Small Mammal Abundance on Native and Improved Foothill Ranges, Utah

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Abstract

Small mammal populations were sampled annually over 4 years in native plant communities and improved rangeland types. All species of rodents were relatively less abundant where western wheatgrass was the dominant vegetation, but other differences among types were specific to individual species. Due to species-specific habitat preferences, total rodent numbers were highest where both sagebrush and seeded vegetation occurred together, and total rodent biomass was slightly greater along this ecotone than in a pure sagebrush type. Small-scale type conversion projects designed to increase the diversity of seeded and native stands may maintain or increase rodent abundance where species with such dissimilar habitat requirements occur.

Brush control and removal of sagebrush (*Artemisia* spp.) and pinyon-juniper (*Pinus-Juniperus*) vegetation have been common practices on Intermountain Region rangelands. Estimates of the public lands treated in this area include some 1,330 km² of various sagebrush control practices in Utah and Idaho (Vale 1974) and 1,350 km² of pinyon-juniper chainings of Utah (Aro 1975, Payne 1980). While these estimates represent a small portion of the public lands in this region, treatments applied in large blocks have substantially altered the composition and form of vegetation in localized areas (Vale 1974).

Some wildlife managers have expressed reservations concerning the value of these range improvements for wildlife. Roberts (1975) generalized that the majority of native wildlife species are adapted to native plant communities and would not benefit from seedings of exotic grasses. Identification of animal species restricted to native vegetation and those with habitat requirements more compatible with these range improvements is then important in balancing wildlife needs with other resource uses. The large size, lack of interspersed native and seeded types, and predominance of seeded monocultures in past conversion projects have also been criticized (International Association of Game, Fish, and Conservation Commissioners 1971, Vale 1974). Interspersion of seeded and native types in smaller units may alleviate some of these features perceived as undesirable. Treatments landscaped to increase the mixture of cover types may improve habitat for some species as an extension of classical principles of wildlife management (Urness 1978).

This paper reports a portion of small mammal studies undertaken at the Tintic Valley Experimental Pastures in central Utah from 1978 through 1981. Our objectives were to compare the relative abundance of small mammals among the existing vegetation types and to provide baseline data for comparison following potential future manipulations.

Study Site

The Tintic Valley Experimental Pastures are located in eastern Juab County, Utah, and typify Intermountain spring-fall ranges. They occupy the lower slopes of the East Tintic Mountains at

elevations from 1,700 to 1,828 m. Mean annual precipitation is approximately 360 mm. Soils are Mollisols and Aridisols, and all have loamy to fine sandy loam textures in the upper horizons.

Beginning in 1948 approximately one-half of this 1,400-ha site was treated to remove native sagebrush and woodland vegetation and seeded to introduced grasses in 28-ha pastures. These improved pastures contain crested wheatgrass (*Agropyron desertorum*), tall wheatgrass (*A. elongatum*), and other exotic grasses in mixed and single-species stands. In some pastures seeded species have been replaced by western wheatgrass (*A. smithii*), a native dominant. Woody cover consists of scattered sagebrush (*Artemisia tridentata* ssp. *tridentata*) and rabbitbrush (*Chrysothamnus* spp.) plants, and some improved pastures contain intermittent windrows of pinyon (*Pinus monophylla*) and juniper (*Juniperus osteosperma*) slash.

The remaining 700 ha support plant communities dominated by pinyon, juniper and big sagebrush. Associated species include bitterbrush (*Purshia tridentata*), greasewood (*Sarcobatus vermiculatus*), western wheatgrass, and bluebunch wheatgrass (*Agropyron spicatum*). Perennial grass production is sparse in these low-condition ranges and has shown no improvement despite 13 years of grazing exclusion (West et al. 1984).

Methods

Small mammal abundance was sampled in 2 studies. Snap-trap transects were used to establish indices of species abundance among the various cover types present from 1978 through 1980. Live-trapping for estimation of small mammal population parameters was undertaken each summer from 1979 through 1981 in seeded and native areas considered most representative of type conversion practices at this location, and in a habitat complex containing portions of both seeded and native plant communities. All data reported here were taken in late summer (August and September) in ungrazed or lightly grazed areas.

Snap-trapping

Snap-trapping was conducted on 4 100-m traplines surrounding a 1-ha sample area. Each trapline contained 10 stations at 10-m intervals consisting of 2 commercial mouse traps and 1 rat trap baited with peanut butter and rolled oats. Trapping was repeated on 3 consecutive nights in each year. Two traplines were used as subsamples in each area in 1979 and 1980, but in 1981 only 1 trapline was used per location. Improved-pasture habitats sampled included crested wheatgrass, western wheatgrass and tall wheatgrass types, and a tall wheatgrass seeding containing slashpiles. Native plant community types included sagebrush and pinyon-juniper stands. Only the sagebrush and crested wheatgrass types were replicated.

The numbers of individuals captured per trapline were compared among types for the most abundant species using analysis of variance with a repeated measures design following Winer (1971, p. 261). An implicit assumption is that differences in capture frequencies among areas reflect unequal abundance rather than variations in capture probabilities. Where sample sizes were adequate, Chi-square tests comparing the number of captures across nights and over areas were used to detect departures in the pattern of removals suggesting such biases. As a further qualification, capture probabilities were estimated by area and year based on constant removal

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Table 1. Number of rodents by species and habitats, and total biomass for all individuals snap-trapped, 1978–1980, Tintic Valley Experimental Pastures.

Species	Habitat								Total
	Improved				Native				
	Tall wheatgr. + slashpiles	Tall wheatgr.	Crested wheatgrass		Western wheatgr.	Sagebrush		Pinyon- juniper	
			rep 1	rep 2		rep 1	rep 2		
Deer mouse (<i>Peromyscus maniculatus</i>)	189	106	96	43	45	165	73	104	821
Great Basin pocket mouse (<i>Perognathus parvus</i>)	18	12	14	13	4	22	14	13	110
Western harvest mouse (<i>Reithrodontomys megalotis</i>)	20	17	17	12	5	1	27	0	99
Least chipmunk (<i>Eutamias minimus</i>)	4	0	0	0	1	9	9	1	24
Pinyon mouse (<i>Peromyscus truei</i>)	0	0	0	2	1	4	0	12	19
Ord kangaroo rat (<i>Dipodomys ordii</i>)	0	3	0	1	2	1	0	1	8
Sagebrush vole (<i>Lagurus curtatus</i>)	1	0	1	0	1	0	2	0	5
Cliff chipmunk (<i>Eutamios dorsalis</i>)	0	0	0	0	0	0	0	1	1
Total number	232	138	128	71	59	202	125	132	1087
Total biomass (g)	3444.4	2065.2	1825.5	1022.8	937.9	3238.2	1830.8	2094.7	16459.5

rates. The number caught each night was compared to expected distributions based on the proportions of the total number of individuals trapped for a series of constant capture probabilities. The probability corresponding to the minimum Chi-square value within the acceptance region ($p < 0.05$) was interpreted as evidence of fit for this assumption and the most appropriate constant capture probability estimate.

Live-trapping

Live-trapping was conducted on 12 × 12-station grids with 10-m spacing between trap stations. Stations consisted of two 7.6 × 7.6 × 25.4 cm live traps baited with rolled oats and peanut butter. Trapping occurred over a period of 5 successive nights in each year. Traps were checked each morning and shut during the day. Captured animals were marked by toe-clipping. Locations sampled included a sagebrush type, a habitat complex located on the border of seeded and sagebrush types, and a separate crested wheatgrass seeding. In 1979 all sample areas were located within approximately 2 km of one another. Heavy livestock grazing in the crested wheatgrass portion of the habitat complex in 1980 necessitated use of an alternative site in 1980 and 1981.

Variability in captures due to behavioral responses (trap happiness and shyness), different nights, and other factors have been demonstrated for a variety of species in live-trapping studies. Population estimators insensitive to these variations in capture probabilities may produce biased and imprecise estimates (Otis et al. 1978). Estimates in this study were derived using the computer program CAPTURE (White et al. 1978). This program compares fit of the data to models based on changes in capture probabilities with time (model M_0), behavioral responses, (M_b), heterogeneity among animals (M_h), only random variation (M_a) and combined sources of variability using Chi-square tests and discriminant function analysis. Population estimates are provided for some models. These methods and the relationship of these models to traditional population estimators are discussed by Otis et al. (1978).

In 1979 snap-trap grids were used to sample marked and unmarked animals in the sagebrush and habitat complex sites the night following conclusion of live-trapping. These data were used to calculate a Lincoln index (Otis et al. 1978) for verification of population estimates from live-trapping. Density estimates followed Otis et al. (1978), assuming an effective trapping area sur-

rounding the grid equal to one-half the distance across the average home range area. Home range estimates followed Jennrich and Turner (1969). Total rodent biomass was calculated using average species weights from previous studies in related habitats (Balph 1973 p. 236-248). All results reported as statistically significant refer to probabilities lower than 0.05 except where noted.

Results and Discussion

Snap-trapping

The numbers of individuals of each species snap-trapped from 1978 through 1980 are shown in Table 1. Deer mice (*Peromyscus maniculatus*), Great Basin pocket mice (*Perognathus parvus*), and western harvest mice (*Reithrodontomys megalotis*) accounted for over 90% of all individuals captured in each location, except in the pinyon-juniper community where pinyon mice (*Peromyscus truei*) were relatively abundant. In addition, 28 desert cottontails (*Sylvilagus audubonii*) and two black-tailed jackrabbits (*Lepus californicus*) were also trapped. All but two lagomorphs were taken in native vegetation types or along slashpiles within the improved pastures. The number of lagomorphs captured and their distribution among native and seeded types does not reflect their abundance or use of the seeded pastures. Large numbers of these animals were observed feeding in the outer edges of the seeded pastures during the morning and evening hours on many occasions.

The hypothesis of equal captures of deer mice among all habitats for data pooled over years were not rejected ($p < 0.66$). Annual variation was highly significant ($p < 0.01$) due to substantially greater numbers in 1978 than in following years (Table 2). The interaction of years and types was significant at the 0.06 probability level. Comparisons within years (Table 2) indicate greater abundance of deer mice where woody cover occurred either as standing vegetation or slashpiles, and smaller annual fluctuations in the sagebrush community compared to seeded types. Frequencies of capture for deer mice were consistently low in the western wheatgrass community relative to seeded types, but were significantly lower only in 1978.

With but 2 exceptions additional analyses failed to indicate biases in these estimates of deer mice abundance qualifying these results. Independence of capture frequencies among areas and over nights for the 1978 data was rejected at the 0.10 probability level ($X^2 = 22.36$, 14 d.f.). Higher than expected captures during the first

Table 2. Number of deer mice snap-trapped by year and habitat, Tintic Valley Experimental Pastures.

Habitat	Year		
	1978	1979	1980
Improved pastures ¹			
Tall wheatgrass + slashpiles	60.5 ^c	27.0 ^b	14.0 ^{ab}
Tall wheatgrass	32.0 ^b	13.0 ^{ab}	16.0 ^{ab}
Crested wheatgrass	28.8 ^b	3.5 ^a	5.0 ^a
Western wheatgrass	10.5 ^a	8.0 ^{ab}	8.0 ^{ab}
Native vegetation			
Sagebrush	25.8 ^b	21.5 ^b	24.5 ^b
Pinyon-juniper	28.0 ^b	21.5 ^b	5.0 ^a
Annual averages	30.9	15.8	12.1

¹Values followed by the same letter do not differ significantly ($p < 0.05$, Least Significant Difference test) from others in the same column. Data for 1978 and 1979 are averages of subsamples.

night of sampling in the pinyon-juniper type, and greater numbers in the last night in crested wheatgrass replicate 2, accounted for the bulk of the deviations. Corresponding capture probability estimates were 0.62 and 0.20 for the pinyon-juniper type and this seeded pasture, respectively, and were the highest and lowest probabilities for all data that could be fit to constant capture probability curves. This indicated that nearly all of the deer mice in the pinyon-juniper type in this year were sampled, but that a considerable proportion remained untrapped in this crested wheatgrass seeding. The remaining data for 1978 and that for 1979 showed little difference in estimated capture probabilities. Data for 1980 were insufficient for these comparisons.

The number of pocket mice captured (Table 1) differed significantly among areas at the 0.10 probability level ($X^2 = 13.49$, 7 d.f.), due to fewer captures in the western wheatgrass pasture than all other types ($X^2 = 6.22$, 1 d.f.). Harvest mice were absent or occurred only infrequently in the pinyon-juniper type and sagebrush replicate 1. These areas contained more bare ground than other habitats, suggesting that lack of herbaceous vegetation limited the distribution of this species. Chi-square tests comparing totals among other habitats rejected independence ($X^2 = 33.72$, 5 d.f.). Captures in the seeded pastures were significantly greater than in the western wheatgrass type ($X^2 = 8.62$, 1 d.f.), but were higher in sagebrush replicate 2 relative to seeded areas ($X^2 = 4.19$, 1 d.f.). Annual variation in the numbers captured was substantial at all locations. Although sagebrush replicate 2 produced the greatest total number of harvest mice, none were recorded there in 1980. Pinyon mice and least chipmunks (*Eutamias minimus*) were captured primarily in the pinyon-juniper and sagebrush communities, respectively.

Total rodent biomass and total rodent numbers in the western wheatgrass type and crested wheatgrass replicate 2 were only one-

half to one-third as large as in other habitats (Table 1). Among the remaining improved and native types the range for these values was similar. Either total reflects the predominance of deer mice in the catch in all areas.

Live-trapping

Deer mice were the most abundant species captured in live-trapping. The number taken in 1980 and 1981 in the crested wheatgrass seeding were insufficient for tests of model assumptions in CAPTURE. In all other instances population estimates were obtained satisfying hypothesis tests provided in that program, or showing close agreement between the most appropriate estimates and Lincoln index estimates from snap-trapping in the same locations on an additional night. Population estimates, density estimates, and numbers of deer mice captured in each year and habitat segment are shown in Table 3. Differences in the magnitude of confidence intervals among population estimates is probably due to estimators rather than variability in the data, per se. Variances obtained using model M_h are likely underestimated (Otis et al. 1978). Neither population nor density estimates showed consistent differences in deer mice abundance between the habitat complex and sagebrush types. Deer mice density was significantly greater in the sagebrush type than the habitat complex in 1980 ($z = 4.54$), but lower in 1981 ($z = 4.05$). The crested wheatgrass seeding had produced lower density than either site containing shrub cover in 1979, and fewer individuals in remaining years.

The numbers of individuals of each species captured in live-trapping are shown by year in Table 4. Reliable population estimates could not be obtained for harvest mice and pocket mice in all locations due to small sample sizes and combined sources of variation in capture probabilities. Estimates were obtained for pocket mice in 3 areas based on model M_b . Population estimates with 95% confidence intervals were 25 ± 13 pocket mice in the crested wheatgrass habitat in 1979, 44 ± 12 in the habitat complex in 1980, and 15 ± 1 in the complex segment in 1981. Corresponding density estimates were 7.4 ± 6.7 animals per hectare in the crested wheatgrass seeding and 16.9 ± 9.9 and 6.3 ± 4.0 in the habitat complex in 1980 and 1981, respectively.

The numbers of pocket mice and harvest mice captured in the sagebrush community were consistently low compared to other habitat segments (Table 4). Higher numbers of individuals of these 2 species in the habitat complex in 1980 and 1981 compared to the initial year of study probably reflect site differences among locations sampled. In view of this site variability and annual fluctuations, assessment of greater or lesser abundance in the crested wheatgrass type relative to the habitat complex is not justified for these species. Least chipmunks were recorded only in the sagebrush habitat and the sagebrush-dominated portion of the habitat complex. Closing of traps during the day no doubt reduced captures for this diurnal species, but their absence in the seeded plant communities further substantiates a strong preference for native vegetation types in this location.

Table 3. Population parameters for deer mice by habitat segment and year, Tintic Valley Experimental Pastures.

Type	Year	Number captured	Population estimate ($\pm$ 95% CI)	Model ¹	Effective area (ha.) ($\pm$ 95% CI)	Density (no./ha.) ($\pm$ 95% CI)
Sagebrush	1979	55	65 ± 8	M_h	2.68 ± 1.1	24.2 ± 14.7
	1980	45	55 ± 17	M_b	2.71 ± 0.8	20.3 ± 10.7
	1981	18	22 ± 6	M_h	2.46 ± 0.5	9.0 ± 3.5
Habitat Complex ²	1979	65	74 ± 8	M_h	2.65 ± 0.9	28.0 ± 15.0
	1980	21	21 ± 2	M_o	2.90 ± 1.4	7.2 ± 5.6
	1981	46	67 ± 36	M_b	2.98 ± 1.1	22.5 ± 18.3
Crested Wheatgrass	1979	22	23 ± 3	M_h	3.41 ± 1.0	6.7 ± 3.5
	1980	4	—	—	—	—
	1981	6	—	—	—	—

¹Model refers to those presented in Otis et al. (1978).

²Habitat complex located on boundary between sagebrush and crested wheatgrass types.

Table 4. Number of rodents live-trapped by habitat segment and year, Tintic Valley Experimental Pastures.

Species	Habitat segment												Grand total
	Crested wheatgrass				Sagebrush				Habitat complex ¹				
	1979	1980	1981	Total	1979	1980	1981	Total	1979	1980	1981	Total	
Deer mouse (<i>Peromyscus maniculatus</i>)	22	4	6	32	55	45	18	118	65	21	46	132	282
Western harvest mouse (<i>Reithrodontomys megalotis</i>)	50	10	6	66	2	2	1	5	9	17	11	37	108
Great Basin pocket mouse (<i>Perognathus parvus</i>)	20	11	7	38	3	3	4	10	7	37	15	59	107
Least chipmunk (<i>Eutamias minimus</i>)	0	0	0	0	4	6	13	23	4	1	5	10	33
Ord kangaroo rat (<i>Dipodomys ordii</i>)	0	0	0	0	0	0	0	0	0	4	3	7	7
Northern grasshopper mouse (<i>Onychomys leucogaster</i>)	1	0	0	1	0	0	0	0	2	0	0	2	3
Pinyon mouse (<i>Peromyscus truei</i>)	0	0	1	1	0	1	0	1	0	1	0	1	3
Sagebrush vole (<i>Lagurus curtatus</i>)	0	0	0	0	0	0	0	0	0	0	3	3	3
Desert woodrat (<i>Neotoma lepida</i>)	0	0	0	0	0	0	0	0	1	0	0	1	1
Total	93	25	20	138	64	57	36	157	88	81	83	252	547

¹Habitat complex located on boundary between sagebrush and crested wheatgrass types.

Total numbers of individuals of all species in the habitat complex were greater than those in either pure type (Table 4). Equal abundance of deer mice and least chipmunks in this area relative to the sagebrush type, and similar numbers of pocket and harvest mice compared to the crested wheatgrass seeding accounted for the bulk of this difference. Thus, greater total rodent numbers in this segment appear to be the result of an additive effect of combined vegetation cover for species with different habitat affinities. Although more species were recorded along this ecotone than in either pure type, the occurrence of most remaining species is not consistent. Soil texture or bare ground on a road running through the habitat complex may also have influenced the occurrence of Ord kangaroo rats (*Dipodomys ordii*). These features are important for this species at other locations (Larrison and Johnson 1973, Johnson 1982).

Excluding the larger species captured only infrequently, biomass of all rodents in the habitat complex was slightly greater than that in the sagebrush type (Table 5). Lower biomass totalled over all

Table 5. Total biomass (g) for all species captured in live-trapping by year and habitat segment, Tintic Valley Experimental Pastures.

Habitat Segment	Year			
	1979	1980	1981	Total
Crested wheatgrass	1033.3	309.0	260.6	1602.9
Sagebrush	1017.4	938.1	728.1	2683.6
Habitat complex ¹	1322.2	1078.4	1220.6	3621.2

¹Habitat complex located on boundary between crested wheatgrass and sagebrush types. Excludes Ord kangaroo rats and desert woodrat.

years in the sagebrush habitat was due largely to the difference in 1981. Estimated biomass in the crested wheatgrass seeding was similar to that in other habitat segments only in 1979 when harvest and pocket mice were numerous. In the following 2 years it was substantially lower than that in the other areas studied.

Summary and Conclusions

Although annual variations and differences in sampling methods and sites have produced some contradictions, these studies do not

support the conclusion that type conversion of sagebrush and pinyon-juniper ranges to communities dominated by seeded grasses necessarily reduces small mammal abundance. Only in the pasture where seeded exotic grasses have been replaced by western wheatgrass were all rodent species captured in lower than average numbers. Smaller rodent abundance in this type may be due to lower total vegetation cover or lower vegetation height. Other differences in relative abundance were species-specific. Deer mice were more abundant in habitats containing woody cover. Pocket mice occurred in equal or greater numbers in seeded areas relative to native plant communities. Live-trapping and snap-trapping produced conflicting results of harvest mice. The number of individuals captured in removal sampling was greater in one sagebrush type than in the seeded areas, but captures with live-trapping were consistently higher in habitats containing crested wheatgrass. This contradiction is likely the result of localized annual fluctuations in harvest mice abundance. Their absence from low-condition native ranges lacking herbaceous cover, and greater abundance in seeded habitats sampled by live-trapping show that they may benefit from type conversions. Pinyon mice and least chipmunks occurred primarily in native community types. We find some supporting evidence for these generalizations in other studies in ungrazed areas (Black 1968, Turkowski and Reynolds 1970, Larrison and Johnson 1973, Reynolds and Trost 1980).

Due to these differences in habitat preferences among species, total rodent abundance increased where native and seeded plant communities occurred together, with slightly higher total rodent biomass. Interspersion of native and seeded vegetation and small-scale type conversions may help maintain habitat for species with more limited habitat requirements. Retention of downed trees as protective cover should also be considered as a positive means of maintaining habitat for these and other non-game wildlife. Removal of woody cover through burning or spraying in areas where western wheatgrass is dominant in the understory appears the least favorable vegetation manipulation for these species.

Future research of some related range-wildlife problems may benefit from developments in wildlife population analyses. The methods provided by CAPTURE offer advantages in the approach to model selection and refinements in statistical methods (Otis et al. 1978). However, we note that rigorous testing of these hypotheses will require larger sample size than observed in this study. A technique for direct density estimation recently described by And-

erson et al. (1983) appears to be a useful alternative. Based on application of distance sampling methods, this procedure avoids some arbitrary assumptions implicit to other population and density estimates. These methods may provide more reliable estimates of animal abundance, and assist in assessing further complementary or conflicting range and wildlife relationships.

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