Habitat Distribution of Small Mammal Communities in Grand Teton National Park

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✦ Objectives

Since Grand Teton National Park adopted a natural fire policy in the early 1970's, four major fires have burned within the park which created a chronosequence of post-burn successional ecosystems. The burns encompassed forests varying in composition from Englemann spruce *(Picea englemanii)* /subalpine fir *(Abies lasiocarpa)* /lodgepole pine *(Pinus contorta)* (Beaver Creek, Mystic Isle) to Englemann spruce / subalpine fir (Waterfalls Canyon) to primarily lodgepole pine (Huckleberry Mountain).

The purpose of this study was to survey small mammal communities in this burn chronosequence and to relate trapping success for each rodent species to microhabitat parameters. Specifically we hypothesized

1. that habitat use and distribution of small mammals cannot be predicted by burn chronosequence *per se*, and
2. that microhabitat features at each individual trapping station such as canopy cover, tree and sapling density, coarse woody debris and herbaceous/woody ground cover are most closely correlated with trap success.

This report describes our trapping efforts for the 1990 field season. It presents a preliminary analysis of small mammal population trends and habitat descriptors of successional states of burned areas and adjacent unburned forests. We provide preliminary data that support Hypothesis 1 above. Microhabitat data to test Hypothesis 2 are being analyzed (principal component or discriminant analysis).

✦ Methods

Study Sites

During summer 1990, 1-ha trapping grids were established on five burned sites and adjacent unburned forests. Waterfalls Canyon (4354N-11043W UTM) burned in 1974, Mystic Isle (4349N-11041W UTM) in 1981, Beaver Creek (4230N-11044W UTM) in 1985, and Huckleberry Mountain (4403N-11041W UTM) in 1988. In the latter burn, two sites were established—one on an east-facing aspect and one west-facing—on opposite sides of John D. Rockefeller Jr. Memorial Parkway. Each of the 10 grids was trapped once a month from June through August. The trapping dates, the number of trap nights per site and the abbreviations for the sites are presented in Table 1.

Each of the 10 sites was surveyed in June and the corners of the plots were permanently marked with metal fence posts. Within these plots, 100 trapping stations (10 m apart) were temporarily marked with wire stakes.

Small Mammals

During each trapping bout (3-5 days) Sherman live traps were placed at each station. All were baited with rolled oats and peanut butter in late afternoon and checked early the following morning. Polyfil was used for bedding. Captured animals were ear-tagged with unique metal fingerling tags and classified by species, sex, age class, reproductive condition and then released. Finally, fecal samples were collected from the traps for fungal spore and parasite analysis. At each corner of the grid, weasel traps were set and baited with fresh liver.

To capture shrews and ground dwelling arthropods, pitfall traps (106 cm^3) were installed at every fourth station and partially filled with propylene glycol. These traps were open continuously for 3 days.

For preliminary analysis, rodent population densities by species were calculated by Schnabel's Method (1938). The Shannon-Wiener Diversity Index ($H'=-\Sigma p_i \log p_i$ where p_i is the proportion of individuals of the ith species) was calculated per grid for all animals trapped. Nomenclature for mammal species is from Jones et al. (1986).

Microhabitat Measurements

At randomly selected stations within each grid, microhabitat measurements were taken. Half of the measurements were made at successful stations (at least one rodent captured) and half were made at unsuccessful stations and the total number of points sampled/grid ranged from 14 to 20. The point-quarter distance method (Cottam and Curtis 1967) was used at each station for trees, saplings (d < 10 cm dbh), logs, shrubs and stumps. In addition, percent canopy closure, woodiness of the adjacent vegetation and percent ground cover were measured at each point as described by Dueser and Shugart (1978). These data will be subsequently used to associate trap failure or success with these habitat characteristics.

✦ Results

Small Mammals

Over the 10,100 trap nights, seven small mammal species were trapped in a total of 1170 captures. But only the deer mouse *(Peromyscus maniculatus)* and the southern red-backed vole *(Clethrionomys gapperi)* were abundant enough to estimate population size (Table 2). Densities across sites for the deer mouse ranged from 0 (HWC) to a high of 45/ha (BCB in August). Densities of the southern red-backed vole ranged from 0 (most of the burns) to a high of 56/ha (HEC in August). The least chipmunk *(Tamius minimus)* was occasionally trapped at all sites (Table 2). The mountain vole *(Microtus montanus)* and the long-tailed vole *(Microtus longicaudus)* were trapped in a small area of BCB and only incidentally at a few other sites. Only two woodland jumping mice *(Zapus princeps)* were trapped (MIC and HWC). The masked shrew *(Sorex cinereus)* was found in low numbers at all sites and typically in more mesic microhabitats.

For all species combined, the highest densities occurred in three controls: 42/ha at BCC, 39/ha at WFC and 38/ha at WCC. Of the burns, BCB had the highest density of 33/ha. The lowest densities were found at MIC (17/ha), MIB (22/ha) and HWB (18/ha). Thus, although the controls tended to support higher densities, the difference between the burns and control was not significant (Mann-Whitney U).

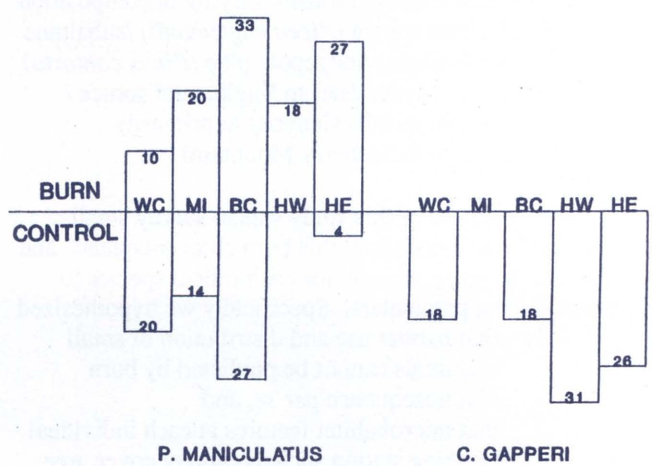

Fig. 1. Population densities of Peromyscus maniculatus *and* Clethrionomys gapperi *in burns and controls.*

Table 1. The trapping dates (and number of trap nights) for 10 sites in and around Grand Teton National Park during summer, 1990.

Sites	Dates June	July	August	Total Days trapped (Trap Nights)
Waterfalls Canyon*	6/28-30	7/24-26	8/21-23	9
Burn(WCB)	(150)	(150)	(150)	(450)
Control (WCC)	(150)	(150)	(150)	(450)
Mystic Isle	6/20-22	7/17-20	8/07-10	11
Burn (MIB)	(300)	(400)	(400)	(1100)
Control (MIC)	(300)	(400)	(400)	(1100)
Beaver Creek	6/14-16	7/03-06	7/31-8/03	12
Burn (BCB)	(300)	(400)	(400)	(1100)
Control (BCC)	(300)	(400)	(400)	(1100)
Huck, West-facing	6/05-08	7/10-13	8/13-16	12
Burn (HWB)	(400)	(400)	(400)	(1200)
Control (HWC)	(400)	(400)	(400)	(1200)
Huck, East-facing	6/05-08	7/10-13	8/13-16	12
Burn (HEB)	(400)	(400)	(400)	(1200)
Control (HEC)	(400)	(400)	(400)	(1200)
Total days				55
Total Trap Nights	(3100)	(3500)	(3500)	(10100)

*These sites at Waterfalls Canyon were established on the grids used by Barmore et al. (1976).

To contrast burn and control communities, densities were averaged over the three trapping sessions (Fig. 1). The deer mouse was the most ubiquitous species and was trapped in both burns and controls at all sites except HWC. At the older burns, it was equally abundant in both burns and controls. At the most recent burns, it was trapped almost entirely within the burns with only incidental occurrences in the control. In contrast, the red-backed vole was almost entirely restricted to unburned forests at four sites and it was never trapped at MI (Fig. 1).

The least chipmunk was captured at all burn sites and in three of the controls and, although numbers were too low at most sites for population estimates, the number of captures (Table 1) suggests that the burns supported higher densities than the unburned forest (if the probability of capture is assumed to be the same in both controls and burns). Shrews were captured almost entirely within the unburned forest. No weasels were trapped.

The number of captures/month was used to calculate the Shannon-Wiener Diversity Index: H' was consistently higher for all months on the controls and the average H' for both burn and control sites increased from June through August (Table 3). At each site, captures on the burn and control were combined and diversity calculated for populations at this "landscape" unit to test the hypothesis that fire increases the overall

Table 2. Population estimates/ha (Schnabel 1938) by species *(Peromyscus maniculatus, Clethrionomys gapperi, Tamias minimus)* for June, July, and August for burn and control in each of the five trapping sites. See Table 1 for site designations.

	June	July	August
		P. maniculatus	
WCB	4(5)	5(9)	21(13)
WCC	14(19)	24(10)	22(15)
MIB	31(23)	8(23)	20(52)
MIC	17(25)	14(23)	10(17)
BCB	22(19)	32(54)	45(87)
BCC	20(30)	32(53)	30(57)
HWB	3(13)	11(19)	39(76)
HWC	*(0)	*(0)	*(4)
HEB	16(31)	23(44)	43(59)
HEC	*(5)	*(3)	13(14)
TOTAL	(170)	(238)	(394)
		C. gapperi	
WCB	*(0)	*(0)	*(1)
WCC	2(4)	10(9)	32(15)
MIB	*(0)	*(0)	*(0)
MIC	*(0)	*(0)	*(0)
BCB	*(0)	*(0)	*(0)
BCC	*(2)	20(17)	15(28)
HWB	*(0)	*(0)	*(4)
HWC	*(3)	22(16)	39(38)
HEB	*(0)	*(3)	*(4)
HEC	9(6)	14(18)	56(72)
TOTAL	(15)	(63)	(162)
		T. minimus	
WCB	*(1)	*(3)	*(7)
WCC	*(0)	*(0)	*(0)
MIB	*(0)	*(0)	6(10)
MIC	*(0)	*(0)	10(20)
BCB	*(0)	11(8)	*(2)
BCC	*(0)	*(1)	*(0)
HWB	*(5)	*(3)	*(11)
HWC	*(1)	*(0)	*(6)
HEB	*(8)	*(2)	*(2)
HEC	*(0)	*(0)	*(0)
TOTAL	(15)	(17)	(58)

*Numbers not sufficient to calculate population estimates. (Total captures).

increases the overall diversity of the community. If H' for the landscape unit is consistently higher than the H' for the controls, the hypothesis is supported. For 2/3 of the site-months, diversity was higher at the landscape level. Thus the trend is suggestive but inconclusive. Finally, no pattern of increasing diversity was found with the age of the burn.

Study Sites: Successional Status

To ascertain how similar the control sites are now and how similar the burns and controls were before the fire, the Point-Quarter Distance Method was used to measure tree and sapling density at randomly selected trapping points on each site. Furthermore, points sampled were separated out by whether they were "successful"—a least one rodent trapped at that point— or "unsuccessful"—no rodents trapped. Importance values (relative density + relative basal area + relative frequency) for canopy trees were calculated for the controls and burns at each site. WCC is primarily an Englemann spruce/subalpine fir forest with few lodgepole pine. In the WCB, lodgepole pine clearly had been the more prevalent pre-burn canopy species and this site may have been in an earlier successional stage when burned, than the site we used as a control. However, because of the age and severity of the burn most of the snags were not identifiable to species.

Similar results were found at MI: lodgepole pine has a higher (IV) in the control than in the burn, indicating a younger successional stage. At BC, the IV for Englemann spruce and subalpine fir are slightly higher in the control. At HW, the control is dominated by lodgepole pine. Lodgepole pine had also dominated the burned stand but it had slightly more fir than in the control.

In summary, the trees were so severely burned at WC that it is impossible to determine if the species composition of the burn and control were similar. At MI, BC and HW, the IV of the overstory species indicate that pre-burn stands were quite similar to the control stands we selected. At HE, the IV of lodgepole pine on the burned sites had been double that of the control.

For WCB, MIB and BCB, the saplings represent post-fire new growth. At HWB and HEB, the 1988 burns, the saplings represent the pre-fire understory. In all five of the control sites, subalpine fir is the

Table 3. Shannon-Wiener Diversity Index (H') in burn and control sites by month, the total diversity of all months combined, landscape diversity/month (burn and control combined) and the diversity averaged over sites in burns and controls.

	June		July		August		Site Average		Landscape Burn & Control		
	B	C	B	C	B	C	B	C	June	July	Aug
WC	.196	.201	.439	.477	.415	.473	.350	.384	.237	.533	.551
MI	0	0	0	.121	.331	.345	.110	.155	0	.075	.383
BC	0	.102	.369	.441	.230	.409	.200	.317	.072	.462	.396
HW	.333	.555	.243	.331	.259	.364	.278	.417	.568	.589	.451
HE	.220	.449	.173	.250	.159	.236	.184	.312	.434	.345	.354
AVE.	.150	.261	.245	.324	.279	.365	.225	.307	.262	.401	.427

dominant understory species. In the burns, WCB has the most diverse understory consisting of Englemann spruce, subalpine fir and lodgepole pine. At MIB and BCB, subalpine fir had been the dominant with a small percentage of lodgepole pine present. The Huck fires burned most of the saplings beyond recognition; but the only ones identifiable were subalpine fir. In the Huck controls, subalpine fir dominates the understory with a smattering of lodgepole pine.

The number of successful trap sites did not appear to be related to IV of any of the canopy species. At three sites, WCC, MIB, BCB traps were more successful where sapling density was higher. No trends were apparent at the other locations. We also examined trap success as a function of the individual components of IV for canopy species (density, basal area, and frequency), and no relationships were apparent on a cursory analysis.

✦ Discussion

Habitat use and distribution of small mammal species (community composition) cannot be predicted by burn chronosequence alone. The only trend related to the age of the burn that may prove significant after further analysis was higher deer mice densities in the more recent burns of 1985 and 1988. Interestingly, Mystic Isle is the only forest site where no southern red-backed voles were trapped. This anomaly may be due to the location of this forest on a peninsula in Jackson Lake. The fire swept through a large section of the peninsula and only a small corridor of intact forest remains connecting the intact forest with the "mainland". The absence of voles may be a function of local extinction and restricted routes for colonization.

Few studies have documented post-fire mammal response in coniferous forests. Our results showing highest diversity in unburned forest contrast with Taylor's (1973). Taylor (1973) trapped small mammals in a burn chronosequence (1-300 years since burning) in Yellowstone National Park and he reported highest species richness in burns of 13 and 25 years old (5 and 9 species respectively).

In a mixed hardwood/coniferous forest in Minnesota, Krefting and Ahlgren (1974) reported that deer mice were dominant in the first seven years following a burn and decreased during the 7-13 year post burn period. Southern red-backed voles increased during this latter period, but were still less abundant than in unburned forests. Chipmunks *(Tamias striatus)* were more abundant in burned areas over the entire 13 year post-burn period. Unlike our findings, deer mice were relatively rare in unburned forest.

Sullivan (1980) found larger deer mice populations than Oregon voles *(Microtus oregoni)* in burned and a slash cut area. Sims and Buckner (1973) snap trapped small mammals in slashed and burned forests of Manitoba and found that Southern red-backed voles were absent from these disturbed sites while deer mice were abundant. The reverse was true on the control sites.

In Yellowstone National Park, Wood (1981) snap trapped small mammals in 1978 and 1979 on a spruce/fir/lodgepole pine site that burned in 1974 and one that burned in 1976. Southern red-backed voles were the most abundant mammal trapped but densities were highest in unburned forest and in the older burn. Over two years of trapping, only 43 deer mice were caught in the burns versus 123 southern red-backed voles. In the adjacent unburned forests, six deer mice were caught versus 335 southern red-backed voles.

In 1975, Barmore et al. (1976) trapped at Waterfalls Canyon on a site that had burned in 1974. In August, they estimated deer mice densities at 38/ha and southern red-backed vole densities at 20/ha. We retrapped this exact site in 1990 and deer mice density was 21/ha, but only one southern red-backed vole was trapped. Because the 1974 fire created a mosaic of burned and unburned understory (Barmore et al. 1976), it is possible that some voles survived the burn and the population gradually declined in the fire-modified habitat.

In Barmore's unburned spruce/fir sites no deer mice were captured and southern red-backed vole density was 64/ha, much higher than our 1990 estimate of 22/ha and 32/ha respectively.

Based upon our 1990 data, deer mice are not restricted to more open habitat as has been reported in other studies. In three of our forests, deer mice and southern red-backed voles coexisted at high densities. Wood (1981) experimentally removed southern red-backed voles from two plots in Yellowstone National Park to assess if interspecific competition might be structuring the observed habitat separation between the two species. At retrapping no differences were found between controls and experimental plots in the ratio of southern red-back voles to mice and, therefore, no evidence for competition emerged.

We suggest that small mammal community structure is not a function of post-fire successional state *per se* but, rather, microhabitat features that are closely related to shelter and preferred food resources. Diet studies have shown that southern red-backed voles consume hypogeous fungi, lichen and conifer seeds (Ure and Maser 1982), and epigeous fungi (Miller et al, in prep) which are most abundant in mature forests. Deer mice are more eurytrophic in their food habits and can tolerate more xeric conditions (Holbrook 1978). Williams (1959) reported that the diet of deer mice in Jackson Hole was composed primarily of coniferous seeds and insects, but the proportion of each type was dependent upon habitat. Van Horne (1982) also found that fruits, seeds and arthropods were the major food sources for deer mice in Alaska. For deer mice in shortgrass prairie, arthropods constituted 99% of their summer diet. Holbrook (1978) concluded that *Peromyscus* sp. are opportunistic foragers, but prefer arthropods (when available) because of their high protein content (Van Horne 1982). Therefore based upon differences in diet and limited experimental evidence, exploitation competition is probably minimal between deer mice and red-backed voles.

Most evidence suggests that microhabitat selection is the force structuring small mammal communities and intraspecific competition is more important than interspecific competition in defining habitat use (Alder 1985). In montane habitats in Utah, deer mice were associated with high densities of fallen logs and high brush cover. Southern red-backed voles were found in areas of dense canopy, fallen logs and woody cover (Belk et al 1988). Our multivariate analysis should reveal if similar preferences exist in the Grand Teton Park populations.

✦ CONCLUSION

In summary, the southern red-backed vole was the only indicator species of mature forest. The deer mouse was found in both burned and unburned forest, chipmunks were more frequently trapped in the burns. No patterns of small mammal density and diversity could be associated with the burn chronosequence, although diversity was consistently higher in unburned forest. At the landscape level (burn + control), diversity tended to be higher when burns were included.

✦ LITERATURE CITED

Adler, G. H. 1985. Habitat selection and species interactions: an experimental analysis with small mammal populations. Oikos 45:380-390.

Belk, M. C., H. D. Smith, and J. Lawson. 1988. Use and partitioning of montane habitat by small mammals. J. Mamm. 69:688-695.

Barmore, W. J., D. Taylor, and P. Hayden. 1976. Ecological effects and biotic succession following the 1974 Waterfalls Canyon fire in Grand Teton National Park. Unpublished research project report, Grand Teton National Park, Wyoming. 99 pp.

Cottam, G., and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451-460.

Dueser, R. D. and H. H. Shugart, Jr. 1978. Microhabitats in a forest-floor small-mammal fauna. Ecology 59:89-98.

Holbrook, S. J. 1978. Habitat relationships and coexistence of four sympatric species of *Peromyscus* in northwestern New Mexico. J. Mamm. 59:18-26.

Jones, J. K. Jr., D. C. Carter, H. H. Genoways, R. S. Hoffman, E. W. Rice, and C. Jones. 1986. Revised checklist of North American mammals north of Mexico. Occasional Papers, The Museum, Texas Tech University, Lubbock, Texas.

Krefting, L. W., and C. E. Ahlgren. 1974. Small mammals and vegetation changes after fire in a mixed conifer-hardwood forest. Ecology 55:1391-1398.

Schnabel, Z. E. 1938. The estimation of the total fish population of a lake. Amer. Math. Mthly 45:348-352.

Sims, H. P., and C. H. Buckner. 1973. The effect of clear cutting and burning of *Pinus banksiana* forests on the populations of small mammals in southeastern Manitoba. Amer. Midl. Nat. 90:228-231.

Sullivan, T. P. 1980. Comparative demography of *Peromyscus maniculatus* and *Microtus oregoni* populations after logging and burning of coastal forest habitats. Can. J. Zool. 58:2252-2259.

Taylor, D. L. 1973. Some ecological implications of forest fire control in Yellowstone National Park, Wyoming. Ecology 54:1394-1396.

Ure, D. C., and C. Maser. 1982. Mycophagy in red-backed voles in Oregon and Washington. Can. J. Zool. 60:3307-3315.

Van Horne, B. 1982. Niches of adult and juvenile deer mice *(Peromyscus maniculatus)* in seral stages of coniferous forest. Ecology 63:992-1003.

Williams, O. 1959. Food habits of the deer mouse. J. Mamm. 40:415-419.

Wood, M. A. 1981. Small mammal communities after two recent fires in Yellowstone National Park. Unpublished Master's Thesis, Montana State University, Bozeman, Montana.