FIRE EFFECTS ON A POPULATION OF HEERMANN'S KANGAROO RATS AT THE ALKALI SINK ECOLOGICAL RESERVE, FRESNO COUNTY, CALIFORNIA

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ABSTRACT: Fire has been shown to cause an increase in kangaroo rat populations in several studies. The increases in population size likely result from a reduction in dense herbaceous growth, which has been shown to impede movements of kangaroo rats. Dense growth limits the ability of kangaroo rats to forage, find mates, and potentially increases their susceptibility to predation. Wildfires on Alkali Sink Ecological Reserve, Fresno Co., California provided an opportunity to study the effects of fire on a population of Heermann's kangaroo rats (*Dipodomys heermanni*). Fire could be considered as a management tool to open previously unoccupied heteromyid habitat for short term use.

*Key word*s: fire effects, *Dipodomys heermanni*, alkali sink.

TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 46:1-6

Fire has been shown to cause an increase in kangaroo rat populations in several studies; including Heermann's kangaroo rat (*Dipodomys heermanni*; Frenzel et al. 1979) and Merriam's kangaroo rat (*D. merriami*; Bock and Bock 1978, Fitzgerald et al. 2001, Simons 1991). However, in one study involving the banner-tailed kangaroo rat (*D. spectabilis*), no change was noted (Valone et al. 2002). The increases in population size likely resulted from a reduction in dense herbaceous growth, which has been shown to impede movements of kangaroo rats, thereby limiting their ability to forage, find mates, and potentially increase their susceptibility to predation (Culbertson 1946, Hawbecker 1951, Williams and Germano 1992).

In May, 1997, two arson-caused wildfires burned 2 adjacent areas of the Alkali Sink Ecological Reserve (ASER, Fresno County, CA), totaling approximately 142 ha (California Department of Fish and Game, unpub. data). The wildfires provided an opportunity to perform an examination of the effects of fire on a population of grassland rodents. The multi-season study focused on a Heerman's kangaroo rat (HKR) population. Results of this study may influence future management actions on ASER and other reserves and wildlife areas in the vicinity.

Study Area

The California Department of Fish and Game owns and manages the 377 ha ASER, located along State Highway 180, 11 km east of Mendota, Fresno County, California (Fig. 1). This reserve was established on 31 August 1979 to protect the Fresno kangaroo rat (*Dipodomys nitratoides exilis*), a state and federally listed endangered species (Chesemore and Rhodehamel 1992, USFWS 1998).

Habitat at ASER is a mosaic of Alkali Sink and Valley Grassland plant communities, reminiscent of historical San Joaquin Valley floor habitats (Germano et al. 2001). This habitat mosaic caused the wildfire burns to be incomplete. Most of the areas that burned completely and at relatively high temperatures were those areas that contained predominantly dense grasses of non-native *Bromus* sp., between 0.5 and 1 m high. These areas were left with a low mat of charred grass. The unburned areas consisted primarily of alkali scalds devoid of vegetation, areas of lesser grass cover, or areas of dense tall grasses that were isolated from the burn by surrounding alkali scalds.

Methods

On the burn plot we established seven trap lines in burned areas and 7 trap lines in interstitial unburned alkali scald areas (Fig. 2). Fourteen trap lines were

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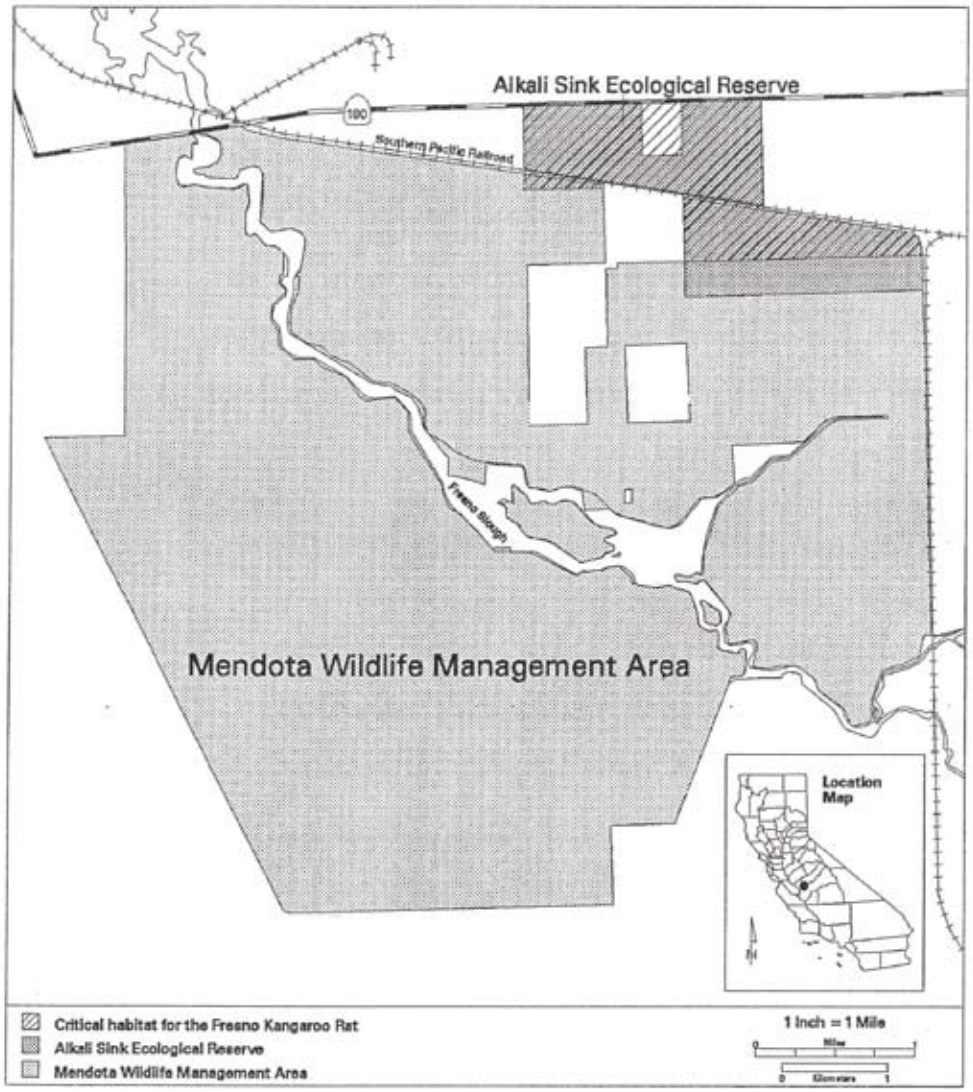

Figure 1. General vicinity map of the Alkali Sink Ecological Reserve, Fresno County, California. Map created by S. Phillips.

placed in an adjacent unburned parcel as a control (7 in dense grass and 7 in alkali scalds, Fig. 2). The grass areas on the control plot were analogous to the areas that burned on the burn plot. Each trap line was 50 m long. Trapping sessions were conducted in summer and fall 1998, summer and fall 1999, and summer 2000.

Single large folding Sherman traps (7.6 x 8.9 x 30.5 cm; H. B. Sherman Traps, Tallahassee, FL) were placed at 10-m intervals along each of the 28 50-m transect lines, resulting in 6 traps per line (168 total traps). Each trap line end point was marked with wooden survey stakes and numbered; reflective flagging was attached for easy identification at night. The lines were also marked with pin flags at 10-m intervals to assist in trap placement.

Small mammal trapping was conducted for 3 consecutive nights during each trapping session. Traps were set in the early evening, baited with millet and a paper towel, and checked and closed starting 2 hours after sunset. All animals captured were identified to species, weighed, and sexed. We marked captured mammals by clipping the fur on the rump.

Results

The HKR was the only rodent species consistently captured throughout the study. House mice (*Mus musculus*) and deer mice (*Peromyscus*

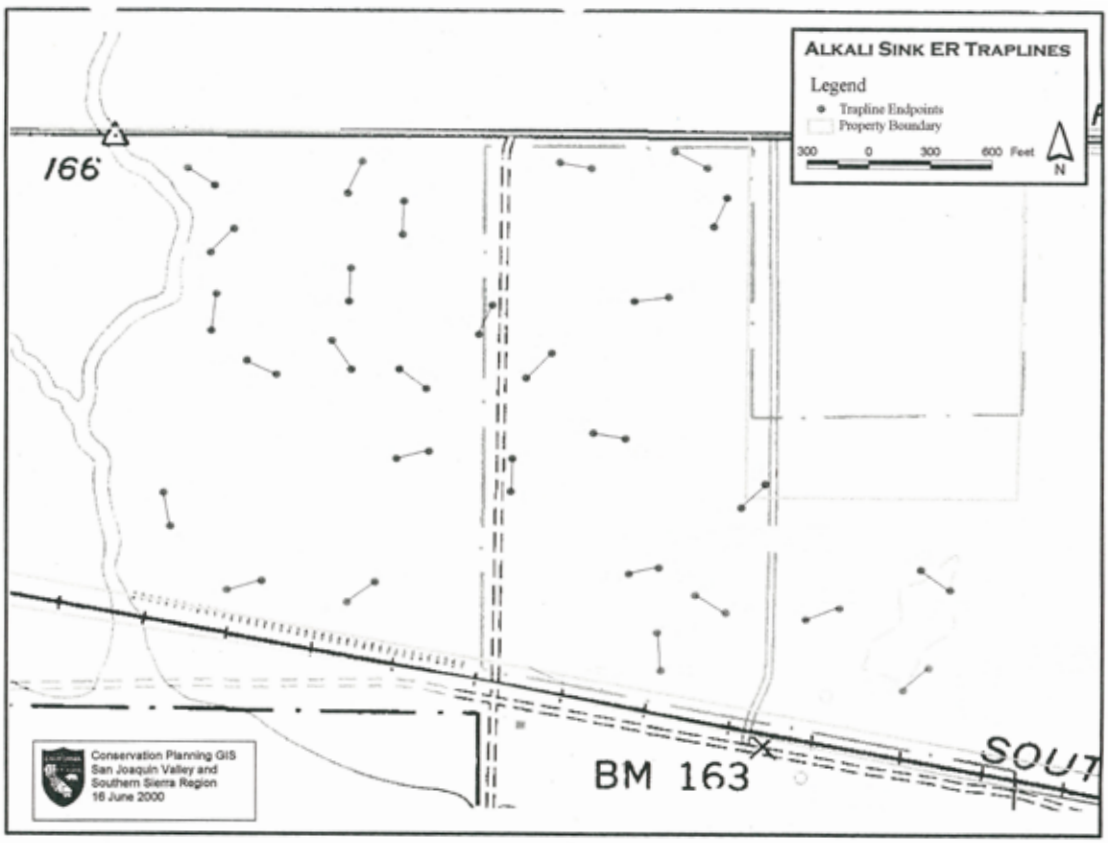

Figure 2. Locations of trap line transects. Transects (n = 14) west of the north-south running dirt road (dashed margins; corresponds to S. Tuolumne Avenue) are positioned in the burn plot, and the transects (n = 14) east of the road are within the control plot.

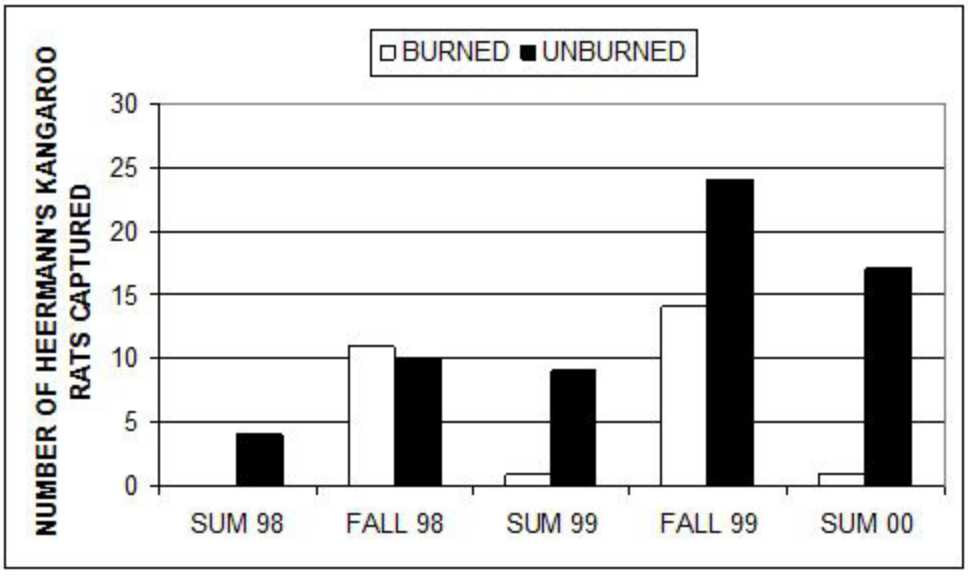

Figure 3. Captures of Heermann's kangaroo rats on the burn plot between summer 1998 and summer 2000 at the Alkali Sink Ecological Reserve, Fresno County, California. "Burned" and "unburned" refer to "burned grass" and "unburned alkali scalds" respectively within the Burn Plot.

Table 1. Summary of all rodent species captured during the 5 trapping sessions. House mice and deer mice decreased in numbers until they were no longer captured during summer 2000.

Species	Burn			Control		
	Burned	Unburned	Total	Grassland	Scald	Total
	Summer 1998					
Dipodomys heermanni	0	4	4	0	7	7
Peromyscus maniculatus	7	2	9	2	1	3
Mus musculus	1	0	1	0	0	0
total	8	6	14	2	8	10
	Fall 1998					
Dipodomys heermanni	11	10	21	0	19	19
Peromyscus maniculatus	13	11	24	8	12	20
Mus musculus	9	2	11	0	0	0
total	33	23	56	8	31	39
	Summer 1999					
Dipodomys heermanni	1	9	10	0	15	15
Peromyscus maniculatus	9	7	16	6	12	18
Mus musculus	2	0	2	2	0	2
total	12	16	28	8	27	35
	Fall 1999					
Dipodomys heermanni	14	24	38	0	10	10
Peromyscus maniculatus	4	8	12	0	2	2
total	18	32	50	0	12	12
	Summer 2000					
Dipodomys heermanni	1	17	18	0	10	10
total	1	17	18	0	10	10

maniculatus) were caught in relatively large numbers during the first two sessions but not in subsequent sessions, so were excluded from further analyses. Table 1 summarizes species captures during the 5 sessions. HKR sex ratios averaged 1:1 all sessions combined. Mass averages are summarized in Table 2. Males averaged 5 g heavier than females with all years combined.

No HKR were captured in grass on the control plot (Table 1). In contrast, HKR were consistently captured in burned areas (analogous to grass) on the burn plot, with the exception of summer 1998 (very few total captures). There were no differences in the number of HKR captured in the burned areas compared to unburned (scald) areas on the burn plot in the summer of 1999 and the summer of 2000 (Fig. 3, X^2 , P=0.83 and 0.10, respectively, df=1).

Trapping in fall 1999 resulted in the highest number of HKR caught during the study on the burn plot. In comparison, the control plot experienced a general decrease in HKR captures as the seasons progressed and plateaued in 1999 and 2000 (Fig. 4).

Annual calendar year rainfall (cm) for 1997 to 2000 was 16, 34, 8, and 20, respectively; data taken at the Five Points, CA, weather station (Fresno County), approximately 38 km ESE from Mendota, CA. The thirty-year average (1971-2000) is approximately 19 cm (NOAA 2008).

Discussion

Originally, this was an *ad hoc* study to explore the effects of fire on endangered Fresno kangaroo rats. However, no Fresno kangaroo rats were captured during the trapping sessions. The data on HKR seemed informative, perhaps enough to provide additional insights into the effects of wildfire on heteromyids.

There appeared to be an effect on the HKR population from the burn events. The fires decreased grass cover and exposed more bare ground, as expected. However, annual rainfall may have had

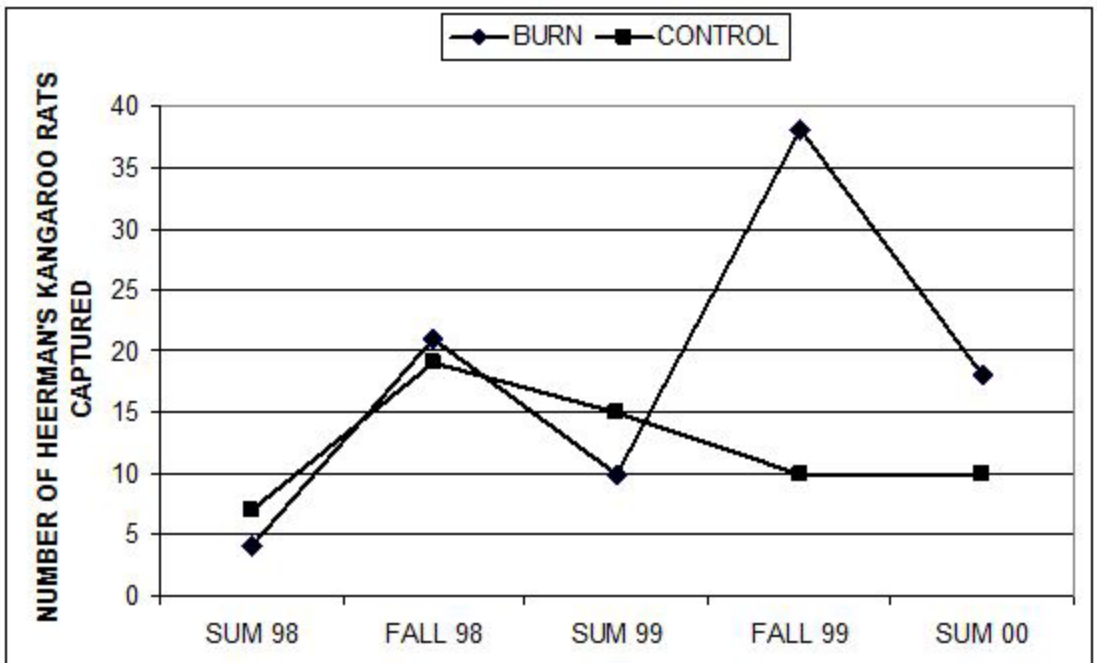

Figure 4. Captures of Heerman's kangaroo rats on the burn and control study plots between summer 1998 and summer 2000 at the Alkali Sink Ecological Reserve, Fresno County, California

Table 2. Average weights (in grams) of captured Heermann's kangaroo rat (*Dipodomys heermanni*).

	Male			Female		
	Mean	Range	*n*	Mean	Range	*n*
Fall 98	64.6	51-76	13	57.8	51-66	6
Summer 99	65	53-74	3	60.7	50-79	15
Fall 99	57.8	52-64	14	50.3	45-57	12
Summer 00	55.8	30-72	14	54.4	35-68	13
Overall mean	60.8			55.8		

additional effects on the population. The fires occurred during May 1997, which was a below average rainfall year. The following year, 1998, experienced nearly double the average rainfall, which likely would have provided more vegetative cover, especially since the fires may have exposed the seed base and provided an ash layer to the soil. By contrast, annual rainfall in 1999 and 2000 was at or below average.

The control plot had dense vegetative cover and may have prevented long-term perseverance of rodent populations. Fire-induced changes in the vegetation in the burn plot likely proved favorable for kangaroo rat movement and use, possibly attracting rodents from neighboring areas, including the control plot (Fig. 4). Recovery of the vegetation, which allowed for the return of the burn plot back to pre-burn conditions, and competition for food and space resources, may have led to the population reduction in non-heteromyids in 2000.

In conclusion, it appears from the data collected for this study that controlled fire could be considered as a management tool to open previously unoccupied

heteromyid habitat for short term use. Opening adjacent habitats for use by heteromyids could enhance species dispersal, as in our study where it appeared HKR moved from the control plot to the burn plot. This could lead to connectivity of heteromyid habitats and overall range expansion.

ACKNOWLEDGMENTS

We thank K. O'Connor, M. Selmon, M. Morton, A. Harpster, J. Smith, S. Messer, and G. Moise for their assistance in the field. T. Sandoval and R. Zwerdling-Morales assisted in early draft inter-agency reports and protocols of this study. The California Department of Fish and Game provided funding. Additional support provided by the Bureau of Reclamation and the U.S. Fish and Wildlife Service. M. Meyer provided comments on the manuscript and S. Phillips created Figure 1.

This paper is dedicated to the memory of Clu Cotter, Kevin O'Connor, Tom Stolberg, and Mike Donovan who were tragically lost in a helicopter crash on 5 January 2010.

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