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SURVIVORSHIP OF TRANSLOCATED KANGAROO RATS IN THE SAN JOAQUIN VALLEY, CALIFORNIA

DAVID J. GERMANO
California State University, Bakersfield
Department of Biology
Bakersfield, CA 93311-1022
dgermano@csub.edu

Efforts to protect endangered species sometimes involve removing animals from sites to be developed and translocating them to protected sites. This method has rarely been successful. Protected kangaroo rats in the San Joaquin Valley of California continue to lose habitat to development. In 2001, I monitored four Tipton kangaroo rats(*Dipodomys nitratoides nitratoides*) and seven Heermann's kangaroo rats (*D. heermanni* ssp.) fitted with radio transmitters that were translocated away from development at an electrical substation to protected native land of the San Joaquin Valley, Kern County, California. I released translocated kangaroo rats into individual artificial burrows that were spaced 10–15 m apart and that were provisioned with bird seed. Only 1 individual survived the 45 days of the study. All four Tipton kangaroo rats were dead within 5 days of release, and all appear to have been eaten by predators. Two Heermann's kangaroo rats appeared to have been killed by conspecifics, three were killed by predators, and the fate of one was undetermined. If translocation is to be considered a useful conservation measure, kangaroo rats need to be released into habitat that is unoccupied, or nearly so, by conspecifics and the use of additional methods of protecting translocated individuals may be necessary.

Key words: *Dipodomys heermanni*, *Dipodomys nitratoides*, kangaroo rat, survivorship, technique, translocation

INTRODUCTION

In the past century, species have been lost at rates as high, or higher, than the rates that occurred during mass extinctions seen in the geologic record (Diamond 1989, Wilson 2002), resulting in a decline of biodiversity that is a major concern throughout the world. Because of this, environmental legislation has been passed to ensure that species are not extirpated. Despite these laws, development has continued and habitat continues to be lost.

Many times loss of habitat for a protected species also has meant the loss of individuals that inhabited the parcel of land developed. In some situations, however, attempts have been made to rescue individuals and translocate them to other areas in their range that are not affected by development. The desired outcome is that the translocated individuals will survive and reproduce at the target site with no net loss of animals (Griffith et al. 1989). However, the outcome of translocating animals often is not determined, and in the few studies where individuals have been monitored, translocation usually has not been successful (Fischer and Lindenmayer 2000, Rathbun and Schneider 2001).

The Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*) is a state and federally listed endangered species, and occurs in only 3-4% of their former range in the southern end of the San Joaquin Valley in California (Williams and Germano 1992). Their numbers continue to decline (Uptain et al. 1999) due to habitat loss and degradation. Tipton kangaroo rats occur in shrub and non-native grassland habitat that has been lost to agricultural activities, energy development, and human infrastructure (Williams and Germano 1992). Past attempts to translocate Tipton kangaroo rats have had poor success (Germano 2001) as determined by live-trapping. However, survivorship would be determined more accurately by fitting kangaroo rats with radio transmitters. Heermann's kangaroo rat (*D. heermanni* ssp.), although not a protected species, co-occurs with Tipton kangaroo rats on the valley floor and their fate once translocated can help shed light on the validity of translocation as a conservation method for small rodents.

In late 2001, I translocated Tipton and Heermann's kangaroo rats from a site at an electrical switching station that was to be developed to an area with natural habitat close to the developed site. Kangaroo rats were fitted with radio transmitters and tracked over the course of 2 months to determine their fate. The objective was to determine if translocated kangaroo rats released into artificial burrows could survive long enough to establish permanent residence at a new site.

METHODS

In September 2001, four Tipton kangaroo rats and three Heermann's kangaroo rats were captured and removed from a proposed expansion area of an electrical switching station 0.2 km east of Buttonwillow, Kern County, California (Figure 1). The expansion area was about 2.8 ha in area and had forbs, non-native annual grasses, and a few native saltbush (*Atriplex* spp.) as cover. I held these animals in captivity for > 2 months because the Tipton kangaroo rats were juveniles and were not large enough to safely carry radio transmitters. I also trapped another four adult Heermann's kangaroo rats in mid December from another site adjacent to the first area.

I fitted each kangaroo rat with a 2-g radio transmitter (Model BD-2, Holohil Systems Ltd., Carp, Ontario, Canada) attached to beaded chain that was clasped around the neck of the animal (modified after Harker et al. 1999). Tipton kangaroo rats weighed 29.3–39.9 g when they were collared and the radio collars were 5.5–7.3% of body mass. Heermann's kangaroo rats weighed 50.0–56.2 g and the radio collars were 4.1–5.4% of body mass. I monitored kangaroo rats for 7 days while in captivity to determine if the collars would stay on and if the collar negatively affected the animal. I also attached ear tags to each kangaroo rat. On 14 November 2001, I constructed seven artificial burrows on preserve land of the Center for Natural Lands Management, approximately 7.5 km southwest of the project site (Figure 1). The release site supported saltbush shrub with some forbs and non-native annual grasses. I chose the site because it was protected natural habitat close to the donor site. I did not trap the target site before the release to assess resident rodents, but few burrows of kangaroo rats appeared active. However, trapping after the release of translocated animals yielded several resident Heermann's kangaroo rats.

I constructed artificial burrows by digging sloping trenches and using two cardboard mailing tubes (90 cm long) as tunnels that ended at a chamber (or den) that I dug into the soil about 30 cm below the surface (Germano 2001). I used a piece of cardboard as the top of the den and I placed a paper towel and seeds in the den before covering the cardboard roof and

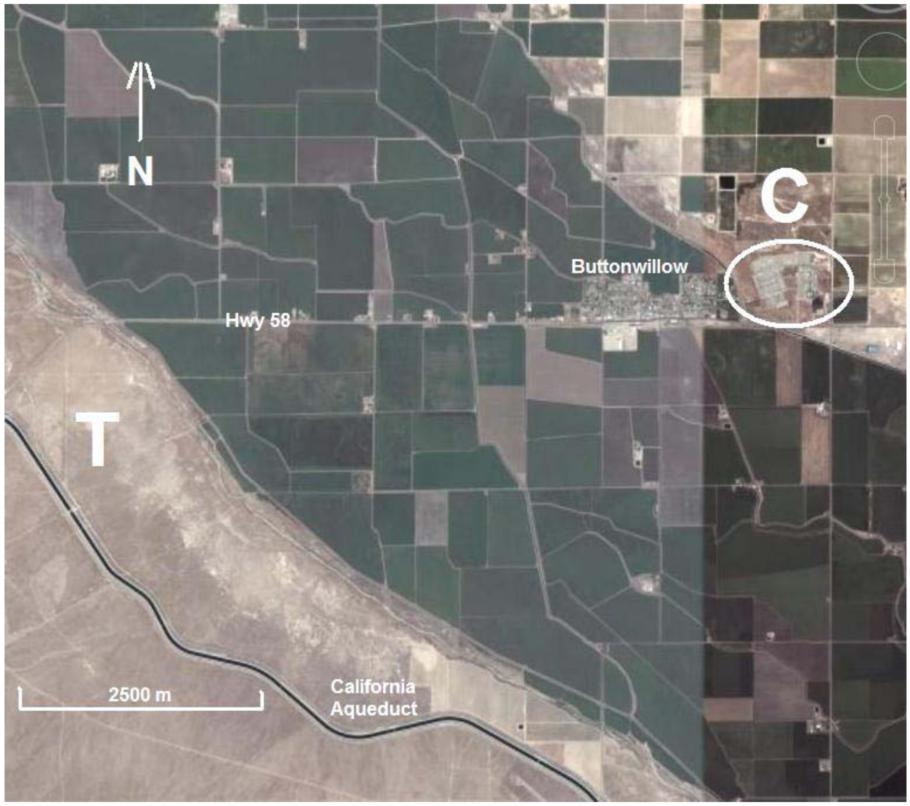

Figure 1. Location of the electrical substation (circled and designated C) in Buttonwillow, Kern County, California, from where kangaroo rats, *Dipodomys* spp., were captured and then translocated to a preserve (T) about 7.5 km to the southwest, November and December 2001.

tubes with soil. I constructed one burrow for each kangaroo rat and I placed the artificial burrows 10–15 m from each other. Burrows of Tipton kangaroo rats were clustered near each other, while those of Heermann's kangaroo rats were clustered together but about 20 m from the cluster of Tipton kangaroo rat burrows. Kangaroo rats were individually released into a burrow the same day the burrows were constructed. I plugged entrance tubes with paper towels to discourage animals from leaving the burrow during the day. At dusk the same day, I unplugged all the burrows. The four Heermann's kangaroo rats I trapped in December were also fitted with radio transmitters and released into their own artificial burrows 12 December 2001, about 60 m south of the original releases.

I radio-tracked the first seven kangaroo rats daily from 15–24 November, or until they were found dead. Those that remained alive, or were thought to be alive, were tracked every 3 days from 27 November until 15 December, and then on 20, 22, and 30 December, at which time I trapped any kangaroo rats remaining and removed their collars. I radio-tracked the second set of four Heermann's kangaroo rats daily from 13–18 December, and on 20, 22, and 30 December. Radiolocations were taken during the day. If the location had changed from the previous location, I recorded the distance moved and the compass direction, and I plotted the location on a map.

RESULTS

Of 11 kangaroo rats translocated to the target site, only 1 individual was known to have survived the 45 days of the study (Table 1). All four Tipton kangaroo rats were dead within 5 days of release into artificial burrows. Based on partially eaten bodies or body parts, all appear to have been killed by predators. Of seven Heermann's kangaroo rats translocated to the site in two groups, only one survived 45 days and it was recaptured and its collar removed (Table 1). Three Heermann's kangaroo rats were dead within 2 days of release, 1 individual was dead in 4 days, one was presumed to have died 22 days after release; a collar came unfastened on another kangaroo rat and its fate was undetermined (Table 1). Of the five Heermann's kangaroo rats presumed or known to have died, two may have been killed by resident kangaroo rats based on bite marks on their tails. Based on bodies or body parts that I found, I suspect that predators killed three individuals.

Table 1. Release dates (2001), number of different locations after release (NDL), greatest distance moved (GDM) in m from artificial burrow, and fate of Tipton kangaroo rats and Heermann's kangaroo rats translocated from an electrical switching station at Buttonwillow, California and released into artificial burrows.

Species and Animal ID	Release Date	NDL	GDM	Fate
Tipton Kangaroo Rats				
#235	14 Nov.	4	23 m	dead aboveground; predation by day 5
#236	14 Nov.	2	6 m	dead underground; predation by day 2
#237	14 Nov.	1	25 m	dead aboveground; predation by day 2
#238	14 Nov.	2	38 m	shed radiocollar aboveground; presumed dead day 3
Heermann's Kangaroo Rats				
#232	14 Nov.	0	0 m	dead aboveground; conspecific aggression, day 2
#233	14 Nov.	5	35 m	alive 30 December (45 days); collar removed
#234	14 Nov.	7	51 m	shed radiocollar aboveground; presumed dead, day 22
#239	12 Dec.	1	48 m	dead aboveground; predation by day 2
#240	12 Dec.	1	50 m	no signal by day 2; presumed predation
#241	12 Dec.	3	50 m	dead aboveground; conspecific aggression, day 4
#242	12 Dec.	1	28 m	collar found unfastened, underground

DISCUSSION

No Tipton kangaroo rats survived longer than 5 days after being translocated, and only one of seven Heermann's kangaroo rats survived > 45 days. Predation appeared to be the cause of death of all the Tipton kangaroo rats and three of the six Heermann's kangaroo rats that died. Intraspecific aggression seems to have been the cause of death of two Heermann's kangaroo rats. All but one Tipton kangaroo rat were young of the year, and their inexperience may have contributed to their deaths. Although I did not catch any resident Tipton kangaroo rats during the study, I did catch Heermann's kangaroo rats, and it is possible that the target site was closer to carrying capacity for this species than initially thought based on numbers of active burrows. Also, I may have placed translocated animals too close to each other, which could have led to aggressive interactions among translocated Heermann's kangaroo rats. All of these factors may have contributed to the poor success of this translocation.

I have participated in two other translocations of kangaroo rats where there was an attempt to determine the fate of the animals. In 1989, 60 giant kangaroo rats (*Dipodomys ingens*) in two groups of 30 were moved to new sites on the Carrizo Plain, San Luis Obsipo County (Williams et al. 1993). One group of 30 kangaroo rats were relocated to artificial burrows in a plowed field that was within the feeding grounds of a pair of San Joaquin kit foxes (*Vulpes macrotis mutica*) and all were dead within 6 months. Another group of 30 animals that were moved to vacant natural habitat outside the feeding range of San Joaquin kit foxes survived for several years, and the population grew exponentially until it crashed when the climate became wet in the mid-1990s (D. Germano, unpublished data). In another study, 12 Tipton kangaroo rats were translocated to another location approximately 2 km from a project site (Germano 2001). Based on 6 months of trapping, three translocated animals were known to have survived, but the fate of the other nine kangaroo rats was undetermined.

Similar short-term results were reported for kangaroo rats in Southern California. In spring, 1998, 15 San Bernardino kangaroo rats (*D. merriami parvus*) were translocated about 4 km from one area to a reclaimed mine site (O'Farrell 1999). Trapping at the translocation site previous to the area receiving animals showed that three San Bernardino kangaroo rats and 23 of the larger Dulzura kangaroo rat (*D. simulans*) occurred there. Rodents translocated to the site were released within 5 days of capture and were not released into artificial burrows. Six translocated San Bernardino kangaroo rats (40% of releases) were caught 3 months later (O'Farrell 1999).

Predation is one of the main detriments to successful translocation of vertebrates (Wolf et al. 1996, Fischer and Lindenmayer 2000). This is often the case with naive animals that were captive-raised, because they had not developed a fear of predators. Risk of predation could be increased if animals stay at their release burrows after translocation because wastes accumulate and scent predators may home in on these individuals. A study of sibling voles (*Microtus rossiaemeridionalis*) showed that death by predation was highest within the first 3 days after release, before the animals moved from the release site (Banks et al. 2002). Kangaroo rats are preyed upon by a variety of species, including snakes, owls, hawks, weasels, and foxes (Grinnell 1932, Culbertson 1946, Hawbecker 1951, Daly et al. 1990). Snakes, weasels, and foxes may be attracted to newly constructed burrows, and kangaroo rats may not have an intricate enough burrow system to escape predators that can enter burrows. However, if kangaroo rats move around immediately, they are exposed to predators that can find them aboveground and they might not know the site well enough to find escape burrows. It is not clear to me that either strategy (moving or holding tight) reduces the risk of predation when animals are released without protection from predators.

The translocation site harbored a number of resident Heermann's kangaroo rats, and this likely contributed to the low survival rates of translocated Heermann's kangaroo rats. This is an important factor that must be considered for translocations. Abundances of kangaroo rats fluctuate greatly among years, and they can occur in high numbers (Price and Endo 1989, Williams et al. 1993, D. Germano unpublished data) and effectively saturate a site. Also, kangaroo rats are territorial, and aggressive interactions over space and resources are common (Eisenberg 1963, Randall 1989, 1993). Thus, sites to which kangaroo rats are to be moved must not have a resident population of the species to be translocated, or the site must have a small population, far below carrying capacity.

If a site appears otherwise to be good habitat, there needs to be an understanding of why resident animals are absent or are present in low numbers. In the San Joaquin Valley ecosystem, average to above-average rainfall increases cover of non-native grasses and forbs, which sometimes lead to population crashes of kangaroo rats (Single et al. 1996, Germano et al. 2001). Somewhat isolated parcels may become acceptable habitat following several dry years when grasses occur at lower densities, and the target species has not re-colonized the area. Also, kangaroo rats may be absent because of past poisoning campaigns or disease events, and may not have recolonized a site after poisoning stopped or the disease ran its course. These are the type of locations that should be considered for translocation projects.

This telemetry study of kangaroo rats in the San Joaquin Valley should not be the last word about the usefulness of translocation as a conservation tool. Because predation is often the cause of failed translocations, some biologists recommend reducing predators in areas where target animals are to be introduced (Banks et al. 2002). In the San Joaquin Valley, this is impractical or illegal, inasmuch as some of the predators are also protected species. The animals I released were provided with artificial burrows but were not afforded protection from predators or conspecifics. What has yet to be tried with kangaroo rats is building field cages around artificial burrows to allow the translocated individuals sufficient time to establish their own burrow system that could provide better protection. Although this study of radio-tagged kangaroo rats in the San Joaquin Valley demonstrated that translocating animals can lead to high mortality, until additional studies are completed, the utility of translocating kangaroo rats in the San Joaquin Valley is uncertain.

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