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Responses of Small Mammals and Vegetation to Wildfire in Shadscale Communities of Southwestern Idaho

Abstract

During the last 10 years, wildfires have burned 50 percent of the shrub-steppe vegetation in the Snake River Birds of Prey Area. Because of the importance of small mammals as prey for raptors, we assessed the species composition and density of the small mammal populations and the percent cover of vegetative species at burned, partially burned, burned/rehabilitated, and unburned (control) sites. Vegetation on unburned sites consisted primarily of shadscale (*Atriplex confertifolia*) and winterfat (*Ceratoides lanata*) associations, whereas cheatgrass (*Bromus tectorum*) dominated the burned, partially burned, and burned/rehabilitated sites. The deer mouse (*Peromyscus maniculatus*) was the most abundant species on all study sites. More deer mice were captured on partially burned and unburned sites than on burned and burned/rehabilitated sites. Abundance of Townsend's ground squirrels (*Spermophilus townsendii*), as measured by hole counts, was greater on unburned sites than burned ones. This study suggests that wildfires in shadscale habitat reduce small mammal abundance for at least one year after a burn.

Introduction

Numerous studies have assessed the effects of fire on small mammal populations (Ream 1981). Although the majority of these studies were conducted in forested habitat, several recent investigations have focused on the impacts of fire on small mammals in shrub-steppe vegetation (Halford 1981, Hedlund and Rickard 1981, Gano and Rickard 1982, McGee 1982, Keller *et al.* 1983). During the last 10 years, approximately 50% of the shrub-steppe vegetation in the Snake River Birds of Prey Area (BOPA) in southwestern Idaho has burned (Kochert and Pellant 1986). The BOPA supports one of the densest and most diverse assemblages of raptor populations in the world (U.S.D.I. 1979). Because all of the raptor species in the BOPA prey upon small mammals to some extent, fire could affect raptor populations by reducing the rodent prey base through direct mortality and habitat alteration. This paper presents the results of a study to assess the relative abundances of small mammals and percent cover of plant species one year after a wildfire in the BOPA.

Study Area

The study was conducted within the 242,884-ha Snake River BOPA in southwestern Idaho. Prior to recent, extensive range fires, vegetation within the BOPA was shrub steppe dominated by big sagebrush (*Artemisia tridentata*), shadscale (*Atriplex confertifolia*), and winterfat (*Ceratoides lanata*) associations (U.S.D.I. 1979). The Snake River Canyon is the principal physiographic feature of the BOPA with elevation ranging from 770 m in the canyon bottom to 1000 m at the rim. Topography above the canyon is generally flat or slightly rolling with a few isolated buttes. Climate in the BOPA is characterized by hot summers and mild winters; average annual precipitation is 20 cm, most of which occurs in winter.

In July 1985, a wildfire burned 2428 ha on the north rim of the Snake River Canyon (Figure 1). No fires had occurred in the vicinity of this burn for at least 30 years prior to 1985, and vegetation had been dominated by shadscale and shadscale/winterfat associations (U.S.D.I. 1979). Both cattle and sheep had grazed the area for a 75-day period each winter.

During May and June 1986, we identified four range conditions in and adjacent to the burn (Figure 1): burned (B), partially burned (P), burned/rehabilitated (R), and control (C). The partially burned transects were located on the southwestern corner of the burn where the fire burned incompletely and left patches of shrub cover. The burned/rehabilitated sites were those

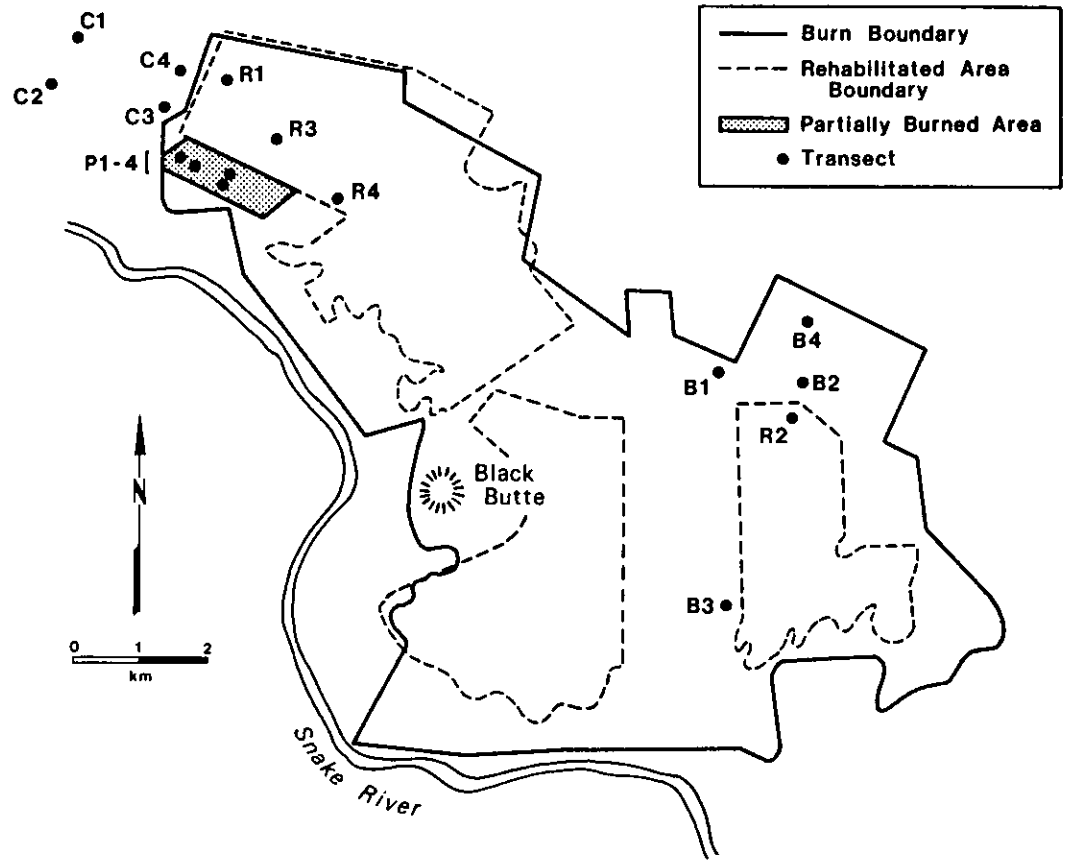

Figure 1. Location of small mammal and vegetation sampling transects on and adjacent to a burned area within the Snake River Birds of Prey Area. B = burned transects; C = control (unburned) transects; P = partially burned transects; R = burned/rehabilitated transects.

areas of the burn that had been drill-seeded in rows spaced 30 cm apart during November 1985 (1860 ha) and March 1986 (240 ha) with a mixture of crested wheatgrass (*Agropyron cristatum* "Fairway" and *Agropyron cristatum* "Siberian"), yellow sweetclover (*Melilotus officinalis*), and fourwing saltbush (*Atriplex canescens*). The control transects were located adjacent to the burn on the west side and consisted primarily of shadscale associations. The burned, partially burned, and burned/rehabilitated sites but not the control sites were rested from grazing in the winter following the fire (1985-86).

Methods

Small mammals were sampled along four 250-m transects randomly located within each of the four range conditions. Each of the 16 transects consisted of 26 trap stations with a 10-m interval between stations. Eight of the 16 transects (B1, B2; P1, P2; R1, R2; C1, C2) were sampled in May with two Museum Special traps and one McGill rat trap at each station. Due to limited catch in rat traps, the other eight transects, which were sampled in June, had only two Museum Special traps per station. Traps were baited with a mixture of peanut butter and whole oats. Following a 2-day prebait period, each transect was trapped for three consecutive days. For each animal captured, information on species, trap station, sex, weight, and reproductive condition was recorded. Males were considered to be in breeding condition if scrotal testes were observed; lactation tissue, noticeable pregnancy, and perforate vaginas were indications of breeding condition for females.

Holes of Townsend's ground squirrels (*Spermophilus townsendii*) and badgers (*Taxidea taxus*) were censused on hole-count transects. Previous work in the BOPA has demonstrated a close correlation between the number of active holes and ground squirrel density ($r = 0.94$, $P = 0.002$) (Nydegger and Smith 1986). Each of the 250-m trapping transects was extended 150 additional meters. We counted all ground squirrel and badger holes in belt transects that were 400 m long and 5 m wide with the transect line serving as the center of the belt. Holes were classified as active if diggings indicated they were used by ground squirrels or badgers during 1986; otherwise holes were recorded as inactive.

Vegetation was sampled on each transect with a point interception frame (Floyd and Anderson 1982). The plant species underneath each point was recorded, and percent cover was calculated independently for each species. Within each transect, five 5-m sections were randomly chosen for vegetation sampling. Thus, a sample unit consisted of one 5-m section of the transect line in which the point frame was used to estimate cover on five consecutive 1-m sections of the transect line. Running means calculated during field sampling indicated that three 5-m sections were adequate to estimate percent cover in the homogeneous B and R transects and that four 5-m sections were sufficient to characterize the more heterogeneous P and C transects. All statistical tests were evaluated at the 0.05 level of significance.

Results

Eighty-two small mammals were captured in 3120 trap nights (Table 1). The deer mouse (*Peromyscus maniculatus*) accounted for approximately 90 percent of the total and was the most common species in all range conditions. Four other species were captured during the study, but their total numbers summed to only seven animals (Table 1). Species richness was highest on the control transects where Great Basin pocket mice (*Perognathus parvus*), a grasshopper mouse (*Onychomys leucogaster*), and a Townsend's ground squirrel were captured in addition to deer mice.

The total number of small mammals captured differed ($\chi^2 = 71.70$, $P < 0.001$) among the four range conditions (Table 1). The same result was observed for deer mice ($\chi^2 = 19.23$, $P < 0.001$). More than twice as many deer mice were trapped on partially burned (P) and control (C) transects than on burned (B) and burned/rehabilitated (R) transects.

TABLE 1. Number of small mammals trapped on transects in burned (B), partially burned (P), burned/rehabilitated (R), and control sites (C) in the Birds of Prey Area (BOPA). Number of small mammals trapped/100 trap nights is given in parentheses.

Species	B	P	R	C	Total
Peromyscus maniculatus	10 (1.3)	31 (4.0)	9 (1.2)	25 (3.2)	75
Perognathus parvus			2	2	4
Dipodomys ordii	1				1
Onychomys leucogaster				1	1
Spermophilus townsendii				1	1
Total	11 (1.4)	31 (4.0)	11 (1.4)	29 (3.7)	82
Trap station nights	312	312	312	312	1248
Trap nights	780	780	780	780	3120

The mean weight of deer mice captured in the study area was 22.4 g (SD = 5.8, n = 59). There was no difference in the mean weight of deer mice among the B, P, R, and C transects. Additionally, there was no difference in the percentage of deer mice in breeding condition among the C (65%, n = 20), P (78%, n = 22), and B and R transects combined (56%, n = 16). We combined results from B and R transects because of small sample sizes.

The active, inactive, and total number of Townsend's ground squirrel holes differed ($\chi^2 = 19.23$, $P < 0.001$; $\chi^2 = 15.52$, $0.001 < P < 0.005$; $\chi^2 = 46.78$, $P < 0.001$) among the four range conditions (Table 2). More than twice as many total holes were counted on C transects compared to B, P, and R transects. The total number of badger diggings was also different ($\chi^2 = 26.83$, $P < 0.001$) among the four range conditions (Table 2). Again, the greatest number of diggings was observed on C transects.

TABLE 2. Number of ground squirrel holes and badger diggings counted on transects in burned (B), partially burned (P), burned/rehabilitated (R), and control (C) sites in the Birds of Prey Area (BOPA).

Species	B	P	R	C	Total
Townsend's Ground Squirrel					
Active	9	19	7	29	64
Inactive	12	12	7	36	67
Total	21	31	14	65	131
Badger					
Active	4	2	1	7	14
Inactive	13	8	10	31	62
Total	17	10	11	38	76

Vegetation on C transects was dominated by a 14 percent cover of shadscale and 7 percent cover of winterfat (Table 3). Important grasses were bottlebrush squirreltail (*Elymus elymoides*) and cheatgrass (*Bromus tectorum*). In contrast, B and R transects had little or no shadscale and winterfat cover, but considerably more cheatgrass (26 and 14%, respectively) and no squirreltail. B, P, and C transects were characterized by 22 percent bare ground, whereas estimates of bare ground in the R transects averaged 54 percent (Table 3). Cover values for litter ranged from 16 percent in the R transects to 34 percent in B transects. The C transects contained the greatest number of plant species (9); the P transects contained the greatest number of exotic species (5). B and R transects were devoid of any moss or lichen cover.

TABLE 3. Mean percent cover values for vegetation sampled on transects in burned (B), partially burned (P), burned/rehabilitated (R), and control (C) sites in the Birds of Prey Area (BOPA). Sample sizes (n) are given in parentheses.

Species	B (n=12)	P (n=16)	R (n=12)	C (n=16)
Shrubs				
Atriplex confertifolia	x[1]	6	—	14
Ceratoides lanata	x	—	—	7
Artemisia spinescens	—	—	—	x
Dead Shrub	4	9	—	5
Grasses				
Elymus elymoides	—	2	—	5
Poa sandbergii	—	—	—	3
Bromus tectorum[2]	26	9	14	5
Vulpia sp.	—	—	x	x
Forbs				
Sisymbrium loeselii[2]	3	3	x	2
Descurainia sophia[2]	5	3	6	x
Chenopodium leptophyllum	—	x	x	—
Salsola kali[2]	x	x	—	—
Halogeton glomeratus[2]	—	x	—	—
Plagiobothrys sp.	—	—	x	—
Amsinckia retrorsa	—	—	x	—
Bare Ground	22	22	54	22
Litter	34	26	16	20
Moss	—	2	—	7
Lichen	—	—	—	2
Total number of species[3]	6	8	7	9

[1]x = species present but mean percent cover < 1.0.

[2]Species introduced to North America.

[3]Does not include moss, lichen, bare ground, litter, or dead shrub.

Discussion

The response of rodent populations to fire depends on the species involved, the vegetation type, and the type and intensity of the burn. The present study was conducted one year after an intense wildfire burned 2428 ha of shrub-steppe vegetation in the Snake River BOPA. Prior to the fire, vegetation on the burned transects was dominated by shadscale (10% canopy coverage) and cheatgrass (3% canopy coverage; U.S.D.I., unpubl.). Our post-fire vegetation sampling showed that shadscale cover had decreased to less than 1 percent in burned and burned/rehabilitated sites and that cheatgrass had increased to approximately 26 percent in burned and 14 percent in burned/rehabilitated sites.

The number of small mammals captured during this study was low for all species, except deer mice, at both burned and control sites. The number of deer mice captured at burned and control sites was also low when compared with other studies. An earlier BOPA study (U.S.D.I. 1979) reported relative densities (number of animals trapped/100 trap nights) of deer mice in shadscale ranging from 4.2-23 for the years 1975-1978. In "depleted" (heavily grazed) and "healthy" stands of shadscale in south-central Idaho, Larrison and Johnson (1973) reported relative densities of deer mice to be 14 and 7.8, respectively. Relative density of deer mice in this study (Table 1) was 3.2 (animals/100 trap nights) in grazed shadscale habitat (C transects) and approximately 1.2 in cheatgrass stands (B and R transects).

Both the number of deer mice and the total number of small mammals captured were lower at burned and rehabilitated sites than at partially burned and control sites. This finding is in agreement with other studies in similar habitat. Rogers and Hedlund (1980) found fewer deer mice in a cheatgrass community compared to needle-and-thread grass (*Stipa comata*) and sagebrush/juniper (*Artemisia tridentata/Juniperus occidentalis*) communities. Gano and Rickard (1982) reported three times as many small mammals in shrub-dominated unburned areas as cheatgrass-dominated burned areas. Larrison and Johnson (1973) commented that cheatgrass stands in south-central Idaho supported only a few pocket mice and deer mice.

Counts of Townsend's ground squirrel and badger holes revealed that these two species also had lower numbers in burned (B, R, and P) sites than control sites (Table 2). A previous live-trapping study of Townsend's ground squirrels in the BOPA (Smith and Johnson 1985) concluded that densities did not differ among several different vegetation types including cheatgrass. Smith and Johnson (1985) did note, however, that densities of ground squirrels in shadscale were too low to effectively study them there. Counts of Townsend's ground squirrel hole numbers in the BOPA, conducted at the same time as our study, have indicated a decrease in squirrel holes in all habitats between 1982 and 1986 (Peterson and Yensen 1986). These decreases were even greater in burned areas than in unburned ones.

Counts of inactive holes may be a reflection of pre-fire squirrel densities. Control transects had greater numbers of inactive holes than burned transects. However, it is not known whether soil movement following fire destroys inactive holes in burned areas. Therefore, we cannot conclude that fire is the primary factor responsible for lower hole counts in burned areas.

This study suggests that wildfire in shadscale habitat reduces small mammal abundance one year after a burn. In burned areas dominated by cheatgrass, two factors may limit small mammal populations. First, the loss of shrub cover may result in increased predation of small mammals (Gano and Rickard 1982, Nydegger and Smith 1986), particularly in the BOPA where dense raptor populations exist. Second, thick stands of cheatgrass may impede small mammal movements which in turn may affect breeding success and population size (Gano and Rickard 1982). Both of these factors could be responsible for the observed decreases in abundance of deer mice and Townsend's ground squirrels, although other factors such as a change in available food resources could also be important.

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Literature Cited

Floyd, D. A., and J. E. Anderson. 1982. A new point interception frame for estimating cover of vegetation. Vegetatio 50:185-186.

Gano, K. A., and W. H. Rickard. 1982. Small mammals of a bitterbrush-cheatgrass community. Northw. Sci. 56:1-7.

Halford, D. K. 1981. Repopulation and food habits of *Peromyscus maniculatus* on a burned sagebrush desert in southeastern Idaho. Northw. Sci. 55:44-49.

Hedlund, J. D., and W. H. Rickard. 1981. Wildfire and the short-term response of small mammals inhabiting a sagebrush-bunchgrass community. Murrelet 62:10-14.

Keller, B. K., C. R. Groves, and J. S. Loven. 1983. Effects of a controlled fire on small rodent populations in a sagebrush community. *In* O. D. Markham, (ed.), Idaho National Engineering Laboratory Radioecology and Ecology Programs 1983 Progress Report. DOE/ID-12098, Natl. Tech. Infor. Serv., Springfield, Virginia. Pp. 211-219.

Kochert, M. N., and M. Pellant. 1986. Multiple use in the Snake River Birds of Prey Area. Rangelands 8:217-220.

Larrison, E. L., and D. R. Johnson. 1973. Density changes and habitat affinities of rodents of shadscale and sagebrush associations. Great Basin Nat. 33:255-264.

McGee, J. M. 1982. Small mammal populations in an unburned and early fire successional sagebrush community. J. Range. Manage. 35:177-180.

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Nydegger, N. C., and G. W. Smith. 1986. Prey populations in relation to *Artemisia* vegetation types in southwestern Idaho. *In* E. D. McArthur and B. L. Welch, (eds.), Proceedings—symposium on the biology of *Artemisia* and *Chrysothamnus*. U.S.D.A. Forest Service Gen. Tech. Rep. INT-200. Ogden, Utah. Pp. 152-156.

Peterson, K., and E. Yensen. 1986. Comparison of 1982 and 1986 Townsend's ground squirrel burrow entrance transects in the Snake River Birds of Prey Area, Southwestern Idaho. *In* K. Steenhof and M. N. Kochert (eds.), Snake River Birds of Prey Research Project Annual Report, 1986. U.S. Dept. Interior, Bureau of Land Manage., Boise, Idaho. Pp. 152-168.

Ream, C. H. 1981. The effects of fire and other disturbances on small mammals and their predators: an annotated bibliography. U.S.D.A. Forest Service Gen. Tech. Rep. INT-106. Ogden, Utah. Pp. 57.

Rogers, L. E., and J. D. Hedlund. 1980. A comparison of small mammal populations occupying three distinct shrub-steppe communities in eastern Oregon. Northw. Sci. 54:183-186.

Smith, G. W., and D. R. Johnson. 1985. Demography of a Townsend ground squirrel population in southwestern Idaho. Ecology 66:171-178.

U.S.D.I. 1979. Snake River birds of prey special research report. Bureau of Land Management, Boise, Idaho. Pp. 142.