Populations of small mammals in central Montana with special reference to tentative sagebrush control sites
by John David Cada

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

Abstract:
Small mammal populations and vegetation on each of six study-plots in central Montana were studied during the summers of 1966 and 1967. This study was prior to sagebrush control operations of varying degrees on the different study plots. Results will be available for comparison with those of a similar study following sagebrush control.

Vegetation was analyzed by determining canopy coverages and frequencies of occurrence for plant taxa. The Artemisia/Agropyron vegetation type characterized each of the plots. Sub-types represented were as follows: Artemisia tridentata/Agropyron smithii; Artemisia tridentata/Agropyron smithii/Bouteloua gracilis; Artemisia triden-tata/Bouteloua gracilis; Artemisia tridentata/Poa canbyi; Artemisia tridentata/Agropyron desertorum; and Artemisia tridentata/Agropyron smithii/Poa secunda. Canopy intercept of shrubs was determined along transect lines. Artemisia tridentata was the only abundant shrub.

Its coverage varied considerably within and between plots. The greatest variation (18 to 62 percent) occurred in one stand of the Artemisia tridentata/Agropyron smithii sub-type where the canopy coverage of Agropyron smithii was inversely related to that of Artemisia tridentata.

Data from live trapping on each of the plots during two trapping series each summer were used in determining home range, movement, and density indexes for the most abundant small mammal, Peromyscus manieu-latus osgoodi. Sixty-six home range indexes were each determined by a "minimum area" method and "boundary strip" method. The mean home' range index in acres of male adults for series I and II, 1966 and series I and II, 1967 was 2.1, 1.9, 1.0, and 1.8 for the "minimum area" method and 3.2, 3.0, 2.0, and 2.9 for the "boundary strip" method respectively. The low index for series I, 1967 corresponded with unusually heavy spring rains. Mean indexes for adult females, sub-adults, and juveniles appeared slightly smaller than those of the adult males.

One hundred one mean recapture radii were determined for Peromys-cus maniculatus. These were used as . indexes of movement. Average movement indexes in feet for male and female adults were 162 and 147 in 1966 and 190 and 184 in 1967 respectively. Movement indexes for sub-adults and juveniles were similar to those of adults.

Population density indexes for resident Peromyscus maniculatus expressed as individuals per 40 acres were determined for each plot during each trapping series. Average population indexes for all plots combined during series I and II, 1966 and series I and II, 1967 were 26.3, 18.6, 9.0, and 14.2 mice per 40 acres respectively. The relative-low population for series I, 1967 corresponded with the heavy spring rains. The relatively high population for early summer 1966 was followed by a population decline by late summer whereas the relatively low population for early summer 1967 showed a strong increase by late summer.

Other small mammals trapped or observed on the plots included: La- gurus curtatus; Lepus townsendii; Microtus sp.; Mus musculus; Onychomys leucogaster; Perognathus fasciatus; and Sylvilagus audubonii.

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POPULATIONS OF SMALL MAMMALS IN CENTRAL MONTANA WITH SPECIAL REFERENCE TO TENTATIVE SAGEBRUSH CONTROL SITES

by

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of

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in

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ABSTRACT

Small mammal populations and vegetation on each of six study plots in central Montana were studied during the summers of 1966 and 1967. This study was prior to sagebrush control operations of varying degrees on the different study plots. Results will be available for comparison with those of a similar study following sagebrush control.

Vegetation was analyzed by determining canopy coverages and frequencies of occurrence for plant taxa. The *Artemisia/Agropyron* vegetation type characterized each of the plots. Sub-types represented were as follows: *Artemisia tridentata/Agropyron smithii; Artemisia tridentata/Agropyron smithii/Bouteloua gracilis; Artemisia tridentata/Bouteloua gracilis; Artemisia tridentata/Poa canbyi; Artemisia tridentata/Agropyron desertorum;* and *Artemisia tridentata/Agropyron smithii/Poa secunda.* Canopy intercept of shrubs was determined along transect lines. *Artemisia tridentata* was the only abundant shrub. Its coverage varied considerably within and between plots. The greatest variation (18 to 62 percent) occurred in one stand of the *Artemisia tridentata/Agropyron smithii* sub-type where the canopy coverage of *Agropyron smithii* was inversely related to that of *Artemisia tridentata.*

Data from live trapping on each of the plots during two trapping series each summer were used in determining home range, movement, and density indexes for the most abundant small mammal, *Peromyscus maniculatus osgoodi.* Sixty-six home range indexes were each determined by a "minimum area" method and "boundary strip" method. The mean home range index in acres of male adults for series I and II, 1966 and series I and II, 1967 was 2.1, 1.9, 1.0, and 1.8 for the "minimum area" method and 3.2, 3.0, 2.0, and 2.9 for the "boundary strip" method respectively. The low index for series I, 1967 corresponded with unusually heavy spring rains. Mean indexes for adult females, sub-adults, and juveniles appeared slightly smaller than those of the adult males.

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Other small mammals trapped or observed on the plots included: *Lagurus curtatus; Lepus townsendii; Microtus* sp.; *Mus musculus; Onychomys leucogaster; Perognathus fasciatus;* and *Sylvilagus audubonii.*

INTRODUCTION

The practice of sagebrush removal to afford better grass production for domestic use is well supported in the literature (Alley 1956; Hyder and Sneva 1956; Mueggler and Blaisdell 1958). The ecological effects resulting from this practice on the resident fauna are more rarely considered. Since this trend toward removal of sagebrush is increasing on public lands as well as private lands, the Montana State Fish and Game Department, in cooperation with the Bureau of Land Management, initiated a 10-year study in 1965 of the effects of ecological changes resulting from eradication upon certain animal populations. The current report is part of that project.

Small mammals were studied largely by live trapping. The deer mouse (*Peromyscus maniculatus osgoodi*) made up the largest portion of all captures. Thus it is the primary concern of this paper. Relatively little quantitative work has been done with this small mammal in a sagebrush habitat.

This project was located in central Montana near the town of Winnett and was conducted on a full-time basis during the summer months of 1966 and 1967. It was a preliminary study to determine population characteristics prior to sagebrush removal operations scheduled for June, 1968. Data obtained were such that valid comparisons could be made with the results of post-eradication studies.

My objectives were to obtain density, home range, and movement indexes for resident small mammals and to determine vegetation composition of the habitat.

STUDY AREAS

Study plots were located in two study areas, both within 20 miles of Winnett (Figure 1). The terrain of these areas was moderately flat adjoined by gently rolling hills and gully bottoms. The clay loam soils were exposed and slightly depressed between sagebrush plants. Commonly these "gumbo" soils retard moisture penetration resulting in large runoff or pools during intense rains.

Much of the area had been homesteaded in the early 1900's (Gieseker 1938). By the 1920's and 30's most attempts to cultivate the land had failed forcing most operators to abandon. Since then it has been commonly used as summer rangeland for cattle and sheep.

Gieseker (*op cit.*) considered the climate semi-arid ...."characterized by a comparatively low rainfall, great temperature extremes, a large number of sunny days, and a relatively low humidity." Records for the U. S. Department of Commerce weather station at Flatwillow 4 ENE show normal mean temperatures for June, July, August, and September to be 61.9, 71.5, 69.2, and 58.9 degrees Fahrenheit respectively. The normal annual rainfall of 12.57 inches occurs mostly in the spring and summer months. The "dry" and "wet" summers experienced during this study were mainly the result of the respective June precipitations of 0.47 inches in 1966 and 4.79 inches in 1967.

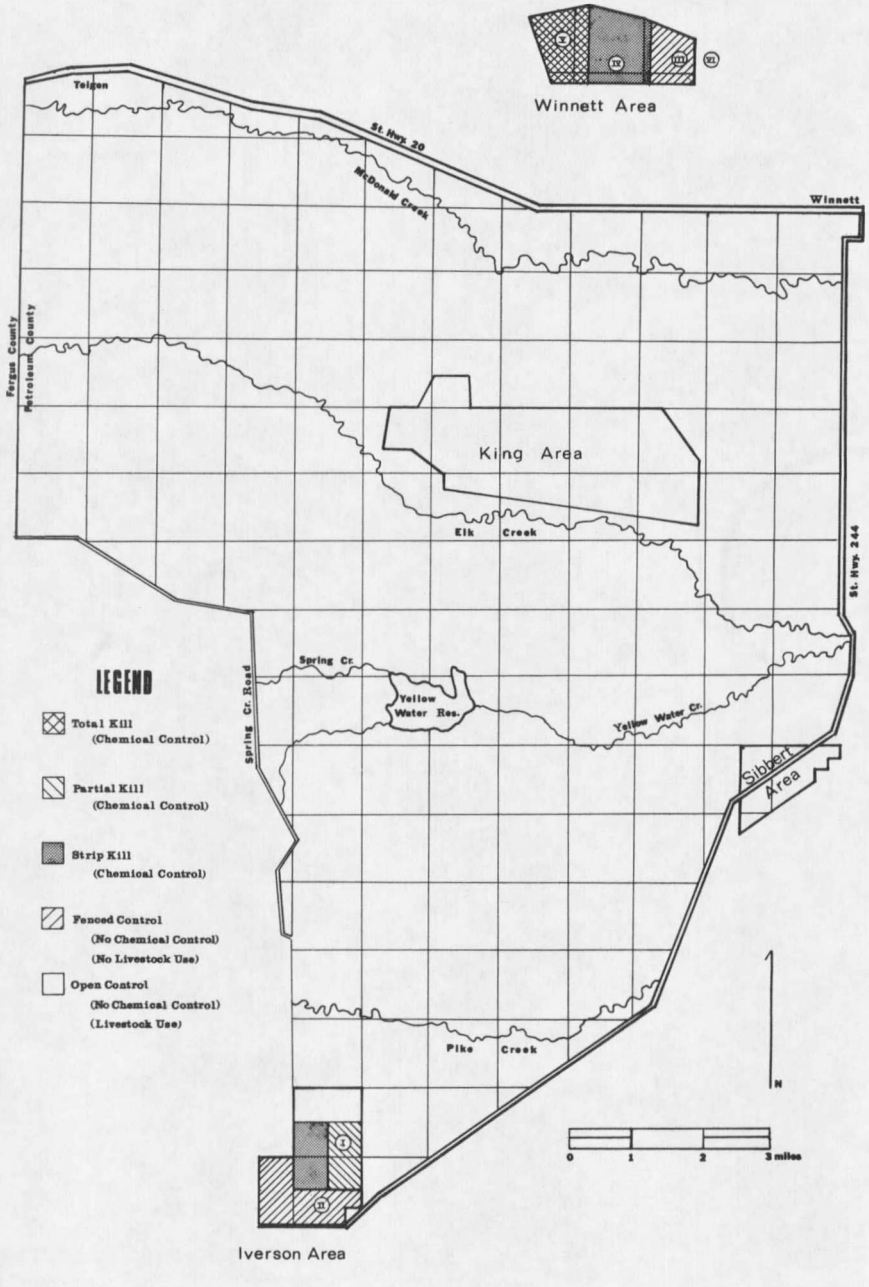


Figure 1. Map showing the four sagebrush control study areas, with special reference to the locations (I-VI) of the six small mammal study plots. The study plots were located on areas that will be subjected to varying degrees of sagebrush control as indicated.

METHODS

Six study plots were strategically positioned so as to sample certain tentative treatment and control sites (Figure 1). Trapping procedures were similar to those outlined by Blair (1941).

Trapping on an individual study plot for a certain period of time is a "trapping period." Trapping on each of the six study plots was conducted consecutively. Hence the six trapping periods represent a "trapping series." Two trapping series occurred each summer. The trapping period and plot size varied between the first and the last three trapping series. In series "I" of 1966 each study plot was 660 ft. sq. (10 acres) and the trapping period was eight days. During each of the following series each study plot was 900 ft. sq. (18.6 acres) and the trapping period was six days. Trapping was carried out during the same trapping period on each of two plots during all series except in series "II" of 1966 when each trapping period was restricted to a single plot.

Each study plot was gridded to 60-foot quadrats with numbered stakes marking trapping stations. Traps were placed at alternate stations along rows and columns each day. Thus during the six- and eight-day trapping periods a trap was in operation at each station during three and four nights respectively. During any one night the trap interval along rows and columns was 120 feet.

Trapping was with Sherman live traps baited with oatmeal and provided with cotton for nesting material to provide insulation for

trapped animals. Traps were made operational in late afternoon for night trapping. They were checked each morning. Traps were non-operational during the day.

When initially caught each animal was individually marked by removal of a toe(s) in accordance with a previously determined marking system. Males were examined for scrotal testes and females for prominent mammary glands before release at the trap site. Mammal nomenclature is according to Hall and Kelson (1959).

Following the thinking of Shillito (1963) who described home range as .... "that area habitually traversed .... within a specific period of time," home range indexes were calculated from points of capture obtained during one trapping period. The "inclusive boundary strip" method (Blair 1942) and the "minimum home range" method (Mohr 1947) were used to calculate indexes to home range size in acres. Points of capture considered for home range index determination were those of animals caught more than four times and whose geometric center of capture points (Hayne 1949) was 120 feet or more within the peripheral row or column of traps.

Distances from points of capture to their calculated geometric center, "recapture radii" (Dice and Clark 1953), were considered an index to the movement of an individual. Only movements of animals caught three or more times and having their geometric center of capture points 120 feet or more inside the peripheral row or column of traps were considered.

All Peromyscus captured were classified as to degree of residency (Hodgson 1968). Mammals caught only once and those caught only twice if on consecutive nights were considered "partial residents." Hence, during a six-day trapping period an individual captured once was a one-sixth resident; and an animal captured only on two consecutive nights a two-sixths resident. Captures other than the partial residents were considered as "full residents." A mammal captured at least once in each of two trapping periods was a full resident (six-sixths resident) for both periods.

In determining population density on each study plot it was necessary to add a border strip along each side to account for captures of mammals having only a portion of their normal home range covered by the trapping grid (Blair 1941). In view of the fact that there was no difference in movement indexes between plots, the width of all border strips for a trapping series was the average movement index (recapture radius) of mammals on all six study plots in that series. For each trapping period the total of all degrees of residency for a study plot was considered the number of animals occupying the total area of the study plot and border strip.

Analysis of the vegetation was done similarly to the method described by Daubenmire (1959). During 1966 four vegetation sampling sites were systematically chosen on each of five study plots. Aerial photographs were used in 1967 to choose from three to six analysis sites on each of the six plots. All areas within each study plot hav-

ing observable differences in sagebrush density and/or other vegetational features were sampled. Twenty 2 x 5 decimeter plot frames were systematically placed along two 100-foot lines at each analysis site. The height and percent canopy coverage of each plant taxon and percentage exposed soil, rock and plant litter were estimated within each plot frame. Frequency and constancy of plant occurrence among plot frames and analysis sites respectively were determined. Sagebrush height and density was determined at each analysis site by making a height and line intercept measurement of each sagebrush plant or plant part intercepting a positioned 100-foot line. Plant nomenclature was taken from Booth (1950) and Booth and Wright (1959).

RESULTS

Vegetation

The *Artemisia/Agropyron* vegetation type occurs on each of the six study plots. Included in this vegetation type are the following sub-types based on dominant or co-dominant grasses: *Artemisia tridentata/Agropyron smithii; Artemisia tridentata/Agropyron desertorum; Artemisia tridentata/Agropyron smithii/Bouteloua gracilis; Artemisia tridentata/Bouteloua gracilis; Artemisia tridentata/Poa canbyi;* and *Artemisia tridentata/Agropyron smithii/Poa secunda.* The vegetation occurring in nine hundred twenty 2 x 5 decimeter plot frames was analyzed at 46 sampling sites on the study plots. The *Artemisia tridentata/Agropyron smithii/Bouteloua gracilis* sub-type, an area of dense *Artemisia tridentata* (big sagebrush) (Table I), and the *Artemisia tridentata/Bouteloua gracilis* sub-type, an area of common sagebrush density, each occupied about one-half of Plot I (Figure 2). The dense sagebrush occurred at one corner of the plot and graded to the more sparce density at the far corner. The canopy coverage, frequency, and constancy of certain taxa occurring in each of these two sub-types are shown in Table II. *Artemisia tridentata* was the only shrub present on the plot. *Bouteloua gracilis* (blue grama) and *Agropyron smithii* (bluestem) were important grasses on both sub-types but the former was most conspicuous on the *Artemisia tridentata/Bouteloua gracilis* sub-type. Other common grasses for both sub-types were *Koeleria cristata* (junegrass), and *Poa secunda* (Sandberg bluegrass). Forbs for both sub-types included *Phlox hoodii* (Hood's phlox), *Artemisia frigida* (fringed sagewort),

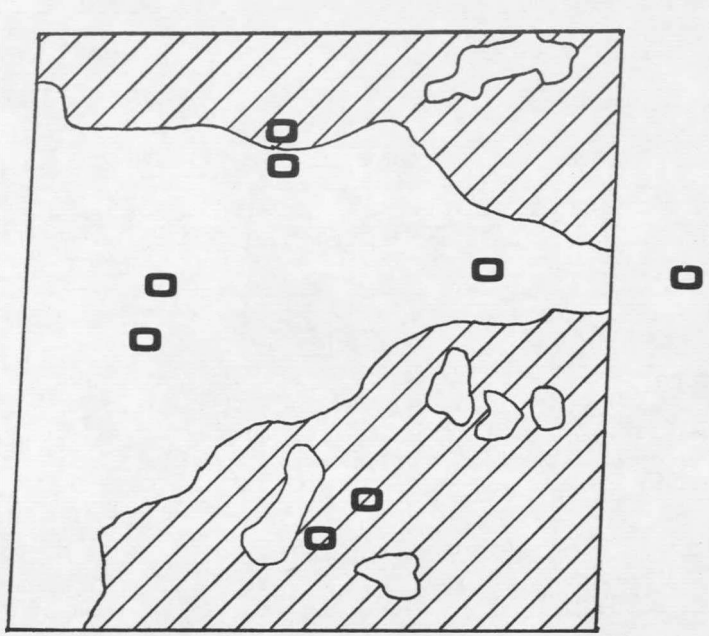
TABLE I. AVERAGE NUMBER, HEIGHT, AND CROWN COVERAGE OF BIG SAGEBRUSH PLANTS ON EACH OF THE STUDY PLOTS AS DETERMINED BY MEASUREMENTS ALONG A 100-FOOT LINE AT VARIOUS SAMPLE SITES (SAMPLE SITES ARE THE SAME AS THOSE FOR TABLES II, III, AND IV).

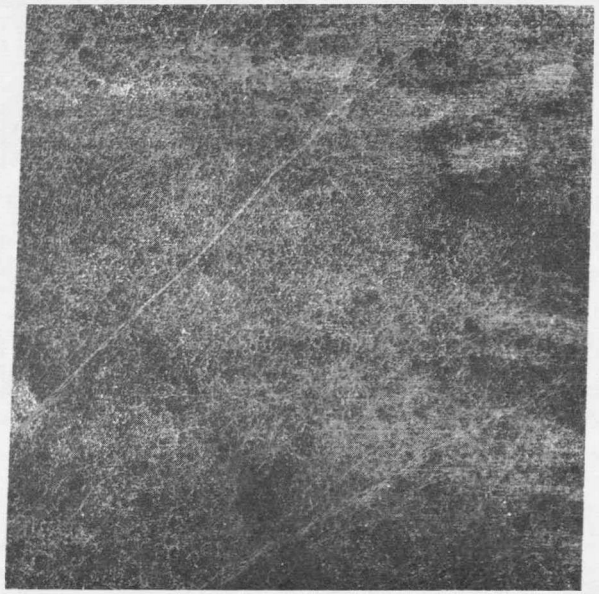
Plot No.	Vegetation Sub-Type	Physio-graphy	No. of Sites	SAGEBRUSH CHARACTERISTICS			
				Crown Coverage		Mean Ht. (inches)	Mean No. of Plants/Site
				Mean(%)	Range(%)		
I	*Artemisia tridentata/ Agropyron smithii/ Bouteloua gracilis*	Typical	5[1]	37(Dense)[2]	29-51	11	44(2)[3]
	Artemisia tridentata/ Bouteloua gracilis	Typical	3	18(Common)	10-25	13	21(1)
II	*Artemisia tridentata/ Agropyron smithii/ Bouteloua gracilis*	Typical	2	14(Common)	12-16	8	16(1)
	Artemisia tridentata/ Agropyron smithii	Typical	5	39(Dense)	30-54	11	60(2)
III	*Artemisia tridentata/ Agropyron smithii*	Typical	1	62(Dense)	-	16	49(1)
		Typical	6	35(Dense)	26-49	11	28(2)
		Typical	1	18(Common	-	9	22(1)
IV	*Artemisia tridentata/ Agropyron smithii*	Typical	1	41(Dense)	-	11	43(1)
		Typical	5	19(Common)	13-25	12	19(1)
		Gully Bottom	1	25(Common)	-	11	25(1)
	Artemisia tridentata/ Agropyron desertorum	Typical	3	25(Common)	21-31	10	44(1)
V	*Artemisia tridentata/ Agropyron smithii*	Typical	4	15(Common)	9-20	8	31(1)
		"Hard Pan"	1	13(Common)	-	12	15(1)
		Gully Bottom	1	23(Common)	-	11	25(1)
	Artemisia tridentata/ Poa canbyi	"Hard Pan"	2	8(Common)	5-11	7	20(1)

TABLE I. (CONTINUED).

Plot No.	Vegetation Sub-Type	Physio-graphy	No. of Sites	SAGEBRUSH CHARACTERISTICS			
				Crown Coverage		Mean Ht. (inches)	Mean No. of Plants/Site
				Mean(%)	Range(%)		
VI	*Artemisia tridentata/ Agropyron smithii*	Typical	3	40(Dense)	36-42	17	35(3)
		"Hard Pan"	1	16(Common)	-	12	15(1)
	Artemisia tridentata/ Agropyron smithii/ Poa secunda	Typical	1	8(Common)	-	14	12(1)

1/ Number of sites where crown coverage and heights were determined.
2/ Sagebrush crown coverages of 5 to 25 and of 26 and greater are categorized as common and dense sagebrush respectively (similarly to Wentland 1968).
3/ The number in parentheses refers to the number of sites at which the mean number of plants per site was determined.





N

400 Feet

LEGEND

Common Sagebrush Density (*Artemisia tridentata/Bouteloua gracilis* Sub-type).

Dense Sagebrush (*Artemisia tridentata/Agropyron smithii/Bouteloua gracilis* Sub-Type).

Sites of Vegetation Analyses.

Figure 2. Aerial Photograph and Diagram of Plot I.

TABLE II. CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR TAXA IN EACH OF THE TWO SAGEBRUSH DENSITY CATEGORIES FOR EACH OF THE TWO SUB-TYPES ON PLOT I AND ON PLOT II.

	PLOT I		PLOT II	
	Vegetation Sub-Type		Vegetation Sub-Type	
	Artemisia tridentata/Agropyron smithii/Bouteloua gracilis	*Artemisia tridentata/Bouteloua gracilis*	*Artemisia tridentata/Agropyron smithii*	*Artemisia tridentata/Agropyron smithii/Bouteloua gracilis*
	SAGEBRUSH DENSITY[2]		SAGEBRUSH DENSITY	
	Dense(37%) 5 Sites 100 Plots	Common(18%) 3 Sites 60 Plots	Dense(39%) 5 Sites 100 Plots	Common(14%) 2 Sites 40 Plots
Taxa[1]	Cv/Fr/Cy[3]	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy
GRASSES				
Bouteloua gracilis	11/41/100	41/97/100	t/ 8/60	20/77/100
Agropyron smithii	10/91/100	14/93/100	27/92/100	26/90/100
Koeleria cristata	3/73/100	2/35/100	2/16/100	t/12/100
Poa secunda	3/45/100	1/30/100	t/26/60	4/70/100
Stipa viridula	3/20/60	--/--/---	2/ 9/60	t/ 3/50
Stipa comata	2/38/100	3/37/100	t/ 1/20	--/--/---
Poa sp.	t/11/40[4]	--/--/---	t/10/80	2/27/100
Agropyron sp.	1/ 4/60	--/--/---	--/--/---	--/--/---
Bromus tectorum	t/ 3/40	--/--/---	6/58/100	--/--/---
ALL GRASSES	39/99/100	63/100/100	42/99/100	57/100/100
FORBS				
Phlox hoodii	2/33/100	1/26/100	t/ 3/40	2/22/100
Artemisia frigida	1/29/100	2/30/100	t/ 6/60	1/12/100
Opuntia polycantha	t/ 5/60	1/10/100	--/--/---	t/ 5/100
Plantago spinulosa	t/15/60	1/33/66	t/32/80	1/50/100
Achillea millefolium	1/12/80	t/ 8/33	t/ 1/20	--/--/---
ALL FORBS	8/76/100	5/78/100	3/56/100	5/32/100
SHRUB				
Artemisia tridentata	37/88/100	15/60/100	39/90/100	9/45/100

TABLE II. (CONTINUED).

	PLOT I		PLOT II	
	Vegetation Sub-Type		Vegetation Sub-Type	
	Artemisia tridentata/Agropyron smithii/Bouteloua gracilis	*Artemisia tridentata/Bouteloua gracilis*	*Artemisia tridentata/Agropyron smithii*	*Artemisia tridentata/Agropyron smithii/Bouteloua gracilis*
	SAGEBRUSH DENSITY		SAGEBRUSH DENSITY	
	Dense (37%) 5 Sites 100 Plots	Common (18%) 3 Sites 60 Plots	Dense (39%) 5 Sites 100 Plots	Common (14%) 2 Sites 40 Plots
Taxa	Cv/Fr/Cy	C/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy
OTHERS				
Carex sp.	5/41/80	2/40/100	--/--/---	1/15/50
Lichen	2/69/100	2/50/100	t/ 2/20	4/80/100
Selaginella densa	1/ 9/60	3/13/66	--/--/--	--/--/---
Bare Ground	34/97/100	28/100/100	57/98/100	39/100/100
Litter	24/80/100	18/45/100	11/50/100	12/90/100

1/ Taxa having canopy coverages of less than 1 percent in all categories of sagebrush density were not included (these are listed in Appendix, Table XI).

2/ Density was obtained from line intercept measurements of sagebrush at each analysis site (Table I).

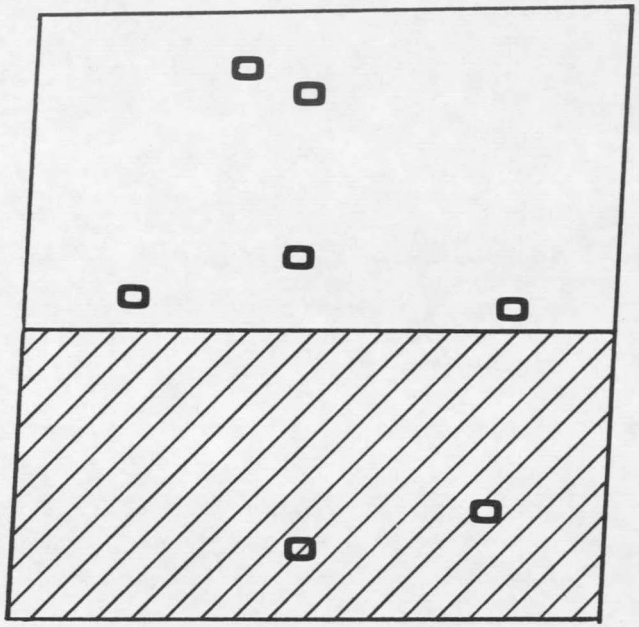
3/ Canopy coverage/Frequency/Constancy.

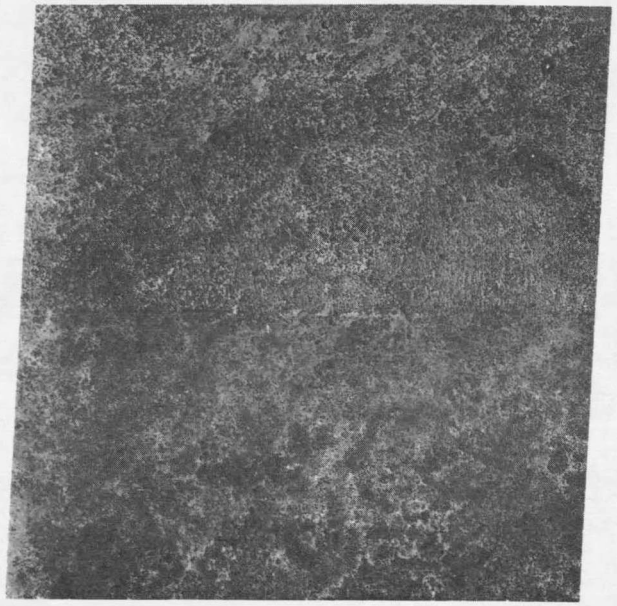
4/ t indicates taxon having less than 1 percent canopy coverage.

Opuntia polycantha (plains pricklypear), *Plantago spinulosa* (spindle plantain) and *Achillea millefolium* (yarrow).

The *Artemisia tridentata/Agropyron smithii* and the *Artemisia tridentata/Agropyron smithii/Bouteloua gracilis* sub-types occupied equal halves of Plot II (Figure 3). Except for *Bouteloua gracilis* and *Bromus tectorum* (downy chess brome) the vegetation was similar on the two sub-types on Plot II as well as on the two sub-types on Plot I (Table II). *Bouteloua gracilis* was rare in the *Artemisia tridentata/Agropyron smithii* sub-type, an area of dense sagebrush. In the *Artemisia tridentata/Agropyron smithii/Bouteloua gracilis* sub-type of Plot II, an area of common sagebrush density, the coverage of *Bouteloua gracilis* was less than on areas of similar sagebrush density for this sub-type on Plot I but greater than on the *Artemisia tridentata/Agropyron smithii* sub-type. *Bromus tectorum* was conspicuous only on the *Artemisia tridentata/Agropyron smithii* sub-type.

The *Artemisia tridentata/Agropyron smithii* sub-type was completely dominant on Plot III and occupied more than one-half of Plot IV (Figures 4 and 5). The sagebrush density in this sub-type graded from areas of low density to areas of high density (Table I). Occurrence of taxa for this sub-type is shown for each of three categories of sagebrush density on each plot (Table III). *Artemisia tridentata* and *Atriplex nuttallii* (Nuttall saltbush) were the only conspicuous shrubs present. On both plots the common grasses of this sub-type were *Agropyron smithii, Koeleria cristata, Agropyron* spp., and *Poa secunda.*





N

400 Feet

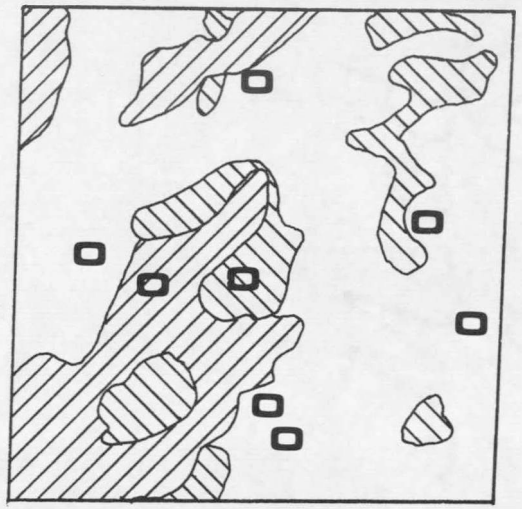
LEGEND

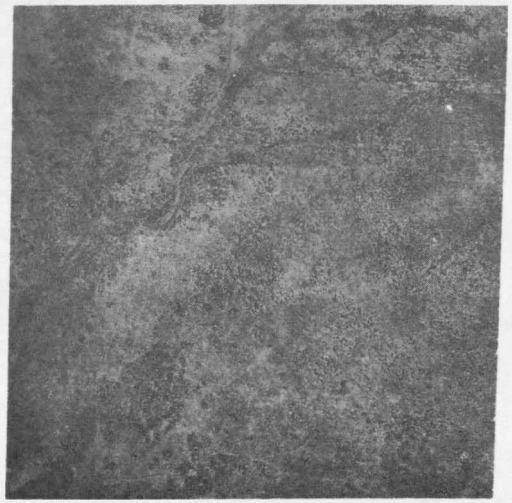
Dense Sagebrush (*Artemisia tridentata/Agropyron smithii* Sub-type).

Common Sagebrush Density (*Artemisia tridentata/Agropyron smithii/Bouteloua gracilis* Sub-type).

Sites of Vegetation Analyses.

Figure 3. Aerial Photograph and Diagram of Plot II.





N

400 Feet

LEGEND

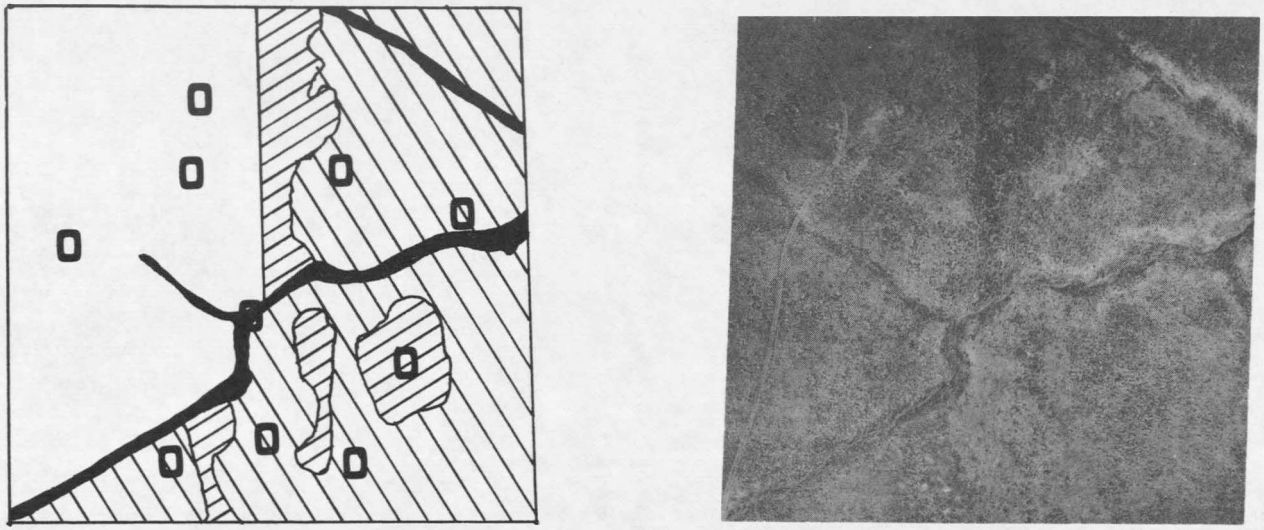
Dense Sagebrush (62%).

Dense Sagebrush (35%).

Common Sagebrush Density.

Sites of Vegetation Analyses.

Figure 4. Aerial Photograph and Diagram of Plot III (*Artemisia tridentata/Agropyron smithii* Sub-type).



LEGEND

Dense Sagebrush (*Artemisia tridentata/Agropyron smithii* Sub-type).

Common Sagebrush Density (*Artemisia tridentata/Agropyron smithii* Sub-type).

Common Sagebrush Density-Gully Bottom (*Artemisia tridentata/Agropyron smithii* Sub-type).

Common Sagebrush Density (*Artemisia/tridentata/Agropyron desertorum* Sub-type).

Sites of Vegetation Analyses.

Figure 5. Aerial Photograph and Diagram of Plot IV.

TABLE III. CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR TAXA IN EACH OF THE DENSITY CATEGORIES[1] OF SAGEBRUSH OCCURRING IN THE *ARTEMISIA TRIDENTATA/AGROPYRON SMITHII* SUB-TYPE OF PLOTS III AND IV AND IN THE *ARTEMISIA TRIDENTATA/AGROPYRON DESERTORUM* SUB-TYPE OF PLOT IV.

Vegetation Sub-Type	PLOT III			PLOT IV			
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/Agropyron desertorum*
Sagebrush Density	Dense (62%)[3]	Dense (35%)	Common (18%)	Dense (41%)	Common (19%)	Common (25%)[4]	Common (25%)
Taxa[2]	1 Site 20 Plots Cv/Fr/Cy[5]	6 Sites 120 Plots Cv/Fr/Cy	1 Site 20 Plots Cv/Fr/Cy	1 Site 20 Plots Cv/Fr/Cv	5 Sites 100 Plots Cv/Fr/Cy	1 Site 20 Plots Cv/Fr/Cy	3 Sites 60 Plots Cv/Fr/Cy
GRASSES							
Agropyron smithii	12/65	28/94/100	42/100	19/80	33/89/100	32/100	6/42/100
Agropyron spp.	3/30	4/30/66	7/30	1/35	13/39/60	10/45	--/--/---
Agropyron desertorum	--/--	--/--/---	--/---	--/--	--/--/---	--/---	31/75/100
Koeleria cristata	4/20	4/42/100	t/5	7/50	3/32/80	10/55	--/--/---
Bouteloua gracilis	--/--	t[6]/1/17	--/---	--/--	3/22/40	--/---	--/--/---
Stipa viridula	--/--	t/ 6/66	--/---	5/35	2/13/80	--/---	--/--/---
Poa secunda	4/30	t/ 1/17	1/10	--/--	2/19/40	8/45	5/34/66
Poa canbyi	--/--	--/--/---	--/---	2/40	2/26/40	13/75	--/--/---
ALL GRASSES	19/70	45/98/100	52/100	36/95	62/100/100	68/100	36/98/100
FORBS							
Vicia americana	6/50	t/13/83	7/65	7/85	3/25/100	6/80	4/20/100
Phlox hoodii	5/65	6/63/83	--/--	6/85	3/40/100	t/20	8/44/100
Taraxacum officinale	t/5	--/--/--	--/--	t/10	--/--/---	16/60	--/--/---

TABLE III. (CONTINUED).

Vegetation Sub-Type	PLOT III			PLOT IV			
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/Agropyron desertorum*
Sagebrush Density	Dense (62%)	Dense (35%)	Common (18%)	Dense (41%)	Common (19%)	Common (25%)	Common (25%)
Taxa	1 Site 20 Plots Cv/Fr/Cy	6 Sites 120 Plots Cv/Fr/Cy	1 Site 20 Plots Cv/Fr/Cy	1 Site 20 Plots Cv/Fr/Cy	5 Sites 100 Plots Cv/Fr/Cy	1 Site 20 Plots Cv/Fr/Cy	3 Sites 60 Plots Cv/Fr/Cy
Gutierrezia sarothrae	t/ 5	4/39/83	t/15	3/10	1/12/60	4/25	--/--/---
Artemisia frigida	t/ 3	3/33/100	--/--	t/15	1/15/60	1/15	--/--/---
Sphaeralcea coccinea	t/10	1/28/83	4/40	t/15	t/ 5/40	t/ 5	t/ 7/66
Iva axillaris	--/--	t/ 5/17	3/45	2/35	t/ 2/20	t/20	--/--/---
Achillea millefolium	--/--	--/--/---	--/--	--/--	t/ 1/20	3/25	--/--/---
Allium textile	t/5	t/ 1/17	--/--	t/ 5	t/ 1/20	2/40	t/ 3/33
Androsace septentrionalis	--/--	1/ 9/33	--/--	--/--	--/--/---	--/--	--/--/---
Arenaria hookeri	--/--	1/14/66	--/--	t/ 5	t/ 1/20	--/--	--/--/---
ALL FORBS	12/95	15/95/100	17/95	15/90	10/93/100	34/100	14/80/100
SHRUBS							
Artemisia tridentata	56/100	35/92/100	13/50	40/95	25/81/100	22/70	30/70/100
Atriplex nuttallii	--/---	1/14/66	2/ 5	--/--	t/ 2/20	--/--	t/13/66

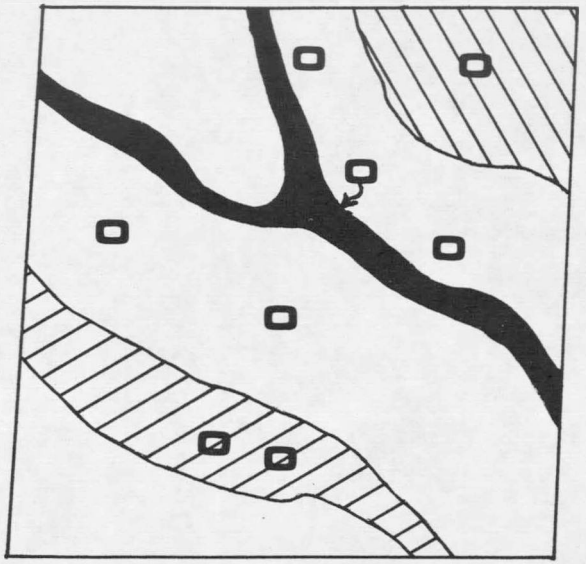
TABLE III. (CONTINUED).

Vegetation Sub-Type	PLOT III			PLOT IV			
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/Agropyron desertorum*
Sagebrush Density	Dense (62%)	Dense (35%)	Common (18%)	Dense (41%)	Common (19%)	Common (25%)	Common (25%)
	1 Site 20 Plots	6 Sites 120 Plots	1 Site 20 Plots	1 Site 20 Plots	5 Sites 100 Plots	1 Site 20 Plots	3 Sites 60 Plots
Taxa	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy
OTHERS							
Litter	38/95	46/100/100	17/90	22/60	23/87/100	25/95	10/95/100
Rock	1/25	4/35/83	2/45	t/20	2/18/60	--/--	t/15/100
Lichen	--/--	t/ 9/33	--/--	t/20	1/21/80	t/ 5	--/--/---
Bare Ground	26/90	45/98/100	42/100	45/100	33/100/100	28/100	57/97/100
Selaginella densa	t/ 5	t/ 1/33	--/---	t/ 5	--/--/---	--/---	t/35/66

1/ Density was obtained from line intercept measurements of sagebrush at each analysis site (Table I).
2/ Taxa having canopy coverages of less than 1 percent in all categories of sagebrush density were not included (these are listed in Appendix, Table XII).
3/ One of several stands of highly dense sagebrush (Figure 4).
4/ Vegetation characteristic of the gully bottom (Figure 5).
5/ Canopy coverage/Frequency/Constancy.
6/ t indicates taxon having less than 1 percent canopy coverage.

Poa canbyi (Canby bluegrass), although not present on Plot III, was common on this sub-type of Plot IV. Canopy coverages and frequencies of *Agropyron smithii* varied inversely with those of *Artemisia tridentata*. *Vicia americana* (American vetch), *Phlox hoodii*, *Artemisia frigida*, *Gutierrezia sarothrae* (broom snakeweed), and *Sphaeralcea coccinea* (scarlet globemallow) were common forbs. Canopy coverage for *Taraxacum officinale* (common dandelion) was conspicuous only for a gully bottom, an area of common (25 percent) sagebrush density, on Plot IV. The *Artemisia tridentata/Agropyron desertorum* sub-type occupied that portion of Plot IV not occupied by the *Artemisia tridentata/Agropyron smithii* sub-type. Common grasses were *Agropyron desertorum* (crested wheatgrass), *Agropyron smithii*, and *Poa secunda*. *Vicia americana* and *Phlox hoodii* were the only forbs having a canopy coverage greater than nine-tenths of one percent.

The vegetation of study Plots V and VI was analyzed with respect to certain physiographic features as well as sub-types and sagebrush density. The *Artemisia tridentata/Agropyron smithii* sub-type occupied the greatest portions of both Plots V and VI but the respective *Artemisia tridentata/Poa canbyi* and *Artemisia tridentata/Agropyron smithii/Poa secunda* sub-types were also represented (Figures 6 and 7). Common sagebrush density was the only category present on each sub-type of Plot V (Table I). Plot VI had both common and dense categories for the *Artemisia tridentata/Agropyron smithii* sub-type and only common for the other sub-type. Both plots possessed a "hard pan"



N

400 Feet

LEGEND

"Hard Pan" (*Artemisia tridentata/Poa cambyi* Sub-type).

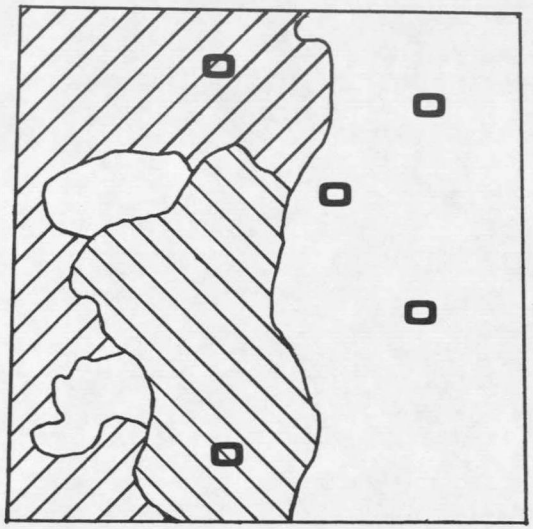
"Hard Pan" (*Artemisia tridentata/Agropyron smithii* Sub-type).

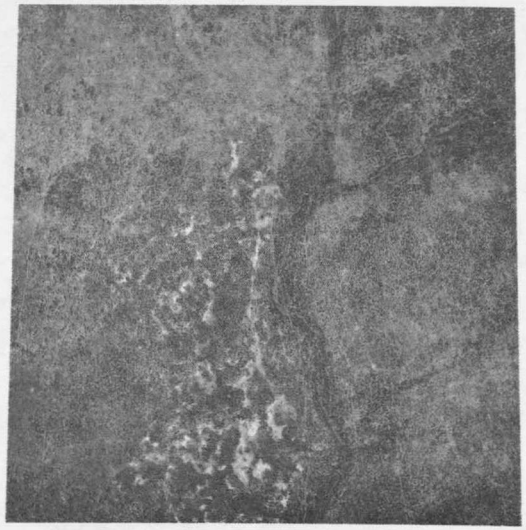
Typical (*Artemisia tridentata/Agropyron smithii* Sub-type).

Gully Bottom (*Artemisia tridentata/Agropyron smithii* Sub-type).

Sites of Vegetation Analyses.

Figure 6. Aerial Photograph and Diagram of Plot V (Common Sagebrush Density).





LEGEND

400 Feet

Dense Sagebrush (*Artemisia tridentata/Agropyron smithii* Sub-type).

Common Sagebrush Density - "Hard Pan" (*Artemisia tridentata/Agropyron smithii* Sub-type).

Common Sagebrush Density (*Artemisia tridentata/Agropyron smithii/Poa secunda* Sub-type).

Sites of Vegetation Analyses.

Figure 7. Aerial Photograph and Diagram of Plot VI.

soil condition on at least a portion of each sub-type except on the *Artemisia tridentata/Agropyron smithii/Poa secunda* sub-type of Plot VI. For both sub-types of Plot V the common grasses were *Agropyron smithii*, unidentified *Agropyron* spp., *Poa canbyi*, *Bouteloua gracilis*, and *Koeleria cristata* (Table IV). The *Artemisia tridentata/Poa canbyi* sub-type differed from the other mainly by having a greater coverage for *Poa canbyi*, the dominant grass, and less coverages for the remainder of the common grasses including *Agropyron smithii*. Common grasses for the "hard pan" of the *Artemisia tridentata/Agropyron smithii* sub-type of Plot VI, an area of common sagebrush density, were similar to those mentioned for Plot V. For the dense sagebrush category of this sub-type on Plot VI, some differences were apparent. *Poa canbyi* and *Bouteloua gracilis* were poorly represented while *Stipa viridula* was prominent. The common grasses in the *Artemisia tridentata/Agropyron smithii/Poa secunda* sub-type were the two *Agropyrons* and *Poa secunda*. The forbs *Vicia americana*, *Phlox hoodii*, and *Artemisia frigida* as well as the shrubs *Artemisia tridentata* and *Atriplex nuttallii* were present in each sub-type of both plots.

Bare ground was conspicuous on all sub-types occurring on the study plots (Tables II, III, and IV).

Abrupt differences in the vegetation as were shown for Plots II and IV (Figures 3 and 5) were evidently due to previous farm operations. The *Artemisia tridentata/Agropyron smithii* sub-type of Plot II and the

TABLE IV. CANOPY COVERAGE, FREQUENCY, AND CONSTANCY FOR TAXA ON PLOTS V AND VI WITH REFERENCE TO VEGETATION SUB-TYPES, SAGEBRUSH DENSITY, AND OTHER NOTICEABLE PHYSIOGRAPHICAL FEATURES.

	PLOT V				PLOT VI		
Vegetation Sub-Type	*Artemisia tridentata/ Agropyron smithii*		*Artemisia tridentata/Poa canbyi*		*Artemisia tridentata/ Agropyron smithii*		*Artemisia tridentata/Agropyron smithii/Poa secunda*
Physiography	"Hard Pan"	Typical	Gully Bottom	"Hard Pan"	"Hard Pan"	Typical	Typical
Sagebrush Density [1]	Common (13%)	Common (15%)	Common (23%)	Common (8%)	Common (16%)	Dense (40%)	Common (8%)
	1 Site 20 Plots	4 Sites 80 Plots	1 Site 20 Plots	2 Sites 40 Plots	1 Site 20 Plots	3 Sites 60 Plots	1 Site 20 Plots
Taxa [2]	Cv/Fr/Cy [3]	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy
GRASSES							
Agropyron smithii	36/95	40/99/100	43/95	12/80/100	28/95	30/93/100	32/95
Agropyron spp.	5/40	8/70/75	12/50	3/30/100	19/80	9/48/100	22/90
Poa canbyi	2/50	3/25/75	5/75	21/72/100	10/70	t/10/66	2/25
Bouteloua gracilis	10/30	11/45/100	15/50	2/12/100	4/20	t/ 2/32	--/---
Koeleria cristata	11/70	7/55/100	9/50	4/45/100	5/65	3/30/66	t/ 5
Poa secunda	--/--	2/24/75	--/--	1/10/50	--/--	t/ 8/33	29/100
Stipa viridula	t [4]/50	t/ 5/25	--/--	--/--/--	--/--	5/22/66	t/ 5
Bromus tectorum	--/--	t/ 2/50	t/25	t/ 2/50	t/ 5	t/15/66	1/40
Schedonnardus paniculatus	1/20	t/ 1/25	t/ 5	t/ 2/50	--/--	--/--/--	--/---
ALL GRASSES	58/100	70/100/100	76/100	51/100/100	60/100	49/99/100	79/100

TABLE IV. (CONTINUED).

Vegetation Sub-Type	PLOT V *Artemisia tridentata/ Agropyron smithii*			PLOT V *Artemisia tridentata/Poa canbyi*	PLOT VI *Artemisia tridentata/ Agropyron smithii*		PLOT VI *Artemisia tridentata/Agropyron smithii/Poa secunda*
Physiography	"Hard Pan	Typical	Gully Bottom	"Hard Pan"	"Hard Pan"	Typical	Typical
Sagebrush Density	Common (13%)	Common (15%)	Common (23%)	Common (8%)	Common (16%)	Dense (40%)	Common (8%)
	1 Site 20 Plots	4 Sites 80 Plots	1 Site 20 Plots	2 Sites 40 Plots	1 Site 20 Plots	3 Sites 60 Plots	1 Site 20 Plots
Taxa	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy
FORBS							
Vicia americana	4/50	2/15/50	5/40	2/35/100	5/55	5/72/100	3/35
Phlox hoodii	5/40	2/19/75	t/10	4/52/100	3/30	3/35/100	t/ 5
Artemisia frigida	2/25	4/21/100	t/ 5	t/18/100	6/65	2/20/66	t/15
Achillea millefolium	--/--	--/--/---	3/25	--/--/---	--/--	4/18/33	--/--
Taraxacum officinale	--/--	--/--/---	4/40	--/--/---	2/15	t/10/66	t/10
Iva axillaris	--/--	t/ 4/50	--/--	4/70/100	--/--	t/ 3/33	--/--
Erigeron ochroleucus	t/ 5	t/ 1/25	--/--	2/25/50	--/--	--/--/---	--/--
Plantago spinulosa	t/ 5	t/11/100	2/65	--/--/---	t/35	t/ 7/33	t/ 5
Camelina microcarpa	--/--	--/--/---	--/--	--/--/---	t/ 5	t/12/66	2/50
Gutierrezia sarothrae	--/--	t/ 9/50	--/--	t/12/100	1/20	t/12/66	t/ 5
Bahia oppositifolia	--/--	--/--/---	--/--	--/--/---	t/ 5	1/ 8/66	t/15
ALL FORBS	11/75	7/67/100	17/95	14/100/100	31/85	18/87/100	6/80

TABLE IV. (CONTINUED).

Vegetation Sub-Type	PLOT V				PLOT VI		
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/Poa canbyi*	*Artemisia tridentata/ Agropyron smithii*		*Artemisia tridentata/Agropyron smithii/Poa secunda*
Physiography	"Hard Pan"	Typical	Gully Bottom	"Hard Pan"	"Hard Pan"	Typical	Typical
Sagebrush Density	Common (13%)	Common (15%)	Common (23%)	Common (8%)	Common (16%)	Dense (40%)	Common (8%)
	1 Site 20 Plots	4 Sites 80 Plots	1 Site 20 Plots	2 Sites 40 Plots	1 Site 20 Plots	3 Sites 60 Plots	1 Site 20 Plots
Taxa	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy	Cv/Fr/Cy
SHRUBS							
Artemisia tridentata	21/75	18/64/100	20/75	12/65/100	11/60	41/92/100	13/55
Atriplex nuttallii	--/--	t/ 1/25	--/--	2/35/50	3/10	t/ 3/33	t/ 5
OTHERS							
Litter	18/90	20/100/100	30/85	5/65/100	17/14	38/92/100	17/85
Rock	t/10	1/14/ 25	--/--	3/45/100	3/40	--/--/---	--/---
Lichen	7/85	4/31/50	2/45	t/22/100	4/70	1/30/66	8/30
Carex spp.	--/--	6/33/50	10/55	t/ 2/25	t/ 5	t/ 1/33	--/---
Bare Ground	29/95	43/99/100	17/95	67/100/100	25/100	16/85/100	28/100

1/ Density was obtained from line intercept measurements of sagebrush at each analysis site (Table I).

2/ Taxa having canopy coverages of less than 1 percent in all categories of sagebrush density were not included (these are listed in Appendix, Table XIII).

3/ Canopy coverage/Frequency/Constancy.

4/ t indicates taxon having less than 1 percent canopy coverage.

Artemisia tridentata/Agropyron desertorum sub-type of Plot IV appear to have been the areas of previous soil disturbance.

Peromyscus maniculatus osgoodi

Home range indexes were calculated for those individuals caught five or more (5 to 8) times during a trapping period. Thirty-nine home range indexes were determined, each by two methods, from data involving 35 individuals (Table V). Data were insufficient to compare indexes between individual plots. By combining data for individual plots comparisons can be made for trapping series. Statistical comparisons (two-tailed t test) of index means showed significance only within the adult-male group. The mean of series I, 1967 when compared with the mean of series I and II, 1966 and series II, 1967 combined showed a significant difference at the 95 percent level. This suggests a valid difference between the index mean of series I, 1967 and each of the other three series means. The combined home range index means for the male-adult group of the three tentative treatment plots (I, IV and V) were similar to the combined index means of the control plots (II, III and VI). The means for the female-adult group appear consistently smaller than comparable series means in the male-adult group but data are insufficient for statistical analyses. Sub-adult and juvenile home range indexes, although few in number, appear similar to those of the adults. Home range indexes vary greatly for both adult sexes (Table VI). Indexes for males appear more diverse than those for females.

Movement indexes (average recapture radii) were calculated for each individual captured three or more (3 to 8) times during a trap-

TABLE V. MEAN HOME RANGE INDEXES OF *PEROMYSCUS MANICULATUS OSGOODI* CAPTURED FIVE OR MORE TIMES; CALCULATED BY TWO METHODS FOR SERIES "I" AND "II" OF 1966 AND 1967.

	Minimum Home Range Index(acres)						Boundary Strip Index(acres)					
	Series I[1]		Series II[2]		Series I & II		Series I		Series II		Series I & II	
Age-Sex	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
ADULT-MALES												
All Plots												
1966	5	2.1	3	1.9	8	2.0	5	3.2	3	3.0	8	3.2
1967	8	1.0[3]	10	1.8	=	===	8	2.0[3]	10	2.9	=	===
Both Years	=	===[4]	13	1.8	18	1.9	=	===	13	2.9	18	3.0
Plots I,IV&V (Both Years)	1	1.7	5	2.0	6	2.0[5]	1	2.7	5	3.6	6	3.5[5]
Plots II,III&VI (Both Years)	4	2.2	8	1.7	12	1.9[5]	4	3.4	8	2.5	12	2.8[5]
ADULT-FEMALES												
All Plots												
1966	2	1.2	4	1.2	6	1.2	2	2.4	4	1.3	6	1.7
1967	-	---	1	1.5	-	---	-	---	1	2.7	-	---
Both Years	2	1.2	5	1.2	7	1.2	2	2.4	5	1.6	7	1.8
SUB-ADULTS												
All Plots												
(Both Years)	1	1.7	2	1.8	3	1.8	1	2.8	2	3.0	3	2.9
JUVENILES												
All Plots												
(Both Years)	3	1.5	-	---	3	1.5	3	2.5	-	---	3	2.5

1/ From June 16 to July 19 in 1966 and from June 18 to July 12 in 1967.
2/ From July 26 to September 13 in 1966 and from August 7 to August 25 in 1967.
3/ Significantly different ($P < .05$) than the mean for the other three series combined.
4/ Mean home range indexes were not combined because the mean for the 1967 series was different from the others (footnote 3).
5/ Series I of 1967 was not included for the reason stated in footnote 4.

TABLE VI. SIZE DISTRIBUTION FOR 33 HOME RANGE INDEXES CALCULATED BY THE BOUNDARY STRIP METHOD OF ADULT MALE AND FEMALE DEER MICE CAPTURED DURING THE SUMMERS OF 1966 AND 1967.

Home Range Index (Acres)	Numbers	
	Male	Female
0.00-0.49	1	0
0.50-0.99	0	1
1.00-1.49	1	3
1.50-1.99	8	0
2.00-2.49	3	1
2.50-2.99	4	1
3.00-3.49	3	1
3.50-3.99	2	0
4.00-4.49	1	0
4.50-4.99	2	0
5.00-5.49	1	0
TOTAL	26	7

ping period. One hundred and one movement indexes were calculated from data involving 87 individuals (Table VII). Index means for plots, although from meager data, are apparently similar. Only combined data of each series were sufficient for statistical comparisons (two-tailed t test) within years. For all age-sex groups the series means within each year were similar. The series means for all age-sex groups in 1967 appear larger than the 1966 means. Significance ($P < .05$) between years was found only by combining both series (I and II) data of adult males and females. For both adult sexes the series means of the control plots (II, III and VI) combined were similar to the comparable means of the treatment plots (I, IV and V). For adults 90 percent of the movement indexes were between 50 and 250 feet (Table VIII).

Population density indexes for each plot with border strip were obtained by totaling degrees of residency determined from individuals captured during a trapping period. Three hundred eighty-two residency determinations were made from 312 individuals. Respective percentages of individuals classed as one-sixth and two-sixths residents for series II, 1966 and series I and II, 1967 or one-eighth and two-eighths residents for series I, 1966 are 17 and 6 for adults, 38 and 5 for subadults, and 33 and 7 for juveniles. Density indexes were expressed as individuals per 40 acres (Table IX). Statistical analyses (F tests) were used to determine differences between density indexes for study plots, for trapping series, and for sexes. No differences at the five

TABLE VII. MEANS OF AVERAGE RECAPTURE RADII (FEET) OF *PEROMYSCUS MANICULATUS OSGOODI* CAPTURED THREE OR MORE TIMES DURING INDIVIDUAL TRAPPING PERIODS IN 1966 AND 1967.

			1966							1967						
			Series I[1]		Series II[2]		Series I & II			Series I[3]		Series II[4]		Series I&II		
Age	Sex	Plot	No.	Mean	No.	Mean	No.	Mean	CI[5]	No.	Mean	No.	Mean	No.	Mean	CI
Adult	Male	I	1	183	3	141	4	151		-	---	4	239	4	239	
		II	3	185	1	237	4	198		3	196	3	157	6	178	
		III	2	152	3	184	5	171		1	243	5	173	6	185	
		IV	1	155	3	134	4	139		4	148	3	184	7	163	
		V	-	---	-	---	-	---		1	371	4	195	5	230	
		VI	1	195	2	137	3	145		1	247	3	140	4	167	
		ALL	8	169	12	157	20	162	±25	10	204	22	184	32	190	±30
Adult	Female	I	1	125	-	---	1	125		-	---	-	---	-	---	
		II	3	194	3	127	6	161		-	---	1	179	-	---	
		III	1	148	3	118	4	125		-	---	1	243	-	---	
		IV	1	103	1	94	2	98		-	---	1	222	-	---	
		V	1	121	1	242	2	182		-	---	1	112	-	---	
		VI	-	---	1	210	1	210		-	---	-	---	-	---	
		ALL	7	154	9	142	16	147	±32	-	---	4	189	-	---	±88
Adult	Both	I,IV & V	5	137	8	146	13	140		5	192	13	202	18	195	
		II,III & VI	10	175	13	154	23	163		5	216	11	160	18	181	
		ALL	15	162	21	147	36	154	±20	10	204	26	185	36	190	±27
Sub-Ad.	Both	All	5	177	10	159	15	165	±40	1	167	3	255	4	233	±173
Juv.	Both	All	7	117	1	96	8	114	±35	1	225	1	123	2	174	±671

1/ From June 16 to July 19.
2/ From July 26 to September 13.
3/ From June 18 to July 12.
4/ From August 7 to August 25.
5/ Ninety-five percent confidence limits for movement means when all plots are considered in the sample.

TABLE VIII. SIZE DISTRIBUTION FOR 72 MOVEMENT INDEXES OF ADULT MALE AND FEMALE DEER MICE CAPTURED DURING THE SUMMERS OF 1966 AND 1967.

Movement Indexes (feet)	NUMBERS					
	1966			1967		
	Male	Female	Total	Male	Female	Total
0.5-50	0	0	0	0	0	0
50.5-100	2	3	5	6	0	6
100.5-150	6	7	13	5	1	6
150.5-200	7	3	10	8	1	9
200.5-250	4	2	6	8	2	10
250.5-300	1	0	1	1	0	1
300.5-350	0	1	1	2	0	2
350.5-400	0	0	0	2	0	2
TOTAL	20	16	36	32	4	36

TABLE IX. RESIDENT DEER MOUSE POPULATION INDEXES (INDIVIDUALS PER 40 ACRES) DETERMINED FROM CAPTURES DURING EACH TRAPPING PERIOD AND SERIES.

		1966				1967			
		Series I[1]		Series II[2]		Series I[3]		Series II[4]	
Age	Plot Number	Male	Female	Male	Female	Male	Female	Male	Female
Adult	I	5.9	6.0	11.9	1.7	1.1	1.1	7.2	0.0
	II	11.3	16.0	5.0	8.8	7.5	3.7	7.2	2.2
	III	9.4	6.0	10.6	9.5	5.4	1.1	10.2	2.2
	IV	7.5	6.2	10.4	4.4	10.0	2.1	17.3	1.1
	V	4.0	6.0	7.1	4.7	7.3	1.2	10.8	3.4
	VI	8.2	2.0	7.7	3.9	2.1	0.0	9.7	2.2
	ALL	7.7	7.0	8.8	5.5	5.6[6]	1.5[5]	10.4	1.9[5]
Sub-Ad.	All	2.6	1.6	2.1	1.4	0.2	0.8	0.5	1.1
Juv.	All	5.4	2.0	0.5	0.3	0.3	0.6	0.0	0.3

1/ From June 16 to July 19.
2/ From July 26 to September 13.
3/ From June 18 to July 12.
4/ From August 7 to August 25.
5/ Significantly different ($P<.025$) than males of same series in 1967 and females of corresponding series in 1966.
6/ Significantly different ($P<.025$) than males of series II, 1967.

percent level was found by comparing individual indexes of all plots or by comparing combined indexes of treatment plots (I, IV and V) with that of control plots (II, III and VI). In 1966 density indexes of adult males and females were similar for both series. Indexes for females of series I and series II in 1967 were significantly less than those of males in 1967 and of females in 1966 for corresponding series. Indexes for adult males in series I, 1967 were significantly less than those of series II, 1967 and appeared less than those of either series I or II, 1966. Only series data were compared for sub-adults and for juveniles. Data were insufficient for statistical analyses. Within each year indexes for sub-adults were similar. Indexes for sub-adults of 1967 were apparently smaller than those in 1966. Indexes for juveniles of series I, 1966 appear larger than those in any of the other three series.

The number of individuals and degrees of residency for deer mice caught on each study plot during 1966 and 1967 is summarized in Table XIV, Appendix.

Delineating aggregates of points of capture for *Peromyscus maniculatus* within plots did not reveal distinct relations between vegetation sub-types and the occurrence of these mice within the *Artemisia/Agropyron* vegetation type but some habitat preferences may be indicated. Few captures were made in areas of dense sagebrush such as that on Plots I, III, and IV. Mice were seldom caught in traps set in areas of dense grass five feet or more from a sagebrush plant(s); eg. Plots III and IV.

Other Species

Thirty-four individuals of six species other than deer mice were captured during the two summers. These individuals comprised 10 percent of all mammals captured. In order of decreasing abundance, they were: *Onychomys leucogaster missouriensis* (northern grasshopper mouse), *Perognathus fasciatus olivaceogriseus* (Wyoming pocket mouse), *Sylvilagus audubonii baileyi* (desert cottontail), *Mus musculus domesticus* (house mouse), *Lagurus curtatus pallidus* (sagebrush vole), and *Microtus* sp. (the one specimen caught was not identified to species). Data were insufficient for home range, movement and population density per unit area determinations. The actual number of individuals captured per trapping period are given in Table X. Three species, Perognathus, Mus, and Lagurus, were captured in 1966 only and one, Microtus, in 1967 only. More captures, especially of Onychomys were made in 1966 than in 1967.

Desert cottontails and whitetail jackrabbits (*Lepus townsendii townsendii*) were observed on the study area as listed in the Appendix, Table XV.

TABLE X. NUMBER, SEX, AND AGE OF ALL SMALL MAMMALS, OTHER THAN DEER MICE, CAPTURED AT LEAST ONCE DURING THE 1966 AND 1967 TRAPPING SERIES.

	PLOT NUMBER																								
	I				II				III				IV				V				VI				
Species	Ser.[1]	N	S	A	Ser.	N	S	A	Ser.	N	S	A	Ser.	N	S	A	Ser.	N	S	A	Ser.	N	S	A	Total
1966																									
Onychomys leucogaster					II	2	M	Su	I&II	1	F	Ad	II	2	M	Ad	I	1	M	Ad	II	1	M	Su	
					II	1	F	Su	II	1	F	Ju	II	1	F	Ad	II	3	M	Ad					
																	I	1	M	Su					
																	I	1	F	Ad					
																	I	1	F	Ju					16
Perognathus fasciatus									II	1	F	Ju					II	1	M	Ad	II	2	F	Ad	
																					II	1	M	Ad	5
Sylvilagus audubonii	II	1	U	Ju	II	2	U	Ju																	3
Mus musculus													I	1	M	Ju									1
Lagurus curtatus													I	1	F	Su									1
TOTAL																									26
1967																									
Onychomys leucogaster									II	1	F	Ad	II	1	M	Ad	II	1	F	Ad	II	1	F	Ad	
									II	1	M	Su					II	1	F	Ju					6
Sylvilagus audubonii	II	1	U	Ju																					1
Microtus sp.													I	1	F	Su									1
TOTAL																									8

1/ Symbols: Ser.=series, N=number, A=age, Ju=juvenile, Su=sub-adult, Ad=adult, U=unsexed, M=male, and F=female.

DISCUSSION

The home range and movement indexes for *Peromyscus maniculatus osgoodi* for this study (Tables V and VII) appear unusually large when compared with some representative studies of *Peromyscus maniculatus* in certain other localities (Blair 1940; Murie and Murie 1931; Redman and Sealander 1958; Williams 1955). This possibly was related to the nature of the habitat which was characterized by sparse ground cover with extensive amounts of bare ground (Tables II, III, and IV). Blair (1951) showed that home ranges were larger for the same species in areas of sparse ground cover as compared to areas of dense ground cover. Allred and Beck (1963) and Gashwiler (1959) found extensive movements in areas having little ground cover. Population densities should also be considered as a factor influencing movements. The low densities and extensive movements found in this study correlate with Stickel's (1960) findings that movements for Peromyscus were more extensive on an area of low population than on an area of high population. The generally larger movement indexes for 1967 as compared to 1966 on my study plots may have been due to the lower populations for 1967. The long and narrow home ranges of series I, 1967 as evidenced from the large movement indexes and relatively small home range indexes may have resulted from the abnormally heavy precipitation in June which discouraged the deer mice from using some areas which were physically available to them.

The total population indexes of both series for 1966 and for 1967 show that deer mice were more abundant on the study plots during

the former summer. This was due to the greater number of young and more adult females present in 1966 than in 1967. The highest density for any series occurred in series I, 1966 which was followed by a late summer (series II) population decline. This resulted mainly from fewer young in the population during late summer. The lowest population for any series occurred in series I, 1967. This was due to fewer numbers of individuals in all age-sex classes. This low population level showed an increase by the late summer trapping series which was resultant primarily from the significant increase in adult males. Errington (1945) noted that population increases spring to fall are inversely related to population densities relative to threshold values. This principle of inversity is also suggested by my data in that the relatively low spring population, of 1967, showed an increase by late summer while the higher spring population, of 1966, had declined by the late summer. The difference in populations between years may be related to differences in weather. The abnormally low precipitation during June, 1966 and the relatively high precipitation during June, 1967 correspond with the high and low spring population densities respectively. Blair (1948) also noted a similar relationship between spring population densities and precipitation. The generally low population densities for my study as compared to some other areas are probably characteristic of this open type of habitat but no studies which sampled similar areas are available for comparison.

APPENDIX

TABLE XI. TAXA WITH LESS THAN 1 PERCENT CANOPY COVERAGE ON PLOTS I AND II(SEE TABLE II IN TEXT).

	PLOT I Vegetation Sub-Type		PLOT II Vegetation Sub-Type	
	Artemisia tridentata/Agropyron smithii/Bouteloua gracilis	*Artemisia tridentata/Bouteloua gracilis*	*Artemisia tridentata/Agropyron smithii*	*Artemisia tridentata/Agropyron smithii/Bouteloua gracilis*
	Sagebrush Density		Sagebrush Density	
Taxa	Dense (37%) 5 Sites 100 Plots	Common (18%) 3 Sites 60 Plots	Dense (39%) 5 Sites 100 Plots	Common (14%) 2 Sites 40 Plots
GRASSES				
Schedonnardus paniculatus		X	X	
FORBS				
Allium textile	X			
Alyssum sp.			X	
Androsace septentrionalis				X
Arenaria hookeri	X			X
Aster sp.			X	
Camelina microcarpa			X	
Erigeron pumilus	X			
Fritillaria pudica				X
Gutierrezia sarothrae	X		X	X
Lappula redowskii	X	X	X	
Lepidium densiflorum				X
Potentilla pennsylvanica	X			
Psoralea tenuiflora	X			
Sphaeralcea coccinea	X	X	X	X
Taraxacum officinale	X			
Thlaspi arvense	X	X	X	
Tragopogon dubius	X			
Vicia americana	X	X	X	

TABLE XII. TAXA HAVING CANOPY COVERAGES LESS THAN 1 PERCENT ON PLOTS III AND IV (SEE TABLE III IN TEXT).

Vegetation Sub-Type	PLOT III			PLOT IV			
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/Agropyron desertorum*
Sagebrush Density	Dense (62%)	Dense (35%)	Common (18%)	Dense (41%)	Common (19%)	Common (25%)	Common (25%)
Taxa	1 Site 20 Plots	6 Sites 120 Plots	1 Site 20 Plots	1 Site 20 Plots	5 Sites 100 Plots	1 Site 20 Plots	3 Sites 60 Plots
FORBS							
Aster canescens		X					
Astragalus gracilis		X					
Bahia oppositifolia		X					
Camelina microcarpa		X			X	X	
Crepis occidentalis				X	X		
Erigeron ochroleucus		X					
Erigeron pumilus					X		
Erigeron sp.		X					
Grindelia squarrosa		X				X	X
Haplopappus nuttallii		X			X		
Hymenoxys richardsonii				X	X		
Lactuca serriola					X		X
Lappula redowskii					X	X	

TABLE XII. (CONTINUED).

Vegetation Sub-Type	PLOT III			PLOT IV			
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/Agropyron desertorum*
Sagebrush Density	Dense (62%)	Dense (35%)	Common (18%)	Dense (41%)	Common (19%)	Common (25%)	Common (25%)
Taxa	1 Site 20 Plots	6 Sites 120 Plots	1 Site 20 Plots	1 Site 20 Plots	5 Sites 100 Plots	1 Site 20 Plots	3 Sites 60 Plots
Lepidium densiflorum		X					
Lomatium cous					X	X	
Musineon divaricatum		X					
Opuntia polycantha				X	X		X
Penstemon nitidus						X	
Plantago spinulosa					X	X	
Psoralea tenuiflora						X	
Rorippa curvisiliqua		X					
Thelesperma marginatum		X					
Thlaspi arvense		X					
Tragopogon dubius		X		X		X	
Viola nuttallii					X	X	
Unidentified Forbs		x		x	x	x	

TABLE XII. (CONTINUED).

Vegetation Sub-Type	PLOT III			PLOT IV			
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/Agropyron desertorum*
Sagebrush Density	Dense (62%)	Dense (35%)	Common (18%)	Dense (41%)	Common (19%)	Common (25%)	Common (25%)
Taxa	1 Site 20 Plots	6 Sites 120 Plots	1 Site 20 Plots	1 Site 20 Plots	5 Sites 100 Plots	1 Site 20 Plots	3 Sites 60 Plots
SHRUBS							
Atriplex argentea		X				X	
OTHERS							
Carex sp.					X	X	
Selaginella densa				X			

TABLE XIII. TAXA WITH LESS THAN 1 PERCENT CANOPY COVERAGE ON PLOTS V AND VI (SEE TABLE IV IN TEXT).

	PLOT V				PLOT VI		
Vegetation Sub-Type	*Artemisia tridentata/ Agropyron smithii*			*Artemisia tridentata/ Poa canbyi*	*Artemisia tridentata/ Agropyron smithii*		*Artemisia tridentata/Agropyron smithii/Poa secunda*
Physiography	"Hard Pan"	Typical	Gully Bottom	"Hard Pan"	"Hard Pan"	Typical	Typical
Sagebrush Density	Common (13%)	Common (15%)	Common (23%)	Common (8%)	Common (16%)	Dense (40%)	Common (8%)
Taxa	1 Site 20 Plots	4 Sites 80 Plots	1 Site 20 Plots	2 Sites 40 Plots	1 Site 20 Plots	3 Sites 60 Plots	1 Site 20 Plots
GRASS							
Hordeum jubatum			X				
FORBS							
Androsace septentrionalis			X			X	
Arenaria hookeri				X	X	X	
Allium textile	X	X	X		X		
Aster canescens		X					
Erigeron pumilus	X	X	X	X	X		
Euphorbia esula		X					
Gutierrezia sarothrae		X		X			
Lappula redowskii						X	
Lomatium cous		X					
Medicago lupulina							X
Opuntia polycantha	X		X	X	X	X	
Penstemon nitidus						X	
Penstemon sp.					X		
Psoralea argophylla						X	
Psoralea tenuiflora						X	

TABLE XIII. (CONTINUED).

Vegetation Sub-Type	PLOT V				PLOT VI		
	Artemisia tridentata/ Agropyron smithii			*Artemisia tridentata/Poa canbyi*	*Artemisia tridentata/ Agropyron smithii*		*Artemisia tridentata/Agropyron smithii/Poa secunda*
Physiography	"Hard Pan"	Typical	Gully Bottom	"Hard Pan"	"Hard Pan"	Typical	Typical
Sagebrush Density	Common (13%)	Common (15%)	Common (23%)	Common (8%)	Common (16%)	Dense (40%)	Common (8%)
Taxa	1 Site 20 Plots	4 Sites 80 Plots	1 Site 20 Plots	2 Sites 40 Plots	1 Site 20 Plots	3 Sites 60 Plots	1 Site 20 Plots
Ratibida sp.				X			
Rorippa islandica						X	X
Sphaeralcea coccinea		X		X			
Thlaspi arvense		X	X	X	X		X
Tragopogon dubius		X		X		X	X
Unidentified Forb				X	X		X
OTHERS							
Selaginella densa			X				

TABLE XIV. NUMBER OF INDIVIDUALS AND DEGREES OF RESIDENCY FOR DEER MICE CAPTURED ON EACH STUDY PLOT, 1966 AND 1967.

Plot Number	Series I						Series II					
	Male			Female			Male			Female		
	Ad.[1]	Su.	Ju.	Ad.	Su.	Ju.	Ad.	Su.	Ju.	Ad.	Su.	Ju.
1966												
I												
No. Caught	4	2	8	3	0	2	11	4	1	3	1	0
Residents	3 1/8	1 1/8	7 1/8	3	0	1 1/8	9 1/2	2 1/3	1/6	1 1/3	1/6	0
II												
No. Caught	6	4	2	8	2	3	4	4	2	9	3	1
Residents	6	3 1/8	1 1/8	8	1 1/8	1 1/4	4	3 1/6	2	6 5/6	1 1/3	1/6
III												
No. Caught	5	0	4	3	1	2	11	3	0	9	2	1
Residents	5	0	3 1/4	3	1	2	8 1/2	2 1/6	0	7 1/3	1 1/6	1
IV												
No. Caught	4	2	3	4	1	1	9	4	0	4	3	0
Residents	4	3/8	2 1/8	3 1/8	1	1/8	8 1/3	3 1/6	0	3 1/3	2 1/6	0
V												
No. Caught	3	3	1	3	3	1	9	2	0	7	2	0
Residents	2 1/8	3	1/4	3	2 1/4	1	5 2/3	1/3	0	3 2/3	1/2	0
VI												
No. Caught	7	2	1	1	0	0	7	5	0	3	2	2
Residents	4 3/8	1 1/8	1	1	0	0	6 1/6	3 1/3	0	3	2	1 1/3
1967												
I												
No. Caught	1	1	1	1	0	0	8	0	0	0	0	0
Residents	1	1	1/6	1	0	0	6 1/3	0	0	0	0	0
II												
No. Caught	7	0	1	5	3	3	8	3	0	2	2	0
Residents	7	0	1/6	3 3/8	3	1 1/3	6 1/3	2/3	0	2	1 1/6	0

TABLE XIV. (CONTINUED).

Plot Number	Series I						Series II					
	Male			Female			Male			Female		
	Ad.	Su.	Ju.	Ad.	Su.	Ju.	Ad.	Su.	Ju.	Ad.	Su.	Ju.
III												
No. Caught	5	0	1	1	1	1	12	0	0	2	5	0
Residents	5	0	1	1	1/6	1	9	0	0	2	2 1/2	0
IV												
No. Caught	10	0	0	2	1	0	16	3	0	1	2	0
Residents	9 1/3	0	0	2	1	0	15 1/3	2 1/6	0	1	1 1/6	0
V												
No. Caught	9	0	0	2	0	1	11	0	0	4	0	0
Residents	6 5/6	0	0	1 1/6	0	1/6	9 1/2	0	0	3 1/3	0	0
VI												
No. Caught	2	0	0	0	0	0	10	0	0	2	2	3
Residents	2	0	0	0	0	0	8 1/2	0	0	2	1 1/6	1 1/3

1/ Ad.=Adult, Su.=Sub-adult, Ju.=Juvenile.

TABLE XV. LOCATIONS AND DATES OF INDIVIDUAL OBSERVATIONS MADE ON TWO SPECIES OF LEPORIDAE ON THE TWO STUDY AREAS.

Species	Date of Observation	Location
Lepus townsendii townsendii	7/28/66	Plot No. II
	7/30/66	Plot No. II
	6/ 8/67	Plot No. II
	6/11/67	Plot No. II
	8/ 8/66	Plot No. III
	8/ 9/67	Plot No. III
	8/11/67	Plot No. III
	8/19/67	Plot No. IV
	8/23/67	Plot No. V
Sylvilagus audubonii baileyi	7/ 1/66	Plot No. III
	8/ 9/66	Plot No. III
	8/11/66	Plot No. III
	6/14/67	Plot No. III
	6/16/67	Plot No. III
	8/16/67	Plot No. III
	8/18/67	Plot No. III
	7/21/66	Northcentral Quarter, Iverson Area
	7/23/66	
	6/ 9/67	
	8/18/67	
	8/22/66	Southwest Quarter, Iverson Study Area
	8/29/66	

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