8.0				Tr /-	Tr /-		
Carex spp.	1.1/0.2	4.8/1.6	3.5/0.9	Tr /-	3.0/12.0	6.0/2.0	10.2/1.5	81.0/5.1		1.7/-	3.2/-	6.7/-	Tr /-	
Equisetum arvense									1.0/-					
Festuca idahoensis	1.7/0.8	16.6/1.0	13.5/6.8		Tr /-	1.6/1.8	4.5/0.4			Tr /-	6.5/-	Tr /-		
Juncus balticus			Tr /-				3.0/-							
Koeleria cristata	1.9/1.9	1.6/1.6	Tr /-			Tr /-	3.3/1.6			10.7/-	8.6/-	Tr /-		Tr /-
Poa spp.	4.7/0.3	15.7/1.6	28.7/1.0	3.3/-	8.4/-	Tr /-	Tr /-	8.0/4.0	13.5/-	76.0/-	22.0/-	21.6/-		
Stipa comata	Tr /-	2.0/5.3	2.3/2.3		Tr /-	25.1/6.3	3.3/-							
Typha latifolia									85.5/0.9					
Unknown		Tr /-	Tr /-	Tr /-	Tr /-		Tr /-	2.0/-						
Forbs	83.7/2.7	27.1/1.5	5.6/1.1	1.3/0.3	3.5/8.0	8.0/1.0	46.9/3.6	1.4/0.3		7.2/-	3.0/-	14.2/-	2.0/-	1.2/-
Agoseris glauca											1.0/-	Tr /-	Tr /-	Tr /-
Antennaria spp.	11.3/1.9	3.2/4.8	Tr /-		Tr /-		Tr /-			Tr /-	Tr /-		Tr /-	Tr /-
Apocynum androsaemifolium												1.6/-		
Artemisia campestris	3.0/1.5	Tr /-	Tr /-				1.7/1.9							
Artemisia frigida	19.2/2.4	10.9/5.4	3.5/1.8		Tr /-	5.7/2.8	40.4/8.1			Tr /-		2.1/-		Tr /-
Artemisia ludoviciana	Tr /-	Tr /-	Tr /-	1.0/1.0	2.5/20.0	2.3/36.8	Tr /-					Tr /-	Tr /-	
Balsamorrhiza sagittata		1.2/0.6	Tr /-	Tr /-								5.5/-		
Geranium arvense	Tr /-	Tr /-	Tr /-							4.1/-	Tr /-	Tr /-		
Eriogon spp.	Tr /-						1.2/1.2							
Phlox hoodii	49.3/7.0	9.2/4.6	Tr /-				1.2/1.6			1.8/-	Tr /-			
Solidago missouriensis								1.4/-						
Shrubs	6.3/0.8	25.3/8.4	24.4/1.7	63.6/2.4	63.0/5.7	20.3/40.6		3.4/0.8			Tr /-	3.6/-	31.9/-	47.5/-
Artemisia tridentata		10.4/22.0	12.3/17.7	19.2/0.9	7.6/3.8	2.9/46.4						Tr /-	7.4/-	1.2/-
Berberis repens			Tr /-		2.4/-									
Pinus flexilis			Tr /-											
Populus trichocarpa								1.0/-						
Prunus virginiana		14.5/29.0	8.3/8.3	24.1/24.1	30.6/30.6	12.4/-						2.5/-	1.4/-	2.5/-
Pseudotsuga menziesii					8.8/8.8									
Rhus trilobata	6.3/1.3	Tr /-	3.1/0.3	19.9/6.6	13.2/6.6	4.9/-								
Ribes cereum											Tr /-	Tr /-	4.9/-	43.8/-
Salix spp.								2.4/0.6						
Symphoricarpos albus				Tr /-									18.3/-	
Mosses	Tr /-	Tr /-	Tr /-				Tr /-	3.6/0.4						

[1]Taxa not appearing in this table because of utilization in only trace amounts but of possible local importance included: *Agrostis scabra*, *Bromus tectorum*, *Elymus canadensis*, *Phleum pratense*, *Comandra umbellata*, *Tragopogon dubius*.

High utilization of forbs during winter, as observed on the alpine plateau, may be unusual for bighorn sheep. Other investigators have reported use of forbs ranging from four to 21 percent during winter (Sugden 1961, Schallenberger 1966, Constan 1972, Morgan 1970, Todd 1975). The difference could reflect the limited availability of forage plants on the alpine plateaus, especially in late winter. Pallister (1974) reported that forbs comprised only two percent of the plant use at one bighorn feeding site on the West Rosebud winter range in December, 1973. General observations in the area of feeding sites on the plateau indicated very little standing vegetation at the time my data were obtained in March, 1975. Lovaas (1958) found increasing use of forbs by mule deer as browse species were depleted on winter range.

When the bighorns migrated down from the alpine plateaus in late winter, grasses (47 percent of the total use at feeding sites) and shrubs (40 percent of the recorded use) became the most important sources of forage in the heavily used *Artr* subtype *(Pipo/Feid* h.t.). Grass usage consisted mainly of new green leaves of king spikefescue and Idaho fescue. Sedges were also important. Big sagebrush leaves were used extensively, especially during periods of heavy snow. Arrowleaf balsamroot and fringed sagewort were the only important forbs, with the latter having a preference index of 13. Hood's phlox received less usage but had a preference index of 7.3.

The one winter rumen sample examined, from a bighorn using the *Artr* subtype, contained 99 percent grasses and grass-like plants and only one percent big sagebrush (Table 18).

Spring (May 1 - June 15). —Throughout the spring grasses and grass-like plants were utilized most heavily in all habitat types (Table 17). Bluebunch wheatgrass, sedges, Idaho fescue, and king spikefescue were highly preferred in nearly all types in which they occurred. Bluegrasses were important on the rock outcrop subtype *(Abla/Vagl* h.t.) and the *Poa/Trifo* h.t. Bastard toadflax *(Comandra umbellata)*, silvery lupine and roundleaved allumroot *(Heuchera cylindrica)* were important forbs. Shrubs were important only on the rock outcrop subtype *(Abla/Vagl* h.t.) where leaves of chokecherry and ninebark were utilized.

The two rumen samples, collected from bighorns using the rock outcrop subtype *(Abla/Vagl* h.t.) during spring in 1973 and 1974 (Table 18) indicated greater usage of grass and less use of forbs than feeding site examinations in 1975. This may have been due to the lack of forbs on the area in May, 1975, when cold weather apparently suppressed forb production.

Summer (June 15 - August 31). — Forbs were the most important forage used during summer in three of the five habitat types sampled (Table 17). The most important species included false dandelion *(Agoseris glauca)*, arnica, milkvetch *(Astragalus vexilliflexus)*,

hairy Indian paintbrush *(Castillega cusickii)*, fleabane, alpine lily, moss silene and Parry's clover. Grasses, including bluebunch wheatgrass, tufted hairgrass, and bluegrasses ranked second for use overall and were most important on the rock outcrop subtype *(Abla/Vagl* h.t.) and the *Abla/Vasc* h.t. Bluegrasses appeared to be highly preferred in all types. Sedges were also preferred. Shrubs were important only on the rock outcrop subtype *(Abla/Vagl* h.t.) where prickly rose, ninebark, and chokecherry were utilized, and on the *Abla/Vasc* h.t. where low red huckleberry was of some importance. Prickly rose and low red huckleberry were especially preferred (Table 17). Pallister (1974) reported much higher utilization of both forbs and browse during the summer.

Fall (September-November). — The most important forage class in the fall was grasses (Table 17). Tufted hairgrass, bluegrasses, spreading wheatgrass and sedges were the most important species. Forbs were utilized only on the *Carex/Podi* h.t. with yellow avens and silvery lupine being most important. Shrubs were not important in the areas sampled. One rumen sample (Table 18), collected in November, showed higher usage of shrubs than occurred at feeding sites. Pallister (1974) reported similar shrub usage but lower utilization of forbs during the fall.

Stillwater Area

Winter (December-April). — Over the winter, utilization of grasses, forbs and shrubs averaged 50.0, 15.4 and 34.4 percent,

respectively, though use varied somewhat by habitat type and/or subtype (Table 19).

Grasses were most important in the *Feid/Agsp* h.t., *Rhtr* and *Agsp* subtypes *(Psme/Agsp* h.t.), *Psme/Feid* h.t. and the *Potr/Salix* h.t. with its *Tyla* subtype. Bluebunch wheatgrass was preferred and heavily used on the *Rhtr* and *Agsp* subtypes and the *Psme/Feid* h.t., but was seldom used on the *Feid/Agsp* h.t. Sedges also were important and preferred in these types. Bluegrasses were very important on the *Rhtr* subtype and the *Feid/Agsp* h.t. where swales maintained at least some green forage throughout the winter. The low preference index for bluegrass in the *Rhtr* subtype (Table 19) reflected the abundance of bluegrass in these swales where canopy coverage transects were generally placed rather than a lack of preference. Idaho fescue was also important and preferred in the *Rhtr* subtype and the *Feid/Agsp* h.t., though most of the usage did not occur until the green-up in March. Usage of grasses and grass-like plants in the *Potr/Salix* h.t. was generally limited to sedges and bluegrasses, while green common cattail shoots were heavily used in the *Tyla* subtype.

Among these types, forbs were of major importance only on the *Feid/Agsp* h.t. and the *Psme/Feid* h.t. Fringed sagewort was very important on both of these types and was highly preferred wherever it occurred. Hood's phlox was also heavily used and highly preferred on the *Feid/Agsp* h.t. Shrub usage was high on the *Feid/Agsp* h.t. as well as the

Rhtr and *Agsp* subtypes. Big sagebrush and chokecherry were heavily utilized and highly preferred with lesser use on skunkbush sumac.

Forbs dominated the bighorn diet only on the grazed phase of the *Feid/Agsp* h.t. Hood's phlox, fringed sagewort and pussytoes were important and highly preferred, possibly because they remained somewhat green throughout the winter. Bluegrasses were also important, while skunkbush sumac was used during storms. Since bighorns selectively fed on this type throughout the winter, forbs probably comprised a greater part of their total diet than indicated by the pooled data from all habitat types. Several observers have reported that fringed sagewort appeared to be a highly important forage species for bighorns (Spencer 1943, Sugden 1961, Schallenberger 1966, Constan 1972, Cooperrider 1969, Todd 1975). Hood's phlox has not previously been considered a major forage species though it appeared to be nearly as important as fringed sagewort in the Stillwater.

Shrubs were the most important forage class used by bighorns on the *Artr* and rock outcrop subtypes *(Psme/Agsp* h.t.). Big sagebrush, chokecherry, and skunkbush sumac were the most important browse species with the latter two being highly preferred. Douglas fir was also used on the rock outcrop subtype. Bluebunch wheatgrass was also important on these sites. Forbs were relatively unimportant, with cudweed sagewort being used most often. On two occasions rams were observed to eat lichen from rock faces.

Two rumen samples, collected during the winter of 1973 showed a high use of grasses and grass-like plants (Table 18). Forbs ranked second, with fringed sagewort, pussytoes, and Hood's phlox being the most important species. Browse was relatively unimportant with big sagebrush, Oregon grape, and lodgepole pine being utilized.

Spring (May 1 - June 15). — Grasses dominated use at feeding sites during the spring with shrubs second in importance (Table 19). New leaves of bluebunch wheatgrass were selected for in nearly all types. Bluegrasses were heavily utilized on the *Feid/Agsp* h.t. and its grazed subtype as well as the *Rhtr* subtype *(Psme/Agsp* h.t.). Idaho fescue and junegrass were important on the *Feid/Agsp* h.t., with the latter also important in the grazed phase. Shrub usage was high in the *Artr* and *Agsp* subtypes *(Psme/Agsp* h.t.) where new green leaves of common snowberry and squaw currant, respectively, were the most important species. Big sagebrush and chokecherry were also utilized.

Forbs were important only on the *Rhtr* subtype with new shoots of arrowleaf balsamroot being heavily utilized.

During winter and spring, utilization of shrubs increased dramatically when snow depths exceeded three inches (Table 20). The change occurred in all habitat types, although the bighorns tended to occupy sites with greater shrub availability during and immediately following snowstorms. Similar changes in food habits during heavy

Table 20. Relationship of snow conditions to mean percentage forage class utilization by bighorn sheep in each habitat type and/or subtype on the Stillwater area from January to June 1975.

Habitat Type	Grasses		Forbs		Shrubs	
	<3 Inches Snow	3 Inches or more Snow	<3 Inches Snow	3 Inches or more Snow	<3 Inches Snow	3 Inches or more Snow
Feid/Agsp h.t.	77.9	38.2	18.5	19.7	3.7	42.1
Grazed Phase	36.0	3.5	64.0	74.8	-	21.7
Psme/Agsp h.t.	-	-	-	-	-	-
Rhtr Subtype	76.8	66.2	10.4	2.9	12.8	30.9
Artr Subtype	46.4	29.8	1.8	0.8	51.8	69.4
Rock Subtype	35.9	28.7	5.1	0.3	59.0	71.0
Agsp Subtype	-	59.7	-	4.0	-	36.2
Psme/Feid h.t.	53.1	-	46.9	-	-	-
Potr/Salix h.t.	-	-	-	-	-	-
Tyla Subtype	97.6	100.0	0.7	-	1.7	-
Total	63.2	46.2	16.0	9.3	20.8	44.5

snow were reported for bighorns by Schallenberger (1966), and for elk by Rouse (1957).

Quantity and Quality of Winter Range Forage

Quantity of Forage Available

Standing crops of forage plants used by bighorn sheep, as measured at the end of the winter, on various habitat types and/or subtypes on the Stillwater and West Rosebud winter ranges are listed in Table 21. Less forage was available per unit area on the important *Carex/Podi* h.t. on the West Rosebud area than on any other type except the rock outcrop subtype *(Psme/Agsp* h.t.) in the Stillwater. Significantly less forage was available on the *Carex/Podi* h.t. than on the grazed phase of the *Feid/Agsp* h.t. on the Stillwater ($p < .0001$), though the difference was not significant when standing crops on all types were tested together using a Bonferroni simultaneous t-test ($p = .05$) (Table 22).

Total available forage could not be calculated for the *Carex/Podi* h.t. because the percentage of that type which was available to bighorns (areas blown free of snow) was not determined. However, winter observations indicated that bighorns limited themselves to only a few small areas on which the total amount of forage available could not have been large.

Significantly more forage was available to bighorns on the West Rosebud as they moved down to the *Artr* subtype *(Pipo/Feid* h.t.) in the

Table 21. Standing crop of bighorn sheep forage species available at the end of the winter period, 1975, on Stillwater and West Rosebud habitat types.

Habitat Type	Standing Crop (lbs./acre)	Standard Deviation	Estimated Area of Habitat Type (acres)	Total Available Forage (lbs.)
Stillwater				
Feid/Agsp h.t.	1,371	941	120	164,520
Grazed Phase	598	231	80	47,840
Psme/Agsp h.t.	-	-	-	-
Rhtr Subtype	1,450	892	160	232,000
Artr Subtype	1,323	1,040	50	66,150
Rock Subtype	293	473	400	117,200
Agsp Subtype	651	417	5	3,255
Psme/Feid h.t.	1,025	456	15	15,375
Total			830	646,340
West Rosebud				
Carex/Podi h.t.	301	158	-	-
Pipo/Feid h.t.	-	-	-	-
Artr Subtype	1,346	934	530	713,380
Total			530+	713,380+

Table 22. Differences of standing crops (lbs./acre) of bighorn forage species available during March and April, 1975, on Stillwater and West Rosebud habitat types.

Habitat Type	*Psme/ Agsp/ Rhtr*	*Feid/ Agsp*	*Pipo/ Feid/ Artr*	*Psme/ Agsp/ Artr*	*Psme/ Feid*	*Psme/ Agsp/ Agsp*	*Feid/ Agsp/* Grazed	*Carex/ Podi*	*Psme/ Agsp/* Rock
Psme/Agsp Rock Subtype	1,157[1]*	1,078*	1,053*	1,030*	732*	358	305	8	0
Carex/Podi	1,149*	1,070*	1,045*	1,022*	724*	350	297	0	
Feid/Agsp Grazed	852*	773*	748*	725*	427	53	0		
Psme/Agsp/ Agsp	799*	720*	695*	672*	374	0			
Psme/Feid	425	346	321	298	0				
Psme/Agsp/ Artr	127	48	23	0					
Pipo/Feid/ Artr	104	25	0						
Feid/Agsp	79	0							
Psme/Agsp/ Rhtr	0								

[1]Indicates difference in standing crop between the *Rhtr* subtype *(Psme/Agsp* h.t.) and the rock subtype *(Psme/Agsp* h.t.) is 1,157 lbs./acre

*Difference is significant ($p < .05$) when tested using a simultaneous t-test based on the Bonferroni t-table.

spring than on the alpine plateaus (Table 22). Because of the large area covered by this subtype, more total forage was available here than on the entire Stillwater winter range.

The much greater amount of forage available on the *Feid/Agsp* h.t. as compared with the grazed phase of that type (Table 21) may be indicative of the effect of heavy summer and fall grazing on availability of forage for bighorns during the following winter and spring.

Standing crops of bighorn forage plants on the various habitat types of the Stillwater area were generally larger than those reported by Stelfox (1974) for bighorn winter ranges in Waterton, Banff, and Jasper National Parks. In the West Rosebud, alpine plateaus supported less forage than ranges evaluated by Stelfox (1974) while the *Artr* subtype *(Pipo/Feid* h.t.) supported substantially more.

Quality of Available Forage Plants

Mean mid-and-late-winter percentages of protein contained in major bighorn forage species on the Stillwater and West Rosebud areas are shown in Table 23. The alpine diet listed for the West Rosebud winter range was a composite sample of all forage species used by bighorns on the alpine winter range, with each species represented in approximately the same proportion as it occurred on the area. This approach seemed justified because the bighorns heavily utilized all plants occurring on the plateau.

Table 23. Mean percentage protein content of major bighorn forage species from the Stillwater and West Rosebud areas.

Taxa	Stillwater		West Rosebud	
	Mid-February	Late-April	Mid-March	Late-April
Agropyron spicatum	2.2/4[1]	18.9/4	-	-
Artemisia frigida	10.0/5	14.7/5	-	10.0/1
Artemisia tridentata	8.6/4	10.0/4		10.0/1
Balsamorrhiza sagittata	-	-	-	4.5/1
Carex spp.	-	-	-	7.1/1
Festuca idahoensis	-	13.4/3	-	6.8/1
Hesperochloa kingii	-	-	-	17.6/1
Phlox hoodii	7.8/2	8.4/2	-	-
Poa spp.	10.7/3	15.6/4	-	-
Prunus virginiana	9.8/4	12.0/4	-	-
Rhus trilobata	8.1/4	9.0/4	-	-
Alpine diet	-	-	6.5/5	-

[1]Mean percent protein/Number of samples analyzed.

On the Stillwater winter range, protein levels in mid-February were highest for bluegrasses, fringed sagewort, and chokecherry. Both bluegrasses and fringed sagewort remained somewhat green throughout the winter, while bighorns selected only the more nutritious terminal buds (Bailey 1967) of chokecherry. Bluebunch wheatgrass, one of the most important species in the bighorn's diet, had the lowest protein level of any species analyzed.

The increased protein content for all species sampled in late April reflected the occurrence of new green growth at that time. Bluebunch wheatgrass, bluegrasses, fringed sagewort and Idaho fescue were particularly nutritious.

During the winter, alpine vegetation on the West Rosebud was relatively low in protein as compared with most forage plants on the Stillwater area. Klein (1965) and Hebert (1973) found alpine vegetation to be generally much higher in protein content than vegetation of lower elevations. Alpine vegetation has also been reported to remain relatively nutritious throughout the winter (Tikhominov 1959, Hebert 1973). However, Nichols (1974) suggested that alpine vegetation which is dessicated and wind scoured probably provides relatively little nutrition compared to vegetation which is snow covered as was apparently the case in studies of Tikhominov (1959) and Hebert (1973).

The late April samples from the West Rosebud were obtained from lower elevational areas used by bighorns at that time. Protein values

were generally higher than for the alpine sample in mid-March and similar to those for samples collected on the Stillwater area at the same time.

Measures of Population Quality

Horn growth (Wishart 1969, Geist 1971), lungworm (*Protostrongylus* spp.) larvae output (Stelfox 1974), and duration of suckling (Geist 1971, Horejsi 1972) have all been suggested as measures of bighorn population quality and ultimately as measures of bighorn range quality. Some data regarding these factors were gathered from the West Rosebud and Stillwater populations incidental to other studies.

Horn Growth

Annual horn growth and circumference at annual rings for all age classes of rams, except lambs, was generally greater for the Stillwater than the West Rosebud herd (Table 24). Although sample sizes were small, and these differences were not significant, their consistancy suggested superior growth among rams in the Stillwater population. Limited data on horn size among ewes indicated only slightly better growth on the Stillwater range. Ewes 3.5 years old and older from that area had a mean horn length of 9.54 inches and a mean basal circumference of 5.29 inches while these measurements averaged only 9.25 and 5.23 inches, respectively, among West Rosebud ewes. Sample sizes for Stillwater and West Rosebud ewes were 7 and 8, respectively.

Table 24. Mean length of annual horn growth segments and mean circumference at annual rings of bighorn rams from the West Rosebud and Stillwater populations.

Horn Growth	Lamb Growth	Yrlg. Growth	2-Yr.-Old Growth	3-Yr.-Old Growth	4-Yr.-Old Growth	5-Yr.-Old Growth	6-Yr.-Old Growth	7-Yr.-Old Growth	8-Yr.-Old Growth
Length									
West Rosebud	3.2/6[1]	8.6/11	6.8/11	5.8/10	3.9/10	3.6/7	3.2/6	1.9/2	1.2/1
Stillwater	2.3/5	9.3/ 5	7.7/ 3	6.3/ 2					
Circumference at Annual Ring									
West Rosebud	3.8/5	7.3/11	10.5/11	12.6/10	13.6/10	13.5/7	14.0/6	14.4/2	14.0/1
Stillwater	3.0/5	7.6/ 5	11.0/ 3	13.7/ 2					

[1]Mean length of horn segment or mean circumference at annual ring in inches/Sample size.

Lungworm Larvae Output

Analysis of 47 fecal samples from the West Rosebud population and 104 samples from the Stillwater population showed a mean output of 20.02 (range 0 - 170.9) and 5.55 (range 0 - 125) larvae per gram, respectively. This difference was highly significant ($p < .001$). Only 4.2 percent of the West Rosebud samples were negative as compared with 8.7 percent of the Stillwater samples. The mean larval output for bighorns in the West Rosebud during this study was similar to that observed in previous years, while that for the Stillwater was lower than reported earlier (Stoneberg 1973, 1974). The Stillwater count was also much lower than had been reported by Forrester and Senger (1964). Both populations had lower larval output than populations studied in Canada (Uhazy et al. 1973, Stelfox 1974). The larval output from the West Rosebud bighorns was similar to that found by Brown (1974) in the Thompson Falls area.

Duration of Suckling Periods

Ten suckling periods were observed in the West Rosebud area on July 27, 1974. The average duration was 13.2 seconds. Horejsi (1972) reported mean durations of 15.3 and 17.3 seconds for 11 and 107 suckling periods during the last two weeks of July in 1969 and 1970, respectively. He associated the short suckling periods for 1969 with poor forage conditions while the longer suckling times occurred during a summer with good forage conditions.

On two occasions, West Rosebud lambs were observed suckling during June nearly one year after birth. Stillwater lambs were observed suckling no later than mid-February.

Lambing Season

Most lambs appeared to be born during the last week of June and early July on the West Rosebud area (Table 25), two to four weeks later than reported for most other bighorn ranges.

Observations of the behavior of ewe groups during June supported this conclusion. Pregnant ewes have been reported to isolate themselves from other sheep for more than a week prior to lambing (Geist 1971). In 1975, 72 percent of the estimated adult ewe population on the West Rosebud was observed on June 23. Only five percent of these were isolated (Table 26), suggesting that a majority were one week or more from lambing. After June 23 the number of ewes observed dropped sharply as more ewes became isolated.

Previous studies of sheep throughout the United States, Canada, and Alaska have generally reported lambing seasons occurring between late April and mid-June (Sugden 1961, Blood 1963, Murie 1944, Nichols 1974, Geist 1971, Spencer 1943, Couey 1950, Smith 1954, Morgan 1970, Moser 1962, Brown 1974). Honess and Frost (1942), and Wishart (1958) suggested that some lambs may be born as late as early to mid-July. The only report of a peak lambing period similar to this study was by

Table 25. Estimated birth dates of newborn lambs observed on the West Rosebud drainage during the early summers of 1974 and 1975.

Date of Observation	Number of Lambs Observed	Estimated Birth Date(s)
June 29, 1974	1	June 23
July 4, 1974	2	Last week of June
June 23, 1975	1	June 23
June 24, 1975	1	-
July 3, 1975	1	July 1
July 5, 1975	1	June 30

Table 26. Progression of isolation of ewes prior to lambing in 1975 on the West Rosebud drainage.

Date of Observation	No. of Ewes Observed	Percent of Est. Ewe Population Observed	Percent of Ewes Observed In Isolation
June 3	24	86	0
June 12	28	100	0
June 19	14	50	0
June 23	20	72	5
June 26	16	57	6
June 29	9	32	0

Cherniavski (1962), who found that snow sheep *(Ovis nivicola)* in northeastern Siberia generally lambed during the last ten days of June.

Variation in lambing dates from area to area may be due to differences in climatic conditions, with lambs born later in areas subject to severe spring weather than in areas with milder conditions (Cherniavski 1962, Geist 1971). It seems doubtful that climatic conditions in the West Rosebud area are sufficiently severe to set back lambing two to four weeks.

The lambing season of the Stillwater bighorns could not be determined. Two young lambs were seen on June 28, 1974, and were thought to be more than one week old at that time (R. Stoneberg pers. comm.).

Range Use and Food Habits of Other Ungulates

Mule Deer

The *Artr* subtype *(Pipo/Feid* h.t.) appeared to receive the greatest use by West Rosebud mule deer during winter and spring, though the *Potr/Syal* h.t. was also used extensively (Table 27). Shrubs, primarily big sagebrush, dominated the diet during the winter period (Table 28). Forbs ranked second, with grasses or grass-like plants only rarely used.

Table 27. Percent of 718 observations of mule deer in various habitat types during winter and spring 1975 in the West Rosebud area.

Season	Sample Size	*Pipo/Feid/Artr*	*Potr/Syal*	*Poa/Trifo*
Winter	323	78	19	3
Spring	395	89	10	1

Use of grasses and forbs increased dramatically during the spring when they appeared to be of equal importance to shrubs. King spike-fescue comprised most of the grass used, and shooting star *(Dodecatheon conjugans* the major forb. Big sagebrush was the only shrub observed to be used.

Table 28. Mean percentage of use (U) and preference indices (P) by habitat type and/or subtype of each plant species used by mule deer during winter and spring, 1975, in the Stillwater and West Rosebud areas. Trace (Tr) amounts are less than 0.5 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

	Stillwater										West Rosebud			
	Winter								Spring		Winter		Spring	
			Psme/Agsp											
	Feid/Agsp (3) (768)		*Rhtr* (7) (6691)		*Artr* (1) (1772)		*Potr/Syal* (1) (214)		*Psme/ Agsp/ Rhtr* (1) (165)		*Pipo/ Feid/ Artr* (2) (1161)		*Pipo/ Feid/ Artr* (3) (706)	
Taxa	U	P	U	P	U	P	U	P	U	P	U	P	U	P
Grasses and Grass-like Plants	1.2/	0.3	1.1/	0.02					60.6/	-	5.2/	-	32.2/	-
Agropyron spicatum			Tr/	-					38.8/	-	3.8/	-	7.2/	-
Carex spp.			Tr/	-							Tr/	-		
Festuca idahoensis	0.7/	0.04							20.6/	-	Tr/	-	2.0/	-
Hesperochloa kingii											0.7/	-	22.7/	-
Juncus balticus													Tr/	-
Poa spp.	0.5/	0.05	0.9/	0.03					1.2/	-				
Forbs	37.6/	2.1	2.4/	0.5					23.0/	-	8.9/	-	32.6/	-
Agoseris glauca													Tr/	-
Allium spp.									12.1/	-			1.6/	-
Anemone patens													0.7/	-
Antennaria spp.	0.8/	0.8									Tr/	-		
Artemisia frigida	20.4/	10.2	1.3/	0.6					6.7/	-	6.5/	-	1.8/	-
Artemisia ludoviciana	1.0/	1.0	Tr/	-										
Balsamorrhiza sagittata	8.1/	4.0	0.6/	1.3							1.2/	-		
Cerastium arvense									0.6/	-			0.7/	-
Chrysopsis villosa	4.9/	1.2												
Claytonia lanceolota													Tr/	-
Delphinium bicolor													5.5/	-
Dodecatheon conjugans													15.2/	-

Table 28. Continued.

Taxa	Stillwater Winter *Feid/Agsp* (3) (768) U	P	*Psme/Agsp* *Rhtr* (7) (6691) U	P	*Artr* (1) (1772) U	P	*Potr/Syal* (1) (214) U	P	Spring *Psme/Agsp/Rhtr* (1) (165) U	P	West Rosebud Winter *Pipo/Feid/Artr* (2) (1161) U	P	Spring *Pipo/Feid/Artr* (3) (706) U	P
Forbs (cont.)														
Erigeron spp.													Tr/-	
Lilaceae									0.6/-					
Musineon divaricatum													1.8/-	
Phlox hoodii	2.3/	1.2	Tr/	-							0.9/-		1.1/-	
Unknown			Tr/	-					3.0/-				3.3/-	
Shrubs	61.2/	20.4	96.5/	6.9	100.0/	3.8	100.0/	5.3	16.4/-		86.0/-		35.3/-	
Artemisia tridentata	11.7/	24.9	26.8/	26.8	11.9/	0.5	4.7/	-			75.7/-		35.3/-	
Juniperus communis			Tr/	-			44.9/	-			1.6/-			
Juniperus horizontalis							8.9/	-						
Pinus flexilus											Tr/-			
Populas tremuloides			0.9/	7.2	Tr/	-								
Prunus virginiana	3.5/	7.0	11.6/	11.6	26.7/	26.7	27.1/	9.0			7.5/-			
Pseudotsuga menziesii							14.5/	-	8.5/-					
Rhus trilobata	46.0/	-	57.0/	5.2	61.0/	20.3			7.9/-					
Ribes spp.					Tr/	-					0.7/-			
Rosa acicularis											Tr/-			

Mule deer on the Stillwater winter range used the *Rhtr* and *Artr* subtypes *(Psme/Agsp* h.t.) heavily throughout the winter (Table 29). During spring, use of the *Feid/Agsp* h.t. increased substantially as new growth of forbs became available.

Table 29. Percent of 1,656 observations of mule deer in various habitat types during winter and spring, 1975, in the Stillwater area.

Season	Sample Size	*Feid/Agsp*		*Psme/Agsp*				*Psme/ Feid*	*Potr/ Syal*	*Potr/ Salix*
		U[1]	G[2]	*Rhtr*	*Artr*	Rock	*Agsp*			
Winter	1,272	17	2	47	25	1	4	-	2	2
Spring	384	42	2	40	9	-	1	2	1	3

[1]Ungrazed.
[2]Grazed.

Browse, especially skunkbush sumac, comprised the major portion of foods used by mule deer on these types during winter (Table 28). Forbs, including fringed sagewort and arrowleaf balsamroot, were important only on the *Feid/Agsp* h.t. Grass use was insignificant.

The one feeding site examined during spring showed predominate use of grasses, especially bluebunch wheatgrass and Idaho fescue. Forbs used included wild onion *(Allium* spp.) and fringed sagewort. Some browsing occurred on Douglas fir and skunkbush sumac.

Bighorns and mule deer were frequently observed feeding side by side. Possible social interaction was observed on only six of 42

occasions when bighorns and mule deer were within 50 yards of each other; on these occasions one or more deer moved away from an area at the approach of bighorns. In one case, a three-year-old bighorn ram moved into a small feeding crater being used by an adult female mule deer which immediately left the area. More often, the deer appeared to be somewhat more alert than usual when in the presence of sheep.

Mountain Goats

Mountain goats were observed primarily in the West Rosebud; only five were seen west of the Stillwater River. Goats appeared to prefer the *Carex/Podi* h.t. and its rock outcrop subtype during the winter and summer (Table 30). Like bighorns, mountain goats moved down from the alpine plateaus during May and early June to use the rock outcrop subtype (*Abla/Vagl* h.t.). From these areas, they followed the receding snowline to the higher elevations during late spring and early summer.

Table 30. Percent of 216 observations of mountain goats in various habitat types during the summer of 1974 and the winter and spring of 1975.

Season	Sample Size	*Carex/Podi*	*Carex/Podi*/Rock	*Abla/Vagl*/Rock
Winter	56	52	48	-
Spring	17	-	-	100
Summer	195	81	12	6

The three mountain goat feeding sites examined indicated substantial usage of grasses and grass-like plants during spring and fall, while forbs appeared to be the dominant forage in summer (Table 31). Idaho fescue, bluegrasses, and sedges were the most important grass and grass-like species in spring, summer, and fall, respectively. During the summer, fleabane and arnica were the important forbs.

Mountain goats and bighorns were seen in close proximity on six occasions. On four of these occasions goats were seen feeding within 100 yards of bighorns without interaction; on another a goat fed within 50 feet of two bighorns. On still another occasion, a bighorn, believed to be a pregnant ewe in search of a place to lamb, rapidly moved away from the area it occupied upon approach of a goat.

Domestic Livestock

Horses. — Horses used the grazed phase of the *Feid/Agsp* h.t. on the Stillwater winter range throughout the year, while the *Psme/Feid* h.t. was grazed during summer and early fall. Occasional use was made of the *Feid/Agsp* h.t. during all seasons.

Examination of feeding sites on these types indicated that grasses and grass-like plants comprised more than 90 percent of the diet of horses during summer, winter and spring (Table 32). Idaho fescue and prairie sand reedgrass were the most important grasses during the summer. Bluebunch wheatgrass and bluegrasses were important during

Table 31. Mean percentage of use of each plant species used by mountain goats during summer and fall, 1974 and spring 1975. Trace (Tr) amounts are less than 0.5 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

Taxa	Spring *Abla/Vagl*/Rock (1) (74)	Summer *Carex/Podi* (1) (412)	Fall *Carex/Podi* (1) (168)
Grasses and Grass-like Plants	97.3	46.6	88.7
Agropyron scribneri	-	7.8	-
Carex spp.	10.8	-	86.9
Festuca idahoensis	86.5	-	-
Poa spp.	-	38.8	1.8
Forbs	2.7	53.4	11.3
Arnica latifolia	-	19.4	-
Brassicaceae	-	Tr	-
Caltha leptosepala	-	-	11.3
Erigeron spp.	-	31.1	-
Heuchera cylindrica	2.7	-	-
Potentilla diversifolia	-	Tr	-
Unknown Forb	-	2.4	-

Table 32. Mean percentage of use (U) and preference indices (P) of each plant species used by horses, cattle and domestic sheep in various seasons and habitat types. Trace (Tr) amounts are less than 0.5 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

	Horses						Cattle		Domestic Sheep	
	Summer		Winter		Spring		Winter		Summer	
	Psme/Feid		*Feid/Agsp*		*Feid/Agsp*		*Feid/Agsp*		*Pial/Acmi*	
	(1)		(2)		(1)		(1)		(1)	
	(324)		(1253)		(822)		(286)		(724)	
Taxa	U	P	U	P	U	P	U	P	U	P
Grasses and Grass-like Plants	99.4/	-	90.4/	2.3	100.0/	-	95.5/	2.4	95.0/	5.9
Agropyron spicatum	5.2/	-	63.9/	8.0			36.7/	4.6		
Bromus tectorum	Tr /	-			8.5/	-				
Calamovilfa longifolia	47.5/	-	Tr /	-						
Carex spp.	2.8/	-	1.7/	0.6					80.2/	10.0
Festuca idahoensis	31.2/	-	2.6/	0.2	Tr /	-	1.7/	0.1		
Festuca ovina									Tr /	-
Juncus balticus	0.9/	-					3.5/	-		
Koeleria cristata	4.6/	-	0.8/	0.8	Tr /	-	3.1/	3.1		
Luzula wahlenbergii									Tr /	-
Poa spp.	3.7/	-	18.9/	1.9	91.0/	-	21.7/	2.2	14.4/	2.4
Stipa comata	3.1/	-	2.3/	6.8			28.7/	84.4		
Forbs	0.6/	-	9.6/	0.5			3.1/	0.2	5.0/	0.1
Achillea millifolium									Tr /	-
Agoseris glauca									1.4/	0.5

Table 32. Continued

Taxa	Horses						Cattle		Domestic Sheep	
	Summer		Winter		Spring		Winter		Summer	
	Psme/Feid (1) (324)		*Feid/Agsp* (2) (1253)		*Feid/Agsp* (1) (822)		*Feid/Agsp* (1) (286)		*Pial/Acmi* (1) (724)	
	U	P	U	P	U	P	U	P	U	P
Forbs (cont.)										
Antennaria spp.									0.8/	0.8
Artemisia campestris			1.4/	4.1						
Artemisia frigida			2.1/	1.0			2.4/	1.2		
Artemisia ludoviciana			Tr /	-			Tr /	-		
Cerastium arvense			3.4/	1.7					0.8/	0.8
Chrysopsis villosa			1.4/	0.4			Tr /	-		
Erigeron spp.									0.6/	0.1
Fragaria virginiana									Tr /	-
Liatris punctata			Tr /	-						
Lupinus argenteus									Tr /	-
Phlox hoodii			0.6/	0.3						
Potentilla diversifolia									0.6/	0.6
Unknown	0.6/	-								
Shrubs							1.4/	0.5		
Prunus virginiana							0.7/	1.4		
Rhus trilobata							0.7/	-		

the winter, while bluegrasses dominated during spring. Forbs appeared to be of some importance only during the winter when field chickweed and fringed sagewort were utilized.

Cattle. — Cattle use on the Stillwater winter range was generally restricted to use of the *Potr/Salix* h.t. by a few animals in winter and spring, though the *Feid/Agsp* h.t. was also used on rare occasions. One feeding site examination suggested a preference by cattle for grass and grass-like plants during winter, with bluebunch wheatgrass, needle-and-thread and bluegrasses being most heavily used (Table 32). Fringed sagewort was the only important forb. Shrubs did not appear important in the cattle diet, though occasional use was noted on chokecherry and skunkbush sumac.

Bighorn sheep appeared wary of cattle and horses on the same range and would invariably move aside at their approach.

Domestic Sheep. — Domestic sheep occupied areas considered to be bighorn range only during the summer in the Sheepherder-Monument Peak area at the head of the Boulder River. They used the alpine *Carex/Podi* h.t. and the subalpine *Pial/Acmi* h.t. most extensively. The one feeding site examined indicated predominant use of grasses and grass-like plants, with sedges and bluegrasses being most important and apparently highly preferred (Table 32).

DISCUSSION AND CONCLUSIONS

The results of this study generally supported Pallister's (1974) suggestion that bighorn sheep associated with the West Rosebud and Stillwater areas comprised distinct populations. At no time were bighorns from these winter ranges observed in the same area. Findings also indicated substantial differences in winter range use and habitat relationships of sheep between the two areas. These differences apparently were reflected in the quality (Geist 1971), dynamics, and trends of the respective populations in recent years.

During winter, bighorns on the West Rosebud ranged on high alpine plateaus until April when they migrated downward to spend spring and early summer on steep valley slopes along West Rosebud Creek. Sheep on the Stillwater wintered at low elevations along a valley bottom. Range usage of bighorns on alpine plateaus was highly restricted to small windswept areas of the *Carex/Podi* h.t. on which relatively little forage of low nutritional value was available, at least by late winter. Observations at that time showed high utilization of all plants, and significant use of dried forbs at feeding sites. The latter appeared unusual for bighorn sheep, contrasting with food habits of sheep on the Stillwater during the same period as well as with winter forage preferences on other ranges, and may have reflected prior heavy utilization of more preferred grasses and sedges on these sites. On the Stillwater range, bighorns fed on a variety of habitat types; and

forage plants of generally higher protein content remained relatively abundant in late winter. Preferred grasses comprised most of the diet throughout the winter, while green or partially green forbs and browse plants were also available and used. These data suggest that bighorn sheep wintering on the West Rosebud were contending with deficiencies in both the quantity and the quality of forage available on primary range sites. The same deficiencies were not apparent on the Stillwater winter range. Inferior horn growth and higher lungworm larvae output among bighorns on the West Rosebud, probably reflected the basic differences in range use and conditions on the two areas. Reduced horn growth (Wishart 1969, Geist 1971) and increased output of lungworm larvae (Stelfox 1974) have been associated with poor quality bighorn ranges and populations in other areas. Similarly, the high lamb mortality observed on the West Rosebud during the winters of 1973-74 and 1974-75, as well as adult mortality in the latter winter, may have been associated with the generally low quantity and quality of winter forage on the alpine plateaus; though numbers of sheep on the plateau and the time and/or degree to which these animals were restricted, by weather and snow conditions, to using a few small windswept areas may also have been important.

Recent trends in total numbers of bighorn sheep on both the West Rosebud and the Stillwater range during spring appeared directly related to the numbers of lambs produced and surviving through winter.

Factors affecting the survival of bighorns through the winter apparently did not affect lamb production on the West Rosebud range. The lamb:ewe ratio observed during the summer of 1974 was high despite extensive mortality of lambs during the winter of 1973-74. Lamb production and early survival may be influenced more by fetal growth, as determined by the nutritional plane of ewes during the last third of gestation, than by forage conditions earlier, as shown for domestic livestock (Maynard and Loosli 1956) and white-tailed deer (Verme 1963). On the West Rosebud, where lambing apparently occurred about the first of July, the period of greatest demand for high quality forage would begin about May 1. By that date all sheep had moved from alpine ranges to lower valley slopes and were utilizing an abundance of highly nutritious green forage.

Assuming the relationship between use of high quality forage during May and June and lamb production is correct, the late lambing period observed on the West Rosebud could represent a local adaptation to seasonal range use and nutritional characteristics on the area. However, lambs born during late June and early July have a shorter summer growing season than those born during "normal" late May or early June lambing periods. Such lambs might be expected to enter the winter substantially smaller and be subject to greater over-winter mortality when forage deficiencies occur.

Comparisons of food and range use habits of cattle and horses,

which grazed portions of the Stillwater winter range, with habits and behavior of bighorns indicated existing livestock grazing probably did not constitute serious competition, though more extensive use of the area by either or both species of livestock would likely be detrimental to the sheep. Existing livestock usage may have had some beneficial effects on sheep by increasing the availability of fringed sagewort and Hood's phlox on portions of the *Feid/Agsp* h.t. Both appeared to be highly preferred and nutritious forage species for bighorns, which made heavy usage of the grazed phase of the *Feid/Agsp* h.t. throughout winter. However, both cattle and horses heavily utilized bluebunch wheatgrass, an important bighorn forage plant on sites used during and following winter storms, as well as Idaho fescue, another important grass in the bighorn's winter diet. These grasses were drastically reduced or eliminated on areas of past heavy livestock use.

Although data were limited, observations of summer grazing of domestic sheep on alpine ranges suggested that such grazing probably would be competitive with bighorns, especially on winter range areas. Domestic sheep preferred and heavily utilized sedges and bluegrass which were found to be extremely important in the diet of bighorns on those areas.

At present population levels, dual use of the West Rosebud and Stillwater ranges by bighorns and mule deer did not appear to be competitive. Mule deer and bighorn sheep generally used the same

habitat types on both the Stillwater and the West Rosebud, except that deer were seldom seen in the rock outcrop subtypes (*Psme/Agsp*, *Abla/Vagl* h.t.'s). Food habits overlapped very little. Mule deer preferred shrubs in all habitat types during the winter with forb use important only in the *Feid/Agsp* h.t. Bighorns generally preferred grasses and forbs with shrubs being most important only in the *Artr* and rock outcrop subtypes (*Psme/Agsp* h.t.). Since mule deer made little use of the *Feid/Agsp* type and forbs were plentiful throughout, little competition with bighorns appeared to occur there. On other types the potential for competition was limited to overlapping use of chokecherry, skunkbush sumac, and big sagebrush. Skunkbush sumac and big sagebrush were very abundant and total utilization was generally only moderate. However, current annual growth twigs of most chokecherry were heavily utilized by both bighorns and mule deer, such that some forage competition for this species may have occurred. Overlapping food habits were also evident during early spring when both deer and sheep utilized new green growth of grasses and forbs. Some forage competition could occur when these are in short supply. Sharp increases in the population of either species may result in both land use and forage use competition (Smith and Julander 1953) between mule deer and bighorns.

Competition between bighorn sheep and mountain goat also appeared to be minimal, though these species occupied much the same habitat types and had very similar food habits. Although this overlap

fulfills criteria for potential land and forage use competition (Smith and Julander 1953) between these two species, the small numbers of bighorns and goats involved made competition unlikely. Similar findings were reported by Pallister (1974).

LITERATURE CITED

Bailey, J. A. 1967. Sampling deer browse for crude protein. J. Wildl. Manage. 31(3):437-442.

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

Blood, D. A. 1963. Some aspects of behavior of a bighorn herd. Canadian Field Naturalist 77(2):77-94.

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

_____. and J. C. Wright. 1966. Flora of Montana, Part II - Dicotyledons. Montana State College, Bozeman. 305 pp.

Brown, G. W. 1974. Distribution and population characteristics of bighorn sheep near Thompson Falls in northwestern Montana. Unpubl. Master's Thesis, University of Montana, Missoula. 134 pp.

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildl. Monographs 4. 174 pp.

Cherniavski, F. B. 1962. On the reproduction and growth of the snow sheep *(Ovis nivicola* Esch). (Translation, Canadian Wildlife Service, Ottawa.) *Zoologisheskii Zhurnal* 41:1556-1566.

Cole, G. F. 1956. The pronghorn antelope - Its range use and food habits in central Montana with special reference to alfalfa. Montana Department of Fish and Game and Montana Agricultural Experiment Station. Tech. Bull. No. 56. 63 pp.

Constan, K. J. 1972. Winter foods and range use of three species of ungulates. J. Wildl. Manage. 36(4):1068-1076.

Cooney, R. 1936. Winter game study index, Beartooth Division, Custer National Forest. U.S.D.A. Forest Service. Unpubl. rept.

_____. 1937. Winter game study index, Beartooth Division, Custer National Forest. U.S.D.A. Forest Service. Unpubl. rept.

Cooperrider, A. Y. 1969. The biology and management of the bighorn sheep of Rock Creek, Montana. Unpubl. Master's Thesis, University of Montana, Missoula. 92 pp.

Couey, F. M. 1950. Rocky mountain bighorn sheep of Montana. Fed. Aid in Wildl. Rest., Proj. 1-R, Bull. 2, Montana Fish and Game Comm. 90 pp.

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

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 of Montana during fall and spring. Unpubl. Master's Thesis, Montana State University, Bozeman. 68 pp.

Forrester, D. J. and C. M. Senger. 1964. A survey of lungworm infection in bighorn sheep of Montana. J. Wildl. Manage. 28(3):481-491.

Geist, V. 1966. Validity of horn segment counts in aging bighorn sheep. J. Wildl. Manage. 30(3):634-635.

_____. 1971. Mountain sheep; a study in behavior and evolution. University of Chicago Press, Chicago and London. 383 pp.

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.

Hebert, D. M. 1973. Altitudinal migration as a factor in the nutrition of bighorn sheep. Unpubl. Ph.D. Thesis, University of British Columbia, Vancouver. 357 pp.

Heimer, W. E. 1973. Dall sheep movements and mineral lick use. Fed. Aid in Wildl. Rest. Proj. W-17-2, W-17-3, W-17-4 and W-17-5, Job 6.1 R, Alaska Department of Fish and Game. 67 pp.

Honess, R. F. and N. M. Frost. 1942. A Wyoming bighorn sheep study. Wyoming Game and Fish Dept., Cheyenne. Bull. 1. 127 pp.

Horejsi, B. 1972. Behavioral differences in bighorn lambs during years of high and low survival. Northern Wild Sheep Council Symposium Proceedings, Alberta Department of Lands and Forests, Hinton. 51-76.

Julander, O., W. L. Robinette and D. A. Jones. 1961. Relation of summer range condition to mule deer herd productivity. J. Wildl. Manage. 25(1):54-60.

Klein, D. R. 1965. Ecology of deer range in Alaska. Ecol. Mono. 35:259-284.

Lovaas, A. L. 1958. Mule deer food habits and range use, Little Belt Mountains, Montana. J. Wildl. Manage. 22(3):275-283.

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

Maynard, L. A. and J. K. Loosli. 1956. Animal Nutrition. McGraw-Hill, New York. 484 pp.

McLean, H. L. 1930. Five year fish and game report. Beartooth Division, Custer National Forest. Unpubl. Rept.

Meagher, M. M. 1973. The bison of Yellowstone National Park. Nat. Park Serv., Sci. Monogr. Ser. No. 1. 161 pp.

Mealey, S. P. 1975. The natural food habits of free ranging grizzly bears in Yellowstone National Park, 1973-1974. Unpubl. Master's Thesis, Montana State University, Bozeman. 158 pp.

Morgan, J. K. 1970. Ecology of the Morgan Creek and East Fork of the Salmon River bighorn sheep herds and management of bighorn sheep in Idaho. Idaho Fish and Game Dept. Compl. Rept., Project W-142-R-1. 155 pp.

Moser, C. A. 1962. The bighorn sheep of Colorado. Colo. Game, Fish, and Parks Dept., Denver. Tech. Pub. No. 10. 49 pp.

Murie, A. 1944. The wolves of Mount McKinley. Fauna Series, No. 5, Washington, D. C. U. S. Fauna National Parks. 238 pp.

Mussehl, T. W. and F. W. Howell. 1971. Game management in Montana. Montana Dept. Fish and Game, Helena. Fed. Aid Proj. W-3-C. 238 pp.

Nichols, L. 1974. Sheep Report. Alaska Dept. of Fish and Game Project Progress Report. Fed. Aid in Wildl. Rest. Proj. W-17-5 and W-17-6. 32 pp.

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

Pallister, G. L. 1974. The seasonal distribution and range use of bighorn sheep in the Beartooth Mountains, with special reference to the West Rosebud and Stillwater herds. Unpubl. Master's Thesis, Montana State University, Bozeman. 67 pp.

Peterson, J. G. 1970. The food habits and summer distribution of juvenile sage grouse in central Montana. J. Wildl. Manage. 34(1):147-155.

Pfister, R. D., B. L. Koralchik, S. F. Arno and R. C. Presby. 1974. Forest habitat types of Montana. Intermountain Forest and Range Experiment Station and Northern Region, U.S.F.S., Missoula, Montana. 213 pp.

Picton, H. D. 1960. Migration patterns of the Sun River elk herd, Montana. J. Wildl. Manage. 24(3):279-290.

Pitzman, M. S. 1970. Birth behavior and lamb survival in mountain sheep in Alaska. Unpubl. Master's Thesis, University of Alaska, College. 116 pp.

Richmond, T. C. and J. E. Adler. 1974. Mineral development and land conservation in Montana's Stillwater district. Presented at the 1974 annual meeting AIME, Dallas, Texas. 19 pp. Mimeo.

Rouse, R. A. 1957. Elk food habits, range use and movements, Gravelly Mountains, Montana. Unpubl. Master's Thesis, Montana State College, Bozeman. 29 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.

Smith, D. R. 1954. The bighorn sheep in Idaho - its status, life history, and management. State of Idaho, Dept. of Fish and Game Wildl. Bull. No. 1. 154 pp.

Smith, J. G. and O. Julander. 1953. Deer and sheep competition in Utah. J. Wildl. Manage. 17(2):101-112.

South, P. R. 1971. Ecosystems of the Absaroka and Beartooth Mountains. U.S.D.A. Forest Service Unpubl. Report. 207 pp.

Spencer, C. C. 1943. Notes on the life history of Rocky Mountain bighorn sheep in Tarryall Mountains of Colorado. J. Mammal. 24(1):1-11.

Stelfox, J. G. 1974. Range ecology of bighorn sheep in relation to self-regulation theories. Proceedings of the Biennial Symposium of the Northern Wild Sheep Council. Montana Dept. Fish and Game, Great Falls. 67-76.

Stoneberg, R. P. 1973. Beartooth-Absaroka Wildlife-Mining Research, Planning Inventory, Game. Montana Dept. Fish and Game, Prog. Rept., Proj. Nos. FW-2-R-1 and FW-2-R-2, Job 1-a. 18 pp.

_____. 1974. Beartooth-Absaroka Wildlife-Mining Research, Planning Inventory, Game. Montana Dept. Fish and Game, Prog. Rept., Proj. No. FW-2-R-3, Job 1-a. 47 pp.

Sugden, L. G. 1961. The California bighorn in British Columbia. B. C. Dept. of Recreation and Conservation, Victoria. 58 pp.

Tikhomirov, B. A. 1959. Relationship of the animal world and the plant cover of the tundra. (Translation by E. Issakoff and T. W. Barry). Botanical Institute, Academy of Science of U.S.S.R. Moscow and Leningrad.

Todd, J. W. 1975. Foods of Rocky Mountain bighorn sheep in southern Colorado. J. Wildl. Manage. 39(1):108-111.

Uhazy, L. S., J. C. Holmes, and J. G. Stelfox. 1973. Lungworms in the Rocky Mountain bighorn sheep of western Canada. Can. Jour. Zool. 51(8):817-824.

U. S. Department of Commerce Weather Bureau. 1974. National Oceanic and Atmospheric Administration Environment Data Service Montana Monthly Summary.

_____. 1975. National Oceanic and Atmospheric Administration Environment Data Service Montana Monthly Summary.

Verme, L. J. 1963. Effect of nutrition on growth of white-tailed deer fawns. Trans. 28th N. A. Wildl. Conf. 431-443.

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

Wishart, W. D. 1958. The bighorn sheep of the Sheep River valley. Unpubl. Master's Thesis. Univ. of Alberta, Edmonton. 66 pp.

_____. 1969. Bighorns and little horns. Alberta 12(3):4-10.

Woodard, T. N., R. J. Gutierrez, and W. H. Rutherford. 1974. Bighorn lamb production, survival, and mortality in south-central Colorado. J. Wildl. Manage. 38(4):771-774.

APPENDIX

Table 33. Actual counts and population estimates of Stillwater bighorn sheep prior to 1971.

Date	Rams	Ewes	Adults	Lambs	Uncl.	Total	Comments	Source
1925						57	Total for Beartooth Mountains	McLean 1930
1926						70	Total for Beartooth Mountains	McLean 1930
1927						75	Total for Beartooth Mountains	McLean 1930
1928						85	Total for Beartooth Mountains	McLean 1930
1929						60	Total for Beartooth Mountains	McLean 1930
1935-36						46		Cooney 1936
1936-37	14	18	32	13		45		Cooney 1937
1944						135	Forest Service Estimate	Montana Fish and Game Files
1945						150	Forest Service Estimate	Montana Fish and Game Files
1946						135	Forest Service Estimate	Montana Fish and Game Files
1952			34	5		39		Montana Fish and Game Files
11/20/53					80	80	Estimate	Ikerman in Buechner 1960
1 /11/54	9	17	26	10		36		Ikerman in Buechner 1960
1954					32	32		Montana Fish and Game Files
1954 (April)			49	6		55		Montana Fish and Game Files
1954						90	Forest Service Estimate	Montana Fish and Game Files
2/ 6/56	5	37	42	10	3	55		Montana Fish and Game Files
3/20/56	10	27	37	7		44		Montana Fish and Game Files
11/24/56	7	16	23	8		31		Montana Fish and Game Files
4/19/57	5	21	26	2	8	36		Montana Fish and Game Files
5/23/57			23	4		27		Montana Fish and Game Files
12/17/58	13	24	37	8		45		Montana Fish and Game Files
1965-66	1	17	18	3		21		Montana Fish and Game Files
12/9/66	1	15	16	5		21		Montana Fish and Game Files
2/10/67	2	15	17	10		27		Montana Fish and Game Files
2/28/68	7	20	27	6		33		Montana Fish and Game Files
4/17/69	5	14	19	2		21		Montana Fish and Game Files
1/28/70	2	21	23	5		28		Montana Fish and Game Files

Table 34. Statistics of bighorn sheep hunting in the Beartooth Mountains, 1953-1974.

Year	Harvest		Season	Number of Permits	Number of Hunters
	Known	Computer Projection			
1953	-	-	10/15-11/15	5	-
1954	4	-	10/15-11/15	8	-
1955	2	-	9/15-11/15	8	-
1956	0	-	10/ 1-10/ 7	Unlimited	-
1957	-	-	10/13-10/20	Unlimited	-
1958	-	-	10/ 5-10/19	Unlimited	-
1959	4	-	9/20-11/ 1	Unlimited	-
1960	13	-	9/18-10/30	Unlimited	-
1961	-	-	9/24-11/ 5	Unlimited	-
1962	6	-	9/16-11/ 4	Unlimited	49
1963	-	-	9/15- ?	Unlimited	-
1964	-	-	9/13-12/20	Unlimited	-
1965	5	11	9/15-12/19	Unlimited	61
1966	6	7	9/15-11/27	Unlimited	73
1967	4	4	9/15-11/19	Unlimited	64
1968	7	9	9/15-12/15	Unlimited	54
1969	2	2	9/15-12/14	Unlimited	22
1970	3	-	9/15-11/29	Unlimited	-
1971	9	22	9/15-11/28	Unlimited	144*
1972	6	24	9/15-11/26	Unlimited	245*
1973	6	22	9/ 1-11/25	Unlimited	337*
1974	16	-	9/15-11/24	Unlimited	338*

*Includes hunters in Area 301 (Yellowstone-Gallatin-Madison) and 501 (Beartooth Mountains).

Table 35. Statistics of grazing allotments on important bighorn sheep range, 1911-1946[1].

Date	Stillwater Area									West Rosebud Area						East Rosebud Area		
	Lake Plateau[2]			W. Stillwater Plateau			Verdigris Creek			W. Rosebud Canyon and Plateau			Mount Wood			E. Rosebud Plateau		
	Allowed	Grazed	Season	Allowed	Grazed	Season	Allowed	Grazed	Season	Allowed	Grazed	Season	Allowed	Grazed	Season	Allowed	Grazed	Season
1911-1914										1,058	1,058	7/1-9/30						
1914-1921										2,685	2,685	7/1-9/30						
1922	2,500	2,375	7/1-9/30	1,200	1,025	7/1-9/30	30	30	6/1-9/30	2,400	-	7/1-9/30						
1923	-	-	-	1,000	1,200	7/1-9/30	30	30	6/1-9/30	2,400	-	7/1-9/30						
1924	2,000	1,065	7/10-9/10	1,200	1,160	7/10-9/10	30	35	6/1-9/30	1,200	-	7/1-9/30						
1925	2,000	2,110	7/10-9/10	1,200	1,160	7/10/9/10	30	30	6/1-9/30	1,200	-	7/1-9/30						
1926	2,200	2,200	7/10-9/10	1,075	1,200	7/10-9/10	30	30	6/1-9/30	1,200	-	7/1-9/30						
1927	2,200	1,200	7/10-9/10	1,200	1,200	7/10-9/10	30	30	6/1-9/30	1,200	-	7/1-9/30						
1928	2,200	2,143	7/10-9/10	1,200	1,200	7/10-9/10	30	0	6/1-9/30	1,200	-	7/1-9/30						
1929	2,200	2,200	7/10-9/10	1,200	0	7/10-9/10	30	30	6/1-7/30	1,500	-	7/1-9/30						
1930	2,200	2,214	7/10-9/10	1,200	1,200	7/10-9/10	30	30	6/1-7/30	1,800	1,400	7/1-9/30	500	575	7/10-9/10	665	-	7/10-9/10
1931	2,200	2,117	7/10-9/10	1,200	1,200	7/10-9/10	30	30	6/1-7/30	1,200	1,500	7/1-9/30	500	765	7/10-9/10	665	-	7/10-9/10
1932	2,200	1,200	7/10-9/10	1,200	1,500	7/10-9/10	30	30	6/1-7/30	1,200	1,500	7/1-9/30	500	700	7/10-9/10	750	-	7/10-9/10
1933	2,200	2,250	7/10-9/10	1,200	1,200	7/10-9/10	30	30	6/1-7/30	1,200	1,500	7/1-9/30	500	700	7/10-9/10	800	-	7/16-9/15
1934	2,200	2,400	7/10-9/10	1,000	646	7/10-9/10	30	30	6/1-7/30	1,200	1,200	7/1-9/30	700	610	7/10-9/10	800	-	7/16-8/31
1935	2,200	2,200	7/10-9/10	1,200	700	7/10-9/10	30	30	6/1-7/30	1,500	1,200	6/16-9/15	700	700	7/10-9/10	800	-	7/16-8/31
1936	2,200	2,200	7/10-9/10	1,200	700	7/10-9/10	30	30	6/1-9/30	1,800	1,175	7/1-9/15	700	700	7/10-9/10	800	-	7/16-8/31
1937	2,200	1,205	7/10-9/10	1,200	900	7/10-9/10	30	30	6/1-9/30	1,800	721	7/1-9/15	700	375	7/10-9/10	730	-	7/16-8/31
1938	2,200	-	7/10-9/10	1,200	1,000	7/10-9/10	30	30	6/1-9/30	1,800	1,050	7/1-9/15	700	375	7/24-9/1	-	-	-
1939	2,200	1,200	7/10-9/10	1,200	1,000	7/11-8/31	30	30	6/1-9/30	1,800	1,000	7/1-9/15	Allotment cancelled			Allotment cancelled		
1940	2,200	1,200	7/11-9/10	1,200	1,000	7/11-8/31	30	0	6/1-9/30	1,800	1,040	7/1-9/15						
1941	1,200	1,170	7/11-9/10	1,000	990	7/11-8/31	30	0	6/1-9/30	1,044	1,040	7/1-9/15						
1942	1,200	1,182	7/11-9/10	1,000	1,000	7/11-8/31	Allotment cancelled			1,044	1,040	6/16-8/31						
1943	1,200	0	7/11-9/10	1,000	981	7/11-8/31				1,044	1,040	6/16-8/31						
1944	1,200	0	-	Allotment cancelled						1,040	1,037	6/16-8/31						
1945	1,200	1,077	-							1,040	1,040	6/16-8/31						
1946	1,200	1,220	-							Converted to cattle								

[1]All allotments are for domestic sheep except the Verdigris Creek allotment for cattle and horses and the W. Rosebud Canyon allotment for cattle after 1946.
[2]Lake Plateau has 2 allotments from 1922 to 1935 when the allotments were combined. Table shows total numbers for both allotments.

Table 36. Monthly and seasonal centers of activity, standard diameters, maximum distances from winter range centers of activity and average distance between consecutive relocations for marked West Rosebud bighorns.

Tag No.	Sex	Month or Season	No. of Obs.	Center of Activity[1]	Std. Dia. in Miles	Max. Distance from Winter Range Center of Activity in Miles	Average Distance Between Relocations in Miles
S3535	F	Spring 1974	6	6007-50116	2.55	3.00	0.72
		Summer 1974	6	5832-49902	15.10	21.80	5.09
		Fall 1974	2	-	-	21.80	-
		Winter 1975	5	6022-50126	0.44	0.50	0.21
S3537	F	Spring 1974	2	-	-	1.60	-
		Summer 1974	5	5987-50109	0.73	1.45	0.41
		Winter 1975	4	5968-50108	1.73	1.50	1.30
		May 1975	5	5985-50103	0.91	1.45	0.59
		June 1-14, 1975	5	5987-50102	0.73	1.50	0.49
		Spring 1975	10	5987-50103	0.82	1.50	0.54
		June 15-30, 1975	8	5991-50091	0.97	2.05	0.49
S3539	F	Spring 1974	2	-	-	0.40*	-
		Summer 1974	11	5961-50096	1.79	2.90	0.57
		Fall 1974	2	-	-	2.50	-
		Winter 1975	2	-	-	1.60	-
		Spring 1975	8	5996-50104	1.16	0.95	0.26
		June 15-30, 1975	8	5989-50095	1.25	2.00	0.51
S3541	F	Summer 1974	3	5986-50110	0.58	1.40	0.30
		Fall 1974	1	-	-	7.00	-
		Winter 1975	5	5967-50107	1.52	1.40	1.19
		May 1975	8	6012-50122	1.82	3.80	0.49
		June 1 -14, 1975	7	5993-50110	2.26	3.25	0.45
		Spring 1975	15	6005-50117	2.37	3.80	0.47
		June 15-30, 1975	4	5986-50101	0.49	1.40	0.27
08	F	Spring 1974	1	-	-	2.00	-
		Summer 1974	4	5987-50108	0.78	2.40	0.53
		Fall 1974	1	-	-	6.50	-
		Winter 1975	6	5958-50109	1.92	1.10	0.84
		May 1975	4	5984-50102	0.95	2.10	0.55
		June 1 -14, 1975	3	5983-50100	0.72	2.05	0.58
		Spring 1975	7	5986-50102	0.90	2.10	0.57
		June 15-30, 1975	9	5991-50091	0.91	2.70	0.42

Table 36. Continued.

Tag No.	Sex	Month or Season	No. of Obs.	Center of Activity[1]	Std. Dia. in Miles	Max. Distance from Winter Range Center of Activity in miles	Average Distance Between Relocations in Miles
11	F	Spring 1974	3	5993-50101	0.40	0.30*	0.30
		Summer 1974	12	5971-50103	2.27	2.15	0.73
		Fall 1974	2	-	-	2.40	-
09	F	Spring 1974	5	5990-50105	0.25	0.25*	0.12
		Summer 1974	2	-	-	0.80	-
		Fall 1974	1	-	-	1.35	-
		Winter 1975	1	-	-	0.95	-
12	M	Spring 1974	7	6020-50129	2.02	2.40*	0.77
		Summer 1974	8	5873-49956	18.39	21.80	8.20
		Fall 1974	2	-	-	21.00	-
		Spring 1975	8	6023-50125	0.90	0.80	0.21
		June 15-30, 1975	7	5990-50106	3.55	4.05	0.79
S3536	M	Spring 1974	5	6023-50128	3.46	2.75*	2.69
		Fall 1974	2	-	-	4.50	-

[1]Coordinates based on 1000 meter grid system on U. S. Geological Survey Topographic Maps.
*For these animals this figure is calculated from the spring range center of activity because of lack of winter range observations.

Table 37. Monthly and seasonal centers of activity, standard diameters, maximum distances from winter range centers of activity and average distance between consecutive relocations for marked Stillwater bighorns.

Tag No.	Sex	Month or Season		No. of Obs.	Center of Activity[1]	Std. Dia. in Miles	Max. Distance from Winter Range Center of Activity in Miles	Average Distance between Relocations in Miles
S4287	F	Fall	1974	6	5862-50247	0.98	0.95	0.72
		January	1975	27	5868-50241	0.71	0.75	0.37
		February	1975	21	5869-50243	0.83	1.10	0.43
		March	1975	18	5873-50246	1.08	1.15	0.38
		April	1975	27	5868-50242	0.42	0.40	0.26
		Winter	1975	93	5869-50243	0.76	1.15	0.36
		May	1975	20	5869-50242	0.90	1.00	0.41
		June	1975	1	-	-	1.80	-
		Spring	1975	21	5869-50242	1.16	1.80	0.48
S4289	F	January	1975	18	5866-50238	0.76	1.00	0.42
		February	1975	24	5870-50243	0.54	0.45	0.33
		March	1975	19	5869-50244	0.49	0.50	0.28
		April	1975	22	5869-50241	0.46	0.50	0.27
		Winter	1975	83	5869-50242	0.57	1.00	0.32
		May	1975	21	5868-50242	0.57	0.55	0.35
		June	1975	1	-	-	0.35	-
		Spring	1975	22	5868-50242	0.57	0.55	0.35
S3543	F	Fall	1974	5	5862-50243	2.81	3.00	0.98
		January	1975	21	5865-50238	1.05	1.60	0.41
		February	1975	23	5869-50243	0.88	1.20	0.49
		March	1975	21	5869-50244	0.61	0.80	0.36
		April	1975	26	5868-50242	0.44	0.45	0.26
		Winter	1975	91	5868-50242	0.77	1.60	0.38
		May/Spring	1975	23	5868-50243	0.76	0.95	0.35
166	F	Fall	1974	1	-	-	0.75	-
		January	1975	18	5867-50239	0.83	1.10	0.39
		February	1975	18	5872-50244	1.04	1.10	0.45
		March	1975	19	5872-50246	1.12	1.15	0.29
		April	1975	23	5870-50243	0.98	0.95	0.42
		Winter	1975	78	5870-50243	0.99	1.15	0.39
		May	1975	16	5870-50243	0.89	0.90	0.48
		June	1975	1	-	-	0.40	-
		Spring	1975	17	5870-50243	0.88	0.90	0.46

Table 37. Continued.

Tag No.	Sex	Month or Season		No. of Obs.	Center of Activity[1]	Std. Dia. in Miles	Max. Distance from Winter Range Center of Activity in Miles	Average Distance Between Relocations in Miles
162	F	Fall	1974	6	5869-50249	1.11	1.10	0.56
		January	1975	19	5879-50253	0.71	0.80	0.35
		February	1975	14	5878-50252	0.72	0.80	0.46
		March	1975	13	5874-50249	0.63	0.55	0.40
		April	1975	15	5873-50248	0.67	0.60	0.29
		Winter	1975	61	5876-50251	0.69	0.80	0.37
		May	1975	12	5873-50248	0.77	0.85	0.37
		June	1975	1	-	-	0.90	-
		Spring	1975	13	5873-50248	0.84	0.90	0.35
167	F	January	1975	25	5868-50243	0.98	1.10	0.38
		February	1975	15	5867-50242	0.64	0.70	0.35
		March	1975	18	5869-50243	0.67	0.90	0.39
		April	1975	25	5869-50242	0.52	0.65	0.33
		Winter	1975	83	5868-50242	0.74	1.10	0.36
		May	1975	18	5870-50242	0.98	1.00	0.48
		June	1975	1	-	-	0.25	-
		Spring	1975	19	5870-50242	0.96	1.00	0.46
169	F	January	1975	27	5867-50241	0.74	0.95	0.41
		February	1975	22	5869-50244	0.92	1.20	0.38
		Winter	1975	49	5868-50242	0.83	1.20	0.40
41	M-Lamb	January	1975	14	5871-50246	1.13	0.95	0.32
		February	1975	18	5867-50241	1.04	1.10	0.50
		March	1975	15	5869-50246	0.78	0.95	0.41
		April	1975	15	5869-50244	0.86	0.90	0.34
		Winter	1975	62	5869-50244	0.96	1.10	0.40
		May	1975	14	5869-50242	0.86	0.95	0.53
		June	1975	1	-	-	0.35	-
		Spring	1975	15	5869-50242	0.85	0.95	0.54
92	F	March	1975	12	5869-50243	0.60	0.50	0.39
		April	1975	25	5868-50242	0.44	0.50	0.30
		Winter	1975	37	5868-50242	0.50	0.50	0.32
		May	1975	20	5869-50242	0.83	1.10	0.40
		June	1975	1	-	-	1.70	-
		Spring	1975	21	5868-50241	1.10	1.70	0.40

Table 37. Continued.

Tag No.	Sex	Month or Season	No. of Obs.	Center of Activity[1]	Std. Dia. in Miles	Max. Distance from Winter Range Center of Activity in Miles	Average Distance Between Relocations in Miles
94	F	March 1975	8	5869-50244	0.77	0.60	0.43
		April 1975	24	5868-50242	0.46	0.50	0.28
		Winter 1975	32	5869-50242	0.55	0.60	0.31
		May/ Spring 1975	18	5868-50242	0.76	1.00	0.34
95	F-Lamb	April/ Winter 1975	15	5870-50243	1.01	1.15	0.51
		May 1975	20	5870-50243	0.92	0.95	0.38
		June 1975	1	-	-	0.40	-
		Spring 1975	21	5870-50243	0.92	0.95	0.37
96	M	Spring 1975	3	5867-50235	2.23	-	1.40

[1]Coordinates based on 1000 meter grid system on U. S. Geological Survey Topographic Maps.

Table 38. Locations of five lambing areas on the West Rosebud drainage during the springs of 1974 and 1975.

Year	Number of Lambs	Map Coordinates[1]
1974	3	5952-50097
1975	1	5983-50098
1975	1	6000-50101
1975	1	5983-50078
1975	1	5983-50111

[1]Based on 1000 meter grid system on U. S. Geological Survey Topographic Maps.

Table 39. Mean percentage of use by month and season of each plant species used by bighorn sheep in the West Rosebud area. Trace (Tr) amounts are less than 0.5 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

Taxa	March (3) (2302)	April (6) (6800)	Winter (9) (9102)	May (10) (10647)	June 1-14 (2) (1668)	Spring (12) (12315)	June 15-30 (2) (3246)	July (5) (1435)	August (2) (986)	Summer (9) (5667)	October (2) (494)	November (4) (1019)	Fall (6) (1513)
Grasses and Grass-like Plants	33.2	47.0	43.5	79.4	84.2	80.0	82.9	25.9	37.1	60.5	78.9	83.3	81.9
Agropyron caninum							9.3			5.3			
Agropyron scribneri									2.0	Tr	14.0		4.6
Agropyron spicatum		4.4	3.3	22.5	25.3	22.9	15.1			8.7			
Agropyron spp.								Tr	0.5	Tr	12.5		4.0
Agrostis scabra							1.9			1.1			
Bromus spp.							Tr			Tr			
Carex spp.	28.5	11.5	15.8	9.4	7.1	9.1	29.3	4.9	15.3	20.7	Tr	37.6	25.4
Dactylis glomerata					2.3	Tr							
Deschampsia atropurpurea									1.7	Tr			
Deschampsia caespitosa	Tr		Tr					5.3		1.3		38.8	26.1
Festuca idahoensis		16.9	12.6	18.5	8.3	17.1	1.4			0.8			
Festuca ovina	4.6		1.2					1.6	Tr	0.5	0.8	1.2	1.1
Heeperochloa kingii		14.2	10.6	26.0		22.5							
Juncus balticus									Tr	Tr			
Koeleria cristata				1.1		1.0		2.4	2.2	1.0	2.4	1.1	1.5
Luzula wahlenbergii									1.7	Tr			
Poa spp.				1.9	41.2	7.3	25.4	11.0	13.0	19.6	49.2	4.7	19.2
Unknown							0.5	Tr		Tr			
Forbs	66.8	12.7	26.4	15.5	8.3	14.5	13.1	40.0	51.9	26.6	21.1	16.5	18.0
Achillea millefolium							Tr		1.0	Tr			
Allium spp.		Tr	Tr	Tr	0.6	Tr							
Agoseris glauca				Tr		Tr			13.7	2.4			
Anemone patens				Tr	1.7	0.5							
Antennaria spp.				0.9		0.8			Tr	Tr			
Apiaceae									Tr	Tr			
Apocynum androsaemifolium								3.6		0.9			
Aquilegia flavescens									1.9	Tr			
Arnica latifolia									8.2	1.4			
Artemisia frigida		3.9	2.9	0.6		0.5							
Aster alpigenus									0.7	Tr			
Asteraceae											3.2		1.1
Astragalus vexilliflexus								6.8		1.7			

Table 39. Continued.

Taxa	March (3) (2302)	April (6) (6800)	Winter (9) (9102)	May (10) (10647)	June 1-14 (2) (1668)	Spring (12) (12315)	June 15-30 (2) (3246)	July (5) (1435)	August (2) (986)	Summer (9) (5667)	October (2) (494)	November (4) (1019)	Fall (6) (1513)
Forbs (cont.)													
Balsamorrhiza sagittata		5.6	4.2	0.6		0.5							
Brassicaceae				Tr		Tr			Tr	Tr			
Campanula rotundifolia								Tr		Tr			
Castillega cusickii								3.8		1.0			
Cerastium arvense		Tr	Tr	Tr	Tr	Tr		Tr		Tr			
Chrysopsis villosa				Tr	0.5	Tr							
Comandra umbellata				4.0		3.5							
Delphinium bicolor				Tr		Tr							
Dodecatheon pauciflorum								Tr		Tr			
Dryas octopetala												Tr	Tr
Epilobium angustifolium								Tr		Tr			
Erigeron spp.				Tr		Tr		0.6	15.9	2.9	2.5	1.0	1.5
Fabaceae		0.7	Tr					3.2	1.0	1.0			
Geum rossii	62.1		15.7					Tr		Tr		13.3	9.0
Fragaria virginiana									Tr	Tr			
Heuchera cylindrica				1.7		1.5	0.5			Tr			
Hydrophyllum spp.											0.6		Tr
Liliaceae				Tr		Tr							
Lloydia serotina								5.5		1.4			
Lupinus argenteus				5.4		4.6			0.5	Tr	13.4		4.4
Mertensia alpina								Tr	1.3	Tr			
Oxyria digyna									0.7	Tr			
Phlox hoodii		2.2	1.7	0.8		0.7			0.6	Tr			
Polygonum bistortoides								0.9	Tr	Tr			
Potentilla diversifolia								0.5	Tr	Tr	0.8	1.9	1.5
Potentilla spp.							0.6			Tr			
Saxifraga bronchialis							Tr			Tr			
Saxifraga spp.	0.8		Tr										
Sedum spp.								Tr		Tr			
Senecio canus							5.6			3.2			
Senecio crassulus									1.9	Tr			
Silene acaulis	3.7		0.9					7.9		2.0			
Solidago missouriensis							5.1			2.9			

Table 39. Continued.

Taxa	March (3) (2302)	April (6) (6800)	Winter (9) (9102)	May (10) (10647)	June 1-14 (2) (1668)	Spring (12) (12315)	June 15-30 (2) (3246)	July (5) (1435)	August (2) (986)	Summer (9) (5667)	October (2) (494)	November (4) (1019)	Fall (6) (1513)
Forbs (cont.)													
Taraxacum officinale					Tr	Tr							
Tragopogon dubius					Tr	Tr	Tr			Tr			
Trifolium parryi								4.5		1.1			
Trifolium spp.					4.5	0.6							
Veronica wormskjoldii									1.1	Tr			
Viola spp.									Tr	Tr			
Unknown	Tr	Tr	Tr	Tr	Tr	Tr	0.7	0.6	1.6	0.8	0.6		Tr
Shrubs		40.3	30.1	5.1	7.5	5.5	4.0	34.1	11.0	12.9		Tr	Tr
Abies lasiocarpa												Tr	Tr
Acer glabrum							0.9			0.5			
Arctostaphylos uva-ursi							1.7			1.0			
Artemisia tridentata		39.2	29.3	0.7		0.6							
Berberis repens								Tr		Tr			
Phyllodoce glandulifiora									0.5	Tr			
Physocarpus malvaceus					6.6	0.9	Tr	11.7		3.1			
Prunus virginiana		1.1	0.8	3.8	0.9	3.4	Tr	7.0		1.9			
Ribes setosum				0.6		0.6	0.9			0.5			
Rosa acicularis								14.0		3.5			
Rubus idaeus				Tr		Tr	Tr	Tr		Tr			
Salix spp.								1.0	Tr	Tr			
Vaccinium scoparium									10.3	1.8			

Table 40. Mean percentage of use by month and season of each plant species used by bighorn sheep in the Stillwater area. Trace (Tr) amounts are less than 0.5 percent. Numbers of feeding sites examined and instances of use are shown in parentheses.

Taxa	Jan. (34) (17878)	Feb. (8) (5561)	Mar. (15) (6946)	Apr. (9) (6327)	Winter (66) (36712)	Spring May (14) (9759)	Summer July (1) (114)	Oct. (1) (102)	Nov. (3) (724)	Fall (4) (826)
Grasses and Grass-like Plants	41.8	62.0	57.4	54.5	50.0	82.6		100.0	40.3	47.7
Agropyron intermedium								37.3	13.0	16.0
Agropyron spicatum	16.9	34.3	1.9	18.0	16.9	51.0			23.6	20.7
Agropyron trachycaulum								62.7		7.7
Agropyron spp.	Tr				Tr				1.4	1.2
Agrostis scabra		Tr			Tr					
Bouteloua gracilis		Tr			Tr					
Bromus tectorum	Tr	Tr	Tr	Tr	Tr	Tr			0.8	0.7
Bromus spp.	Tr				Tr					
Calamovilfa longifolia	0.9	Tr	0.9		0.6	Tr				
Carex spp.	2.4	15.4	3.2	3.4	4.7	3.6			Tr	Tr
Elymus canadensis	Tr				Tr					
Equisetum spp.			Tr		Tr					
Festuca idahoensis	1.4	Tr	18.5	17.1	7.1	2.4			1.0	0.8
Juncus balticus	Tr				Tr					
Koeleria cristata	0.5	Tr	0.6	2.1	0.7	4.1				
Phleum pratensis	0.6				Tr					
Poa spp.	15.9	4.7	24.2	4.6	13.8	21.1				
Sporobolus airoides	Tr				Tr					
Stipa comata	0.7	5.9	0.9	1.2	1.6				Tr	Tr
Typha latifolia	1.6		7.0	7.8	3.5					
Unknown	Tr	0.8			Tr					

Table 40. Continued.

Taxa	Jan. (34) (17878)	Feb. (8) (5561)	Mar. (15) (6946)	Apr. (9) (6327)	Winter (66) (36712)	Spring May (14) (9759)	Summer July (1) (114)	Oct. (1) (102)	Nov. (3) (724)	Fall (4) (826)
Forbs	16.4	5.1	27.5	8.6	15.4	6.9	56.1		56.5	49.5
Agoseris glauca						0.7			Tr	Tr
Allium spp.			Tr		Tr	Tr				
Anemone patens						Tr				
Antennaria spp.	2.9	Tr	Tr	Tr	1.5	Tr			21.8	19.1
Apocynum androsaemifolium						0.5				
Artemisia campestris	0.7	Tr	Tr	Tr	Tr				0.7	0.6
Artemisia frigida	6.9	3.0	8.7	3.5	6.0	0.8			2.1	1.8
Artemisia ludoviciana	1.3	1.3	Tr		0.9	Tr			27.5	24.1
Asteraceae			0.7							
Astragalus spp.						Tr				
Balsamorrhiza sagittata	0.7		Tr		Tr	1.9				
Brassicaceae						Tr				
Campanula rotundifolia							14.9		Tr	Tr
Castillega miniata							6.1			
Cerastium arvense	Tr		Tr	Tr	Tr	0.5				
Chrysopsis villosa	Tr	Tr	Tr	Tr	Tr	Tr			Tr	Tr
Cirsium spp.						Tr			Tr	Tr
Comandra umbellata						Tr				
Delphinium bicolor						Tr				
Epilobium angustifolium							2.6			
Erigeron spp.	Tr		Tr		Tr					
Fabaceae			Tr		Tr	Tr				
Geranium richardsonii							2.6			

Table 40. Continued.

Taxa	Jan. (34) (17878)	Feb. (8) (5561)	Mar. (15) (6946)	Apr. (9) (6327)	Winter (66) (36712)	Spring May (14) (9759)	Summer July (1) (114)	Oct. (1) (102)	Nov. (3) (724)	Fall (4) (826)
Forbs (cont.)										
Hedysarum sulphurescens							25.4			
Heracleum lanatum							0.9			
Heuchera cylindrica				Tr	Tr					
Liatris punctata			Tr		Tr					
Lupinus argenteus							0.9		Tr	Tr
Opuntia polycantha				Tr	Tr	Tr				
Phlox hoodii	3.3	Tr	16.7	4.4	5.5	Tr			0.6	0.5
Potentilla spp.									1.1	1.0
Solidago missouriensis		Tr			Tr				1.1	1.0
Taraxacum officinale						Tr				
Tragopogon dubius				Tr	Tr	Tr				
Unknown	Tr				Tr	Tr	2.6		Tr	Tr
Shrubs	41.8	32.3	15.0	36.9	34.4	10.5	43.9		1.9	1.7
Artemisia tridentata	12.9	6.9	0.6	16.1	10.2	1.1			Tr	Tr
Berberis repens	Tr	Tr	1.3		Tr					
Cornus stolonifera	Tr				Tr					
Pinus flexilus			0.7		Tr					
Populus tremuloides			Tr	Tr	Tr					
Populus trichocarpa	Tr	Tr			Tr					
Prunus virginiana	16.8	14.1	10.6	13.9	14.7	1.3				
Pseudotsuga menziesii		9.2			1.4					
Rhus trilobata	11.5	1.3	1.7	6.9	7.3	5.8			Tr	Tr

Table 40. Continued.

Taxa	Jan. (34) (17878)	Feb. (8) (5561)	Mar. (15) (6946)	Apr. (9) (6327)	Winter (66) (36712)	Spring May (14) (9759)	Summer July (1) (114)	Oct. (1) (102)	Nov. (3) (724)	Fall (4) (826)
Shrubs (cont.)										
Ribes cereum	Tr				Tr					
Ribes montigenum							35.1			
Rosa acicularis						Tr	8.8		0.7	0.6
Salix spp.		Tr			Tr					
Symphoricarpos albus	Tr				Tr	2.2			Tr	Tr
Unknown	Tr	Tr			Tr				Tr	Tr
Mosses	Tr	0.5	Tr	Tr	Tr				1.2	1.1
Selaginella densa	Tr		Tr	Tr	Tr				1.2	1.1
Unknown		0.5	Tr		Tr					