



Small mammal abundance and distribution in the Missouri River Breaks, Montana
by Robert Garst Trout

A thesis submitted in partial fulfillment of MASTER OF SCIENCE in Zoology
Montana State University
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Abstract:

Objectives of this study were to obtain seasonal population indices for small rodents in major vegetation types, to estimate home range size, density, turnover rate, and seasonal population changes of small rodents in two vegetation types, to obtain population indices for leporids, and to obtain quantitative measurements of vegetation types sampled for small mammals. Field work for this study of small mammal abundance and distribution in the Missouri River breaks, northeastern Fergus County, Montana, was conducted on a full time basis from April through September, 1976, and from June through August, 1977. Methods used were snap-trap lines, live trap grids, headlight surveys, pellet group counts, and a point method of measuring vegetation. *Peromyscus maniculatus* was the most abundant and widely distributed small mammal trapped. There were few significant differences in the mean number of captures of *P. maniculatus* per 100 trap nights among vegetation types within trap periods due to the wide variation in this index among lines within a vegetation type. Indices for the *Artemisia tridentata*-*Agropyron Smithii*, *Pinus ponderosa*-*Juniperus scopulorum*, *Sarcobatus vermiculatus*-*Agropyron Smithii*, *Artemisia tridentata*-*Agropyron smithii*, *Agropyron Spicatum*, *Pseudotsuga menziesii*—*Juniperus scopulorum*, and *Artemisia cana*-*Agropyron smithii* vegetation types for all trap periods combined were 3.27, 2.29, 6.48, 2.20, 3.22, and 3.72, respectively.

Population indices for *P. maniculatus* were low in early summer but increased by late summer. A late summer decline in breeding activity was observed. Density estimates of *P. maniculatus* on the Artr-Agsm and Save-Agsm live trap grids ranged from 1.18/ha-3.29/ha and 1.16/ha-3.87/ha, respectively. No significant differences were found among the average home range sizes of .39 ha, .26 ha, .11 ha, and .35 ha for adult males, adult females, juvenile males, and juvenile females, respectively. Turnover of *P. maniculatus* had a direct relationship with the length of the interval between trapping series. Other species trapped were *Onychomys leucogaster*, *Spermophilus tridecemlineatus*, *Eutamias minimus*, *Zapus princeps*, *Lagurus Curtatus*, *Dipodomys Ordii*, and *Microtus* sp. Leporid indices were similar in 1976 and 1977 and showed an increase from early to late summer. The Arca-Agsm and Save-Agsm vegetation types had the highest concentrations of leporids.

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IN THE MISSOURI RIVER BREAKS,

MONTANA

by

ROBERT GARST TROUT

A thesis submitted in partial fulfillment

of

MASTER OF SCIENCE

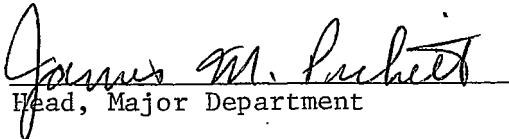
in

Zoology

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Bozeman, Montana

May, 1978

ACKNOWLEDGMENT

I wish to express my appreciation to those who assisted in this study: Dr. Robert E. Moore for project planning and aid in preparation of the manuscript; Dr. Harold Picton and Dr. Calvin Kaya for critical reading of the manuscript; Richard F. Lund for developing the MSUSTAT and MINISTAT programs used in the analysis of data; Dalton Burkhalter and Victor Riggs for aid in interpretation of the computer analysis of data. Duane Pyrah, Ken Hamlin, and Arnold "Butch" Dood for field assistance and good company; Eugene Allen and Montana Fish and Game for needed equipment; and my wife Marleen for her support and patience. During the study the author was supported by the Montana Fish and Game Department under Federal Aid Project W-120-R-9.

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ABSTRACT

Objectives of this study were to obtain seasonal population indices for small rodents in major vegetation types, to estimate home range size, density, turnover rate, and seasonal population changes of small rodents in two vegetation types, to obtain population indices for leporids, and to obtain quantitative measurements of vegetation types sampled for small mammals. Field work for this study of small mammal abundance and distribution in the Missouri River breaks, northeastern Fergus County, Montana, was conducted on a full time basis from April through September, 1976, and from June through August, 1977. Methods used were snap-trap lines, live trap grids, headlight surveys, pellet group counts, and a toe point method of measuring vegetation. *Peromyscus maniculatus* was the most abundant and widely distributed small mammal trapped. There were few significant differences in the mean number of captures of *P. maniculatus* per 100 trap nights among vegetation types within trap periods due to the wide variation in this index among lines within a vegetation type. Indices for the *Artemesia tridentata*-*Agropyron smithii*, *Pinus ponderosa*-*Juniperus scopulorum*, *Sarcobatus vermiculatus*-*Agropyron smithii*, *Artemesia tridentata*-*Agropyron smithii*-*Agropyron spicatum*, *Pseudotsuga menziesii*-*Juniperus scopulorum*, and *Artemesia cana*-*Agropyron smithii* vegetation types for all trap periods combined were 3.27, 2.29, 6.48, 2.20, 3.22, and 3.72, respectively. Population indices for *P. maniculatus* were low in early summer but increased by late summer. A late summer decline in breeding activity was observed. Density estimates of *P. maniculatus* on the Artr-Agsm and Save-Agsm live trap grids ranged from 1.18/ha-3.29/ha and 1.16/ha-3.87/ha, respectively. No significant differences were found among the average home range sizes of .39 ha, .26 ha, .11 ha, and .35 ha for adult males, adult females, juvenile males, and juvenile females, respectively. Turnover of *P. maniculatus* had a direct relationship with the length of the interval between trapping series. Other species trapped were *Onychomys leucogaster*, *Spermophilus tridecemlineatus*, *Eutamias minimus*, *Zapus princeps*, *Lagurus curtatus*, *Dipodomys ordii*, and *Microtus* sp. Leporid indices were similar in 1976 and 1977 and showed an increase from early to late summer. The Arca-Agsm and Save-Agsm vegetation types had the highest concentrations of leporids.

Introduction

The importance of small mammals to coyotes as a food source has been documented (Hawthorne 1972; Korschgen 1972; Sperry 1941; Stoddart and Wagner 1972); thus, the abundance of small mammals as alternative prey species is an important consideration in an investigation of coyote-deer interactions (Leopold 1933). This study of the abundance and distribution of small mammals is part of a larger project initiated by the Montana Department of Fish and Game in January, 1976, to examine the relationships between coyotes and deer. Although information on abundance and distribution of small mammals in northern plains habitats is available (Birney 1974; Cada 1968; Dusek and McCann 1974; French and Grant 1974; Lampe, et al. 1974; Maxwell and Brown 1968; Pefaur and Hoffmann 1975), baseline information on small mammal populations was needed in the specific study area where the Department of Fish and Game project was located. The study area was located in a portion of the Missouri River breaks and adjacent prairie, northeastern Fergus County, Montana. Censusing of small mammals by snap-trapping, live trapping, and road surveys was begun in April, 1976, and was conducted on a full time basis through September, 1976, and from June through August, 1977.

Specific objectives in this study were fourfold: (1) to obtain seasonal population indices of small rodents for the major vegetation types found in the study area; (2) to estimate home range size, density, turnover rate, and seasonal population changes of small rodents in two

vegetation types; (3) to obtain population indices for leporids in relation to month, year, and vegetation type; (4) to describe the vegetation in the vegetation types sampled for small rodents.

STUDY AREA

The study area, in northeastern Fergus County, Montana was bounded on the north by the Missouri River, on the east by the Fergus-Petroleum county line, on the south by Crooked Creek, and on the west by Highway 191. It had an approximately 517 km^2 (200 mi^2).

Topography of the area has been influenced by the Missouri River. The terrain near the river is rough with intermittent streams forming a pattern of deep coulees interspersed with flat-topped ridges. The southern portion of the area is not as rugged, with undulating hills and little change in elevation. Height above sea level in the area ranges from approximately 701 m (2250 ft) on the river to approximately 966 m (3,100 ft) on the southern edge.

The soils, as described by Gieserker (1938), are primarily clay loams of the Lismas and Pierre Series derived from the Bearpaw Formation. These "gumbo" soils are alkaline and relatively impermeable to water, but become very heavy when wet.

The semi-arid climate is characterized by extremes in temperature and low amounts of rainfall. Records from the Roy 8 NE weather station (Climatological Data, 1975, 1976, 1977) show average temperature of -8°C (17°F) for January and 21°C (70°F) for July (Table 1). Precipitation, falling mostly in the spring and summer, was high in 1975 and near the 29 year mean in 1976 and in 1977 through August. The number of days with snow cover of seven centimeters or more from November, 1976, through April, 1977, averaged 12 days a month.

Table 1. Monthly precipitation totals and days per month with seven cm snow cover for 1975, 1976, and 1977 through August and the 29 year means for monthly precipitation totals and average monthly temperature. These data were recorded at the National Oceanic and Atmospheric Administration Weather Station, Roy 8 NE. (Precipitation is given in centimeters and temperature in degrees Celsius.)

Month	29 Year Mean		1975		1976		1977	
	Precip.	Temp.	Precip.	# Days with seven cm Snow Cover	Precip.	# Days with seven cm Snow Cover	Precip.	# Days with seven cm Snow Cover
Jan.	1.14	-8.27	2.08	2	.33	9	3.12	31
Feb.	1.02	-4.77	.51	17	1.70	1	.51	9
Mar.	1.47	-1.38	2.03	20	1.06	8	5.26	4
Apr.	2.69	6.27	8.81	10	2.84	1	.51	5
May	6.35	11.83	8.05	0	2.54	0	6.76	0
June	8.45	15.94	11.86	0	9.80	0	4.01	0
July	3.86	20.83	7.72	0	2.97	0	5.97	0
Aug.	3.27	19.88	7.26	0	2.56	0	6.15	0
Sept.	2.97	13.77	.99	0	2.87	0		
Oct.	1.93	8.44	3.47	0	1.72	0		
Nov.	1.24	.22	2.99	7	1.57	6		
Dec.	.93	-4.94	1.29	17	.40	7		
Total	35.32		57.06	73	30.36	32	32.29*	49*

* Totals from January-August.

The vegetation of the area reflects the soil and climate of the region. The ridge-tops of the breaks, and the plains to the south, are shrub-grasslands dominated by *Artemesia tridentata* (Big Sagebrush) and *Agropyron smithii* (Western Wheatgrass). The slopes in the breaks are timbered, either with *Pseudotsuga menziesii* (Douglas Fir) or *Pinus ponderosa* (Ponderosa Pine) (Mackie 1970).

Livestock grazing on the area was begun in the 1800's by large cattle companies and continued to the early 1900's. At that time, homesteaders settled the area and attempted to raise small grains. In the 1920's and again in the 1930's drought conditions led to the abandonment of cultivation and grazing again became the major land use (Gieserker, et al. 1953).

METHODS

Snap-trap index lines were the primary method used to examine the abundance and distribution of small mammals on the study area. Live trapping was used to supplement the snap-trapping. Headlight surveys and pellet group counts were used to obtain information on leporid populations. The vegetation of the live trap and snap-trap sites was described with quantitative measurements.

Snap-Trapping

Snap-trap index lines consisted of 20 stations placed 15 m apart with two traps per station. Victor Rat Traps were used exclusively. A mixture of one half moist rolled oats and one half peanut butter was used for bait. Lines were set out in the late afternoon or evening. They were checked and rebaited the following two mornings, then picked up the third. Traps were left operational during the day to be available to diurnal mammals.

Vegetation types to be sampled for small mammals were classified after a review of Mackie's (1970) vegetational description and a period of field reconnaissance. The term vegetation type refers to the actual vegetation on a site. One to four stands in each selected vegetation type were sampled with a snap-trap index line during each trap period.

Sites trapped in 1976 were trapped again in 1977. The sample size was increased in 1977 by trapping several additional sites in each vegetation type. Total number of different sites trapped in each vegetation type are shown in Table 2. Homogeneity of the vegetation

Table 2. The number of sites sampled for small mammals with a snap-trap line in each vegetation type in each trapping period and the total number of sites trapped for each vegetation type.

Vegetation Type	Trap Period ¹					Total Number of Sites
	I	II	III	IV	V	
<i>Pinus ponderosa</i> - <i>Juniperus scopulorum</i> (Pipo-Jusc)	3	3	*	4	4	8
<i>Artemesia tridentata</i> - <i>Agropyron smithii</i> (Artr-Agsm)	3	3	2	4	4	10
<i>Sarcobatus vermiculatus</i> - <i>Agropyron smithii</i> (Save-Agsm)	3	3	*	4	4	8
<i>Artemesia tridentata</i> - <i>Agropyron smithii</i> - <i>Agropyron spicatum</i> (Artr-Agsm-Agsp)	3	3	*	4	4	8
<i>Pseudotsuga menziesii</i> - <i>Juniperus scopulorum</i> (Psme-Jusc)	2	1	*	2	2	4
<i>Artemesia cana</i> - <i>Agropyron smithii</i> (Arca-Agsm)	*	*	3	4	3	10
<i>Populus sargentii</i> - <i>Symphoricarpos</i> <i>occidentalis</i> (Posa-Syoc)	3	3	*	*	*	6
Upland Swales	3	*	*	*	*	3
Agricultural Edges	3	3	*	*	*	6
Total	23	19	5	22	21	63

1 Dates for trap period were: I, May 5-June 6, 1976; II June 28-August 10, 1976; III, April 16-18, 1977; IV, June 22-July 8, 1977; V, August 23-September 5, 1977.

* Indicates no sampling during trap period.

between stands within a given type was tested by comparing the frequency of occurrence of selected plant taxa at each stand sampled. Sites trapped are shown in Figure 1.

During the course of the study there were five snap-trapping periods: Trap Period I, May 6-June 5, 1976; Trap Period II, June 28-August 10, 1976; Trap Period III, April 16-18, 1977; Trap Period IV, June 22-July 8, 1977; Trap Period V, August 25-September 5, 1977.

An index of abundance, the number of captures per 100 trap nights, was calculated for each line for *Peromyscus maniculatus* Wagner (deer mouse). This calculation was based on 120 trap nights per line. In 1977 this index was also calculated using 120 trap nights minus the number of snapped or baitless traps (Schladweiler 1976). Mean number of captures per 100 trap nights for *P. maniculatus* was calculated for each vegetation type within a trap period, each trap period, and each vegetation type through all trap periods. Analyses of variance were performed on the data and the means were compared. Data recorded for species other than *P. maniculatus* were species, site, and date captured.

Two age classes, adult and juvenile, were recognized for *P. maniculatus*. Reproductive tracts of *P. maniculatus* were examined. Females considered to be in reproductive condition were those with embryos or placental scars. Males with testes lengths of 8 mm or greater were classified as being in reproductive condition (Sheppe 1963).

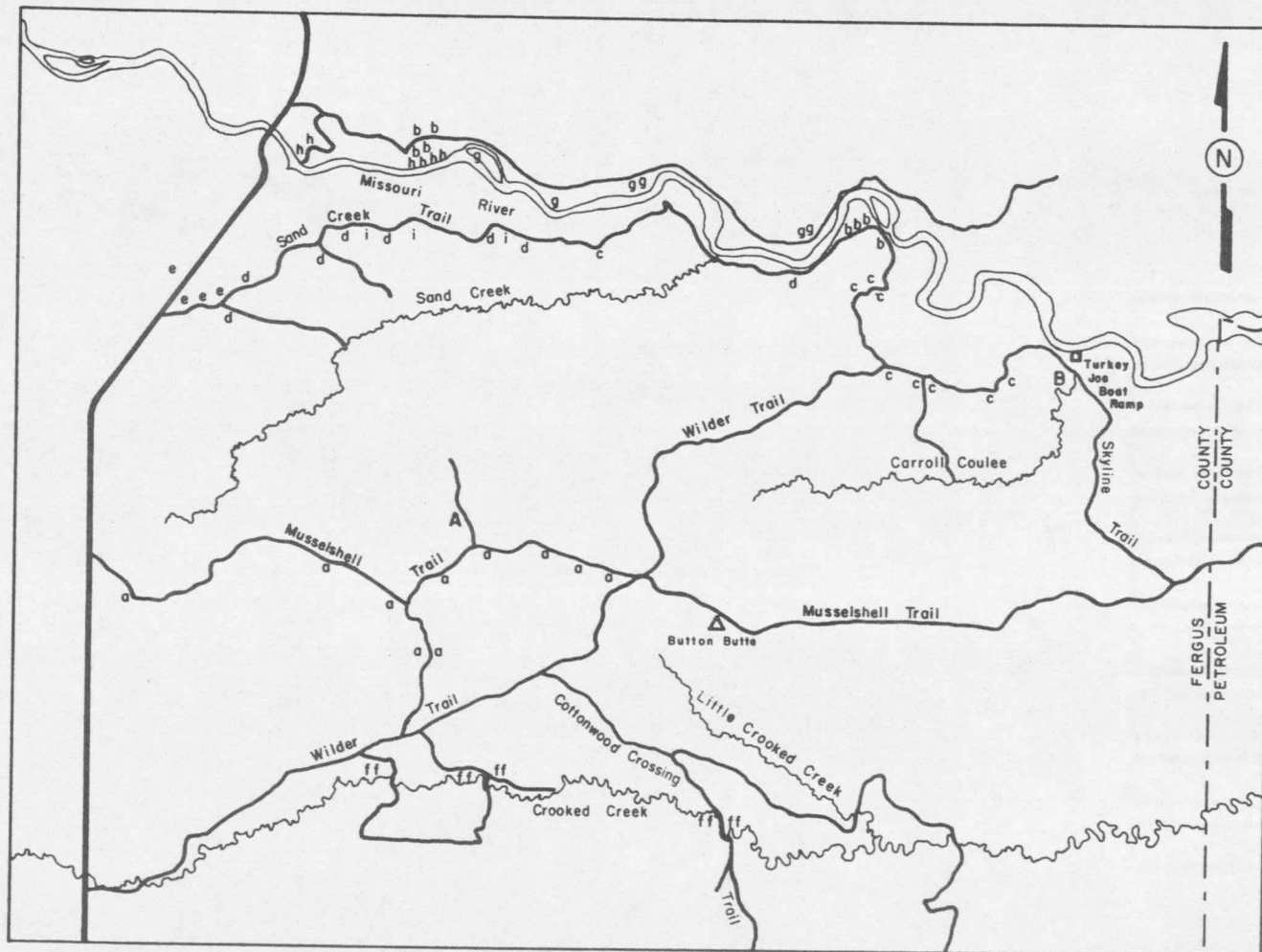
Live Trapping

A 15 X 15 live trap grid was placed in an *Artemesia tridentata*-

Key to Map Symbols

- A Artr-Agsm Live Trap Grid
- B Save-Agsm Live Trap Grid
- a Artr-Agsm Snap-Trap Sites
- b Save-Agsm Snap-Trap Sites
- c Pipo-Jusc Snap-Trap Sites
- d Artr-Agsm-Agsp-Snap-Trap Sites
- e Psme-Jusc Snap-Trap Sites
- f Arca-Agsm Snap-Trap Sites
- g Posa-Syoc Snap-Trap Sites
- h Agricultural Edge Snap-Trap Sites
- i Upland Swales Snap-Trap Sites

Figure 1. Map of study area showing snap-trap lines and live trap grid sites. Scale: .756cm = 1 mi.



Agropyron smithii vegetation type and a 10 X 18 live trap grid was placed in a *Sarcobatus vermiculatus*-*Agropyron smithii* vegetation type. The rows within the grids were 15 m apart, and the traps within the rows were 15 m apart. Figure 1 shows the location of each grid.

There were six trapping series during the course of the study. A trapping series is defined as the simultaneous trapping of both grids. Series I consisted of eight nights of trapping while the other five series consisted of six nights of trapping. Series dates were: I, July 27-August 4, 1976; II, September 9-15, 1976; III, December 17-23, 1976; IV, June 13-19, 1977; V, July 17-23, 1977; VI, August 13-19, 1977.

Operation of the grids was similar to that of Cada (1968). In each grid 8 X 8 X 23 cm Sherman live traps, baited with oats, were placed in alternating rows. The traps were checked each morning and moved to an adjacent row that had been empty the previous night. Thus, each row within the grid was trapped four nights during the eight-night trapping series and three nights in the six-night series. Traps were left operational during the day to be available to diurnal mammals.

Each animal was individually marked using a clipped toe numbering system. Species, field number, sex, age class, and locations of capture were noted for each animal.

Home range size for each individual with three or more captures per series was calculated using the "boundary strip method" (Hayne 1949). The area trapped was calculated for each species within each grid and series by enlarging the trap grid on each side by the radius of a circle with an

area equal to the average home range for all individuals with three or more captures. Density estimates by species were obtained by dividing the total number of individuals of a species captured on a grid during a series by the area trapped during that series (Blair 1941).

Analyses of variance were performed on home range data. Means for age and sex classes, vegetation types, and trap series were compared.

Turnover of *P. maniculatus* between trapping series on the Artr-Agsm live trap grid and on the Save-Agsm live trap grid was estimated by calculating the percent loss of marked *P. maniculatus* during the interval between trapping series.

Headlight Surveys and Pellet Group Counts

Headlight surveys (Lord 1959) and pellet group counts (Trippensee 1948) were used to calculate indices of leporid abundance and distribution.

The two headlight survey routes are shown in Figure 2. The Wilder-Musselshell route was 35.2 km (22 mi) long and the Skyline-Sand Creek route was 52.8 km (33 mi) long.

The Wilder-Musselshell route was surveyed on the following dates: May 27-29, June 30-July 1, July 19-21, July 26-28, August 16-18, and December 16-18, 1976; April 17-19, June 27-29, July 15-17, July 29-31, and August 31-September 2, 1977. The Skyline-Sand Creek route was surveyed July 18-20, and August 16-18, 1977.

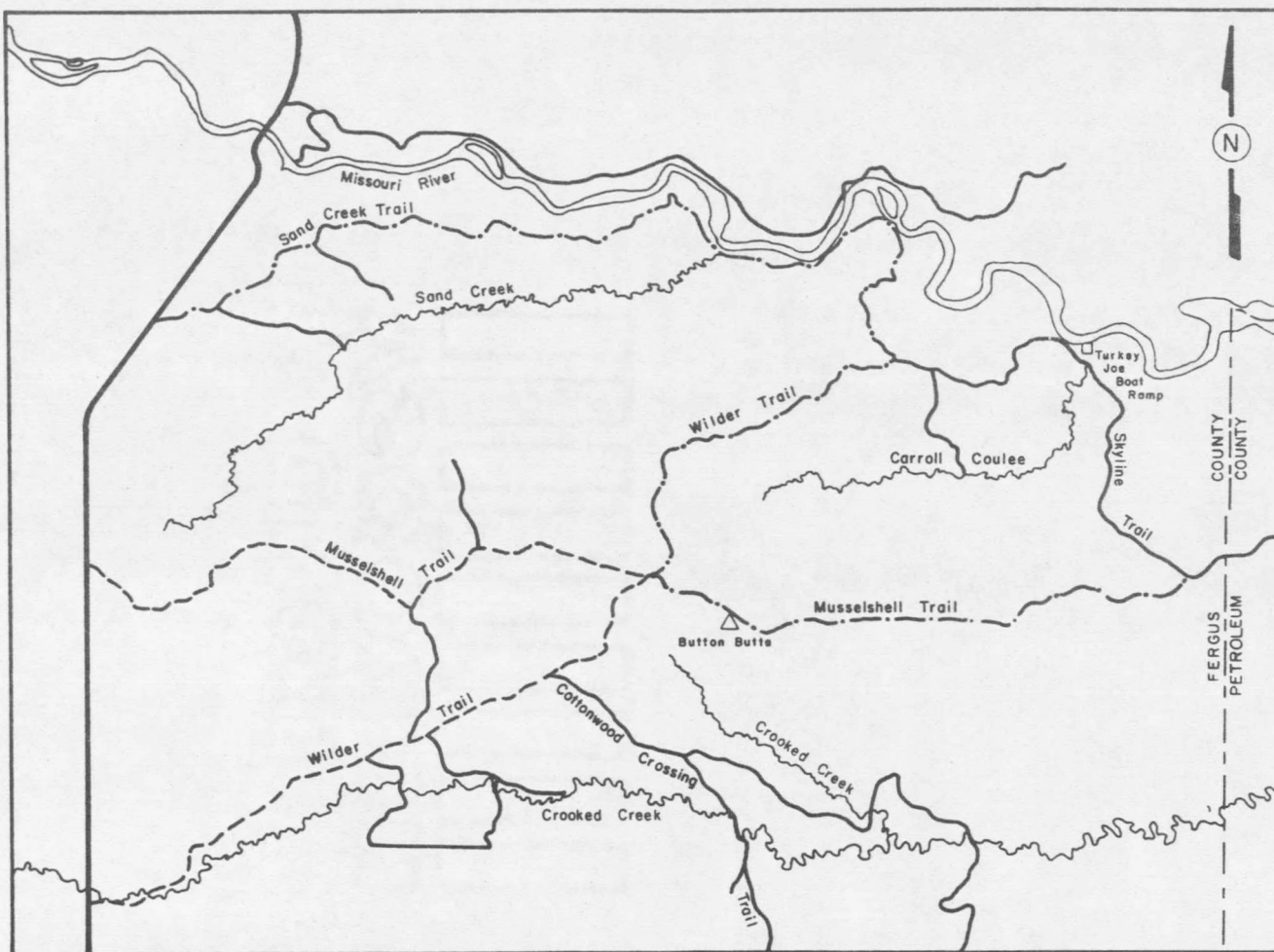
Each survey consisted of driving the route three consecutive nights at 32-48 km/hr (20-30 mph) and recording all sightings of leporids.

Key to Map Symbols

----- Wilder-Musselshell Route

..... Skyline-Sand Creek Route

Figure 2. Map of study area showing Wilder-Musselshell and Skyline-Sand Creek leporid survey routes. Scale: .765 cm = 1 mi.



Observations were recorded by the distance from the starting point, species, and age classes (adult and juvenile).

Two indices of abundance were calculated from the headlight survey data. Index I was calculated by summing the number of leporids, by species, observed over the three night survey, dividing this sum by the total number of kilometers traveled, then multiplying this quotient by 100. This calculation produces the index of number of leporids observed per 100 kilometers.

In the calculation of Index II all observations of leporids during a three night survey were listed in order of distance from the starting point. Using age class and species and assuming leporids observed within .8 km (.5 mi) of each other on different nights to be a single individual, individual rabbits were identified, counted and the index calculated as the number of individuals per 100 kilometers. The divisor in this case is the length of the route. Eight tenths of a kilometer (.5 mi) was used as a criterion of separation since French, et al. (1965) found that *Lepus californicus* Gray (black-tailed jack rabbit) in Idaho rarely moved more than .4 km (.25 mi) from the point of capture.

Pellet group counts were used to calculate an index of abundance to compare vegetation types. This index was calculated by counting the number of leporid pellet groups in the vegetation survey. This data is presented as the average number of pellet groups per line for each vegetation type.

Vegetation Measurement

A slightly modified "step point method" (Evans and Love 1957) was used to describe the vegetation in six of nine vegetation types snap-trapped for small mammals and on the two live trap grids. The vegetation types measured were: Artr-Agsm; Pipo-Jusc; Save-Agsm; Artr-Agsm-Agsp; Psme-Jusc; Arca-Agsm.

At each site snap-trapped for small mammals in the above vegetation types a 300 pace transect was walked along each snap-trap line beginning at the first trap station of each line. Marks on the toes of both boots generated points for observations. From 6 groups of 50 points for each line the mean percent cover of plant species, bare ground, rock, litter, and lichen was calculated.

At each grid live trapped for small mammals two perpendicular 300 pace transects parallel to the rows and columns of the trap grid were walked, their midpoints intersecting in the center of the grids. Mean percent cover of plant species, bare ground, rock, litter, and lichen was calculated from 6 groups of 50 points for each line.

Overstory species such as *Pinus ponderosa* and *Pseudotsuga menziesii* were measured in conjunction with the understory species. After each step was taken and the observation made of the understory, a decision was made as to whether the overstory canopy covered the point. Mean percent cover, by species, was calculated from six groups of 50 points for each transect.

Analyses of variance were performed on the data for selected plant species and bare ground. Means were compared within vegetation types.

General Methods

Mammals named follow Hoffmann and Pattie (1968). Plants named follow Booth (1950) and Booth and Wright (1966). Means were compared using the Montana State University Statistical Library Compare Test (Multiple) (MINISTAT program developed by Richard E. Lund, Department of Mathematics, Montana State University, Bozeman, Montana) on file in the university computer. Significance to the 95 percent level was determined using the Newman-Keuls Q Test. Statistical methods follow Snedecor and Cochran (1957).

RESULTS

Snap-Trapping

P. maniculatus was the most abundant and widely distributed small mammal snap-trapped. Three-hundred-fifty-one individuals of this species were snap-trapped in all trap periods and vegetation types combined. They were captured in each vegetation type in each trap period except for the Pipo-Jusc vegetation type in Trap Period I (Tables 3 and 4). Within trap periods there were few significant differences in the mean number of captures per 100 trap nights between vegetation types. This was due to the wide variation in this index among lines within a vegetation type.

Trapping success for the Save-Agsm vegetation type was significantly higher than that for the other vegetation types in Trap Period IV. The combined mean number of captures of *P. maniculatus* per 100 trap nights for all five trap periods for the Save-Agsm vegetation type was also significantly higher than that for the Pipo-Jusc, Artr-Agsm, Artr-Agsm-Agsp, Psme-Jusc, and Arca-Agsm vegetation types (Table 3). Trapping success per 100 trap nights was also significantly higher for Trap Period V than for the other four trap periods.

Table 4 shows the mean number of captures of *P. maniculatus* per 100 trap nights for the Posa-Syoc, Agricultural Edge and Upland Swale vegetation types in each trap period in which these types were sampled. These types were sampled only once or twice and vegetation was not quantitatively sampled; however the indices are similar to those in

Table 3. Mean number of captures of *P. maniculatus* per 100 trap nights in each trap period for the Pipo-Jusc, Artr-Agsm, Save-Agsm, Artr-Agsm-Agsp, Peme-Jusc, and Arca-Agsm vegetation types, combined means for each vegetation type for all trap periods, and the combined mean for each trap period for all vegetation types. Numbers in parentheses are the mean number of captures of *P. maniculatus* per 100 trap nights based on 120 trap nights per line minus the number of snapped or baitless traps.

Veg. Type	Trap Period					Combined
	I	II	III	IV	V	
	May 1976	July 1976	April	June 1977	August	
Pipo-Jusc	0.00	4.60	*	.62 (.69)	3.95 (5.25)	2.29
Artr-Agsm	1.11	1.94	2.08 (2.92)	4.58 (5.37)	5.20 (7.33)	3.27
Save-Agsm	1.94	5.55	*	7.91 ¹ (9.32) ³	9.16 (13.58) ³	6.48 ²
Artr-Agsm-Agsp	1.11	2.49	*	1.04 (1.14)	3.96 (4.87)	2.20
Peme-Jusc	3.75	2.50	*	2.91 (3.10)	3.75 (4.24)	3.22
Arca-Agsm	*	*	2.22 (3.40)	2.70 (3.46)	6.68 (7.33)	3.72
Combined	1.43	3.48	2.16	3.33	5.47 ⁴	

* Denotes no sampling during trap period.

¹ Denotes a significant difference within a trap period.

² Denotes a significant difference among combined vegetation type means.

³ Denotes a significant difference within a trap period for numbers in parentheses.

⁴ Denotes a significant difference among combined trap period means.

Table 4. Mean number of captures of *P. maniculatus* per 100 trap nights in the Posa-Syoc, Upland Swale, and Agricultural Edge vegetation types. These means were calculated using 120 trap nights per line for Trap Periods I and II.

Trap Period	Date	Vegetation Type	Mean
I	May, 1976	Posa-Syoc	1.66
		Ag. Edges	.28
		Upland Swales	3.61
II	July, 1976	Posa-Syoc	2.08
		Ag. Edges	1.67

Table 3.

In each trap period numbers of male *P. maniculatus* captured exceeded females within both adult and juvenile age classes (Table 5). The percent of adult males captured that were in breeding condition ranged from 91 to 100 percent for Trap Periods I-IV, but fell to 70 percent in Trap Period V. In Trap Periods I, II, IV, and V the percent of adult females in breeding condition ranged from 64 to 80 percent, but was zero in Trap Period III, when sample size was small.

Twenty-four individuals of seven species other than *P. maniculatus* were snap-trapped in the five sampling periods. Seven *Onychomys leucogaster* (Weid-Neuweid) (northern grasshopper mouse) were captured in shrub-grass vegetation types in Trap Periods IV and V in June and August, 1977. Three *Spermophilus tridecemlineatus* (Mitchill) (thirteen-lined ground squirrel) were snap-trapped in the Artr-Agsm vegetation type, one in Trap Period I, and two in Trap Period V.

The seven *Eutamias minimus* (Backman) (least chipmunk) that were captured were trapped primarily in the two timbered vegetation types with one specimen trapped in the Upland Swale vegetation type in Trap Period I. One *Microtus sp.* (vole) was captured in each of the following types; Artr-Agsm, Artr-Agsm-Agsp, and Psme-Jusc. Two *Zapus princeps* J. A. Allen (western jumping mouse), one *Dipodomys ordii* Woodhouse (Ord's kangaroo rat), and one *Lagurus curtatus* (Lopo) (sagebrush vole), were captured in the Agricultural Edge, Artr-Agsm, and Artr-Agsm vegetation types respectively.

Table 5. Total number of *P. maniculatus*, percent adult male, percent adult female, percent juvenile male, percent juvenile female, percent adult males in breeding condition, and percent adult females in breeding condition snap-trapped in each trap period.

Trap Period	Date	Total No. Deer Mice	% A Males	% A Females	% J Males	% J Females	% A Males Breeding	% A Females Breeding
I	May, 1976	44	52	25	16	7	91	81
II	July, 1976	66	47	42	9	2	91	64
III	April, 1976	13	70	30	0	0	100	0
IV	June, 1977	88	40	34	16	10	91	90
V	August, 1977	140	41	33	11	15	70	83

Live Trapping

Density estimates were obtained only for *P. maniculatus* as data for other species were insufficient for an estimation. Density estimates for *P. maniculatus* on the Artr-Agsm live trap grid ranged from a high of 3.29/ha in Trap Series VI to a low of 1.18/ha in Trap Series V, with an average of 2.19/ha for all six trapping series (Table 6). Density estimates for *P. maniculatus* on the Save-Agsm live trap grid ranged from a high of 3.87/ha in Trap Series III to a low of 1.16/ha in Trap Series V and averaged 2.27/ha for all five trapping series (Table 7).

Sample sizes for home ranges were large enough only for comparisons among adult males and adult females in each of the two grids. There were no significant differences among these average home range sizes; thus, home range data from both grids were pooled for each age and sex class. Means were: adult males, .39 ha; adult females, .26 ha; juvenile males, .11 ha; juvenile females, .34 ha.

There were no significant differences among average home range sizes, calculated from all age and sex classes, for each trap series and each grid (Tables 6 and 7). Significant differences among home range means did not occur due to the wide variation within each group compared. This wide variation is shown in Tables 6 and 7 by the standard deviation of the average home range for all age and sex classes for each grid and series.

Turnover of *P. maniculatus* was expressed as the percent loss of marked animals during the interval between trapping series (Table 8). On the Artr-Agsm grid the highest percent loss, 89%, occurred between Trap

Table 6. Total number of *P. maniculatus* trapped during a series, number of individual home ranges used to calculate the average home range (N_1), average home range ($\bar{X}$), standard deviation of the average home range (S.D.), effective area trapped, and a density estimate (No./ha) for all series on the Artr-Agsm live trap grid.

Series	Date	Number Trapped	N_1	Home Range $\bar{X}$ (ha)	S.D.	Effective Area Trapped (ha)	Density No./ha
I	July, 1976	10	6	.32	.33	7.50	1.33
II	Sept., 1976	23	8	.28	.26	7.29	3.15
III	Dec., 1976	19	12	.43	.23	8.06	2.36
IV	June, 1977	14	6	.35	.18	7.65	1.83
V	July, 1977	10	5	.53	.63	8.50	1.18
IV	Aug., 1977	24	2	.28	.06	7.29	3.29
Total/Average		100	39	.39	.30	7.71	2.19

Table 7. Total number of *P. maniculatus* trapped during a series, number of individual home ranges used to calculate the average home range (N_1), average home range ($\bar{X}$), standard deviation of the average home range (S.D.), effective area trapped, and a density estimate (No./ha) for all series on the Save-Agsm live trap grid.

Series	Date	Number Trapped	N_1	Home Range $\bar{X}$ (ha)	S.D.	Effective Area Trapped (ha)	Density No./ha
I	July, 1976	11	6	.38	.25	6.66	1.65
II	Sept., 1976	19	8	.26	.20	6.00	3.17
III	Dec., 1976	23	10	.25	.33	5.94	3.87
IV	June, 1977	7	4	.26	.07	6.00	1.16
V	July, 1977	9	2	.28	.07	6.09	1.48
VI	Aug., 1977	*	*	*	*	*	*
Total/Average		69	30	.28	.24	6.15	2.27

* No data collected due to impassable roads.

Table 8. Turnover of *P. maniculatus* expressed as percent loss of marked animals during the intervals between trapping series for the Artr-Agsm live trap grid and the Save-Agsm live trap grid.

Interval	Dates	Artr-Agsm % Loss P.m.	Save-Agsm % Loss P.m.
I-II	July, 1976-Sept., 1976	60	82
II-III	Sept., 1976-Dec., 1976	74	68
III-IV	Dec., 1976-June, 1977	89	100
IV-V	June, 1977-July, 1977	64	0
V-VI	July, 1977-Aug., 1977	30	*

* No data collected due to impassable roads.

Series III, December, 1976, and Trap Series IV, June, 1977, and the lowest percent loss, 30%, occurred between Trap Series V, July, 1977, and Trap Series VI, August, 1977. The highest percent loss, 100% and the lowest percent loss, zero percent, on the Save-Agsm grid, occurred between Trap Period III, December, 1977, and Trap Period IV, June, 1977, and between Trap Period IV, June, 1977, and Trap Period V, August, 1977, respectively.

Eighteen individuals of three species other than *P. maniculatus* were live trapped. These eighteen individuals consisted of nine *Spermophilus tridecemlineatus*, seven *Onychomys leucogaster*, and two *Lagurus curtatus* (Table 9).

Headlight Surveys and Pellet Group Counts

Indices I (number of observations per kilometer) and II (number of individuals per kilometer), calculated for the Wilder-Musselshell route (Table 10) and Skyline-Sand Creek route (Table 11) show the same relative changes. However, Index II is a more accurate reflection of the population and is used in the following discussion. Index I is presented for comparisons with other studies.

Index II for the Wilder-Musselshell route was relatively low in May, 1976, with a value of 42.3 leporids per 100 km of transect, and also in June, 1977, with a value of 16.9. However, a rise in population levels of leporids with the progression of summer was indicated by a value of 62.1 for the survey run in August, 1976, and a value of 62.0

Table 9. Number of individuals of species other than *P. maniculatus* live trapped in each series in the Artr-Agsm and the Save-Agsm grid.

Arthr-Agsm Grid			
Series	Date	Species	No.
I	July, 1976	<i>Spermophilus tridecemlineatus</i>	6
		<i>Lagurus curtatus</i>	1
II	Sept., 1976	<i>Spermophilus tridecemlineatus</i>	1*
III	Dec., 1976	<i>Onychomys leucogaster</i>	2
		<i>Lagurus curtatus</i>	1
IV	June, 1977	<i>Spermophilus tridecemlineatus</i>	1
		<i>Onychomys leucogaster</i>	1
V	July, 1977	<i>Spermophilus tridecemlineatus</i>	1
		<i>Onychomys leucogaster</i>	1*
VI	Aug., 1977	<i>Spermophilus tridecemlineatus</i>	1
		<i>Onychomys leucogaster</i>	3
Save-Agsm Grid			
Series	Date	Species	No.
III	Dec., 1976	<i>Onychomys leucogaster</i>	1

* Indicates this individual was captured for the first time in the previous trap series.

Table 10. Indices I and II, calculated for *Lepus townsendii* (L.t.), *Sylvilagus auduboni* (S.a.), and total number of leporids, for each date surveyed on the Wilder-Musselshell route.

Date	Index I			Index II		
	L.t./100 km	S.a./100 km	Leporids/100 km	L.t./100 km	S.a./100 km	Leporids/100 km
5/27-5/29 1976	6.0	0.	6.0	42.3	0.	42.3
6/30-7/1 1976	28.2	0.	28.2	76.2	0.	76.2
7/19-7/21 1976	32.2	0.	32.2	59.2	0.	59.2
7/26-7/28 1976	32.3	0.	32.3	48.3	0.	48.3
8/16-8/18 1976	28.2	0.	28.2	62.1	0.	62.1
12/16-12/18 1976	2.8	0.	2.8	8.4	0.	8.4
4/17-4/19 1977	9.4	0.	9.4	16.8	0.	16.8
6/27-6/29 1977	5.6	.9	6.5	14.1	2.8	16.9
7/15-7/17 1977	22.5	0.	22.5	50.8	0.	50.8
7/29-7/31 1977	35.7	2.8	38.5	76.1	8.4	84.5
8/31-9/1 1977	31.0	.9	31.9	59.2	2.8	62.0

Table 11. Indices I and II calculated for *Lepus townsendii* (L. t.), *Sylvilagus audubonii*, (S. a.), and total number of leporids, for each date surveyed on the Skyline-Sand Creek route.

Date	Index I			Index II		
	L.t./100 km	S. a./100 km	Total Leporids/100 km	L. t./100 km	S. a./100 km	Total Leporids/100 km
7/18-7/20 1977	12.4	5.6	18.0	28.2	13.2	41.4
8/16-8/18 1977	1.9	3.7	5.6	7.5	5.6	13.1

for the survey run in August, 1977. Population levels of leporids appear to be low in winter and early spring on the Wilder-Musselshell route. The December, 1976, and April, 1977, surveys yielded values of 8.4 and 16.8 leporids per 100 km of transect, respectively.

The leporid populations in the vicinity of the Wilder-Musselshell route were near the same level in both years. The average number of leporids per 100 km of transect in 1976 from May through August was 57.6. The average number of leporids per 100 km of transect in 1977 from June through August was similar with a value of 53.5.

No year to year comparisons can be made with data from the Skyline-Sand Creek route since this route was surveyed only twice, once in July, and again in August, 1977. However, comparisons can be made between the Skyline-Sand Creek route and the Wilder-Musselshell route for those two months. The Skyline-Sand Creek route appears to have a larger *Sylvilagus audubonii* (Baird) (desert cottontail) population living near the route with a value of 13.2 for July 18-20, 1977, compared with a value of zero on the Wilder-Musselshell route for July 14-17, 1977. Relationships of indices for August, 1977, are similar along the two routes (Tables 10 and 11).

The number of leporids per 100 mi, calculated for Indices I and II, are presented in Appendix Table 13 for the Wilder-Musselshell route and in Appendix Table 14 for the Skyline-Sand Creek route.

The average number of leporid pellet groups per transect line, counted in July, 1977, was 5.14 in the Arca-Agsm vegetation type and

1.14 in the Save-Agsm vegetation type (Table 12). The average number of pellet groups per line in the other four vegetation types sampled, Pipo-Jusc, Artr-Agsm, Artr-Agsm-Agsp, and Psme-Jusc, were less than one and are indicated in Table 14 as trace amounts.

Vegetation

The mean percent coverages and standard deviations of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in each vegetation type are presented in Appendix Tables 15-20. Also shown in these tables are the combined mean percent coverages of bare ground, rock, litter, lichen, and plant taxa for each vegetation type and the standard deviation of the means used in calculating the combined means.

The Artr-Agsm vegetation type, located primarily in the southern portion of the study area, had as its principal shrub *Artemesia tridentata* and its principal grass *Agropyron smithii*. *Chrysothamnus nauseosus* (rubber rabbitbrush) was the only other shrub found in abundance. Other grasses and sedges found in this vegetation type included *Bouteloua gracilis* (blue gramma), *Koeleria cristata* (junegrass), *Stipa viridula* (green needlegrass), and *Carex* sp. (sedge). Forbs found in the Artr-Agsm vegetation type included *Artemesia frigida* (fringed sagewort), *Astragalus bisulcatus* (two grooved milkvetch), *Comandra umbellatum* (bastard toadflax), *Gutierrezia sarothrae* (broom snakeweed), *Opuntia polycantha* (pricklypear), *Phlox hoodii* (Hood's phlox), *Psoralea argophylla* (silverleaf scurfpea), *Selaginella densa* (dense clubmoss), and *Thermopsis rhombifolia* (prairie thermopsis).

Table 12. The average number of leporid pellet groups per line in the Arca-Agsm, Save-Agsm, Pipo-Jusc, Artr-Agsm-Agsp, Artr-Agsm, and Psme-Jusc vegetation types.

Vegetation Type	Average Number of Pellet Groups Per Line
Arca-Agsm	5.14
Save-Agsm	1.14
Pipo-Jusc	T
Artr-Agsm-Agsp	T
Artr-Agsm	T
Psme-Jusc	T

T indicates trace amounts (Mean of less than one).

The Arca-Agsm vegetation type , located in the bottoms associated with Crooked Creek, had as its principal shrub *Artemesia cana* (silver sagebrush), and its principal grass *Agropyron smithii*. *Artemesia tridentata* and *Rosa sp.* (rose) were two other species of shrub found in quantity in this vegetation type. Grasses found in the Arca-Agsm vegetation type included *Bouteloua gracilis*, *Spartina pectinata* (prairie cordgrass), and *Stipa viridula*. Forbs found in this vegetation type included *Achillea millefolium* (yarrow), *Artemesia frigida*, *Astragalus bisulcatus*, *Comandra umbellatum*, *Gutierrezia sarothrae*, *Glycyrrhiza lepidota* (licorice), *Opuntia polycantha*, *Phlox hoodii*, and *Zanthium strumarium* (cocklebur).

The Save-Agsm vegetation type, associated with the benches of the major coulees, had as its principal shrub *Sarcobatus vermiculatus* (greasewood), and as its principal grass *Agropyron smithii*. *Artemesia cana* and *Artemesia tridentata* were two other shrub species associated with this vegetation type. The herbaceous layer was poorly developed in this vegetation type, with *Chenopodium album* (lamb's quarter), *Chenopodium sp.*, *Lepidium perfoliatum* (clasping pepperweed), *Opuntia polycantha*, and *Thlaspi arvense* (fanweed) representing the abundant forbs.

Located primarily on the south-facing slopes of the breaks, the Pipo-Jusc vegetation type had as its principal tree *Pinus ponderosa* and its principal shrub *Juniperus scopulorum* (rocky mountain juniper).

Pseudotsuga menziesii was found scattered among the pines in several sites. *Prunus virginiana* (chokecherry), *Rhus trilobata* (skunkbrush sumac), *Rosa* sp. and *Symphoricarpos albus* (common snowberry) contributed to the scattered shrub cover. Grasses and sedges in this vegetation type had relatively small cover values and forbs were poorly represented. The herbaceous layer was represented by *Agropyron smithii*, *Agropyron spicatum* (bluebunch wheatgrass), *Bouteloua gracilis*, *Carex* sp., *Koeleria cristata*, and *Stipa viridula*.

Pseudotsuga menziesii and *Juniperus scopulorum* were the principal tree and shrub, respectively, of the Psme-Jusc vegetation type located on some of the north-facing slopes in the northern portion of the study area. *Pinus ponderosa* was also present at several sites. *Prunus virginiana*, *Rhus trilobata*, *Ribes cereum* (currant), and *Rosa* sp. contributed to the heavy shrub cover found in this vegetation type. The herbaceous layer in this type was poorly developed with *Carex* sp. and mosses the abundant species.

Located on the lightly grazed ridgetops of the breaks, the Artr-Agsm-Agsp vegetation type had as its principal shrub *Artemesia tridentata* and its principal grass *Agropyron smithii*. *Agropyron spicatum* could not be considered abundant in the sites trapped for small mammals in this vegetation type; however, it was present and was used to separate the ridgetop type from the more heavily grazed Artr-Agsm vegetation type found in the southern portion of the study area. *Chrysothamnus nauseosus* and *Sarcobatus vermiculatus* were two shrub species that were present at

several sites trapped in the Artr-Agsm-Agsp vegetation type. Grasses and sedges found in this type included *Bouteloua gracilis*, *Carex* sp., *Koeleria cristata*, *Stipa comata* (needle-and-thread), and *Stipa viridula*. Forbs in this type were represented by *Artemesia frigida*, *Comandra umbellatum*, *Gutierrisia sarothrae*, *Opuntia polycantha*, *Phlox hoodii*, and *Thermopsis rhombifolia*.

In Appendix Tables 21-26 the mean percent coverages of bare ground and the name taxa (i.e. *Artemesia tridentata* and *Agropyron smithii* for the Artr-Agsm vegetation type) for each transect surveyed within a vegetation type are compared. Within a vegetation type, these comparisons show no or few significant differences in the mean percent coverages of these groups among the transects. This indicates that the sites chosen for trapping within a given vegetation type were similar in respect to the compared groups.

The other three vegetation types sampled for small mammals, Posa-Syoc, Upland Swales, and Agricultural Edges, but not described in this section, were not surveyed for vegetation composition since they were only sampled once or twice. A more complete analysis of the vegetation in the study area can be found in Mackie (1970) and Allen (1968).

DISCUSSION

Peromyscus maniculatus

The most widely distributed and abundant rodent captured during this study was *P. maniculatus*. This animal was trapped in every vegetation type sampled and was captured more often than any other species. Cada (1968), Dusek and McCann (1974), Lampe, et. al. (1974), Maxwell and Brown (1968), and Rickard (1960) demonstrated a similar pattern of distribution and abundance for this species in areas with vegetation comparable to that found in the Missouri River breaks. In spite of the fact that few significant differences were found in the mean number of captures of *P. maniculatus* per 100 trap nights among vegetation types, either within a trap period or for all trap periods combined, some general trends in the distribution of this animal with respect to vegetation type may be noted from the snap-trap data.

Assuming that numbers of mice caught in each vegetation type are a measure of suitability of habitat (Rickard 1960), vegetation types can be arranged into three groups. The Pipo-Jusc and Artr-Agsm-Agsp vegetation types, with combined indices of 2.29 and 2.20 captures per 100 trap nights respectively, appear to be poor habitats for *P. maniculatus*. With combined indices of 3.27, 3.22, and 3.72, the Artr-Agsm, Psme-Jusc, and Arca-Agsm vegetation types, respectively, seem to be good habitats for *P. maniculatus*. The Save-Agsm vegetation type, with an index of 6.48 (significantly different from the other vegetation types), appears to be the best habitat for this species

sampled in the study area. Rickard (1960) and Dusek and McCann (1974) also found that this animal reached its greatest abundance in their study areas in shrub-grasslands and was least abundant in stands of *Pinus ponderosa*.

Due to the seasonal breeding pattern of *P. maniculatus*, abundance indices were low in late spring or early summer but increased by late summer. Sheppe (1963) found *Peromyscus* reproductive activity to begin in late winter, peak in the spring, decline during the summer, and end in late summer or early fall. The breeding activity data from this study suggest a similar pattern. However, data were only collected during the summer and only the late summer decline can be observed. The sex ratio of snap-trapped *P. maniculatus* ranged from 1.1 to 2.3 males per female for all trap periods. This observed sex ratio is probably higher than the real sex ratio due to the greater susceptibility to trapping of males produced by their larger home ranges (Blair 1942; Stickel 1968).

The density of *P. maniculatus*, as reflected by the number of captures per 100 trap nights was low in the Missouri River breaks compared to areas with different vegetation composition, but was similar to areas with comparable vegetation composition. Schladweiler (1976) reported 61.6 and 45.8 captures per 100 trap nights for two sites in cutover *Pseudotsuga menziesii* habitat types in Gallatin County, Montana, in September, 1975. These are seven and five times greater, respectively, than the maximum of 9.16 attained in the

Save-Agsm vegetation type in Trap Period V, August, 1977. However, Schladweiler (1976) obtained index values of 2.2 and 2.7 in September, 1975, for two *Artemesia tridentata* sites in McCone County, Montana. Conversion of Rickard's data (1960) to captures per 100 trap nights show index values of 3.0, 2.4, 1.1, and 2.6 for *Artemesia*, *Agropyron*, *Pinus ponderosa*, and *Festuca* zones, respectively, in eastern Washington and western Idaho.

In contrast to the differences in abundance indices for *P. maniculatus* indicated by the snap-trapping data, live trap grids produced similar density estimates for the Artr-Agsm and Save-Agsm vegetation types. This conflict between the live trapping and snap-trapping data may reflect the bias possible in sampling only one site in each vegetation type by live trapping.

My density estimates which ranged from 1.16 to 3.87 per hectare for the two vegetation types in the Missouri River breaks were quite similar to those obtained by Cada (1968) and Tschache (1970) in an *Artemesia tridentata* vegetation type in Musselshell County, Montana. The density estimates obtained in this study were on the low end of the range presented by Terman (1968) and indicate that the Missouri River breaks area is relatively unproductive with respect to *P. maniculatus*.

The live trapping data show summer population increases similar to the snap-trapping data. The observed December, 1976, densities on the Artr-Agsm (2.36/ha) and Save-Agsm (3.87/ha) grids, respectively,

were surprisingly high. Three possible explanations are: breeding was occurring through the fall; the loss of marked animals between the August and December trapping was low; or the animals were more susceptible to trapping in the winter. Sheppe (1963) found breeding in *Peromyscus* in the northwest United States to cease in late summer or early fall. The percent loss of marked animals from the August to December trapping periods was 74 and 68 percent for the Artr-Agsm and Save-Agsm grids, respectively. This would suggest that the animals were more susceptible to trapping in winter than in summer, due perhaps to differences in food supply. A greater susceptibility to trapping in the winter would produce a relative overestimation of densities.

Home range sizes for *P. maniculatus* calculated for this study are within the range of .01 to 10 acres presented by Stickel (1968). However, in contrast with Stickel (1968), average home range sizes did not show an inverse relationship to density estimates. The average home range for males was larger than that calculated for females but the difference was not significant. Home range sizes were not significantly different among trapping series or grids. Stickel (1968) indicated that home range size is influenced by a combination of physiological and environmental factors such as habitat, food supply, season, weather, age, sex, and population density. These factors, combined with the small sample sizes in this study, have produced high variances in home range size, making it difficult to demonstrate significant differences.

Turnover of *P. maniculatus*, expressed as the percent loss of marked animals during the interval between trapping series, had a direct relationship with the length of the interval. Terman (1968) estimated mortality of *P. maniculatus* as high as 99 percent for one year, but suggests that this may be too high since it is difficult to separate loss from mortality and loss from emigration. The turnover data from this study indicate a similar rate of loss.

Other Species

Density estimates and abundance indices for the seven other species of rodents captured were not calculated due to the paucity of data obtained for these species. The second most abundant species trapped was *Onychomys leucogaster*. A total of 14 individuals were captured in shrub-grassland vegetation types. Anderson and Jones (1971), French and Grant (1974), Cada (1968), and Maxwell and Brown (1968) also found this species associated with shrub-grasslands or grasslands.

Twelve individual *Spermophilus tridecemlineatus* were captured in the Artr-Agsm vegetation type. *S. tridecemlineatus* has been found to be associated with short-grass prairie communities (Anderson and Jones 1971; French and Grant 1974; Maxwell and Brown 1968; Turner 1974). This suggests that in the Missouri River breaks study area this mammal is limited to the southern portion and is not found in the more rugged breaks.

A total of seven individual *Eutamias minimus* were captured. All except one of these individuals were captured in timbered vegetation

types. The one exception was captured in an Upland Swale vegetation type that was in close proximity to a timbered vegetation type. Others working in similar habitats have also found *Eutamias* to be associated with timbered types (Anderson and Jones 1971; Dusek and McCann 1974; Lampe, et. al. 1974; Turner 1974).

Two *Zapus princeps* were snap-trapped in an Agricultural Edge type located in a river bottom next to an alfalfa field. According to Krutzsch (1954), *Z. princeps* is most commonly found near streams where grasses and herbs are abundant and is often taken from alder, aspen, or stands of willows where the moist ground supports a lush undergrowth. The diet of *Z. princeps* consists almost completely of seeds of grasses and grass-like plants (Krutzsch 1954). *Zapus princeps* is probably limited to the bottomlands of the Missouri River where a lush growth of grasses occurs.

Three *Lagurus curtatus* were captured, all in the Artr-Agsm vegetation type. This species has been found to be associated with sagebrush and may even use sagebrush as a source of food (Cada 1968; Birney and Lampe 1972; Lampe, et. al. 1974; Rickard 1960).

Dipodomys ordii was a rare species in the study area, with only one specimen captured. This individual was snap-trapped in the Artr-Agsm vegetation type. Its occurrence in this area is an anomaly as this species is usually associated with sandy soils (Anderson and Jones 1971; Maxwell and Brown 1968; Turner 1974).

The three *Microtus* sp. that were trapped were each caught in a different vegetation type. As no identification was made to species, distributional comparisons would be worthless. The species of *Microtus* with ranges overlapping in this area include *M. ochrogaster* and *M. pennsylvanicus* (Hoffmann and Pattie 1968). In this area *M. ochrogaster* should be associated with dry shrub-grasslands and *M. pennsylvanicus* with riparian habitats or timbered areas with a dense undergrowth (Hoffmann and Pattie 1968).

Leporids

Lepus townsendii was most abundant in the areas of shortgrass prairie found in the southern portion of the study area. On the Skyline-Sand Creek route, which surveyed both the shortgrass prairie to the south and the rugged timbered breaks to the north, this species was observed most often in the southern section of the route from the Skyline Trail to the Wilder-Musselshell junction and was rarely observed in the northern section of that route. Hoffmann and Pattie (1968) state that this species is associated with shortgrass prairie, and Flinders (1975), while studying the effects of grazing systems on leporid abundance in northeastern Colorado, found that *L. townsendii* selected upland sites that were sparsely vegetated.

The geographic distribution of *Sylvilagus nuttalli* and *Sylvilagus auduboni* overlap extensively in the western United States (Hoffmann and Pattie 1968). However, according to Hoffmann and Pattie (1968) where these two species are sympatric in eastern and central Montana,

Sylvilagus nuttallii is restricted to riparian habitats and *Sylvilagus audubonii* is found in dry grasslands, semi-desert and sagebrush desert.

Six *Sylvilagus* were taken in two different areas for identification to species. Four were taken from Crooked Creek and two from a Missouri River bottomland. All six were identified as *Sylvilagus audubonii* (Dennis Flath, Montana Department of Fish and Game, Pers. Comm.). Since all six were taken from riparian habitats it appears as though *S. nuttallii* is not present on the study area.

Seasonal abundance of leporids in this area is a function of the breeding patterns of the species involved. James and Seabloom (1969) found that *L. townsendii* in North Dakota had four synchronous breeding peaks, the first in the latter half of April, the second in early June, the third in mid-July, and the fourth (consisting of only 29 percent of the population) in late August to early September. These breeding peaks were not observable in the data gathered for this study. However, the leporid populations censused in the breaks, consisting mostly of *L. townsendii*, do show an increase from early to late summer. The population levels of leporids were similar in 1976 and 1977.

Pellet group count data indicates leporids were most concentrated in the Arca-Agsm and Save-Agsm vegetation types. *Sylvilagus audubonii* were responsible for the relatively high pellet group counts in these vegetation types as they were flushed frequently in these types during trapping and vegetation surveys.

Recommendations

Abundance and distribution of small mammals may have an important influence on the predator-prey relationship between coyotes and deer (Hawthorne 1972; Korschgen 1972; Leopold 1933; Sperry 1941; Stoddart and Wagner 1972). This study of small mammals provides information on some of the possible alternative prey species of coyotes during the critical fawning and post-fawning period of deer in the Missouri River breaks study area. *P. maniculatus* may be the most abundant and widely distributed alternative prey species. However, as coyotes are selective hunters, other species, such as *Microtus* or leporids, may be more important as alternative prey (Reichel 1976). Further field work in the Missouri River breaks study area should concentrate on identifying *Microtus* habitat, obtain information on the *Microtus* populations, and examine leporid-coyote relationships more closely.

Further field work on small mammal populations should also include the greater use of live trap grids in order to obtain more accurate information on small mammal densities. To obtain population parameters from many sites live trap lines may be more useful than snap-trap lines as the same site can be trapped during each trapping session.

The headlight survey gives only rough indices of leporid abundance. A refinement of this method might be to trap and mark leporids along the routes in order to identify individuals, thus increasing the accuracy of the index.

APPENDIX

Table 13. Indices I and II, calculated in number per 100 miles for *Lepus townsendii* (L. t.) *Sylvilagus audubonii* (S. a.), and total number of leporids, for each date surveyed on the Wilder-Musselshell route.

Date	Index I			Index II		
	L. t./100 mi	S. a./100 mi	Total Leporids/100 mi	L. t./100 mi	S. a./100 mi	Total Leporids/100 mi
5/27-29 1976	9.6	0	9.6	68.2	0	68.2
6/30-7/1 1976	45.4	0	45.4	122.7	0	122.7
7/19-21 1976	51.8	0	51.8	95.4	0	95.4
7/26-28 1976	52.0	0	52.0	77.8	0	77.8
8/16-18 1976	45.4	0	45.4	100.0	0	100.0
12/16-18 1976	4.5	0	4.5	13.6	0	13.6
4/17-19 1977	15.1	0	15.1	27.2	0	27.2
6/27-29 1977	9.1	1.5	10.6	22.7	4.5	27.2
7/15-17 1977	36.3	0	36.3	81.8	0	81.8
7/29-31 1977	57.5	4.5	62.1	122.7	13.6	136.3
8/31-9/1 1977	50.0	1.5	51.5	95.4	4.5	99.9

Table 14. Indices I and II, calculated in number per 100 miles for *Lepus townsendii* (L. t.), *Sylvilagus auduboni* (S. a.), and total number of leporids, for each date surveyed on the Skyline-Sand Creek route.

Date	Index I			Index II		
	L. t./100 mi	S. a./100 mi	Total Leporids/100 mi	L. t./100 mi	S. a./100 mi	Total Leporids/100 mi
7/18-20 1977	20	9	29	45.4	21.2	66.6
8/16-18 1977	3	6	9	12.1	9.1	21.2

Table 15. Mean percent coverages ($\bar{X}$) and standard deviations (SD) of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in the Artr-Agsm vegetation type, mean percent coverages ($\bar{X}_1$) of the preceding groups for all transects of the Artr-Agsm vegetation type combined, and the standard deviation (SD₁) of the means used in calculating the combined mean percent cover.¹ Transects 9 and 10 were at the Artr-Agsm live trap grid.

Taxa	Transect																					
	1		2		3		4		5		6		7		8		9		10		Combined	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}_1$	SD ₁
Ground	23	11	31	11	37	7	33	9	33	8	32	7	34	9	26	9	40	7	39	3	33	5
Rock	4	3	14	5	10	8	2	4	1	2	4	3	3	3	4	2	2	1	0	0	4	4
Litter	2	1	3	3	6	1	10	4	6	4	8	4	2	1	6	4	2	2	4	3	5	3
Lichen	6	1	8	2	3	3	5	7	2	1	2	3	5	3	4	3	T	-	2	2	4	2
<i>Artemesia tridentata</i>	10	5	6	5	23	12	13	9	14	4	10	4	5	6	16	8	13	9	22	6	13	6
<i>Chrysothamnus nauseosus</i>	0	0	0	0	T	-	1	2	0	0	0	0	T	-	T	-	T	-	T	-	T	-
<i>Agropyron smithii</i>	22	10	11	4	15	3	18	11	23	9	27	7	18	7	16	8	27	9	21	7	20	5
<i>Bouteloua gracilis</i>	25	4	16	8	3	2	4	3	13	4	10	6	23	4	10	6	3	2	2	2	11	8
<i>Carex</i> sp.	0	0	0	0	0	0	T	-	0	0	1	2	0	0	T	-	0	0	0	0	T	-
<i>Koeleria cristata</i>	0	0	5	3	T	-	3	2	0	0	0	0	1	1	1	1	0	0	0	0	T	-
<i>Stipa viridula</i>	0	0	0	0	0	0	1	2	2	2	0	0	T	-	0	0	2	1	3	2	T	-
<i>Artemesia frigida</i>	0	0	3	2	0	0	T	-	0	0	0	0	5	3	0	0	3	2	T	-	T	-
<i>Astragalus bisulcatus</i>	T	-	T	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T	-
<i>Comandra umbellatum</i>	0	0	0	0	2	2	4	3	1	2	3	3	0	0	2	2	3	3	5	5	2	2
<i>Opuntia polycantha</i>	2	2	T	0	0	0	1	2	1	2	1	1	3	2	1	2	0	0	1	1	1	1
<i>Phlox hoodii</i>	1	2	T	-	0	0	1	2	1	1	1	1	1	1	1	1	0	0	0	0	T	-
<i>Psoralea argophylla</i>	1	2	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	T	-
<i>Selaginella densa</i>	4	6	T	-	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	T	-
<i>Thermopsis rhombifolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	T	-

¹ Data were obtained from a modified step-point method.

T Indicates trace amounts less than one.

Table 16. Mean percent coverages ($\bar{X}$) and standard deviations (SD) of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in the Arca-Agsm vegetation type, mean percent coverages ($\bar{X}_1$) of the preceding groups for all transects of the Arca-Agsm vegetation type combined, and the standard deviation (SD_1) of the means used in calculating the combined mean percent coverage.¹

Taxa	Transect										Combined							
	1		2		3		4		5				6		7		8	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}_1$	SD ₁
Ground	18	8	20	7	26	10	22	7	23	7	16	7	19	7	22	9	20	3
Rock	0	0	0	0	0	0	0	0	1	2	T	-	1	2	0	0	T	-
Litter	6	3	2	3	8	5	5	3	2	3	3	3	5	3	3	3	4	2
Lichen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Artemesia oana</i>	27	8	28	6	17	10	23	14	5	5	7	8	21	6	17	8	18	8
<i>Artemesia tridentata</i>	2	4	3	5	10	10	2	4	1	2	2	2	1	2	2	2	3	3
<i>Rosa</i> sp.	5	5	3	4	2	2	6	6	17	2	14	13	7	8	11	9	8	5
<i>Agropyron smithii</i>	36	6	40	15	31	8	35	17	41	13	21	11	26	13	30	13	32	7
<i>Bouteloua gracilis</i>	0	0	1	2	3	4	1	2	0	0	0	0	4	4	0	0	1	1
<i>Spartina pectinata</i>	3	4	1	1	0	0	2	5	1	2	3	5	0	0	2	3	2	1
<i>Stipa viridula</i>	0	0	0	0	0	0	0	0	3	3	5	4	2	3	6	9	2	3
<i>Achillia millefolium</i>	0	0	0	0	0	0	0	0	0	0	1	1	3	3	3	3	1	1
<i>Artemesia frigida</i>	0	0	0	0	0	0	0	0	0	0	0	0	5	4	1	1	T	-
<i>Astragalus bisulcatus</i>	0	0	0	0	0	0	0	0	0	0	25	10	5	4	1	1	3	3
<i>Comandra umbellatum</i>	0	0	T	-	0	0	1	1	0	0	0	0	0	0	0	0	T	-
<i>Gutierrezia sarothrae</i>	0	0	0	0	0	0	0	0	0	0	T	-	0	0	0	0	T	-
<i>Glycyrrhiza lepidota</i>	1	2	1	2	T	-	1	2	1	2	1	2	T	-	2	3	2	2
<i>Opuntia polyacantha</i>	0	0	0	0	1	2	T	-	0	0	0	0	2	2	0	0	T	-
<i>Phlox hoodii</i>	0	0	T	-	1	1	T	-	0	0	0	0	0	0	0	0	T	-
<i>Xanthium strumarium</i>	0	0	0	0	0	0	0	0	4	3	3	4	0	0	0	0	1	1

¹ Data were obtained from a modified step-point method.
T Indicates trace amounts less than one.

Table 17. Mean percent coverages ($\bar{X}$) and standard deviations (SD) of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in the Save-Agsm vegetation type, mean percent coverages ($\bar{X}_1$) of the preceding groups for all transects of the Save-Agsm vegetation type combined, and the standard deviation (SD₁) of the means used in calculating the combined mean percent cover.¹ Transects 9 and 10 were at the Save-Agsm live trap grid.

Taxa	Transect																					
	1		2		3		4		5		6		7		8		9		10		Combined	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}_1$	SD ₁
Ground	49	19	51	8	12	8	26	12	26	8	37	6	40	6	30	10	50	8	49	7	37	13
Rock	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T	-
Litter	3	3	5	2	3	4	5	3	3	2	3	2	3	3	5	4	5	4	5	3	4	1
Lichen	1	2	3	4	0	0	0	0	T	-	0	0	0	0	0	0	4	2	4	2	1	2
<i>Artemesia cana</i>	0	0	0	0	0	0	0	0	0	0	0	0	T	-	0	0	0	0	0	0	T	-
<i>Artemesia tridentata</i>	7	8	1	2	0	0	T	-	0	0	0	0	0	0	0	0	1	2	3	3	1	2
<i>Sarcobatus vermiculatus</i>	18	6	19	6	28	7	27	4	35	9	26	7	30	10	29	10	14	2	13	2	24	7
<i>Agropyron smithii</i>	14	6	12	8	45	12	9	4	20	20	24	6	21	6	27	12	14	3	14	4	20	10
<i>Chenopodium album</i>	0	0	2	3	4	2	14	9	4	4	1	2	T	-	0	0	0	0	T	-	4	3
<i>Chenopodium</i> sp.	2	2	4	3	T	-	0	0	5	4	0	0	T	-	0	0	6	4	5	3	2	2
<i>Lepidium perfoliatum</i>	0	0	0	0	2	3	10	4	T	-	0	0	0	0	0	0	0	0	0	0	1	3
<i>Opuntia polycantha</i>	3	4	3	2	2	2	10	8	5	4	4	3	5	2	8	2	6	2	7	3	5	2
<i>Thlaspi arvense</i>	2	2	T	-	1	1	T	-	0	0	0	0	0	0	0	0	T	-	T	-	T	-

¹ Data were obtained from a modified step-point method.

T Indicates trace amounts less than one.

Table 18. Mean percent coverages ($\bar{X}$) and standard deviations (SD) of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in the Pipo-Jusc vegetation type, mean percent coverages ($\bar{X}_1$) of the preceding groups for all transects of the Pipo-Jusc vegetation type combined, and the standard deviation (SD_1) of the means used in calculating the combined mean percent coverage.¹

Taxa	Transect																Combined	
	1		2		3		4		5		6		7		8			
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}_1$	SD ₁
Ground	4	4	1	2	20	8	17	9	11	7	4	4	11	8	8	8	10	7
Rock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Litter	50	15	65	5	66	9	50	4	72	15	72	11	72	8	49	8	68	10
Lichen	T	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T	-
<i>Artemesia tridentata</i>	T	-	0	0	0	0	T	-	1	1	0	0	0	0	0	0	T	-
<i>Juniperus scopulorum</i>	27	10	14	5	0	0	9	8	8	3	8	5	12	5	22	10	13	8
<i>Prunus virginiana</i>	0	0	0	0	0	0	0	0	0	0	T	-	0	0	0	0	T	-
<i>Rhus trilobata</i>	1	1	0	0	0	0	2	2	T	-	0	0	1	2	1	2	T	-
<i>Rosa sp.</i>	T	-	0	0	0	0	0	0	T	-	0	0	T	-	0	0	T	-
<i>Symphoricarpos albus</i>	0	0	0	0	0	0	0	0	0	0	0	0	4	4	1	2	T	-
<i>Agropyron smithii</i>	6	6	4	1	0	0	2	2	2	2	1	2	1	2	0	0	2	2
<i>Agropyron spicatum</i>	4	2	0	0	T	-	2	2	2	2	1	2	1	1	3	3	2	1
<i>Bouteloua gracilis</i>	0	0	0	0	T	-	0	0	0	0	0	0	0	0	0	0	T	-
<i>Carex sp.</i>	2	3	16	5	11	5	17	3	4	3	12	11	1	1	15	5	10	6
<i>Koeleria cristata</i>	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T	-
<i>Stipa viridula</i>	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	T	-
<i>Artemesia frigida</i>	0	0	0	0	T	-	0	0	0	0	0	0	0	0	0	0	T	-
<i>Pinus ponderosa</i>	35	13	39	15	32	10	17	5	40	13	25	8	39	12	34	10	33	8
<i>Pseudotsuga menziesii</i>	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	T	-

¹ Data were obtained from a modified step-point method.

T Indicates trace amounts less than one.

Table 19. Mean percent coverages ($\bar{X}$) and standard deviations (SD) of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in the Psme-Jusc vegetation type, mean percent coverages ($\bar{X}_1$) of the preceding groups from all transects of the Psme-Jusc vegetation type combined, and the standard deviation (SD_1) of the means used in calculating the combined mean percent coverage.¹

Taxa	Transect									
	1		2		3		4		Combined	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}_1$	SD_1
Ground	8	7	8	6	6	5	9	4	7	1
Rock	0	0	0	0	0	0	0	0	0	0
Litter	21	11	29	15	19	9	53	8	30	15
Lichen	3	4	1	2	1	2	0	0	1	1
<i>Juniperus scopulorum</i>	36	15	38	14	42	11	27	10	35	6
<i>Prunus virginiana</i>	3	2	0	0	0	0	0	0	T	-
<i>Rhus trilobata</i>	5	5	4	5	5	4	0	0	3	2
<i>Ribes cereum</i>	4	4	3	3	4	4	0	0	2	2
<i>Rosa sp.</i>	17	9	13	15	15	14	0	0	11	7
<i>Carex sp.</i>	2	2	2	2	2	2	3	6	3	2
Moss	4	4	5	4	5	4	8	3	5	2
<i>Pinus ponderosa</i>	2	2	3	2	2	3	6	3	3	2
<i>Pseudotsuga menziesii</i>	37	8	35	13	35	14	36	9	35	1

¹ Data were obtained from a modified step-point method.

T Indicates trace amounts less than one.

Table 20. Mean percent coverages ($\bar{X}$) and standard deviations (SD) of bare ground, rock, litter, lichen, and plant taxa for each transect surveyed in the Artr-Agsm-Agsp vegetation type, mean percent coverages ($\bar{X}_1$) of the preceding groups for all transects of the Artr-Agsm-Agsp vegetation type combined, and the standard deviation (SD_1) of the means used in calculating the combined mean percent coverage.¹

Taxa	Transect													
	1		2		3		4		5		6		7	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
													Combined	
													$\bar{X}_1$	SD_1
Ground	35	15	34	8	32	4	30	3	26	4	23	8	19	6
Rock	5	6	2	3	6	4	7	3	1	1	4	4	7	8
Litter	6	3	3	4	2	2	6	4	4	3	3	2	T	-
Lichen	T	-	T	-	4	3	2	1	T	-	1	1	1	1
<i>Artemesia tridentata</i>	4	3	23	11	12	7	10	2	13	6	12	3	8	4
<i>Chrysothamnus nauseosus</i>	0	0	T	-	T	-	0	0	0	0	0	0	0	0
<i>Sarcobatus vermiculatus</i>	T	-	T	-	1	1	2	2	T	-	0	0	0	0
<i>Agropyron smithii</i>	34	12	28	14	18	4	31	8	28	5	33	7	18	7
<i>Agropyron spicatum</i>	1	1	0	0	T	-	1	1	T	-	1	1	0	0
<i>Bouteloua gracilis</i>	7	5	3	3	13	8	3	3	10	3	11	9	38	12
<i>Carex</i> sp.	0	0	0	0	0	0	T	-	0	0	T	-	0	0
<i>Koeleria cristata</i>	1	1	2	2	3	2	T	-	3	2	2	1	2	2
<i>Stipa comata</i>	0	0	0	0	0	0	T	-	0	0	0	0	0	0
<i>Stipa viridula</i>	0	0	T	-	T	-	T	-	7	3	4	1	0	0
<i>Artemesia frigida</i>	0	0	0	0	1	2	0	0	0	0	0	0	2	2
<i>Comandra umbellatum</i>	1	1	2	3	2	2	2	2	2	2	3	4	1	1
<i>Gutierrezia sarothrae</i>	0	0	0	0	0	0	0	0	T	-	0	0	T	-
<i>Opuntia polyacantha</i>	4	3	2	3	3	2	5	1	5	3	3	2	4	3
<i>Phlox hoodii</i>	1	1	0	0	T	-	0	0	1	2	T	-	1	1
<i>Thermopsis rhombifolia</i>	0	0	0	0	0	0	T	-	0	0	T	-	0	0

¹ Data were obtained from a modified step-point method.

T Indicates trace amounts less than one.

Table 21. Mean percent coverages of bare ground, *Artemesia tridentata* (Artr), and *Agropyron smithii* (Agsm) at each site trapped for small mammals in an Artr-Agsm vegetation type. Transects 1-8 were at the snap-trap sites. Trasects 9 and 10 were at the live trap grid. Means within a taxon with identical letters were not significantly different.

Bare Ground		Artr		Agsm	
Transect	Mean	Transect	Mean	Transect	Mean
3	37 a	3	23 a	6	27 a
4	34 a	8	16 ab	8	27 a
7	34 a	5	14 ab	5	24 ab
5	33 a	4	13 ab	1	22 ab
6	32 a	6	11 b	7	18 ab
2	31 a	1	11 b	4	18 ab
1	26 a	10	9 b	10	18 ab
8	26 a	9	6 b	3	15 ab
9	23 a	2	6 b	9	14 b
10	23 a	7	5 b	2	12 b

Table 22. Mean percent coverages of bare ground, *Artemesia cana* (Arca), and *Agropyron smithii* (Agsm) at each site snap-trapped for small mammals in an Arca-Agsm vegetation type. Means within a taxon with identical letters were not significantly different.

Bare Ground		Arca		Agsm	
Transect	Mean	Transect	Mean	Transect	Mean
3	26 a	2	28 a	2	41 a
5	24 a	1	27 a	5	41 a
4	23 a	4	23 a	1	36 a
8	22 a	7	21 a	4	35 a
2	20 a	3	17 ab	3	31 a
7	19 a	8	17 ab	8	30 a
1	18 a	6	7 b	7	26 a
6	16 a	5	5 b	6	21 a

Table 23. Mean percent coverages of bare ground, *Sarcobatus vermiculatus* (Save), and *Agropyron smithii* (Agsm) at each site trapped for small mammals in a Save-Agsm vegetation type. Transects 1-8 were at the snap-trap sites. Transects 9 and 10 were at the live trap grid. Means within a taxon with identical letters were not significantly different.

Bare Ground		Save		Agsm	
Transect	Mean	Transect	Mean	Transect	Mean
2	51 a	5	35 a	3	45 a
9	50 a	6	31 ab	8	28 b
1	49 a	7	30 abc	6	24 b
10	49 a	8	29 abc	7	21 b
7	39 ab	3	28 abc	5	21 b
6	37 ab	4	27 abc	9	15 b
8	30 b	2	19 bcde	10	14 b
5	26 b	1	18 cde	1	14 b
4	26 b	9	14 de	2	12 b
3	15 b	10	13 e	4	9 c

Table 24. Mean percent coverages of bare ground, *Pinus ponderosa* (Pipo), and *Juniperus scopulorum* (Jusc) at each site snap-trapped for small mammals in a Pipo-Jusc vegetation type. Means within a taxon with identical letters were not significantly different.

Bare Ground		Pipo		Jusc	
Transect	Mean	Transect	Mean	Transect	Mean
3	20 a	2	39 a	1	27 a
4	17 ab	5	39 a	8	22 a
5	11 abc	7	39 a	2	14 bc
7	11 abc	1	35 ab	7	12 c
8	8 bc	8	34 ab	4	10 cd
1	4 c	3	32 ab	6	9 cd
6	4 c	6	25 ab	5	8 cd
2	1 c	4	17 b	3	0 d

Table 25. Mean percent coverages of bare ground, *Pseudotsuga menzeisii* (Psme), and *Juniperus scopulorum* (Jusc) at each site snap-trapped for small mammals in a Psme-Jusc vegetation type. Means within a taxon with identical letters were not significantly different.

Bare Ground					
Transect	Mean	Transect	Mean	Transect	Mean
4	9 a	1	37 a	3	42 a
1	8 a	4	37 a	2	38 a
2	8 a	3	36 a	1	36 a
3	6 a	2	35 a	4	26 a

Table 26. Mean percent coverages of bare ground, *Artemesia tridentata* (Artr), *Agropyron smithii* (Agsm), and *Agropyron spicatum* (Agsp) at each site snap-trapped for small mammals in an Artr-Agsm-Agsp vegetation type. Means within a taxon with identical letters were not significantly different

Bare Ground		Artr		Agsm		Agsp	
Transect	Mean	Transect	Mean	Transect	Mean	Transect	Mean
1	35 a	2	23 a	1	34 a	8	4 a
2	34 a	8	16 ab	6	33 ab	1	1 b
3	32 a	5	13 bc	4	31 ab	6	1 b
4	30 a	6	12 bc	2	29 ab	4	1 b
5	26 ab	3	12 bc	5	28 ab	3	0 b
6	24 ab	4	10 bc	8	26 ab	5	0 b
7	19 b	7	8 bc	3	18 b	2	0 b
8	16 b	1	4 c	7	18 b	7	0 b

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