



Food habits, range use and interspecific relationships of bighorn sheep in the Sun River area,
west-central Montana
by Allen Dee Schallenberger

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University
© Copyright by Allen Dee Schallenberger (1966)

Abstract:

Field studies were conducted during 1964 and 1965 on big game winter range in the Sun River Canyon of west-central Montana. The primary objective was to gather quantitative data on winter food habits and range use of bighorn sheep to aid in evaluating range use relationships of bighorn sheep, elk, mule deer, whitetail deer and horses. The physiography of the area was described. Seven habitat types were recognized as follows: bunchgrass, rocky reef, old burn, Douglas fir, lodgepole pine and quaking aspen which were sampled quantitatively and bottom which was described.

Observations were made of horses during summer and of other species during winter to evaluate range use. Numbers of observations were 2,997 for bighorn sheep, 906 for elk, 1,123 for mule deer, 669 for whitetail deer and 20 for horses. Percentages of observations for each animal species recorded in bunchgrass, rocky reef and old burn habitat types respectively were 37, 31 and 24 for bighorn sheep; 38, 0 and 20 for elk; 17, 26 and 36 for mule deer; and 24, 4 and 2 for whitetail deer. Southward facing slopes provided 79, 67, 75, and 54 per cent of the bighorn sheep, elk, mule deer and whitetail deer observations respectively.

Autumn food habits of bighorn sheep were determined by analyses of 15 rumen samples. Volumes of Gramineae, forbs and browse were 86.5, 8.9 and 1.9 per cent respectively. Food-habits in winter were evaluated from feeding site examinations of 67 bighorn sheep, 18 elk, 34 mule deer and 25 whitetail deer groups respectively. The data indicated percentage use of grass, forb and browse forage classes in winter was 36, 21 and 43 for bighorn sheep; 37, 22 and 42 for elk; 5, 22 and 73 for mule deer; and 5, 30 and 65 for whitetail deer respectively. Plant species significant in food habits of both bighorn sheep and elk in bunchgrass and old burn habitat types were bluebunch wheatgrass, Idaho fescue, rough fescue, silky lupine, arrowleaf balsamroot, buckbrush and fringed sagewort. Among browse species, fringed sagewort ranked first in use by bighorn sheep and sixth for mule deer. Western serviceberry, quaking aspen and choke cherry were also used in common. The five forbs with highest percentages of use by bighorn sheep were also the ones mule deer utilized most. Common use of several plant species by bighorn sheep and whitetail deer was recorded in bunchgrass and Douglas fir habitat types. Bighorn sheep seldom grazed bunchgrass "flats" frequented by whitetail deer. One feeding site examination of horses during summer indicated 95 per cent of their diet was grasses. Bunchgrass and browse utilization transects revealed overuse of key plant species. The data indicated severe competition between bighorn sheep and elk on parts of winter range that were jointly used. The data also suggested serious competition between bighorn sheep and mule deer in areas where there was overlap of winter range. Bighorn sheep and whitetail deer competed for forage in the Douglas fir habitat type during periods of cold, windy weather. Summer use of bunchgrass and rocky reef habitat types by horses possibly resulted in less forage for bighorn sheep during winter.

FOOD HABITS, RANGE USE AND INTERSPECIFIC RELATIONSHIPS OF
BIGHORN SHEEP IN THE SUN RIVER AREA, WEST-CENTRAL MONTANA

by

ALLEN DEE SCHALLENBERGER

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

of

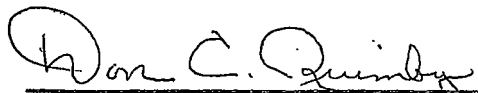
MASTER OF SCIENCE

in

Fish and Wildlife Management

Approved:


Head, Major Department


Chairman, Examining Committee


Ass. Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

June, 1966

ACKNOWLEDGEMENT

To the following, among others, the author wishes to express appreciation for their contributions to this study: Dr. Don C. Quimby, Montana State University, who directed the study and aided in preparation of the manuscript; members of the Montana Fish and Game Department including Mr. Richard Knight for project planning and field assistance; Mr. Bert Goodman for field assistance and use of facilities; other personnel of District Four for field assistance and cooperation; Mr. Kenneth Greer for assistance and use of facilities in analyses of rumen contents; personnel of Augusta District, Lewis and Clark National Forest for use of facilities; sportsmen who collected rumen samples from bighorn sheep; Dr. W. E. Booth, Montana State University, for aid in identification of plant specimens. The writer was employed by the Montana Fish and Game Department under Federal Aid Projects W-98-R-4 and W-98-R-5 during the study.

TABLE OF CONTENTS

	Page
VITA.....	ii
ACKNOWLEDGEMENT.....	iii
TABLE OF CONTENTS.....	iv
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
ABSTRACT.....	viii
INTRODUCTION.....	1
DESCRIPTION OF AREA.....	2
Bunchgrass Habitat Type.....	3
Rocky Reef Habitat Type.....	6
Old Burn Habitat Type.....	10
Bottom Habitat Type.....	10
Douglas-fir Habitat Type.....	10
Lodgepole Pine Habitat Type.....	13
Quaking Aspen Habitat Type.....	13
METHODS.....	14
BIGHORN SHEEP POPULATION.....	16
RANGE USE.....	18
Bighorn Sheep.....	18
Elk.....	18
Mule Deer.....	20
Whitetail Deer.....	20

TABLE OF CONTENTS
(Continued)

	Page
Horses.....	20
Use of Slopes.....	21
FOOD HABITS.....	22
Bighorn Sheep.....	22
Elk.....	26
Mule Deer.....	26
Whitetail Deer.....	27
Horses.....	28
BROWSE AND BUNCHGRASS UTILIZATION.....	29
INTERSPECIFIC RELATIONSHIPS.....	31
Bighorn Sheep and Elk.....	31
Bighorn Sheep and Mule Deer.....	31
Bighorn Sheep and Whitetail Deer.....	32
Bighorn Sheep and Horses.....	33
Discussion and Conclusions.....	33
APPENDIX.....	35
LITERATURE CITED.....	43

LIST OF TABLES

Table	Page
I. PER CENT CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANTS IN HABITAT TYPES AS DETERMINED BY EXAMINATION OF 2 X 5 DECIMETER PLOTS.....	7
II. SEX AND AGE COMPOSITION OF GROUPS OF BIGHORN SHEEP COMPLETELY CLASSIFIED JANUARY-MARCH 1965.....	17
III. PER CENT OF BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER OBSERVED ON EACH HABITAT TYPE JANUARY-MARCH 1965.....	19
IV. PER CENT OF OBSERVATIONS FOR BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER BY DIRECTION OF SLOPE JANUARY-MARCH 1965	21
V. CONTENTS OF RUMEN SAMPLES FROM 15 BIGHORN SHEEP OBTAINED DURING OCTOBER-NOVEMBER 1964.....	23
VI. BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER FOOD HABITS AS DETERMINED FROM 19,483 INSTANCES OF PLANT USE AT 144 FEEDING SITES JANUARY-MARCH 1965.....	24
VII. PER CENT UTILIZATION OF BROWSE SPECIES ON KEY AREAS OF SUN RIVER RANGE AS DETERMINED BY OCCULAR ESTIMATE IN MAY 1965...	30
VIII. PLANT SPECIES WITH LESS THAN 10 PER CENT FREQUENCY IN HABITAT TYPES AS DETERMINED BY 2 by 5 DECIMETER PLOTS.....	36
IX. PERCENTAGES OF BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER OBSERVED JANUARY-MARCH 1965, LISTED BY 1/4 SQUARE MILES	40
X. PLANT SPECIES WHICH WERE UTILIZED AT LEVELS OF LESS THAN THREE PER CENT OF THE TOTAL INSTANCES OF USE IN ANY HABITAT TYPE.....	41

LIST OF FIGURES

Figure		Page
1.	Aerial Photograph Showing Parallel Reefs on the Study Area.	3
2.	Map of the Study Area.....	4
3.	Aerial Photograph Showing Relative Occurrence of Forested and Open Habitat Types on the Study Area.....	5
4.	Bunchgrass and Quaking Aspen Habitat Types in Foreground-- Rocky Reef and Douglas-fir (upper right) in Background.....	6
5.	Typical Reef Showing Vegetation Characteristics.....	9
6.	Old Burn Habitat Type.....	11
7.	Bottom Habitat Type in Winter.....	11
8.	Douglas-fir Habitat Type in Winter.....	12
9.	Lodgepole Pine Habitat Type.....	12
10.	Grid Map of Study Area for Use with Table IX in Showing Locations of Animal Observations. Locations of Browse and Bunchgrass Transects are also Shown.....	39

ABSTRACT

Field studies were conducted during 1964 and 1965 on big game winter range in the Sun River Canyon of west-central Montana. The primary objective was to gather quantitative data on winter food habits and range use of bighorn sheep to aid in evaluating range use relationships of bighorn sheep, elk, mule deer, whitetail deer and horses. The physiography of the area was described. Seven habitat types were recognized as follows: bunchgrass, rocky reef, old burn, Douglas-fir, lodgepole pine and quaking aspen which were sampled quantitatively and bottom which was described.

Observations were made of horses during summer and of other species during winter to evaluate range use. Numbers of observations were 2,997 for bighorn sheep, 906 for elk, 1,123 for mule deer, 669 for whitetail deer and 20 for horses. Percentages of observations for each animal species recorded in bunchgrass, rocky reef and old burn habitat types respectively were 37, 31 and 24 for bighorn sheep; 38, 0 and 20 for elk; 17, 26 and 36 for mule deer; and 24, 4 and 2 for whitetail deer. Southward facing slopes provided 79, 67, 75 and 54 per cent of the bighorn sheep, elk, mule deer and whitetail deer observations respectively.

Autumn food habits of bighorn sheep were determined by analyses of 15 rumen samples. Volumes of Gramineae, forbs and browse were 86.5, 8.9 and 1.9 per cent respectively. Food habits in winter were evaluated from feeding site examinations of 67 bighorn sheep, 18 elk, 34 mule deer and 25 whitetail deer groups respectively. The data indicated percentage use of grass, forb and browse forage classes in winter was 36, 21 and 43 for bighorn sheep; 37, 22 and 42 for elk; 5, 22 and 73 for mule deer; and 5, 30 and 65 for whitetail deer respectively. Plant species significant in food habits of both bighorn sheep and elk in bunchgrass and old burn habitat types were bluebunch wheatgrass, Idaho fescue, rough fescue, silky lupine, arrowleaf balsamroot, buckbrush and fringed sagewort. Among browse species, fringed sagewort ranked first in use by bighorn sheep and sixth for mule deer. Western serviceberry, quaking aspen and chokecherry were also used in common. The five forbs with highest percentages of use by bighorn sheep were also the ones mule deer utilized most. Common use of several plant species by bighorn sheep and whitetail deer was recorded in bunchgrass and Douglas-fir habitat types. Bighorn sheep seldom grazed bunchgrass "flats" frequented by whitetail deer. One feeding site examination of horses during summer indicated 95 per cent of their diet was grasses.

Bunchgrass and browse utilization transects revealed overuse of key plant species. The data indicated severe competition between bighorn sheep and elk on parts of winter range that were jointly used. The data also suggested serious competition between bighorn sheep and mule deer in areas where there was overlap of winter range. Bighorn sheep and whitetail deer competed for forage in the Douglas-fir habitat type during periods of cold, windy weather. Summer use of bunchgrass and rocky reef habitat types by horses possibly resulted in less forage for bighorn sheep during winter.

INTRODUCTION

One of the largest herds of bighorn sheep (Ovis canadensis canadensis Shaw) in Montana ranges in the Sun River drainage in the west-central part of the state. A portion of the herd winters in the lower Sun River Canyon area. According to Knight (1965), U. S. Forest Service records show that this area was set aside for game winter range in 1929. Prior to this time as many as 500 cattle were summer residents and several hundred were spring and fall transients. At present the Forest Service allows approximately 125 horses on portions of the range for about six months during summer and autumn. The area is also used for winter range by large numbers of elk, mule deer and whitetail deer.

I conducted full time field studies on the Sun River winter range from June 8 to September 23, 1964, and from December 29, 1964, to March 28, 1965. Supplementary data were gathered during October and November 1964, and May 1965. The primary objective was to gather quantitative data on winter food habits and range use of bighorn sheep to aid in evaluating range use relationships of bighorn sheep, elk, mule deer, whitetail deer and horses. Several authors including Couey (1950), Smith (1954) and Sugden (1961) have studied winter food habits of bighorn sheep and range relationships with other species. Findings from these studies were of aid in evaluating my data.

DESCRIPTION OF AREA

Sun River Canyon is located in the Sawtooth Mountain Range. According to Deiss (1943), the range was formed by the Lewis overthrust which moved Proterozoic and Paleozoic shales and limestones over younger Mesozoic sediments. Glacial action and water erosion have modified the range to a characteristic series of closely spaced parallel reefs running in a north to south direction (Fig. 1). The reefs have steep east facing sides with vertical limestone cliffs several hundred feet high. West facing sides slope gradually and are covered by scattered patches of timber. Elevations vary from 4,590 at Gibson Dam to 8,330 feet on Castle Reef at the eastern edge of the mountains. Most reef tops are at 5,000 to 6,000 feet elevation.

Boundaries of the 23 square mile study area (Fig. 2) were Arsenic Creek and North Fork of the Sun River on the west, Gibson Reservoir and the Sun River on the south, Wagner Basin and Castle Reef on the east, and heads of Mortimer and Hannon Gulches on the north.

Climatological data recorded at Gibson Dam (U. S. Dept. Commerce Weather Bureau, 1929-65) indicate mean temperature is 41.4 degrees with extremes of 100 and -42. Mean annual precipitation is 17.5 inches. From November 1, 1964, through March 31, 1965, the number of days with 18+, 12-18, 6-12 and 6 inches or less of snow on the ground were 6, 31, 49 and 65 respectively. Strong westerly winds and "chinooks" remove most of the snow cover from sparsely timbered slopes within a few days after snowstorms. Precipitation throughout the study period was greater than normal with almost 11 inches above the mean recorded for 1964. The worst flood in the

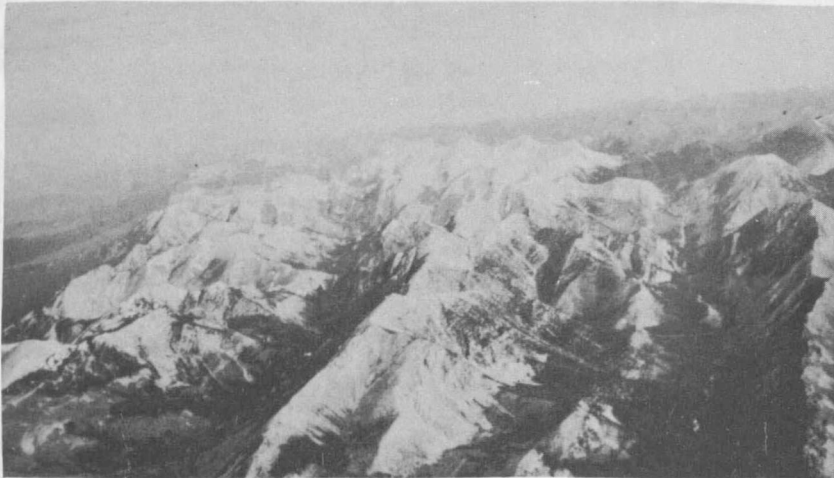


Figure 1. Aerial Photograph Showing Parallel Reefs on the Study Area.

history of the area occurred in June 1964. Much of the stream bank cover in side canyons and along Sun River was destroyed.

Seven habitat types were recognized as follows: bunchgrass, rocky reef, bottom, old burn, Douglas-fir (Pseudotsuga menziesii), lodgepole pine (Pinus contorta) and quaking aspen (Populus tremuloides). Similar classifications were given by Couey (1950). All habitat types were generally found throughout the study area with old burn and lodgepole pine most common in the eastern end. Relative occurrence of forested and open types is shown in Fig. 3.

Bunchgrass Habitat Type

Greatest relative occurrence of the bunchgrass habitat type (Fig. 4) was in Scattering Springs-Reclamation Flat area, Big George Gulch and in Wagner Basin (Fig. 2). Typical locations were flats, small hills at bases

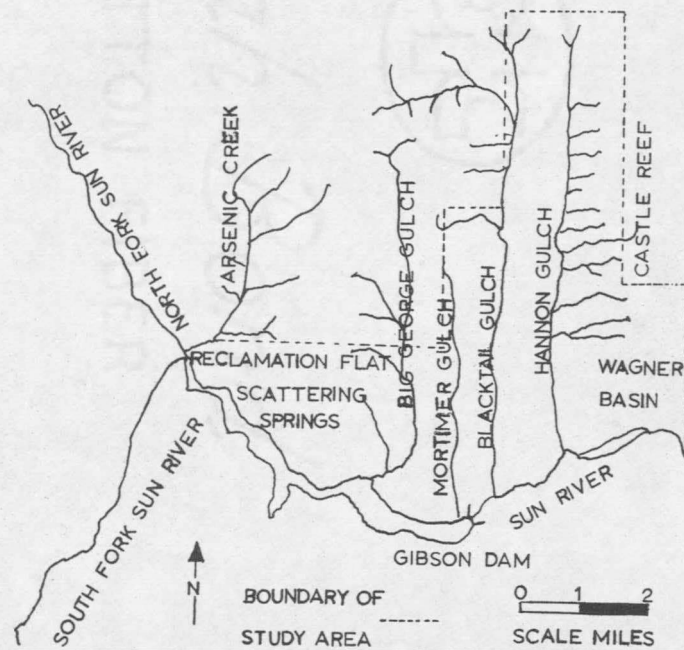


Figure 2. Map of the Study Area.



Figure 3. Aerial Photograph Showing Relative Occurrence of Forested and Open Habitat Types on the Study Area.

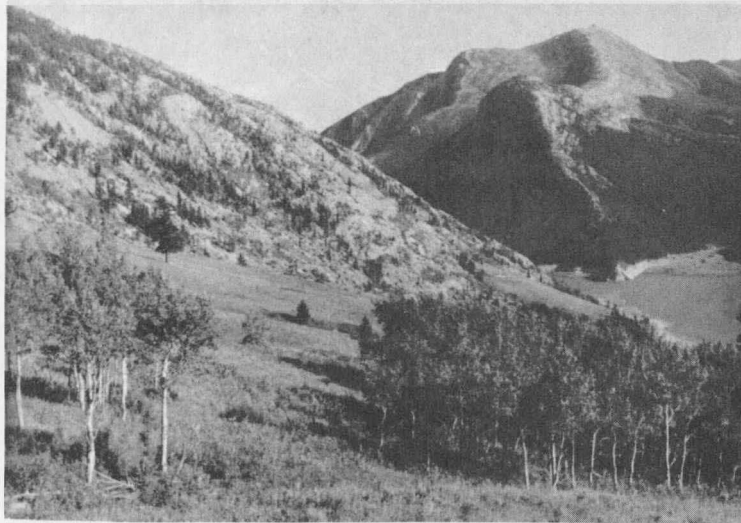


Figure 4. Bunchgrass and Quaking Aspen Habitat Types in Foreground--
Rocky Reef and Douglas-fir (upper right) in Background.

of reefs and hill tops at heads of canyons. Idaho fescue (Festuca idahoensis), bluebunch wheatgrass (Agropyron spicatum) and rough fescue (Festuca scabrella) had the greatest canopy coverages and frequencies of all grasses (Table I). Forbs with greatest frequencies included yarrow (Achillia millifolium), silky lupine (Lupinus sericeus), Hoods phlox (Phlox hoodii) and ballhead sandwort (Arenaria congestis). Common shrubs were fringed sagewort (Artemisia frigida), rose (Rosa spp.) and buckbrush (Symphoricarpos spp.).

Rocky Reef Habitat Type

The rocky reef habitat type was characterized by steep, rocky, wind blown slopes which were sparsely vegetated. This type covered more area than any of the others. A typical reef (Fig. 5) had a zone of shrubs at the base including Rocky Mountain maple (Acer glabrum), western

TABLE I. PER CENT CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANTS
IN HABITAT TYPES AS DETERMINED BY EXAMINATION OF 2 X 5 DECIMETER PLOTS.

Species ^{2/}	Habitat Types						
	Bunchgrass	Rocky reef	Old burn	Bottom	Douglas fir	Lodgepole pine	Quaking aspen
	18 ^{1/} C 3/ F 4/	11 C F	4 C F		3 C F	3 C F	5 C F
Grasses and grass-like plants							
<u>Agropyron spicatum</u>	9.3/73	9.8/82	14.8/84	-- 5/	1.0/18	--	--
<u>Agropyron spp.</u>	1.2/13	--	--	X	--	--	--
<u>Bromus marginatus</u>	--	--	.2/10	X	--	--	--
<u>Calamagrostis rubescens</u>	--	--	--	X	4.7/39	11.8/75	--
<u>Carex spp.</u>	.9/23	--	--	X	--	--	--
<u>Elymus cinereus</u>	--	--	--	X	--	--	2.6/25
<u>Festuca idahoensis</u>	10.7/70	3.4/45	1.3/31	--	.8/18	--	--
<u>Festuca scabrella</u>	5.1/49	.9/12	--	--	1.5/14	--	--
<u>Koeleria cristata</u>	.4/14	.9/19	.1/77	--	--	--	--
<u>Poa spp.</u>	.9/18	1.0/24	--	X	--	--	1.5/15
<u>Stipa richardsonii</u>	--	--	--	--	--	1.6/25	--
<u>Stipa spp.</u>	.8/19	--	--	--	1.0/28	--	--
Forbs							
<u>Achillea millefolium</u>	1.4/30	1.2/25	.6/28	X	.9/37	.6/23	.6/20
<u>Antennaria rosea</u>	.5/15	.6/14	--	--	--	--	--
<u>Arennaria congestis</u>	.9/23	1.7/42	.4/16	--	--	--	--
<u>Aster spp.</u>	--	--	.5/10	X	7.8/57	2.5/19	8.7/57
<u>Bupleurum americanum</u>	--	--	.4/11	--	--	--	--
<u>Chrysopsis villosa</u>	.9/16	1.3/15	--	--	--	--	--
<u>Commandra umbellata</u>	.5/13	--	.4/12	--	--	--	--
<u>Crepis acuminata</u>	.6/15	--	.4/10	--	--	--	--
<u>Erigeron compositus</u>	--	1.3/21	--	--	--	--	--
<u>Fragaria virginiana</u>	--	--	1.1/13	X	.7/23	6.3/55	7.3/66
<u>Galium boreale</u>	.8/15	1.0/18	1.1/30	X	1.1/42	7.0/40	1.4/40
<u>Geranium richardsonii</u>	--	--	--	X	--	.8/19	1.2/14
<u>Geranium viscosissimum</u>	--	--	--	X	--	--	1.1/10

TABLE I. CONTINUED

Species	Habitat Types												
	Bunchgrass		Rocky reef		Old burn		Bottom	Douglas fir		Lodgepole pine		Quaking aspen	
	18		11		4			3		3		5	
	C	F	C	F	C	F		C	F	C	F	C	F
<u>Hedysarum sulphurescens</u>	--		--		--		X	--		2.8/23		1.0/11	
<u>Linum lewisii</u>	.3/10		--		.4/17		--	--		--		--	
<u>Lomatium</u> spp.	--		.3/10		--		--	--		--		--	
<u>Lupinus sericeus</u>	5.2/29		--		.9/15		X	1.5/17		--		.5/10	
<u>Phlox hoodii</u>	8.8/25		3.8/13		--		--	--		--		--	
<u>Potentilla glandulosa</u>	--		--		--		--	.7/12		--		--	
<u>Senecio canus</u>	--		--		.2/10		--	--		--		--	
<u>Taraxacum officinale</u>	--		.1/10		--		X	--		--		--	
Unidentified forbs	--		.7/25		1.1/22		X	--		.8/18		.8/11	
Shrubs													
<u>Artemisia frigida</u>	1.6/25		.4/11		--		--	--		--		--	
<u>Arctostaphylos uva-ursi</u>	--		6.3/20		1.6/10		X	--		11.1/40		4.3/18	
<u>Berberis repens</u>	--		--		1.0/30		X	.4/17		2.6/40		--	
<u>Rosa</u> spp.	2.4/30		1.4/15		1.4/22		X	2.0/22		13.8/70		11.2/69	
<u>Shepherdia canadensis</u>	--		--		--		X	--		7.0/18		--	
<u>Spiraea betulifolia</u>	--		--		3.1/22		X	4.2/31		7.5/53		3.9/31	
<u>Symphoricarpos</u> spp.	1.0/22		--		5.5/58		X	5.2/42		5.1/42		6.2/38	
Soil	19.6/89		20.3/98		32.2/100		X	7.4/43		--		--	
Rock ^{6/}	5.1/46		30.0/95		11.6/45		X	--		--		--	
Elk ^{6/}	19		--		10		--	--		--		--	
Deer &/or sheep	29		41		13		X	29		--		--	

1/ Number of stands in which forty 2 X 5 decimeter plots were evaluated.

2/ Includes species with at least 10 per cent frequency of occurrence in at least one type.

Other plants present are listed in Appendix Table VIII.

3/ Mean per cent canopy coverage in plots examined.

4/ Per cent frequency of occurrence in plots examined.

5/ Species present but no quantitative data for bottom type.

6/ Per cent frequency of occurrence of elk, deer and/or bighorn sheep pellets in plots examined.



Figure 5. Typical Reef Showing Vegetation Characteristics.

serviceberry (Amelanchier alnifolia), rose, Canadian buffalo-berry (Shepherdia canadensis), kinnikinnick (Arctostaphylos uva-ursi) and snowbrush ceanothus (Ceanothus velutinus). Above the shrub zone were talus slopes and near the top vertical cliffs. Scattered limber pine (Pinus flexilis), Douglas-fir and Rocky Mountain juniper (Juniperus scopulorum) occurred most frequently in two lower zones. Bluebunch wheatgrass occurred frequently on sides of reefs. Idaho fescue was a common plant on reef tops along with fringed sagewort. Characteristic forbs were ballhead sandwort, yarrow, fernleaf fleabane (Erigeron compositus) and bedstraw (Galium boreale).

Old Burn Habitat Type

The old burn habitat type (Fig. 6) was most extensive in Hannon Gulch and Wagner Basin. Most of the burns occurred 40 to 50 years ago. The burn aspect was dominated by standing dead trees, fallen trees and regrowth consisting of small trees and shrubs. Common shrubs included Canadian buffalo-berry, western serviceberry, Rocky Mountain maple, buckbrush, rose and white spiraea (Spiraea betulifolia). Douglas-fir, lodgepole pine and quaking aspen were representative small trees. Bluebunch wheatgrass was the predominant grass in the understory. Forbs with highest frequencies of occurrence were yarrow, bed straw, blue flax (Linum lewisii) and ballhead sandwort.

Bottom Habitat Type

No quantitative data were taken in the bottom habitat type due to abundance of various growth forms and debris deposited by the flood in June 1964. This type (Fig. 7) was present along creeks, the Sun River and also in spring seepage areas at bases of reefs. Table I lists some of the species present and others are included in Appendix Table VIII.

Douglas-fir Habitat Type

Douglas-fir (Fig. 8) was the dominant member of the overstory on north facing slopes and it formed the most extensive forest habitat type. Mean diameter breast high (DBH) of 40 Douglas-fir trees was 8.0 inches. A line intercept of 600 feet indicated a canopy coverage of 47.7 per cent. Among the grasses present, pinegrass (Calamagrostis rubescens) had greatest canopy coverage and frequency as did asters in the forb class.

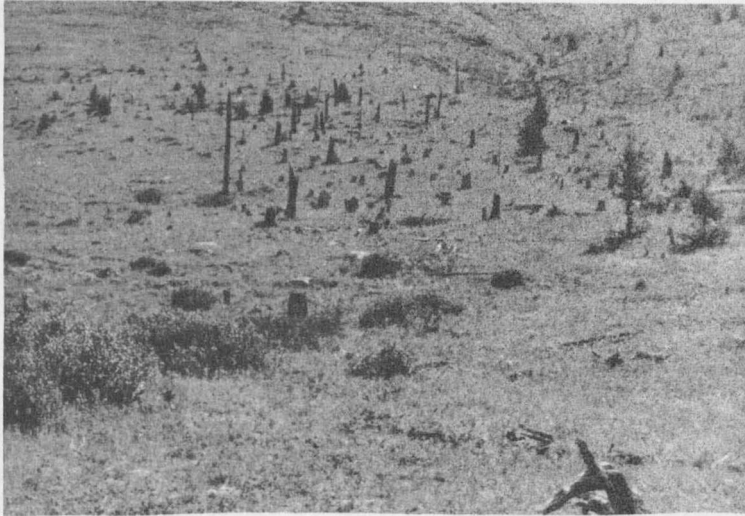


Figure 6. Old Burn Habitat Type.



Figure 7. Bottom Habitat Type in Winter.



Figure 8. Douglas-fir Habitat Type in Winter.



Figure 9. Lodgepole Pine Habitat Type.

Characteristic shrubs in the understory were buckbrush, white spiraea and rose.

Lodgepole Pine Habitat Type

The lodgepole pine habitat type (Fig. 9) was most extensive in Hannon Gulch. It appeared to be a seral stage which grew in burns originally covered by Douglas-fir. Mean DBH of 20 lodgepole pines was 7.4 inches. This species had a canopy coverage of 56.4 per cent in 300 feet of line intercept. Highest frequencies among grasses, forbs and shrubs were recorded for pinegrass, Virginia strawberry and rose respectively.

Quaking Aspen Habitat Type

The quaking aspen habitat type (Fig. 4) grew in mesic sites throughout the study area. Scattered stands were present on hill tops and denser stands occurred in canyon bottoms. Canopy coverage of 900 feet of line intercept was 81.8 per cent and mean DBH of 60 trees was 4.5 inches. Table I lists species occurring with 10 or more per cent frequency in the understory.

METHODS

A four wheel drive vehicle, motorboat, horses, helicopter and snowshoes were used to travel over the area. Practically all travel during winter was on foot, with or without snowshoes. I tried to make an equal number of observation trips to the various sections of the study area. Animal observations were made with the aid of a 7 X 35 mm. binocular and a 20X spotting scope. When practicable, individual animals were recorded only once each day. Animal locations were plotted on a U. S. Geological Survey map to the nearest half mile.

Vegetation composition of the range was studied during the summer of 1964 using the 2 X 5 decimeter plot method of Daubenmire (1959) for low growing plants. Forty 2 X 5 decimeter plots inside a 20 X 50 foot plot were evaluated in stands considered to be representative. A modification of the line intercept method of Canfield (1941) was used to determine canopy cover of trees in forest habitat types. A densiometer was used to determine the point of interception of the canopy. DBH of trees in representative stands was measured. Plant nomenclature follows Booth (1950) and Booth and Wright (1959).

Food habits data were obtained from analyses of rumen contents from bighorn sheep and feeding site examinations of bighorn sheep, elk, mule deer, whitetail deer and horses. Techniques followed Cole (1956) except one instance of use at feeding sites was recorded for use of a single stem of a forb or shrub and for one or more "bites" from a single grass plant. The data were tabulated according to the aggregate percentage

method of Martin et al. (1946).

Data on intensity of bunchgrass utilization were gathered from key plant species by following methods of Cole (1958).

BIGHORN SHEEP POPULATION

The estimated minimum bighorn sheep population for the study area, based on daily observations, was 265 with 90 in the Scattering Springs-Reclamation Flat area, 60 in Big George Gulch, 10 in Mortimer and Blacktail Gulches, 35 in Hannon Gulch and 70 in the Wagner Basin-Castle Reef area. Data from 32 observations of three ewes marked with neck bands suggested home range during winter was limited to a relatively small area. From January 6 to March 26, 1965, 31 observations were in a rectangle $1\frac{1}{2}$ X $3\frac{3}{4}$ miles. The other was only $1\frac{1}{2}$ mile outside the rectangle.

Sex and age structure of completely classified groups are given in Table II. It was difficult to differentiate yearling ewes (1 and $2\frac{2}{3}$ years old) from older ewes so all yearlings were included in the adult class. Ram-ewe-lamb groups made up 45 per cent of the total groups. The number of ram only groups may be low in relation to other groups. This group was often found in areas of greater snow depth and more rugged topography. This made travel difficult which decreased opportunity for observations. The ratio of ewes to rams was 1 to .5. Ratio of ewes to lambs was 1 to .4. The latter ratio is similar to the ratio of 1 to .41 Couey (1950) found in the Sun River area in 1944 when he classified 2,215 ewes and lambs through repeated observations of the same individuals. Spencer (1943) listed a ratio of 1 to .42 for 271 animals in the Tarryall herd of Colorado.

TABLE II. SEX AND AGE COMPOSITION OF GROUPS OF BIGHORN SHEEP COMPLETELY CLASSIFIED JANUARY-MARCH 1965. ^{1/}

Groups	No. groups	Mean no. per group	Range	Total ad. ♂ ^{2/}	Total ad. ♀ ^{2/}	Lambs
Rams, ewes and lambs	85	23.6	3-71	510	1,051	447
Ewes and lambs	36	4.4	2-17	-	121	70
Ewes	26	2.5	1-7	-	65	-
Rams and ewes	19	7.6	2-25	75	69	-
Rams	14	2.7	1-10	38	-	-
Rams and lambs	4	4.8	2-8	9	-	10
Total	184	7.6	1-71	632	1,306	527

^{1/} Includes repeated observations of the same individuals.

^{2/} Yearlings were classified as adults.

RANGE USE

Bighorn Sheep

The highest percentage of bighorn sheep observations for the entire period, January through March, was in the bunchgrass habitat type (Table III). This was due to the high per cent for January which was probably related to the presence of deep crusted snow over most of the area. Drifted snow accumulations were lowest in this type because most of the plant species present had low growth forms. Observations of bighorn sheep on the rocky reef type during January may have been biased because the icy crust made travel difficult and decreased opportunity for making observations. Increasing use of the old burn type throughout the period may be attributed to snow conditions and/or decreasing amounts of forage present in bunchgrass and rocky reef types as a result of earlier utilization by bighorn sheep and other species. Although snow depths were nearly as great in the latter part of March as in early January, the snow was not crusted in March. Use of Douglas-fir and bottom types by bighorn sheep was noted only on days when strong winds and cold temperatures forced them to seek shelter.

Elk

Data for elk observations during January may not be comparable to data for other months. Only 8 per cent of the total observations were made during this month. The greatest percentage of elk was observed in the bunchgrass habitat type. Increased use of the old burn type as winter progressed, particularly in February, may have been related to decreased

TABLE III. PER CENT OF BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER
OBSERVED ON EACH HABITAT TYPE JANUARY - MARCH 1965.

Habitat Types	Bighorn sheep				Elk				Mule deer				Whitetail deer			
	J	F	M	JFM	J	F	M	JFM	J	F	M	JFM	J	F	M	JFM
Bunchgrass	53 ^{1/}	29	29	37	30	46	39	38	31	10	9	17	28	24	19	24
Rocky reef	24	36	33	31	--	--	--	--	21	16	40	26	3	7	3	4
Old burn	15	28	38	24	14	46	21	20	21	55	31	36	4	--	2	2
Bottom	tr ^{2/}	1	--	tr	--	--	--	--	5	6	10	7	42	29	35	35
Douglas-fir	7	5	tr	4	40	18	14	24	18	10	23	14	23	19	41	28
Quaking aspen	--	--	--	--	30	22	--	17	9	2	--	4	--	29	--	10
Lodgepole pine	--	--	--	--	--	--	--	--	--	1	--	tr	--	--	--	--
Total animals ^{3/}	735	1,100	1,162	2,997	74	403	429	906	267	327	529	1,123	232	178	259	669

^{1/} Per cent of 735 bighorn sheep observations for January; F=February and M=March.

^{2/} Less than .5 per cent.

^{3/} Includes repeated observations of the same individuals.

availability of forage in bunchgrass, Douglas-fir and quaking aspen habitat types.

Mule Deer

The old burn habitat type provided the highest percentage of observations for mule deer. There was relatively little snow during February. This and an abundance of browse species may account for the high percentage of mule deer observed in the old burn type during the month. Greatest use of the bunchgrass type was during January when usage was influenced by crusted snow as indicated previously for bighorn sheep. Heavy utilization of forage in bunchgrass and old burn types prior to March may account for the high per cent of use of the rocky reef type during this month.

Whitetail Deer

The greatest percentage of whitetail deer observations was in the bottom habitat type. Use of this type appeared to be directly related to snow depths. Usage was greatest during January and March when snow depths were greatest on the study area. Use of the bunchgrass type was generally restricted to "flats" adjacent to the river and creek bottoms. Use of the bunchgrass habitat type decreased steadily throughout the period, possibly due to decreasing availability of forage. Use of the quaking aspen type in February may have been related to the disappearance of deep snow drifts.

Horses

During the summer of 1964, 20 horses were observed feeding on bunchgrass and rocky reef habitat types. Horses were attracted to windy reef tops which were relatively free of insect pests.

Use of Slopes

Percentages of bighorn sheep, elk, mule deer and whitetail deer observations recorded by direction of slope are presented in Table IV. Southward facing slopes provided 79, 67, 75 and 54 per cent of bighorn sheep, elk, mule deer and whitetail deer observations respectively.

Distribution by locality of bighorn sheep, elk, mule deer and whitetail deer observations are listed in Appendix Table IX and Appendix Fig. 10.

TABLE IV. PER CENT OF OBSERVATIONS FOR BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER BY DIRECTION OF SLOPE JANUARY-MARCH 1965.

	Bighorn sheep	Elk	Mule deer	Whitetail deer
Direction of slope				
South	14 ^{1/}	33	16	31
Southeast	33	22	37	16
Southwest	32	12	22	7
East	5	26	7	14
North	tr ^{2/}	--	--	tr
Northeast	1	--	--	--
Northwest	3	--	--	--
West	11	17	17	tr
Level	--	--	--	30
Total animals ^{3/}	2,997	906	1,123	669

^{1/} Per cent of total animals.

^{2/} Less than .5 per cent.

^{3/} Includes repeated observations of the same individuals.

FOOD HABITS

Bighorn Sheep

Data on contents of rumen samples from 15 bighorn sheep from hunter killed animals in the Sun River area during October-November 1964, are shown in Table V. Members of the grass family constituted 86.5 per cent of the rumen contents. Separation by species was generally not possible although bluebunch wheatgrass and inland giant wildrye (Elymus cinereus) were identified in some samples. Moser (1962) listed 74.65 per cent volume for grass and grass-like plants for contents of 81 rumen samples of bighorn sheep collected in September in Colorado.

Data in Table VI are from examination of 67 feeding sites of bighorn sheep in winter. Mean percentages for instances of plant use were 36, 21 and 43 for grass and grass-like plants, forbs and browse respectively.

Highest percentages for grasses were recorded in bunchgrass and rocky reef habitat types. Bluebunch wheatgrass, Idaho fescue and bluegrasses received the greatest use of all grasses and grass-like plants in all habitat types except bottom where use of rushes (Juncus spp.) predominated. Use of bluebunch wheatgrass declined in March and use of green growth on Idaho fescue, rough fescue and bluegrasses increased. In the bunchgrass habitat type, percentages for bluegrasses, January through March, were 2, 2 and 13 respectively.

Forbs which received significant use included asters (Aster spp.), arrowleaf balsamroot (Balsamorhiza sagittata), silky lupine, drummond milkvetch (Astragalus drummondii) and common salsify (Tragopogon dubius).

TABLE V. CONTENTS OF RUMEN SAMPLES FROM 15 BIGHORN SHEEP OBTAINED DURING OCTOBER-NOVEMBER 1964. 1/

Plants	% Volume
Gramineae	86.5
<u>Antennaria</u> spp.	5.5
<u>Astragalus</u> spp.	.9
<u>Eriogonum</u> spp.	1.2
Unidentified forbs	1.3
Total forbs	8.9
<u>Symphoricarpos</u> spp.	1.9
Total	97.3

1/ The following plants, each of which constituted less than .5 per cent by volume, are excluded. Grass-like plants: Carex spp.; Forbs: Aster spp., Cirsium spp., Galium boreale, Lathyrus ochroleucus, Lupinus spp., Phlox hoodii, Physaria didymocarpa; Shrubs and trees: Amelanchier alnifolia, Arctostaphylos uva-ursi, Artemisia frigida, Berberis repens, Betula glandulosa, Ceanothus velutinus, Picea engelmanni, Pinus contorta, Pinus flexilis, Populus tremuloides, Pseudotsuga menziesii, Ribes spp., Rosa spp., Salix spp., Shepherdia canadensis; Thallophytes.

Fringed sagewort, willow, buckbrush, skunkbrush sumac (Rhus trilobata), chokecherry (Prunus virginiana) and western serviceberry were browse species which received significant use. Canadian buffalo-berry, one of the most common shrubs, was used during periods when snow was deep and crusted.

Others have reported food habits for bighorn sheep in winter. Couey (1950) noted heavy use of fescues, bluegrasses, wheatgrasses and fringed sagewort in the Sun River area. In Idaho, Smith (1954) found bighorn sheep were taking 39 per cent browse. In British Columbia, Sugden (1961) recorded 61.6, 29.3 and 9.1 per cent use of browse, grass and forbs respectively.

TABLE VI. BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER FOOD HABITS AS DETERMINED
FROM 19,483 INSTANCES OF PLANT USE AT 144 FEEDING SITES JANUARY-MARCH 1965.

	Habitat Types																	
	Bunchgrass				Rocky reef			Old burn				Bottom			Douglas-fir			
	S	E	MD	WT	S	E	MD	S	E	MD	WT	S	MD	WT	S	E	MD	WT
Instances plant use	3,386	1,515	486	890	2,426	110	1,157	2,228	803	1,570	77	115	329	1,476	590	506	478	1,148
Plant species ^{1/}																		
Grasses and grasslike plants																		
<u>Agropyron spicatum</u>	19 ^{2/}	13	tr ^{3/}	2	28	38	2	22	19	1	3	--	--	--	21	--	--	11
<u>Agropyron spp.</u>	tr	6	--	--	tr	--	--	tr	--	--	--	--	--	--	--	--	tr	--
<u>Festuca idahoensis</u>	8	16	1	tr	5	3	--	4	3	tr	--	--	--	--	tr	--	--	--
<u>Festuca scabrella</u>	3	13	1	1	2	7	--	2	5	--	--	--	--	--	tr	--	--	--
<u>Juncus spp.</u>	--	--	--	--	--	--	--	--	--	--	--	21	--	1	--	--	--	--
<u>Koeleria cristata</u>	tr	tr	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--
<u>Phleum pratense</u>	--	tr	1	2	--	--	--	1	--	3	--	3	--	tr	--	--	--	10
<u>Poa spp.</u>	6	1	--	tr	4	--	--	2	3	--	--	--	--	--	1	--	--	--
Total Grass	36	49	3	5	43	48	2	31	30	4	3	24	--	1	22	2	--	11
Forbs																		
<u>Apocynum medium</u>	--	--	--	--	tr	--	tr	2	--	--	--	--	--	--	--	--	--	--
<u>Aster spp.</u>	tr	1	--	7	1	--	3	2	3	8	--	22	--	3	1	23	7	15
<u>Astragalus drummondii</u>	5	1	4	11	--	--	--	1	--	2	--	--	--	--	3	--	--	tr
<u>Astragalus missouriensis</u>	1	1	--	6	1	--	2	--	--	--	--	--	--	--	tr	--	--	1
<u>Astragalus spp.</u>	tr	1	--	tr	tr	8	tr	--	--	--	--	--	--	--	--	--	--	--
<u>Balsamorhiza sagittata</u>	4	5	16	11	2	--	1	1	5	9	31	--	--	--	8	--	6	11
<u>Chrysopsis villosa</u>	3	tr	--	6	2	--	tr	tr	--	--	--	--	--	--	--	--	--	tr
<u>Cirsium spp.</u>	tr	--	tr	--	tr	--	--	tr	2	tr	--	--	--	--	--	--	--	tr
<u>Galium boreale</u>	tr	tr	1	tr	--	--	1	tr	3	--	--	--	--	--	--	--	--	--
<u>Hieracium albertinum</u>	tr	--	--	3	--	--	--	--	tr	--	--	--	--	--	--	--	--	--
<u>Liatrus punctata</u>	1	1	1	3	--	--	1	--	--	--	--	--	--	--	--	--	--	6
<u>Lithospermum ruderales</u>	1	1	--	1	--	--	--	--	tr	1	--	--	--	--	5	--	1	tr
<u>Lupinus sericeus</u>	6	5	4	6	--	7	tr	5	6	4	--	--	--	--	3	--	2	6
<u>Tragopogon dubius</u>	2	tr	8	1	tr	--	1	4	4	7	--	--	--	--	1	--	2	1
Total forbs	23	16	34	55	6	15	9	15	23	31	31	22	--	3	24	23	18	34
Browse																		
<u>Acer glabrum</u>	--	--	--	--	2	--	13	tr	--	8	--	--	37	10	3	--	3	--
<u>Amelanchier alnifolia</u>	--	--	10	--	8	--	5	tr	2	1	--	--	--	1	--	--	13	1
<u>Artemisia dracunculoides</u>	2	6	--	4	1	--	--	1	1	1	--	--	--	--	--	--	--	--

TABLE VI. CONTINUED

	Habitat Types																				
	Bunchgrass				Rocky reef			Old burn				Bottom			Douglas-fir				Quaking aspen		
	S	E	MD	WT	S	E	MD	S	E	MD	WT	S	MD	WT	S	E	MD	WT	MD	WT	
<u>Artemisia frigida</u>	20	7	12	3	13	--	3	16	5	7	4	--	--	--	20	--	--	2	--	4	
<u>Arctostaphylos uva-ursi</u>	--	3	2	--	2	--	16	1	2	2	--	--	--	--	--	--	--	1	--	--	
<u>Betula glandulosa</u>	--	--	--	--	--	--	--	--	--	1	--	--	5	16	--	--	--	--	--	--	
<u>Ceanothus velutinus</u>	tr	--	29	--	1	--	9	1	--	20	--	--	--	--	--	--	7	3	--	--	
<u>Cornus stolonifera</u>	--	--	--	--	--	--	--	--	--	5	--	--	--	18	--	--	--	--	--	--	
<u>Juniperus communis</u>	--	--	--	--	--	--	2	--	1	--	--	--	--	--	--	--	4	--	--	--	
<u>Juniperus horizontalis</u>	--	--	--	tr	tr	--	7	tr	1	--	--	--	--	--	--	2	10	tr	--	--	
<u>Pinus contorta</u>	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	--	--	--	--	
<u>Populus tremuloides</u>	--	1	--	--	6	--	4	1	13	5	--	--	14	8	2	29	--	--	21	21	
<u>Prunus virginiana</u>	--	--	--	24	3	--	6	5	4	6	34	--	--	17	4	1	3	3	--	30	
<u>Pseudotsuga menziesii</u>	--	--	--	--	tr	--	--	--	--	--	--	--	--	1	--	6	7	1	--	--	
<u>Rhus trilobata</u>	tr	--	--	1	--	--	1	--	tr	1	19	16	--	2	--	--	20	13	--	--	
<u>Rosa spp.</u>	1	2	--	tr	--	--	tr	tr	1	--	--	--	--	2	--	1	--	5	--	--	
<u>Salix spp.</u>	--	--	--	--	--	--	1	--	--	1	--	36	29	1	--	4	--	15	--	--	
<u>Shepherdia canadensis</u>	--	--	--	--	4	--	2	2	1	--	--	--	--	--	--	4	--	2	--	--	
<u>Spiraea betulifolia</u>	--	--	--	--	--	--	tr	--	1	--	--	--	--	--	--	4	--	--	--	4	
<u>Symphoricarpos spp.</u>	7	4	4	8	3	25	1	7	5	2	9	--	--	7	5	tr	11	4	--	--	
Total browse	30	23	57	40	43	25	7	34	37	60	66	52	100	82	31	64	78	49	71	59	
Total ^{4/}	89	88	94	100	91	88	82	79	90	95	100	98	85	81	77	89	96	95	96	95	

1/ Each of the species listed provided three or more per cent of the total instances of plant use in at least one habitat type or for one or more of the animals. Other species are listed in Appendix Table X.

2/ Nineteen per cent of 3,386 instances of plant use.

3/ Less than .5 per cent.

4/ Sum of percentages of all plants listed.

Elk

Eighteen feeding sites of elk were examined during the winter.

Percentages of use for plants in Table VI by forage classes were 37, 22 and 42 for grass and grass-like plants, forbs and browse respectively.

The data suggested that the four most important grasses in the diet of elk were bluebunch wheatgrass, rough fescue, Idaho fescue and blue-grasses. Bluebunch wheatgrass received greatest usage and most use occurred in the old burn habitat type. Idaho fescue received its greatest relative use in the bunchgrass habitat type.

Asters, silky lupine, arrowleaf balsamroot, milkvetch (Astragalus spp.) and common salsify were forbs with high usage values. Asters made up almost 1/4 of the food taken in the Douglas-fir habitat type.

In the browse forage class, quaking aspen received greatest use and was followed by buckbrush, lodgepole pine, fringed sagewort and false-tarragon sagewort (Artemisia dracunculus). Relative significance of plant species in the various habitat types is shown in Table VI.

Stevens (1965) noted elk studies made in northwest United States demonstrated one common fact--ability of elk to adapt to vegetation composition of the range. Winter studies of elk by Rouse (1957), Kirsch (1962) and others have shown high percentages of grass use. Knight (1961) mentioned browse was an important part of the diet of elk in certain areas of Sun River range. This was similar to results of my study.

Mule Deer

Mule deer were frequently observed feeding with bighorn sheep on

bunchgrass, rocky reef and old burn habitat types. Examination of 34 feeding sites of mule deer indicated food consumed consisted of 5, 22 and 73 per cent grass, forbs and browse respectively (Table VI).

Eight important browse species utilized by mule deer were Rocky Mountain maple, snowbrush ceanothus, quaking aspen, western serviceberry, willow, fringed sagewort, skunkbrush sumac and buckbrush. Relative importance of each of these plants for the various habitat types is shown in Table VI.

Use of forbs by mule deer was greatest in bunchgrass and old burn habitat types. Important forbs included arrowleaf balsamroot, asters, common salsify, silky lupine and drummond milkvetch.

Two grasses which received most use were timothy (Phleum pratense) and bluebunch wheatgrass. Lovaas (1958) reported grasses constituted 9.1 per cent of the diet of mule deer in the Little Belt Mountains of Montana during winter. He also reported 75.6 per cent of the food was browse and 14.8 per cent was forbs.

Whitetail Deer

Twenty-five feeding sites of whitetail deer were examined. Percentages of use for grass and grass-like plants, forbs and browse were 5, 30 and 65 respectively which is similar to that reported by Allen (1965) for white-tail deer along the Missouri River in central Montana.

Seven browse plants utilized by whitetail deer and arranged from greatest to least use were chokecherry, quaking aspen, skunkbrush sumac, buckbrush, red dogwood, (Cornus stolonifera), scrub birch (Betula glandulosa)

and fringed sagewort (Table VI). Practically all chokecherry utilization was noted in January which may have indicated it was largely depleted early in the winter when other browse species were still available.

Forbs receiving greatest usage were arrowleaf balsamroot, asters, silky lupine, false-tarragon sagewort and dotted blazing star (Liatrus punctata). Forbs were utilized most heavily in the bunchgrass habitat type with arrowleaf balsamroot, silky lupine and drummond milkvetch receiving greatest usage.

Greatest use of grass, mostly bluebunch wheatgrass, was noted in stands of Douglas-fir where trees were widely spaced.

Horses

One feeding site of four horses was examined in the bunchgrass habitat type in July 1964. One-hundred and ten instances of plant use were recorded. Percentages of use observed were 41, 30, 20, 4, 4 and 1 for bluebunch wheatgrass, needlegrasses, Idaho fescue, rough fescue, common salsify and sedges (Carex spp.) respectively.

BROWSE AND BUNCHGRASS UTILIZATION

Utilization of bunchgrass and browse species was measured on key areas of big game winter range in May 1965. Data from seven browse transects, each consisting of 25 plants, are presented in Table VII. Ninety-seven per cent of all plants examined were classed as decadent. Available portions of 85 per cent of the plants were severely hedged. Relatively low percentages of resprouting were noted for all species, with Rocky Mountain maple highest and western serviceberry lowest. Average utilization for the five species ranged from 77 to 90 per cent. Cole (1958) tentatively set 70 per cent as maximum utilization for vigorous browse species during severe winters.

Data on bunchgrass utilization were gathered from 14 transects, each consisting of 100 plants. The number of individual plants that were unused was determined for each species. Percentages of unused plants were calculated and compared to a chart for utilization of bunchgrass range. The chart was used to convert the percentages to per cent utilization for each plant species (Cole, 1958). Per cent utilization was 71, 50 and 70 for bluebunch wheatgrass, Idaho fescue and rough fescue respectively. Cole (1958) stated 50 per cent utilization of key bunchgrasses is allowable on elk winter ranges in Montana.

TABLE VII. PER CENT UTILIZATION OF BROWSE SPECIES ON KEY AREAS OF SUN RIVER RANGE AS DETERMINED BY OCCULAR ESTIMATE IN MAY 1965.

Plant Species	No. Plants	Leader Use ^{1/}	% Form Class ^{2/}	% Age Class ^{3/}	R ^{4/}
<u>Acer glabrum</u>	86	85	69-3 3-5 28-6	1-M 99-D	-- 54
<u>Amelanchier alnifolia</u>	29	77	17-2 76-3 7-6	100-D	16
<u>Populus tremuloides</u>	25	77	8-2 92-3	16-M 84-D	-- --
<u>Prunus virginiana</u>	14	90	79-3 7-5 14-6	100-D	36
<u>Rhus trilobata</u>	<u>21</u> 175	85	100-3	100-D	43

^{1/} Average per cent growth of previous year utilized.

^{2/} 2 = all available, moderately hedged; 3 = all available, severely hedged; 5 = partly available, moderately hedged; 6 = partly available, severely hedged.

^{3/} M = mature = stems greater than 1/4 inch in diameter; D = decadent = 25 per cent or more of crown area dead.

^{4/} Per cent of plants in age class with resprouts.

INTERSPECIFIC RELATIONSHIPS

Bighorn Sheep and Elk

Overlap in range use between bighorn sheep and elk occurred on bunchgrass, old burn and Douglas-fir habitat types (Table III). The bunchgrass type received greater usage by each of the species than did any other habitat type. The old burn habitat type ranked third in use for each species. Overlap in the Douglas-fir type was minimized because of differences in areas used. Utilization of forage classes by bighorn sheep and elk was similar (Table VI). Plant species significant in food habits of each animal species in bunchgrass and old burn habitat types were bluebunch wheatgrass, Idaho fescue, rough fescue, silky lupine, arrowleaf balsamroot, buckbrush and fringed sagewort. Common salsify was used equally by each animal species in the old burn habitat type. Data from bunchgrass utilization transects indicated utilization of Idaho fescue was maximum and overuse of rough fescue and bluebunch wheatgrass had occurred. The data indicated severe interspecific competition on parts of winter range that were used jointly. Greatest overlap of winter range of bighorn sheep and elk occurred at the head of Hannon Gulch, in Big George Gulch and Scattering Springs-Reclamation Flat area. Couey (1950) listed 120 elk months of use for Wagner Basin during the autumn and winter of 1942-43. I observed no elk in this area during the winter of 1965.

Bighorn Sheep and Mule Deer

Greatest overlap in range use between bighorn sheep and mule deer

was in bunchgrass, rocky reef and old burn habitat types (Table III). Herds of bighorn sheep and mule deer in these habitat types frequently associated with each other while feeding. Food habits data indicated similarities in use of browse (Table VI). Fringed sagewort ranked first in use by bighorn sheep and fifth for mule deer. Utilization of this plant by each animal species was greatest in bunchgrass and old burn habitat types. Buckbrush ranked second for bighorn sheep and sixth for mule deer. Greatest use of buckbrush by each animal species was in bunchgrass and Douglas-fir habitat types. Western serviceberry, quaking aspen and chokecherry were other browse species extensively utilized by both bighorn sheep and mule deer. The five forbs with highest usage values for bighorn sheep were also highest ranking for mule deer. Total use of the forb forage class was similar for each of the animal species.

Considering overuse of browse on the area (Table VII), the data seem to indicate serious interspecific competition in areas where there was overlap of winter range. Animal observations suggested overlap of bighorn sheep and mule deer range use was greatest in Wagner Basin and Big George Gulch.

Bighorn Sheep and Whitetail Deer

Joint use of the bunchgrass habitat type by bighorn sheep and whitetail deer was noted in Hannon Gulch and Wagner Basin. The whitetail deer used "flats" along the river and creek bottoms. Relatively little use of these areas by bighorn sheep was noted. A dense stand of Idaho

fescue and rough fescue was present on the "flats". This excellent stand of bunchgrass probably reflected limited grazing by bighorn sheep and other animals. The bighorn sheep seemed to prefer grazing the bunchgrass habitat type in locations near the steep, rocky reef habitat type. Smith (1954) found bighorn sheep in Idaho utilized grassy slopes bordered by steep, rocky terrain during winter. In Wagner Basin, dual use of scattered clumps of the Douglas-fir habitat type was observed during blizzards but interspecific competition was minimized because extremely bad weather, which forced bighorn sheep to use this habitat type, was seldom of more than one or two days duration.

Bighorn Sheep and Horses

Limited data from the summer of 1964 suggested horses grazing in the bunchgrass habitat type and on tops of reefs probably were utilizing vegetation which was potential food for bighorn sheep in winter. Tops of reefs were favorite "bed-grounds" of bighorn sheep during the winter. Greatest use of winter range of bighorn sheep by horses was recorded in the Reclamation Flat-Scattering Springs area.

Discussion and Conclusions

Range use, food habits and utilization of key forage plants indicated varying degrees of interspecific competition between bighorn sheep and elk, mule deer, whitetail deer and horses. It seemed greatest between bighorn sheep and elk, and bighorn sheep and mule deer. Less conflict for forage was noted between bighorn sheep and whitetail deer, and bighorn sheep and horses. Greater interspecific competition could conceivably

result if horse and whitetail deer populations increase.

Other data corroborate the seriousness of interspecific competition with bighorn sheep. Bighorn sheep used southward facing slopes more than any of the other big game species studied. This and the fact that bighorn sheep were never observed very far from steep, rocky reefs showed the relatively small area of winter range available for this species. Smith (1954) noted that "although gregarious, bighorn in Idaho have not exhibited an ability to thrive where elk or deer are overly abundant".

-35-

APPENDIX

TABLE VIII. PLANT SPECIES WITH LESS THAN 10 PER CENT FREQUENCY IN HABITAT TYPES AS DETERMINED BY 2 BY 5 DECIMETER PLOTS. 1/

Plant species	Habitat Types						
	Bunch- grass	Rocky reef	Old burn	Bottom	Douglas fir	Lodgepole pine	Quaking aspen
Grass and grass- like plants							
<u>Agropyron dasystachyum</u>			X				
<u>Agropyron smithii</u>	X		X				
<u>Agropyron trachycaulum</u>				X	X		X
<u>Allium cernuum</u>	X	X	X		X	X	X
<u>Allium textile</u>		X					
<u>Bromus japonicus</u>		X					
<u>Bromus marginatus</u>			X	X		X	X
<u>Bromus spp.</u>	X			X			
<u>Bromus tectorum</u>					X		
<u>Carex filifolia</u>		X					
<u>Danthonia intermedia</u>					X	X	X
<u>Danthonia parryi</u>	X			X			
<u>Elymus cinereus</u>	X			X		X	X
<u>Festuca eleator</u>			X				
<u>Iris missouriensis</u>				X			X
<u>Juncus spp.</u>				X			
<u>Muhlenbergia cuspidata</u>	X					X	
<u>Oryzopsis hymenoides</u>			X				
<u>Phleum pratense</u>	X	X		X	X	X	X
<u>Scirpus spp.</u>				X			
<u>Sisyrinchium montanum</u>	X			X		X	
<u>Smilacina racemosa</u>			X	X	X		X
<u>Stipa williamsii</u>		X				X	X
Unidentified grass	X	X	X	X	X	X	X
<u>Zygadenus venosus</u>	X	X					
Forbs							
<u>Agoseris spp.</u>	X				X	X	
<u>Anemone piperi</u>		X				X	
<u>Apocynum medium</u>	X	X	X				
<u>Arnica cordifolia</u>					X		X
<u>Arnica sororia</u>	X				X	X	X
<u>Astragalus crassiocarpus</u>	X						
<u>Astragalus drummondii</u>	X	X	X		X		
<u>Astragalus miser</u>	X	X	X				

TABLE VIII. CONTINUED

Plant species	Habitat Types						
	Bunch- grass	Rocky reef	Old burn	Bottom	Douglas fir	Lodgepole pine	Quaking aspen
<u>Astragalus missouriensis</u>		X			X		
<u>Astragalus</u> spp.	X						X
<u>Balsamorhiza sagittata</u>	X	X	X		X		
<u>Campanula parryi</u>		X					
<u>Campanula rotundifolia</u>	X	X	X		X	X	X
<u>Castilleja cervina</u>		X	X				
<u>Castilleja miniata</u>			X	X			
<u>Cirsium</u> spp.	X	X		X			
<u>Cirsium undulatum</u>	X		X				
<u>Clematis columbiana</u>				X			
<u>Clematis hirutissima</u>	X						X
<u>Cryptanthus bradburiana</u>	X		X				
<u>Cruciferae</u>		X	X				
<u>Dodecatheon conjugens</u>	X	X					
<u>Epilobium angustifolium</u>			X				X
<u>Erigeron corymbosus</u>	X	X					
<u>Erigeron</u> spp.	X	X	X		X	X	X
<u>Eriogonum umbellata</u>	X		X				
<u>Erysimum inconspicuum</u>		X					
<u>Gaillardia aristata</u>	X	X					
<u>Glycyrrhiza lepidota</u>	X	X		X			
<u>Heracleum lanatum</u>				X			
<u>Iva axillaris</u>	X						
<u>Lactuca biennis</u>				X			X
<u>Lathyrus ochroleucus</u>				X			X
<u>Liatrus punctata</u>	X		X			X	
<u>Lithospermum ruderales</u>	X	X	X		X	X	
<u>Microseris cuspidata</u>	X	X					
<u>Monarda fistulosa</u>		X	X	X			
<u>Orthocarpus tenuifolius</u>	X		X				
<u>Oxytropis besseyi</u>	X		X				
<u>Oxytropis sericea</u>	X						
<u>Oxytropis splendens</u>			X				
<u>Oxytropis viscida</u>		X					
<u>Penstemon albertinus</u>	X	X	X		X		X
<u>Penstemon flavescens</u>			X				
<u>Penstemon</u> spp.			X				
<u>Phlox longifolia</u>	X	X			X		
<u>Potentilla ovina</u>		X					
<u>Senecio</u> spp.			X	X			X

TABLE VIII. CONTINUED

Plant species	Habitat Types						
	Bunch- grass	Rocky reef	Old burn	Bottom	Douglas fir	Lodgepole pine	Quaking aspen
<u>Solidago missouriensis</u>	X						X
<u>Thalictrum venulosum</u>			X	X			X
<u>Townsendia parryi</u>	X	X					
<u>Tragopogon dubius</u>	X	X	X				
<u>Trifolium pratensis</u>				X			
<u>Vicia americana</u>				X			
Browse							
<u>Acer glabrum</u>		X	X	X			
<u>Amelanchier alnifolia</u>	X			X		X	X
<u>Artemisia ludoviciana</u>	X						X
<u>Betula glandulosa</u>				X			
<u>Ceanothus velutinus</u>	X	X	X				
<u>Cornus stolonifera</u>		X	X	X			
<u>Eleagnus commutata</u>				X	X		
<u>Gutierrezia sarothrae</u>		X	X				
<u>Juniperus horizontalis</u>		X	X		X	X	
<u>Physocarpus malvaceus</u>		X					
<u>Pinus contorta</u>			X			X	
<u>Populus tremuloides</u>		X		X		X	X
<u>Populus trichocarpa</u>				X			
<u>Potentilla fruticosa</u>	X	X	X	X			
<u>Prunus virginiana</u>	X		X	X			
<u>Psuedotsuga menziesii</u>		X	X		X		
<u>Ribes setosum</u>		X					
<u>Ribes spp.</u>				X			
<u>Rubus spp.</u>					X	X	
<u>Salix spp.</u>				X			X

1/ Qualitative listing for bottom habitat type.

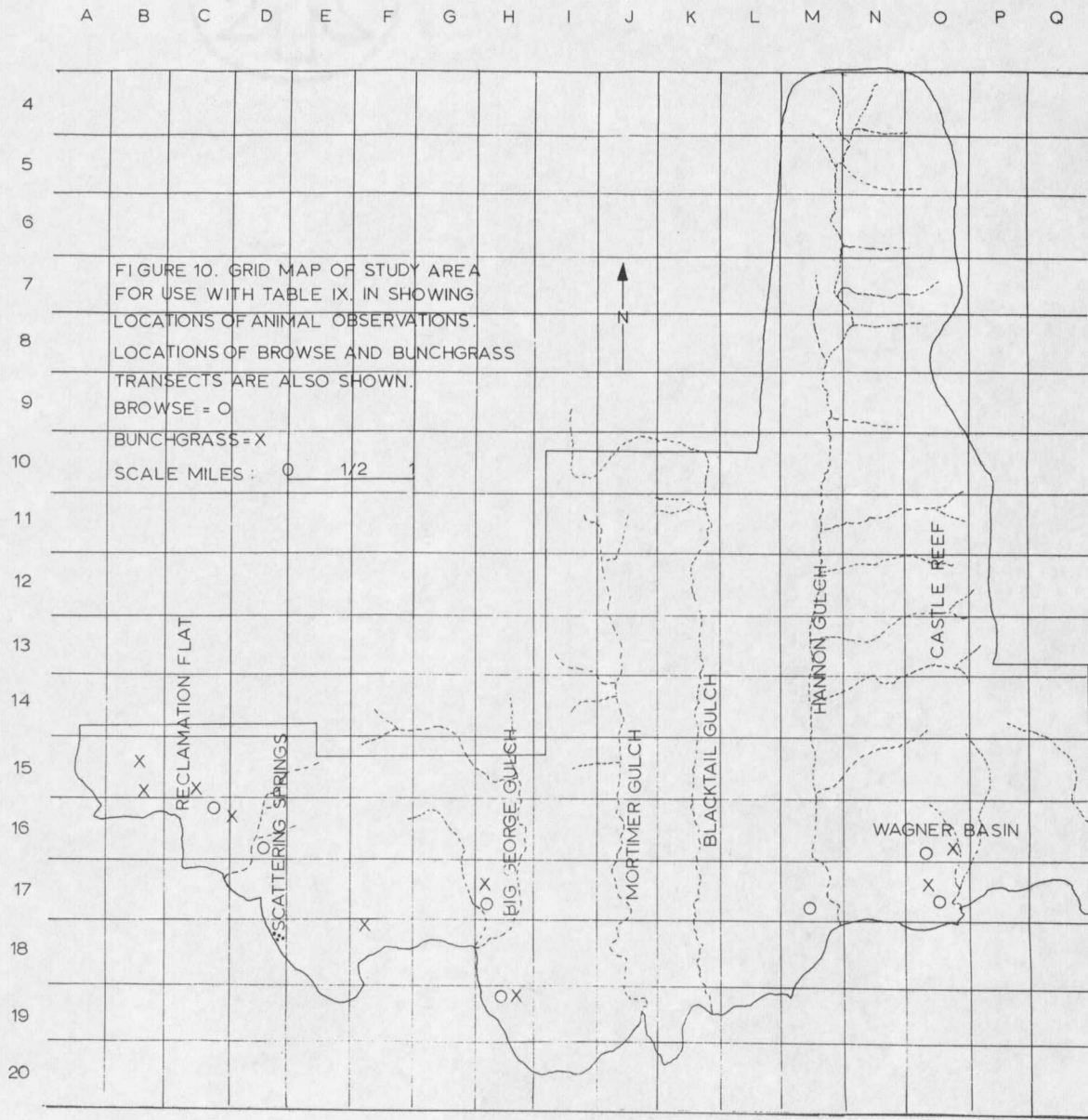


Figure 10. Grid Map of Study Area for Use with Table IX in Showing Locations of Animal Observations. Locations of Browse and Bunchgrass Transects are also Shown.

TABLE IX. PERCENTAGES OF BIGHORN SHEEP, ELK, MULE DEER AND WHITETAIL DEER OBSERVED JANUARY-MARCH 1965, LISTED BY 1/4 SQUARE MILES. ^{1/}

Location ^{2/}	S	E	MD	WT	Location	S	E	MD	WT
B-16	1	--	--	--	M-17	--	--	tr	1
C-14	--	1	--	--	M-18	--	--	1	tr
C-15	8	1	--	--	M-19	--	--	1	tr
C-16	2	--	--	--	N- 6	--	1	--	--
D-15	--	10	1	--	N-12	--	tr	--	--
D-16	15	5	tr ^{3/}	--	N-13	--	3	--	--
D-17	1	tr	--	--	N-14	--	tr	--	--
E-15	--	tr	--	--	N-15	--	2	--	10
E-16	2	2	1	--	N-16	--	1	--	5
E-17	11	--	4	--	N-17	4	--	tr	27
E-18	tr	--	--	--	N-18	--	--	--	5
F-17	--	1	--	--	N-19	--	--	--	tr
F-18	1	--	2	--	O-10	--	--	1	--
G-16	--	6	--	--	O-11	--	3	--	--
G-17	2	5	tr	--	O-12	tr	--	1	--
G-18	1	tr	1	--	O-13	tr	--	3	--
H-14	--	3	--	--	O-14	1	--	1	--
H-15	--	11	--	--	O-15	--	--	4	1
H-16	1	19	1	--	O-16	2	--	5	--
H-17	5	7	1	--	O-17	3	--	2	2
H-18	--	10	--	--	P-11	tr	--	--	--
I-16	4	--	--	--	P-12	--	--	1	--
I-17	3	7	8	--	P-13	tr	--	1	--
I-18	5	--	2	--	P-14	--	--	tr	--
I-20	1	--	--	--	P-15	--	--	4	--
J-19	--	--	tr	1	P-16	2	--	16	1
K-16	--	--	--	tr	P-17	12	--	12	31
K-18	--	--	--	tr	Q-14	--	--	3	--
K-19	tr	2	--	3	Q-15	4	--	tr	--
L-19	tr	--	--	1	Q-16	2	--	3	4
L-20	tr	--	--	--	Q-17	tr	--	tr	1
M-12	--	tr	--	--	R-14	tr	--	1	2
M-14	--	--	tr	--	R-15	2	--	7	--
M-16	--	--	tr	--	R-16	tr	--	--	--

^{1/} Sample size in Table III.

^{2/} See Fig. 10 for locations.

^{3/} Less than .5 per cent.

TABLE X. PLANT SPECIES WHICH WERE UTILIZED AT LEVELS OF LESS THAN THREE PER CENT OF THE TOTAL INSTANCES OF USE IN ANY HABITAT TYPE.

Plant Species	Bighorn Sheep	Elk	Mule Deer	Whitetail Deer
Grasses and grass- like plants				
<u>Agropyron dasystachyum</u>	X			
<u>Agropyron trachycaulum</u>		X		
<u>Allium cernuum</u>	X			
<u>Bromus marginatus</u>				X
<u>Bromus spp.</u>	X			
<u>Calamagrostis rubescens</u>	X	X		X
<u>Carex spp.</u>	X	X	X	X
<u>Danthonia parryi</u>	X	X		
<u>Elymus cinereus</u>	X	X		
<u>Iris missouriensis</u>		X		
<u>Koeleria cristata</u>	X	X		
<u>Muhlenbergia cuspidata</u>	X	X		
<u>Oryzopsis hymenoides</u>	X		X	X
<u>Scirpus spp.</u>				X
<u>Stipa richardsonii</u>		X		
Forbs				
<u>Achillea millefolium</u>	X	X	X	X
<u>Angelica spp.</u>				X
<u>Anemone piperi</u>			X	
<u>Antennaria rosea</u>	X			
<u>Arrenaria congestis</u>	X			
<u>Arrenaria spp.</u>	X	X	X	X
<u>Astragalus crassiocarpus</u>	X			
<u>Bupleurum americanum</u>	X	X		
<u>Campanula rotundifolia</u>	X			
<u>Castilleja spp.</u>				X
<u>Clematis spp.</u>				X
<u>Crepis acuminata</u>	X	X	X	X
<u>Cryptanthus bradburiana</u>	X			
<u>Dodecatheon spp.</u>			X	
<u>Fragaria virginiana</u>	X			
<u>Gaillardia aristata</u>	X	X	X	X
<u>Geum triflorum</u>	X			
<u>Glycyrrhiza lepidota</u>	X			
<u>Hedysarum spp.</u>		X	X	X

TABLE X. CONTINUED

Plant Species	Bighorn Sheep	Elk	Mule Deer	Whitetail Deer
<u>Lactuca biennis</u>			X	X
<u>Lactuca pulchella</u>				X
<u>Linum lewisii</u>	X	X	X	X
<u>Melilotus officinalis</u>	X			X
<u>Microseris cuspidata</u>	X	X	X	
<u>Oxytropis besseyi</u>	X			
<u>Oxytropis splendens</u>			X	
<u>Penstemon spp.</u>	X		X	
<u>Phlox spp.</u>	X			
<u>Potentilla glandulosa</u>		X		
<u>Potentilla ovina</u>	X			
Unidentified forbs	X	X	X	X
Browse				
<u>Artemisia ludoviciana</u>	X	X		X
<u>Artemisia michauxiana</u>	X		X	
<u>Berberis repens</u>	X	X	X	
<u>Cornus stolonifera</u>			X	X
<u>Eleagnus commutata</u>	X			
<u>Gutierrezia sarothrae</u>	X			
<u>Juniperus scopulorum</u>	X		X	
<u>Philadelphus lewisii</u>			X	
<u>Physocarpus malvaceus</u>				X
<u>Potentilla fruticosa</u>	X	X	X	
<u>Ribes spp.</u>	X		X	

LITERATURE CITED

- Allen, E. O. 1965. Food and range use habits of whitetail deer on Missouri River bottomlands in north-central Montana. Unpubl. Thesis (M.S.) Montana State Univ., Bozeman. 41 pp.
- Booth, W. E. 1950. Flora of Montana, Part I, Conifers and Monocots. Research Foundation at Montana State Coll., Bozeman. 232 pp.
- _____ and J. C. Wright. 1959. Flora of Montana, Part II, Dicotyledons. Montana State Coll., Bozeman. 280 pp.
- Canfield, R. H. 1941. Application of the line intercept method in sampling range vegetation. J. Forestry 39: 388-394.
- Cole, G. F. 1956. The pronghorn antelope-Its range use and food habits in central Montana with special reference to alfalfa. Mont. Fish and Game Dept. and Mont. Agr. Expt. Sta. Tech. Bull. 516. 63 pp.
- _____. 1958. Range survey guide. Mont. Fish and Game Dept. Multilith. 18 pp. In Fish and Game Dept. files at Helena, Montana.
- Couey, F. M. 1950. Rocky Mountain bighorn sheep of Montana. Fed. Aid in Wildl. Rest. Proj. 1-R, Bull. 2, Mont. Fish and Game Comm. 90 pp.
- Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33(1): 43-64.
- Deiss, C. F. 1943. Structure of central part of Sawtooth Range, Montana. Geol. Soc. Bull. 54: 1123-1167.
- Kirsch, J. B. 1962. Range use, relationships to logging, and food habits of the elk in the Little Belt Mountains, Montana. Unpubl. Thesis (M.S.) Montana State Coll., Bozeman. 44 pp.
- Knight, R. 1961. Elk population trends, food habits and range relationships in the Sun River area. P. R. Completion Report, Project W-98-R-1. Mont. Fish and Game Dept. Multilith. 25 pp. On file with Mont. Fish and Game Dept., Helena, Montana.
- _____. 1965. History of Sun River area. Unpubl. typewritten copy. 7 pp. In personal file.
- Lovaas, A. L. 1958. Mule deer food habits and range use, Little Belt Mountains, Montana. J. Wildl. Mgmt. 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. Mgmt. 10(1): 8-12.
- Moser, C. A. 1962. The bighorn sheep of Colorado. Colo. Fish and Game Dept. Tech. Publ. No. 10. 49 pp.
- Rouse, R. A. 1957. Elk food habits, range use and movements, Gravelly Mountains, Montana. Unpubl. Thesis (M. S.) Montana State Coll., Bozeman. 29 pp.
- Smith, D. R. 1954. The bighorn sheep in Idaho--its status, life history and management. Idaho Fish and Game Dept. Wildl. Bull. 1. 154 pp.
- Spencer, C. C. 1943. Notes on the life history of Rocky Mountain bighorn sheep in Tarryall Mountains of Colorado. J. Mamm. 24(1): 1-11.
- Stevens, D. R. 1965. Crow Creek elk, sheep and cattle summer range relationships study. Unpubl. Thesis (M. S.) Montana State Coll., Bozeman. 68 pp.
- Sugden, L. G. 1961. The California bighorn in British Columbia with particular reference to the Churn Creek herd. B. C. Fish and Game Branch. 58 pp.
- U. S. Dept. Commerce Weather Bureau. 1929-1965. Montana monthly summary. U. S. Gov't. Printing Office, Washington, D. C.

MONTANA STATE UNIVERSITY LIBRARIES



3 1762 10015436 6

N378
Sch 15
cop. 2

