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SMALL MAMMAL COMMUNITY STRUCTURE IN NORTHEASTERN NEVADA

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ABSTRACT—The small mammal communities in four major plant associations were examined in the Whirlwind Valley, Eureka and Lander Counties, Nevada. All associations have been extensively grazed by livestock. Live trapping plots were placed and sampled seasonally in each habitat. *Dipodomys microps* and *Perognathus parvus* were the primary species within the big sagebrush and shadscale associations. In the greasewood association, *P. maniculatus* and *Eutamias minimus* were primary species. *Microtus montanus, Reithrodontomys megalotis, Sorex vagrans*, and *Thomomys talpoides* formed the small mammal community in the marsh-meadow association. Density was low on all plots, not exceeding a total of 13 individuals/ha. Grazing pressure probably accounts for the low habitat quality which did not support more than 0.6 kg/ha biomass in shadscale and big sagebrush-shadscale, whereas less than 0.3 kg/ha was supported on each of the remaining habitats. Mammal species diversity was highest in greasewood and the ecotonal plot which corresponded to the habitats with the greatest plant diversity, cover, and vertical structure.

The composition of small mammal communities changes from east to west in the Great Basin Desert of Nevada (Hall, 1946). The western edge of Nevada contains components of the southern Nevada Mohave Desert fauna that is lacking in the remainder of the northern part of the state. Detailed population studies which relate the temporal and spatial properties of small mammal community structure have not been conducted in northeastern Nevada.

The high elevation, cold Great Basin Desert encompasses the intermontane region of Nevada, California, Utah, Idaho, Oregon, Washington, Montana, and Wyoming. In addition to the expected rigors of desert existence, small mammals must also cope with winters marked by intense cold. Inasmuch as this desert region consists of such a massive area, there are considerable variations in habitat mosaic and concomitant structural differences within respective small mammal communities. The shrub-steppe of south central Washington represents a six-species system of small mammals with 99% of the community represented by *Perognathus parvus* and *Peromyscus maniculatus* (O'Farrell et al., 1975). The Great Basin scrub of eastern California had a seven-species system with virtually all of the individuals belonging to *Dipodomys microps, D. merriami*, and *Perognathus longimembris* (Kenagy, 1973). Several habitat types were examined in Idaho and the composite community consisted of five species (Larrison and Johnson, 1973). A total of 12 species was documented for a sagebrush community in west-central Nevada (O'Farrell, 1974). Measures of seasonal population fluctuations are presented for all of these studies.

The purpose of this study was to provide a baseline description of existing faunal conditions in the Whirlwind Valley in northern Nevada as a part of an environmental assessment of the Geysers Geothermal Resource Area. A thorough seasonal examination took place in all the major habitat types within this valley.

STUDY AREA—The Whirlwind Valley is located about 80 km west of Elko, in portions of Lander and Eureka Counties, Nevada. The valley is formed by a bifurcation of the northern end of the Shoshone Range, bordered on the northwest by the Argenta Rim and on the southeast by the Malpais. Plant associations were mapped using aerial photographs and extensive ground truthing and designated by the nomenclature of Cronquist et al. (1972). Species identification follows Cronquist et al. (1972, 1977) and Holmgren (1942). Four major plant associations were found: big sagebrush, shadscale, greasewood, and marsh-meadow.

The big sagebrush association occupied the upper elevations (1525 to 2205 m), including the Malpais with its steep northern slope. Soil tended to be rocky (17% ground cover). Dominant perennial species consisted of *Artemisia tridentata, Poa nevadensis, Gutierrezia sarothrae, Grayia spinosa* and *Sitanion hystrix*, in decreasing order of importance. Abundant annuals were *Microsteris gracilis* ($30.2/m^2$) and *Bromus tectorum* ($3.5/m^2$). Aerial perennial cover was 29% and mean height was 25.2 cm ± 5.0 (1 S.E.). Perennial species richness was 18, diversity (H′) 1.82, and evenness (V′) 0.63.

The shadscale association occurred adjacent to and interdigitated with big sagebrush (1463 to 1525 m) throughout most of the valley floor and gentler slopes. Soil tended to be less rocky (10% ground cover) and more saline than at the higher elevations. Dominant perennials were *Atriplex confertifolia, Artemisia spinescens, Grayia spinosa*, and *Poa nevadensis.* Annuals were dominated by *Lepidium perfoliatum* ($49.2/m^2$), *Microsteris gracilis* ($23.0/m^2$), and *Bromus tectorum* ($14.9/m^2$). Aerial perennial cover was 24% and mean height was 21.1 cm ± 6.2. Perennial species richness was 9, diversity 1.48, and evenness 0.67.

The greasewood association occupied the lowest elevations (1402 to 1463 m) and the most saline soils. The soil surface predominantly was a salty crust devoid of rock. Dominant perennials were *Sarcobatus vermiculatus, Suaeda fruticosa, Distichlis stricta, Chrysothamnus parryi*, and *Atriplex lentiformis.* The primary annual was *Atriplex pusilla* ($8.4/m^2$). Aerial perennial cover was 45% and mean height was 41.9 cm ± 12.7. Perennial species richness was 10, diversity 1.70, and evenness 0.74.

The marsh-meadow association was a relatively small, discrete patch found in the runoff areas from the geothermal pools. This area was limited to seepage zones where water was readily available (1402 to 1463 m). Predominant perennial species were *Distichlis stricta, Juncus balticus, Carex* spp., *Scirpus nevadensis*, and *Solidago spectabilis.* Vegetative cover, excluding litter, was 70%.

Climatic records taken during this study show some differences when compared to long term trends (Table 1). Mean temperature extremes differed slightly for most months although mean minimum values were generally higher than long term values from August 1982 through January 1983. Rainfall in 1982 was 5.3 cm greater than the 11 year mean. Large quantities of rain in March and September coupled with warm temperatures provided suitable conditions for germination and growth of annual vegetation.

Data on livestock use in the Whirlwind Valley is generic at best. Bureau of Land Management (BLM) data is given in animal unit months (AUM); one animal unit (1 cow, 455 kg, plus a calf <6 months old or 5 sheep) consumes 10.9 kg dry weight of forage daily, thus the amount of forage required for an animal unit for one month equals an AUM. Recommended grazing rates in the Whirlwind Valley range from 7.3 to 8.5 ha/AUM. Actual grazing pressure may approximate recommended rates, although there is no agency verification of this. In addition the records do not separate AUM's for cattle and sheep within allotments. The BLM did state that for over a decade grazing use is nearly year-round, with the bulk of use from April through September. Based upon a single utilization transect in the valley, utilization is considered moderate for most years.

MATERIALS AND METHODS—Non-marsh vegetation was assessed using belt transects (Mueller-Dombois and Ellenberg, 1974). A transect was measured in each association and consisted of three 50 m lines (big sagebrush contained four lines). All perennials were counted within a 6 m swath to yield density. All perennials with main stems within a 1 m swath along each line were measured for height and width of canopy at the highest and widest points. The latter value was used as a diameter to calculate the area of a circle yielding aerial cover. Annuals were counted in 1 m^2 plots at 10 m intervals along the left side of each line. Density, cover, and frequency of occurrence were converted to relative values, the sum of which provided an importance value for each perennial species.

TABLE 1—Mean maximum and minimum temperatures (°C) and precipitation (cm) for the Whirlwind Valley for 1982 and means for the preceding 11 years (1971-1981). The study period was from May 1982 to January 1983.

	1982			11-year mean		
Month	Mean max	Mean min	Precip	Mean max	Mean min	Precip
Jan	2.7	−10.9	1.7	5.2	−8.7	1.7
	(6.5)*	(−6.0)*	(4.0)*			
Feb	7.4	−5.9	1.0	8.9	−5.3	1.6
Mar	10.8	−1.7	4.0	11.9	−3.5	1.4
Apr	16.5	−2.0	1.2	17.0	−1.1	1.9
May	23.1	2.5	1.5	22.3	3.4	2.5
Jun	27.0	7.7	2.1	28.9	7.2	1.3
Jul	32.4	10.8	1.1	34.7	11.0	0.8
Aug	34.8	11.1	0	32.7	9.4	1.5
Sep	25.2	7.1	4.1	27.2	4.7	1.9
Oct	17.7	0.3	2.8	20.1	−0.5	1.4
Nov	9.1	−4.4	3.5	10.9	−4.6	1.3
Dec	4.9	−5.9	1.5	6.2	−8.5	1.9
Precip Total			24.5			19.2

*Values for January 1983

Marsh-meadow vegetation was sampled using the point-frequency method (Mueller-Dombois and Ellenberg, 1974). A 1 m-wide frame, with a point at every decimeter, was placed on the ground every meter for 100 m. The species touched by each point was recorded as well as bare ground, rock, small rock, or litter. These data were used to calculate relative cover and frequency of occurrence. Inasmuch as neither density nor importance value could be obtained, diversity and evenness values were not calculated.

Seasonal live trapping was performed on five plots utilizing the methodology of O'Farrell et al. (1977). Each trapping configuration consisted of two parallel lines, 53 m apart, and four assessment lines transecting the parallel lines at a 45° angle. Each parallel line contained 20 stations and each assessment line 18 stations, all using 15 m intervals between trap stations. Each assessment line extended 15 stations beyond the parallel lines. The parallel line configuration yields comparable density estimates to a grid, which represents an intensive sampling effort (O'Farrell and Austin, 1978).

Plot 1 (T31N, R47E, Sec. 24 NW 1/4 of SW 1/4) was placed at the base of the Malpais in order to sample a habitat representative of the interdigitation of big sagebrush and shadscale. Plot 2 (T31N, R47E, Sec. 13 SW 1/4 of SE 1/4) was situated in relatively homogeneous shadscale association. Plot 4 (T31N, R48E, Sec. 4 SE 1/4 of SE 1/4) was placed in relatively homogeneous greasewood. Plot 5 (T31N, R48E, Sec. 18 NW 1/4 of NE 1/4) sampled the marsh-meadow habitat. These plots were situated on the valley floor whereas Plot 3 (T31N, R48E, Sec. 20 SW 1/4 of SW 1/4) was located in homogeneous big sagebrush on the Malpais, approximately 150 m elevation above the valley floor.

Trapping was conducted from May 16 to 22, July 21 to 26, September 20 to 24, 1982 and January 10 to 15, 1983. Standard protocol called for trapping on the parallel lines for three consecutive nights and then moving traps to the assessment lines for an additional three consecutive nights. However, there was a one day hiatus between the three day sets in May, and the last night of assessment trapping was omitted in September due to heavy rainfall and deterioration of the roads. The trapping regimen was as follows: one collapsible Sherman live trap was placed at each station and baited with crimped oats; traps were checked each morning and evening; each captured animal was identified to species, marked by toe-clipping, sexed, reproductive condition assessed, aged, weighed and released at point of capture. These data were used to calculate density (number/ha), biomass (g/ha), sex ratio, reproductive activity, linear movement, and juvenile recruitment into the population.

Plant and small mammal community structure are described in terms of ecological diversity (Pielou, 1977), Species richness is the sum of species (only perennials for plants) found on each plot. Species diversity (H′) was calculated using importance value for plants and separately using density and biomass for small mammals. Therefore, diversity serves as a descriptive index incorporating the number of species and the contribution of each species to community structure with respect to importance value, density or biomass. Evenness provides an index of the distribution of each species' contribution to the community.

Temperature and precipitation values were obtained from U.S. Weather Bureau records taken from a weather station at Beowawe, approximately 8 km airline distance from the study area. Grazing allocations were obtained from the Bureau of Land Management offices in Elko and Battle Moutain, Nevada.

RESULTS—The composition of the small mammal community differed among habitat types as well as from season to season within habitats (Tables 2, 3, 4 and 5). Plots 1, 2 and 3 (big sagebrush-shadscale, shadscale and big sagebrush habitats, respectively) were similar in species composition except that *Dipodomys ordii* was found transient on Plot 1 and *Neotoma lepida* occurred in rock outcrops peripheral to Plot 3; however, most species varied in seasonal occurrence. *Dipodomys microps* and *Perognathus parvus* formed the core of the community with *Peromyscus maniculatus* and *Ammospermophilus leucurus* generally in a secondary role. Plots 4 and 5 (greasewood and marsh-meadow, respectively) represent more specialized habitats tending towards high salinity and at least periodic mesic conditions. Consequently, Plot 5 supported only species adapted to mesic conditions (e.g., *Microtus montanus*), and remained low in species richness. Plot 4 contained the greatest richness through contributions from surrounding habitats (*P. parvus, D. microps, R. megalotis*) and from those species more suitable to the greasewood (*P. maniculatus* and *Eutamias minimus*).

Density of any species was relatively low throughout the year, although seasonal peaks were observed. Plots 1, 2 and 4 demonstrated greatest total density during July whereas Plots 3 and 5 reached peak density in September. Density and species richness declined in January except on Plot 2, which had an influx of *P. maniculatus*. Density-based diversity remained relatively constant or increased from May through September except on Plot 4, which declined due to a loss of two species. Diversity dropped to the lowest recorded value only on Plots 1 and 4, mainly due to loss of species from the community. Evenness was relatively low, primarily during the marked fluctuations of *P. parvus* on Plots 1, 2 and 3.

Total small mammal biomass did not exceed 0.6 kg/ha at any time for any plot. The contributions of *D. microps* and *A. leucurus* on Plots 1 and 2 accounted for the two high values. The remaining habitats did not support more than 0.3 kg/ha. Seasonal trends in biomass mirrored those presented for density values.

Sex ratios did not differ significantly from 1:1 except for Plots 4 and 5. On the former, *P. maniculatus* adult males were 8:1 in July and males were more abundant during the other seasons. On Plot 5, male *P. parvus* predominated in May and July (5:1 and 4.3:1, respectively).

Juveniles were not captured often, however there were ample signs among adults to indicate reproductive activity. Therefore, we conclude that quarterly sampling resulted in a masking of juvenile recruitment. Many young of the year, having attained adult pelage and at least minimal adult weight, were probably assigned adult status. Most juveniles were captured

TABLE 2—Density (N/ha), biomass (g/ha), species richness (S*), diversity (H′) and evenness (V′) for the May 1982 sampling. Plot 1 = big sagebrush-shadscale; Plot 2 = shadscale; Plot 3 = big sagebrush; Plot 4 = greasewood; Plot 5 = marsh-meadow.

Species	Density					Biomass				
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Perognathus parvus	1.63	0.73	1.46	0.0	0.0	38.5	13.5	36.7	0.0	0.0
Dipodomys microps	2.02	2.56	2.16	0.0	0.0	110.8	141.9	135.7	0.0	0.0
Dipodomys ordii	1.08	0.0	0.0	1.08	0.0	55.7	0.0	0.0	56.1	0.0
Peromyscus maniculatus	0.0	0.0	0.0	2.16	0.0	0.0	0.0	0.0	38.0	0.0
Reithrodontomys megalotis	0.0	0.0	0.0	0.55	1.08	0.0	0.0	0.0	8.1	15.0
Microtus montanus	0.0	0.0	0.0	0.0	5.40	0.0	0.0	0.0	0.0	95.2
Eutamias minimus	0.0	0.0	0.0	0.85	0.0	0.0	0.0	0.0	29.3	0.0
Total	4.73	3.29	3.62	4.64	6.48	205.0	155.4	172.4	131.5	110.2
S*	3	2	2	4	2	3	2	2	4	2
H′	1.07	0.53	0.67	1.26	0.45	1.00	0.30	0.52	1.23	0.40
V′	0.97	0.76	0.97	0.91	0.65	0.91	0.43	0.75	0.89	0.57

TABLE 3—Density (N/ha), biomass (g/ha), species richness (S*), diversity (H′) and evenness (V′) for the July 1982 sampling. Plot 1 = big sagebrush-shadscale; Plot 2 = shadscale; Plot 3 = big sagebrush; Plot 4 = greasewood; Plot 5 = marsh-meadow.

Species	Density					Biomass				
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Perognathus parvus	5.28	10.22	3.83	2.16	0.0	97.8	178.6	70.4	37.3	0.0
Dipodomys microps	5.41	0.95	2.16	1.66	0.0	306.1	53.8	139.9	84.4	0.0
Dipodomys ordii	0.0	0.0	0.0	0.55	0.0	0.0	0.0	0.0	18.8	0.0
Peromyscus maniculatus	0.0	0.0	0.41	1.51	0.0	0.0	0.0	11.4	33.7	0.0
Onychomys leucogaster	0.0	0.0	0.0	0.34	0.0	0.0	0.0	0.0	8.0	0.0
Reithrodontomys megalotis	0.0	0.0	0.0	0.55	0.55	0.0	0.0	0.0	6.6	6.6
Microtus montanus	0.0	0.0	0.0	0.0	1.63	0.0	0.0	0.0	0.0	49.5
Ammospermophilus leucurus	2.16	0.55	0.05	0.0	0.0	185.8	53.0	4.2	0.0	0.0
Eutamias minimus	0.0	0.0	0.0	3.24	0.0	0.0	0.0	0.0	91.8	0.0
Sorex vagrans	0.0	0.0	0.0	0.0	0.55	0.0	0.0	0.0	0.0	3.3
Total	12.85	11.72	6.45	10.01	2.73	589.7	285.4	225.9	280.6	59.4
S*	3	3	4	7	3	3	3	4	7	3
H′	1.03	0.47	0.89	1.71	0.95	1.00	0.92	0.89	1.62	0.56
V′	0.94	0.43	0.64	0.88	0.87	0.91	0.84	0.64	0.83	0.51

TABLE 4—Density (N/ha), biomass (g/ha), species richness (S*), diversity (H′) and evenness (V′) for the September 1982 sampling. Plot 1 = big sagebrush-shadscale; Plot 2 = shadscale; Plot 3 = big sagebrush; Plot 4 = greasewood; Plot 5 = marsh-meadow.

	Density					Biomass				
Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Perognathus parvus	0.14	3.48	6.98	0.34	0.0	2.4	58.8	118.1	4.8	0.0
Dipodomys microps	4.66	0.78	0.88	0.48	0.0	271.5	46.4	55.1	27.4	0.0
Peromyscus maniculatus	1.08	0.0	0.91	1.85	0.0	17.8	0.0	16.6	36.7	0.0
Peromyscus truei	0.55	0.0	1.08	0.0	0.0	11.3	0.0	23.6	0.0	0.0
Onychomys leucogaster	0.0	0.0	0.0	0.34	0.0	0.0	0.0	0.0	6.9	0.0
Reithrodontomys megalotis	0.0	0.0	0.0	0.0	1.30	0.0	0.0	0.0	0.0	15.6
Neotoma lepida	0.0	0.0	1.10	0.0	0.0	0.0	0.0	97.6	0.0	0.0
Microtus montanus	0.0	0.0	0.0	0.0	5.19	0.0	0.0	0.0	0.0	241.2
Ammospermophilus leucurus	1.08	2.16	0.0	0.0	0.0	89.6	184.7	0.0	0.0	0.0
Eutamias minimus	0.0	0.0	0.0	2.58	0.0	0.0	0.0	0.0	80.5	0.0
Sorex vagrans	0.0	0.0	0.0	0.0	3.24	0.0	0.0	0.0	0.0	14.0
Total	7.51	6.42	10.95	5.59	9.73	392.6	289.9	311.0	156.3	270.8
S*	5	3	5	5	3	5	3	5	5	3
H′	1.12	0.95	1.16	1.27	0.97	0.87	0.90	1.39	1.23	0.42
V′	0.70	0.87	0.72	0.79	0.88	0.54	0.82	0.86	0.77	0.38

in July, however *P. parvus* juveniles were captured in May, July and September, and *Microtus montanus* young were only captured in May.

Reproductive activity was observed during the spring and summer sampling periods with the following notable exceptions: Males of both *D. microps* and *P. maniculatus* with scrotal testes were captured during all seasons; the smallest percent active in fall and winter was found in shadscale. Several estrous and pregnant females were captured in September for both species and most of the *D. microps* females on Plots 1 and 2 were in estrus in January.

DISCUSSION—Composition of the small mammal community in the Whirlwind Valley was not as rich as the 12 species found on a single 2.7 ha plot near Reno, Nevada (O'Farrell, 1974). For the habitats sampled, species composition was identical to that found in Idaho by Larrison and Johnson (1973). *Sorex vagrans* and *Microtus montanus* were restricted to a single, specialized habitat, whereas *Dipodomys microps, Perognathus parvus*, and *Peromyscus maniculatus* were found in most of the habitat types.

The contribution or importance of each species varied among habitats. During the spring, summer and fall *D. microps* and *P. parvus* comprised

TABLE 5—Density (N/ha), biomass (g/ha), species richness (S*), diversity (H′) and evenness (V′) for the January 1983 sampling. Plot 1 = big sagebrush-shadscale; Plot 2 = shadscale; Plot 3 = big sagebrush; Plot 4 = greasewood; Plot 5 = marsh-meadow.

Species	Density Plot 1	Density Plot 2	Density Plot 3	Density Plot 4	Density Plot 5	Biomass Plot 1	Biomass Plot 2	Biomass Plot 3	Biomass Plot 4	Biomass Plot 5
Dipodomys microps	3.18	2.43	0.52	1.45	0.0	209.4	172.0	37.4	95.3	0.0
Peromyscus maniculatus	0.71	7.78	1.36	1.87	0.0	12.6	148.7	26.4	32.8	0.0
Peromyscus truei	0.0	0.0	0.61	0.0	0.0	0.0	0.0	14.4	0.0	0.0
Reithrodontomys megalotis	0.0	0.0	0.0	0.0	1.65	0.0	0.0	0.0	0.0	14.6
Ammospermophilus leucurus	0.0	2.16	0.0	0.0	0.0	0.0	259.3	0.0	0.0	0.0
Eutamias minimus	0.0	0.0	0.0	1.08	0.0	0.0	0.0	0.0	28.3	0.0
Sorex vagrans	0.0	0.0	0.0	0.0	1.08	0.0	0.0	0.0	0.0	5.1
Total	3.89	12.37	2.49	4.40	2.73	222.0	580.0	78.2	156.4	19.7
S*	2	3	3	3	2	2	3	3	3	2
H′	0.48	0.92	1.00	1.08	0.67	0.22	1.07	1.03	0.94	0.57
V′	0.69	0.84	0.91	0.98	0.97	0.31	0.97	0.94	0.85	0.83

the majority of rodents found in big sagebrush, shadscale and the interdigitation of the two. *Peromyscus maniculatus* occurred in all three situations but occupied a secondary position. This species was found during most seasons in big sagebrush but was only abundant in shadscale in the winter. This latter pattern may simply reflect dispersal of young adults from core areas in other habitats. The single diurnal species, *Ammospermophilus leucurus,* was periodically taken within both plant associations and the combination subset. This sporadic occurrence represents a range extension (O'Farrell and Clark, 1984), and reflects the low abundance and secretive nature of the species in this region. Virtually no sightings were obtained during our daily movements throughout the valley and vocalizations were totally absent.

In the greasewood association, *P. maniculatus* and the diurnal *Eutamias minimus* were the primary rodents whereas *D. microps* and *P. parvus* were more secondary species. According to Hall (1946), *E. minimus* is primarily an animal of the big sagebrush and only infrequently found in greasewood. The presence of *A. leucurus* in other habitats may have acted to restrict the smaller *E. minimus* to a single habitat within the Whirlwind Valley. Although species richness varied seasonally in all habitats, the greasewood association was as rich (fall and winter) or the richest (spring and summer) of any habitat.

The presence of uncommon or rare species in small mammal communities has been documented for a variety of habitats (M'Closkey, 1972; Kenagy, 1973; Larrison and Johnson, 1973; O'Farrell, 1974; O'Farrell et al., 1975; Whitford, 1976). In this study *Dipodomys ordii* was captured in both the greasewood and big sagebrush-shadscale. This species is known to prefer sandy substrate (Larrison and Johnson, 1973; O'Farrell, 1980), which was conspicuously absent within the valley. However, the former authors noted that *D. ordii* also appeared to be associated with disturbed roadways. This may account for the spurious occurrence within the present study. The presence of *Peromyscus truei* represented not only a range extension but an unusual habitat occurrence (O'Farrell and Clark, 1984). The nearest pinyon woodland was 21 km distant; therefore the fall and winter habitation within the big sagebrush and shadscale illustrates more than simple post-breeding emigration. One female had recently stopped lactating, suggesting breeding within these lower elevation plant associations. *Onychomys leucogaster* was caught only in the greasewood habitat, which conforms to results by Egoscue (1960). He additionally noted that this species was absent from extensive stands of shadscale or in rocky substrate similar to what we found in the big sagebrush on the Malpais. He further hypothesized that *O. leucogaster* traveled in colonizing pairs. A nomadic existence on the part of a pair or even family group would certainly explain our data. Nomadic family groups may also occur in such species as *P. truei* moving between islands of preferred woodland habitats. *Reithrodontomys megalotis* has an affinity for grassland (Larrison and Johnson, 1973) which is consistent with the patchy distribution in our study.

Rodent species diversity has been correlated with resource abundance (Brown, 1973; Whitford, 1976) and with habitat structure (Rosenzweig and Winakur, 1969). M'Closkey (1972), on the other hand, demonstrated temporal fluctuations in diversity due primarily to changes in species richness through time. We also found marked variations in diversity, although evenness of the frequency distribution of species was equally important in explaining oscillations. This was due to a characteristic population surge then disappearance of the hibernating *Perognathus*. Our study was not long enough to examine annual differences in resource abundance as a variable. However, there was a tendency for higher small mammal species diversities in the more diverse habitat types. In fact, the highest rodent diversity occurred in greasewood which had the second highest plant diversity, based on importance value, and likewide had a perennial aerial cover and height twice that of the other habitats. A comprehensive knowledge of temporal fluctuations in rodent populations is critical in determining the relative contributions of habitat complexity and resource abundance to overall rodent community structure.

Although Nevada has experienced a wet cycle over the past decade and the annual bloom in the Whirlwind Valley appeared to be good during our study, the overall habitat quality was low, as evidenced by the low standing crop biomass of small mammals supported in each of the habitats. The area has been actively grazed, which may account for the poor quality. Larrison and Johnson (1973) found the greatest rodent abundance in depleted habitats, and *P. maniculatus* the most abundant species in all habitats. Whitford (1976) reported that an increase in some populations occurred after exclusion of cattle. Hanley and Page (1982) documented a 65% decrease in structural diversity of Great Basin shrublands and a concomitant decrease in rodent numbers, except for *D. microps*. Basically, increased ground cover appears to impede kangaroo rat movements, thereby limiting population size. However, grazing must reduce available resources to such a level that only low population densities can be supported.

Reproduction observed in the present study occurred in spring and summer with a mid-summer and autumn recruitment of young of the year. *Peromyscus maniculatus* had at least a nominal activity through all seasons, which indicates favorable climatic and resource conditions. This also was apparent for *D. microps*. Kenagy (1973) concluded that this species maintained a single synchronous reproductive period early in the year due to its dietary reliance on *Atriplex* leaves rather than annual seed production which is controlled by yearly weather patterns. However, in the present study a large proportion of males captured in all seasons had scrotal testes and at least a few females were found in estrus, including some with copulatory plugs, in each season sampled. It appears that at least in northern Nevada *D. microps* responds reproductively to unseasonably warm periods characterized by good annual germination and bloom.

Small mammal communities in the Great Basin face not only the rigorous conditions of a high, cold desert but must cope with pressures of livestock and other human related use which seem to be increasing at a rather steady rate. Community composition and dynamics are highly variable, underscoring the need for further studies of a long range, descriptive nature.

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