Small Mammal Populations in an Unburned and Early Fire Successional Sagebrush Community

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Abstract

Species composition and total numbers of small mammals changed little in the unburned sagebrush while individual species capture rates varied considerably. Following spring burning, the number of small mammal species and abundance were slightly lower than control levels and were near unburned levels after 3 years. Species composition was greatly reduced on the fall burn in the first postburn year. Two years after burning four species were captured, although only two were caught in live-traps. Total small mammal density increased dramatically in the first two postburn years. The large increase in abundance on both burns was due primarily to *Peromyscus maniculatus* and *Spermophilus armatus*. Food use patterns on the fall burn were similar to those observed on the spring burn where small mammals utilized their preferred food types in relation to its abundance and availability.

Prescribed burning of sagebrush *(Artemisia tridentata)* to increase livestock forage, type conversion, and wildlife habitat improvement is becoming commonplace throughout the Intermountain Region. Management of sagebrush communities with fire for livestock or wildlife requires information on the interrelationships between plants and animals in the postburn stages to better understand successional relationships.

Lawrence (1966) indicated species composition was altered but small mammal abundance was not decreased following fire in chaparral. Stout et al. (1971) reported that densities of small mammals were not unusually high in a burned coniferous forest in northern Idaho. In addition, Taylor (1969) showed the number of small mammal species increased during the first 25 years following fire in lodgepole pine *(Pinus contorta)* forests in Yellowstone National Park. There are no existing studies on the effects of fire on small mammal populations in sagebrush communities in the Intermountain Region.

This study determines species composition, abundance, and food habits of small mammals in an unburned sagebrush community along with changes in these parameters following prescribed spring and fall burns.

Study Areas and Methods

Study Areas

The study areas were on Burro Hill about 40 km northwest of Jackson, Wyoming, within the Buffalo District, Bridger-Teton National Park. In unburned areas mountain big sagebrush *(Artemisia tridentata vaseyana)* is the most abundant shrub, forming dense, homogeneous stands. The most common grasses are wheatgrasses (*Agropyron* spp.), Idaho fescue *(Festuca idahoensis)*, bluegrasses (*Poa* spp.) and needlegrasses (*Stipa* spp.). Characteristic forbs include yarrow *(Archillea millefolium)*, wild buckwheat *(Eriogonum umbellatum)*, geranium (*Geranium* spp.), lupine (*Lupinus* spp.), and northwest cinquefoil *(Potentilla gracilis)*. Grasses and forbs form a continuous understory with few open areas. The sagebrush is bordered by stands of Douglas-fir *(Pseudotsuga menziesii)* and aspen *(Populus tremuloides)*.

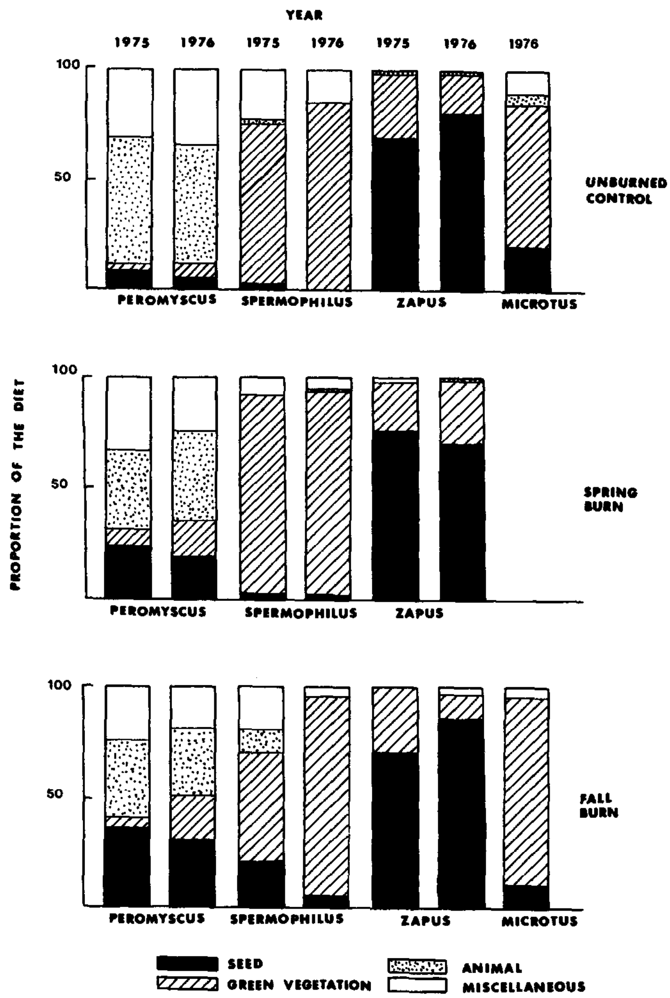

Fig. 1. *Proportion of food types in the diets of small mammals.*

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On June 3, 1974, 15–20 ha were burned by the Forest Service (spring burn) on the eastern end of Burro Hill, resulting in a mosaic of burned patches ranging from completely burned to partially burned, to unburned. Approximately 70–80 ha were completely burned on August 27, 1974 (fall burn). Approximately 40–50 ha of sagebrush were left unburned along the eastern and western ends of of Burro Hill.

The spring burn was sampled during the first (1974), second (1975), and third (1976) postburn growing seasons. Due to timing of the burns, preburn sampling on the spring burn was not possible. However, the fall burn was sampled in preburn state (1974), and during the first (1975) and second (1976) postburn growing seasons. An unburned control was sampled in all 3 years. It is assumed that preburn conditions on the spring burn plots were not significantly different from those on the fall burn's preburn state and the unburned control.

Sampling

Plant species composition, frequency of occurrence, and percent cover of understory species were determined using the Daubenmire (1959) canopy coverage method. Forty to fifty quadrats (0.1 m^2) were distributed in a stratified random design on each study area based on variations in vegetative distribution. Shrubs were sampled using the line intercept method (Canfield 1941) on ten randomly located 40-m transects.

Small mammals were assessed on five live-trapping grids (1.5 ha) and five snap-trap removal transects (500 m) during more than 21,000 trap nights. Animals were live-trapped five consecutive nights each month during June, July, and August. Removal transects were established in 1975 to collect data on food habits and reproduction. Two parallel trap lines were installed on the fall burn and control area, and one line in the spring burn. The relative abundances of small mammals were compared using catch per unit effort (number per 100 trap nights).

Food habits of small mammals from the spring burn were studied in its second (1975) and third (1976) postburn years and from the fall burn in its first (1975) and second (1976). The unburned control was also sampled in 1975 and 1976. Stomach contents of 305 kill-trapped animals were removed, separated under a dissecting microscope, divided into major food groups, (seed, green vegetation, animal) dried, and weighed. The proportion and percent

Table 1. Species composition, total captures, and catch per unit effort (in parentheses expressed as number captured per 100 trap nights) of small mammals on Burro Hill.

	Live trap			Snap trap		Totals		
Species	1974	1975	1976	1975	1976	1974	1975	1976
Unburned control:								
Peromyscus maniculatus	26 (1.7)	36 (2.4)	50 (2.6)	3 (0.2)	6 (0.6)	26 (1.7)	39 (1.9)	56 (2.7)
Spermophilus armatus	18 (1.1)	16 (2.5)	20 (3.2)	6 (0.6)	10 (0.9)	18 (1.1)	22 (1.1)	30 (1.5)
Zapus princeps	17 (1.1)	24 (1.6)	23 (1.5)	5 (0.5)	8 (0.7)	17 (1.1)	29 (1.4)	31 (1.5)
Microtus montanus	11 (0.7)	0	6 (0.6)	0	4 (0.3)	11 (0.7)	0	10 (0.5)
Sorex vagrans	2	8 (0.5)	16 (1.1)	0	0	2	8 (0.5)	16 (1.1)
Eutamias minimus	2	2	2	0	0	2	2	2
Mustela frenata	1	2	1	0	0	1	2	1
Thomomys talpoides	0	0	3	0	0	0	0	3
Clethrionomys gapperi	0	1	0	0	0	0	1	0
Spring burn:								
Peromyscus maniculatus	29 (1.8)	58 (3.9)	24 (1.6)	20 (3.7)	22 (4.0)	29 (1.8)	78 (3.8)	46 (2.3)
Spermophilus armatus	12 (0.8)	7 (0.5)	29 (1.9)	2 (0.4)	9 (1.7)	12 (0.8)	9 (0.4)	38 (1.9)
Zapus princeps	1	4 (0.3)	9 (0.6)	12 (2.2)	13 (2.4)	1	16 (0.8)	22 (1.1)
Microtus montanus	0	0	20 (1.3)	0	0	0	0	20 (1.3)
Sorex vagrans	0	1	10 (0.7)	0	0	0	1	10 (0.7)
Eutamias minimus	4 (0.3)	2	3	0	0	4 (0.3)	2	3
Mustela frenata	1	2	0	0	0	1	2	0
Thomomys talpoides	0	1	1	0	0	0	1	1
Fall burn:								
Peromyscus maniculatus	14 (0.9)	284 (18.9)	305 (20.3)	113 (10.5)	157 (14.5)	14 (0.9)	397 (19.5)	462 (22.7)
Spermophilus armatus	30 (2.0)	155 (24.6)	145 (23.6)	5 (0.5)	17 (1.6)	30 (2.0)	160 (7.8)	162 (7.9)
Zapus princeps	4 (0.3)	0	0	7 (0.7)	4 (0.3)	4 (0.3)	7 (0.3)	4 (0.2)
Microtus montanus	5 (0.4)	0	0	0	7 (0.7)	5 (0.3)	0	7 (0.3)
Eutamias minimus	4 (0.3)	0	0	0	0	4 (0.3)	0	0
Sorex vagrans	2	0	0	0	0	2	0	0
Microtus longicaudus	2	0	0	0	0	2	0	0
Mustela frenata	1	0	0	0	0	1	0	0
Sorex cinereus	1	0	0	0	0	1	0	0

Table 2. Percent coverage of major plant groups. Values are means for six sampling dates during the growing season.

Plant group	Unburned control			Spring burn			Fall burn		
				Postburn			Preburn	Postburn	
	1974	1975	1976	1974	1975	1976	1974	1975	1976
Shrubs	50	49	48	10	15	19	48	3	9
Grass and grass-like plants	27	30	28	14	19	22	33	6	15
Forbs	30	35	41	26	32	31	40	15	44
Total cover	107	114	117	50	66	72	121	24	68

occurrence of each group in the diet were calculated for each captured species.

Results and Discussion

Eight species of rodents, two species of insectivores, and one carnivore were captured during the 3-year period: deer mouse *(Peromyscus maniculatus),* Uinta ground squirrel *(Spermophilus armatus),* western jumping mouse *(Zapus princeps),* montane vole *(Microtus montanus),* least chipmunk *(Eutamias minimus),* long-tailed vole *(Microtus longicaudus),* northern pocket gopher *(Thomomys talpoides),* masked shrew *(Sorex cinereus),* and long-tailed weasel *(Mustela frenata).*

Information on species composition and abundance in the unburned sagebrush indicates that the small mammal community consists of a mixture of species whose total numbers varied little. Deer mouse and ground squirrel numbers varied most. There was little dietary overlap among species; different species were partitioned along the food dimension with *Spermophilus* (herbivore), *Microtus* (herbivore), *Zapus* (granivore), and *Peromyscus* (omnivore), each specializing in one food type (Fig. 1).

Following spring burning, total small mammal numbers were at low levels, but this was short-lived (Table 1). By the end of the second postburn year, densities were similar to unburned estimates with the responses being caused by one or two species. The unburned and partially burned islands that remained following the burn undoubtedly served as refuges for small mammals. Three years after spring burning, total cover of the understory was near unburned levels (Table 2), and small mammal numbers were approaching control values.

The fall burn differed from the spring burn in that no patches of unburned sagebrush remained and revegetation was slower. One year after burning, total cover was still dramatically lower than unburned estimates although deer mouse and ground squirrel captures had increased dramatically. It appears that the loss of cover had no negative effect on their densities, and that food may have been the factor affecting them most. Both deer mice and ground squirrels changed their food habits to utilize the increased availability of food. The absence of potentially competitive species may also have enhanced their success.

Species with rather specific niche requirements (e.g., voles, jumping mouse, shrews) cannot sustain populations on severe fall burns. Cook (1959) discovered that lack of cover following burning is the restricting factor in reducing vole populations, which require 1 year of mulch for runways. Jumping mice nest on the surface under protection of grasses and herbs (Burt and Grossenheider 1964), and Whittaker (1963) suggested that the absence of a well-developed, extensive herbaceous layer may exclude jumping mice.

Stout et al. (1971) correlated the absence of shrews on a burned coniferous forest in northern Idaho with their limited powers of dispersal and lack of ground litter on the burned sites. Stout's data also indicate a significantly reduced number of species of small mammals in the years following the burn.

Peromyscus maniculatus is particularly suited to exploit burns since it prefers seeds of grasses and herbs and insects (Drickamer 1970). Ahlgren (1966) contends that accumulations of seeds remain in unburned portions of forest floors and production by annual grasses is sufficient to support substantial populations of seed-eating rodents. Many authors (Tevis 1956; Cook 1959; Gashwiler 1959) have shown that granivores are favored in the initial stages of secondary succession following fire. Cook (1959) reported an irruption of western harvest mice *(Reithrodontomys megalotis)* during a period of maximum seed production. Both Cook (1959) and Lawrence (1966) have documented the shift in *Peromyscus* species abundance to favor *P. maniculatus* in the years following burning. Ahlgren (1966) and Beck and Vogal (1972) found significantly higher populations of *P. maniculatus* in other burned habitats. In addition, Ahlgren (1966) and Tester (1965) contend that burning improved habitat and food conditions for small rodents.

Kirkland (1976) describes a case of opportunism by *P. maniculatus* on mine wastes in New York and attributes its success to its ecological plasticity and the absence of congeneric competitors. The results from my study further illustrate the broad ecological tolerance of *P. maniculatus* and reflect the adaptability of this species in invading and exploiting harsh habitats. I attribute its success on the burns to increased immigration from surrounding areas and a maximization of reproductive potential (McGee 1976) in response to an increased availability of food.

These results support the contention that total small mammal numbers are not depleted by fire, but that there is a differential effect on the species present before burning. In my opinion, ideal sagebrush management should create a mosaic of different aged successional stages. The optimum proportion of unburned, spring and fall burned sites should mimic historic fire frequency and size where feasible. Consequently, no small mammal species, or group of similar species, will be significantly displaced in space and time.

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