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ENERGY MEASUREMENTS

MORTALITY OF SAN JOAQUIN KIT FOX (Vulpes velox macrotis) AT CAMP ROBERTS ARMY NATIONAL GUARD TRAINING SITE, CALIFORNIA

September 1992

SANTA BARBARA OPERATIONS

130 Robin Hill Road

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by

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ABSTRACT

Sources and rates of mortality of a San Joaquin kit fox population (Vulpes velox macrotis) were investigated at Camp Roberts Army National Guard Training Site, California, from November 1988 through September 1991. National Guard-authorized activities, including military training, caused the death of 3 of the 94 (3%) kit foxes radiocollared, and do not appear to jeopardize the continued existence of the population. Predation by larger carnivores, primarily coyotes (Canis latrans), caused the death of 75% of the 32 radiocollared kit foxes recovered dead for which a cause of death could be determined; vehicle impacts, disease (rabies), poisoning, and shooting were each responsible for the deaths of 6.3%. Adult annual mortality rate was 0.47 and the juvenile mortality rate was 0.80, and both rates are similar to rates reported for kit foxes in other locations. There was no significant difference between male and female mortality rates in either age class. The proportions of dead kit foxes recovered in different habitat types were similar to the availability of the habitat types within the distribution of kit fox on the installation.

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1. INTRODUCTION

The San Joaquin kit fox population (Vulpes velox macrotis, formerly Vulpes macrotis mutica; Dragoo et al. 1990) was listed as endangered by the U. S. Fish and Wildlife Service (FWS) in 1967 (U. S. Department of the Interior 1967). San Joaquin kit foxes primarily inhabit the semi-arid habitats of the San Joaquin Valley, California, although small populations occur outside of the San Joaquin Valley (Morrell 1975). There has been only one comprehensive analysis of mortality in a population of San Joaquin kit foxes (Berry et al. 1987), and there is little information available on kit fox mortality within a grassland/oak woodland habitat (Balestreri 1981, O'Farrell et al. 1987).

Mortality of San Joaquin kit foxes inhabiting a grassland/oak woodland habitat in the Salinas Valley, California, was investigated from November 1988 until September 1991, as part of a study of the effects of activities occurring at Camp Roberts Army National Guard Training Site on kit fox. The purpose of the study was to provide sufficient data to evaluate whether activities authorized to take place on Camp Roberts are compatible with the continued existence of kit foxes on the installation (Berry et al. 1992).

Sources of mortality that have been documented in San Joaquin kit fox populations include predation by larger animals, vehicle impacts, shooting, poisoning, starvation, and burial (Grinnell et al. 1937, Morrell 1975, Knapp 1978, Berry et al. 1987). Morrell (1972) also considered starvation a factor in limiting the size of San Joaquin kit fox populations. Balestreri (1981) suspected that predation by larger carnivores, primarily coyotes (Canis latrans), was the major cause of kit fox mortality at Camp Roberts. O'Farrell et al. (1987) reported two kit foxes killed by vehicles on Camp Roberts.

Annual mortality rates reported for adult San Joaquin kit foxes in other locations were 0.52 on Naval Petroleum Reserve #1 in western Kern County (Berry et al. 1987), and 0.36 on the Carrizo Plain in southeastern San Luis Obispo County (Ralls et al. 1990). Mortality rates reported for juvenile San Joaquin kit foxes were 0.74 (Berry et al. 1987) and 0.46 (Ralls et al. 1990).

2. STUDY AREA

Camp Roberts is a military training site operated by the California Army National Guard with funding from the National Guard Bureau. It is located approximately 43 km east of the Pacific Ocean, midway between Los Angeles and San Francisco along U. S. Highway 101 in San Luis Obispo and Monterey Counties (Figure 1). Camp Roberts encompasses 172 km^2 of mostly gently rolling hills that form a transition zone between the Salinas River floodplain and the steep foothills of the Santa Lucia Mountains. Elevations range between 161 and 521 m above sea level. Average annual rainfall is 28.5 cm and over 90% occurs between November and April (Nakata and Associates 1987). Fog is common in winter months. Dominant vegetation associations are grassland, oak (Quercus spp.) woodland, mixed chaparral, and riparian habitat. Kit foxes occur mainly in grassland and low to medium density oak woodlands, although they also occupy developed areas of the installation where they live under buildings (Reese et al. 1992). California ground squirrels (Spermophilus beecheyi) are abundant on the installation and are the most frequent item found in kit fox scats (Logan et al. 1992). Other predators that occur on Camp Roberts include coyote, red fox (Vulpes vulpes), gray fox (Urocyon cinereoargenteus), bobcat (Felis rufus), badger (Taxidea taxus), and golden eagle (Aquila chrysaetos).

Military training activities occur throughout the year at Camp Roberts, with most occurring during the National Guard's Annual Training cycle (May - July). During this study, monthly utilization in terms of peak strength (number of individuals on the installation during the month) was lowest in January 1991 (1,214) and highest in June 1989 (13,784). Training activities include live-fire exercises from established ranges using weapons that range from .22 caliber rifles to 8-inch howitzers. Most live-ammunition firing is directed into an established impact area. Vehicles used during military activities range from motorcycles to tracked vehicles weighing over 66 metric tons. Although vehicle traffic mostly takes place along roads and tank trails, cross country travel does occur as part of certain training exercises.

Other activities authorized by the National Guard to occur on Camp Roberts include: 1) livestock grazing that allows restricted use by sheep and cattle during spring and summer; 2) controlled burning to reduce the spread of range fires that can be accidentally started by training activities; 3) a hunting and fishing program operated by the California Department of Fish and Game (CDFG); 4) a limited amount of pest control conducted to reduce rodent populations within buildings and at the sanitary landfill; and 5) a wood cutting program that allows woodcutters to remove downed dead trees. A more detailed description of all activities that occur on Camp Roberts is included in Berry et al. (1992).

3. METHODS

Radiocollars (Telonics, Mesa, AZ) were attached to 94 kit foxes after they were captured in wire mesh live-traps according to methods described in O'Farrell (1987). Foxes were trapped and collared throughout the study period, although they were generally not trapped between January 15 and May 1 to avoid causing undue stress to foxes during pregnancy and pup-rearing. A maximum of 37 kit foxes wore radiocollars at one time, which represented over 75% of the foxes known to be on Camp Roberts at the time (1991). Radiocollars weighed from 30 to 100 g, and each radiocollar weighed less than 5% of the body weight of the fox on which it was placed. The heavier (> 50 g) radiocollars were only used during the first two years of the study and were replaced with lighter collars during the last year. Radiocollars contained motion detectors that caused the transmitted pulse rate to double when they remained motionless for over 4 h (mortality mode).

Radiocollared foxes were monitored approximately five times per week and tracked to their location using a hand-held yagi antenna approximately three times per week. Attempts were made to locate radiocollared foxes that could not be detected from the ground by flying an airplane with wing-mounted antennas over the installation and surrounding areas. Carcasses of all radiocollared and non-radiocollared foxes found dead were retrieved for examination. When a carcass was recovered, time and date were recorded, and the location was plotted on a 1:24,000 U. S. Geological Survey topographic map. When only the radiocollar was recovered, location of death was assumed to be where the collar was recovered, unless additional evidence indicated otherwise.

Foxes found dead were necropsied to determine cause of death. All deaths were assigned to one of six cause of death categories: predation, road kill, disease, poison, other, or unknown. Deaths were determined to be caused by predators by the presence of tooth-puncture wounds and associated hemorrhages. When possible, predator-caused deaths were attributed to particular species based on distances between paired puncture wounds or evidence at the recovery location. Deaths caused by vehicles were determined by the presence of massive trauma and proximity of the carcass to a road. Deaths caused by either disease or poisoning were determined by a qualified veterinary diagnostic laboratory (University of California Veterinary Diagnostic Laboratory, Tulare, CA). Foxes for which a cause of death was determined but were not killed by predators, vehicles, disease, or poison were grouped into an "other" category. Cause of death was classified as unknown when the carcass was too decomposed, desiccated, or scavenged, or if only the radiocollar was recovered. Non-radiocollared fox mortality was analyzed separately from radiocollared foxes because non-radiocollared animals killed on roads are much more likely to be discovered than those killed by other causes.

Foxes were considered to be juveniles until November 30 of their birth year because San Joaquin kit foxes can breed in their first year and breeding begins in December (Zoellick et al. 1987). Foxes that were not known to be juveniles were categorized as adults. When possible, exact ages of foxes recovered dead were determined by tooth cementum annuli analyses (Matson's Laboratory, Milltown, MT).

Mortality rates were estimated with Maximum Likelihood Estimates using number of transmitter days, number of mortalities due to particular causes of death, and number of days in a time interval according to methods described in Heisey and Fuller (1985). A transmitter day was defined as any day a radiocollared fox was known to be alive. Transmitter days were considered to end on the last day a signal was received for radiocollared foxes whose transmitter signals were permanently lost. These foxes were not considered as deaths, however, because this results in overestimating mortality rates (Ralls et al. 1990). Dates of death of foxes recovered dead after their transmitter signals were lost were estimated to be midway between the last date their signals were received and the day they were recovered. Annual mortality rates of adult radiocollared kit foxes were estimated from December 1 until November 30. Juvenile mortality rates were estimated from May 30 until November 30 because May 30 was the earliest any juvenile foxes were radiocollared. All estimates of mortality rates are presented with associated 95% confidence intervals (CI) as calculated in Heisey and Fuller (1985). Initially models were constructed that included three factors: sex, month, and cause of death. Simpler models were constructed by pooling one or more of the factors. The likelihood-ratio test was used to determine if significant differences existed between models. If models were not significantly different, the simplest model was used to estimate mortality rates (Heisey and Fuller 1985). The Z-test was used to determine if significant differences existed between male and female mortality rates.

Chi-square contingency table analysis was used to assess relationships between cause of death (excluding unknowns) and year, month, sex, age class (juvenile and adult), and habitat types where fox carcasses were recovered. The habitat type for each recovery location was determined by plotting its location on a habitat map of Camp Roberts (ESA Planning and Environmental Services 1989). Habitats were classified according to one of five categories adapted from ESA Planning and Environmental Services (1989): developed or barren, grassland, low to medium density oak woodland, medium to high density oak woodland, and chaparral. Expected values were calculated by multiplying the proportion of each habitat type within the minimum kit fox distribution on Camp Roberts by the total number of deaths. The minimum kit fox distribution was defined as the minimum convex polygon that included all known fox dens and trap locations where kit foxes were trapped, excluding the installation boundary and impact area (Reese et al. 1992). Carcasses that were recovered outside of the minimum kit fox distribution were excluded from habitat analyses.

Monthly trends in mortality of juvenile and adult foxes were analyzed using a chi-square analysis comparing the total number of deaths occurring in each month to expected values. Expected values were calculated using the following formula:

$$\frac{\text{transmitter days in month}}{\text{total transmitter days}} \times \text{total number of deaths (all causes)}$$

Test statistics were considered to be statistically significant whenever probabilities were ≤ 0.05. Any differences with probabilities ≤ 0.15 were also presented because of possible biological significance.

4. RESULTS

Of 94 kit foxes that were fitted with radiocollars, 27 were collared as juveniles (14 male, 13 female) and 67 were collared as adults (30 male, 37 female). Of the 94 radiocollared kit foxes, 55.3% (52) were recovered dead, 13.5% (7) were lost, and 37.2% (35) were still alive at the end of the study. The deaths of three foxes were excluded from analyses of causes of death, mortality rates, and recovery locations because they occurred as result of the research project itself; two radiocollared foxes (an adult male and an adult female) died after getting a foreleg caught in their radiocollar; and one fox (an adult male) was euthanized after its mate died of rabies. The male occupied the same den as its mate until the day before the female was found dead so, with concurrence of FWS, it was killed to prevent it from possibly transmitting rabies to other foxes.

Of 16 non-radiocollared kit foxes recovered dead, nine were adults, three were juveniles, and the age could not be determined for four. The oldest of 39 radiocollared and non-radiocollared foxes recovered for which an exact age was determined was 8 years.

4.1 CAUSES OF DEATH

Cause of death was determined for 32 of 49 (65.3%) radiocollared kit foxes recovered dead (Table 1). Twelve of the 17 foxes classified as having an unknown cause of death were too heavily scavenged or decomposed to determine cause of death, four were recovered in good condition, but had no evidence indicating cause of death, and one had only its radiocollar recovered with no additional evidence indicating cause of death.

Three of the 32 (9.4%) foxes for which a cause of death was determined were attributed to National Guard-authorized activities: adult female #3380 was killed by a vehicle impact on the installation; adult female #3818 died after it became entangled in concertina wire that was being used during a training exercise; and adult male #3588 was apparently shot by a hunter during one of the hunting periods. Only the radiocollar was recovered from the fox that was shot. The radiocollar was found in the middle of the Nacimiento River where it flows through Camp Roberts. The collar had been cut and there were indentations on the transmitter consistent with those made by shotgun pellets.

Cause of death was determined for 8 (50.0%) of the 16 non-radiocollared kit foxes recovered dead. National Guard-authorized activities were known to cause the death of one of the eight (12.5%) foxes for which cause of death could be determined: adult #R004 (unknown sex) was killed by vehicle impact within Camp Roberts. The remaining eight non-radiocollared foxes classified as having an unknown cause of death were too desiccated or decomposed to determine cause of death.

Seventy-five percent (24) of the 32 radiocollared foxes for which cause of death was determined were killed by predators. Of the 24 predator-caused deaths, 45.8% (11) were attributed to coyotes, 8.3% (2) to bobcats, 4.2% (1) to a badger, and 41.7% (10) could not be attributed to a specific predator. All predator-caused deaths attributed to a specific predator, except for the badger, were determined from paired puncture wounds and evidence at the

recovery location. The circumstances leading to the conclusion that a kit fox was killed by a badger were as follows:

> While tracking adult female #3877 to its location at 1110 h on 8 September 1989, a badger was observed entering the same den the fox was occupying. The transmitter was not transmitting in mortality mode. When checked at 1600 h of the same day, the transmitter was still transmitting in the normal mode. At 0900 h on 9 September, the transmitter was transmitting in mortality mode from the same location. After excavating the den and recovering the fox, puncture wounds and associated hemorrhages were found, indicating it had been killed by a predator. There were no distinct pairs of puncture wounds so inter-puncture distances could not be measured.

Vehicle impacts, disease (rabies), and poisoning each caused the death of 6.3% (2) of the radiocollared foxes for which a cause of death was determined. Of the two foxes killed by vehicles, one (#3380) was previously discussed, and the other was killed on a county road outside Camp Roberts boundaries. Both foxes that died of rabies died in early 1990 (one in January and the other in April). The two foxes were recovered approximately 8 km from each other and there was no evidence that the foxes were ever in contact with each other. The fox that was euthanized because it was known to be in contact with its rabid mate did not have detectable levels of rabies antibodies in its brain tissue, but the fox could have been in the early stages of the disease when detection is nearly impossible. The poison that caused the death of two foxes was identified as chlorophacinone, an anticoagulant that was being used to kill ground squirrels on private land adjacent to Camp Roberts. Two other foxes were found dead in the same area and chlorophacinone was detected in the carcasses, but poison could not be confirmed as the cause of death; consequently, causes of death were categorized as unknown. Deaths of two radiocollared foxes were categorized as "other": fox #3818 died after becoming entangled in concertina wire, and fox #3588 was shot by a hunter, both previously discussed.

No significant relationships existed between cause of death (excluding unknowns) and month or year of death, sex, or age. Only one of the relationships had a P-value ≤ 0.15 (between cause of death and age; $X^2 = 7.47$, df = 4, P = 0.11), although the results may be invalid because there were expected values less than 1.0.

When pooled over years, there was a significant difference between observed and expected number of deaths within months for adult male radiocollared foxes ($X^2 = 28.11$, df = 11, P = 0.004), but not for adult females ($X^2 = 5.83$, df = 11, P = 0.89; Table 2), or juveniles ($X^2 = 5.10$, df = 6, P = 0.55; Table 3). The number of adult males that died in January (n = 6) was more than three times the expected value (1.53), and the number that died in December (n = 4) and in August (n = 3) were both more than twice the expected values (1.58 and 1.45, respectively).

Five (62.5%) of the eight non-radiocollared foxes for which cause of death was determined were killed by vehicle impacts (including fox #R004, previously discussed), and three (37.5%) were killed by predators.

4.2 MORTALITY RATES

A total of 20,366 adult (9,396 male, 10,970 female) and 1,874 juvenile (945 male, 929 female) transmitter days were used to estimate mortality rates. The simplest model, with data pooled over years, months, sex, and cause of death, was not significantly different from any of the more detailed models (all P-values > 0.20). The annual mortality rate for adult radiocollared kit foxes was 0.47 (95% CI: 0.34 - 0.57, Table 4). The mortality rate for juveniles from May 30 until November 30 was 0.80 (95% CI: 0.54 - 0.91). There was no significant difference between male and female mortality rates in either age class (adults: $Z = 0.05$, $P = 0.96$; juveniles: $Z = 0.50$, $P = 0.62$).

4.3 RECOVERY LOCATIONS

The locations where 47 radiocollared foxes (or their radiocollars) were recovered within the minimum kit fox distribution are plotted in Figure 2. Recovery locations of two foxes were not included in the figure: one was recovered over 5 km east of the Camp Roberts boundary, and one had only its collar recovered from the middle of a river where it had been apparently thrown by the hunter that shot the fox. Four additional recovery locations were excluded from habitat analyses because they were out of the minimum kit fox distribution: three kit foxes were recovered from within the impact area (one fox was killed by a predator, and the causes of death of the other two were unknown) and one was killed by a vehicle just outside of the southernmost boundary of the installation. Fifty-three percent (23) of the 43 foxes recovered within the minimum kit fox distribution were recovered in grassland, 33% (14) in low to medium density oak woodland, 12% (5) in medium to high density oak woodland, and 2% (1) in developed or barren habitat (Table 5). The number of foxes recovered in the different habitats were not significantly different from expected values ($X^2 = 2.28$, $df = 4$, $P = 0.69$).

5. DISCUSSION

During the 35 month study National Guard-authorized activities resulted in the death of three of the 94 (3%) radiocollared kit foxes and one of the 16 (6%) non-radiocollared foxes. There was no evidence that any of the fox deaths that could not be attributed to a specific cause were the result of National Guard-authorized activities. Consequently, activities currently occurring at Camp Roberts do not appear to jeopardize the continued existence of the kit fox population on the installation.

The percentage of radiocollared kit fox deaths due to predation during this study (75%) supports Balestreri's (1981) suggestion that predation is the major cause of mortality at Camp Roberts. This percentage is similar to the 78% figure reported by Berry et al. (1987) for radiocollared San Joaquin kit foxes in Kern County, California. The percentage of the predator-caused deaths that were due to coyotes (45.8%) was lower than expected. Berry et al. (1987) and Ralls et al. (1990) reported that 98.3% and 70.0%, respectively, of predator caused kit fox deaths were due to coyotes. It is likely that the majority of predator-caused deaths that could not be attributed to a specific predator during this study were due to coyotes. If all of the nonspecific predator-caused deaths were coyote-caused, the percentage of predator caused deaths that were due to coyotes would be 87.5%.

Bobcat predation on San Joaquin kit foxes has been previously reported (Berry et al. 1987), but prior to this study, predation by badgers had not been reported. Another kit fox-badger interaction was witnessed at Camp Roberts in 1990 when a badger was seen entering a den occupied by a radiocollared kit fox and the fox was forced to leave shortly thereafter. Ralls et al. (1990) reported that two kit foxes were killed by red foxes. While red foxes do occur on Camp Roberts, no evidence was found that any kit foxes had been killed by them.

The percentage of radiocollared San Joaquin kit foxes killed by vehicle impacts (6.3%) is slightly lower than the 10.7% reported by Berry et al. (1987). The California Army National Guard imposes speed limits of 57 km/h (35 mph) or less on all roads within Camp Roberts that may reduce the probability that animals will be killed by vehicle impacts relative to other locations.

The occurrence of rabies in San Joaquin kit fox populations has not been documented prior to this study, although a rabid kit fox was found in Death Valley National Monument in 1989 (Nancy Hagerman, National Park Service, pers. comm.). Raccoons (Procyon lotor), striped skunks (Mephitis mephitis), red foxes, and gray foxes are known vectors of rabies (Carey 1982) and all four species occur on Camp Roberts. Raccoons and striped skunks were regularly captured while trapping for kit foxes (EG&G/EM 1991). San Luis Obispo County had the highest incidence of wildlife rabies cases of all counties in California during this study (Barrett 1990, Schultz and Barrett 1991, Reilly and Mangiamele 1992). Berry et al. (1987) reported that two kit foxes died of pneumonia, but that the disease may have resulted from unusually high endoparasite burdens. Serological surveys of kit foxes have found positive antibody responses to parvovirus, toxoplasmosis, distemper, coccidioidomycosis, leptospirosis, and hepatitis (McCue and O'Farrell 1988, Standley and McCue 1992).

Poisoning was reported as a cause of death in kit foxes as early as 1937 (Grinnell et al. 1937). All anticoagulant rodenticides are generally considered to be a threat to mammalian predators, particularly canids (Hegdal et al. 1980). There are no county, state, or federal restrictions on the use of chlorophacinone within the distribution of San Joaquin kit foxes, although it is not used on Camp Roberts. The Environmental Protection Agency is currently in formal consultation with the U. S. Fish and Wildlife Service concerning pesticides, including chlorophacinone, that may affect endangered species (U. S. Department of the Interior 1991).

Shooting has been reported as a cause of death for kit foxes on several occasions (Grinnell et al. 1937, Egoscue 1962, Morrell 1975, Berry et al. 1987). All hunters must check in and out of Camp Roberts through a CDFG-operated check station, where information regarding kit foxes and the penalties for harassment of endangered species is distributed. These policies may reduce the possibility that any kit foxes will be shot on the installation.

Entrapment within dens has been reported as a cause of death of kit foxes in other studies (Knapp 1978, O'Farrell and Gilbertson 1986), but no evidence of this occurring at Camp Roberts was found. The California Army National Guard requires surveys for kit fox dens be conducted prior to any construction activities or training exercises which involve mechanical digging which may impact kit foxes, so that dens can be avoided when possible. These surveys may reduce the probability that kit foxes are killed by entrapment.

Mortality rates estimated during this study were similar to rates estimated for kit foxes in other locations. The adult annual mortality rate estimated during this study (0.47) is slightly lower than the 0.52 reported by Berry et al. (1987) for kit foxes on Naval Petroleum Reserve #1, and slightly higher than the 0.36 reported by Ralls et al. (1990) for foxes on the Carrizo Plain. The mortality rate for juveniles from May 30 until November 30 of 0.80 is similar to the 0.74 reported by Berry et al. (1987), but 74% higher than the 0.46 reported by Ralls et al. (1990). Because National Guard-authorized activities did not result in the death of any radiocollared juvenile kit foxes, the difference between juvenile mortality rates in the two areas were not likely to be due to those activities.

6. CONCLUSIONS

Over a 35-month duration, National Guard-authorized activities resulted in the death of four kit foxes, but do not appear to jeopardize the continued existence of the population on Camp Roberts. Predation by larger carnivores, primarily coyotes, is the main cause of kit fox mortality. Vehicle impacts, disease, poisoning, and shooting were also responsible for the deaths of kit foxes on the installation. Mortality rates of kit foxes at Camp Roberts are similar to rates reported for kit foxes in other locations. The proportion of dead kit foxes recovered in different habitat types were similar to the availability of the habitat types within the distribution of kit fox on Camp Roberts.

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7.2 PERSONAL COMMUNICATIONS

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Table 1. Causes of death for radiocollared San Joaquin kit foxes recovered at Camp Roberts from November 1988 to September 1991, by sex and age.

AGE	SEX	CAUSE OF DEATH						
		Predation	Roadkill	Disease	Poison	Other	Unknown	All
Adult	Male	10	1	0	0	1	4	16
	Female	7	1	2	0	1	8	19
	Both	17	2	2	0	2	12	35
Juvenile	Male	4	0	0	1	0	3	8
	Female	3	0	0	1	0	2	6
	Both	7	0	0	2	0	5	14

Table 2. Observed and expected monthly number of deaths of adult radiocollared San Joaquin kit foxes at Camp Roberts from November 1988 to September 1991.

MONTH	MALE		FEMALE	
	Observed	Expected	Observed	Expected
December	4	1.58	2	1.58
January	6	1.53	2	1.89
February	2	1.18	3	1.61
March	1	1.19	3	1.62
April	0	1.19	1	1.51
May	0	1.34	2	1.60
June	0	1.38	0	1.64
July	0	1.43	1	1.69
August	3	1.45	2	1.88
September	0	1.51	2	1.73
October	0	1.08	0	1.07
November	0	1.16	1	1.18

Table 3. Observed and expected monthly number of deaths of juvenile radiocollared San Joaquin kit foxes at Camp Roberts from November 1988 to September 1991.

MONTH	MALE		FEMALE	
	Observed	Expected	Observed	Expected
May	0	0.03	0	0.01
June	1	1.57	0	0.58
July	2	2.13	2	1.59
August	2	1.53	4	1.45
September	2	1.01	0	1.19
October	0	0.74	0	0.60
November	1	1.00	0	0.58

Table 4. Mortality rates of San Joaquin kit foxes radiocollared at Camp Roberts from November 1988 to September 1991, by sex and age.

AGE	SEX	N	MORTALITY RATE[1]	95% CONFIDENCE INTERVAL
Adult	Male	16	0.46	0.27 - 0.60
	Female	19	0.47	0.29 - 0.60
	Both	35	0.47	0.34 - 0.57
Juvenile	Male	8	0.84	0.43 - 0.95
	Female	6	0.75	0.24 - 0.92
	Both	14	0.80	0.54 - 0.91

1 - Adult annual mortality rate from December through November, juvenile mortality rate from May 30 through November 30.

Table 5. Observed and expected number of deaths of San Joaquin kit foxes at Camp Roberts from November 1988 to September 1991, by habitat.

HABITAT	NUMBER OF DEATHS	
	Observed	Expected
Developed/barren	1	3.62
Grassland	23	22.12
Oak woodland, low - medium density	14	12.01
Oak woodland, medium - high density	5	5.24
Chaparral	0	0.003