Ecology of bighorn sheep in the Sun River area of Montana during fall and spring
by Michael Redvers Frisina

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


Abstract:
A study of bighorn sheep was conducted in the Sun River area of west central Montana during the fall and spring of 1972 and 1973 to obtain quantitative data on range use, feeding habits, physical condition, quality of nutrition, productivity, and movements. Vegetation resulting from past fires was classified into two vegetation types and three subtypes. Percent canopy coverages and frequencies of occurrence were determined for low growing plant taxa on these types and subtypes. Sex and age composition of the herd was determined from 4,923 ground and 676 aerial observations of bighorn sheep. Numbers per 100 ewes for rams, lambs, and yearlings were 25, 59, and 14 during fall and 36, 54, and 10 during spring, respectively. Range use was determined by recording the locatiohs of 2,149 and 3,291 observations of bighorn sheep in the fall and spring, respectively. During fall 64 percent of the bighorn sheep observations were made on the rocky reef type and 34 percent were on the bunchgrass type. During spring 59 percent of the bighorn sheep observations were made on the bunchgrass type. During both fall and spring those subtypes related to past fires received greatest use by bighorns. Southerly exposures received greater use than other exposures during both spring and fall. A mean slope of 60 and 42 percent was used by bighorns during fall and spring, respectively. An inverse relationship between mean bighorn sheep group sizes and security level of habitat was found. Spring and fall food habits were determined from the contents of 34 rumen samples and 3,993 instances of plant use at feeding sites. Grasses and grass-like plants, forbs, and browse made up 92, 5, and 1 percent of the diet during fall and 94, 3, and 2 percent of the diet during spring, respectively. These data were combined with those of earlier studies to summarize the year-round food habits of bighorn sheep in the Sun River area. Crude fiber and protein content of rumen samples, crude fiber in fecal samples, and percent light transmittancy of rumen liquor samples from each of 10 adult ewes collected in spring were determined. A kidney fat index was determined for each of the animals. Kidney fat indices indicated all bighorn sheep, except one, were in good condition. The values for protein and crude fiber may represent at least minimum and maximum values, respectively, for bighorn sheep on adequate ranges. A negative correlation between percent light transmittancy for rumen liquor and nutritive quality was found.

Each pair of ovaries of 10 adult ewes collected during spring contained one corpus luteum which together with embryo counts indicated a frequency of fertilization of 100 percent. Relocations of 60 marked bighorn sheep indicated that during spring they confined their movements to the winter concentration areas previously described and during fall were found on both the winter concentration areas and almost all portions of the summer range.

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

of

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Bozeman, Montana

June, 1974

## ACKNOWLEDGMENT

To the following, among others, the author wishes to express his sincere appreciation for their contributions to this study: Dr. Don C. Quimby, Montana State University, who directed the study and aided in preparation of the manuscript; Drs. Robert L. Eng and H. D. Picton, Montana State University, for reviewing the manuscript; Mr. Kenneth Greer, Montana Fish and Game Department Laboratory Supervisor, for use of the lab facilities; Mr. Allen Schallenberger, for initial project planning and field assistance; Mr. Bert Goodman, Sun River Game Range Manager, for use of facilities and field assistance; Messrs. Leo Klotz and Fred Taylor, Montana Fish and Game Department personnel, for field assistance; Kenneth Hamlin, graduate student, Montana State University, for field assistance; personnel of Augusta District and Teton District, Lewis and Clark National Forest for use of facilities and cooperation; my wife, Ruth, for her encouragement and typing of preliminary manuscripts. The author was supported by the Montana Fish and Game Department under Federal Aid Projects W-120-R(6098) and W-130-R(6074) during this study.

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## ABSTRACT

A study of bighorn sheep was conducted in the Sun River area of west central Montana during the fall and spring of 1972 and 1973 to obtain quantitative data on range use, feeding habits, physical condition, quality of nutrition, productivity, and movements. Vegetation resulting from past fires was classified into two vegetation types and three subtypes. Percent canopy coverages and frequencies of occurrence were determined for low growing plant taxa on these types and subtypes. Sex and age composition of the herd was determined from 4,923 ground and 676 aerial observations of bighorn sheep. Numbers per 100 ewes for rams, lambs, and yearlings were 25, 59, and 14 during fall and 36, 54, and 10 during spring, respectively. Range use was determined by recording the locations of 2,149 and 3,291 observations of bighorn sheep in the fall and spring, respectively. During fall 64 percent of the bighorn sheep observations were made on the rocky reef type and 34 percent were on the bunchgrass type. During spring 59 percent of the bighorn sheep observations were made on the bunchgrass type. During both fall and spring those subtypes related to past fires received greatest use by bighorns. Southerly exposures received greater use than other exposures during both spring and fall. A mean slope of 60 and 42 percent was used by bighorns during fall and spring, respectively. An inverse relationship between mean bighorn sheep group sizes and security level of habitat was found. Spring and fall food habits were determined from the contents of 34 rumen samples and 3,993 instances of plant use at feeding sites. Grasses and grass-like plants, forbs, and browse made up 92, 5, and 1 percent of the diet during fall and 94, 3, and 2 percent of the diet during spring, respectively. These data were combined with those of earlier studies to summarize the year-round food habits of bighorn sheep in the Sun River area. Crude fiber and protein content of rumen samples, crude fiber in fecal samples, and percent light transmittancy of rumen liquor samples from each of 10 adult ewes collected in spring were determined. A kidney fat index was determined for each of the animals. Kidney fat indices indicated all bighorn sheep, except one, were in good condition. The values for protein and crude fiber may represent at least minimum and maximum values, respectively, for bighorn sheep on adequate ranges. A negative correlation between percent light transmittancy for rumen liquor and nutritive quality was found. Each pair of ovaries of 10 adult ewes collected during spring contained one corpus luteum which together with embryo counts indicated a frequency of fertilization of 100 percent. Relocations of 60 marked bighorn sheep indicated that during spring they confined their movements to the winter concentration areas previously described and during fall were found on both the winter concentration areas and almost all portions of the summer range.

# INTRODUCTION

One of the largest herds of Rocky Mountain Bighorn Sheep (*Ovis canadensis canadensis* Shaw) ranges in the Sun River area of west central Montana. The early history of this herd was described by Couey (1950). The estimated population has increased from 260 in 1943 (Couey, 1950) to 805 in 1972. Annual bighorn sheep hunting seasons, under a permit system, were initiated in 1953 following a long closure which dated to 1912 (Watts *et al.*, 1971).

Winter food habits of animals of this herd were reported by Couey (1950) and Schallenberger (1966). Summer food habits were investigated by Erickson (1972). The latter author also studied movements of marked animals in winter and summer which resulted in the delineation of different herd segments for the Sun River, Ford Creek, and Deep Creek drainages. The study reported here was conducted during the summer and fall of 1972 and spring of 1973. I concentrated on range use, food habits, and movements during fall and spring to complement the data for the seasons previously reported. Special attention was given to use by bighorn sheep of habitats resulting from large wildfires which occurred between 1910 and 1945. Ewes were collected during spring for information concerning productivity, body condition, and food habits.

## METHODS

Ninety-eight bighorn sheep have been live-trapped, marked for individual identification and released during winter and spring in the study area since 1967 by Montana Fish and Game Department personnel. Ewes were marked with three inch wide neckbands. Rams were tagged in each ear with orange cattle tags embossed with black numerals. With the use of ocular aides these neckbands and ear tags can be observed for distances of approximately one mile and a few yards, respectively (Erickson, 1972).

Two aerial flights in the fall and three in the spring were conducted to locate groups of bighorns. A packtrain was used to establish base camps in areas where bighorns had been observed from the air. Daily searches for bighorn sheep were made in these localities. A 60X variable spotting scope, a 7 x 35 binocular and a 10 x 40 binocular were used as observational aides in locating bighorn sheep. Information recorded at each bighorn sheep observation site included an estimate of temperature and wind velocity, time of day, the vegetation type, exposure, distance to escape cover, elevation as determined by U.S.G.S. quadrangle maps, and percent slope as determined by abney level and estimation. The animals were classified as to sex, age, activity, and whether marked or unmarked. Rams were placed in one of five categories depending on the degree of horn curl: 1/4 or less, 1/4-1/2, 1/2-3/4, 3/4, or 3/4+.

Plants from the study area were collected and identified according to Booth (1950) and Booth and Wright (1959) to aid in food habits evaluations and classification of the vegetation. A plant collection was compiled for reference and verified by referring to a Montana Fish and Game Department reference collection. Areas considered representative of vegetation types were selected for study. Quantitative data on coverage and frequency of occurrence for herbaceous plants less than one and shrubs less than .5 meter in height, respectively, were gathered by examination of 20 randomly-spaced 2 x 5 or 4 x 10 decimeter plots located along a line transect. Tree heights and dbh were recorded by estimation and tape measure, respectively. The study area was divided according to vegetation types and subtypes to correlate use by bighorns of various plant communities during different seasons.

Information concerning bighorn sheep spring and fall feeding habits were obtained by examination of feeding sites (Cole, 1956). An estimation of one bite was considered to represent one instance of use for a plant species. At most feeding sites at least 100 instances of use were obtained. Rumen samples collected during the autumns of 1972 and 1973 by hunters and spring of 1973 by the author were examined. Analyses of data for both feeding site examinations and rumen analyses followed the aggregate percentage method of Martin *et al.* (1946).

During the spring of 1973 ten adult ewes were collected with the aid of a rifle for information concerning productivity, body condition, forage quality of rumen samples, and other biological data. Each bighorn sheep was measured for physical characteristics according to Russo (1965), and weighed with a spring scale. Kidneys, rumens, rumen liquor samples, lungs, fecal samples, ovaries and fetuses were placed in individual plastic bags which were frozen and saved for laboratory analysis. Heart, visceral, and sternal fat were recorded as "present" or "not present". Crown rump and head length measurements as described by Cheatum and Morton (1946) and other physical measurements as described by Russo (1965) were made on fetuses.

Personnel of the Montana State University Analytical Chemistry Laboratory analyzed rumen samples for crude fiber and nitrogen, fecal samples for crude fiber, and rumen liquor for light transmittance in a manner similar to that described by Klein (1962).

## DESCRIPTION OF AREA

The study area is the same as that described by Erickson (1972) and the following is from his paper: "The 800 square-mile . . . area lies within the Sawtooth Mountain Range, approximately 65 miles west of Great Falls, Montana. Boundaries . . . were Moose Creek, Headquarters Creek, and Teton River on the north, the West Fork of the South Fork of Sun River, Wood Creek, Ford Creek, and Willow Creek on the south, 112°35" longitude on the east, and the Continental Divide on the west (Figure 1). The Sun River, which flows eastward along the boundary between Teton County to the north and Lewis and Clark County to the south, constitutes the major drainage in the area. Minor drainages include Deep Creek and Ford Creek to the north and south of the Sun River, respectively. A prominent feature of the area is Gibson Lake which extends 7 miles in length and was formed by a large dam completed in 1929 for irrigation."

Two-thirds of the study area is within the Bob Marshall Wilderness from which motorized vehicles have been excluded. That portion of the study area between the north and south forks of the Sun River lies within the boundaries of the Sun River Game Preserve, established in 1913 to protect the Sun River elk herd.

The topography of the study area is characterized by parallel reefs running north and south with abrupt cliffs on the east and precipitous slopes on the west. The reefs are connected by east-west

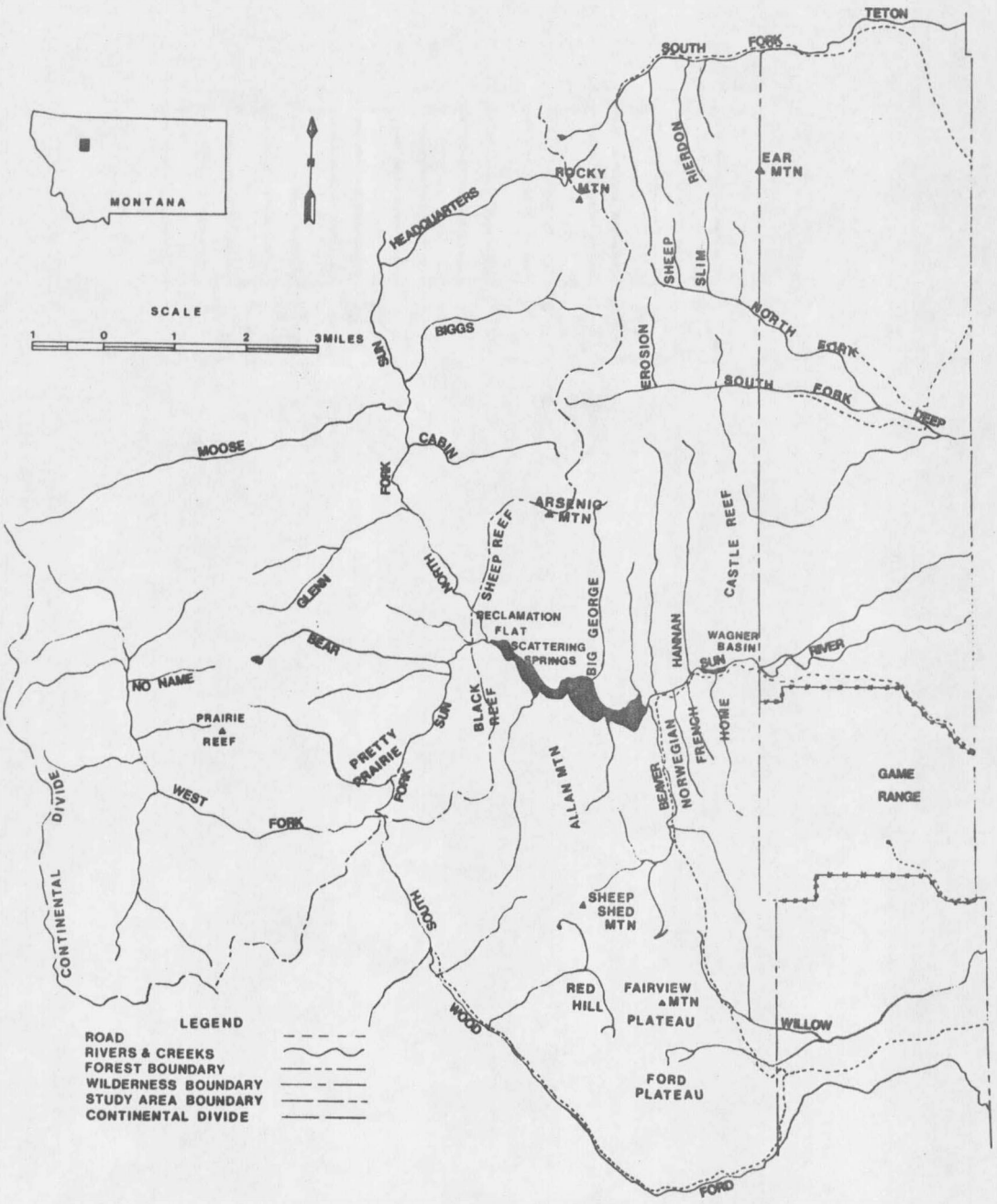


Figure 1. Map of study area showing major drainages (Erickson, 1972).

passes (Figure 2). These passes and the reeftops are used as migration routes by bighorn sheep. The geologic formation and character of the area have been described by Deiss (1943) and Mudge (1972).

Figure 2. East-west pass connecting two parallel reefs running in a south to north direction.

The area is subject to great variations in temperatures and precipitation. Table 1 shows average temperatures, precipitation and departures from normal during the period of study as recorded at the United States Weather Bureau Station at Gibson Dam at the elevation of 4,590 feet (Montana Annual Weather Summary 1972 and Monthly Summary 1973). The extreme temperatures were 89 degrees on August 28, 1972 and -22 degrees on January 8, 1973 (Montana Annual Weather Summary

TABLE 1. AVERAGE TEMPERATURES, TOTAL PRECIPITATION AND DEPARTURES FROM NORMAL.

| Month | Temperature °F | Departure | Precipitation (inches) | Departure |
|---|---|---|---|---|
| 1972 | | | | |
| June | 57.7 | 3.5 | 1.22 | -2.31 |
| July | 58.9 | -3.5 | 2.51 | 1.10 |
| August | 62.0 | 1.5 | 2.24 | .80 |
| September | 48.1 | -4.6 | 2.02 | .30 |
| October | 41.3 | -3.5 | 1.04 | - .19 |
| November | 34.2 | 1.0 | .08 | - .97 |
| December | 18.1 | -9.7 | 1.55 | .66 |
| 1973 | | | | |
| January | 23.9 | 1.2 | .29 | - .46 |
| February | 29.0 | 4.5 | .07 | - .56 |
| March | 34.9 | 5.3 | .47 | - .46 |
| April | 37.6 | -2.1 | 1.41 | .13 |
| May | 48.7 | .5 | 1.73 | -1.90 |
| June | 56.9 | 2.7 | .73 | -2.80 |

1972). From January through June, except April, temperatures were consistently above normal and precipitation below normal. This resulted in one of the mildest winters on record with very light snowpack in the mountains.

Vegetation in the study area has previously been described by Picton (1960), Schallenberger (1966), Knight (1970), and Erickson (1972). Seven major vegetation types and five subtypes have been recognized. The most commonly occurring vegetation types were bunchgrass, Douglas-fir *(Pseudotsuga menziesii)*, and rocky reef, while quaking aspen *(Populus tremuloides)*, lodgepole pine *(Pinus contorta)*,

lodgepole-aspen and beargrass *(Xerophyllum tenax)* were less commonly found. Three of the five subtypes resulted from burns in the bunchgrass or rocky reef types. The lodgepole pine and lodgepole-quaking aspen types were also related to past fires. Montana State Fish and Game Department personnel indicated that vegetation resulting from past fires were used frequently by bighorn sheep. For this reason my study of vegetation was restricted to these types and subtypes, and I secured quantitative measurements which are reported in the results section.

# RESULTS

## Vegetation Measurements

"Old burns" used by bighorn sheep represented two of the vegetation types and three of the subtypes previously described. The species composition and quantitative measurements of taxa for these types and subtypes are presented in Table 2 and Appendix Table 13.

### Bunchgrass Type

Burn Subtype. This subtype is found throughout the bunchgrass type (Figure 3). Idaho fescue *(Festuca idahoensis)*, rough fescue *(Festuca scabrella)*, bluebunch wheatgrass *(Agropyron spicatum)*, and June grass *(Koelaria cristata)* were the grasses with greatest canopy coverages and frequencies of occurrence. The dominant forbs were chickweed *(Cerastium arvense)*, pussy toes *(Antennaria rosea)*, yarrow *(Achillea millefolium)*, and bedstraw *(Galeum boreale)*. Clubmoss *(Selaginella* spp.*)* was commonly found. Standing and fallen fire-scarred trees were common. Invasion by conifer trees was apparent.

### Rocky Reef Type

Grass-Forb Burn Subtype. This subtype occurs most commonly in the following areas: Sun River Canyon, Cabin Creek, Deep Creek, Miner's Fork, Ear Mountain, No Name Gulch, and Grizzly Gulch (Figure 4). It is characterized by standing and fallen fire-scarred logs and

TABLE 2. PERCENT CANOPY COVERAGE AND FREQUENCY OF LOW GROWING TAXA IN EACH OF THREE VEGETATION SUBTYPES AND TWO VEGETATION TYPES AS DETERMINED BY EXAMINATION OF TWENTY, 2X5 OR 4X10 DECIMETER PLOTS AT EACH OF 30 SITES.

| | Bunchgrass Type | Rocky Reef Type | | Lodgepole Pine Type | Lodgepole-Quaking Aspen Type |
|---|---|---|---|---|---|
| Taxa[1] | Burn Subtype 9 Sites | Grass Forb Burn Subtype 18 Sites | Rock Slide Burn Subtype 1 Site | 1 Site | 1 Site |
| Grass | 40/100[2] | 28/80 | ------ | 11/70 | 35/100 |
| Forb | 32/90 | 30/80 | ------ | 17/55 | 28/90 |
| Shrub | 5/40 | 6/50 | ------ | 62/100 | 15/85 |
| Sedge | 3/10 | 2/20 | ------ | 2/15 | ------ |
| Litter | 56/100 | 48/90 | 74/100 | 97/100 | 97/100 |
| Bare Ground | 36/90 | 52/90 | 58/95 | 3/15 | ------ |
| Rock | 6/50 | 40/90 | 78/100 | 2/15 | ------ |
| Moss | ------ | ------ | .5/3 | ------ | ------ |
| *Equisetum* spp. | ------ | ------ | ------ | ------ | Tr/50[3] |
| *Selaginella* spp. | 6/100 | ------ | 2/2 | ------ | ------ |
| GRASSES & GRASS-LIKE PLANTS: | | | | | |
| *Agropyron spicatum* | 9/50 | 12/50 | 25/75 | ------ | ------ |
| *Agropyron* spp. | Tr/2 | .7/6 | ------ | ------ | ------ |
| *Calamagrostis rubescens* | ------ | ------ | ------ | 11/70 | 31/10 |
| *Carex* spp. | Tr/5 | 2/100 | 3/10 | .9/10 | Tr/.5 |
| *Festuca idahoensis* | 17/70 | 5/50 | ------ | ------ | ------ |
| *Festuca scabrella* | 8/30 | 2/10 | ------ | ------ | ------ |
| *Koelaria cristata* | 4/40 | 2/.8 | ------ | ------ | ------ |
| *Poa* spp. | 1/10 | 1/10 | 2/5 | ------ | ------ |
| FORBS: | | | | | |
| *Achillea millefolium* | 3/30 | 4/30 | 6/20 | ------ | ------ |
| *Antennaria racemosa* | ------ | .6/7 | 5/25 | ------ | ------ |
| *Antennaria rosea* | 2/20 | .9/10 | ------ | ------ | Tr/50 |
| *Arnica cordifolia* | .5/10 | 1.0/8 | 5/25 | 2/15 | Tr/5 |
| *Artemesia frigida* | 3/20 | Tr/3 | ------ | ------ | ------ |
| *Artemesia longifolia* | Tr/5 | Tr/Tr | ------ | ------ | ------ |
| *Campanula rotundifolia* | 5/5 | ------ | ------ | ------ | ------ |
| *Cerastium arvense* | 4/30 | .7/8 | ------ | ------ | ------ |
| *Commandra umbellatum* | Tr/10 | Tr/Tr | ------ | ------ | ------ |
| *Erigeron compositus* | ------ | Tr/1 | ------ | ------ | ------ |
| *Fragaria virginiana* | Tr/2 | 1/6 | ------ | ------ | 5/40 |
| *Gaillardia aristata* | .6/5 | .5/3 | .7/5 | ------ | ------ |
| *Galium boreale* | 2/30 | 1/10 | .7/5 | ------ | ------ |
| *Geranium viscosissimum* | Tr/Tr | Tr/Tr | .75/5 | ------ | ------ |
| *Linum perenne* | 1/10 | .9/8 | ------ | ------ | ------ |
| *Lupinus sericeus* | Tr/5 | 1/3 | 6/20 | ------ | ------ |
| *Monarda fistulosa* | Tr/Tr | ------ | .7/5 | ------ | ------ |
| *Pedicularis contorta* | .9/10 | .2/1 | ------ | ------ | ------ |
| *Penstemon* spp. | Tr/10 | .6/3 | 10/55 | ------ | ------ |
| *Potentilla* spp. | 1/10 | Tr/Tr | ------ | ------ | ------ |
| *Sedum stenopetalum* | Tr/5 | 1/20 | 2/15 | ------ | ------ |
| *Tragopogan dubius* | .5/5 | Tr/1 | ------ | ------ | ------ |
| *Xerophyllum tenax* | ------ | ------ | ------ | 13/35 | ------ |
| Unknown Forbs | .7/20 | 2/20 | ------ | 1/15 | Tr/.5 |
| SHRUBS: | | | | | |
| *Amelanchier alnifolia* | ------ | .5/4 | ------ | ------ | ------ |
| *Arctostaphylos uva-ursi* | ------ | 1/3 | ------ | ------ | 10/65 |
| *Berberis repens* | ------ | 1/20 | 5/35 | ------ | 2/30 |
| *Juniperus horizontalis* | .9/3 | ------ | ------ | ------ | ------ |
| *Populus tremoloides* | ------ | ------ | ------ | ------ | .5/20 |
| *Rosa* spp. | 1/20 | ------ | 15/60 | ------ | .5/25 |
| *Salix* spp. | ------ | Tr/.8 | ------ | 2/5 | ------ |
| *Shepherdia canadensis* | ------ | Tr/.8 | ------ | ------ | .75/5 |
| *Spiraea betulifolia* | Tr/.5 | ------ | 25/85 | .75/5 | 5/70 |
| *Symphoricarpos albus* | 3/.1 | .9/3 | ------ | 5/70 | ------ |
| *Vaccinium membranaceum* | ------ | ------ | ------ | 12/60 | Tr/15 |

[1] Includes those taxa with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one type or subtype. Others are listed in Appendix Table 13.

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

[3] Tr = trace: a value less than .5 percent.

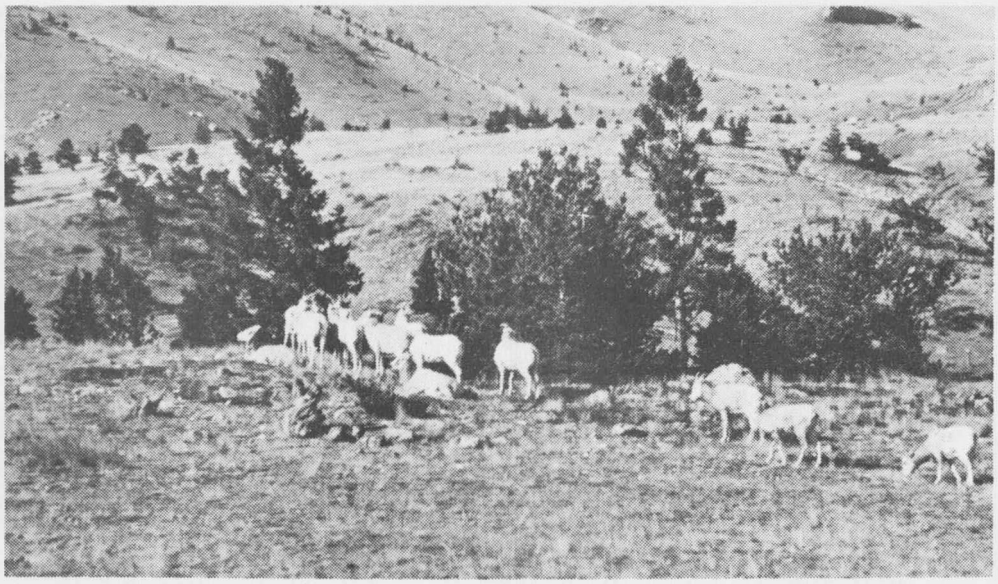

Figure 3. Burn subtype within the bunchgrass vegetation type in the background.

Figure 4. The grass-forb burn subtype within the Rocky Reef vegetation type.

by invasion of white bark pine *(Pinus albicaulis)* and other conifers. Bluebunch wheatgrass, Idaho fescue, rough rescue and June grass were the grasses with greatest canopy coverages and frequencies of occurrence. Dominant forbs were yarrow, heart leaf arnica *(Arnica cordifolia)* and bedstraw.

Rockslide Burn Subtype. This subtype occurs most frequently along the north shore of Gibson Dam and Willow Creek Gorge (Figure 5). Bluebunch wheatgrass and bluegrasses *(Poa* spp.*)* were the grasses with greatest canopy coverages and frequencies of occurrence. Yarrow, heart leaf arnica and raceme pussytoes *(Antennaria racemosa)* were the most common forbs. Wild rose *(Rosa* spp.*)*, white spiraea *(Spiraea betulifolia)* and Oregon grape *(Berberis repens)* were shrubs that occurred quite commonly on this subtype. Rock coverage was 78 percent. Fallen fire-scarred trees were common.

Lodgepole Pine Type

This type occurred throughout the study area and was often located in old restocked burns (Figure 6). Pine grass *(Calamagrostis rubescens)* was the dominant grass and bear grass was the dominant forb in the understory. Height and diameters at breast height were measured on 150 lodgepole pine trees at five sites. The average height and dbh were 11 meters and 8.9 cm, respectively.

Figure 5. Rockslide burn subtype within the Rocky Reef vegetation type.

Figure 6. Lodgepole pine vegetation type in middle — Lodgepole-Quaking Aspen vegetation type in the foreground.

Lodgepole-Quaking Aspen Type

This type occurs throughout the study area, usually in areas previously burned (Figure 6). Pine grass was the dominant grass and virginia strawberry *(Frageria virginiana)* was the dominant forb in the understory. Important shrubs were Kinnikinnick *(Arctostaphyls uva-ursi)*, Oregon grape, and white spiraea. Height and dbh were measured on 30 trees at one site. The average height and dbh were 18 meters and 17 cm, respectively.

## Bighorn Population

Erickson (1972) described the major bighorn sheep wintering areas, herd segments, and calculated a population estimate of 700 sheep for the study area during his period of research. The results of my December 1972 ground census based on unduplicated observations of bighorn sheep on fall transitional ranges is presented in Table 3. These data were combined with State of Montana Fish and Game Department information to provide a conservative estimate of 805 bighorn sheep in the study area during the fall of 1972. A comparison of this estimate with that of Erickson (1972) indicates an increase in the herd of about 13 percent over a time span of approximately one year.

Information on sex and age composition based on the classification of 4,923 and 676 observations of individual bighorns during ground and aerial counts is given in Table 4 and Appendix Table 14, respectively.

TABLE 3. NUMBERS OF BIGHORN SHEEP BY SEX AND AGE OBSERVED ON FIVE AREAS DURING A DECEMBER 1972 GROUND CENSUS.[1]

| | Rams | Ewes | Lambs | UNK | Total For Area | Number Per 100 Ewes | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Rams | Lambs | Yearlings[2] |
| Sun River east of Gibson Dam | 31 | 111 | 57 | 0 | 199 | 28 | 51 | 16 |
| Sun River west of Gibson Dam | 50 | 120 | 67 | 1 | 238 | 42 | 55 | 25 |
| Ford Creek | 34 | 47 | 27 | 8 | 116 | 72 | 57 | 25 |
| Deep Creek | 11 | 32 | 14 | 20 | 77 | 34 | 43 | 12 |
| Ear Mountain | 23 | 31 | 15 | 5 | 74 | 74 | 48 | 19 |
| TOTAL 704 | | | | | | | | |

[1]This census is based on unduplicated observations made between December 18, 1972 and December 27, 1972.

[2]Calculated assuming a 50/50 ratio of yearling males to females (yearling males are distinguished by horn characteristics).

TABLE 4. SEX AND AGE COMPOSITION OF BIGHORN SHEEP AS DETERMINED FROM 4,923 OBSERVATIONS OF INDIVIDUAL ANIMALS OF THE SAME POPULATION WHILE CONDUCTING GROUND COUNTS (Includes multiple observations of the same animals).

| | | Males | | | | | | Females | | | Number Per 100 Ewes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Sample Size | 0-1/4[1] Curl | 1/4-1/2 Curl | 1/2-3/4 Curl | 3/4 Curl | 3/4+ Curl | Total Males | Adult | Yrlg. | Lambs | UNK | Rams | Lambs | Yrlgs. |
| June 1972-1973 | 140 | 5 | 3 | 4 | 0 | 0 | 12 | 50 | 7 | 36 | 35 | 21 | 63 | 24 |
| Sept.-Nov. 1972 | 641 | 22 | 18 | 20 | 7 | 11 | 78 | 317 | - | 188 | 58 | 25 | 59 | 14[2] |
| Dec. 1972 | 1,273 | 67 | 69 | 89 | 35 | 18 | 278 | 612 | - | 333 | 50 | 45 | 54 | 22[2] |
| Mar.-May 1973 | 2,869 | 39 | 215[3] | 198 | 19 | 32 | 503 | 1,392 | - | 749 | 225 | 36 | 54 | 10[2] |
| TOTAL | 4,923 | | | | | | | | | | | | | |

[1]Yearling Males.

[2]Assuming a 50/50 ratio of yearling males to females (yearling males are distinguished by horn characteristics).

[3]32 individuals in the 1/4-1/2 curl class for the period March-May 1973 were considered to be yearlings and were, therefore, used in calculating the number yearlings per 100 ewes for this time period.

The yearling ratios for males may be biased due to an overlap in the degree of horn curl circumference between the yearling male class and the two-year-old male class (Erickson, 1972). This is more marked in spring than in fall. Yearling ewes could not be distinguished from adult ewes during fall or spring. Except for June, the number of yearlings per 100 ewes was calculated assuming an equal ratio of yearling males to females in the population.

The 54 lambs per 100 ewes for spring was the same as for December indicating high survival during winter. Erickson (1972) reported a similar number of lambs in December, but fewer in spring. The greater survival during my study was very likely due to the extremely mild winter of 1972-73.

The difference between 10 yearlings per 100 ewes in spring as compared to 22 in December is most likely due to my inability to distinguish males of this year class from older males during spring. Erickson (1972) reported nearly twice as many yearlings per 100 ewes in December as compared to my results, but the percent drop in the yearling/ewe ratio by March was comparable to my data.

The number of rams per 100 ewes, except for December, is in all probability low due to difficulty of locating mature rams during the non-breeding season.

## Range Use

The distribution of bighorn sheep observations by vegetation types and subtypes and the physical characteristics of bighorn sheep observation sites for the fall of 1972 and the spring of 1973 are presented in Table 5 and Table 6 respectively.

### Fall (September-December)

Throughout the fall, bighorn sheep were distributed as described in Figure 7.

Sixty-four percent of 2,149 observations of individual bighorn sheep during the fall was made on the rocky reef type. From September through November this was the most extensively used type. The grass-forb burn subtype and the subalpine subtype which were generally used by different herd segments were the subtypes receiving greatest usage. My infrequent observations of the subalpine subtype during October probably accounts for the indicated non-use of this subtype for that month. In November sheep were first observed on the rockslide burn subtype. This subtype was used by sheep enroute to their wintering areas and by rams in search of ewes during the breeding season. Most of the alpine subtype was uninhabitable to bighorns during the fall because of weather conditions at these higher elevations.

Thirty-four percent of the observations of bighorn sheep during the fall were made on the bunchgrass type with 24.5 percent occurring

TABLE 5. PERCENT OF OBSERVATIONS OF BIGHORN SHEEP ON VARIOUS VEGETATION TYPES AND SUBTYPES BY MONTH AND SEASON FOR FALL 1972 AND SPRING 1973.

| Vegetation Type or Subtype | Fall | | | | | Spring | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sept. | Oct. | Nov. | Dec. | Season | Mar. | Apr. | May | June[2] | Season |
| Rocky Reef Type | 70.0 | 74.0 | 76.1 | 36.2 | 64.1 | 25.6 | 24.0 | 17.6 | 77.8 | 36.2 |
| Grass Forb Burn Subtype | 25.0 | 60.0 | 29.0 | 30.2 | 36.0 | 14.6 | 8.7 | 12.9 | 53.6 | 22.4 |
| Subalpine Subtype | 45.0 | ---- | 37.0 | 4.3 | 21.6 | 8.4 | 12.2 | 4.7 | 11.4 | 9.2 |
| Rockslide Burn Subtype | ---- | ---- | 4.1 | 1.7 | 1.4 | 2.6 | 3.1 | Tr[1] | ---- | 1.4 |
| Alpine Subtype | ---- | 14.0 | 6.0 | ---- | 5.0 | ---- | ---- | ---- | 12.8 | 3.2 |
| Bunchgrass Type | 29.5 | 21.3 | 23.7 | 62.2 | 34.2 | 68.2 | 64.6 | 80.7 | 21.4 | 58.7 |
| Burn Subtype | 23.0 | 18.0 | 23.7 | 33.5 | 24.5 | 36.9 | 33.9 | 46.3 | 6.4 | 30.9 |
| Lodgepole Pine Type | ---- | Tr | ---- | ---- | Tr | ---- | ---- | Tr | ---- | Tr |
| Lodgepole-Quaking Aspen Type | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| Quaking Aspen Type | ---- | ---- | ---- | ---- | ---- | 1.3 | ---- | ---- | ---- | .3 |
| Douglas-Fir Type | ---- | 2.0 | ---- | 2.5 | 1.1 | 5.0 | 11.4 | 1.1 | .7 | 4.5 |
| Beargrass Type | ---- | 2.4 | ---- | ---- | .6 | ---- | ---- | ---- | ---- | ---- |
| Total Number of Sheep Observations | 159 | 451 | 266 | 1,273 | 2,149 | 925 | 1,351 | 875 | 140 | 3,291 |
| Percent of Total Sheep Observed | 7.4 | 21.0 | 12.4 | 59.2 | 100 | 28.1 | 41.0 | 26.7 | 4.2 | 100 |

[1]Tr = trace: less than .5% of the total number of sheep observations occurring in a vegetative type during a month or season.

[2]Data for June 1972 and June 1973 are combined.

TABLE 6. PERCENT DISTRIBUTION OF BIGHORN SHEEP OBSERVATIONS ACCORDING TO PHYSICAL CHARACTERISTICS OF THE HABITAT FOR THE FALL OF 1972 AND SPRING OF 1973 BASED ON MULTIPLE OBSERVATIONS OF INDIVIDUALS OF THE SAME POPULATION.

| | Distance From Escape Cover | | | Exposure | | | | | | | | | | % Slope | | Elevation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | Within 150 Yards | Greater Than 150 Yards | Sample Size | N | S | E | W | SE | SW | NE | NW | Level[1] | Sample Size | Mean | Sample Size | Mean | Extremes | Sample Size |
| Fall | | | | | | | | | | | | | | | | | | |
| September | 94.1 | 5.9 | 171 | --- | ---- | 8.8[2] | 62.0 | 4.1 | 25.1 | --- | --- | --- | 171 | 70 | 161 | 5494 | (6000-4800) | 128 |
| October | 93.8 | 6.2 | 355 | 4.6 | 16.8 | 34.7 | 25.9 | 5.0 | 1.3 | 1.9 | --- | 9.7 | 475 | 66 | 123 | 6398 | (8300-4020) | 382 |
| November | 80.6 | 19.4 | 242 | --- | 10.2 | 3.5 | 15.0 | 25.2 | 38.6 | 6.3 | Tr[3] | .8 | 254 | 57 | 256 | 5390 | (7800-4800) | 267 |
| December | 77.0 | 23.0 | 884 | --- | 43.9 | 4.0 | 5.6 | 31.8 | 7.6 | 4.3 | --- | 2.6 | 1243 | 52 | 825 | 5078 | (6400-4600) | 489 |
| Season | 86.4 | 13.6 | 1652 | 1.1 | 17.7 | 13.0 | 26.1 | 16.6 | 18.8 | 3.1 | Tr | 3.3 | 2127 | 60 | 1349 | 5590 | (8300-4020) | 1266 |
| Spring | | | | | | | | | | | | | | | | | | |
| March | 90.1 | 9.9 | 823 | 4.8 | 37.1 | 1.2 | 9.2 | 28.8 | 16.0 | 2.8 | --- | Tr | 751 | 45 | 695 | 5154 | (6400-4520) | 478 |
| April | 96.7 | 3.3 | 1368 | 3.1 | 32.4 | 6.5 | 4.7 | 36.8 | 8.5 | .6 | 1.2 | 6.2 | 1371 | 46 | 1153 | 4951 | (6600-4200) | 1001 |
| May | 84.4 | 15.6 | 659 | Tr | 22.8 | 6.2 | 4.6 | 47.5 | 18.6 | --- | --- | --- | 644 | 39 | 648 | 5326 | (7200-4600) | 540 |
| June[4] | 89.2 | 10.8 | 74 | 13.0 | 18.8 | --- | --- | 56.5 | 11.5 | --- | --- | --- | 69 | 39 | 39 | 6053 | (8200-5000) | 49 |
| Season | 90.1 | 9.9 | 2924 | 5.2 | 27.8 | 3.5 | 4.6 | 42.4 | 13.6 | .85 | Tr | 1.5 | 2835 | 42 | 2535 | 5371 | (8200-4200) | 2068 |

[1]Level refers to a slope so close to zero that a particular exposure could not be determined.

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

[3]Tr = trace: less than .5% of the total number of sheep observations occurring on an exposure during a month or season.

[4]Data for June 1972 and June 1973 are combined.

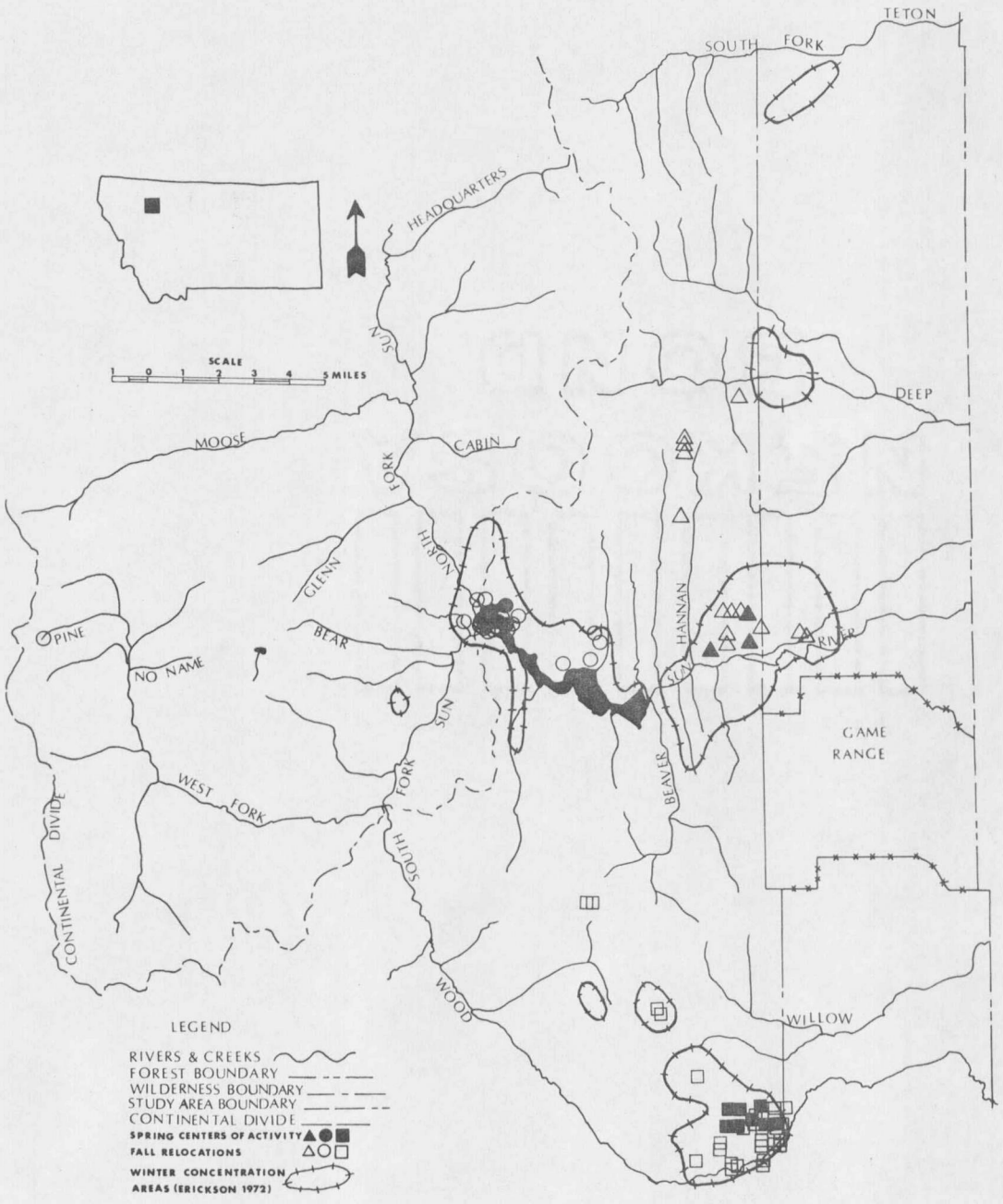


Figure 7. Map of the study area showing the distribution of bighorn sheep in fall and spring.

on the burn subtype. This type received its greatest use in the late fall as it was most commonly found within the winter range.

With the first snow storm of the season in September a few bighorns began to appear on the various wintering areas described by Erickson (1972). The number of sheep on the winter range increased continuously from September until the end of December when all the individuals composing the various herd segments were apparently on their respective wintering areas. Coinciding with this movement from the fall areas to wintering areas is a shift from dominant use of the rocky reef type to use of the bunchgrass type. It should be noted that both during and upon completion of this change in range use, the use of those subtypes related to old burns remained the most heavily used components of the bighorn sheep range in the study area.

The use of the forest types may be underestimated due to the difficulty of making observations in these types. Sheep passed through them enroute to winter ranges and they were of some importance as escape terrain on the winter range.

The beargrass type appeared to be of very little value to bighorn sheep as it was located away from areas typically used by them. Only one observation which included 11 sheep was made on this vegetation type.

The importance of escape terrain in the life habits of bighorn sheep has been discussed by Schallenberger (1966), Oldemeyer *et al.*

(1971), and Erickson (1972). In this study 86.4 percent of 1,652 observations of individual bighorn sheep were within 150 yards of escape cover with forest types being used in approximately 10 percent of the observations. The forest types were used as escape terrain when bighorns were forced by severe weather to move away from rocky terrain in search of food. As reported by Erickson (1972) interspersion of rocky terrain with the various habitat types had an important effect on the distribution of bighorn sheep.

During the fall, south, southeast, and southwest exposures received 17.7, 16.6, and 18.8 percent of the use, respectively, in 2,127 observations of individual bighorns. Throughout the fall there was a decrease in use of the west exposure and an increase in use of the southerly exposures. The reason for this change is likely due to the milder climatic conditions provided by south exposures and less accumulation of snow.

A mean slope of 60 percent was used by bighorns in 1,349 observations. The gradual decline in mean slope used by bighorns as the fall progressed is due to an increased use of the less precipitous bunchgrass type as bighorns appeared on the winter range.

The mean and the low extreme elevation used by bighorns remained fairly constant throughout the fall. The high extreme elevation used by bighorns decreased as the fall progressed. The reason for this was that as weather conditions became severe at higher elevations there

was s shift from the higher limits of the fall areas to the lower wintering areas.

Spring (March-June)

Throughout the spring bighorn sheep occupied areas which were similar to the winter concentration areas described by Erickson (1972) (Figure 7).

Approximately 59 percent of 3,291 observations during the spring were made on the bunchgrass type with 30.9 percent occurring on the burn subtype. From March through May this was the most important subtype.

Forest types received more use in the spring than in the fall. They increased in importance as escape cover.

At the end of May use of the bunchgrass type declined drastically which corresponded with a sharp increase in use of the rocky reef type in June. This change in range use coincided with the movement of bighorns from their wintering areas to their summer range.

Those subtypes related to past fires accounted for 54.7 percent of all recorded use of range in spring.

As in the fall, bighorns remained close to escape cover with 90.1 percent of 2,924 observations of individuals occurring within 150 yards of escape cover.

Southerly exposures were consistently the most heavily used exposure types throughout the spring.

A mean slope of 42 percent was used by bighorns in 2,535 observations. This mean slope is considerably less than that for the fall. This is likely due to the constant and intensive use of the less precipitous bunchgrass type throughout the spring.

The mean and the low extreme elevation used by bighorns remained fairly constant throughout the spring. The high extreme elevation increased as spring progressed. This is a result of bighorns moving to the summer range due to mild weather conditions.

## Group Characteristics

In a study in the Sun River area, Picton (1960) found the average group size of elk to be consistently higher for the open areas of grassland and barrens than for the timbered areas. In my study similar results with respect to bighorn sheep and security level of the habitat were observed. In Table 7 mean bighorn sheep group sizes by season and vegetation types are listed with the latter in order of increasing thresholds of security.

There seemed to be an inverse relationship between group sizes and strength of habitat.

Due to small sample sizes, mean bighorn group sizes for the forest types and the beargrass type are probably biased.

During fall and spring, bighorn sheep on the bunchgrass type are subject to a higher degree of disturbance, especially human, than are bighorns on other vegetation types. This disturbance factor and the

TABLE 7. MEAN GROUP SIZE AND NUMBERS OF GROUPS OBSERVED ON VEGETATION TYPES AND SUBTYPES FOR THE FALL OF 1972 AND SPRING OF 1973 BASED ON 5,440 OBSERVATIONS OF INDIVIDUAL BIGHORN SHEEP OF THE SAME POPULATION.

| | Fall September-December | Spring March-June[1] |
|---|---|---|
| Bunchgrass Type | 14.0/71[2] | 17.1/131 |
| Burn Subtype | 16.0/38 | 18.3/66 |
| Beargrass Type | 11.0/1 | -------- |
| Quaking Aspen Type | -------- | 12.0/1 |
| Lodgepole-Quaking Aspen Type | -------- | -------- |
| Douglas-Fir Type | 10.0/4 | 11.1/19 |
| Lodgepole Pine Type | 2.0/1 | 4.0/1 |
| Rocky Reef Type | 9.4/110 | 11.3/73 |
| Grass-Forb Subtype | 10.7/72 | 11.6/38 |
| Subalpine Subtype | 10.7/21 | 11.5/26 |
| Alpine Subtype | 9.9/8 | 9.0/2 |
| Rockslide Burn Subtype | 3.7/9 | 9.6/7 |
| Season | 11.9/181 | 14.6/225 |

[1]Data for June 1972 and June 1973 are combined.

[2]Mean group size/number of groups observed.

weather conditions of fall and spring may be contributing influences to these differences in mean group sizes.

The mean bighorn group size for the spring season is slightly larger than that for the fall. Also, the mean bighorn group size for each vegetation type or subtype for the spring period was slightly larger than the corresponding mean group size for the fall period. The reason for this might be that in the spring bighorns have been subjected to severe weather conditions and disturbance for a greater length of time than have bighorns in the fall.

## Food Habits

Fall and spring food habits of bighorn sheep were determined from the contents of 34 rumen samples and the examination of 40 feeding sites involving 3,993 instances of use (Tables 8 and 9).

### Fall (September-December)

The diet as indicated by rumen samples and feeding sites was comparable. Grass and grass-like plants, forbs, and browse constituted 92.1, 5.6, and .5 percent of the instances of use at 14 feeding sites and 92.7, 3.7, and 1.5 percent of the contents of 24 rumen samples, respectively. The contents of rumens for the fall periods of 1972 and 1973 were very similar.

Seventy-nine percent of the fall feeding sites were made on the rocky reef type with 43, 29, and 7 percent occurring on the grass-forb

TABLE 8. FOOD HABITS OF BIGHORN SHEEP BY YEAR AND SEASON AS DETERMINED FROM THE EXAMINATION OF 34 RUMEN SAMPLES.

| | Fall | | | Spring |
|---|---|---|---|---|
| | 1972 | 1973 | Mean | 1973 |
| | 10[1] | 14 | 24 | 10 |
| Plant Taxa | Sept.-Nov. | Sept.-Nov. | Sept.-Nov. | March-May |
| Grasses and Grass-like Plants | 91.6[2] | 93.9 | 92.7 | 94.7 |
| FORBS: | | | | |
| *Antennaria rosea* | Tr[3] | -- | Tr | .7 |
| *Antennaria* sp. | .7 | Tr | Tr | -- |
| *Artemesia frigida* | Tr | Tr | Tr | Tr |
| *Astragalus* sp. | -- | Tr | Tr | Tr |
| *Cerastium arvense* | Tr | Tr | Tr | -- |
| Compositae | -- | Tr | Tr | -- |
| *Cirsium* sp. | -- | 1.9 | .9 | -- |
| *Fragaria vesca* | Tr | -- | Tr | -- |
| *Galium boreale* | Tr | -- | Tr | -- |
| *Heuchera parvifolia* | .9 | .6 | .7 | .4 |
| Leguminosae | Tr | -- | Tr | -- |
| *Lupinus* sp. | 1.2 | Tr | .6 | Tr |
| *Penstemon* sp. | Tr | -- | Tr | -- |
| *Phlox* sp. | -- | Tr | Tr | -- |
| *Potentilla* sp. | Tr | -- | Tr | -- |
| Unknown Forbs | 1.9 | 1.2 | 1.5 | .8 |
| Total Forbs | 4.7 | 3.7 | 3.7 | 1.9 |

TABLE 8. Continued.

| Plant Taxa | Fall 1972 10 Sept.-Nov. | Fall 1973 14 Sept.-Nov. | Mean 24 Sept.-Nov. | Spring 1973 10 March-May |
|---|---|---|---|---|
| SHRUBS: | | | | |
| *Amelanchier alnifolia* | .6 | .6 | .6 | -- |
| *Berberis repens* | 1.3 | .6 | .9 | 2.3 |
| Pinaceae | Tr | Tr | Tr | Tr |
| *Populus* sp. | -- | Tr | Tr | -- |
| *Rosa* sp. | -- | Tr | Tr | -- |
| *Shepherdia canadensis* | -- | -- | Tr | -- |
| *Symphoricarpos albus* | Tr | .5 | Tr | Tr |
| Total Shrubs | 1.9 | 1.7 | 1.5 | 2.3 |
| Unknown Woody Material | .6 | .6 | .6 | Tr |
| Unknown Material | Tr | Tr | Tr | Tr |

[1]Sample size.

[2]Percent of monthly or seasonal diet.

[3]Tr = trace: percent of monthly or seasonal diet less than .5%.

TABLE 9. FALL AND SPRING FOOD HABITS OF BIGHORN SHEEP AS DETERMINED FROM THE EXAMINATION OF 40 FEEDING SITES.

| | Rocky Reef Type | | | | | | | Bunchgrass Type | | | Rocky Reef Type | | | | | | Bunchgrass Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grass-Forb Burn Subtype | | | | Subalpine Subtype | | Rockslide Burn Subtype | Burn Subtype | | | Grass-Forb Burn Subtype | | | Subalpine Subtype | | Rockslide Burn Subtype | Burn Subtype | | | | | |
| | Sept. | Oct. | Nov. | Dec. | Sept. | Nov. | Nov. | Nov. | Dec. | Fall | March | April | May | March | April | March | March | April | March | April | May | Spring |
| | (1)[1] | (3) | (1) | (1) | (3) | (1) | (1) | (1) | (2) | (14) | (1) | (4) | (1) | (1) | (1) | (1) | (4) | (5) | (1) | (4) | (3) | (26) |
| Plant Taxa | (106)[2] | (324) | (113) | (117) | (299) | (104) | (101) | (56) | (226) | (1446) | (113) | (415) | (100) | (43) | (121) | (115) | (403) | (471) | (109) | (403) | (254) | (2,547) |
| GRASSES AND GRASS-LIKE PLANTS: | | | | | | | | | | | | | | | | | | | | | | |
| *Agropyron spicatum* | 14.1[3] | 20.4 | 90.3 | 47.0 | Tr[4] | Tr | 99.0 | 32.1 | 75.2 | 36.7 | 100.0 | 10.4 | 21.0 | -- | -- | 98.3 | 10.9 | 17.4 | 22.0 | 9.9 | -- | 26.3 |
| *Agropyron* sp. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19.3 | -- | 2.3 | 47.9 | -- | 26.5 | 6.6 | 11.9 | 13.6 | 14.6 | 13.0 |
| *Bromus tectorum* | -- | 4.3 | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | -- | -- | 3.7 | -- | -- | 11.7 | -- | 1.4 |
| *Bromus* sp. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | -- | 14.9 | -- | 1.6 |
| *Carex* sp. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | Tr |
| *Festuca idahoensis* | -- | .6 | -- | 32.5 | 65.2 | 91.3 | -- | -- | 6.6 | 23.9 | -- | 4.6 | 58.0 | 86.0 | 35.5 | -- | 3.0 | 20.6 | 2.7 | 9.7 | -- | 20.0 |
| *Festuca scabrella* | -- | -- | -- | -- | 4.1 | -- | -- | -- | 13.7 | 2.8 | -- | 27.9 | -- | -- | -- | -- | 7.9 | 11.7 | 37.6 | 2.0 | 76.4 | 14.9 |
| *Koeleria cristata* | 1.9 | 13.5 | 9.7 | 12.8 | 4.3 | -- | -- | 12.5 | -- | 6.4 | -- | 1.7 | -- | 4.6 | 1.6 | -- | 20.6 | 5.9 | 11.0 | -- | -- | 4.1 |
| *Oryzopsis hymenoides* | 80.1 | -- | -- | -- | -- | -- | -- | -- | -- | 5.9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Phleum pratense* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | .5 | -- | Tr |
| *Poa* sp. | 2.8 | 37.0 | -- | -- | 21.7 | 7.7 | -- | 25.0 | -- | 14.5 | -- | 18.3 | 16.0 | 7.0 | 11.6 | -- | 20.8 | 10.2 | 14.7 | 22.3 | 8.7 | 11.8 |
| *Stipa* sp. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | .7 | -- | -- | -- | -- | Tr |
| Unknown Grasses | 1.0 | 1.0 | -- | -- | 2.3 | -- | -- | 5.3 | .8 | .9 | -- | 1.7 | -- | -- | .8 | 1.7 | 1.7 | 2.5 | -- | 3.0 | -- | 1.0 |
| Total Grasses and Grass-like Plants | 99.9 | 76.8 | 100.0 | 92.3 | 97.6 | 99.0 | 99.0 | 74.9 | 96.3 | 92.1 | 100.0 | 85.1 | 98.0 | 99.9 | 97.4 | 100.0 | 95.8 | 74.9 | 99.9 | 87.6 | 99.7 | 94.1 |
| FORBS: | | | | | | | | | | | | | | | | | | | | | | |
| *Achillea millefolium* | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | Tr | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Antennaria racemosa* | -- | .6 | -- | -- | -- | -- | -- | -- | -- | Tr | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Antennaria rosea* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11.6 | -- | -- | -- | -- | -- | Tr | -- | -- | -- | 1.0 |
| *Artemisia frigida* | -- | 4.9 | -- | -- | -- | -- | -- | -- | -- | 1.1 | -- | 1.7 | -- | -- | -- | -- | 2.7 | 1.9 | -- | .5 | -- | .6 |
| *Astragalus* sp. | -- | 12.3 | -- | -- | -- | -- | -- | 19.6 | -- | 3.5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.5 | -- | Tr |
| *Cerastium arvense* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.2 | -- | -- | -- | -- | .7 | Tr | -- | 1.2 | -- | Tr |
| *Gaillardia aristata* | -- | Tr | -- | -- | -- | -- | -- | -- | -- | Tr | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Linum perenne* | -- | Tr | -- | -- | -- | -- | -- | -- | -- | Tr | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Monarda fistulosa* | -- | 2.2 | -- | -- | -- | -- | Tr | -- | -- | .5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Potentilla* sp. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6.4 | -- | .6 |
| *Trifolium* spp. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.5 | -- | -- | -- | -- | -- | -- | Tr |
| *Zygadenus elegans* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 22.5 | -- | 2.3 | -- | 2.5 |
| Unknown Forbs | -- | -- | -- | 4.3 | -- | -- | -- | 5.3 | 3.5 | .5 | -- | -- | 2.0 | -- | -- | -- | .5 | -- | -- | .5 | .4 | Tr |
| Total Forbs | -- | 20.0 | -- | 4.3 | 1.0 | -- | Tr | 24.9 | 3.5 | 5.6 | -- | 14.5 | 2.0 | -- | 2.5 | -- | 3.9 | 24.4 | -- | 12.4 | .4 | 4.7 |
| SHRUBS: | | | | | | | | | | | | | | | | | | | | | | |
| *Berberis repens* | -- | -- | -- | 3.4 | -- | -- | -- | -- | -- | Tr | -- | .5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | Tr |
| *Symphoricarpos albus* | -- | 2.5 | -- | -- | -- | -- | -- | -- | -- | .5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total Shrubs | -- | 2.5 | -- | 3.4 | -- | -- | -- | -- | -- | .5 | -- | .5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | Tr |

[1] Number of sites.

[2] Number of instances of use.

[3] Percent of monthly or seasonal diet.

[4] Tr = trace: percent of monthly or seasonal diet less than .5%.

burn, subalpine, and rockslide burn subtypes, respectively.

Bluebunch wheatgrass, Idaho fescue, June grass and bluegrasses constituted the major portion of the diet of bighorn sheep on the grass-forb burn subtype. The high use of Indian rice grass *(Oryzopsis hymenoides)* reported for September is biased as the only feeding site measured was on an Indian rice grass dominated dirt slide which was atypical of this subtype. Forbs comprised a very small portion of the bighorn sheep diet. Milkvetch *(Astragulus* spp.*)* was the forb that received greatest use. As with other forbs eaten, bighorns appeared to select those plants with green leaves. Oregon grape and common snowberry were the only browse species on which use was observed.

Idaho fescue and bluegrasses were the most important food sources in the diet of bighorn sheep on the subalpine subtype. Forbs were of little importance and browse use was not observed.

Usage at one fall feeding site on the rockslide burn subtype consisted of approximately 100 percent bluebunch wheatgrass.

Twenty-one percent of the fall feeding sites were made on the burn subtype of the bunchgrass type. Bluebunch wheatgrass, rough fescue, June grass, and bluegrasses were the grasses that made up the greatest portion of the bighorn sheep diet on this subtype. Milkvetch was the only forb that received significant use. Very little browse use was recorded.

Spring (March-May)

Grass and grass-like plants, forbs, and browse constituted 94.1, 4.7, and trace percent of the instances of use at 26 feeding sites and 94.7, 1.9, and 2.3 percent of the contents of 10 rumen samples, respectively. The higher proportion of forbs and browse in the diet for feeding sites and rumen samples, respectively, resulted from the use of Death camas *(Zygadenus elegans)* at feeding sites and the presence of Oregon grape in rumen samples.

Sixty-five percent of the spring feeding sites were made on the bunchgrass type with 31 percent on the burn subtype. Bighorn sheep feeding habits were essentially the same on the bunchgrass type and burn subtype. Rough fescue, Idaho fescue, bluebunch wheatgrass, and other wheat grasses *(Agropyron* sp.*)* were the most important food items in the diet. Cinquefoils, Death camas, fringed sagewort, and chickweed were the most commonly used forbs. No browse use was recorded.

Thirty-five percent of the spring feeding sites were made on the rocky reef type with 23, 8, and 4 percent of them occurring on the grass-forb burn, subalpine, and rockslide burn subtypes, respectively.

Rough fescue, Idaho fescue, bluegrasses, bluebunch wheatgrass and other wheat grasses were the most important food items in the diet of bighorn sheep on the grass-forb burn subtype. Pussytoes, fringed sagewort, and chickweed were the most commonly used forbs. Very little browse use was observed.

Idaho fescue was the most important grass in the diet of bighorn sheep on the subalpine subtype. Clover *(Trifolium* sp.*)* was the only forb on which use was observed. No browse use was recorded on this subtype.

Bluebunch wheatgrass was by far the most important plant in the diet of bighorn sheep on the rockslide burn subtype.

On all vegetation types and subtypes during spring and fall, bighorn sheep tended to select for the green succulent grass leaves which appeared to grow when weather conditions were mild. At all feeding sites the more common plants made up the greatest proportion of the diet (Tables 2 and 9).

Year-Round Food Habits

A graph of the year-round food habits of bighorn sheep in the Sun River area was constructed from data of Erickson (1972), Schallenberger (1966) and my study (Figure 8).

Erickson (1972) reported that browse use by bighorn sheep increased as summer progressed but during my period of research in fall browse constituted a very small portion of the diet at both feeding sites and in rumen samples. This lack of browse use was likely due to mild climatic conditions. The high browse use reported for winter by Schallenberger (1966) is probably a result of the above average snow conditions during his period of research. Possibly use of browse in

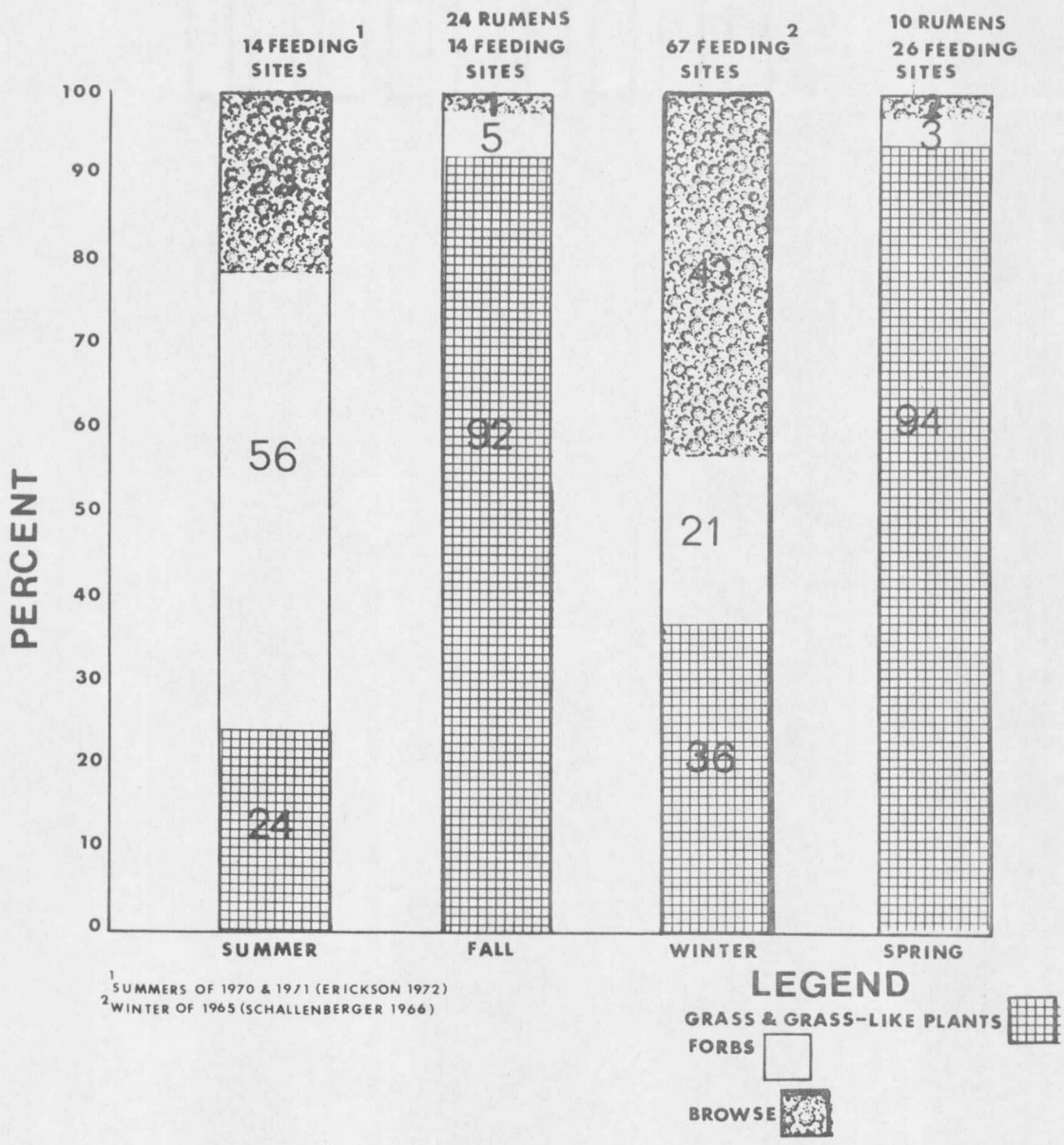


Figure 8. Percent grasses, forbs, and browse occurring in the year-long diet of bighorn sheep as determined from the analysis of 34 rumens and 121 feeding sites.

fall would be greater during a fall characterized by severe weather.

During summer months bighorn sheep in the Sun River area apparently prefer forbs. During other seasons grass is preferred with the amount of browse use determined by the severity of snow conditions.

## Physical Condition and Quality of Nutrition

A kidney fat index to be used for an indicator of body condition (Riney, 1955) was calculated for each of 10 pregnant adult ewes collected during the spring of 1973 (Table 10). The weights and measurements of these sheep and their unborn fetuses are presented in Appendix Tables 15 and 16. The kidney fat indices indicate all bighorn sheep collected with the possible exception of Number 7 were in good physical condition. This animal with an index of 36 possibly was bordering on a condition characterized by use of marrow fat (Ransom, 1965), but like all other sheep collected, had an abundant supply of mesenteric, brisket, heart, and subcutaneous fat. This suggests this sheep was either suffering or recovering from some form of stress that had resulted in poor body condition. All fetuses appeared healthy and developing normally.

Protein and crude fiber for rumen samples and light transmittancy values for rumen liquor samples as well as fiber content for fecal samples from the same ewes for which kidney fat indices were calculated is presented in Table 11 and Appendix Table 17. The values for protein and crude fiber may represent at least minimum and maximum values,

TABLE 10. PERCENT KIDNEY FAT FOR 10 BIGHORN SHEEP COLLECTED FROM FIVE DIFFERENT LOCALITIES DURING THE SPRING OF 1973.

| Collection Number | Date Collected 1973 | Location | Kidney Fat |
|---|---|---|---|
| 1 | March 22 | Castle Reef | 139[1] |
| 2 | March 23 | Ford Creek | 178 |
| 3 | March 28 | Scattering Springs | 97 |
| 4 | April 3 | S. F. Deep Creek | 121 |
| 5 | April 11 | Homes Gulch | 125 |
| 6 | April 17 | Ford Creek | 74 |
| 7 | April 18 | Scattering Springs | 36 |
| 8 | April 23 | Castle Reef | 114 |
| 9 | May 1 | S. F. Deep Creek | 81 |
| 10 | May 10 | Homes Gulch | 80 |

[1]% of kidney weight.

TABLE 11. PERCENT CRUDE FIBER, PERCENT PROTEIN AND LIGHT TRANSMITTANCY FOR RUMEN SAMPLES AND PERCENT CRUDE FIBER FOR FECAL SAMPLES AS DETERMINED FROM 10 RUMEN AND 10 FECAL SAMPLES COLLECTED DURING THE SPRING OF 1973.

| Location | Crude Fiber | | Protein[1] | Light Transmittancy[2] |
|---|---|---|---|---|
| | Rumen | Fecal | Rumen | Rumen |
| Castle Reef | 24.7[3] | 21.0 | 21.6 | 47.9 |
| Ford Creek | 28.1 | 21.4 | 15.0 | 43.0 |
| Scattering Springs | 24.6 | 20.6 | 15.0 | 54.5 |
| South Fork Deep Creek | 24.6 | 21.0 | 16.8 | 52.0 |
| Homes Gulch | 25.3 | 23.9 | 18.0 | 22.5 |
| Total | 25.3[4] | 21.6 | 17.4 | 44.0 |

[1]Calculated by the following formula: (Rumen Nitrogen) x 6 = rumen protein (Faulkner *et al.*, 1968), Appendix Table 17.

[2]Measured at a wavelength of 545 nm.

[3]Mean percent from a sample of two, Appendix Table 17.

[4]Mean percent from a sample of ten, Appendix Table 17.

respectively, for bighorn sheep on adequate ranges. No standards are available for comparison, but it should be noted that the animals supplying the samples were in good condition.

According to Klein (1962) the degree of light transmittancy, relative amounts of dissolved plant pigments present in the rumen liquor and nutritive quality of the range may be related. Negative correlations between nutritive quality and light transmittancy was indicated. Scattering Springs and South Fork of Deep Creek appeared to be of less range quality than the other areas from which samples were collected (Table 11). Samples from these areas had the highest light transmittancy.

## Productivity

The ovaries of one 2½ year old and nine three-year-old or older gravid ewes collected during the spring of 1973 were sectioned and examined for corpora lutea of pregnancy in a manner similar to that described by Cheatum (1949). Each pair of ovaries contained one corpus luteum which together with embryo counts indicated a frequency of fertilization of 100 percent. No evidence of twinning as reported by Spalding (1966) was found in this study. The prenatal sex ratio for 10 embryos was 4 females to 6 males.

The number of lambs surviving winter in this study was 54 per 100 ewes of all age classes including yearlings. The relatively small numbers of yearlings in the population (Table 4) would not account for

this discrepancy between potential and actual production. Smith (1954) was of the opinion that only a few ewes breed at 1½ years of age and that all ewes were receptive to breeding at 2½ years of age. Environmental factors influencing the survival of young are apparently responsible for the difference between potential and actual production.

## Movements

Movements of bighorn sheep in the Sun River area during spring and fall were studied to complement the summer and winter movements information presented by Erickson (1972). Due to the mild weather conditions prevalent during this study, the movements described should be considered characteristic of these conditions. The geographic locations of observations of marked bighorn sheep are presented in Appendix Table 18. The spring and fall distribution of bighorn sheep within the study area, as indicated by observations of marked individuals, is presented in Figure 7.

A center of activity as described by Hayne (1949) and standard diameter as defined by White (1964) were calculated for each of 22 marked bighorn sheep. The standard diameter was calculated using the formula: $SD=\sqrt{\Sigma D^2/N}$ where D equals twice the distance from the center of activity to each relocation and N equals the number of relocations (Harrison, 1958). The standard diameter is defined as a circle which has the center of activity at it's center and contains 68.26 percent

of the relocations of the marked animal (White, 1964). Standard diameters and centers of activity were calculated only for those bighorn sheep which were relocated three or more times during spring.

Spring

The spring centers of activity presented in Figure 7 are very similar to the winter centers of activity presented by Erickson (1972) and they indicate that throughout the spring period bighorn sheep confined their movements within the winter concentration areas delineated by Erickson (1972).

The magnitude of movement by bighorn sheep during spring was somewhat greater than the movement reported during winter months by Erickson (1972). The distance between consecutive relocations of 38 marked bighorn sheep, during spring, ranged from 0-5.03 airline miles and averaged 1.24 airline miles, while these values for winter ranged from 0-3 miles and averaged .67 miles.

As mentioned earlier, the reluctance of bighorn sheep to venture far from rocky terrain probably had an important effect on the movements presented here.

During April and early May the abundance of green succulent grass shoots may have had an influence on keeping the bighorns at lower elevations. The greenup at higher elevations did not occur until somewhat later. Bighorn sheep appeared to leave the winter concentration areas between May 14 and May 18, 1973. From then on almost

all observations of bighorns were made on the summer range. In late May bighorns became very difficult to observe. This was probably due to females assuming a more secretive nature during the lambing period.

The pooled spring standard diameters of 3.63 and 2.37 presented in Table 12 for the Sun River-east of dam and Ford Creek areas, respectively, are considerably larger than the pooled standard diameters of 1.48 and 1.37 reported for these areas during winter by Erickson (1972). This is likely due to the milder weather conditions rendering more of the bighorn sheep range accessible. However, the sample size for the area east of Gibson Dam is quite small. The pooled standard diameter for the Sun River-west of dam is comparable to that reported by Erickson (1972) for winter. This is likely due to the fact that bighorn sheep in this area occupy winter and spring range which is in many respects similar to the summer range. Also, bighorns in this area possibly move shorter distances to lambing areas than bighorns in other herd segments.

Fall

During fall bighorn sheep movements were on both the winter concentration areas described by Erickson (1972) and on almost all portions of the summer range (Figure 7).

The degree of movement by bighorns during fall was greater than that reported for spring. The distance between consecutive relocations

TABLE 12. RANGES OF ACTIVITY OF BIGHORN SHEEP ON THREE WINTERING AREAS DURING THE PERIOD MARCH-MAY, 1973 AS INDICATED BY STANDARD DIAMETERS OF MARKED ANIMALS.

| Wintering Area | Sample Size | Number of Relocations | Pooled Standard Diameter In Miles | Range of Individual Standard Diameters |
|---|---|---|---|---|
| Sun River-east of dam | 3 | 14 | 3.63 | 2.03-4.44 |
| Sun River-west of dam | 10 | 42 | 1.15 | .57-1.67 |
| Ford Creek | 9 | 52 | 2.37 | .64-3.98 |

of 18 marked bighorn sheep during fall ranged from 0-12.50 airline miles and averaged 2.00 airline miles.

The greatest recorded fall movement was 12.50 airline miles from the site of capture. This sheep was observed at the head of Pine Creek on October 16 and on December 19 was observed near the Fish and Game cabin at Gibson Lake. This movement apparently represented a shift from summer to winter range.

During both spring and fall, weather conditions appeared to have a major influence on the movements of bighorn sheep in the Sun River area.

Aberrant Movements

An adult ewe which was marked at Castle Reef was observed on the South Fork of Deep Creek on October 5, 1972. This sheep was relocated on the Sun River-east of dam winter area in December and was also

observed there the following spring.

One adult ewe marked at Castle Reef in March of 1969 was observed in Big George Gulch during April of 1973. Erickson (1972) reported that a mixing of the two herd segments wintering in the Sun River area west and east of Gibson Dam occurred during summer.

# APPENDIX

TABLE 13. TAXA WITH LESS THAN .5 PERCENT CANOPY AND/OR FREQUENCIES OF LESS THAN 5 PERCENT ON VEGETATION TYPES AS DETERMINED BY EXAMINATION OF 2X5 OR 4X10 DECIMETER PLOTS.

| Taxa | Bunchgrass Type | Rocky Reef Type | | Lodgepole Pine Type | Lodgepole-Quaking Aspen Type |
|---|---|---|---|---|---|
| | Burn Subtype 9 Sites | Grass-Forb Burn Subtype 18 Sites | Rockslide Burn Subtype 1 Site | 1 Site | 1 Site |
| GRASSES & GRASS-LIKE PLANTS: | | | | | |
| *Bromus marginatus* | -- | X | -- | -- | -- |
| *Phleum alpinum* | X | X | -- | -- | -- |
| *Phleum pratense* | X | -- | -- | -- | -- |
| *Stipa* spp. | X | -- | -- | -- | -- |
| Unknown Grasses | X | -- | -- | -- | -- |
| FORBS: | | | | | |
| *Agoseris glauca* | -- | X | -- | -- | -- |
| *Allium cernuum* | X | X | -- | -- | -- |
| *Anaphalis margaritacea* | X | -- | -- | -- | -- |
| *Anemone patens* | X | X | -- | -- | -- |
| *Apocynum androsaemifolium* | -- | X | -- | -- | -- |
| *Aquilegia caerulea* | -- | X | -- | -- | -- |
| *Artemisia ludoviciana* | X | -- | -- | -- | -- |
| *Artemisia* spp. | -- | X | -- | -- | -- |
| *Astragalus* spp. | -- | X | -- | -- | -- |
| *Balsamorhiza sagittata* | X | -- | -- | -- | -- |
| *Besseya* spp. | X | -- | -- | -- | -- |
| *Castilleja miniata* | -- | X | -- | -- | -- |
| *Cirsium foliosum* | X | -- | -- | -- | -- |
| *Clematis* spp. | -- | X | -- | -- | -- |
| Cruciferae | X | X | X | -- | -- |
| *Erigeron* spp. | -- | X | -- | -- | -- |

TABLE 13. Continued.

| Taxa | Bunchgrass Type | Rocky Reef Type | | Lodgepole Pine Type | Lodgepole-Quaking Aspen Type |
|---|---|---|---|---|---|
| | Burn Subtype 9 Sites | Grass-Forb Burn Subtype 18 Sites | Rockslide Burn Subtype 1 Site | 1 Site | 1 Site |
| *Fritillaria pudica* | -- | X | -- | -- | -- |
| *Gentiana calycosa* | -- | X | -- | -- | -- |
| *Geum triflorum* | X | X | -- | -- | -- |
| *Glycyrrhiza lepidota* | X | -- | -- | -- | -- |
| *Heuchera richardsonii* | -- | X | -- | -- | -- |
| *Smilacina racemosa* | -- | X | -- | -- | -- |
| *Taraxacum officinale* | X | X | -- | -- | -- |
| *Vicia americana* | X | X | -- | -- | -- |
| *Zygadenus elegans* | X | X | -- | -- | -- |
| SHRUBS: | | | | | |
| *Juniperus communis* | -- | X | -- | -- | -- |
| *Pinus albicaulis* | -- | X | -- | -- | -- |
| *Populus tremuloides* | -- | -- | -- | -- | X |
| *Potentilla fruticosa* | X | -- | -- | -- | -- |
| *Pseudotsuga menziesii* | X | X | -- | -- | -- |
| *Ribes lacustre* | -- | X | -- | -- | -- |
| *Vaccinium caespitosum* | -- | X | -- | X | -- |

TABLE 14. NUMBER OF BIGHORN SHEEP AND CLASSIFICATION OF RAMS AS OBSERVED DURING FIVE FLIGHTS OVER PORTIONS OF THE STUDY AREA.

| Date | Males | | | | | UNK | Total |
|---|---|---|---|---|---|---|---|
| | 0-1/4 | 1/4-1/2 | 1/2-3/4 | 3/4 | 3/4+ | | |
| October 2, 1972 | -- | 1 | -- | 2 | 3 | 146 | 152 |
| October 16, 1972[1] | 1 | -- | 6 | 2 | 1 | 77 | 87 |
| March 18, 1973 | -- | -- | -- | -- | -- | 143 | 143 |
| March 24, 1973 | -- | -- | -- | -- | -- | 75 | 75 |
| May 13, 1973[2] | -- | -- | -- | -- | -- | 219 | 219 |
| | | | | | | Grand Total | 676 |

[1]Flight made by Allen Schallenberger.

[2]Flight made by Bert Goodman.

TABLE 15. WEIGHTS AND MEASUREMENTS OF 10 ADULT EWE BIGHORN SHEEP COLLECTED DURING THE SPRING OF 1973.

| | | | Centimeters | | | | | | | | | | | | | | | Kilograms | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date Collected | Collection Number | Age[1] | Total Length | Height | Girth | Length Hind Foot | Width Hind Hoof | Length Fore Hoof | Width Fore Hoof | Length Hind Foot | Tail Length | Ear Length | Length Right Horn | Length Left Horn | Diameter At Base Of Right Horn | Diameter At Base Of Left Horn | Distance Between Horn Tips | Whole Weight | Dressed Weight | Visceral Weight[3] |
| 3/22/73 | 1 | 7½[2] | 151.13 | 91.44 | 110.49 | 6.98 | 4.45 | 7.62 | 4.44 | 39.37 | 10.16 | 12.70 | 23.0 | 20.0 | 12.1 | 12.0 | 24.0 | 70.31 | 56.70 | 13.61 |
| 3/23/73 | 2 | 6+[2] | 157.48 | 83.82 | 98.42 | 5.71 | 4.45 | 6.35 | 5.08 | 39.37 | 12.70 | 13.33 | 25.8 | 17.5 | 11.8 | 11.0 | 25.8 | 65.77 | 43.09 | 22.68 |
| 3/28/73 | 3 | 4½[2] | 147.32 | 88.90 | 97.79 | 7.62 | 4.11 | 6.98 | 4.11 | 40.00 | 12.70 | 12.06 | 23.5 | 22.5 | 11.9 | 12.3 | 24.2 | 63.50 | 40.82 | 22.68 |
| 4/3/73 | 4 | 4+ | 147.95 | 87.50 | 105.41 | 6.35 | 4.44 | 6.98 | 4.44 | 34.29 | 12.70 | 12.70 | 24.2 | 25.0 | 13.5 | 13.1 | 19.0 | 72.57 | 47.63 | 24.95 |
| 4/11/73 | 5 | 2½[2] | 143.51 | 89.53 | 105.00 | 7.29 | 3.81 | 7.62 | 4.11 | 39.37 | 17.14 | 12.70 | 26.0 | 24.5 | 12.7 | 12.8 | 42.5 | 56.70 | 38.55 | 18.14 |
| 4/17/73 | 6 | 6+[2] | 147.32 | 81.28 | 99.06 | 5.71 | 4.44 | 5.71 | 5.08 | 40.64 | 13.33 | 12.70 | 23.0 | 23.0 | 12.4 | 12.3 | 20.0 | 63.50 | 40.82 | 22.68 |
| 4/18/73 | 7 | 4+ | 134.62 | 85.09 | 96.52 | 4.75 | 3.81 | 6.65 | 4.75 | 40.64 | 16.18 | 13.97 | 24.0 | 23.5 | 12.7 | 12.9 | 27.9 | 56.70 | 37.65 | 19.05 |
| 4/23/73 | 8 | 7½[2] | 153.67 | 85.09 | 103.75 | 7.62 | 4.44 | 8.87 | 4.75 | 36.83 | 15.87 | 12.06 | 22.0 | 26.0 | 12.0 | 12.3 | 28.3 | 68.04 | 47.63 | 20.41 |
| 5/1/73 | 9 | 4+ | 152.40 | 88.9 | 112.50 | 7.92 | 4.11 | 4.44 | 7.29 | 38.73 | 19.35 | 11.58 | ---- | ---- | ---- | ---- | ---- | 74.84 | 52.16 | 22.68 |
| 5/10/73 | 10 | 4+ | 148.59 | 86.25 | 91.87 | 6.98 | 4.44 | 7.62 | 4.44 | 40.64 | 13.97 | 13.33 | ---- | ---- | ---- | ---- | ---- | 62.14 | 40.82 | 21.32 |

[1]Age determined by dental replacement (Deming, O. V. 1952).

[2]Known age specimens (age determined from banding records).

[3]Visceral weight was calculated by subtracting the dressed weight from the whole weight.

TABLE 16. WEIGHTS AND MEASUREMENTS OF 10 FETUSES TAKEN FROM THE 10 ADULT EWES PRESENT IN APPENDIX TABLE 15.

| Collection Number | Centimeters | | | | | Kilograms | |
|---|---|---|---|---|---|---|---|
| | Length Hind Foot | Chest Girth | Crown Rump | Head Length | Total Length | Weight | Sex |
| 1 | 12.2 | 21.0 | 32.7 | 9.5 | 40.9 | 1.20 | ♀ |
| 2 | 13.3 | 23.6 | 35.7 | 11.2 | 44.6 | 1.45 | ♂ |
| 3 | 13.5 | 23.2 | 34.4 | 10.0 | 42.6 | 1.30 | ♀ |
| 4 | 17.5 | 31.5 | 40.1 | 11.8 | 55.0 | 2.46 | ♂ |
| 5 | 16.1 | 28.0 | 38.6 | 11.3 | 48.4 | 1.91 | ♂ |
| 6 | 15.0 | 21.0 | 29.9 | 9.2 | 38.7 | 9.24 | ♂ |
| 7 | 16.6 | 27.1 | 40.9 | 12.4 | 50.3 | 2.17 | ♀ |
| 8 | 20.5 | 32.9 | 41.5 | 13.3 | 59.2 | 3.51 | ♂ |
| 9 | 23.6 | 34.7 | 50.3 | 14.0 | 67.9 | 4.51 | ♂ |
| 10 | 17.8 | 30.5 | 40.4 | 12.6 | 56.2 | 2.58 | ♀ |

TABLE 17. PERCENT CRUDE FIBER, NITROGEN, AND LIGHT TRANSMITTANCY AS DETERMINED FROM 10 BIGHORN SHEEP RUMEN SAMPLES AND PERCENT OF CRUDE FIBER IN 10 BIGHORN SHEEP FECAL SAMPLES COLLECTED DURING THE SPRING OF 1973.

| | | | Rumen | | | Fecal |
|---|---|---|---|---|---|---|
| Collection Number | Location | Date 1973 | Crude Fiber | Nitrogen | Light[1] Trans-mittancy | Crude Fiber |
| 1 | Castle Reef | March 22 | 26.8 | 3.03 | 34.1 | 21.8 |
| 2 | Ford Creek | March 23 | 29.3 | 2.84 | 37.9 | 22.2 |
| 3 | Scattering Springs | March 28 | 28.0 | 2.12 | 41.0 | 22.0 |
| 4 | South Fork Deep Creek | April 3 | 26.2 | 2.38 | 54.0 | 20.1 |
| 5 | Homes Gulch | April 11 | 28.2 | 2.19 | 25.0 | 24.1 |
| 6 | Ford Creek | April 17 | 27.0 | 2.24 | 48.2 | 20.6 |
| 7 | Scattering Springs | April 18 | 21.2 | 2.89 | 68.1 | 19.2 |
| 8 | Under Castle | April 23 | 22.7 | 4.15 | 61.8 | 20.3 |
| 9 | South Fork Deep Creek | May 1 | 23.7 | 3.32 | 50.1 | 22.0 |
| 10 | Homes Gulch | May 10 | 22.4 | 3.86 | 19.5 | 23.7 |

[1]Measured at a wavelength of 545 nm.

TABLE 18. RELOCATIONS, SPRING CENTERS OF ACTIVITY AND SPRING STANDARD DIAMETERS OF 60 MARKED BIGHORN SHEEP. (For locations, refer to Figures 9, 10, and 11).

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| S-3745 | Female | 3/14/69 | Castle Reef A-3 #59 | 12/15/72 | Castle Reef AF-2 #59 | 1.02 | ---- | ------- | ---- |
| | | | | 12/18/72 | Castle Reef AI-2 #55 | 1.02 | 1.26 | | |
| | | | | 2/25/73 | Castle Reef -------- | ---- | ---- | | |
| | | | | 3/22/73 | Castle Reef A-3 #58 | .26 | ---- | | |
| S-3748 | Female | 3/14/69 | Castle Reef A-3 #59 | 10/5/72 | S.F. Deep Crk. G-2 #56 | 7.13 | ---- | | |
| | | | | 12/18/72 | Castle Reef AE-2 #56 | 1.55 | 5.75 | | |
| | | | | 3/22/73 | Castle Reef A-3 #58 | .26 | 1.50 | | |
| | | | | 3/25/73 | Castle Reef B-3 #58 | .40 | .75 | | |
| S-3177 | Female | 3/14/69 | Castle Reef A-3 #59 | 4/5/73 | Castle Reef A-3 #58 | .26 | ---- | A-3 #57 | 3.98 |
| | | | | 4/8/73 | Castle Reef A-3 #58 | .26 | .0 | | |
| | | | | 5/9/73 | Wagner Basin AJ-2 #54 | 1.41 | .33 | | |
| S-3742 | Female | 3/14/69 | Castle Reef A-3 #59 | 12/18/72 | Castle Reef AE-2 #56 | 1.55 | ---- | AJ-2 #53 | 4.44 |
| | | | | 2/25/73 | Castle Reef -------- | ---- | ---- | | |
| | | | | 3/25/73 | Castle Reef AJ-2 #59 | .17 | ---- | | |
| | | | | 4/8/73 | Castle Reef A-3 #58 | .26 | .33 | | |
| | | | | 4/18/73 | Big George B-3 #38 | 5.70 | 5.01 | | |
| | | | | 4/23/73 | Castle Reef AH-2 #59 | .62 | 5.03 | | |
| S-3744 | Female | 3/14/69 | Castle Reef A-3 #59 | 12/18/72 | Wagner Basin AH-2 #55 | 1.14 | ---- | | |
| | | | | 4/23/73 | Castle Reef AH-2 #59 | .62 | | | |
| S-3781 | Male | 3/16/70 | Castle Reef A-3 #59 | 12/15/72 | Castle Reef AI-2 #64 | 1.31 | ---- | ------- | ---- |
| S-3784 | Female | 3/16/70 | Castle Reef A-3 #59 | 9/15/72 | Head Hannon O-2 #49 | 5.65 | ---- | AF-2 #57 | 2.03 |
| | | | | 11/22/72 | Hannon V-2 #50 | 3.98 | 1.76 | | |
| | | | | 3/25/73 | Castle Reef AH-2 #63 | 1.19 | 4.22 | | |
| | | | | 4/5/73 | Castle Reef A-3 #58 | .26 | 1.48 | | |
| | | | | 4/23/73 | Castle Reef AG-2 #58 | .91 | .93 | | |
| | | | | 4/26/73 | Wagner AH-2 #56 | .95 | .57 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| R-0875 | Male | 3/2/72 | Castle Reef A-3 #59 | 4/23/73 | Castle Reef AG-2 #58 | .91 | ---- | -------- | ---- |
| ------ | Female | ------ | ---------- | 9/15/72 | Head Hannon O-2 #49 | 5.65 | ---- | -------- | ---- |
| | | | | 10/19/72 | Head Hannon J-2 #50 | 5.68 | 1.29 | | |
| | | | | 12/15/72 | Castle Reef AI-2 #64 | .81 | 6.70 | | |
| | | | | 12/18/72 | Castle Reef AE-2 #56 | 1.55 | 2.19 | | |
| | | | | 3/25/73 | Castle Reef AH-2 #63 | 1.19 | 1.74 | | |
| | | | | 4/8/73 | Castle Reef A-3 #58 | .26 | 1.40 | | |
| 195 | Female | 12/20/70 | Scattering Springs A-3 #32 | 11/13/72 | Big George AH-2 #39 | 1.81 | ---- | -------- | ---- |
| J-349 | Female | 12/20/70 | Scattering Springs A-3 #32 | 9/18/72 | Sheep Reef AG-2 #26 | 1.81 | ---- | | |
| | | | | 5/26/73 | Sheep Reef -------- | ---- | ---- | | |
| 265 | Female | 12/20/70 | Scattering Springs A-3 #32 | 11/15/72 | Sheep Reef V-2 #27 | 3.57 | ---- | -------- | ---- |
| | | | | 5/4/73 | Gibson Cabin AG-2 #29 | 1.12 | 2.60 | | |
| 271 | Female | 12/20/70 | Scattering Springs A-3 #32 | 12/20/72 | Spring Reef AH-2 #28 | 1.17 | ---- | AF-2 #27 | 1.17 |
| | | | | 3/6/73 | Gibson Cabin AG-2 #29 | 1.15 | .36 | | |
| | | | | 3/29/73 | Sheep Reef AD-2 #26 | 2.17 | 1.05 | | |
| | | | | 4/19/73 | Sheep Reef AC-2 #26 | 2.34 | .24 | | |
| | | | | 5/2/73 | Klicks AH-2 #27 | 1.35 | 1.26 | | |
| | | | | 5/5/73 | Gibson Cabin AH-2 #29 | 1.05 | .50 | | |
| 272 | Female | 12/20/70 | Scattering Springs A-3 # 32 | 12/19/72 | Gibson Cabin AH-2 #29 | 1.05 | ---- | -------- | ---- |
| | | | | 3/6/73 | Gibson Cabin AH-2 #29 | 1.05 | 0.00 | | |
| | | | | 3/28/73 | Elbow Gorge A-3 #31 | .26 | .76 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| 273 | Female | 12/20/70 | Scattering Springs A-3 #32 | 9/18/72 | Sheep Reef AG-2 #26 | 1.81 | ---- | AH-2 #29 | .75 |
| | | | | 3/28/73 | Scattering Springs AH-2 #31 | .64 | 1.26 | | |
| | | | | 5/2/73 | Klicks AH-2 #27 | 1.36 | .98 | | |
| | | | | 5/4/73 | Gibson Cabin AH-2 #29 | 1.05 | .50 | | |
| | | | | 5/5/73 | Gibson Cabin AG-2 #29 | 1.12 | .24 | | |
| 200 | Female | 10/20/70 | Scattering Springs A-3 #32 | 10/16/72 | Head Pine Creek SW¼ Sec 27 T-22N R-12W | 12.50 | ---- | AH-2 #29 | 1.28 |
| | | | | 12/19/72 | Gibson Cabin AH-2 #29 | 1.05 | 12.50 | | |
| | | | | 3/6/73 | Gibson Cabin AH-2 #29 | 1.05 | 0.00 | | |
| | | | | 3/28/73 | Scattering Springs AH-2 #31 | .64 | .50 | | |
| | | | | 4/19/73 | Klicks AG-2 #27 | 1.48 | 1.00 | | |
| 265 | Female | 10/20/70 | Scattering Springs A-3 #32 | 12/19/72 | Gibson Cabin AH-2 #29 | 1.05 | ---- | AH-2 #30 | 1.21 |
| | | | | 3/28/73 | Scattering Springs A-3 #32 | 0.00 | 1.05 | | |
| | | | | 4/19/73 | Klicks AG-2 #27 | 1.48 | 1.71 | | |
| | | | | 5/5/73 | Gibson Cabin AG-2 #30 | 1.05 | .76 | | |
| 52 | Male | 1/16/71 | Scattering Springs | 3/6/73 | Gibson Cabin AG-2 #30 | 1.05 | ---- | -------- | ---- |
| | | | | 3/28/73 | Scattering Springs AI-2 #31 | .40 | .55 | | |
| 59 | Male | 1/16/71 | Scattering Springs A-3 #32 | 5/2/73 | Klicks AG-2 #27 | 1.48 | ---- | -------- | ---- |
| S-1336 | Female | 1/16/71 | Scattering Springs A-3 #32 | 3/29/73 | Sheep Reef AD-2 #26 | 2.17 | ---- | -------- | ---- |
| | | | | 4/19/73 | Sheep Reef AC-2 #26 | 2.34 | .24 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| S-1343 | Female | 1/16/71 | Scattering Springs A-3 #32 | 3/6/73 | Gibson Cabin AG-2 #30 | 1.05 | ---- | AE-2 #27 | 1.11 |
| | | | | 3/29/73 | Sheep Reef AD-2 #26 | 2.17 | 1.26 | | |
| | | | | 4/19/73 | Sheep Reef AC-2 #26 | 2.34 | .24 | | |
| 132 | Male | 3/21/70 | Scattering Springs A-3 #32 | 4/23/73 | Castle Reef AG-2 #38 | 6.44 | ---- | -------- | ---- |
| 134 | Male | 3/21/70 | Scattering Springs A-3 #32 | 5/2/73 | Klicks AG-2 #27 | 1.48 | ---- | -------- | ---- |
| 148 | Male | 3/21/70 | Scattering Springs A-3 #32 | 11/15/72 | Scattering Springs A-3 #31 | .26 | ---- | -------- | ---- |
| | | | | 12/19/72 | Gibson Cabin AH-2 #29 | 1.05 | 1.05 | | |
| | | | | 3/28/73 | Scattering Springs B-3 #33 | .94 | 1.43 | | |
| 176 | Female | 3/21/70 | Scattering Springs A-3 #32 | 10/13/72 | Gibson Cabin AH-2 #29 | 1.05 | ---- | -------- | ---- |
| | | | | 12/19/72 | Scattering Springs AI-2 #32 | .24 | .79 | | |
| | | | | 3/29/73 | Sheep Reef AD-2 #26 | 2.17 | 1.96 | | |
| 126 | Female | 3/21/70 | Scattering Springs A-3 #32 | 11/16/72 | Scattering Springs AG-2 #33 | 1.26 | ---- | -------- | ---- |
| | | | | 12/19/72 | Big George C-3 #36 | 1.07 | 1.45 | | |
| 191 | Female | 3/21/70 | Scattering Springs A-3 #32 | 3/6/73 | Gibson Cabin AG-2 #30 | 1.05 | ---- | AG-2 #29 | .91 |
| | | | | 3/28/73 | Scattering Springs AH-2 #31 | .64 | .33 | | |
| | | | | 5/2/73 | Klicks AG-2 #27 | 1.48 | 1.00 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| 189 | Female | 3/21/70 | Scattering Springs A-3 #32 | 9/21/72 | Sun Butte AG-2 #26 | 1.81 | ---- | AG-2 #28 | .57 |
| | | | | 12/19/72 | Gibson Cabin AH-2 #29 | 1.05 | .79 | | |
| | | | | 3/6/73 | Gibson Cabin AH-2 #29 | 1.05 | 0.00 | | |
| | | | | 4/19/73 | Klicks AG-2 #27 | 1.48 | .36 | | |
| | | | | 5/2/73 | Klicks AG-2 #27 | 1.48 | 0.00 | | |
| 144 | Female | 3/21/70 | Scattering Springs A-3 #32 | 3/28/73 | Scattering Springs B-3 #33 | .94 | ---- | AI-2 #31 | 1.60 |
| | | | | 4/18/73 | Scattering Springs AI-2 #32 | .24 | .50 | | |
| | | | | 5/2/73 | Klicks AG-2 #27 | 1.48 | .55 | | |
| 178 | Female | 3/21/70 | Scattering Springs A-3 #32 | 12/20/72 | Big George B-3 #39 | 1.64 | ---- | AG-2 #29 | .68 |
| | | | | 3/6/73 | Gibson Cabin AG-2 #30 | 1.05 | 2.46 | | |
| | | | | 3/28/73 | Elbow Gorge AH-2 #31 | .64 | .33 | | |
| | | | | 5/2/73 | Klicks AG-2 #27 | 1.48 | 1.00 | | |
| 141 | Female | 3/21/70 | Scattering Springs A-3 #32 | 11/14/72 | Klicks AH-2 #28 | 1.17 | ---- | ------- | ---- |
| | | | | 11/15/72 | Gibson Cabin AI-2 #30 | .51 | .60 | | |
| | | | | 12/19/72 | Scattering Springs AI-2 #30 | .51 | 0.00 | | |
| | | | | 3/28/73 | Scattering Springs AI-2 #30 | .51 | 0.00 | | |
| | | | | 4/18/73 | Scattering Springs AI-2 #32 | .24 | .48 | | |
| --- | Female | 4/16/70 | Scattering Springs A-3 #32 | 3/29/73 | Big George ---------- | ---- | ---- | ------- | ---- |
| | | | | 4/18/73 | Big George B-3 #38 | 1.48 | ---- | | |
| | | | | 5/4/73 | Scattering Springs AH-2 #32 | .60 | 1.60 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| S-3728 | Female | 4/16/69 | Scattering Springs A-3 #32 | 12/19/72 | Scattering Springs AI-2 #32 | .24 | ---- | -------- | ---- |
| | | | | 3/29/73 | Big George | ---- | ---- | | |
| S-3752 | Female | 4/29/71 | Scattering Springs A-3 #32 | 3/29/73 | Big George | ---- | ---- | -------- | ---- |
| | | | | 5/4/73 | Scattering Springs AJ-2 #32 | .14 | | | |
| S-3193 | Female | 4/30/71 | Scattering Springs A-3 #32 | 3/28/73 | Scattering Springs AI-2 #33 | 1.26 | ---- | -------- | ---- |
| S-3754 | Female | 4/30/71 | Scattering Springs A-3 #32 | 5/11/73 | Castle Reef AF-2 #59 | 6.77 | ---- | -------- | ---- |
| S-3751 | Female | 4/30/71 | Scattering Springs A-3 #32 | 12/20/72 | Scattering Springs A-3 #32 | 0.0 | ---- | AI-2 #30 | 1.67 |
| | | | | 3/6/73 | Klicks AG-2 #27 | 1.48 | 1.48 | | |
| | | | | 3/28/73 | Scattering Springs B-3 #33 | .94 | 2.07 | | |
| | | | | 4/18/73 | Scattering Springs AI-2 #32 | .24 | .50 | | |
| | | | | 5/2/73 | Klicks AG-2 #27 | 1.48 | 1.33 | | |
| S-3189 | Female | 4/30/71 | Scattering Springs A-3 #32 | 11/13/72 | Big George AH-2 #39 | 1.86 | ---- | -------- | ---- |
| | | | | 12/19/72 | Scattering Springs A-3 #31 | .26 | 2.07 | | |
| | | | | 4/18/73 | Scattering Springs AI-2 #32 | .24 | | | |
| S-000 | Female | 3/22/70 | Gibson Cabin AH-2 #29 | 9/10/72 | Klicks AH-2 #27 | 1.36 | ---- | -------- | ---- |
| | | | | 9/11/72 | Klicks AH-2 #27 | 1.36 | .43 | | |
| 193 | Female | 3/22/70 | Gibson Cabin AH-2 #29 | 12/19/72 | Gibson Cabin AH-2 #29 | 1.05 | ---- | -------- | ---- |
| | | | | 3/29/73 | Sheep Reef AD-2 #26 | 2.17 | 1.38 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| 181 | Male | 3/22/70 | Gibson Cabin AH-2 #29 | 11/17/72 | Big George ---------- | ---- | ---- | -------- | ---- |
| R-0076 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/17/72 | Ford Creek T-19N R-9W SE¼ of NE¼ Sec 12 | .25 | ---- | -------- | ---- |
| | | | | 12/29/72 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | 1.06 | 1.25 | | |
| | | | | 3/23/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | 1.06 | 0.00 | | |
| R-0051 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/8/72 | Fairview Mtn T-20N R-9W SE¼ of NE¼ Sec 21 | 5.5 | ---- | T-19N R-9W NW¼ of SE¼ Sec 2 | 2.37 |
| | | | | 12/14/72 | Ford Creek T-19N R-9W NW¼ Sec 11 | 1.5 | 3.87 | | |
| | | | | 3/26/73 | Ford Creek T-19N R-9W NE¼ of SW¼ Sec 11 | 1.37 | .37 | | |
| | | | | 4/9/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | 1.06 | 2.00 | | |
| | | | | 4/16/73 | Ford Creek T-19N R-9W NW¼ of NE¼ Sec 12 | .25 | 1.00 | | |
| | | | | 4/21/73 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 11 | .87 | .75 | | |
| | | | | 4/27/73 | Ford Creek T-19N R-9W SW¼ of SE¼ Sec 1 | .37 | 1.12 | | |
| | | | | 5/15/73 | Fairview Plateau T-20N R-9W SW¼ of SE¼ Sec 21 | 4.75 | 4.12 | | |
| R-0065 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 3/26/73 | Ford Creek T-19N R-9W NE¼ of SW¼ Sec 11 | 4.50 | ---- | T-20N R-9W SW¼ of SW¼ Sec 2 | 3.98 |
| | | | | 4/16/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | .25 | 2.00 | | |
| | | | | 5/15/73 | Fairview Plateau T-20N R-9W SE¼ of SW¼ Sec 21 | 4.37 | 3.62 | | |

TABLE 18, Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| R-0081 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 9/25/72 | Sheep Shed Mtn T-20N R-9W NW¼ of NE¼ Sec 6 | 1.12 | ---- | ------- | ---- |
| | | | | 12/8/72 | Fairview Plateau T-20N R-9W SE¼ of NE¼ Sec 21 | 4.50 | 4.12 | | |
| | | | | 12/14/72 | Ford Creek T-19N R-9W NW¼ Sec 11 | 1.37 | 3.87 | | |
| | | | | 12/29/72 | Ford Creek T-19N R-9W NW¼ of SE¼ Sec 11 | 1.12 | .25 | | |
| | | | | 4/9/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | .25 | 1.87 | | |
| | | | | 4/27/73 | Ford Creek T-19N R-9W SE¼ of SW¼ Sec 1 | .62 | .87 | | |
| R-0083 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/29/72 | Ford Creek T-19N R-9W SE¼ of SW¼ Sec 1 | .62 | ---- | T-19N R-9W NW¼ of NE¼ Sec 2 | 2.31 |
| | | | | 3/20/73 | Ford Plateau T-20N R-9W NW¼ of NW¼ Sec 34 | 3.12 | 2.75 | | |
| | | | | 3/21/73 | Ford Plateau T-20N R-9W SE¼ of NE¼ Sec 34 | 2.50 | .87 | | |
| | | | | 4/17/73 | Ford Creek T-19N R-9W SE¼ of SE¼ Sec 1 | .37 | 2.25 | | |
| | | | | 4/21/73 | Ford Creek T-19N R-9W SE¼ of SE¼ Sec 1 | .37 | 0.00 | | |
| R-0059 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 11/16/72 | Fairview Plateau T-20N R-9W NW¼ Sec 21 | 5.00 | ---- | ------- | ---- |
| | | | | 12/14/72 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 12 | .25 | 1.62 | | |
| | | | | 12/20/72 | Red Creek T-19N R-9W NW¼ of SE¼ Sec 10 | 2.12 | 2.25 | | |
| | | | | 12/29/72 | Ford Creek T-19N R-9W NW¼ of SE¼ Sec 11 | 1.12 | 1.00 | | |
| | | | | 3/21/73 | Red Creek T-19N R-9W SW¼ of NE¼ Sec 10 | 2.12 | 1.00 | | |
| | | | | 3/23/73 | Ford Creek T-19N R-9W SE¼ of NE¼ Sec 12 | .25 | 2.12 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| R-0060 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/14/72 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 12 | .25 | ----- | T-19N R-9W NE¼ of NW¼ Sec 1 | 2.01 |
| | | | | 3/21/73 | Ford Plateau T-20N R-9W SE¼ of NE¼ Sec 34 | 2.50 | 2.62 | | |
| | | | | 3/23/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | 1.06 | 2.12 | | |
| | | | | 3/26/73 | Ford Creek T-20N R-9W SE¼ of SE¼ Sec 36 | 1.37 | .37 | | |
| | | | | 3/30/73 | Ford Creek T-19N R-9W NE¼ of SW¼ Sec 12 | .62 | 1.87 | | |
| | | | | 4/16/73 | Ford Creek T-19N R-9W SW¼ of NE¼ Sec 1 | .75 | 1.25 | | |
| | | | | 4/27/73 | Ford Creek T-19N R-9W SW¼ of SE¼ Sec 1 | .37 | .50 | | |
| R-0086 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/8/72 | Ford Creek T-19N-R-9W NE¼ of NW¼ Sec 12 | 1.12 | ----- | T-19N R-9W NE¼ of SE¼ Sec 1 | .64 |
| | | | | 4/9/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | .25 | 1.00 | | |
| | | | | 4/16/73 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 1 | .25 | .25 | | |
| | | | | 4/21/73 | Ford Creek T-19N R-9W SE¼ of SE¼ Sec 1 | .37 | .25 | | |
| R-0090 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/8/72 | Ford Creek T-19N R-9W NE¼ of NW¼ Sec 12 | .37 | ----- | T-19N R-9W SW¼ of NW¼ Sec 1 | 2.02 |
| | | | | 12/17/72 | Ford Creek T-19N R-9W SE¼ of SW¼ Sec 12 | .37 | .62 | | |
| | | | | 12/20/72 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 1 | 1.06 | 1.12 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/21/73 | Ford Plateau T-20N R-9W SE¼ of NE¼ Sec. 34 | 2.50 | 2.25 | | |
| | | | | 4/16/73 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 1 | .62 | 2.25 | | |
| | | | | 4/21/73 | Ford Creek T-19N R-9W SE¼ of SE¼ Sec 1 | .37 | .25 | | |
| | | | | 4/27/73 | Ford Creek T-19N R-9W SW¼ of SE¼ Sec 1 | .37 | .25 | | |
| R-0048 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/14/72 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 12 | .25 | ---- | ------- | ---- |
| | | | | 12/29/72 | Ford Creek T-19N R-9W SW¼ of SE¼ Sec 1 | .37 | .37 | | |
| R-0068 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/14/72 | Ford Creek T-19N R-8W NW¼ of NW¼ Sec 6 | 1.12 | ---- | T-19N R-9W NE¼ of SE¼ Sec 2 | 2.60 |
| | | | | 12/20/72 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 1 | .25 | .50 | | |
| | | | | 12/29/72 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 1 | 1.12 | 0.00 | | |
| | | | | 3/21/73 | Ford Plateau T-20N R-9W SE¼ of NE¼ Sec 34 | 2.50 | 2.25 | | |
| | | | | 3/26/73 | Ford Creek T-20N R-9W SE¼ of SE¼ Sec 36 | 1.37 | 2.00 | | |
| | | | | 3/30/73 | Ford Creek T-19N R-9W NE¼ of SW¼ Sec 12 | .62 | 1.87 | | |
| | | | | 4/9/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | 1.06 | 1.50 | | |
| | | | | 4/16/73 | Red Creek T-19N R-9W SW¼ of NE¼ Sec 10 | 2.12 | 2.37 | | |
| | | | | 4/17/73 | Red Creek T-19N R-9W NE¼ of SE¼ Sec 10 | 1.87 | .37 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| R-0071 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/17/72 | Ford Creek T-19N R-9W SE¼ of SW¼ Sec 12 | .37 | ---- | ------- | ---- |
| | | | | 12/20/72 | Ford Creek T-20N R-9W NE¼ of SW¼ Sec 1 | .62 | 1.00 | | |
| | | | | 4/9/73 | Ford Creek T-19N R-9W NE¼ of NE¼ Sec 1 | 1.06 | .62 | | |
| | | | | 4/16/73 | Ford Creek T-19N R-9W SW¼ of NE¼ Sec 1 | .75 | .37 | | |
| R-0036 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/17/72 | Ford Creek ---------- | ---- | ---- | ------- | ---- |
| | | | | 12/29/72 | Ford Creek ---------- | ---- | ---- | ------- | ---- |
| | | | | 4/16/73 | Ford Creek ---------- | ---- | ---- | ------- | ---- |
| | | | | 4/21/73 | Ford Creek T-19N R-9W SE¼ of SE¼ Sec 1 | .37 | | | |
| R-0078 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/20/72 | Fairview Plateau T-20N R-9W NE¼ of SE¼ Sec 34 | 2.37 | ---- | T-19N R-9W SW¼ of NE¼ Sec 1 | .68 |
| | | | | 4/9/73 | Ford Creek T-19N R-9W SE¼ of NW¼ Sec 1 | .87 | 1.62 | | |
| | | | | 4/16/73 | Ford Creek T-19N R-9W SW¼ of NE¼ Sec 1 | .75 | .25 | | |
| | | | | 4/21/73 | Ford Creek T-19N R-9W SE¼ of SE¼ Sec 1 | .37 | 1.50 | | |
| R-0044 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/20/72 | Ford Creek T-19N R-9W NE¼ of SE¼ Sec 1 | .62 | ---- | T-19N R-9W NE¼ of NE¼ Sec 2 | 2.83 |
| | | | | 12/29/72 | Ford Creek T-19N R-9W NW¼ of SE¼ Sec 11 | 1.12 | 1.50 | | |
| | | | | 3/20/73 | Ford Plateau T-20N R-9W NW¼ of NW¼ Sec 34 | 3.12 | 2.87 | | |

TABLE 18. Continued.

| Tag Number | Sex | Date Marked | Trap Location | Date Relocated | Drainage and/or Map Coordinates of Relocation | Distance From Site of Original Capture In Miles | Distance From Site of Last Relocation In Miles | Location of Spring Center of Activity | Standard Diameter of Spring Area In Miles |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 4/16/73 | Ford Creek T-19N R-9W SW¼ of NE¼ Sec 1 | .75 | 2.62 | | |
| | | | | 4/27/73 | Ford Creek T-19N R-9W SW¼ of SE¼ Sec 1 | .37 | 1.5 | | |
| R-0043 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 3/21/73 | Red Creek T-19N R-9W SW¼ of NE¼ Sec 10 | 2.00 | ----- | -------- | ----- |
| R-0056 | Male | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 3/20/73 | Fairview Plateau T-20N R-9W NW¼ of SE¼ Sec 1 | .62 | ----- | -------- | ----- |
| R-0039 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 12/29/72 | Ford Creek ---------- | ----- | ----- | -------- | ----- |
| R-0041 | Female | 2/10/71 | Ford Creek T-19N R-9W NE¼ Sec 12 | 9/25/72 | Sheep Shed Mtn T-20N R-9W NW¼ of NE¼ Sec 6 | 4.50 | ----- | -------- | ----- |

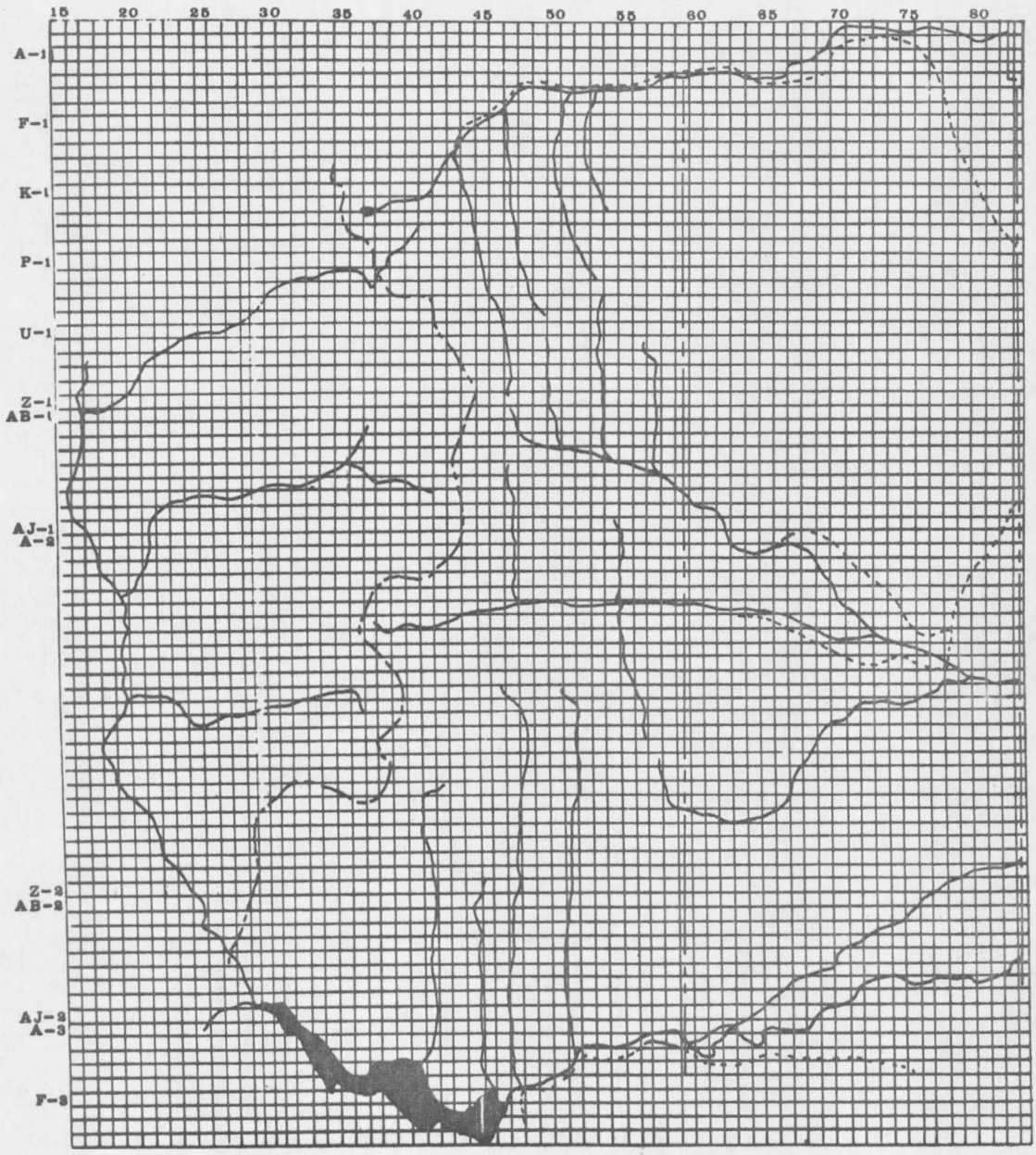


Figure 9. Map of portion of study area north of Gibson Dam with one-sixteenth square mile grid for use with Table 18 in showing locations of marked animal relocations.

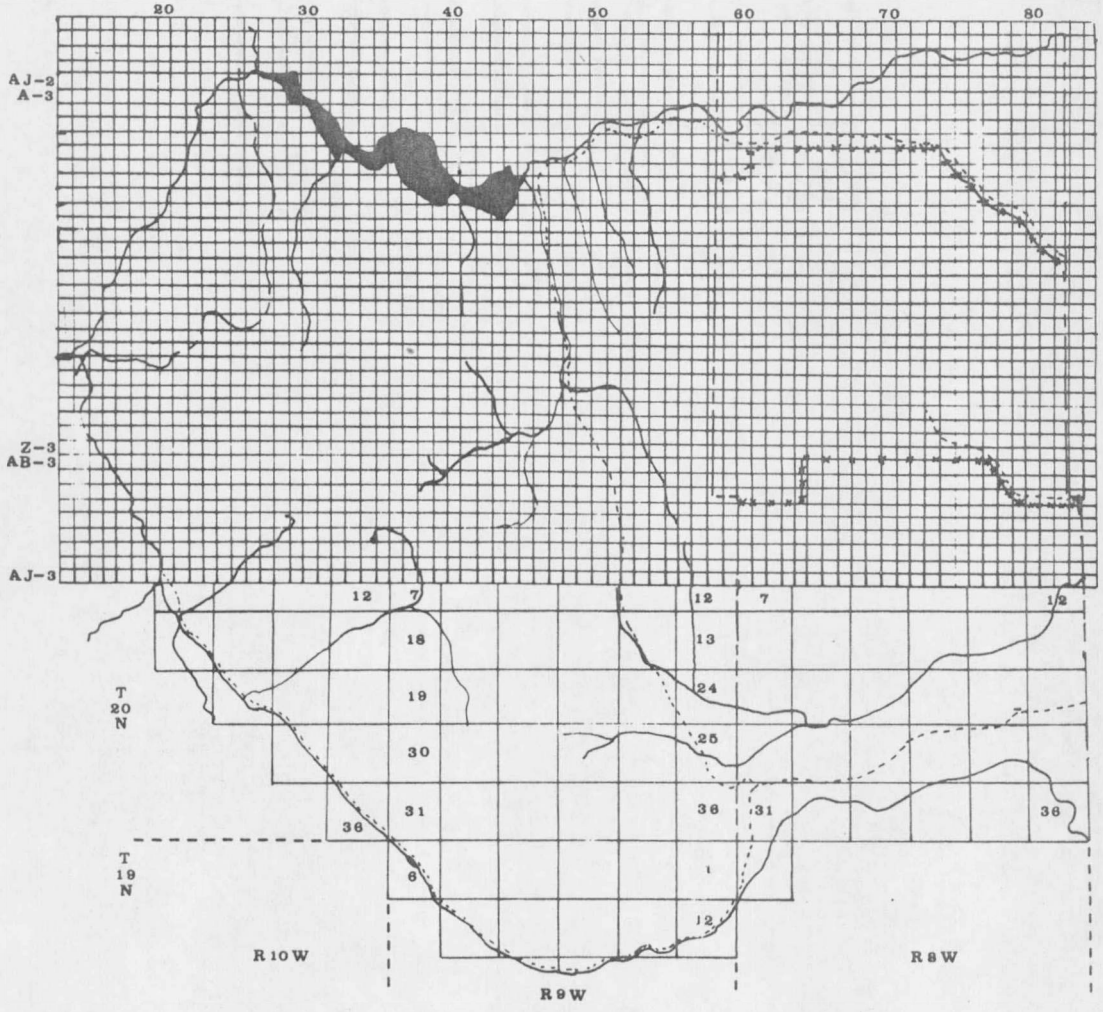


Figure 10. Map of portion of the study area south of Gibson Dam with one-sixteenth square mile grid and sections for use with Table 18 in showing locations of marked animal relocations.

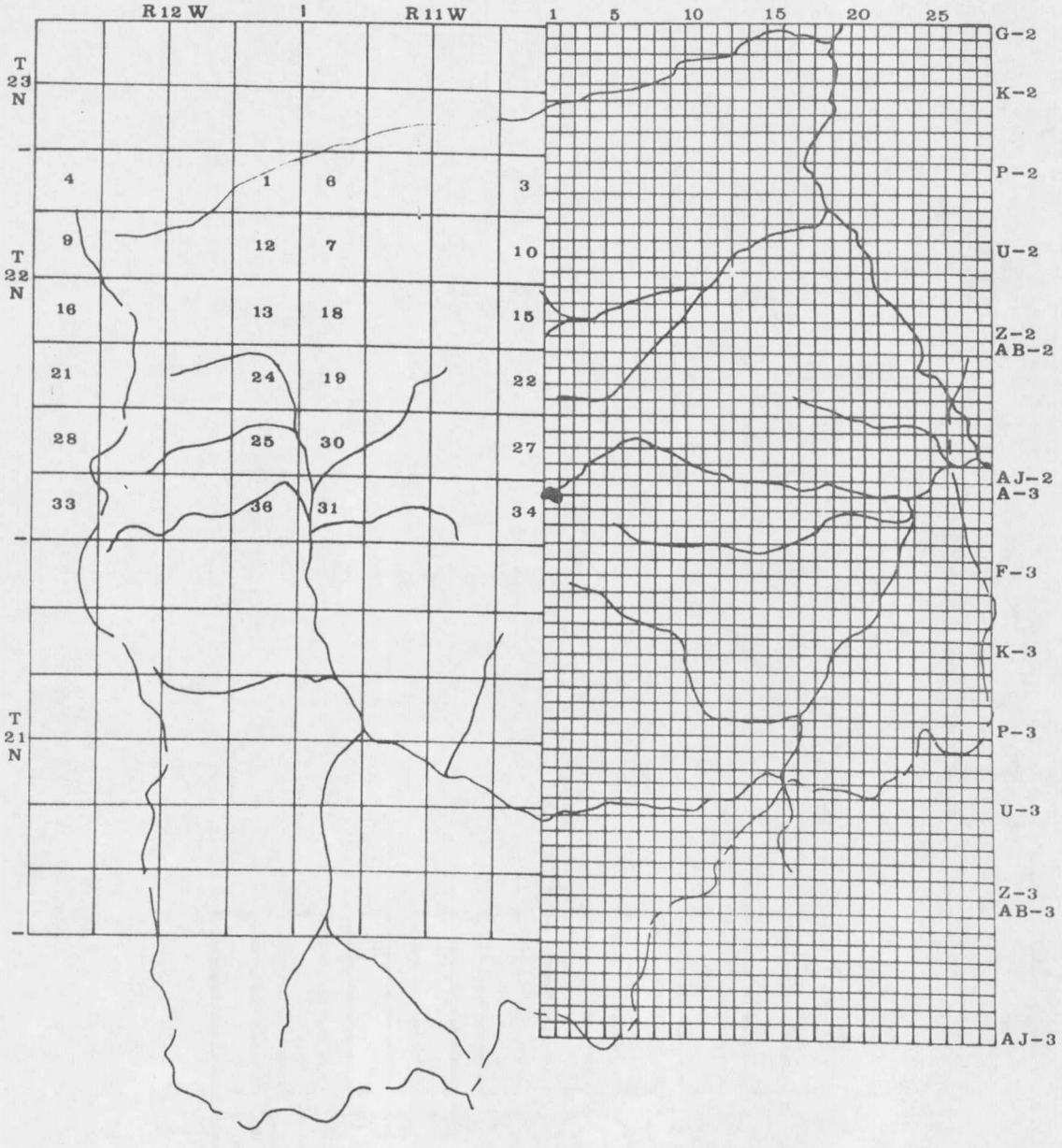


Figure 11. Map of portion of study area west of Gibson Dam with one-sixteenth square mile grid and sections for use with Table 18 in showing locations of marked animal relocations.

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