Captures and Recaptures of Small Mammals to Assess Responses to Fire in a Coniferous Forest in the Greater Yellowstone Area

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Natural fires are common in coniferous forests in the Rocky Mountains, and one of the largest fires in recent history occurred in the Greater Yellowstone Area (GYA) in 1988 when over a million acres of lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) burned. In the summers of 1989, 1990 and 1991 and again in 1997 and 1998, we trapped small mammals in two burned and two adjacent unburned forests in the Huckleberry Mountain fire in the Rockefeller Memorial Parkway, 0.5 km north of Grand Teton National Park (GTNP). Here we report on the captures and recaptures of the two most common species of small mammals, the deer mouse (*Peromyscus maniculatus*) and the southern red-backed vole (*Clethrionomys gapperi*); and analyze retrapping frequency for each species in the burned and unburned forest. Our intent was to test the hypothesis that the probability of recapture is the same for both species in burned and unburned habitats. These capture/recapture data will be used by other co-investigators in additional publications to report on estimated population sizes and microhabitat associations.

✦ MATERIALS AND METHODS

In 1989, we established study areas in two burns and adjacent unburned forests on east- and west-facing slopes along the John D. Rockefeller Memorial Parkway. In a preliminary study in 1989, we trapped on three consecutive nights in July, August and September in the unburned forest, burned forest and edge (trees killed but not burned). Twenty-four Sherman live traps (4 grids of 6 traps each, 10 m apart) were set in each habitat for a total of 72 stations/slope. Other specifics of this trapping effort are the same as described below.

For the other four years (1990, 1991, 1997 and 1998), the following trapping procedure was used. For four consecutive nights in June, July and August, we sampled from 1 ha permanently marked grids located in the burned and adjacent unburned forest on east (EF) and west-facing (WF) slopes. During each sampling period, Sherman live traps (100 stations/ha, 10 m apart) were baited with rolled oats and peanut butter, provided with polyester bedding, opened between 1530 and 1730 hr, and

checked between 0500 and 0830 hr the following morning. Captured animals were ear-tagged with unique metal fingerling tags, classified by species, sex, age class (juvenile or adult) and reproductive condition and released at the site of trapping.

✦ RESULTS

During five years of trapping (10896 trap nights), 10 species of small mammal species were trapped: the deer mouse, the southern red-backed vole, the montane vole *(Microtus montanus)*, the western jumping mouse (*Zapus princeps*), the masked shrew (*Sorex cinereus*), the dusky shrew (*S. monticolus*), the dwarf shrew (*S. nanus*), the least chipmunk (*Tamias minimus*), the northern flying squirrel (*Glaucomys sabrinus*) and the bushy-tailed wood rat (*Neotoma cinerea*) but only the southern red-backed vole and the deer mouse were abundant and retrapped in significant numbers.

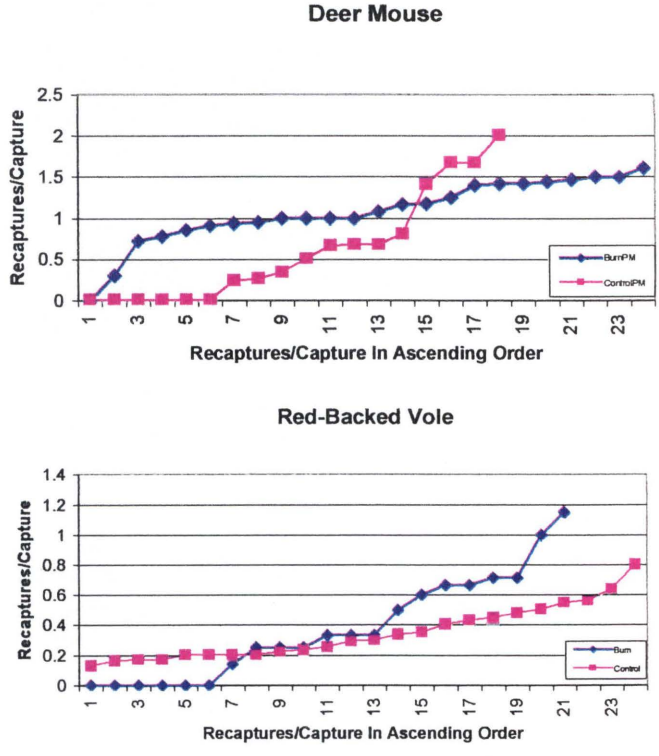
The 1989 trapping season consisted of 12 small grids aligned from unburned through the edge into burned forest (1296 trap nights for the season). A total of 24 southern red-backed voles and 65 deer mice were trapped (Table 1). Recaptures were lower for the red-backed vole (5) than for the deer mouse (25). The deer mouse was captured primarily in the burns, but five were trapped in unburned forest. Red-backed voles were trapped only in unburned forest. Both species were trapped in the edge, which consisted of standing trees with dead needles and intact ground cover. The total number of individual small mammals trapped was highest in burns (44) and lower in the edge (25) and unburned forest (20) (Table 1). For the deer mouse, the total number of animals trapped increased from July to September (7, 26, 32) but not for the red-backed vole (9,10, 5).

Larger grids (100 traps/ha) were established only on burns and controls in 1990 and retrapped in 1991, 1997 and 1998. Again the deer mouse was most abundant in burns and the red-backed vole in unburned forest (Table 2, 3, 4, 5). For the burned forest, we calculated the percentage of captures of the deer mouse relative to all captures in the burns (deer mice plus red-back voles). This percentage ranged from a high of 100% in 1989 and 94% in 1990 to lower percentages in subsequent years (77%, 1991; 56% 1997; 79%, 1998). For the red-backed voles in the burns, this ratio of captures to all captures ranged from lows of 0% in 1989 and 6% in 1990 to higher percentages in subsequent years (1991, 23%; 1997, 44%; 1998, 21%). In the unburned forest, the deer mouse accounted for about 20% and the red-backed vole about 80% of the captures for 1989, 1990, 1991 and 1998. The exception was in 1997 when only 4% of the captures were deer mice and 96% were red-backed voles.

Over the 4 years of trapping on the 1 ha grids, the highest number of both species was caught in 1991 (520 total animals trapped), the second highest was in 1990 (262) while fewer were caught in 1997 (181) and in 1998 (162). These counts were not related to precipitation for June, July and August (Moran Station, NOAA). The total precipitation from May through June was lowest in 1990 (8.2 cm), intermediate for 1991 (10.4 cm) and 1998 (13.2 cm) and highest in 1997(19.3 cm) (Table 6). Although it is interesting to note that in the wettest summer (1997), very few deer mice were trapped in the controls (4% of the total animals trapped) but in the burns deer mice (54%) and voles (46%) were trapped with similar frequency.

To examine the "retrappability" of each species in burns and controls, we plotted the ratio of recaptures/animal captured for each monthly trapping session in ascending numerical order from the data in Tables 2, 3, 4 and 5 for each trapping season in 1990, 1991, 1997 and 1998. The patterns are quite different (Fig. 1).

Fig. 1. The number of recaptures/capture of a deer mice and red-backed voles in burns and controls: each point represents this ratio for a trapping session plotted in ascending order.



For the deer mouse, the mean of this ratio was higher in the burns (1.08) than controls (0.45). For red-backed voles, the mean of recaptures to captures was similar (0.38 in burns and 0.34 in controls). However, for deer mice, the Coefficient of Variation for recaptures/captures was higher in the controls (149) than in the burns (23.5). The opposite was true for the red-backed voles: the Coefficient of Variation in recaptures/captures was higher in burns (89.9) than controls (13.8) although the means did not differ.

✦ DISCUSSION

In 1989, the summer following the fires, only deer mice were trapped in the burns; both species were trapped in the edge but deer mice were far more abundant. A few deer mice were captured in the unburned forest and here the red-backed vole was more abundant. During this year the regenerating vegetation was sparse in the burns and the only cover was downed and severely burned logs. The habitat was probably unsuitable for the red-backed voles. The edge provided more cover with dead needle canopy, downed logs and unburned ground cover. Two years post-burn this habitat separation was still marked. However, in the three subsequent years of trapping, the red-backed vole constituted a much higher percentage of small mammals trapped in the burn reaching a peak of 44% in 1997. But the general pattern of higher abundance of deer mice in the burns and a higher abundance of red-backed voles in the unburned forest held for all years. Other investigators have reported similar associations for these two species (Sims and Buckner 1973, Campbell and Clark 1980, Martell 1984, Kirkland 1990, Walters 1991).

Both species peaked in abundance in 1991--two summers post-burn--with a total of 268 deer mice and 252 red-backed voles trapped. Six and seven years later, the abundance of both species had declined for reasons that can only be speculated. Neither of these years were particularly dry. Since these abundance patterns were similar for both species in both burns and controls we cannot attribute the large increase in 1991 and subsequent decline to successional changes in the vegetation. In all years except one (1997) in the unburned forest, the percentage of captures of red-backed vole and deer mice was constant (80% and 20%). In 1997, the summer of highest precipitation, very few deer mice were caught in the control (4%) and far more red-backed voles were caught in the burns (44%). We interpret this peculiarity as fewer deer mice inhabiting the unburned forest and more red-backed voles moving into the burn. The implication is that more resources were available in the burned forest.

However, precipitation may affect trap success in different ways. First, indirectly--higher rains bring more forage (herbaceous vegetation and mushrooms), which could result in population increases via reproduction and migration; but conversely animals may be less attracted to baited traps when natural forage is plentiful. Second, rainfall may discourage foraging and result in lower trap success. These data remain open to a variety of explanations.

This most disconcerting finding of our analysis concerns the assumption that trap success reflects actual abundance or density. Our results show that the ratio of recaptures/captures varies both with habitat and species. The mean of this ratio was higher for deer mice in the burns (1.08) compared to the controls (0.45) and higher in both habitats than it was for red-backed voles, but the mean of this ratio did not differ between habitats for the red-backed vole (0.34 and 0.38). For each species, the Coefficient of Variation was lower in each species "preferred" habitat: burned forests for the deer mouse and unburned forests for the red-backed voles. One explanation may be that animals establish home ranges in their preferred habitat so the probability of retrapping an animal did not vary that much across trapping sessions. In the habitats with lower abundance (burns for the red-backed vole and unburned forest for the deer mouse), six trapping sessions for each species yielded no recaptures. However, for the red-backed vole, 14 trapping sessions had higher recaptures than in the unburned forests. For the deer mouse, only three trapping sessions in the unburned forest yielded higher recaptures than the control. In other words, the less preferred habitat for each species produced more trap-happy and more trap-shy individuals relative to preferred habitats. If capture/recapture population estimates are to be applied to these data, these patterns may be useful in interpreting the variance in population estimates among trapping sessions for each species.

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Table 1. For A) July, B) August, and C) September of 1989, the number of individuals trapped and their recaptures for the deer mouse (*Peromyscus maniculatus*), the southern red-backed vole (*Clethrionomys gapperi*) on the east and west-facing burns (EF-Burn, WF-Burn), the east and west-facing edge (EF-Edge, WF-Edge) and the east and west-facing unburned sites (EF-Control, WF-Control); 24 traps/habitat for 3 trap nights.

A. July 1989

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1989	Deer Mouse				
EF-Burn	3	0	0	0	0
WF-Burn	3	0	1	0	1
EF-Edge	0	0	0	0	0
WF-Edge	0	0	0	0	0
EF-Control	0	0	0	0	0
WF-Control	1	0	0	0	0
	Red-backed Voles				
EF-Burn	0	0	0	0	0
WF-Burn	0	0	0	0	0
EF-Edge	3	1	0	0	1
WF-Edge	2	0	0	0	0
EF-Control	2	0	0	0	0
WF-Control	2	0	0	0	0

B. August 1989

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
August 1989	Deer Mouse				
EF-Burn	6	3	0	0	3
WF Burn	11	3	1	0	5
EF-Edge	5	0	1	0	2
WF-Edge	2	1	0	0	1
EF-Control	1	0	0	0	0
WF-Control	1	0	0	0	0
	Red-backed Voles				
EF-Burn	0	0	0	0	0
WF-Burn	0	0	0	0	0
EF-Edge	2	1	1	0	0
WF-Edge	1	0	0	0	0
EF-Control	2	1	0	0	1
WF-Control	5	1	0	0	1

C. September 1989

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
Sept. 1989	Deer Mouse				
EF-Burn	8	2	1	0	4
WF Burn	13	4	1	0	6
EF-Edge	5	1	1	0	3
WF-Edge	4	0	0	0	0
EF-Control	0	0	0	0	0
WF-Control	2	0	0	0	0
	Red-backed Voles				
EF-Burn	0	0	0	0	0
WF-Burn	0	0	0	0	0
EF-Edge	1	0	0	0	0
WF-Edge	0	1	0	0	1
EF-Control	4	1	0	0	1
WF-Control	0	0	0	0	0

Table 2. For A) June, B) July and C) August of 1990, the number of different individuals trapped and the number of recaptures for the deer mouse (*Peromyscus maniculatus*) and the southern red-backed vole (*Clethrionomys gapperi*) on the east-facing and west-facing burns (EF-Burn, WF-Burn) and the east-facing and west-facing unburned sites (EF-Control, WE-Control) on 1 ha grids with 100 traps.

A June 1990

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
June 1990	Deer Mouse				
EF-Burn	16	3	6	0	15
WF-Burn	5	0	1	2	7
EF-Control	4	1	0	0	1
WF-Control	0	0	0	0	0
	Red Backed Voles				
EF-Burn	0	0	0	0	0
WF-Burn	0	0	0	0	0
EF-Control	4	0	1	0	2
WF-Control	5	1	0	0	1

C. July 1990

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1990	Deer Mouse				
EF-Burn	21	6	3	3	21
WF-Burn	11	4	2	0	8
EF-Control	4	0	1	0	2
WF-Control	1	0	0	0	0

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1990	Red Backed Voles				
EF-Burn	2	1	0	0	1
WF-Burn	0	0	0	0	0
EF-Control	11	3	2	0	7
WF-Control	12	1	1	0	3

C August 1990

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
August1990	Deer Mouse				
EF-Burn	43	13	0	0	13
WF-Burn	39	12	5	5	37
EF-Control	13	3	0	0	3
WF-Control	3	1	0	0	1
	Red Backed Voles				
EF-Burn	3	2	0	0	2
WF-Burn	3	0	0	0	0
EF-Control	31	5	0	0	5
WF-Control	31	5	2	0	9

Table 3. For A) June, B) July and C) August of 1991 (See heading Table 2).

A June 1991

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
June 1991	Deer Mouse				
EF-Burn	19	4	4	5	27
WF-Burn	17	5	7	2	25
EF-Control	6	2	1	0	4
WF-Control	3	0	1	1	5
	Red-Backed Voles				
EF-Burn	2	0	1	0	2
WF-Burn	6	0	0	0	0
EF-Control	8	1	0	0	1
WF-Control	10	2	3	0	8

B. July 1991.

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1991	Deer Mouse				
EF-Burn	42	8	8	4	36
WF-Burn	13	2	2	5	21
EF-Control	5	0	0	0	0
WF-Control	6	1	1	0	3

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1991	Red-Backed Voles				
EF-Burn	5	3	0	0	3
WF-Burn	14	4	1	2	10
EF-Control	27	6	1	0	8
WF-Control	41	8	3	3	23

C. August 1991

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
August1991	Deer Mouse				
EF-Burn	79	19	18	10	85
WF-Burn	36	9	9	5	42
EF-Control	32	11	2	2	21
WF-Control	10	2	3	2	14
	Red-Backed Voles				
EF-Burn	14	3	2	1	10
WF-Burn	20	4	5	3	23
EF-Control	46	6	2	2	16
WF-Control	59	14	3	4	32

Table 4. For A) June, B) July and C) August of 1997 (See heading Table 2).

A. June 1997

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
June 1997	Deer Mouse				
EF-Burn	7	2	1	1	7
WF-Burn	2	0	0	1	3
EF-Control	0	0	0	0	0
WF-Control	2	0	0	0	0
	Red-Backed Voles				
EF-Burn	1	0	0	0	1
WF-Burn	7	1	0	0	0
EF-Control	9	2	2	0	6
WF-Control	13	3	1	0	5

B. July 1997

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1997	Deer Mouse				
EF-Burn	17	8	3	2	20
WF-Burn	2	1	1	0	3
EF-Control	0	0	0	0	0
WF-Control	1	0	0	0	0

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1997	Red-Backed Voles				
EF-Burn	12	3	0	0	3
WF-Burn	8	0	1	1	5
EF-Control	15	3	1	1	8
WF-Control	18	6	1	1	11

C. August 1997

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
August 1997	Deer Mouse				
EF-Burn	19	5	5	4	27
WF-Burn	1	1	0	0	1
EF-Control	1	0	1	0	2
WF-Control	0	0	0	0	0
	Red-Backed Voles				
EF-Burn	6	2	1	0	4
WF-Burn	4	1	0	0	1
EF-Control	21	10	2	0	14
WF-Control	15	3	0	1	6

Table 5. For A) June, B) July and C) August of 1998 (See heading Table 2).

A. June 1998

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
June 1998	Deer Mouse				
EF-Burn	9	2	1	3	13
WF-Burn	4	1	2	0	5
EF-Control	0	0	0	0	0
WF-Control	0	0	0	0	0
	Red-Backed Voles				
EF-Burn	3	1	0	0	1
WF-Burn	4	1	2	0	5
EF-Control	10	4	1	1	9
WF-Control	6	1	3	0	7

B. July 1998

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
July 1998	Deer Mouse				
EF-Burn	32	13	4	2	29
WF-Burn	2	0	0	0	0
EF-Control	5	4	0	0	4
WF-Control	1	0	0	0	0
	Red-Backed Voles				
EF-Burn	5	0	0	0	0
WF-Burn	3	2	0	0	2
EF-Control	7	3	1	0	5
WF-Control	6	1	3	0	7

C. August 1998

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
August 1998	Deer Mouse				
EF-Burn	27	5	5	2	21
WF-Burn	7	0	2	1	7
EF-Control	4	0	0	0	0
WF-Control	1	0	0	0	0
	Red-Backed Voles				
EF-Burn	1	0	0	0	0
WF-Burn	6	2	2	0	6
EF-Control	9	4	1	0	6
WF-Control	10	2	0	0	2

DATE/SITE	Individuals Captured	1-Recapture	2-Recaptures	3-Recaptures	Total-Recaptures
August 1998	Deer Mouse				
EF-Burn	27	5	5	2	21
WF-Burn	7	0	2	1	7
EF-Control	4	0	0	0	0
WF-Control	1	0	0	0	0
	Red-Backed Voles				
EF-Burn	1	0	0	0	0
WF-Burn	6	2	2	0	6
EF-Control	9	4	1	0	6
WF-Control	10	2	0	0	2

Table 6. Mean monthly precipitation (Moran, WY Station, NOAA data) for June, July and August for 1990, 1991, 1997 and 1998, the three-month total precipitation and the total number of red-backed voles and deer mice trapped.

Year	June	July	August	Total Precip	Total Trapped
1990	2.7	2.4	3.1	8.2	262
1991	3.0	3.2	4.2	10.4	520
1997	3.8	8.4	7.0	19.3	181
1998	8.4	1.4	3.8	13.7	162

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