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The effects on small mammal abundance after a wildfire in the Warner Mountains

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THE EFFECTS ON SMALL MAMMAL ABUNDANCE AFTER A WILDFIRE IN THE WARNER MOUNTAINS

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THE EFFECTS ON SMALL MAMMAL ABUNDANCE
AFTER A WILDFIRE IN THE WARNER MOUNTAINS

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ABSTRACT

THE EFFECTS ON SMALL MAMMAL ABUNDANCE AFTER A WILDFIRE IN THE WARNER MOUNTAINS

by Jesse Rose West

From June to August, 2001, a large fire, known as the Blue Fire, burned 34,425 acres in the Warner Mountains (USDA 2003), Modoc National Forest, Modoc County, California. The Blue Fire caused a major disturbance to the structure of the native flora and fauna (USDA 2003). Patterns of both mammalian and vegetation succession after a fire have been of particular interest to biologists for many years. The aim of this study was to address whether small mammal abundance is different in heavily burned areas versus lightly burned areas within the Warner Mountain Range three years after a fire. During the summer of 2004 rodents were trapped in three different sites, each made up of a heavily burned quadrat and a lightly burned quadrat, which spanned a section of the Blue Fire. Results showed that the abundance of deer mice is not significantly different in the heavily burned areas versus the lightly burned areas where severity of burn is defined by difference in tree canopy only. Deer mice appear to be good invaders of newly modified habitat regardless of the amount of change.

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INTRODUCTION

In the Warner Mountains, Modoc National Forest, Modoc County, California, a large fire, known as the Blue Fire, burned 34,425 acres (USDA 2003). The Blue Fire took place from June to August, 2001. The disturbance of the fire caused the structure of the native flora and fauna to change (USDA 2003). Small mammals interact with the flora and fauna across multiple trophic levels and are an important segment of forest ecosystems (Coppeto et al. 2006; Krefting and Ahlgren 1974). They serve as dispersers of seeds, consumers of plant material and parasitic organisms, and as prey for other mammalian and avian predators (Coppeto et al. 2006). Understanding the reaction of small mammals to changes in the forest ecosystem can help us understand the various aspects of succession, such as small mammal responses to habitat changes (Krefting and Ahlgren 1974). The Blue Fire region offers a natural experiment in small mammal ecology and succession, such as small mammal community structure in response to forest fires.

Biologists have had particular interest in patterns of both mammalian and vegetation succession after a fire. The effects of fire on the reconstitution of vegetation have been the topic of several studies (Bock and Bock 1978; Bock et al. 1978; Horton and Kraebel 1955; Krefting and Ahlgren 1974; M'Closkey 1975). The effects of fire on mammalian succession in fire-damaged grassland, brush land, chaparral, and forest habitats have also been the topic of several studies. Cook (1959) studied mammalian succession in fire-damaged grassland in Northern California. McGee (1976 and 1982) studied mammalian succession in fire-damaged brush land in Wyoming. Chew et al.

(1959), and Lawrence (1966) studied mammalian succession in fire-damaged chaparral in Southern California. Converse et al. (2006), Halvorson (1982), Krefting and Ahlgren (1974), Stout et al. (1971), and Sullivan et al. (1999) studied mammalian succession in fire-damaged forests throughout the Western United States. A common theme found in the studies above is that the fires did not drastically alter the diversity of small mammals but did alter the relative abundance of small mammals. Furthermore, similar patterns of small mammals re-invading areas disturbed by fire were evident in all four habitats. In North America, species of *Peromyscus* (deer mice) were the first small mammals to re-invade the area in all four habitat types, grassland, brush land, chaparral, and forests.

Habitat structure and various microhabitat variables can also affect small mammal diversity and abundance. The amount of grass, shrub, rock, and bare ground cover are some microhabitat variables which may play important roles in determining small mammal diversity and abundance (Coppeto et al. 2006; Dueser and Shugart 1978). Because ground vegetation in the Warner Mountains recovered substantially between 2001 and 2003 after the Blue Fire (USDA 2003), microhabitat variables associated with the ground vegetation may affect small mammals after a burn by altering there relative populations and species diversity.

Several documented studies were conducted immediately after a fire (Beck and Vogl 1972; Chew et al. 1959; Cook 1959; Howard et al. 1959; Komarek 1969; Krefting and Ahlgren 1974; Lawrence 1966; McGee 1976 and 1982; Mills 1986; Rice 1932; Tester 1965) and insufficient time had passed for significant vegetative and small mammal community succession to occur. The research cited above compared burned areas to unburned areas and concluded that the number of mammals trapped in unburned habitats was significantly smaller than the number of mammals trapped in burned habitats immediately after a fire. More specifically they found that members of the genus *Peromyscus* were the dominant species and found higher densities in burned areas than in the unburned areas. This might indicate that members of the genus *Peromyscus* are good invaders to new habitats.

Beck and Vogl (1972) and Sullivan et al. (1999) conducted studies on unburned areas and controlled burned areas. These studies concluded that there was no significant difference in diversity between the unburned areas and the controlled burned areas but they did find an increase in deer mice abundance. McGee (1982) studied unburned areas and compared her findings after a natural fire burned the areas she was studying. McGee (1982) concluded that the species composition did not change significantly but deer mice did increase in abundance.

The purpose of this study was to investigate the effects of heavily burned and lightly burned areas on small mammal community composition three years after a fire. The area was not studied previous to the fire and the fire was not a controlled burn so there is no comparative information. Based upon information available in the literature described above, the hypothesis tested in this study was that while small mammal diversity will remain relatively stable, the abundance of deer mice will be greater in heavily burned areas versus lightly burned areas.

MATERIALS AND METHODS

Study Area. - The Warner Mountains are located in northeastern California (Fig. 1) on the volcanic Modoc Plateau. They represent the western-most range in the Basin and Range Province of the Great Basin (Schoenherr 1992). The Warner Mountains range in elevation from a low of approximately 1433 meters (Russell 1928) to a high of approximately 2963 meters (Schoenherr 1992). Surprise Valley lies to the east of the Warner Mountains with the Pitt River Valley to the west of the mountains.

The plant community structure is greatly impacted by the surrounding Modoc Plateau (Hickman 1993). Lower elevations on the Modoc Plateau consist of Juniper Savanna and Sagebrush Steppe dominated by Western Juniper (*Juniper occidentalis*) and (*Artemisia tridentata*), respectively, as the dominants. As elevation increases, the plant communities change to a mixed conifer series, with Jeffrey Pine (*Pinus jeffreyi*), Ponderosa Pine (*Pinus ponderosa*), and White Fir (*Abies concolor*) as the dominants (Sawyer and Keeler-Wolf 1995). At the highest elevations in the Warner Mountains the plant community consists of Ponderosa Pine, White Fir, and Lodgepole Pine (*Pinus contorta*) as the dominants.

The Warner Mountain range has a Mediterranean highland climate (Holland and Keil 1995). It is part of California Zone 1 defined by the extremely frigid winters reaching temperatures below freezing, which may occur throughout the entire year, and the extremely brief growing season lasting on average only 100 growing days a year (Hickman and Roberts 1993).

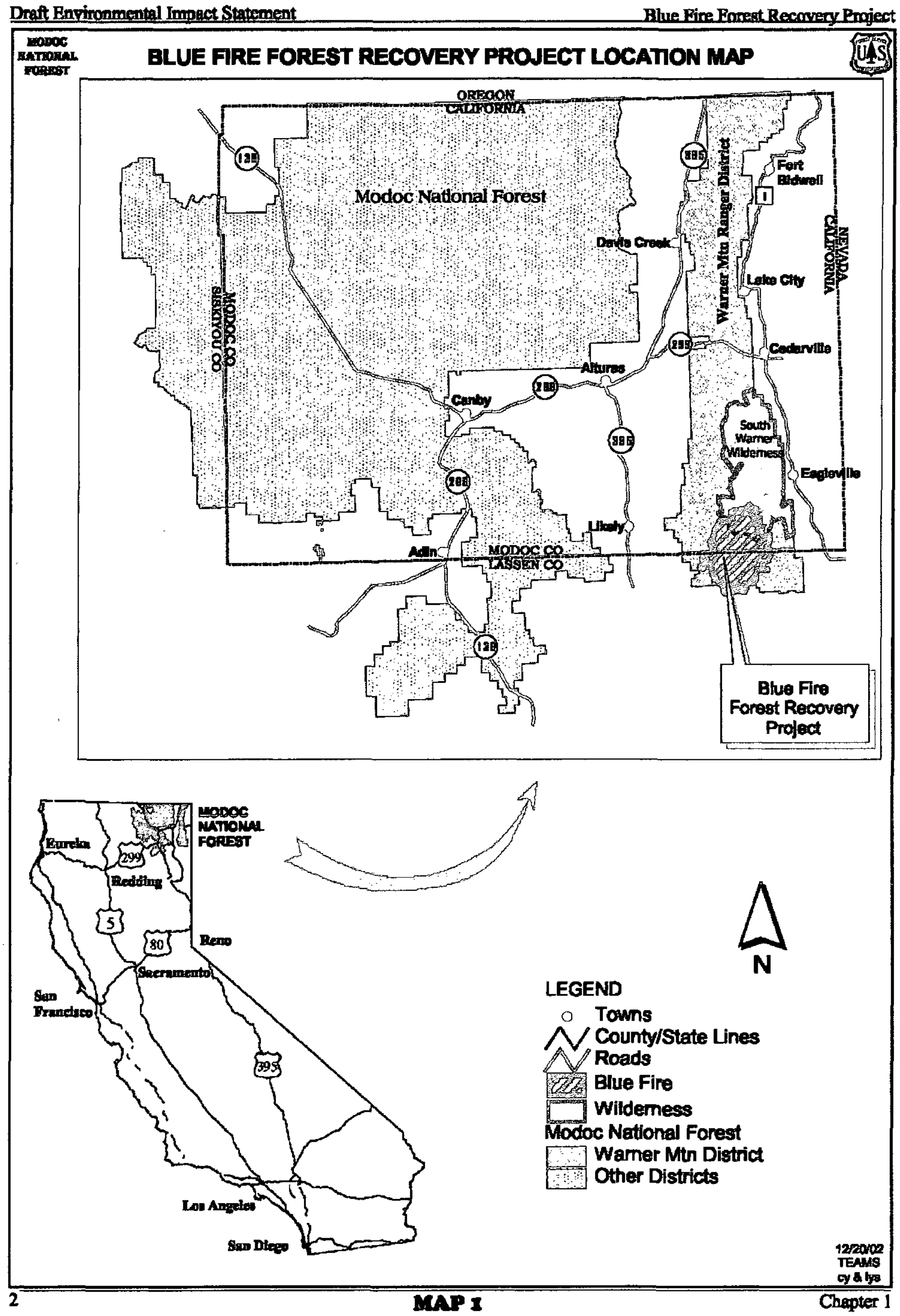

Fig. 1. – Map of the Warner Mountains of Modoc County, California (Map Source: United States Department of Agriculture, Final Environmental Impact Statement, Blue Fire Forest Recovery Project, 2003).

Study Sites. - Three study sites were selected within the Blue Fire area of the southern section of the Warner Mountains of Modoc County, California (Table 1 and Fig. 2). Each site consisted of two sample quadrats. "Quadrat A" at each site was defined as heavily burned, mixed conifer forest. "Quadrat B" at each site was defined as lightly burned, mixed conifer forest. In this study the mixed conifer forest consisted of Ponderosa Pine (*Pinus ponderosa*) and White Fir (*Abies concolor*) as dominants. This community was selected because it is the most prominent community in the fire zone (Mary Flores, personal communication).

Table 1. – GPS coordinates taken at each corner of the 57,600 m^2 quadrats for all six quadrats and the elevation at the center of each quadrat.

	Elevation	NW Corner	NE Corner	SW Corner	SE Corner
Site 1 Light Burn	6450'	N 41° 09.506 W 120° 16.123	N 41° 09.541 W 120° 16.016	N 41° 09.376 W 120° 16.121	N 41° 09.406 W 120° 15.962
Heavy Burn	6400'	N 41° 09.526 W 120° 16.264	N 41° 09.601 W 120° 16.116	N 41° 09.506 W 120° 16.123	N 41° 09.541 W 120° 16.016
Site 2 Light Burn	6800'	N 41° 08.859 W 120° 15.005	N 41° 08.852 W 120° 14.868	N 41° 08.759 W 120° 15.049	N 41° 08.782 W 120° 14.918
Heavy Burn	6850'	N 41° 08.851 W 120° 15.279	N 41° 08.897 W 120° 15.184	N 41° 08.762 W 120° 15.193	N 41° 08.851 W 120° 15.071
Site 3 Light Burn	7000'	N 41° 10.784 W 120° 16.114	N 41° 10.784 W 120° 16.042	N 41° 10.697 W 120° 16.242	N 41° 10.652 W 120° 16.042
Heavy Burn	6950'	N 41° 10.716 W 120° 16.254	N 41° 10.666 W 120° 16.133	N 41° 10.612 W 120° 16.324	N 41° 10.573 W 120° 16.203

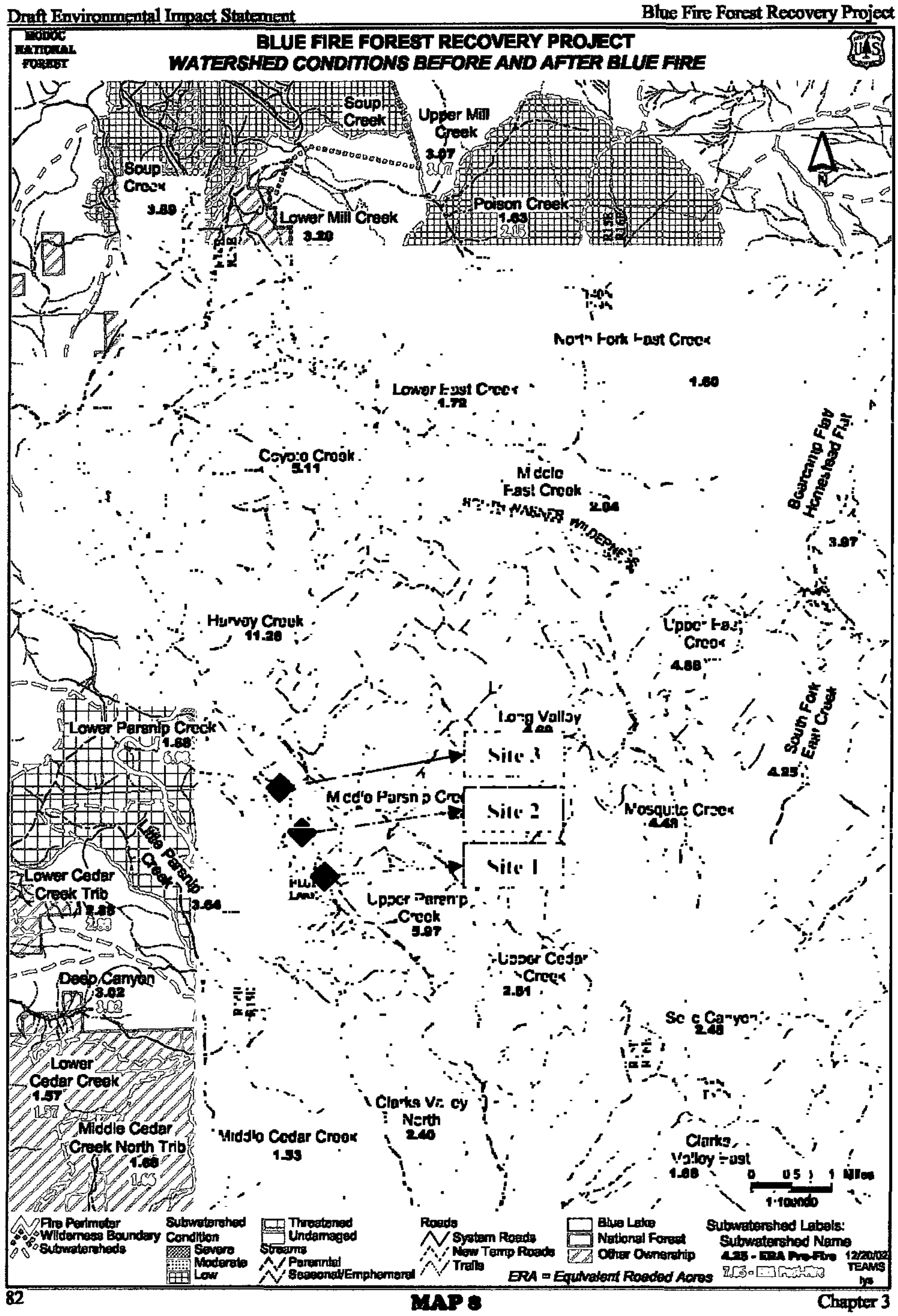

Fig. 2. – Map of the Warner Mountain Blue Fire area with the three trap-sites marked. All trap-sites (Sites 1, 2 and 3) contained both heavily burned mixed conifer forest and lightly burned mixed conifer forest (Map Source: United States Department of Agriculture, Final Environmental Impact Statement, Blue Fire Forest Recovery Project,2003).

The working definition of heavily burned, mixed conifer forest was determined by visual inspection and the use of a densiometer:

- Seventy percent or more of the trees were scorched by fire at a height two meters above the base of the tree.
- Within the 70 percent of the scorched trees all needles had either fallen or were dead.
- Thirty percent or less of the trees could exhibit any condition including completely untouched by fire.
- Seventy percent or more of the ground was covered in ash.
- Thirty percent or less tree cover was visible in the densiometer.

The working definition of lightly burned, mixed conifer forest was also determined by visual inspection and the use of a densiometer:

- Seventy percent or more of the trees were completely untouched by fire and or burned only at the base of the tree to a height of no more than two meters.
- Within the 70 percent of the untouched trees all needles remained intact and untouched by fire.
- Thirty percent or less of the trees could exhibit any condition including heavily scorched.
- Thirty percent or less of the ground was covered in ash.
- Seventy percent or more tree cover was visible in the densiometer.

Site 1 was located south of National Forest Service (NFS) Route 64, 1.9 kilometers northeast of Blue Lake Campground. The lightly burned quadrat was on a northeast-facing slope, whereas the heavily burned quadrat was on a north-facing slope (Figs. 3 and 4).

Fig. 3. – Site 1 Quadrat A Heavily Burned

Fig. 4. – Site 1 Quadrat B Lightly Burned

Site 2 was located near Parsnip Springs NFS Route 38N27, 2.2 kilometers northeast of Blue Lake Campground. The lightly burned quadrat was on the east side of the road on a west-facing slope, whereas the heavily burned quadrat was on the west side of the road on a southeast-facing slope (Figs. 5 and 6).

Fig. 5. – Site 2 Quadrat A Heavily Burned

Fig. 6. – Site 2 Quadrat B Lightly Burned

Site 3 was located on Mahogany Ridge west of the NFS Route 39N90, 5.2 kilometers northeast of Blue Lake Campground. The lightly burned quadrat was on a northwest-facing slope, whereas the heavily burned quadrat was on a west-facing slope (Figs. 7 and 8).

Fig. 7. – Site 3 Quadrat A Heavily Burned

Fig. 8. – Site 3 Quadrat B Lightly Burned

All three sites were selected using the following criteria:

- Each site contained a minimum 57,600 m^2 quadrat of both lightly burned habitat and heavily burned habitat. A 240-meter by 240-meter quadrat was defined by a grid of 25 by 25-possible trap lines set 10-meters apart. This would include sufficient area to sample both vegetation and small mammal populations.
- Each site must have a mixed conifer habitat predominantly composed of Ponderosa Pine (*Pinus ponderosa*) and White Fir (*Abies concorta*). This community was selected because it is the most prominent community in the fire zone.

Slope aspect was not considered because the selection criteria and the area of the fire limited the site choices available. Therefore the three sites and the quadrats within a site have different slope aspects. These restrictions preclude random selection and there is no attempt to make generalizations beyond the areas studied.

Each quadrat was a 240 m by 240 m square (57,600 m^2). The quadrats were used for small mammal trapping and vegetation analysis. Global Positioning System (GPS) coordinates were taken with a Garmin Etrex 12 Channel GPS at each corner of the 57,600 m^2 quadrat (Table 1).

Small Mammal Sampling. - Sampling of small mammals took place during the summer of 2004. The United States Department of Agriculture (USDA 2003) initiated logging in burned areas to reduce accumulation of combustible material and to lower fire risk. Therefore, the order (i.e. the dates from May through August) of sampling at the three sites was dependent on the expected date for logging to occur within the burned portion of each site.

The 240-meter by 240-meter quadrat was defined by a grid of 25 by 25-possible trap lines set 10-meters apart. Each line in a north-south or east-west direction was given a number (1-25). The shape of the burned areas governed the orientation of each quadrat. Sampling of small mammals on each quadrat (both heavily and lightly burned at each site) was accomplished by randomly selecting six of the possible 25 trap lines.

Each trap line consisted of 25 Sherman live-traps set at 10-meter intervals. Traps were baited with walnuts and oatmeal. Polyester fiber was placed in each trap to provide insulation and bedding. The traps were opened and baited at 1800 hours and checked, emptied, and closed at 0800 hours. Trap lines were run for three consecutive nights. Thus, for each quadrat a total of 450 trap nights was recorded.

Each morning traps were checked and the following data recorded: species, sex, mass, and on the second and third day if it was a recapture. Each individual was ear punched to identify recaptures. An ear punch was taken from the right pinna on the first day. If an animal was recaptured on the second day the left pinna was ear-punched. An individual with no ear punch was reported as a single capture. Individuals with a hole in the right pinna were recorded as a recapture. Individuals with holes in both the right and left pinnae were recorded as a double recapture.

Voucher specimens were kept and prepared as museum study or alcohol specimens. The specimens are deposited in the Bird and Mammal Museum at San Jose State University and the Museum of Vertebrate Zoology at the University of California at Berkeley. The California Department of Fish and Game (CDFG) issued the collection permit (CDFG Permit #803034-05). The San Jose State University Institutional Animal Care and Use Committee approved this study (Protocol #793) following the guidelines of the American Society of Mammalogists (Animal Care and Use Committee 1998).

Habitat Sampling. - Habitat characteristics in each quadrat were recorded along three of the six trap-lines (1^{st}, 3^{rd}, and 6^{th} lines). A one-meter square plot was placed beside traps 1, 12, and 25 at the 1^{st}, 3^{rd}, and 6^{th} lines at all six quadrats. Thus, each quadrat contained nine plots to sample habitat characteristics. A total of 18 plots was recorded in each burn (lightly burned and heavily burned) for each site. The habitat variables recorded were: percentage of bare ground, percentage of litter cover, percentage of rock cover, percentage of herb and shrub cover, and percentage of tree canopy cover.

The habitat variables were measured by visual inspection, estimating actual percentages of bare ground cover, litter cover, rock cover, and herb and shrub cover within the one-meter plots. The tree canopy cover was measured using a densiometer by standing in the middle of the one-meter plots. The densiometer used was a homemade replica of the Forestry Suppliers Incorporated densiometer (Forestry Suppliers Incorporated Catalogue 2004-2005). The instrument provided a consistent method in measuring tree canopy cover percentage relative to the amount of sky visible.

Data Analysis. - Field data were collected from a total of three sites. The data were entered into a custom Visual Basic Program (VBP) used to sort data for statistical tests. Microsoft Excel and Minitab 12 were used to perform the statistical analysis.

Chi-square tests were used to test for differences between the two quadrats at each site. The data were pooled from all three sites to test the main hypothesis that light burned and heavily burned have different small mammal diversity and abundances. Data from each site were tested individually. Data for each small mammal species with more than ten captures were tested individually. Age categories were tested individually. Finally, the data from different months were tested individually, as well as pooled data for all months together.

Two sample t-tests were used to test for differences in microhabitat variables between the heavily burned quadrats and the lightly burned quadrats. Mann-Whitney U-tests were used when the variances were not equal and a value of U is given in place of t.

Due to the exploratory nature of this study, in all analyses $\alpha = 0.10$ was used as the level for statistical significance.

RESULTS

A total of 2700 trap-nights produced 266 individual rodents with a total of 370 captures, a trapping success rate of 14%. Five rodent species were recorded: California kangaroo rat (*Dipodomys californicus*), montane vole (*Microtus montanus*), dusky-footed wood rat (*Neotoma fuscipes*), deer mouse (*Peromyscus maniculatus*), and yellow pine chipmunk (*Neotamias amoenus*) (Table 2). The trapping success rate (Table 2) varied between the lightly burned sites (6%) and the heavily burned sites (33%). Of the five rodent species captured only the deer mouse had enough captures to warrant statistical analyses.

Because Site 1A exhibited a disproportionate number of deer mice compared to Sites 2A and 3A, the proportion of adults captured, excluding recaptures, was calculated for each quadrat and used in the subsequent statistical analysis. This was done to eliminate the effect of total numbers in each quadrat (Table 2) and prevent the larger number of captures in Site 1 from controlling the statistical analysis of all data. Thus, the proportion of adults in each quadrat was used when comparing within and between sites.

Combining data across all sites for all heavily burned versus all lightly burned quadrats indicated that there was not a significant difference between the number of deer mice in the two habitats (Table 3). When each site was tested individually the results showed there was not a significant difference between the heavily burned and lightly burned habitats (Table 3).

Table 2.–Trapping summary for entire study period (31 May – 7 August 2004) including total number of individuals caught in each quadrat. Each quadrat recorded 450 trap nights. For *Peromyscus maniculatus* the numbers in parentheses are adult and subadult respectively, excluding recaptures.

Quadrat	Species				
	Dipodomys californicus	*Microtus montanus*	*Neotoma fuscipes*	*Peromyscus maniculatus*	*Neotamias amoenus*
1A Heavily Burned	0	0	2	146 (51, 37)	2
1B Lightly Burned	0	0	0	34 (12, 9)	7
2A Heavily Burned	0	1	0	26 (11, 10)	1
2B Lightly Burned	0	0	0	24 (11, 5)	2
3A Heavily Burned	0	0	0	50 (23, 14)	18
3B Lightly Burned	1	0	0	47 (21, 19)	9

Table 3.–Results of X^2 analyses of the proportion of adult *Peromyscus maniculatus* captured, excluding recaptures.

Heavily Burned Quadrats (A) Versus Lightly Burned Quadrats (B)	χ^2 Statistic d.f. = 1	P
A Quadrats vs. B Quadrats	4.025×10^{-5}	0.995
Site 1 Quadrat A vs. Quadrat B	2.251×10^{-6}	0.999
Site 2 Quadrat A vs. Quadrat B	2.212×10^{-2}	0.882
Site 3 Quadrat A vs. Quadrat B	8.142×10^{-3}	0.928

For the present study, two sample t-tests ($\alpha = 0.10$), using pooled variances, were performed with data for all habitat variables measured (percentage of bare ground, percentage of litter cover, percentage of rock cover, percentage of herb and shrub cover, and percentage of tree canopy) to determine if the heavily burned and the lightly burned Sites were equivalent. Only tree canopy was found to statistically differ between the heavily burned quadrats (A) and lightly burned quadrats (B) across all sites (Tables 4-6). The heavily burned quadrats had significantly less tree canopy than the lightly burned quadrats. Bare ground was different ($P < 0.10$) only at Site 1. Rock cover was different ($P < 0.10$) for Site 3 (Tables 4-6). Thus, there are differences in bare ground and rock cover between the quadrats but they were not consistent among all three sites.

It is noteworthy that the only habitat variable shown to be significantly different between the heavily and lightly burned quadrats was tree canopy; however, the previous research to which the present data are being compared has shown that deer mice abundance is influenced by ground cover. No influence of tree canopy is suggested in the previous work.

Table 4.– Site 1 comparison of heavily versus lightly burned habitat data using two sample t-test with d.f. = 16.

Site 1	1A Mean	SD	1B Mean	SD	t	P
Bare Ground	35%	0.457	6%	0.104	59.5[a]	P < 0.10
Litter Cover	39%	0.443	43%	0.276	0.150	0.850
Rock Cover	17%	0.200	13%	0.293	-0.389	0.746
Herb & Shrub Cover	43%	0.431	46%	0.286	0.118	0.884
Tree Canopy	27%	0.346	71%	0.304	2.511	0.012

[a] Mann-Whitney U-Test was used when the variances were not equal and a value of U is given in place of t.

Table 5.– Site 2 comparison of heavily versus lightly burned habitat data using two sample t-test with d.f. = 16.

Site 2	2A Mean	SD	2B Mean	SD	t	P
Bare Ground	39%	0.407	37%	0.339	0.136	0.877
Litter Cover	10%	0.094	16%	0.225	1.397	0.431
Rock Cover	9%	0.122	11%	0.088	0.383	0.648
Herb & Shrub Cover	64%	0.389	56%	0.324	-0.429	0.628
Tree Canopy	19%	0.318	47%	0.253	1.753	0.056

Table 6.– Site 3 comparison of heavily versus lightly burned habitat data using two sample t-test with d.f. = 16.

Site 3	3A Mean	SD	3B Mean	SD	t	P
Bare ground	52%	0.275	36%	0.178	-1.171	0.160
Litter Cover	19%	0.220	24%	0.226	0.454	0.641
Rock Cover	22%	0.189	7%	0.095	66[a]	P < 0.10
Herb & Shrub Cover	46%	0.239	51%	0.243	0.418	0.666
Tree Canopy	17%	0.212	49%	0.249	3.090	0.008

[a] Mann-Whitney U-Test was used when the variances were not equal and a value of U is given in place of t.

DISCUSSION

Because the data collected at Site 1 exhibited a disproportionate number of deer mice compared to Sites 2 and 3, the proportions of adult deer mice captured, excluding recaptures, were used to compare heavily and lightly burned quadrats. There was not a significant difference between the abundance of deer mice in heavily burned areas versus lightly burned areas in the Warner Mountains (Table 3).

The results of the present study appear to contradict the findings of several other studies, which show that relative abundance of deer mice, the mammal captured most often in all study sites, is significantly greater in post-burn habitats versus unburned habitats (Ahlgren 1966; Beck and Vogl 1972; Bock and Bock 1978 and 1983; Chew et al. 1959; Cook 1959; Halvorson 1982; McGee 1976; Sims and Buckner 1973; Stout et al. 1971; Tester 1965; Tevis 1956). Although each study cited was conducted at various times post-burn, taken altogether, they span a time period from immediately post burn up to five years post burn; thus, the current work falls within the time period covered by the cited investigations. The above cited studies showed that fire affects the density and composition of species by altering the habitat. The exact type of habitat change, in terms of the food and shelter availability, determines the type of species that will invade after a fire. According to Beck and Vogl (1972) deer mice prefer a xeric habitat, open vegetation, and sparse litter cover. Deer mice are omnivores, and this allows them to adapt their diets according to the availability of invertebrates and seeds (McGee 1976). The food and habitat preferences of deer mice allow them to exploit burned areas and show a positive response to the early stages of secondary succession (Beck and Vogl

1972). Additional studies found that deer mouse populations continue to increase on post-burned areas for up to three years after a fire (Bock and Bock 1978 and 1983; Halvorson 1982). The present study took place in the third year after the "Blue Fire" of 2001.

The previous studies would suggest that deer mice abundance should have been different between the heavily burned areas and the lightly burned areas if the habitat variables of importance were sufficiently different. In general, the results of the current study suggest that, compared with other studies, small mammals have relatively similar responses. Deer mouse populations are relatively high in burned areas, regardless of the extent of burn compared to unburned areas that have been sampled in the Warner Mountains (John O. Matson, personal communication). As other studies show (Cook 1959; McGee 1976 and 1982; Chew et al. 1959; Lawrence 1966; Converse et al. 2006; Halvorson 1982; Krefting and Ahlgren 1974; Stout et al. 1971; and Sullivan et al. 1999), deer mouse populations respond as if they are the first invaders into disturbed areas.

Microhabitat variables including grass, shrub, rock, and bare ground cover play an important role in determining small mammal diversity and abundance (Dueser and Shugart 1978). In the present study only one of the habitat variables (tree canopy cover) showed any differences between heavily and lightly burned quadrats. However, this is an artifact of the way heavily and lightly burned was defined.

The results of the habitat analysis illustrate the deficiency of the criteria used to select "heavily" and "lightly" burned areas. Tree canopy cover was the only habitat parameter which was shown to be consistently different between "heavily" and "lightly" burned sites. This study, in essence, investigated the effect of tree canopy cover on small mammal abundance. Thus, it is premature to draw any conclusions regarding the effect of burn severity on small mammal abundance.

A more rigorously defined set of criteria need to be established which enable consistent and meaningful selection of burned areas. Once these criteria are developed and validated then a study, such as this one, can be performed again and will hopefully yield insight into the effect that burn severity has on the relative abundance of small mammals. In conclusion, the abundance of deer mice is not significantly different in the heavily burned areas versus the lightly burned areas where severity of burn is defined by difference in tree canopy only.

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