



Ecological distribution of small mammals at Sarpy Creek, Montana, with special consideration of the deer mouse, *Peromyscus maniculatus*
by Kenneth Lee Scow

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

In conjunction with the development of coal mining activities, a study of the ecological distribution of small mammals was conducted in the Sarpy Creek area of southeastern Montana from 1975-1976. Small mammal species were snap trapped in six important vegetation types and live trapped in the ponderosa pine, skunkbush sumac and grassland types. Small mammal species were distributed ecologically as expected, and results agreed with similar studies which have been conducted in southeastern Montana from 1975-1980. Small mammal diversity was highest in the grassland type, followed in order by the shrubland and woodland types. The species most commonly trapped at Sarpy Creek was the deer mouse (*Peromyscus maniculatus*). Deer mouse densities, based upon calculations of home range size, averaged three to four individuals per hectare in the pine type and one to two individuals per hectare in the shrubland and grassland types. These densities generally agreed with those found in the aforementioned studies. Computer analyses were run to correlate the trapping success of deer mice with vegetation species frequency of occurrence and canopy coverage on the three live trap grids. A limited number of correlations were found by discriminant analysis, probably due to the nature of the system tested and/or field methodology. Correlations could not be attributed to plants as a food source. Canopy cover comparisons indicated that deer mice on the pine grid showed a positive correlation with bare ground and a negative correlation with tree cover.

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ECOLOGICAL DISTRIBUTION OF SMALL MAMMALS AT SARPY CREEK,
MONTANA, WITH SPECIAL CONSIDERATION OF THE
DEER MOUSE, PEROMYSCUS MANICULATUS

by

KENNETH LEE SCOW

A thesis submitted in partial fulfillment
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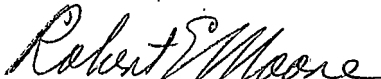
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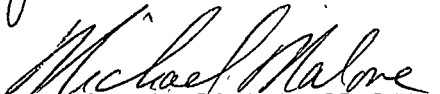
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ABSTRACT

In conjunction with the development of coal mining activities, a study of the ecological distribution of small mammals was conducted in the Sarpy Creek area of southeastern Montana from 1975-1976. Small mammal species were snap trapped in six important vegetation types and live trapped in the ponderosa pine, skunkbush sumac and grassland types. Small mammal species were distributed ecologically as expected, and results agreed with similar studies which have been conducted in southeastern Montana from 1975-1980. Small mammal diversity was highest in the grassland type, followed in order by the shrubland and woodland types. The species most commonly trapped at Sarpy Creek was the deer mouse (Peromyscus maniculatus). Deer mouse densities, based upon calculations of home range size, averaged three to four individuals per hectare in the pine type and one to two individuals per hectare in the shrubland and grassland types. These densities generally agreed with those found in the aforementioned studies. Computer analyses were run to correlate the trapping success of deer mice with vegetation species frequency of occurrence and canopy coverage on the three live trap grids. A limited number of correlations were found by discriminant analysis, probably due to the nature of the system tested and/or field methodology. Correlations could not be attributed to plants as a food source. Canopy cover comparisons indicated that deer mice on the pine grid showed a positive correlation with bare ground and a negative correlation with tree cover.

INTRODUCTION

Hoffmann and Pattie (1968) expressed the need for additional information on the distribution and habitat requirements of numerous small mammal species in Montana, especially in the eastern section of the state. Few studies of the ecological distribution of small mammals had been conducted in eastern Montana prior to exploration for and development of coal mining activities in the region during the 1970's.

The Montana Strip and Underground Mine Reclamation Act (Title 50, Chapter 10, R.C.M. 1947) recognized the importance of small mammals in complex ecosystems. Baseline study goals were outlined to determine pre-mining small mammal community structure in terms of species diversity and densities in relation to habitat. A major theoretical contention was that reclamation of disturbed land may be considered to be progressing favorably when small mammal populations in reclaimed areas resemble pre-mining populations.

This survey of small mammals was conducted in the Sarpy Creek, Montana area during the summers of 1975 and 1976 and during short trips to the area in February and May, 1976. The objectives of the study were to:

- 1) describe the major vegetation types on the study area;
- 2) utilize snap trapping procedures to compare relative densities of small mammal species in predominant Sarpy Creek vegetation types;

- 3) calculate home ranges and densities of deer mice (Peromyscus maniculatus) from live trapping in three important vegetation types;
- 4) correlate various features of vegetation on the three live trap sites with trapping success of deer mice; and
- 5) compare trapping success of deer mice and other species of small mammals at Sarpy Creek with the results of recent small mammal surveys in other areas of southeastern Montana.

DESCRIPTION OF THE STUDY AREA

The Sarpy Creek study area is located in southeastern Montana approximately 30 miles south of Hysham and 40 miles east of Hardin. The area includes approximately 14,770 hectares of parts of Townships 1-3 North, Ranges 37 and 38 East at the junction of Big Horn, Treasure and Rosebud Counties (Figure 1). The study area encompasses portions of the drainages of Sarpy, East Fork Sarpy and Horse Creeks.

The Tongue River Member of the Fort Union Formation is the principal geologic feature of the study area. The primary soil associations are the Flasher-Bainville and the Bainville-Midway, both having low to moderate water storage capabilities (Soil Conservation Service, 1967). The climate is semi-arid with hot, dry summers and moderately cold, dry winters. Lowest average monthly precipitation occurs during February (0.4 inches) and the highest during June (2.6 inches) (NOAA, 1976).

Broad creek bottoms along major drainages such as Sarpy Creek support riparian vegetation dominated by deciduous tree species. Grain and alfalfa agriculture is limited to the bottomlands. Creek bottoms grade into rolling foot hills dominated by stands of big sagebrush (Artemisia tridentata) and some silver sagebrush (Artemisia cana). There is also open grassland composed of wheatgrass/grama grass associations (Agropyron/Bouteloua). Well-dissected, sometimes rugged upland areas are characterized by irregular, mostly open

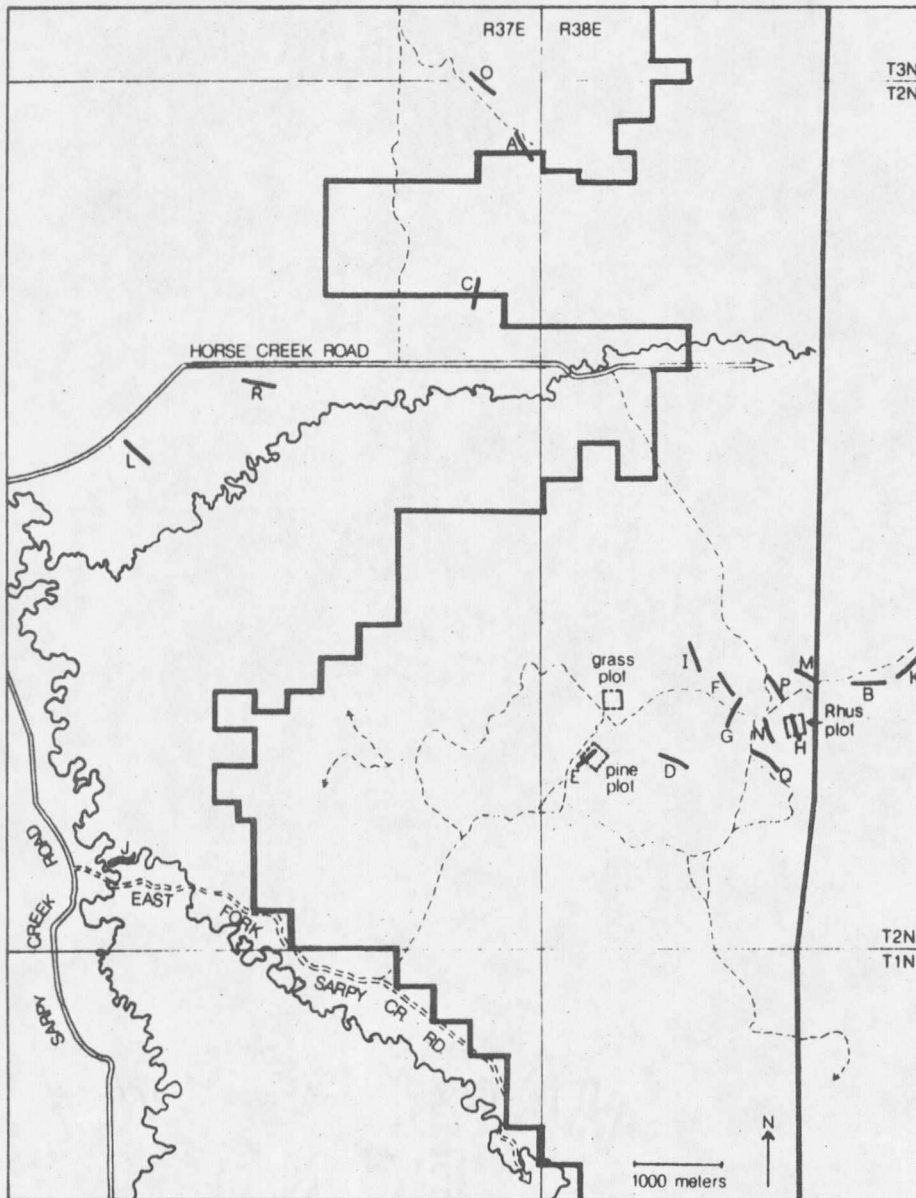


Fig. 1. Map of the study area showing locations of snap trap lines and live trap grids. Refer to page 7 of text for identification of vegetation types of snap trapping lines.

stands of ponderosa pine (Pinus ponderosa). Many upland sites are dominated by skunkbush sumac (Rhus trilobata) and silver sagebrush, as well as big sagebrush and wheatgrass/grama grassland. Where upland bottoms are not dominated by ponderosa pine, a deciduous shrub association of hawthorn/chokecherry/rose (Crataegus/Prunus virginiana/Rosa woodsii) usually dominates. All portions of the study area are utilized for grazing of livestock.

METHODS

Vegetation

Quantitative measurements of the vegetation on three live trap grids and along three snap trap lines were made to describe the important habitats for small mammals. All pine trees on the ponderosa pine live trap plot were counted and classified according to 5 cm dbh classes in August, 1975. Core samples were taken from ten specimens of each dbh class on the plot.

In August, 1976, a circular plot method was employed to measure vegetation on the three live trap plots. The center of a 4 m² circular plot (1.13 m radius) was placed at each of the 225 station markers of a given live trap plot. At each station all trees, shrub and herbaceous species within the circular plot were recorded. Woody plants 2.5 m or greater in height were classified as trees and those between 0.25 and 2.5 m as shrubs. All non-woody species as well as plants less than 0.25 m were considered to be herbs. Percent coverage within each circular plot was estimated to the nearest five percent for the following classes: rock, bare ground, litter, grasses, forbs and lichens. Tree and shrub canopy coverages were estimated by species in the same manner. The herbaceous species present at each station were listed in order from greatest to least coverage. These rankings were averaged by species for each plot to obtain a relative index of coverage.

The circular plot method was used to obtain similar vegetational data for three important habitats not represented by the live trap plots. Data were obtained in August, 1976, on the following snap trap lines: "N" (silver sage), "I" (deciduous shrub bottom), and "J" (bottomland) (Figure 1). A circular plot was placed at each of the 20 stations of each trap line and at a supplementary 20 stations on a line parallel to and 30 m from each trap line.

Plant specimens from throughout the study area were collected and pressed. These were later identified by reference to Booth and Wright (1966), verified by Dr. J. Rumely, curator of the Montana State University herbarium, and compiled into a species list.

Small Mammal Trapping

Eighteen snap trap lines were established in seven major habitats (Figure 1), and small mammals were sampled along the lines during five trapping periods. The habitats and their respective traplines are given below. Table 1 gives the schedule for snap trapping.

<u>Vegetation Type</u>	<u>Trapline Designations</u>
Ponderosa Pine	A, B, C, D, E, Q
Skunkbush Sumac	F, G, H
Deciduous Shrub Bottom	I
Riparian Deciduous Tree	J
Silver Sagebrush	K, L, M, N
Big Sagebrush	O, P
Grassland	R

TABLE 1.--DATES OF SNAP TRAPPING ALONG LINES IN SEVEN HABITATS. REFER TO FIGURE 1 FOR LOCATIONS OF THE LINES

Date of Trapping Period	Vegetation Type	Lines Trapped
17 August - 6 September, 1975	Ponderosa Pine	A, B, Q
	Sumac	F
	Silver Sage	K
	Big Sage	O
17-19 February, 1976	Ponderosa Pine	C
	Silver Sage	L
	Grassland	R
22-24 May, 1976	Ponderosa Pine	D, Q
	Sumac	F
	Deciduous Shrub Bottom	I
	Big Sage	P
18-25 July, 1976	Ponderosa Pine	D, Q
	Sumac	G
	Deciduous Shrub Bottom	I
	Riparian Deciduous Tree	J
	Silver Sage	M
12-17 September, 1976	Ponderosa Pine	E
	Sumac	H
	Deciduous Shrub Bottom	I
	Riparian Deciduous Tree	J
	Silver Sage	N

Each snap trap line consisted of 20 stations, spaced 15 m apart. Three Museum Special snap traps, baited with peanut butter and oats, were set within 1 m of each station marker. Each line was trapped for three consecutive nights. Traps were checked each morning, rebaited and reset. Animals were collected, tagged and recorded as to species, sex, age and reproductive condition. Later, standard length measurements were made, and each animal was dissected to determine its reproductive status. Testis length and width were measured to the nearest mm in males. In females, any embryos present were counted and measured along their longest axes. Males were designated as being in reproductive condition if testes lengths were 8 mm or longer (Sheppe, 1963). Females were judged as to reproductive condition by the presence of embryos, size of reproductive tracts or external appearance of mammae and genital areas.

Three live trap plots were established in common habitats of the Sarpy Creek drainage, each dominated by a distinctly different physiognomic form of vegetation (Figure 1). One woodland plot was established in a ravine stand of ponderosa pine (Pinus ponderosa). A shrubland plot was located within a mature stand of skunkbush sumac (Rhus trilobata). The third plot, representing a grassland habitat, was situated on a hillside which had been cultivated as recently as the 1920's.

The three plots were trapped for small mammals during four

summer periods: July 11-29 and August 9-20, 1975, and June 21 - July 3 and August 19-29, 1976. A live trap plot consisted of a grid of 15 by 15 stations spaced 15 m apart, thus encompassing an area of 4.41 hectares. One Sherman live trap (8 x 8 x 23 cm) baited with rolled oats was placed within 0.5 m of each station. A single trapping period spanned six consecutive nights.

Sanderson (1950) summarized nine different trapping methodologies in an attempt to determine sample adequacy for a local small mammal population. Since trap method, time of sample and type of habitat sampled all varied, and trap avoidance varies among species, sample adequacy varied from four to ten or more days to capture a significant number of a local population. Morris (1955) found three nights were required to capture most of a local population of deer mice.

Redman and Sealander (1958) stated that a minimum of three captures of an individual were required to calculate home range, and that no more than one-third of the captures could be on perimeter stations. In their study, traps were closed after the first capture. Blair (1942) and Tanaka (1953) felt that more captures were necessary; however they used repeated captures in the same trap in their calculations.

All stations on eight alternate lines of the grid were trapped for one-half of the period and the remaining seven alternate lines the other half. The traps were checked each morning and were rebaited

and reset if necessary. Those animals captured were marked by toe-clipping for identification and released. Each animal was identified by species, number, station location, sex, age class (adult or juvenile according to size and pelage) and external reproductive condition.

Density estimates of deer mice were made following the method described by Blair (1941), and home ranges of all animals trapped three or more times in one trapping period were calculated by the inclusive boundary strip method (Stickel, 1954). Both density estimates and home ranges were calculated from captures made only during single six-day trapping periods. Deer mouse densities were also estimated from the Jolly-Seber model (Seber, 1973) using a computer program derivation (Sauer, 1979).

Computer analysis and statistical tests were run to correlate features of the vegetation with trapping success of deer mice (Nie et al., 1975).

Scientific and common names of mammals follow Hoffmann and Pattie (1968). Species of small mammals of potential special interest follow Flath (1977).

RESULTS

Vegetation Types

Six vegetation types were examined quantitatively and qualitatively on three live trap grids and along three snap trap lines (lines I, J and N in Figure 1). Table 2 presents mean percent cover by cover class for each type. The mean percent cover for shrub and tree species is given in Table 3. Percent frequency and mean coverage rank for dominant graminoid, forb and subshrub species are given in Table 4. Table 18 (Appendix) lists the frequency of occurrence of all graminoid, forb and subshrub taxa found in the six vegetation types.

Ponderosa Pine Type

The ponderosa pine type occurred on all aspects of ridges, slopes and drainage bottoms. It was generally found on loamy and stony loam soils. Size classes of pines were distributed in a mosaic pattern throughout the stand sampled. Considerable pine reproduction was occurring within the stand as indicated in Figure 2. The most mature trees averaged 130 years of age (Figure 3).

The stand sampled was representative of the variation in pine community types in the study area. Ponderosa pine (Pinus ponderosa) averaged 21 percent cover on the stand. Dominant understory species varied according to site characteristics. Moist drainage bottoms were dominated by western snowberry (Symphoricarpos occidentalis), Kentucky bluegrass (Poa pratensis) and western wheatgrass (Agropyron

TABLE 2.--MEAN PERCENT COVER BY COVER CLASS FOR SIX VEGETATION TYPES AT SARPY CREEK, MONTANA,
1975-1976^a

Cover Class	Ponderosa Pine	Sumac	Grassland	Silver Sagebrush	Riparian Deciduous Tree	Deciduous Shrub Bottom
Bare Ground	17.6	20.0	22.3	7.0	0.5	1.3
Rock	1.2	0.6				
Litter	22.4	8.2	5.1	5.3	6.8	9.0
Lichens	0.6					
Graminoids	44.6	61.8	65.3	73.4	68.8	73.8
Forbs	13.6	9.2	7.3	14.3	24.0	16.0
Shrubs	21.4	20.2	0.9	14.6	48.5	55.3
Trees	22.5	3.4			23.8	23.3

^a N = 225 4 m² plots for each of the first three types; 40 m² plots for each of the last three types.

TABLE 3.--MEAN PERCENT COVER FOR SHRUB AND TREE SPECIES FOR SIX VEGETATION TYPES AT SARPY CREEK, MONTANA, 1975-1976

Species	Ponderosa Pine	Sumac	Grass- land	Silver Sagebrush	Riparian Deciduous Tree	Deciduous Shrub Bottom
<u>Acer negundo</u>					17.3	
<u>Artemisia cana</u>	1.5	T ^a		14.4	1.0	T
<u>Crataegus succulenta</u>						19.3
<u>Elaeagnus angustifolia</u>					1.5	
<u>Juniperus horizontalis</u>		T				
<u>Juniperus scopulorum</u>	1.2	T				
<u>Pinus ponderosa</u>	21.4	3.3				
<u>Prunus virginiana</u>	T				5.0	4.0
<u>Rhus trilobata</u>	13.9	12.7				5.5
<u>Ribes aureum</u>	T				14.3	6.0
<u>Rosa woodsii</u>	T				9.8	36.0
<u>Symphoricarpos occidentalis</u>	4.2	T		T	23.5	7.3

^aTrace indicates less than one percent cover

TABLE 4.--PERCENT FREQUENCY OF OCCURRENCE/MEAN COVERAGE RANK FOR GRAMINOID, FORB AND SUB-SHRUB SPECIES WHICH OCCURRED AT 20 PERCENT OR GREATER FREQUENCIES IN SIX VEGETATION TYPES AT SARPY CREEK, MONTANA, 1975-1976^a

Species	Ponderosa Pine	Sumac	Grass- land	Silver Sagebrush	Riparian Deciduous Tree	Deciduous Shrub Bottom
GRAMINOIDS						
<u>Agropyron cristatum</u>			74.2/2.4			
<u>Agropyron smithii</u>	54.7/1.9				90.0/1.2	40.0/2.0
<u>Agropyron spicatum</u>	56.4/1.4	21.3/2.0				40.0/2.1
<u>Andropogon scoparius</u>		20.0/2.4				
<u>Agrostis palustris</u>						20.0/1.3
<u>Aristida longiseta</u>			49.3/2.1			
<u>Bouteloua curtipendula</u>	40.9/1.3					
<u>Bouteloua gracilis</u>		25.3/1.8		30.0/1.8		
<u>Bromus japonicus</u>	32.0/3.3	42.2/2.8		50.0/2.8		37.5/3.2
<u>Bromus tectorum</u>			88.4/1.6			
<u>Calamovilfa longifolia</u>		37.8/2.6				
<u>Carex filifolia</u>		44.9/2.1				
<u>Elymus cinereus</u>					30.0/2.0	
<u>Koeleria cristata</u>		43.1/3.0		22.5/2.3		

TABLE 4.--Continued

Species	Ponderosa Pine	Sumac	Grass- land	Silver Sagebrush	Riparian Deciduous Tree	Deciduous Shrub Bottom
<u>Poa pratensis</u>		12.0/2.1	26.2/2.6	85.0/1.4	85.0/1.5	80.0/1.4
<u>Poa secunda</u>		50.0/3.0				
<u>Stipa comata</u>		39.1/2/1	79.0/2.1			
<u>Stipa viridula</u>				60.0/2.5		20.0/3.3
<u>Vulpia octoflora</u>				40.0/1.9		
FORBS						
<u>Achillea millefolium</u>	24.9/2.8					22.5/2.9
<u>Ambrosia psilostachya</u>	32.0/2.3	72.4/1.8	53.3/2.1	95.0/1.9		
<u>Artemisia dracunculus</u>		21.0/2.1				
<u>Artemisia ludoviciana</u>	28.0/2.4	29.3/1.7		40.0/2.1		
<u>Chenopodium album</u>					27.5/1.6	
<u>Chrysopsis villosa</u>		24.4/2.1				
<u>Cirsium arvense</u>					45.0/1.8	
<u>Eriogonum annuum</u>		21.3/2.5	54.7/1.6			
<u>Gutierrezia sarothrae</u>				47.5/2.2		
<u>Medicago sativa</u>					65.0/2.5	
<u>Psoralea tenuiflora</u>				35.0/1.4		

TABLE 4.--Continued

Species	Ponderosa Pine	Sumac	Grass- land	Silver Sagebrush	Riparian Deciduous Tree	Deciduous Shrub Bottom
<u>Ratibida columnifera</u>				20.0/2.5		20.0/3.0
<u>Tragopogon dubius</u>					20.0/3.3	

^a Mean coverage ranks were calculated only from those plots on which a given species occurred. A lower relative rank indicates a relatively higher canopy coverage for that species where it occurred

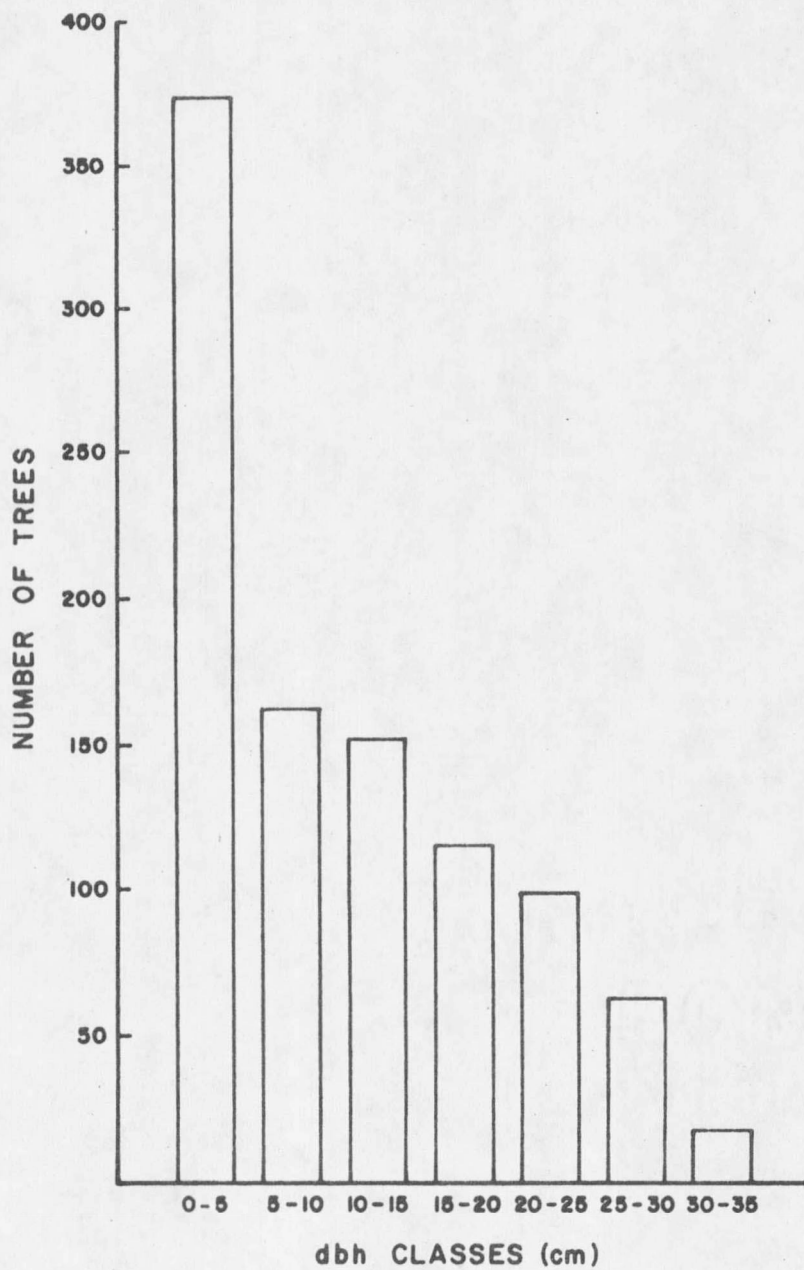


Fig. 2. Size distribution of all ponderosa pine trees on the ponderosa pine live trap grid, Sarpy Creek, Montana, 1976.

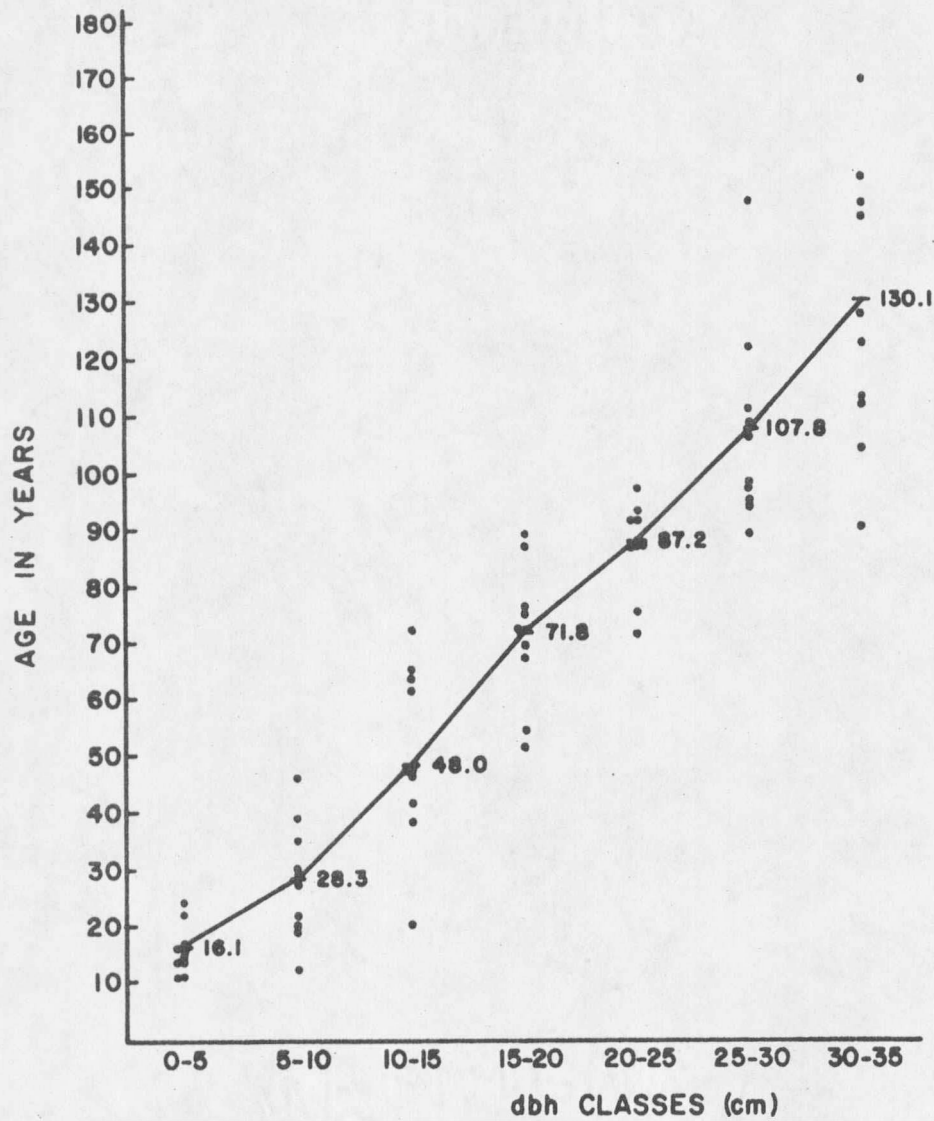


Fig. 3. Age distributions of ten ponderosa pine trees for each five centimeter dbh class. Mean ages are shown.

smithii). Skunkbush sumac (Rhus trilobata), bluebunch wheatgrass (Agropyron spicatum) and sideoats grama (Bouteloua curtipendula) dominated drier, sandy sites of southerly exposures. Moist, shaded, north-facing slopes of other pine stands often had substantial coverage of chokecherry (Prunus virginiana).

Plant species diversity was higher in the Ponderosa pine type than any other type sampled. Litter cover due to fallen needles was substantially higher and grass cover was lower than for other vegetation types (Table 2).

Skunkbush Sumac Type

This type was found on sandy sites, usually of southerly exposure, where pine trees did not dominate. The sumac type frequently formed a mosaic of communities with the grassland and silver sagebrush (Artemisia cana) types. The grassland type occurred where site conditions did not allow sumac to dominate. Where groundwater was relatively more available, the silver sagebrush type dominated many sites topographically below sumac stands, on heavier silty soils.

Skunkbush sumac dominated shrub cover on these sites (Table 3). Important graminoid constituents of the sumac type included prairie sand reedgrass (Calamovilfa longifolia), thread-leaved sedge (Carex filifolia), prairie junegrass (Koeleria cristata), native bluegrass (Poa secunda) and needle-and-thread (Stipa comata). A high frequency

of occurrence of Japanese brome (Bromus japonicus) and common ragweed (Ambrosia psilostachya) attested to prior grazing stress by livestock.

Grassland Type

The grassland site investigated was the grassland live trap grid. It had been disturbed by cultivation as recently as the 1920's, thus it was not typical of native grassland on the study area. Species composition of native grassland was comparable to the graminoid elements in the understory of the ponderosa pine and sumac vegetation types.

The most significant native component found on the grassland grid was the needle-and-thread. The disturbed nature of the site was indicated by the predominance of planted and invading species, including crested wheatgrass (Agropyron cristatum), cheatgrass (Bromus tectorum), red three-awn (Aristida longiseta) and forb species such as common ragweed and annual buckwheat (Eriogonum annuum).

Silver Sagebrush Type

This type was found on broad swales and other sites where sufficient surface or groundwater allowed growth of silver sagebrush. Grazing utilization of this and other relatively moist vegetation types (riparian deciduous tree and deciduous shrub bottom types) has allowed invasion by introduced graminoids and "weedy" forb species. The dominant native graminoid remaining in the silver sagebrush type

was green needlegrass (Stipa viridula). As in other moist site types, Kentucky bluegrass was an important constituent of the understory. Other abundant species were Japanese brome, common ragweed, cudweed sagewort (Artemisia ludoviciana), and broom snakeweed (Gutierrezia sarothrae). Overall graminoid cover was higher in the silver sage type than all others except the deciduous shrub bottom type.

Riparian Deciduous Tree Type

This type was narrowly limited to major drainage channels on the study area. Boxelder (Acer negundo) was the principal overstory species with 17 percent cover. Shrub species diversity and canopy cover were high in this type. Important shrubs in order of coverage were western snowberry, golden currant (Ribes aureum), Wood's rose (Rosa woodsii) and chokecherry. Western wheatgrass was an important native graminoid as well as giant wild rye (Elymus cinereus). Other dominant grass and forb species reflected disturbance by livestock and adjacent cultivation. These included Kentucky bluegrass, alfalfa (Medicago sativa), Canada thistle (Cirsium arvense) and lambsquarter (Chenopodium album).

Deciduous Shrub Bottom Type

Floristically similar to the preceding vegetation type, this type occurred along the more mesic tributary drainages. Tall shrub (short tree) cover was dominated by hawthorn (Crataegus succulenta),

as well as chokecherry and wild plum (Prunus americana). Lower story shrubs included Wood's rose, western snowberry and skunkbush sumac.

Important native moist site graminoids were western wheatgrass and green needlegrass. Bluebunch wheatgrass was also common owing to proximity to drier site vegetation types. Kentucky bluegrass was again the dominant invading grass, followed by Japanese brome. Yarrow (Achillea millefolium) was an important forb.

Total vegetation cover was highest in the riparian deciduous tree and deciduous shrub bottom types due to moist site characteristics and stratification of vegetation.

Snap Trapping Survey

A total of 138 small mammals were trapped on snap trap lines during 4500 trap nights. Of these, there were 125 deer mice (Peromyscus maniculatus), six common shrews (Sorex cinereus), three least chipmunks (Eutamias minimus), two meadow voles (Microtus pennsylvanicus) and one each of Wyoming pocket mouse (Perognathus fasciatus) and northern pocket gopher (Thomomys talpoides). Table 5 gives snap trapping results for 1975 and 1976.

Species other than deer mice were caught only in spring and summer when populations were high. Trapping success of common shrews was approximately equal to deer mice in the riparian deciduous tree habitat type, possibly indicating high shrew densities there for 1976.

TABLE 5.--PERCENT SUCCESS OF SNAP TRAPPING SMALL MAMMALS, SARPY CREEK, MONTANA, 1975-1976.

Species	Vegetation Types									
	Riparian ^a Deciduous Tree	Deciduous ^a Shrub Bottom	Silver Sage		Big Sage		Sumac		Ponderosa Pine	
	1976 N ^b =360	1976 N=540	1975 N=180	1976 N=360	1975 N=180	1976 N=360	1975 N=180	1976 N=540	1975 N=540	1976 N=900
<u>Eutamias minimus</u>									0.6	
<u>Microtus pennsylvanicus</u>		0.4								
<u>Perognathus fasciatus</u>	0.3									
<u>Peromyscus maniculatus</u>	1.4	1.8	2.2	1.4	13.9	0.6	2.8	3.9	2.8	3.4
<u>Sorex cinereus</u>	1.7									
<u>Thomomys talpoides</u>						0.6				

^anot trapped during 1975

^bN=total number of trap nights

Meadow voles almost surely occur in this habitat also, as well as in the closely related deciduous shrub bottom type, but none were trapped there. Wyoming pocket mice were found on or near where loose, sandy substrate allowed excavation of burrows. Least chipmunks were rather narrowly limited to or at the edge of stands of ponderosa pine. The big sage, silver sage and sumac habitats yielded only deer mice to snap trapping except for one pocket gopher.

Populations of deer mice were highest in late summer and spring. Low points occurred during winter and midsummer (Table 6). Trends in numbers caught through the year were similar in all habitats sampled. Breeding season of deer mice extended from at least April through August and probably considerably longer, based upon the presence of juveniles in the population in May, 1976, and the number of adult females in reproductive condition (Table 7). However, sample size was too small later in the year to draw definitive conclusions. There was likely a peak in breeding in spring, and subsequently smaller percentages of females were breeding after midsummer. The mean number of embryos for six pregnant females was 5.0. The sex ratio of all deer mice captured in snap traps during the study was 2.0 males per female. The sex ratio of adult mice captured was 2.6 males per female. The reasons for the deviation from the expected ratio of 1:1 are unknown, although a larger home range size of males and seasonal restrictions of females to nest during periods of nursing often contribute to an

TABLE 6.--POOLED DATA ON NUMBERS OF DEER MICE CAUGHT ALONG SNAP TRAP LINES AND THE NUMBER OF DEER MICE PER 100 TRAP-NIGHTS OF EFFORT FOR EACH TRAPPING PERIOD

Trapping Period	Trap Nights	Number Deer Mice Captured	Percent Success
1975			
August	1080	49	4.5
1976			
February	540	3	0.6
May	900	36	4.0
July	1080	11	1.0
September	900	26	2.9

observed sex ratio which slightly favors males (Terman, 1968).

Live Trapping Survey

One hundred fifteen individual deer mice were captured a total of 440 times on the live trap plots. In addition, 54 individuals of seven other species of small mammals were live trapped a total of 84 times. Table 8 presents the numbers and species of small mammals captured on each of the three live trap grids during the four trapping periods. The grassland grid supported the greatest diversity of small mammals, followed by the sumac grid. However, the ponderosa pine grid supported the densest deer mouse population and a

TABLE 7.--POOLED DATA FROM ALL VEGETATIVE TYPES OF NUMBERS OF DEER MICE IN REPRODUCTIVE CONDITION AND NUMBERS OF JUVENILES CAUGHT DURING EACH SNAP TRAPPING PERIOD

<u>Trapping Period</u>	<u>Adult Males in Reproductive Condition</u>	<u>Adult Females in Reproductive Condition</u>	<u>No. of Females with embryos</u>	<u>No. of Juveniles</u>	<u>Total No. of Mice Caught</u>
1975					
August	6 (28) ¹	2 (15) ²	0	5	48 ³
1976					
February	1 (3)	0 (0)	0	0	3
May	14 (17)	6 (11)	5	8	36
July	8 (8)	2 (3)	1	0	11
September	19 (23)	1 (1)	0	2	26

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¹Number in parentheses indicates total number of adult males trapped.

²Number in parentheses indicates total number of adult females trapped.

³This number does not include one deer mouse whose sex could not be determined because of consumption by scavengers.

[illegible]

relatively dense population of least chipmunks.

Thirteen-lined ground squirrels (Spermophilus tridecemlineatus) were common in the grassland habitat. A few meadow voles were caught only where there was dense grass cover. Wyoming pocket mice were caught on relatively sandy sites on the grassland and shrubland grids. They were probably somewhat more abundant than trapping success indicated. Only one cottontail was caught on the grassland grid, since this species is not readily trapped by Sherman live traps. Similarly, red squirrels (Tamiasciurus hudsonicus) were more abundant than the individual trapped on the woodland grid would indicate. Only one grasshopper mouse (Onychomys leucogaster) was caught on the grassland grid since rolled oats bait is not particularly attractive to this species and probably also due to low population density in the Sarpy Creek area.

Table 9 gives age and sex ratios for live-trapped deer mice. The sex ratio for all individual deer mice captured throughout the study period on all three live trap plots was 1.7 males per female. The sex ratio of adults was 1.8 males per female. Both are significant deviations from the expected 1:1 ratio.

Home ranges for some species of small mammals are given in Table 10. Home ranges were calculated from three or more captures within a single trapping period to eliminate inclusion of seasonal shifts in activity as part of the home ranges. Mean home ranges of

TABLE 9.--AGE AND SEX RATIOS OF DEER MICE FROM LIVE TRAP GRIDS, SARPY CREEK, MONTANA, 1975-1976

Trapping Period	Juveniles ^a :100 Adults	Males:100 Females
1975		
July	32:100	262:100
August	36:100	140:100
1976		
June	50:100	173:100
August	54:100	162:100

^aincluding subadults.

TABLE 10.--MEANS AND RANGES OF HOME RANGE SIZES IN HECTARES FOR DEER MICE ON THE THREE LIVE TRAP GRIDS. HOME RANGES ARE CALCULATED FROM CAPTURES ONLY WITHIN EACH SINGLE 6-NIGHT TRAPPING PERIOD

<u>Grid</u>	<u>Males</u>		<u>Females</u>		<u>All Individuals</u>	
	<u>N</u>	<u>ha</u>	<u>N</u>	<u>ha</u>	<u>N</u>	<u>ha</u>
Grassland						
July 1975	1	0.57			1	0.57
Aug. 1975	3	0.39			3	0.39
June 1976					0	----
Aug. 1976					0	----
Overall Means and Ranges	4	0.48 (0.17 - 0.66)	0	----	4	0.48
Sumac						
July 1975	4	0.21			4	0.21
Aug. 1975	5	0.32	4	0.20	9	0.26
June 1976	4	0.26	3	0.11	7	0.20
Aug. 1976	4	0.41	2	0.25	6	0.36
Overall Means and Ranges	17	0.30 (0.07 - 0.69)	9	0.18 (0.07 - 0.38)	26	0.26

TABLE 10.--Continued

<u>Grid</u>	<u>Males</u>		<u>N</u>	<u>Females</u>		<u>All Individuals</u>	
	<u>N</u>	<u>ha</u>		<u>ha</u>	<u>N</u>	<u>ha</u>	
Ponderosa Pine							
July 1975	4	0.20			4	0.20	
Aug. 1975	14	0.22	6	0.23	20	0.22	
June 1976	5	0.19	3	0.22	8	0.20	
Aug. 1976	8	0.24	7	0.19	15	0.22	
Overall Means and Ranges	31	0.22 (0.07 - 0.50)	16	0.21 (0.05 - 0.61)	47	0.21	
Overall Means from All Plots	52	0.26	25	0.20	77	0.24	

deer mice were approximately a quarter of a hectare in both the sumac and ponderosa pine habitats. Home ranges in the grassland habitat were about twice the size of those in the other two plots. Statistically, the only significant difference between home range sizes sampled within each sex in the three habitats was that between males in grassland and ponderosa pine habitats ($p < 0.2$, Mann and Whitney rank test). Mean sizes of male home ranges were slightly larger than female home ranges, although the differences were not statistically significant. A large amount of individual variation occurred in sizes of home ranges. Only three home ranges of juveniles, all in sumac and ponderosa pine habitats could be calculated, and the mean was 0.19 ha. One home range of an adult female ground squirrel on the grassland plot was calculated as 0.17 ha. An adult male Wyoming pocket mouse on the grassland plot had a home range of 0.11 ha, and two adult male chipmunks in the pine plot had home ranges of 0.64 and 0.21 hectares.

Table 11 presents estimates of population density for some species of small mammals trapped on the three Sarpy Creek live trap grids, corrected for estimated home range sizes. Densities notably increased where total vegetation canopy coverage increased.

For purposes of comparison, deer mouse densities were also estimated using a computer program of the Jolly-Seber model of analysis (Table 12). The two methods of estimating populations produced very similar calculations and indicated the same population trends. The

TABLE 11.--ESTIMATES OF POPULATION DENSITY (INDIVIDUALS/HECTARE) FOR SOME SPECIES OF SMALL MAMMALS ON THREE SARPY CREEK LIVE-TRAPPED HABITATS^a

Species	Grassland				Sumac				Ponderosa Pine			
	1975		1976		1975		1976		1975		1976	
	July	Aug.	June	Aug.	July	Aug.	June	Aug.	July	Aug.	June	Aug.
<u>Peromyscus maniculatus</u>	0.34	0.51			0.88	1.81	1.33	1.43	2.94	6.23	3.09	3.34
<u>Eutamias minimus</u>								0.25	0.87	0.99	0.87	1.12
<u>Perognathus fasciatus</u>		0.16	0.16	0.49		0.49		0.16				
<u>Spermophilus tridecemlineatus</u>	0.15	0.46	1.06	0.46	0.46	0.46						

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^aExcept for Peromyscus, based on a single estimate of home range size for each species.

TABLE 12.--POPULATION ESTIMATES (INDIVIDUALS/HECTARE) FOR DEER MICE IN TWO SARPY CREEK VEGETATION TYPES USING JOLLY-SEBER MODEL OF ANALYSIS

Trapping Period	Ponderosa Pine	Sumac
July, 1975	2.25	1.22
August, 1975	7.94	2.04
June, 1976	3.40	1.72
August, 1976	3.66	1.66

Jolly-Seber model yielded a higher population estimate than did the home range model in all cases except for the first trapping period for the ponderosa pine type. Densities for deer mice in the grassland type and for other small mammal species in all vegetation types could not be calculated with the Jolly-Seber model due to small sample size.

Correlation of Vegetation Features with Trapping Success of Deer Mice

Vegetation data was gathered during summer, 1976; hence correlation with trapping data was limited to the third and fourth trapping periods. Since no deer mice were trapped on the grassland grid during these periods, correlation was further limited to the skunk-bush sumac and ponderosa pine live trap grids.

Different statistical tests were utilized to examine various

features of vegetation with respect to the trapping success of deer mice. First, the data of trapping success for the sumac and pine grids were submitted to both simple regression and step-wise multiple regression analyses (Nie et al., 1975). Trapping success was regressed against percent cover by major vegetation class, including trees, shrubs, grasses, forbs, litter, bare ground and rock. Additionally, simple and multiple regressions were done for these variables combined as grasses, forbs and litter versus bare ground and rock. The latter test was an effort to examine the correlation between trapping success and organic versus inorganic matter for the lowest (ground) stratum of vegetation.

The F values in every case for both live trap grids yielded p values greater than 0.05, thus no significant correlations could be established.

Subsequently, step-wise discriminant analysis (Nie et al., 1975) was performed on all vegetation sites (trap stations) for each of the two grids. With a potential maximum trapping success of six captures per trap site, discriminant analysis was run using the following segregations:

All Sites Catching: Against All Sites Catching:

0 deer mice	1 or more deer mice
0-1 deer mice	2 or more deer mice
0-2 deer mice	3 or more deer mice

Sites catching 0, 1, 2, 3, 4 or 5 deer mice were run against each other, thus all possible permutations were investigated. The variables examined were percent cover of the major vegetation classes in one series of runs and percent cover of shrub species in a second series of runs. The criterion used to discriminate was Rao's V, a generalized distance measure which allows for the greatest overall separation of groups.

The variables used were not able to discriminate significantly ($P < 0.05$) for the sumac live trap grid. Significant discriminating power was attained for the pine grid by variables of certain major vegetation cover classes and certain shrub species.

The canonical correlation derived from the comparison of capture sites with non-capture sites indicated that seven percent of the variance could be explained by tree and bare ground coverages ($p = .0002$). Deer mice displayed an affinity for bare ground and an aversion to pine cover.

Some shrub species yielded a significant ($p = 0.024$) but not highly separated discrimination between capture and non-capture trap stations on the pine grid, based on shrub canopy coverage. However, results of the statistical test could not be confidently interpreted since these shrub species all occurred at such low frequencies.

The frequency of occurrence of all grass and forb species was calculated for vegetation plots (trap stations) with captures of deer

mice and for plots with no captures. Plots with captures were tested against plots with no captures by Chi-square (Lund, 1978) for the sumac and pine live trap grids. Significant differences in only a few plant species were seen between the two classes of plots.

One species which displayed a positive correlation with trapping success of deer mice in the sumac vegetation type was thread-leaved sedge ($p = 0.019$). Species showing a negative correlation were prairie junegrass ($p = 0.002$), tarragon sagewort (Artemisia dracunculus, $p = 0.043$) and whorled milkweed (Asclepias verticillata, $p = 0.040$). For the ponderosa pine type, significant positive correlation was displayed by common ragweed ($p = 0.020$) and negative correlation by Kentucky bluegrass ($p = 0.023$).

DISCUSSION

Live trapping permits recapture of an individual, thus allowing assessment of home range size and, ultimately, calculation of population density. Sarrazin and Bider (1973) have reviewed studies in an examination of problems which are inherent in the use of home range estimates to calculate population densities. One problem is that most home ranges overlap (Williams, 1955). A second problem is that individuals may extend their activity outside of the trapping area (Redman and Sealander, 1958). Another difficulty arises in that the size of home range varies with sex and age; with season and habitat (Stickel and Warbach, 1960); and inversely with population density (Stickel, 1960). A fourth problem in using home range estimates to calculate population densities arises from trap shy individuals or species (Dice, 1931; Mohr, 1947; Davis, 1953). The final problem addressed by Sarrazin and Bider (1973) was that trap spacing can alter the apparent size of home range (Hayne, 1949 and 1950; Morris, 1955; Faust et al., 1971).

Following computer modeling, Otis, et al. (1978) stated that in theory, each trapping grid should ideally consist of 225 to 400 live traps arranged in a 15 x 15 or 20 x 20 grid at a 10 m or 15 m trap interval. A minimum trapping period of six consecutive nights was recommended.

Deer Mouse Distribution/Vegetation Correlations

Blair (1942) felt that vegetation analysis would be important to ascertain why an animal avoided certain trap stations within its home range. Computer analysis of Sarpy Creek data found little significant correlation between trapping success of deer mice and various features of vegetation. One problem arises in the type of statistical test selected to examine possible correlations. Multiple regression tests were unable to find any significant correlations, while discriminant analysis found some. The inherent nature of the regression test was unable to accept cases where any variable was zero, and the data base following deletion of such cases was too small to permit discovery of significant correlations. Since discriminant analysis affords inclusion of such cases, correlations were found. The limited number of correlations found is probably attributable to either the nature of the system tested or to field methodology.

In the first case, it may be that there are few real correlations to be found; or that the nature of correlations between trapping success and vegetation features are so complexly related that they are not easily discovered without a much larger data base. This data base may in fact be necessarily so large as to preclude the amount of field effort found in the majority of small mammal studies thus far reported, at least for those discussed in this study.

In the second case, that of methodology modeled for the field,

any parameters which affect the results of small mammal or vegetation sampling may influence errors in assessing correlations. For instance, trapping success may be affected by many temporal and spatial parameters other than vegetation, such as animal mobility. Deer mouse mobility is in turn dependent on species-related, physiologic and demographic parameters. Furthermore, methods to sample and define vegetation are temporally as well as spatially dependent. Thus, a four m² plot used to measure vegetation at each trap station may be inadequate to determine deer mouse/vegetation correlations, due simply to the inherent mobility of deer mice. That is, vegetation species frequency of occurrence or canopy coverage on a four m² plot may not reveal anything significant about the occurrence of deer mice at that site.

The correlations found by discriminant analysis may therefore be somewhat fortuitous with regard to vegetation species frequency. Few grass or forb species occurred on either the sumac or pine live trap grid at sufficiently high frequency to allow a significant test of their correlation with trapping success. Of these, fewer still indicated a significant correlation either positive or negative. These remaining few plant species are ultimately difficult to explain in terms of their relationship to deer mice, at least with respect to food potential for seed-eating Peromyscus. Food plant species may not be a good indicator of trapping success of small mammals on the

microsite basis of individual plants (Cogshall, 1928 and Lovejoy, 1975). The plant species involved in the correlations better indicate observed trapping success of deer mice probably because of their relationship to various soil features, past grazing or other disturbance and topographical features on a local basis.

Canopy cover comparisons indicated that trapping success of deer mice on the pine grid showed a positive correlation with bare ground and a negative correlation with tree cover, although deer mice were trapped more successfully on the pine grid than on the sumac shrub and grassland live trap grids. This agrees with Pearson (1959) and Sly (1976) who found that deer mice preferred intermediate successional stages with open, woody vegetation.

Comparison of Results with Similar Southeastern Montana Studies

Owing to a dramatic increase in coal production and exploration in southeastern Montana in the 1970's, a number of studies have recently investigated small mammal populations throughout the area. Such studies have been conducted for Peabody (ECON, 1975, 1976, 1977, 1978 a), Decker (Pitcher, 1977), Pearl (Farmer, 1977 and 1978), Intake (Swenson, 1978), P.M. and Divide in the Bull Mountains (Bergeron, 1978 a & b), Colstrip (ECON, 1978 b), Coal Creek (Bergeron, 1979), Montco (Olson-Elliott and Associates, 1980), Otter Creek and Hanging Woman Creek (Martin, 1980a) and at the Sweeney-Snyder, Greenleaf-Miller,

Foster, Sand Creek, Birney, Kirby and Tongue River Dam sites (Martin, 1980b).

Variables which can affect trapping success were not controlled among the studies reviewed, consequently only relative densities of deer mice were examined for the purposes of this review. Dice (1938) was uncomfortable with using the number of animals captured per trap night as an index of abundance since apparent densities may differ from true densities as a function of trapping effort. However, when considering many studies of different trapping strategies over six years' duration, relative densities allow an observer perhaps the only common basis for comparison of results.

Table 13 compares relative densities of deer mice in recent coal-related studies conducted in southeastern Montana. In general, smaller trapping efforts increased the likelihood of apparent fluctuations from true population density. Theoretically, the more trap nights expended, the greater the probability that capture results will reflect the true population level. Studies from southeastern Montana represented several years' effort (1974-1980), and yearly fluctuations should be expected. Although all studies were in southeastern Montana, site differences in deer mouse populations can be expected, which may also account for different capture rates. Also, definition of various habitats differs considerably from one study to the next.

The years of the Sarpy Creek study (1975-1976) were relatively

TABLE 13.--COMPARISON OF RELATIVE DENSITIES OF DEER MICE AS DETERMINED BY THE NUMBER OF CAPTURES PER 100 TRAP NIGHTS (LIVE AND/OR SNAP TRAPPING) IN SOUTHEASTERN MONTANA

<u>Study</u>	<u>Habitat Types^a</u>				
	<u>Woodland</u>	<u>Shrubland</u>	<u>Grassland</u>	<u>Agriculture</u>	<u>Disturbed</u>
Sarpy Creek (1975)	4.1 (1890) ^b	2.8 (1980)	0.5 (1350)		
Sarpy Creek (1976)	3.1 (2610)	1.9 (2970)	0 (1350)		
Peabody (1975)					23.0 (300)
Peabody (1976)		0.8 (120)	2.2 (180)		
Peabody (1977)		3.0 (200)	2.0 (200)		4.0 (200)
Peabody (1978)		7.5 (400)	5.0 (100)		23.0 (200)
Decker (1976 ^c)	2.9	3.3	2.0	4.7	18.3
Pearl (1977)	3.9 (600)	7.9 (1350)	2.4 (1200)	2.2 (75)	
Pearl (1978)	2.7 (450)	3.0 (1350)	3.8 (1280)	1.3 (75)	
Intake (1977)	1.5 (840)	4.2 (1200)	2.1 (720)	1.4 (1200)	
P.M. (1978)	1.3 (400)	2.7 (150)	1.3 (1380)	0.2 (400)	
Divide (1978)	1.1 (2500)		0.3 (700)		
Colstrip (1978)	5.0 (100)	8.0 (400)	5.0 (100)		23.0 (200)
Coal Creek (1979)	3.6 (190)	2.7 (780)			
Montco (1978)	7.6 (720)	13.0 (2440)	8.0 (2440)		
Montco (1979)	5.9 (720)	3.5 (2440)	2.6 (2440)		

TABLE 13.--Continued

<u>Study</u>	<u>Habitat Types^a</u>				
	<u>Woodland</u>	<u>Shrubland</u>	<u>Grassland</u>	<u>Agriculture</u>	<u>Disturbed</u>
Otter Creek (1979)	1.5 (1270)	0.2 (490)	1.8 (450)		
Hanging Woman (1979)		1.7 (460)	0.2 (490)		
Sweeney-Snyder (1980)	0.4 (840)	0.5 (840)			
Greenleaf-Miller (1980)	0.7 (830)	0.1 (820)			
Foster (1980)	1.5 (810)	0.8 (800)			
Sand Creek (1980)	2.0 (900)	0.7 (880)			
Birney (1980)	0.6 (810)	0.7 (760)			
Kirby (1980)	2.0 (770)	2.3 (780)	2.0 (680)	2.0	18.3
Tongue R. Dam (1980)	3.0 (810)	2.6 (740)			
Average	2.7	3.2	4.2	2.0	18.3

^aWoodland = coniferous and/or deciduous tree overstory; Shrubland = mesophytic shrubland dominated by big sagebrush, silver sagebrush, skunkbush sumac, chokecherry/rose.

^bNumbers in parentheses indicate total number of trap nights.

^c8080 total trap nights for study.

moist years, and estimated densities were generally higher than in later years. Sarpy Creek results in 1976 were consistently lower than in 1975, despite an increased trapping effort in 1976. Seasonal and annual fluctuations in small mammal populations have been well documented (Myers and Krebs, 1974). In this case, the change could be reflected in changes in on-site vegetation cover and seed production, a major food source for Peromyscus maniculatus. Also, severity of the 1975-1976 winter could have affected deer mouse populations. Although all studies were in southeastern Montana, site differences in deer mouse populations can be expected, which may also account for different capture rates. Also, definition of various habitats differs considerably from one study to the next.

Allowing for the above variables, capture rates for woodland habitats ranged from 0.4-7.6 percent, with an average of 2.7 percent and a median of 2.0 percent. In comparison, Sarpy Creek results were slightly higher. Similarly, shrubland deer mouse densities varied from 0.1-13.0 percent, averaging 3.2 percent with a median of 2.7 percent. Sarpy Creek densities were comparable. Differences were probably due to wide variety of shrubland habitat types and the wide variety of grass/litter understory species. Grassland habitat types yielded densities which ranged from 0.0-8.0, averaging 2.4 percent with a median of 2.0 percent. Sarpy Creek densities were lower.

The average density in shrubland was greater than in woodland, followed in order by grassland and agriculture. This reflected the

decreasing diversity of microsite habitat and the habitat "edge effect". The 1975-1976 study conducted at Decker (Pitcher, 1977) derived similar conclusions. Pitcher (1977) also found intermediate diversity, but the highest Peromyscus densities, in disturbed habitat for the Decker study.

Table 13 indicates that disturbed types had generally higher densities than all other habitat types, indicating the ability of Peromyscus maniculatus to successfully reinvade a site, that is, to be an "early succession" species. Although reclamation sites are often monoculture, deer mouse densities are higher than in grassland because of greater seed production in reclamation, lack of competition from grazing livestock, and a lower diversity of other potentially competitive small mammal species.

Other recent southeastern Montana studies have made similar observations. ECON (1977) found deer mouse populations in various native plant communities were usually low (1.2-2.4/ha). It was thought that higher populations were found in recently reclaimed areas, since new vegetation growth afforded ample cover and food. During repopulation, deer mouse numbers increased rapidly for a period of time, then declined to near normal levels. However, during dry years, deer mouse numbers were low even on reclaimed areas. All studies found that deer mice occupied a wider range of habitats and were trapped in greater numbers than other small mammal species. ECON (1978 a) found much

higher deer mouse populations in reclaimed areas than in native habitats for three studies in southeastern Montana conducted from 1973 through 1978.

Other papers on Peromyscus ecology have reported the same deer mouse affinity for disturbed sites. Gashwiler (1959) investigated the relationship between native timber habitat and newly logged areas. Phillips (1936) and Smith (1940) found that deer mice enjoyed population booms on overgrazed sites. Jameson (1955) found deer mice were the first small mammal species to invade disturbed sites.

A comparison of population estimates of deer mice for Sarpy Creek and other nearby studies is made in Table 14. Difficulties in comparison of the results of the studies listed arise from different methodologies, sample sizes and the season of trapping. Sarpy Creek densities were generally lower than those of the other studies shown in Table 14. Differences in the localities trapped also contribute to different apparent densities. The Decker and Pearl studies, less than 10 miles apart, displayed roughly similar densities compared to Montco (60 miles) and Sarpy Creek (80 miles). Substantially higher densities at Montco were probably due mostly to season of trapping and locality. Although not indicated in Table 14, population characteristics were generally comparable among studies, i.e., males generally outnumbered females (at least in likelihood of capture), populations were greatest in summer and autumn, and home ranges of

TABLE 14.--COMPARISON OF DEER MICE DENSITIES (INDIVIDUALS/HECTARE) FOR FOUR SOUTHEASTERN MONTANA STUDIES

Vegetation Type	Sarpy Creek 1975	Creek 1976	Decker ^a 1976	Montco ^b 1978	Pearl ^c 1978-79
Grassland	0.4		4.9	10.4	7.7
Shrubland	1.3	1.4	3.6	12.2	4.0
Woodland	4.6	3.2	3.5		3.0
Reclaimed Grassland			81.3		

^aPitcher (1977)^bOlson-Elliott and Associates (1980)^cFarmer (1980)

males were larger than home ranges of females.

Table 15 gives the occurrence of small mammal species by vegetation type for the 19 studies presented in Table 13. The data indicate the widespread occurrence of Peromyscus maniculatus. A less than thorough examination might confuse Mus musculus with Reithrodontomys megalotis, although Mus may be as widespread in southeastern Montana as the data in Table 15 indicate. Most species were trapped in the habitats expected (Hoffmann and Pattie, 1968).

Grassland produces the greatest diversity of species, followed by

TABLE 15. NUMBER OF SOUTHEASTERN MONTANA STUDIES IN WHICH SPECIES OF SMALL MAMMALS WERE RECORDED AS PRESENT IN COMMON VEGETATION TYPES. REFER TO TABLE 13 FOR A LISTING OF THE 19 STUDIES SURVEYED

Species	Riparian Deciduous Tree N=8	Deciduous Shrub Bottom N=2	Silver Sage N=6	Grease- wood N=1	Big Sage N=18	Sumac N=5	Breaks N=3	Grassland N=12
<u>Dipodomys ordii</u>								2
<u>Eutamias minimus</u>	1		1		2	1	1	2
<u>Lagurus curtatus</u>	1		1	1	2			2
<u>Microtus ochrogaster</u>	1	1	2	1	4	1		3
<u>Microtus pennsylvanicus</u>	2	1	1			1		2
<u>Mus musculus</u>	1				3			2
<u>Neotoma cinereus</u>								
<u>Onychomys leucogaster</u>					1			4
<u>Perognathus fasciatus</u>	2			1	2	1		3
<u>Peromyscus maniculatus</u>	6	1	6	1	18	5	3	11
<u>Reithrodontomys megalotis</u>	2			1	2			2
<u>Reithrodontomys montanus</u>								
<u>Sorex cinereus</u>	3	1						
<u>Spermophilus richardsoni</u>								1
<u>Spermophilus tridecemlineatus</u>	1		1		2	1		8
<u>Tamiasciurus hudsonicus</u>								
<u>Thomomys talpoides</u>					1			
<u>Zapus hudsonius</u>								1

TABLE 15.--Continued

Species	Riparian Grass N=3	Ponderosa Pine N=17	Agriculture N=5	Reclamation N=3
<u>Dipodomys ordii</u>				
<u>Eutamias minimus</u>		8		1
<u>Lagurus curtatus</u>				
<u>Microtus ochrogaster</u>	2	1	1	3
<u>Microtus pennsylvanicus</u>	1	1	1	
<u>Mus musculus</u>		3	1	
<u>Neotoma cinereus</u>		2		
<u>Onychomys leucogaster</u>		1		
<u>Perognathus fasciatus</u>		1	1	
<u>Peromyscus leucopus</u>				
<u>Peromyscus maniculatus</u>	3	17	5	3
<u>Reithrodontomys megalotis</u>	2		1	2
<u>Reithrodontomys montanus</u>				1
<u>Sorex cinereus</u>	3		1	
<u>Spermophilus richardsoni</u>				
<u>Spermophilus</u> <u>tridecemlineatus</u>			2	1
<u>Tamiasciurus hudsonicus</u>		1		
<u>Thomomys talpoides</u>				
<u>Zapus hudsonius</u>				

^aN = number of studies in which a given habitat type was investigated

the big sagebrush and riparian deciduous tree habitat types. The riparian grass type has a low species diversity, probably due to extensive grazing in this type and because only three studies sampled this habitat for small mammals. It appears that, in general, small mammal diversity decreases as grass cover/litter decreases, although some habitats display low diversities partially due to a low sample effort.

Pitcher (1977) had rather different diversity results at Decker. Woodland habitat produced the greatest diversity with six genera captured in xerophytic shrublands, and agriculture and mine disturbance habitats each had four genera. The least diverse habitat type was grassland, with only three genera captured. This is due, in part, to a relatively smaller sampling effort in the grassland type than other types and because lumping of different habitats into a general habitat type (e.g. shrubland or woodland) in effect increases habitat diversity and thus, niche diversity.

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APPENDIX

TABLE 16.--SPECIES LIST OF SMALL MAMMALS, SARPY CREEK, MONTANA

Insectivores

<u>Sorex cinereus</u>	common shrew	X
<u>Sorex merriami</u>	Merriams' shrew	*
<u>Sorex preblei</u>	Preble's shrew	*

Bats

<u>Myotis evotis</u>	long-eared bat	X
<u>Myotis leibii</u>	least bat	
<u>Myotis lucifugus</u>	little brown bat	
<u>Myotis volans</u>	long-eared bat	*
<u>Lasiorycteris noctivagans</u>	silver-haired bat	
<u>Eptesicus fuscus</u>	big brown bat	
<u>Lasiurus cinereus</u>	hoary bat	
<u>Euderma maculatum</u>	spotted bat	*
<u>Plecotus townsendii</u>	western big-eared bat	*

Lagomorphs

<u>Lepus townsendii</u>	white-tailed jack rabbit	X
<u>Sylvilagus nuttallii</u>	mountain cottontail	
<u>Sylvilagus audubonii</u>	desert cottontail	X

Rodents

<u>Erethizon dorsatum</u>	porcupine	X
<u>Castor canadensis</u>	beaver	
<u>Thomomys talpoides</u>	northern pocket gopher	X
<u>Perognathus fasciatus</u>	Wyoming pocket mouse	X
<u>Dipodomys ordii</u>	Ord's kangaroo rat	X
<u>Eutamias minimus</u>	least chipmunk	X
<u>Spermophilus tridecemlineatus</u>	thirteen-lined ground squirrel	X
<u>Tamiasciurus hudsonicus</u>	red squirrel	X
<u>Mus musculus</u>	house mouse	X
<u>Reithrodontomys megalotis</u>	western harvest mouse	
<u>Onychomys leucogaster</u>	northern grasshopper mouse	X
<u>Peromyscus maniculatus</u>	deer mouse	X
<u>Ondatra zibethicus</u>	muskrat	X
<u>Lagurus curtatus</u>	sagebrush vole	X
<u>Microtus ochrogaster</u>	prairie vole	
<u>Microtus pennsylvanicus</u>	meadow vole	X

TABLE 16.--Continued

Rodents (continued)

Microtus longicaudus

long-tailed vole

X - Species identified on Sarpy Creek study area

* - Species listed by Flath (1977) as being of special interest
or concern

TABLE 17.--SARPY CREEK PLANT SPECIES LIST

Pinatae

Cypressaceae

Juniperus horizontalis
Juniperus scopulorum Sarg.

Pinaceae

Pinus ponderosa Dougl.

Liliatae

Commelinaceae

Tradescantia bracteata Small.

Cyperaceae

Carex filifolia
Scirpus microcarpus Presl.

Iridaceae

Sisyrinchium angustifolium Miller

Juncaceae

Juncus nodosus L.

Liliaceae

Allium textile Nels. & Macbr.
Calochortus nuttallii Torr.
Fritillaria pudica (Pursh) Spreng.
Leucocrinum montanum
Smilacina stellata (L.) Desf.
Yucca glauca Nutt.
Zygadenus venenosus S. Wats.

Poaceae

Agropyron cristatum (L.) Gaertn.
Agropyron smithii Rydb.
Agropyron spicatum (Pursh) Scribner & Smith
Agrostis palustris Huds.
Andropogon gerardi Vitman
Andropogon scoparius Michx.
Aristida longiseta Steud.
Avena sativa L.
Bouteloua curtipendula (Michx.) Torr.
Bouteloua gracilis (H.B.K.) Lag.

TABLE 17.--Continued

Poaceae (continued)

Bromus japonicus Thunb.
Bromus tectorum L.
Calamovilfa longifolia (Hook) Scribn.
Elymus cinereus Scribn. & Merrill
Festuca idahoensis Elmer
Hordeum distichon L.
Hordeum jubatum L.
Koeleria cristata (L.) Pers.
Muhlenbergia cuspidata (Torr.) Rydb.
Muhlenbergia racemosa (Michx.) BSP.
Oryzopsis hymenoides
Poa bulbosa L.
Poa pratensis L.
Poa secunda
Poa sp. (1)
Poa sp. (2)
Phleum pratense L.
Sitanion hystrix (Nutt.) J.G. Smith
Spartina gracilis Trin.
Stipa comata Trin. & Rupr.
Stipa viridula Trin.
Triticum aestivum L.
Vulpia octoflora (Walt.) Rydb.

Magnoliatae

Aceraceae

Acer negundo L.

Anacardiaceae

Rhus radicans L.
Rhus trilobata Nutt.

Apiaceae

Lomatium macrocarpum (Hook. & A.) C.&R.
Musineon divaricatum (Pursh) Raf.

Asclepiadaceae

Asclepias speciosa Torr.
Asclepias syriaca L.
Asclepias verticillata L.

TABLE 17.--Continued

Asteraceae

Achillea millefolium L.
Ambrosia psilostachya DC.
Antennaria microphylla Rydb.
Arctium lappa L.
Arnica sororia Greene
Artemisia cana Nutt.
Artemisia dracunculus L.
Artemisia frigida Willd.
Artemisia ludoviciana Nutt.
Artemisia tridentata Nutt.
Balsamorhiza sagittata (Pursh) Nutt.
Chrysopsis villosa (Pursh) Nutt.
Cirsium arvense (L.) Scop.
Cirsium canovirens (Pydb.) Petrak
Cirsium undulatum (Nutt.) Spreng.
Crepis occidentalis Nutt.
Erigeron divergens T. & G.
Erigeron pumilus Nutt.
Gaillardia aristata Pursh
Grindelia squarrosa (Pursh) Dunal.
Gutierrezia sarothrae (Pursh) B. & R.
Helianthus annuus L.
Helianthus petiolaris Nutt.
Lactuca serriola L.
Liatris punctata Hook.
Microseris nutans (Geyer) Sch.
Ratibida columnifera (Nutt.) Woot. & St.
Senecio plattensis Nutt.
Solidago gigantea Ait.
Solidago missouriensis Nutt.
Solidago mollis Bartl.
Taraxacum officinale Weber
Tragopogon dubius Scop.
Xanthium strumarium L.

Berberidaceae

Berberis repens Lindl.

Boraginaceae

Crypthanthe celosioides (Eastw.) Pays.
Cynoglossum officinale L.
Lithospermum incisum Lehm.

TABLE 17.--Continued

Brassicaceae

Camelina microcarpa Andrż.
Erysimum inconspicuum (S. Wats.) MacM.
Hesperis matronalis L.
Sisymbrium altissimum (L.) Britt.
Stanleya pinnata (Pursh) Britt.
Thlaspi arvense L.

Cactaceae

Mamillaria missouriensis Sweet.
Opuntia polyantha Haw.

Campanulaceae

Campanula rotundifolia L.

Capparidaceae

Cleome serrulata Pursh

Caprifoliaceae

Symphoricarpos occidentalis Hook.

Caryophyllaceae

Cerastium arvense L.

Chenopodiaceae

Chenopodium album L.
Kochia scoparia (L.) Schrad.
Sarcobatus vermiculatus (Hook.) Torr.

Convolvulaceae

Convolvulus arvensis L.
Convolvulus sepium L.

Elaeagnaceae

Elaeagnus angustifolia L.

Euphorbiaceae

Euphorbia glyptosperma Engelm.

Fabaceae

Astragalus gilviflorus Sheld.
Glycyrrhiza lepidota (Nutt.) Pursh
Medicago lupulina L.

TABLE 17.--Continued

Fabaceae (continued)

Medicago sativa L.
Melilotus officinalis (L.) Lam.
Oxytropis Lambertii Pursh
Oxytropis sericea Nutt.
Petalostemon candidum Michx.
Petalostemon purpureum (Vent.) Rydb.
Psoralea argophylla Pursh
Psoralea esculenta Pursh
Psoralea tenuiflora Pursh
Thermopsis rhombifolia Nutt.
Vicia americana Muhl.

Grossulariaceae

Ribes aureum Pursh

Hydrophyllaceae

Phacelia linearis (Pursh) Holz

Lamiaceae

Mentha arvensis L.
Monarda fistulosa L.

Linaceae

Linum perenne L.
Linum rigidum

Malvaceae

Sphaeralcea coccinea (Pursh) Rydb.

Onagraceae

Gaura coccinea Pursh
Oenothera albicaulis Pursh
Oenothera serrulata Nutt.

Orobanchaceae

Orobanche fasciculata Nutt.

Papaveraceae

Argemone intermedia Sweet

Plantaginaceae

Plantago patagonica Jacq.

TABLE 17.--Continued

Polemoniaceae

Collomia linearis Nutt.Phlox hoodii Rich.

Polygalaceae

Polygala alba Nutt.

Polygonaceae

Eriogonum annuum Nutt.Eriogonum flavum Nutt.Eriogonum multiceps Nees.Rumex crispus L.

Primulaceae

Dodecatheon conjugens Greene

Ranunculaceae

Delphinium bicolor Nutt.Ranunculus sceleratus L.Ranunculus glaberrimus Hook.

Rosaceae

Crataegus succulenta Schrad.Fragaria virginiana SuchesneGeum aleppicum Jacq.Geum triflorum PurshPrunus americana Marsh.Prunus virginiana L.Rosa acicularis Lindl.Rosa arkansana PorterRosa woodsii Lindl.

Rubiaceae

Galium boreale L.

Salicaceae

Populus deltoides MarshSalix exigua Nutt.

Scrophulariaceae

Orthocarpus luteusPenstemon albidus Nutt.

TABLE 17.--Continued

Scrophulariaceae (continued)

Penstemon sp.

Verbenaceae

Verbena bracteata L. & R.

Violaceae

Viola canadensis L.Viola nuttallii Pursh.

TABLE 18.--PERCENT FREQUENCY OF OCCURRENCE OF GRAMINOID, FORB AND SUBSHRUB SPECIES FOR SIX VEGETATION TYPES AT SARPY CREEK, MONTANA, 1975-1976

<u>Species</u>	<u>Ponderosa Pine</u>	<u>Sumac</u>	<u>Grass- land</u>	<u>Silver Sage- brush</u>	<u>Riparian Deciduous Tree</u>	<u>Deciduous Shrub Bottom</u>
GRAMINOIDS						
<u>Agropyron cristatum</u>	1		75			
<u>Agropyron smithii</u>	55	3		8	90	40
<u>Agropyron spicatum</u>	56	21				40
<u>Agrostis palustris</u>						20
<u>Andropogon gerardi</u>	2	16				
<u>Andropogon scoparius</u>		20				
<u>Aristida longiseta</u>	4	2	50	15		
<u>Bouteloua curtipendula</u>	41	5				10
<u>Bouteloua gracilis</u>	7	27	1	30		5
<u>Bromus japonicus</u>	32	42	8	50		38
<u>Bromus tectorum</u>	5	12	88	5		
<u>Calamovilfa longifolia</u>	9	38	9			8
<u>Carex filifolia</u>	1	45				
<u>Elymus cinereus</u>					30	
<u>Festuca idahoensis</u>	9					
<u>Hordeum jubatum</u>	1					
<u>Juncus nodosus</u>	1					
<u>Koeleria cristata</u>	7	43	1	22		
<u>Muhlenbergia racemosa</u>	1					
<u>Oryzopsis hymenoides</u>	1	1				
<u>Poa pratensis</u>	10	12	26	85	85	80
<u>Poa secunda</u>	6	50				

TABLE 18.--Continued

<u>Species</u>	<u>Ponderosa Pine</u>	<u>Sumac</u>	<u>Grass- land</u>	<u>Silver Sage- brush</u>	<u>Riparian Deciduous Tree</u>	<u>Deciduous Shrub Bottom</u>
GRAMINOIDS (cont)						
<u>Scirpus microcarpus</u>	1					
<u>Sitanion hystrix</u>			1			
<u>Stipa comata</u>	12	39	73	10		10
<u>Stipa viridula</u>	9			60	5	20
<u>Triticum aestivum</u>	1					
<u>Vulpia octoflora</u>				40		
FORBS						
<u>Achillea millefolium</u>	24			15	5	22
<u>Allium textile</u>	1	1				
<u>Ambrosia psilostachya</u>	32	72	53	95		10
<u>Antennaria microphylla</u>	8	2				
<u>Arctium lappa</u>					8	
<u>Argemone intermedia</u>	1					
<u>Arnica sororia</u>	14	8	6			8
<u>Artemisia dracunculus</u>	5	21	2	18		
<u>Artemisia frigida</u>	11	4				
<u>Artemisia ludoviciana</u>	28	29	2	40	18	12
<u>Asclepias syriaca</u>			2		5	
<u>Asclepias verticillata</u>	4	15	1	2		
<u>Astragalus gilviflorus</u>		9	5			
<u>Balsamorhiza sagittata</u>	1					
<u>Berbis repens</u>	4					

TABLE 18.--Continued

<u>Species</u>	<u>Ponderosa Pine</u>	<u>Sumac</u>	<u>Grass- land</u>	<u>Silver Sage- brush</u>	<u>Riparian Deciduous Tree</u>	<u>Deciduous Shrub Bottom</u>
FORBS (cont)						
<u>Calochortus nuttallii</u>	1	3				
<u>Camelina microcarpa</u>	1	1		8		
<u>Cerastium arvense</u>	4	1				
<u>Chenopodium album</u>					28	
<u>Chrysopsis villosa</u>	8	24	15	2		
<u>Cirsium arvense</u>	1				45	
<u>Cirsium undulatum</u>	3	2	5	5		
<u>Collomia linearis</u>		1				
<u>Crepis occidentalis</u>	1					
<u>Cryptanthus celosioides</u>	1					
<u>Cynoglossum officinale</u>	1					
<u>Erigeron divergens</u>			1			
<u>Eriogonum annuum</u>		21	55			
<u>Eriogonum multiceps</u>	2					
<u>Euphorbia glyptosperma</u>		1				
<u>Fragaria virginiana</u>	1					5
<u>Galium boreale</u>	1					
<u>Glycyrrhiza lepidota</u>	3		1			
<u>Grindelia squarrosa</u>	3			2	5	
<u>Helianthus petiolaris</u>			4			
<u>Hesperis matronalis</u>	1				2	
<u>Kochia scoparia</u>					8	
<u>Lactuca serriola</u>			1			
<u>Liatris punctata</u>		11	1			

TABLE 18.--Continued

<u>Species</u>	<u>Ponderosa Pine</u>	<u>Sumac</u>	<u>Grass- land</u>	<u>Silver Sage- brush</u>	<u>Riparian Deciduous Tree</u>	<u>Deciduous Shrub Bottom</u>
FORBS (cont)						
<u>Linum perenne</u>	8	1				10
<u>Lithospermum incisum</u>		8				
<u>Medicago lupulina</u>	1					
<u>Medicago sativa</u>					65	
<u>Mentha arvensis</u>	1					
<u>Microseris nutans</u>						2
<u>Monarda fistulosa</u>	1					
<u>Oxtropis lambertii</u>			6			
<u>Petalostemon candidum</u>		1				
<u>Petalostemon purpureum</u>		9	4			
<u>Phacelia linearis</u>						5
<u>Phlox hoodii</u>	1	4				
<u>Plantago patagonica</u>	3	2	1	2		
<u>Psoralea argophylla</u>	12	6	6	5		
<u>Psoralea esculenta</u>				2		
<u>Psoralea tenuiflora</u>	8		12	35		5
<u>Ratibida columnifera</u>	18	1	1	20		20
<u>Rumex crispus</u>	3					
<u>Sisymbrium altissimum</u>			1	8	5	
<u>Smilacina stellata</u>	3	1				
<u>Solidago missouriensis</u>	1					
<u>Solidago mollis</u>		1				
<u>Taraxacum officinale</u>	1					
<u>Thlaspi arvense</u>		1				

TABLE 18.--Continued

<u>Species</u>	<u>Ponderosa Pine</u>	<u>Sumac</u>	<u>Grass- land</u>	<u>Silver Sage- brush</u>	<u>Riparian Deciduous Tree</u>	<u>Deciduous Shrub Bottom</u>
FORBS (cont)						
<u>Tradescantia bracteata</u>	2	1				
<u>Tragopogon dubius</u>	9	1	7		20	2
<u>Verbena bracteata</u>	1					
<u>Vicia americana</u>	1					
<u>Viola canadensis</u>	1					
<u>Yucca glauca</u>	2	2	2			
SUBSHRUBS						
<u>Gutierrezia sarothrae</u>	12	1	1	48		5
<u>Oenothera serrulata</u>		3				

Ecological distribution of Simian marmosets

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Ecological distribution
of small mammals at Sarpy
Creek, Montana, with
special consideration ...

DATE	ISSUED TO
(9)	Todd Borchers 6-30-89 [REDACTED] [REDACTED] [REDACTED]
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