State of California
The Resources Agency
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INTRODUCED RED FOX IN CALIFORNIA

by

Jeffrey C. Lewis
Kevin L. Sallee
and
Richard T. Golightly Jr.

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CONTRACTOR

Department of Wildlife, Humboldt State University

Arcata, CA 95521

AUTHORS

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ABSTRACT

In a telephone survey of wildlife professionals in California, introduced red fox were reported from 36 of 58 (62%) counties in California. The introduced red fox ranged along the Pacific coast from southern San Diego County to Marin County. They were reported in western Riverside County northward through the Sacramento valley and western Sierra foothills to central Shasta County. Populations were contiguous in urban areas and may be contiguous in rural areas as well. The diet of the introduced red fox in the urban environment was diverse and consisted of birds, mammals, insects, seeds, fruit and human foods. Among radio-collared foxes (n = 23) in urban Orange County, California, females had the greatest survival rate for both juveniles and adults. Overall, dispersing juveniles had the greatest mortality rate. Sources of mortality for urban foxes included collisions with autos, disease, an attack by a dog, and accidents other than vehicle collisions. Juvenile males were the most likely to disperse. Average dispersal distance for all successful dispersers was 9.8 ± 1.85 km (6.1 ± 1.15 mi.). Three of the radio-collared foxes were known to have bred their first year. Average litter size was 4 pups per litter (n = 7 litters) in 1991 and 3 pups per litter (n = 5 litters) in 1992. Urban foxes were found to use all aspects of the urban environment, from open fields and beaches to residential developments. Corridors for travel for both resident and dispersing foxes included flood channels, beach strands, railroad tracks, and powerline corridors. Red fox densities varied between sites.

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INTRODUCTION

In California, the red fox (Vulpes vulpes) has been reported to be native to the Sierra Nevada and southern Cascade Mountains (Grinnell et. al. 1937). However, since the 1890's the red fox has been found in several areas of California which were not part of its historical range (Grinnell et al. 1937); these foxes were probably fur farm escapees, fox hunt survivors, and intentionally-released pets or captives that have established breeding populations. Based on morphological parameters, the introduced foxes from the Sacramento Valley appear more closely related to the Northern Great Plains subspecies of red fox (V. v. regalis) rather than the Sierra Nevada red fox (V. v. necator) (Roest 1977).

Introduced red fox have established breeding populations throughout the Sacramento Valley (Gray 1975, 1977). Gould (1980) reported the range expansion of this population into Contra Costa and Alameda counties, as well as additional sightings in Marin, Santa Cruz, Ventura, and Los Angeles counties.

Introduced red foxes are considered a threat to populations of endangered wildlife including the light-footed clapper rail (Rallus lonagirostris levipes), the California clapper rail (Rallus longirostris obsoletus), the California least tern (Sterna antillarum browni), the salt marsh harvest mouse (Reithrodontomys raviventris), Belding's Savannah sparrow (Passerculus sandwichensis beldingi) (U. S. Fish and Wildlife Service and U. S. Navy 1990, U. S. Fish and Wildlife Service 1990), and the San Joaquin kit fox (V. macrotis mutica) (Ralls et. al. 1990). The introduced red fox may also present a threat to the native Sierra Nevada red fox by competing for available habitat, interbreeding or transmitting diseases.

Red fox trapping programs have been used as a means to protect the California least tern and the light-footed clapper rail from predation, but have also created controversy (U. S. Fish and Wildlife Service and U. S. Navy 1990). In some urban parks these foxes were treated as pets, and fed daily by people. In these same areas they may present health risks to the public. These concerns present difficult management problems.

Information about introduced red foxes in California has not been avaliable for wildlife managers. To develop or assess management alternatives to red fox control programs, a better understanding of the ecology of red foxes was needed. Specifically, need existed to understand local sources of depredating red foxes, how they traveled to endangered-species nesting areas, and the age of foxes that colonized on or near these areas. Sex-specific dispersal patterns, dispersal distances, dispersal routes, rates of dispersal, timing of dispersal, and dispersal direction needed to be investigated to answer these questions. Further, identification of home range, food habits, habitat use, and movement characteristics of resident foxes would clarify the impact on native fauna.

An investigation of the distribution of red fox sightings throughout California was necessary to assess the present range and population status. Determining the extent to which an introduced species has become established was important in assessing or forecasting impacts on native species and habitats.

Specific components of juvenile dispersal that were addressed in this study included: dispersal routes, dispersal distances, mortality of dispersing and non-dispersing foxes, proportions of juveniles dispersing, and timing of dispersal. Specific home range and land-parcel use questions that were addressed included: age- and sex-specific home range size and land-parcel use of radio-collared foxes. Questions related to food habits included; what food items were consumed by red foxes?; and how consistant these items were found in the red fox diet? Specific statewide distribution questions included: where have red foxes been sighted outside of the accepted range of the native Sierra Nevada red fox?; and what was the range of the introduced red fox in California?

The California Department of Fish and Game (CDFG), Nongame section, and the U. S. Fish and Wildlife Service (USFWS) cooperatively provided financial support for the project.

STUDY AREA

The distribution of the introduced red fox was investigated throughout California except in areas inhabited by the Sierra Nevada red fox. The northwestern half of Orange County, California, was used as the study area for investigating dispersal, home range and land-parcel use, mortality, survival, reproduction, and age structure (Figure 1). The study area was bounded on the northwest by the San Gabriel River and Coyote Creek flood channels, which delineate Orange County from Los Angeles County. It was bounded on the West by the Pacific Ocean, and to the North by California State Highway 91. The study area included the Pacific coast from Seal Beach to Newport Beach, and included areas as far east as the cities of Tustin and Orange. This portion of Orange County was predominantly urban and suburban in nature and was interspersed with open spaces. These open spaces included golf courses, parks, airfields, cemeteries, wetlands, agricultural fields, powerline and highway corridors, and undeveloped lands.

Much of Orange County (including the study area) is located in the Southern California coastal plain. Orange County has a Mediterranean climate characterized by wet winters and dry summers. Average annual rainfall was 32.0 cm (12.6 inches) (Kehew 1992). Mean temperatures ranged from 13.3 °C (55.9 °F) in January to 22.9 °C (73.3 °F) in August while the annual mean temperature was 17.8 °C (64.0 °F) (Kehew 1992). The elevation of the study area ranged from sea level to approximately 100 m (328 feet).

Research activities were frequently located at specific sites within the study area and these areas warrant detailed description. Mile Square Park is administered as an Orange County Regional Park. It is one mile square in area (2.25 km^2) and includes a park and two privately-owned golf courses in Fountain Valley, California. Orange County Sewage Treatment Plant #2 is an industrial facility with open space; the plant is located adjacent to the Pacific coast at the mouth of the Santa Ana River in Huntington Beach, California. Bolsa Chica Ecological Reserve includes tidal salt marsh, grassy uplands, and scattered oil-pump sites and is located on the Pacific coast in Huntington Beach, California. Los Alamitos Armed Forces Reserve Center is an 8.0 km^2 (3.0 mi^2) military installation located north of Interstate Highway 405 in Los Alamitos, California. It consists of an airfield, open grasslands, agricultural lands, and two golf courses.

METHODS

Red Fox Distribution

The statewide distribution of the introduced red fox was investigated by conducting telephone interviews with wildlife professionals and related individuals throughout the state. A sighting was any red fox that had been seen in the field by the person being interviewed or a red fox that the person had direct knowledge of as a specimen (i.e., museum specimen). Each telephone interview sought to acquire information about each red fox sighting, including reliability, date, and location of the sighting. The reliability of a sighting was based on the experience that the interviewed individual had with red foxes, and/or the accuracy of the description of the reported animal. For efficiency, new locations were mapped only if they were at least 1.6 km (1 mile) distant from the nearest previously reported location.

Presently, no reliable means is available to visually distinguish the native Sierra Nevada red fox from the introduced red fox. Therefore, interviewing efforts were concentrated in areas outside of the historical range of the Sierra Nevada red fox as reported by Grinnell et al. (1937). Consequently, no red fox sightings above 1066 m (3500 ft.) in the Sierra or Cascade Ranges were included in the distribution. With the exception of Orange County and two sightings acquired from letters that included photographs of the red foxes, sightings were collected only by telephone interview. In Orange County, historical references (e.g., reports and books) were also used in determining distribution within that one county.

Red Fox Food Habits

Food habits were investigated by collecting fox fecal material (scat) once each month from specific sites. Collection sites were cleared of scat during each collection; thus subsequent collections contained only recent (since last collection) scat deposition. This allowed assessment of seasonal variation in fox food habits. Scats were air-dried and shipped to the Humboldt State University (HSU) Department of Wildlife. Upon arrival at HSU, scats were frozen until analysis.

Fecal samples were randomly chosen from within each monthly collection at each collection site. Samples (11-13g: 3-5 fecal deposits) were washed and the remaining insolubles were then oven-dried. The oven-dried samples were stored in a desiccator until analyzed. Samples were separated into food items by similar groups of fragments (i.e., feathers, seeds, hair, bones, etc.) with the aid of a dissecting microscope. Each sample was searched until all identifiable fragments had been separated, or for a maximum of 2 hours. Usual search time was approximately 1 hour.

Additional samples from a single collection continued until no new prey items were found in succeeding samples. Once food remains were separated they were identified using reference texts (Ingles 1965, Swanson and Papp 1972) and mammalian, avian, invertebrate, and plant reference collections at HSU. We were assisted by the U. S. Department of Agriculture and the San Diego Museum of Natural History in the identification of seeds. Once identified, food items were summed by season, food type, and specific food item.

Population Information and Dispersal

Red foxes were captured and radio-collared (Mod 300 collar, Telonics, Mesa, AZ) to obtain location data for determining home range, habitat use, arid dispersal. Tomahawk box (cage) traps (121 cm by 68 cm by 52 cm, or 107 cm by 41 cm by 41 cm, or 81 cm by 33 cm by 28 cm; Tomahawk Live Trap Co., Tomahawk, WI) were used in all trapping. Degree of wear on incisors was used as a primary indicator of age (Harris 1978), and weight and coat condition were used as secondary age indicators. For the purposes of this study, distinguishing between adults and juveniles was adequate.

Each radio-collared fox was identifiable by the individual markings on its ear tags and radio-collar. Colored reflective tape was placed on the ear tags and radio-collar so that individual animals had a unique color combination (e.g., red tag in right ear, blue tag in left ear). Color-coded ear tags and radio-collars allowed other biologists and lay individuals without radio-receivers to identify individual foxes. The colored reflective tape could be seen at a 150 m distance at night with a spotlight, or during the day.

Survival and mortality rates of radio-collared foxes were estimated using the Micromort computer program (Heisey and Fuller 1985). The interval over which survival rate was estimated for juveniles began on 9 July (earliest radio-collaring) and continued for 250 days until 15 March, which was the estimated whelping date for observed litters. For adults, a 365-day interval was used (15 March - 14 March). Survival and mortality rates were estimated age- and sex-specifically for dispersers and l-year olds, and for juveniles captured in July. Mortality rates were estimated cause-specifically.

Midnight spotlight surveys were conducted at Los Alamitos Armed Forces Reserve Center and Mile Square Park to assess population size and trends at these two northwestern Orange County sites. All observed red foxes were counted and the presence or absence of a tag or collar was recorded. Survey routes were chosen to minimize the possibility of recounting any individuals seen while the observer drove once along a predetermined route through the site.

Dispersal characteristics were determined for individuals that moved away from established home ranges or natal sites.

When a radio-collared individual could not be located, a search was conducted to locate its radio signal. This was continued until the individual was found or considered missing (after extensive searches). Once the animal was found, the direction of dispersal from the original home range (or den site for juveniles) and the straight-line distance was recorded. Radio-telemetry locations were obtained at the rate of three locations per week in the new home range (which was calculated as distinct from the pre-dispersal home range).

Home range and land-parcel use by foxes were determined by obtaining at least three independent locations per week per individual fox. Adults and juveniles were followed to observe temporal land-parcel use and movement rates. The Mcpaal computer program (Stuwe and Blohowiak 1985) was used to generate Minimum Convex Polygon (MCP) (Harvey and Barbour 1965) and Harmonic Mean Transformation (HMT) (Dixson and Chapman 1980) estimates of home range size. All HMT estimates were based on a calculation using 15 grid divisions and 95% of the locations.

Juveniles were considered adults when they survived to 15 March. If a fox did not disperse, the total number of locations as a juvenile and adult were included when estimating their adult home range. However, dispersing juveniles had two home ranges.; a juvenile home range prior to dispersal and an adult home range after dispersal. This methodology caused a loss of independence between non-dispersing juvenile and adult home ranges so no tests beyond the average home range size of each group was performed.

Different features of the urban environment, such as residential areas, open fields, parks, etc., were categorized as different land-parcel types. Any land-parcel type or types that were separated only by a road, flood channel, or other thin barrier were considered contiguous. A patch of open space was considered to consist of the total area of contiguous land parcels exclusive of residential and retail business development. Home range size in comparison to the amount of open space was investigated using linear correlation (Zar 1984). The areas of land parcels were calculated from color aerial photographs (1:17400; Airborne Systems, Anaheim, CA).

Movement patterns of red foxes were determined by continual tracking of collared animals. Because constant surveillance of collared foxes was usually difficult, movement information was gathered by analyzing relocations collected as frequently as possible. However, sampling techniques other than constant surveillance cannot fully describe a fox's movement during a single time period.

RESULTS

Red Fox Distribution

Telephone interviews were conducted with 199 individuals. Of these, 125 individuals (63%) had sightings of red foxes. These individuals produced 319 sightings of introduced red fox (below 1066 m or 3500 ft. in elevation) (Table 1, Figure 2, and Appendix 1). Red foxes are extremely mobile, can travel large distances in a short period of time, and can have large home ranges. Locations do not infer the presence of reproductive or large established populations nor do locations infer density or timing of colonization of certain areas; however in some areas the density of locations may be grossly associated with a generalized (and perhaps dense) fox population.

Red fox sightings were recorded in the coastal areas from Mission Bay just north of San Diego in San Diego County to Point Reyes National Seashore in Marin County. Red foxes were sighted throughout the San Joaquin and Sacramento Valleys from an area extending from Bakersfield in Kern County northward to the Whiskeytown National Recreation Area in Shasta County. Sightings were reported as far east as western Riverside County and the western Sierra Nevada foothills (below 1066 m or 3500 ft.) in El Dorado, Madera, Fresno, Placer and Tulare Counties. Other sightings were reported in the Salinas River Valley in Monterey and San Luis Obispo Counties, in the Carrizo Plain in San Luis Obispo County, and in the San Francisco Bay Area in Alameda, Contra Costa, Santa Clara, and San Mateo Counties. Additional sightings for the North Bay and Delta region occurred in Solano, Napa and Sonoma Counties. No sightings were recorded for the coastal area between northwestern Santa Barbara County and Monterey Bay in Monterey County.

Excluding the Sierra and Cascade foothills, red foxes were reported at relatively high elevations in some counties. Sightings were reported as high as 750 m in the coastal ranges in San Luis Obispo county, and 800 m in Santa Clara County. Maximum elevations of 1000 m and 1100 m were recorded for sightings in the San Gabriel mountains in Los Angeles County and the San Jacinto Mountains in Riverside County, respectively.

Two red fox sightings occurred near Fall River Mills in northeastern Shasta County; these sightings were located directly between the 2 northern most portions of the historical Sierra Nevada red fox range. Because of the uncertainty of the taxonomic status of these foxes they were not included in the statewide distribution map (Figure 2). In the Sierra Nevada and Cascade Ranges, only sightings that occurred below 1066 m (3500 ft.) in elevation were considered to be observations of the introduced red fox. Sightings of red fox above this elevation in the Sierra and Cascade Ranges were not included in the statewide distribution of introduced red fox.

The distribution of introduced red foxes in Orange County was also investigated in detail (Appendix 2). Twenty-two den sites and 39 independent sightings were reported in Orange County (Figure 3). Prior to this report, the scientific literature had not reported red foxes in Orange County (Grinnell et al. 1937, Hall and Kelson 1959, Ingles 1965), however we recorded sightings in Orange County as early as 1942 and 1965. Only den sites greater than 1.6 km (1 mile) away from previously mapped den sites were added to the distribution of den sites in Orange County. All den sites, and 35 of the 38 independent sightings occurred in urban areas; urban areas were characterized by residential, industrial, commercial, or similarly developed areas with interspersed open spaces and corridors. These landscape features characterized much of northern Orange County.

Red Fox Food Habits

Fox scats were collected approximately once a month from 7 sites in Orange County (Table 2). Scat was collected once at Seal Beach NWR and Costa Mesa High School.

From the 7 collection sites, 447 fecal samples (approximately 1800 scats) over all seasons were analyzed. Insects, seeds, birds, mammals, and human-food packaging were regularly ingested. Invertebrates, seeds, birds, and mammals were each found in ≥ 50% of the samples, regardless of season (Table 3, Figure 4). While anatids and passerines were the most frequently found avian food items in scat samples, their percent occurrence was greatest in the summer and fall samples (Table 4). Pocket gophers (Geomyidae) were the most frequently encountered mammalian food item regardless of the season (Table 5). Invertebrates in scats included insects (6 orders), arachnids, crustaceans, and mollusks (Appendix 3). Seeds occurring in scats included ≥ 44 genera in ≥ 28 plant families (Appendix 4). Most seeds were consumed as part of a plant fruit. Aluminum foil, plastic, and paper were the most frequently found human food packaging and were consistently found in the samples. Eggshells were found in all seasons.

Opportunistically acquired food was difficult to quantify or observe due to limited access to certain areas (e.g., pet food-dishes in back yards). However, regular feeding of foxes by people was consistent in some areas and was thus measurable. At Mile Square Park a single individual provided an average of 7.12 ± 0.033 kg (mean ± standard error) of food per day (measured during a 48 day period) to the approximately 40 foxes at Mile Square Park (which equates to 0.177 kg/fox-day). Food provided at this site consisted of beef, chicken, turkey, and fish.

Additional food habits data were collected by observations of predation, and identifying remains at red fox cache sites and den entrances (Table 6). Only vertebrate species were identified at den entrances. Seven species of birds that were not identified in the scats were found at dens. These included gulls (*Larus* sp.), a marbled godwit (*Limosa fedoa*), house sparrow

(*Passer domesticus*), mourning dove (*Zenaida macroura*), crow (*Corvus* sp.), cormorant (*Phalacrorax* sp.) and American avocet (*Recurvirostra americana*).

Red Fox Population Information and Dispersal

Fox Capture and Tagging

From June 1990 to March 1992 red foxes were captured and radio-collared at 8 different sites. A total of 33 red foxes were captured including 18 juveniles and 15 adults (excluding a fox family removed by the CDFG from the 55-freeway in May 1991) (Appendix 5). A total of 23 foxes were radio-collared and ear-tagged (15 juveniles and 8 adults). The remaining 10 were ear-tagged (3 juveniles and 7 adults, all at Mile Square Park). Each radio-collared and ear-tagged fox appeared to be in good condition and was released unharmed.

Of the 23 foxes, 18 were captured in baited box traps. The remaining 5 foxes were captured by chasing them out of a 75 m long culvert (used by these foxes as a diurnal resting area) into unbaited box traps. From June 1990 to January 1991, 15 foxes were captured using box-traps in 444 trap nights (3.38% trap success). The three foxes caught from July 1991 to March 1992 were captured in 67 trap nights following 341 pre-bait nights (4.48% trap success) (Table 7). There were 17 recaptures during the two-year period.

Survival

Fifteen radio-collared juveniles (11 in 1990 and 4 in 1991) were followed over a portion of their first year (Figure 5). Seven of these were captured in July. The remainder of the juveniles were captured between September and January. The survival rate was lowest for dispersing juveniles (all July captures). No juvenile female mortalities were observed; their survival was 100%. Small sample size (n = 6) may contribute to the result; however, lack of mortality may also represent a higher survival likelihood for juvenile females. The small sample sizes for each population segment consequently result in survival estimates that lack precision (as evidenced by the large confidence intervals; Table 8). Survival rates were estimated for 12 radio-collared adults over a 365-day period from 15 March 1991 to 14 March 1992 (Table 8, Figure 5). Adult survival rates ranged from 0.50 for males to 0.72 for females (Table 8).

Mortality

There were 12 (52.2%) mortalities among the radio-collared foxes (Table 9). The causes of the mortalities included collisions with automobiles (n = 4), unknown causes (n = 4), removal via red fox control program (n = 2), suffocation in a tar pit (n = 1), and an attack by a dog (n = 1). The tar pit was labeled a hazardous-substance lagoon by the property owners. Adult males, juvenile males, and dispersing juveniles suffered the highest mortality rates (Table 10). Small sample size may partially explain the lack of juvenile female mortality; however, juvenile and adult females collectively suffered the fewest mortalities among the radio-collared foxes.

Unknown deaths included disappearances and unrecoverable foxes, as well as foxes dying of unknown causes (Table 9). Fox #17 at Los Alamitos Armed Forces Reserve Center was last located on 25 July 1991. Despite extensive searching around the area and on Seal Beach Naval Weapons Station, she was never located. Fox #15 from Mile Square Park had a radio signal in an inaccessible location (under a building). The signal did not move from its location from 27 January 1992 to 1 June 1992. Consequently, the status of the animal was unknown.

Between 1 September 1991 and 31 October 1991, seven fox carcasses were retrieved from Los Alamitos Armed Forces Reserve Center and all were infested with sarcoptic mange. There was a corresponding decrease in the number of live foxes observed during spotlight surveys at Los Alamitos Armed Forces Reserve Center during this same time period (Figure 6).

Density

There were 13 animals with reflective ear-tags at Mile Square Park on 15 November 1991 when a spotlight survey was conducted. By counting the number of marked (n = 7) and unmarked animals (n = 14) an estimated 39 foxes occupied this site (Seber 1973). This corresponded to a density of 17 red fox per square kilometer (39 per square mile). Density of foxes was not estimated at Los Alamitos Armed Forces Reserve Center, however a maximum of 12 individual foxes were identified during a spotlight survey on 20 August 1991. The 12 individuals probably represented only a portion of the foxes present at this site. Sites including Bristol St. (55-Freeway), Crescent Ave., Orange County sewage treatment plant #2, and the Anaheim powerline site were occupied by single fox families. Densities of foxes at these sites were not determined because an appropriate and bounded area of use could not be delineated for the entire family; consequently mark-recapture techniques could not be used.

Dispersal

Dispersal was defined in 3 ways: 1) a gradual shift from one home range to another; 2) a series of exploratory trips prior to a final departure; and 3) a single, unpredictable exodus (Voigt and Macdonald 1984). Seven dispersals were observed (Table 11) among the 23 radio-collared foxes.

Five of the 15 radio-collared juveniles (33%) dispersed. There were 4 males (80%) and 1 female (20%) among the 5 juvenile dispersers. There were 4 dispersers (44%) among the 9 juvenile males radio-collared. Among the 6 juvenile females radio-collared, 1 (17%) dispersed. Because dispersal occurred as early as August, it was not possible to ascertain if the foxes captured after (or during) August had not already dispersed. Therefore it was possible that some of the foxes captured after August may have completed dispersal prior to capture. When considering only juveniles captured in July, 80% (4 of 5) of the males and 50% (1 of 2) of the females dispersed. Adult males dispersed proportionately less than juvenile males captured in July (40% vs. 80% respectively). Only two of five dispersing juveniles (40%) survived and established home ranges (1 male, fox #9; 1 female, fox #23).

Two of the radio-collared foxes dispersed as adults (n = 18; 11%); both were males > 3 years old. Yearling adults accounted for 10 of the 18 radio-collared adults, however none dispersed as adults. Of the 10 radio-collared adult males, 25% moved their home range.

The timing of dispersal for radio-collared juveniles ranged from 12 August to 5 January (Table 11). Juveniles first dispersed at approximately 5 months of age (using 15 March as an average whelping date). The 2 adult males dispersed on 24 November (fox #l) and 15 December (fox #3).

Flood channels, powerline right-of-ways, beach strands, and railroad corridors were considered the most likely features to facilitate dispersals. Land-parcels with open or green space characteristics that were linked continuously or directly adjacent would also facilitate dispersal. Though not all foxes could be followed during dispersal, continuous tracking data of resident and 2 dispersing foxes have shown that these landscape features were used by foxes.

Straight-line dispersal distances were determined for both successful and unsuccessful dispersers (Table 11). Successful dispersers were those that survived dispersal and established a home range. Unsuccessful dispersers were those that died during dispersal. Successful foxes dispersed an average of 9.8 ± 1.85 km (Figure 7). Fox #l was known to disperse 9.8 km within a 48 hr period. Unsuccessful dispersal distances varied greatly but only partially reflected the progress of dispersal before mortality (Figure 8). For example, from 2 January to 12 January 1992 fox #15 made a 21 km (13 mi; straight-line distance). exploratory round-trip to Seal Beach Naval Weapons Station and back to Mile Square Park, moving from Seal Beach Naval Weapons Station to Mile Square Park in less than 24 hours. This fox died 1.7 km from the park during a movement the following night.

Dispersal directions ranged from 211 to 75 degrees. Orange County is bounded by the Pacific Ocean on its southwestern border and this limited dispersal direction. Foxes #22 and #23 both dispersed along the coast in a northwesterly direction, and were known to use the beach strand (Figures 7 and 8). Fox #l dispersed and established a home range that bordered the ocean (Figure 7).

<u>Reproduction</u>

Fox #2 (The Crescent Avenue female) and the Bristol Street female (an untagged female that was associated with fox #l) each used at least 3 different dens to raise single litters of pups. Pups of one litter occupied more than one den at a time; this occurred in one instance when dens were 1.1 km apart. Foxes #21 and #23 were radio-collared yearling females that were observed raising pups. Yearling male #9 apparently mated and raised a litter of pups. Individuals #9 and #23 dispersed prior to mating.

In 1991 litter sizes were observed to range from 1 to 9 pups with a mean of 4.0 pups per litter (n = 7 litters). In 1992 litter sizes were observed to range from 2 to 4 with a mean of 3.0 pups per litter (n = 5 litters). However, litter size estimates used inconsistent methodology because some litters were counted before emergence (n = 3 litters) from the den while other litters were counted at various times after emergence (n = 9 litters). Pup mortality before or after emergence was unknown. Dens which were not located may have contained additional pups.

Den sites at Los Alamitos Armed Forces Reserve Center and Mile Square Park were found in flat open areas. At Mile Square Park 8 active den-sites were observed in both 1990 and 1991. At Los Alamitos Armed Forces Reserve Center, 5 active den sites were observed in 1991. Active den sites however do not correspond directly to numbers of litters, but it is believed that multiple litters were raised at both Mile Square Park and Los Alamitos Armed Forces Reserve Center. At Seal Beach Naval Weapons Station and Seal Beach NWR, 8 red fox dens were found in 1987 and 14 were found in 1988 (U. S. Fish and Wildlife Service and U. S. Navy 1990). Other den sites within Orange County were located in flood channel embankments (n = 7), freeway embankments (n = 4), golf course sand traps (n = 2), Christmas tree plantations (n = 2), scrap metal and rock piles (n = 2), a railroad embankment (n = 1), a pipeline passageway under a road (n = l), and a salt marsh dike (n = 1).

Home Range and Land Parcel Use

Home range estimates were calculated for all collared foxes (n = 23) as adults and juveniles using data collected from June 1990 to 30 May 1992 (Table 12). Mean home range size as estimated by the Minimum Convex Polygon (MCP) method for adult males (n = 11) and females (n = 8) was 4.35 ± 1.52 km^2 and 4.15 ± 1.58 km^2, respectively. Mean home range size as estimated by the Harmonic Mean Transformation (HMT) method for adult males and females was 3.80 ± 1.21 km^2 and 3.85 ± 1.59 km^2, respectively. Mean juvenile home range size was 71.1% of mean adult home range size as estimated by the MCP method and 87.2% as estimated by the HMT method.

Land-parcel types that were found in red fox home ranges included: (1) non-residential manicured lawns (athletic fields, parks, and golf courses), (2) wetlands and estuaries (vegetated salt flats, tidal salt marshes, and vegetated dunes), (3) flood control channels and riparian areas, (4) vacant fields or undeveloped lands (airport fields, grasslands, and disturbed lands), (5) agricultural land (farmland, tree plantations and nurseries often associated with powerline right-of-ways), (6) residential and retail business areas, (7) beaches, (8) railroad tracks and major highways, (9) and industrial lands (e.g., oil-fields and industrial parks) (Table 13). Vacant fields were found in all (100%), manicured lawns were found in almost all (96%), and flood channels were found in most (68%) of the home ranges. No other single land parcel type occurred in more than 40% of the home ranges.

Four sites had two or more radio-collared foxes. The mean home range size calculated with MCP was 10.02 ± 0.10 km^2 for the foxes at Bolsa Chica Ecological Reserve, 2.84 ± 0.22 km^2 for foxes at Los Alamitos Armed Forces Reserve Center, 0.81 ± 0.14 km^2 for foxes at Mile Square Park, and 0.46 ± 0.05 km^2 for foxes at the Crescent Ave. site. Using a nonparametric ANOVA test (Zar 1984), home range size varied significantly between these sites (H. = 11.9, P < 0.01). In addition, there was a positive correlation (r = 0.90 for MCP, r = 0.91 for HMT) between the log,, of the average home range size and the area of open space

Movements

Movement data were collected for eight individual foxes through continuous tracking for a period of time (Table 14). Travel rates varied from 0.58 km/hr to 3.3 km/hr with a mean of 1.66 ± 0.33 km/hr. Four radio-collared foxes (#l, #8, #17, and #23) crossed streets during tracking episodes. Two foxes (#4 and #15) used home ranges without streets. Collared foxes were found to use an average of 2.67 ± 0.43 land-parcel types per hour.

DISCUSSION

Red Fox Distributions

State-wide Distribution

Red foxes were brought to California for the purposes of fox-hunting (Sleeper 1987) and fur ranching. Roest (1977) suggested that red foxes may have been brought from the midwest via the newly-constructed (in 1869) transcontinental railroad as settlers moved west after the Civil War. Foxes that survived being hunted, or that escaped from fur farms or transporting vehicles (Fichter and Williams 1967) were likely ancestors of foxes that presently occupy much of the range of the introduced red fox. Vail (1942) reported that in the early 1940's, approximately 125 fox farms existed in California which supported approximately 20,000 foxes. Other means of red fox introduction may have included transplantations of previously introduced foxes, escaped or released pet foxes, or intentional introduction of foxes to control rodent populations. Davidson et al. (1992) reported the illegal translocation of red foxes as recent as 1989 from Ohio to South Carolina.

Introduced red fox colonization is not specific to California; it has occurred in other states including Washington (Aubry 1984) and Idaho (Fichter and Williams 1967). Escapees from fur farms, and foxes intended for fox-hunting were also believed to be sources of introduced foxes in these states. In Washington, inbreeding and competition with the native red fox (V. v. cascadensis) were biological concerns of non-native red fox introduction (Aubry 1984). In Idaho, Fichter and Williams (1967) reported public concern over game bird and livestock predation by introduced red foxes but also reported the geographically expanded harvest of red foxes for fur. Macdonald (1987:14) described the introduction of red foxes into Australia for fox-hunting. He stated that introduced red foxes were held partially responsible for the decline of the brush-tailed rock wallaby (Petrogale penicillata), the crescent nail-tailed wallaby (Onychogalea sp.), and the native malee fowl (Leipoa ocellata).

The state-wide distribution described from telephone interviews illustrates the extent of introduced red fox colonization in California (Figure 2). The present distribution appears to be expanding both internally and externally. The increase in the number and distribution of counties with reported red fox sightings represents an external expansion from earlier reports such as Gray 1975 (Table 1). The accumulation of sightings, particularly those after 1985, suggests that recently an expansion has also occurred within several counties. Unfortunately, population density cannot be inferred from the distribution or number of sightings. A single fox could be seen at different times and places; conversely, large numbers of foxes may exist undetected if people do not frequent the site of the population.

Considering only areas actively studied in Orange County and the Orange County Animal Control records for the same time period, 103 individual foxes were counted in the summer of 1991. This was a very conservative estimate given the inabilities to account for all individuals in an area. For example, at Mile Square Park there would have been an estimated 18 foxes (maximum number of foxes seen at one time) had there not been the mark-recapture population estimate, which yielded 39 foxes. Further, the 103 individuals did not include foxes in other areas with multiple families or large fox populations (i.e., Seal Beach NWR and Seal Beach Naval Weapons Station, Westminster Memorial Park, and others; Figure 3) which were not surveyed or counted. For example, in 1988, at least 133 individual red foxes were reported at Seal Beach NWR and Seal Beach Naval Weapons Station (U. S. Fish and Wildlife Service and U. S. Navy 1990).

Areas where introduced red foxes were located in California varied considerably in type of habitat and degree of urbanization (Appendix 1, Figure 2). The clumping of red fox sightings in some urban areas may represent an affinity for urban environments (Stamps 1990), but may also represent an increased likelihood of being sighted. It is apparent in several large urban areas, including the San Francisco Bay Area and urban Los Angeles and Orange Counties, that the distribution of foxes represent contiguous populations. The ability of radio-collared foxes to disperse across urban Orange County (Table 11, Figures 7 and 8) and the size of individual home ranges (Table 12) strongly support the contention that these populations are contiguous. The red foxes in Santa Barbara probably represent a contiguous population; the same is possible for foxes in the Bakersfield and Fresno areas as well.

Given the present state-wide distribution (Figure 2) and the ability of foxes to disperse considerable distances across urban (Table 11, and Trewhella et al. 1988) and rural (Storm et al. 1976) environments, the introduced red fox population may eventually become contiguous over much of California (although density may vary considerably). Storm et al. (1976:41-42) reported that dispersing rural foxes circumvented cities and lakes, but that highways, streams, and rivers did not present barriers to fox dispersal. Though no evidence suggests that introduced red foxes have colonized northern coastal California (Del Norte, Humboldt, and Mendocino Counties), these areas may be susceptible to introduction of red foxes. It must be noted that these counties contain extensive wetlands (e.g., Humboldt Bay) and red fox introduction at these sites would probably cause considerable environmental damage.

Introduced red foxes were reported from areas where Hall and Kelson (1959) reported the presence of San Joaquin kit foxes (*Vulpes macrotis mutica*), gray foxes (*Urocyon cinereoargenteus*), and coyotes (*Canis latrans*). Consequently, interactions between native canids and introduced red foxes are very likely including competition for food and den sites (Sargeant et al. 1987, Voigt and Earle 1983), predator-prey interactions (Dekker 1983, Voigt and Earle 1983, Harrison et al. 1989, Ralls et al. 1990), interbreeding (Thornton et al. 1971), and disease transmission (Lloyd 1980:248-251, Wandeler 1980, Davidson et al. 1992). The threat to kit foxes by introduced red foxes involving predation (Ralls et. al. 1990), or interbreeding (Thornton et al. 1971) is not well known; however, all interactions between these two species may be detrimental to the endangered San Joaquin kit fox.

The native Sierra Nevada red fox may also suffer from interactions with the introduced red fox. The unknown status and distribution of the Sierra Nevada red fox population, and the lack of a visual means to distinguish these two foxes, make the assessment of potential interactions extremely difficult.

Local Distribution

In urban Orange County, introduced red foxes were locally abundant (Figures 1 and 3). They reside and reproduce in open spaces and corridors found in urban and suburban areas where coyote numbers are reduced (Soule et al. 1988, U. S. Fish and Wildlife Service and U. S. Navy 1990) and supplemental feeding is often available. Consequently, interactions between foxes, urban wildlife (including some endangered species), feral animals, pets and humans, exist in urban areas (U. S. Fish and Wildlife Service and U. S. Navy 1990).

The transmission of diseases including rabies (Lloyd 1980, Macdonald 1980, Wandeler 1980) canine distemper (Lloyd 1980, Davidson et al. 1992), leptospirosis (Lloyd 1980), mange (Olive and Riley 1948, Ross and Fairley 1969, Stone et al. 1972, Storm et al. 1976) and other diseases that infect foxes (Lloyd 1980, Macdonald and Newdick 1982, Davidson et al. 1992), is a realistic biological and management concern. Disease outbreaks and transmission may be more likely in locations like Mile Square Park and Los Alamitos Armed Forces Reserve Center which support multiple fox families, recreational users and their pets, farm workers, and a variety of other wildlife and feral animals. Davidson et al. (1992) reported that 15 gray foxes (covertly purchased from an animal dealer in Indiana) were incubating canine distemper when necropsied. Lloyd (1980:248) described the role of the red fox in rabies transmission to other wildlife, livestock, feral animals, pets, and humans. Red foxes were considered largely responsible for the maintenance and spread of rabies where epizoatics occurred (North America, Europe, and northern Asia), accounting for 60-85% of diagnosed rabies cases (Wandeler 1980). While the control of rabies in wildlife, and rabies vaccinations and treatments have improved, approximately 25,000 people world-wide die of rabies every year (Winkler and Bogel 1992).

Presently the main concern with the introduced red fox in urban Orange County is its impact on populations of endangered species in coastal wetlands (U. S. Fish and Wildlife Service and U. S. Navy 1990). Introduced red foxes reside in or adjacent to most of these sensitive areas (Figure 3). Monitoring of endangered species populations in these sensitive areas has been conducted by CDFG and USFWS. Removal of red foxes by control efforts have coincided with increased counts of light-footed clapper rails at Seal Beach NWR (U. S. Fish and Wildlife Service and U. S. Navy 1990) and increased numbers of active least tern nests at Bolsa Chica Ecological Reserve (E. Burkett, CDFG Biologist, pers. comm.).

Population Characteristics

Density

Other studies have reported variable densities of urban red fox. Harris and Raynor (1986) estimated mean densities of red foxes in several British cities which ranged from 0.19-2.03 fox families per km^2 and reported local densities of up to 5 fox families per km^2. In London, Page (1981) reported minimum densities of 2.06 fox families per km^2, and 2.61 adult foxes per km^2 when including unproductive vixens. Trewhella et al. (1988) reported that population densities of red foxes in London, Oxford, and Bristol, England (largely urban/suburban investigations) ranged from 1.08 to 3.64 families per km^2, while investigations in rural settings found population densities considerably lower (usually $\leq$ 0.50 fox families per km^2).

In these studies fox families were defined as a litter of pups and associated adults. However, adult numbers may vary considerably due to the presence of nonbreeding adults that may or may not be related to the breeding adults (Macdonald 1979).

Using a conservative estimate of 5 for family size (2 adults and 3 pups), Harris and Raynor (1986) may have described a summer density of approximately to 25 foxes per km^2 in some areas. Mile Square Park supported an estimated density of 17 red foxes per km^2 in November 1991 which was probably similar to sites with high fox densities in England. Such a density may facilitate rapid disease transmission. Los Alamitos Armed Forces Reserve Center supported at least 12 foxes prior to an outbreak of mange (Table 9, Figure 6) which was implicated in the mortalities of at least 7 foxes at this site.

Densities at multiple fox-family sites apparently vary with available space, adequate cover, available food, and history of colonization by red foxes (carrying capacity may not be reached for a number of years after colonization). Communal denning (2 reproductive females share a single den to raise their litters) has been reported for red foxes (Sheldon 1950, Kruuk 1964, Tullar et al. 1976), but was not observed in Orange County. From Mile Square Park only 3 (37.5%) of the radio-collared juveniles dispersed and they were all males (Figures 7 and 8). The proportion of juveniles that disperse from Mile Square Park may be influenced by either the mortality of resident foxes in a population at carrying capacity, or the availability of unoccupied space in a population not yet at carrying capacity.

Areas with multiple fox families may have dynamic carrying capacities due to supplemental feeding fluctuations, potential disease outbreaks, and landscape alteration effects on cover availability. As carrying capacities change, populations with multiple fox families probably serve as a source of or recipient site for dispersing foxes.

Many areas where foxes reside in Orange County did not support the number of foxes that Mile Square Park, Los Alamitos Armed Forces Reserve Center (Figure 6), or Seal Beach NWR (U. S. Fish and Wildlife Service and U. S. Navy 1990) supported in the past. Many locations (Bristol Street, Crescent Avenue, Anaheim Powerline, Orange County Sewage Treatment Plant #2, and others) support single families of red foxes. Because an accumulation of adults has not occurred over time at these single family sites (excepting at the Bristol Street site where a third adult was present) it is assumed that most juveniles disperse from these sites or suffer mortality. The dispersal of the two remaining juveniles (both radio-collared) at the Orange County Sewage Treatment Plant site in 1991 also suggests dispersal from the single family sites is a regular event. It was unknown if spatial, behavioral or food constraints defined the carrying capacity at single family sites.

Dispersal

Although a number of studies have investigated red fox juvenile dispersal in North America (Storm 1965, Phillips et al. 1972, Andrews et al. 1973, Storm et al. 1976, Pils and Martin 1978, Voigt 1987), few have investigated dispersal of urban red foxes. Storm et al. (1976) found that the mean dispersal distance was 31 km (19.4 miles) for juvenile and subadult males, and 11 km (6.7 miles) for juvenile and subadult females in rural Illinois and Iowa. A similar proportion of the population of juvenile red foxes dispersed in both rural and urban settings (Phillips et al. 1972, Storm et al. 1976, Voigt 1987, Harris and Trewhella 1988). Relatively extensive investigations of red fox juvenile dispersal in the urban environment have been conducted in Bristol (Harris and Trewhella 1988, Woollard and Harris 1990), Oxford (Voigt and Macdonald 1984), and London (Page 1981) England and Edinburgh, Scotland (Kolb 1984).

Red foxes in urban areas may be limited to small pockets or patches of habitat. This arrangement of patches of suitable habitat may be similar to habitat distribution in rural areas. However dispersal from one suitable habitat to another may be quite different in the urban environment. In an urban situation, Harris and Trewhella (1988) found mean juvenile dispersal distances were 2.8 km and 1.6 km for males and females, respectively. They also found that 67% of juvenile males and 32% of juvenile females dispersed by the end of their first year, while approximately 30% of adults of both sexes dispersed.

Radio-collared foxes in Orange County dispersed greater distances on average (Table 11) than urban red foxes studied in Europe (Trewhella et al. 1988). However the proportion of dispersers from each population segment was lower than found by Harris and Trewhella (1988). Dispersal characteristics of radio-collared foxes from Orange County must be cautiously compared to other studies due to the small sample examined in Orange County.

In urban Orange County, foxes dispersed from late summer to early winter. Dispersal may also occur very quickly (< 1 week) or may be a prolonged or continual process (Voigt and Macdonald 1984, Macdonald 1987:182).

Numerous urban features facilitate dispersal including flood control channels, culverts, beach strands, railroads, powerline and highway corridors, freeway underpasses, and tunnels. Railway lines were used both for dispersal routes and as home range features in Scotland (Kolb 1984) and in England (Trewhella and Harris 1990). Hunt et al. (1987) reported red foxes using tunnels constructed under railways.

In Orange County, the urban environment was interspersed with a dendritic array of flood control channels that converge and ultimately empty into the Pacific Ocean at several sites. These flood channels passed through or emptied at ecologically sensitive areas including: Seal Beach NWR, Bolsa Chica Ecological Reserve, Upper Newport Bay Ecological Reserve, and the Huntington Beach least tern nesting colony at the mouth of the Santa Ana River (a large flood channel). These flood channels also pass through or adjacent to Mile Square Park, Los Alamitos Armed Forces Reserve Center, the Crescent Avenue site, the Bristol Street site, the Anaheim powerline site, and the Orange County Sewage Treatment Plant #2 site.

Flood channels were used by resident foxes, and they may have facilitated dispersal to sensitive coastal habitats because of their connection between red fox den sites and the coastal sites. The Santa Ana River was adjacent to the Anaheim powerline site, Mile Square Park, and Orange County Sewage Treatment Plant #2. It was suspected that fox #10 used the Santa Ana River to disperse from Mile Square Park to the Anaheim powerline site. He also used the Santa Ana River corridor while he resided at the Anaheim powerline site. Westminster Memorial Park, a cemetery which contained a red fox population, had a direct connection to Seal Beach Naval Weapons Station and Seal Beach NWR via a railroad.

Areas with multiple families, like Mile Square Park and Los Alamitos Armed Forces Reserve Center, are likely to produce more offspring than areas with single fox families, and thus produce more potential dispersers. These dispersers (which may include adults as well) may then travel to sensitive habitats (e.g., coastal wetlands). Because dispersers entering sensitive wildlife habitats may originate from distant sites, all centers of fox activity within 10 km of a management area should be given consideration in the management plan for that area (Table 11). Given the dispersal distances observed by juveniles and adults, and the proximity of resident foxes (at high or low densities) to sensitive coastal habitats, localized red fox control efforts in these habitats may be continually necessary to protect endangered species. Unless it is possible to erect effective barriers to dispersal, new foxes will eventually recolonize these areas.

The effect of dispersal on Sierra Nevada red fox was not studied. However, the mean dispersal distances reported by Storm et. al. (1976) may represent dispersal distances of introduced red foxes in rural locations of California. Given the proximity of introduced red fox sightings to the historical range of the Sierra Nevada red fox (Grinnell et al. 1937), moderate dispersal distances from the locations of a number of sightings (see section on distribution) could allow invasion of the historical range by introduced red foxes.

The variability and versatility in dispersal behaviors exhibited by red foxes makes the likelihood that red foxes will colonize or recolonize sensitive habitats both spatially and temporally unpredictable.

Survival

While disease may periodically cause marked declines in local populations of red foxes (Tullar et al. 1976, Lloyd 1980, Voigt 1987), vehicle collisions appear to be the largest cause of mortality in urban Orange County (Tables 9 and 10). Factors other than vehicle related collisions have accounted for a number of red fox deaths as well (Tables 9 and 10).

Bias can occur in survival estimates when animals are radio-tagged at different times of the year when survival rates differ (Heisy and Fuller 1985). Survival estimates were biased upwards when juveniles, collared after the initiation of a survival interval, were included in the analysis. Juveniles captured later in the year (and therefore later in the survival interval) were older and more experienced than foxes collared earlier in the year and their survival probabilities were therefore greater. This may explain why July-captured juveniles had an empirically lower survival rate than overall juveniles (Table 8). While 100% survival of radio-collared juvenile females (Table 8) may not generally represent the survival rate of this cohort in Orange County in 1991, it may indicate a greater likelihood of survival for females than males.

The proportions of the sexes that disperse may significantly influence survival rates. Juvenile males that dispersed (n = 4) suffered the greatest number of mortalities (n = 3). The one radio-collared juvenile female that dispersed, fox #23, established a home range and produced $\geq$ 2 pups as a yearling. Because assessing reproductive status is difficult with foxes (especially males) at areas with multiple families it was not possible to determine differential reproductive success among dispersers and non-dispersers. Of those that successfully dispersed, 75% were believed to produce offspring after dispersing, yet not a single non-dispersing juvenile (n = 6) was observed with offspring in the spring.

Storm et al. (1976) reported that both females and males breed as yearlings. Three radio-collared juveniles in Orange County were known to have bred and raised pups as yearlings.

Macdonald (1987:144) found that approximately 95% of wild red foxes die before the age of 4; however he knew of wild and captive red foxes that lived to 9 and 14 years of age, respectively. In Orange County 2 radio-collared adults were estimated conservatively at $\geq$ 5 years of age (in 1992), based on comparisons of teeth wear with known-age captive and wild red foxes. An additional fox (recovered by Orange County Animal Control) had more pronounced tooth wear than both of our older radio-collared adults and was assumed $\geq$ 6 years of age. Both radio-collared foxes (adults #1 and #2) reproduced in 3 consecutive years (1990-1992). These foxes have the reproductive potential to reproduce as yearlings, reproduce each year, produce 4-6 pups per year, and live to $\geq$ 5 years of age.

Red Fox Use of Land and Food Resources

Use of Land Resources

Red foxes now inhabit the most expansive geographical range of any wild carnivore and use habitats as varied as arctic tundra, arid deserts, and metropolitan centers (Macdonald 1987:14, Voigt 1987). In Orange County red foxes were observed inhabiting a wide range of areas in an environment previously devoid of this species. As coyote numbers decreased through expansive urbanization, red foxes were able to inhabit patches of habitat within urban areas where they became the largest wild predator (U. S. Fish and Wildlife Service and U. S. Navy 1990). Red foxes may, in fact, seek refuge in (or around) human inhabitances in rural areas as a coyote avoidance mechanism (Dekker 1983).

Red foxes in urban Orange County were found inhabiting most open spaces, often locations with concentrations of human use such as parks, golf courses, airports, and cemeteries. Use of these areas reflects a tolerance for human presence. However these sites were also where foxes were commonly fed or had an abundance of prey (e.g., gophers or waterfowl). In Orange County, foxes were fed by people at every site studied; some feeding was done on a daily basis.

Radio-collared foxes were observed using all the features of the urban environment, including shopping mall and stadium parking lots, commercial and industrial areas, agricultural areas, and residential areas. These features were interspersed with other open areas and were often connected by travel corridors (as traveled by our foxes). However, radio-collared foxes did not limit themselves to such corridors and also moved directly through residential or similarly developed urban areas. Foxes were observed crossing city streets up to 5 lanes in width (observed in the early morning hours when traffic was minimal). There was no evidence that any urban structure was a barrier to their movements.

Home range and land-parcel use by red foxes varied depending on the land-parcel type and the amount of available open space (Figure 9). Mean home range size for urban red foxes was 0.45 km^2 in Bristol (Harris 1980), and Oxford (Voigt and Macdonald 1984), while it was 1.65 km^2 for foxes studied in London (Page 1981). In contrast, mean home ranges for rural foxes (using mostly open space) was estimated at 6.0 km^2 by Murie (1936) to 34 km^2 by Jones and Theberge (1982).

In Orange County individuals varied considerably with regard to home range size and land-parcel use. However, home range size was positively correlated to the amount of open space at each site (open space perhaps being analogous to the rural case). This does not necessarily imply cause and effect because the relationships between open space, natural food availability, and supplemental feeding were unknown. Home ranges of foxes often overlapped. Areas of overlap commonly included areas of special use like the culverts in Mile Square Park that were used for diurnal cover. Every radio-collared fox at Mile Square Park used the culverts, and foxes at other sites commonly used available culverts as well.

Hersteinsson and Macdonald (1982) described typical habitat features of urban red foxes in Oxford, England. Woodlands, pastures, arable lands, and residential habitats (gardens, orchards, scrubland, and houses) were common components of urban fox home ranges, and these were also observed in Orange County. Harris (1977) found 60% of all recovered foxes were associated with residential habitats including gardens, garden sheds, cellars, and houses. The greatest percentage of dens were located at these same locations, with railway and other embankments used frequently as well (Harris 1977). While freeway and railway embankments were used by Orange County foxes for den sites, flat open areas were used most and residential habitats (specifically yards, gardens or buildings) were not observed being used as den sites. A comprehensive den site survey could not be conducted in Orange County and observed den site locations may be biased by likelihood of detection.

In contrast to Harris (1977) it was found that land-parcels including vacant lands, golf courses, parks, and airports were used more often by radio-collared foxes in Orange County than residential habitats. It was likely that supplemental feeding influenced home range sizes and land-parcel use. Locations of special habitat features (e.g., culverts) and supplemental food sources probably concentrated fox use. Supplemental feeding may be more extensive or predictable at highly urbanized sites (e.g., Mile Square Park) when compared to larger open spaces (Los Alamitos Armed Forces Reserve Center, Bolsa Chica Ecological Reserve).

<u>Use of Food Resources</u>

The adaptive nature of the red fox is demonstrated well by its ability to forage on a wide variety of foods. Red fox predation upon invertebrate and vertebrate prey (including domestic and feral animals), and their utilization of carrion, human food offerings, and garbage in urban areas has been widely reported (Harris 1981, Macdonald 1987, Doncaster et al. 1990). In urban Orange County, birds, mammals, seeds, insects, and human food packaging were frequently found in scat samples. Much of the human food remains and food packaging may be attributed to intentional feeding by people, though scavenging and garbage may contribute. Eggs were present in the diet. In Spring and Summer, the increase in egg shell fragments probably results from the consumption of eggs of native avifauna. Domestic chicken eggs provided purposefully or inadvertently by people could explain the year-round use of eggs. However, egg caching could also explain the year-round observation of egg fragments. The frequency of egg shells in the scat may relate only indirectly to the number or size of eggs eaten.

Food item size and characteristics are important when considering frequency of food items in scat samples. Food item frequency does not illustrate the relative importance of food items consumed by foxes (Lockie 1959). It does however indicate seasonal changes and the regularity with which items may be consumed.

Surplus killing and food caching are behaviors reported of red foxes (Kruuk 1972, Macdonald 1976, Macdonald 1987:164,171). Animals that are killed in surplus are sometimes cached to eat later. Conclusions about red fox food habits can not be drawn from cache data alone. Large food items are more persistent in caches than small food items; less preferred food items are also more persistent (Macdonald 1987:43). Conversely, large food items may be less likely to appear in the scat because of a greater proportion of digestible material. In addition, Sargeant et al. (1984) reported that only 5% of adult ducks taken by a red fox family were left above ground at an average den. Consequently both scat and caches are important in examining food habits.

Orange County foxes were observed preying upon and provisioning pups with ducks (common to local parks and golf courses), domestic chickens, and domestic rabbits. Foxes were also observed preying upon killdeer (Charadrius vociferus) and American avocet. Birds were regularly taken and were consistently part of the diet. Harris (1981) found that the diet of juvenile foxes consisted largely of passerines (song birds). In Orange County, passerines were commonly found in scat samples and were present at den and cache sites. Thus the introduced red fox is considered a threat to Belding's Savannah sparrow (designated as endangered by the California Fish and Game Commission in 1974).

Macdonald (1977) found that red foxes preferred voles (Microtus sp.) over other rodents and other potential prey. In scats collected from Orange County, gophers were the most frequently found rodent, but California ground squirrels (Spermophilus beecheyi) and deer mice (Peromyscus sp.) were also present (Table 5). Harris (1981) and Macdonald (1987:180) reported that most instances of domestic cat (Felis domesticus) mortality by foxes involved juvenile cats. We observed several cat carcasses at den sites and cats were detected in scat samples.

The relative importance of supplemental feeding to the Orange County red fox population is poorly understood. However, supplemental feeding of foxes appears to be a widespread phenomenon which contributes large volumes of food to some locations, while only occurring occasionally at (or in small amounts) at others. Supplemental feeding does provide human-fox interactions for members of the public that may not otherwise interact with wildlife. Where food is limiting, supplemental feeding may increase local carrying capacity, and conversely, emigration or a lowering of carrying capacity may occur where supplemental feeding is reduced or ceased. In California ground squirrels, Dobson (1979) found adult and juvenile female immigration to areas with supplemental feeding; however he found that juvenile male dispersal was largely independent of supplemental feeding and population density.

Using the slightly smaller gray fox in captivity as a model, Ball and Golightly (1992) found that 0.133 kg of mice/fox-day served as a weight-maintenance diet. Free-ranging foxes may well consume twice this amount (i.e., 0.27 kg/fox-day) (Golightly 1981). Sargeant (1978) found that the average consumption for adult red foxes under 4 experimental treatments (including 3 treatments with ad libitum food) was 0.320 kg/fox-day for captive red foxes fed natural prey species. Using the range of food consumption of 0.27-0.320 kg/fox-day, Mile Square Park could support 22-27 adult foxes solely on supplemental food (7.12 ± 0.033 kg/day). The estimate of supplemental food quantity was conservative because all sources of supplemental food were not quantified (or known). Supplemental food was provided at Mile Square Park but this did not preclude consumption of prey species by resident foxes. Proportions of birds and mammals in scat samples collected from Mile Square Park were similar to proportions in scat samples from other sites. Apparently foxes at Mile Square Park fed on animal prey despite the availability of supplemental food.

The vulnerability of the California least tern and the light-footed clapper rail to red fox predation has become a management concern (U. S. Fish and Wildlife Service and U. S. Navy 1990). Neither species has evolved in the presence of red foxes and therefore have not developed specific defenses against them. California least tern chicks and eggs are particularly vulnerable when foxes invade colonies on nest islands; much of a colony's reproduction can be decimated in a single night (E. Burkett, CDFG Biologist, pers. comm.). Newly hatched least tern chicks weigh approximately 6.0 g (Massey 1974). In an extreme case, a single red fox would be expected to consume 43-53 newly-hatched least tern chicks in a single night if they were the sole source of energy intake. Surplus killing and caching behaviors have allowed foxes to decimate colonies of nesting gulls (Kruuk 1964). Other endangered species or species of special concern may be vulnerable to introduced red fox predation including the

San Joaquin kit fox (Ralls et al. 1990), the snowy plover (Charadrius alexandrinus), the salt marsh harvest mouse, the burrowing owl (Athene cunicularia), and the California clapper rail (U. S. Fish and Wildlife Service 1990).

SUMMARY

1) Introduced red fox sightings were extensive in California; from Shasta County (northern extent) to San Diego County (southern extent), and from the Pacific coast (western extent) to western Riverside County and the western Sierra Nevada foothills (eastern extents). The population appeared to be contiguous in the San Francisco Bay Area and the urban area of Los Angeles and Orange Counties, but may also be contiguous in other areas of the present range.

2) The diet of the introduced red fox was variable and included birds and bird eggs, mammals, insects, seeds, and human food. Supplemental feeding by people may be an important aspect of food provisioning in these animals.

3) Reproduction can occur every year with litter sizes ranging from 1-9 pups. Young may reproduce in the spring following their birth. Multiple dens were used for single litters, and dens were located in flat open areas, embankments, golf-course sand traps, plantations, and rock or scrap metal piles.

3) Among radio-collared foxes, females had the highest survival rates, 100% for juveniles, and 72% for adults. Males had lower survival rates, 42% and 50% for juveniles and adults respectively. Juvenile dispersers had the lowest survival rate (37%). Two radio-collared red foxes, alive at the end of the project, were estimated at $\geq$ 5 years of age.

4) Causes of mortality in radio-collared foxes included vehicle collisions, attack by dogs, disease (mange), accidents other than vehicle collisions, and unknown causes.

5) Dispersal occurred most often with juvenile males, but adult males and 1 juvenile female dispersed (no adult females dispersed). Dispersal distances range from 0.7-13.8 km. Successful foxes dispersed 9.8 $\pm$ 1.85 km. Foxes dispersed from August to January.

6) Radio-collared red foxes used open spaces in the urban environment including: undeveloped land, disturbed land, vacant fields (e.g., airfields), athletic fields, golf courses, parks, flood channels, riparian areas, agricultural land, wetlands, railroad right-of-ways, highway corridors, industrial land, and beaches. They were also found in residential and retail business areas.

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Table 1. Number of confirmed red fox locations (319) from telephone surveys in California by county. Data were from telephone surveys conducted June 1990 to January 1993. Counties not listed were not surveyed.

County	Cumulative No. of Locations (year) <1975	(1985	≤1992	Sightings from Gray 1975 presence (+), absence (-) not surveyed (ns)
Alameda	0	2	33	-
Butte	1	3	4	+
Colusa	2	5	9	+
Contra Costa	0	4	9	-
El Dorado	0	0	2	+
Fresno	0	1	16	-
Glenn	3	4	6	+
Humboldt	0	0	0	ns
Imperal	0	0	0	ns
Kern	0	0	14	-
Kings	0	0	2	-
Los Angeles	5	8	17	+ [a]
Madera	0	1	1	+
Marin	0	1	7	+
Mendocino	0	0	0	+
Merced	0	0	15	-
Monterey	0	3	23	-
Napa	1	1	1	+
Nevada	0	0	0	ns
Orange	5	7	35	ns
Placer	0	0	1	ns
Riverside	0	0	3	ns
Sacramento	1	1	3	+
San Benito	0	2	16	-
San Bernardino	0	1	2	ns
San Diego	0	1	4	ns
San Francisco	0	0	0	ns
San Joaguin	0	2	6	+
San Luis Obispo	0	4	24	ns
San Mateo	0	1	5	-
Santa Barbara	0	5	14	ns
Santa Clara	0	3	16	-
Santa Cruz	0	0	1	-
Shasta	4	5	6	+
Solano	0	1	4	+
Sonoma	1	1	2	-
Stanislaus	0	0	0	ns
Sutter	2	2	2	+
Tehema	4	4	6	+
Trinity	0	0	0	+
Tulare	0	0	3	-
Ventura	0	1	3	ns
Yolo	0	2	4	+
Yuba	0	0	0	+
total	29	76	319	

[a]Los Angeles County was not formally surveyed but sightings of red foxes at El Dorado Nature Center in Long Beach were included.

Table 2. Red fox trapping and scat collection sites in Orange County, California, June 1990 - March 1992.

Site	Location	Scat Collections
Bristol Street	At Jct. with Route 55 in Costa Mesa, CA	7
Costa Mesa High School	Costa Mesa, CA	1
Crescent Ave.	At Dad Miller Golf Course in Anaheim, CA	13
Mile Square Park	Fountain Valley, CA	17
Orange Co. Sewage Treatment Plant #2	At Jct. of Brookhurst St. and Pacific Coast Highway in Huntington Beach, CA	0
Los Alamitos Armed Forces Reserve Center	Los Alamitos, CA	12
Bolsa Chica State Ecological Reserve	Huntington Beach, Orange Co., CA	3
Seal Beach National Wildlife Refuge[a]	Seal Beach, CA	1
Anaheim Powerline[a]	At Jct. of Cerritos Ave. and State College Ave. in Anaheim, CA	4
Edison Power Plant	On Pacific Coast Highway, between Newland Street and Magnolia Avenue, in Huntington Beach, CA	2

[a]No trapping conducted at these sites.

Table 3. Percent occurrence[a] of major food types in red fox fecal samples by season in Orange County, California, 1990-1991.

Food Type	Winter (n=124)	Spring (n=58)	Summer (n=114)	Fall (n=125)
Mammals	74	84	60	51
Aves	56	76	81	66
Egg Shell	2	2	10	6
Invertebrates	84	90	97	99
Seeds	60	69	77	84
Human Food and Food Packaging	86	41	59	60

[a]Percent occurrence of food types equals the number of fecal samples containing the food type within a specific season, divided by the total number of fecal samples analyzed from that season.

Table 4. Percent occurrence[a] of avian prey items in red fox fecal samples by season in Orange County, California, 1990-1991.

Prey Item	Winter (n=69)	Spring (n=44)	Summer (n=92)	Fall (n=83)
Strigidae (owl family)	4	0	1	0
Anatidae (duck family)	1	5	41	32
Euphagus cyanocephalus (Brewer's blackbird)	0	0	1	0
Columba livia (pigeon)	0	2	5	2
Falco sp. (falcon family)	0	0	11	1
Sturnus vulgaris (starling)	0	0	8	0
Unidentified passerine (songbirds)	20	5	53	50
Gallus domesticus (domestic chicken)	0	0	2	1
Phasianidae (pheasant family)	0	0	1	1
Unidentified bird	81	87	[b]	[b]

[a]Percent occurrence of prey items is the number of fecal samples containing the prey item divided by the number of samples containing avian prey (e.g., 69 samples in Winter contained avian prey items).
[b]Awaiting final analysis.

Table 5. Percent occurrence[a] of mammalian prey items in red fox fecal samples by season in Orange County, California, 1990-1991.

Food Item	Winter (n=92)	Spring (n=49)	Summer (n=68)	Fall (n=64)
Geomyidae (gopher family)	44	31	40	42
Peromyscus sp. (deer mice)	1	2	3	6
Spermophilus beecheyi (Calif. ground squirrel)	3	0	16	3
Didelphis virginianus (opossum)	1	0	3	0
Felis domesticus (domestic cat)	1	0	0	6
Sylvilagus auduboni (cottontail rabbit)	4	0	0	2
Unidentified mammal	57	73	38	41

[a]Percent occurrence of prey items is the number of fecal samples containing the prey item divided by the number of samples containing mammalian prey.

Table 6. Food items' identified at red fox dens and cache sites in Orange County, California, June 1990 - July 1992.

Food item[b]	Number Recovered
Larus sp. (gulls)	9
Anatidae (duck family)	7
Spermophilus beecheyi (Calif. ground squirrel)	5
Gallus domesticus (domestic chicken)	3
Columba livia (pigeon)	3
Sylvilagus auduboni (cottontail rabbit)	2
Domestic rabbit	2
Felis domesticus (domestic cat)	2
Didelphis virginianus (oppossum)	2
Geomyidae (pocket gopher family)	1
Limosa fedoa (marbled godwit)	1
Passer domesticus (house sparrow)	1
Zenaida macroura (mourning dove)	1
Corvus sp. (crows)	1
Phalacrorax sp. (cormorants)	1

[a]Food items other than human food offerings and food packaging. Charadrius vociferus (killdeer) and *Recurvirostra americana* (American avocet) predation by a radio-collared red fox were observed. A cormorant *Phalacrorax sp).* was entangled in fishing line and was either scavenged or killed by foxes.
[b]Anatidae include ducks with typical mallard *(Anas platyrhynchos)* coloration and white domestic ducks, both commonly seen in parks and golf courses.

Table 7. Trap-nighs and trap success for red fox captures in Orange County, California.

Site[a]	Pre-bait nights[b]	Trap-nights	No. of Captures	No. of Recaptures	Trap Success[c] (%)
I) June 1990 - January 1991					
Crescent	NA	116	2	8	1.72
Bristol	NA	94	1	0	1.06
MSP	NA	34	4	1	11.76
STP	NA	114	0	0	0.00
LAAFRC	NA	42	5	0	11.90
BCER	NA	14	2	0	14.29
Total	--	444	14	9	3.38
II) June 1991 - March 1992					
Cresent	11	12	0	2	0.00
LAAFRC	123	18	0	2	0.00
ACP	5	0	0	0	0.00
SCEP	20	18	2	4	11.11
BCER	77	0	0	0	0.00
CMHS	82	2	0	0	0.00
OCSTP	23	17	1	0	5.88
Total	341	67	3	8	4.48

[a] Crescent is Crescent Ave. site, Bristol is Bristol St. site, CMHS is Costa Mesa High School,-MSP is Mile Square Park, OCSTP is Orange Co. sewage treatment plant #2, LAAFRC is Los Alamitos Armed Forces Reserve Center, BCER is Bolsa Chica State Ecological Reserve, ACP is the Associated Concrete Products Inc. on McArthur Blvd., SCEP is the Huntington Beach Southern California Edison Plant.

[b] NA = Not Available

[c] Trap success = captures/trap nights

Table 8. Survival[a] of radio-collared red foxes in Orange County, California, 1990-1992.

Population segment	Survival rate estimate	95% CI[b]
Juveniles[c]		
Captured in July (n = 7)	0.54	0.31-1.00
Known dispersers (n = 5, 4M:lF) (all captured in July)	0.37	0.16-1.00
Males (n = 9)	0.42	0.21-0.98
Females (n = 6)	1.00	1.00-1.00
Overall (n = 15)	0.65	0.42-0.99
Adults[d]		
Known l-yr olds (n = 6, 4M:2F)	0.64	0.38-1.00
Males (n = 8)	0.50	0.28-0.99
Females (n = 4)	0.72	0.43-1.00
Overall (n = 12)	0.58	0.38-0.94

[a]Survival was estimated using the Micromort computer program (Heisy and Fuller 1985).
[b]Confidence interval
[c]Juvenile survival rates were based on a 250-day interval (9 Aug.- 15 Mar.). The 1990 and 1991 cohorts were combined in the analysis.
[d]Adult survival rates were based on a 365-day interval (15 Mar 1991 - 14 Mar. 1992)

Table 9. Mortalities of radio-collared red foxes in Orange County, California, 1990-1992.

Fox	Age	Sex	Date	Cause of death
#7	ad	F	1 Oct. 1990	suffocation in tar pit[a]
#19	juv	M	23 Oct. 1990	killed by dogs
#10	juv	M	28 Nov. 1990	hit by vehicle
#5	ad	M	7 Mar. 1991	unknown
#20	juv	M	20 Apr. 1991	euthanization[b]
#21	juv	F	23 Apr. 1991	euthanization[b]
#17	juv	F	25 Jul. 1991	missing[c]
#22	juv	M	25 Aug. 1991	hit by vehicle
#9	juv	M	3 Sep. 1991	hit by vehicle
#18	juv	M	12 Sep. 1991	unknown[d]
#4	ad	M	28 Sep. 1991	unknown[d]
#3	ad	M	7 Nov. 1991	hit by vehicle
#8	ad	F	11 Feb. 1992	unknown

[a]Tar pit was a man-made pit containing tar and was labeled a "Hazardous Sustance Lagoon."
[b]Foxes were trapped and euthanized at Bolsa Chica Ecological Reserve through a red fox control program.
[c]Fox was not found since 25 July 1991 and was considered missing.
[d]Fox had severe sarcoptic mange at time of death.

Table 10. Cause-specific mortality rates for radio-collared red foxes in Orange County, California, 1990-1992.

Population segment	Mortality Rate Estimates[a]		
	Vehicle collisions (n) (95% CI)	Other (n) (95% CI)	Unknown (n) (95% CI)
Juveniles[b]			
Males (n = 9)	0.27 (2) (0.00-0.59)	0.14 (1) (0.00-0.38)	0.14 (1) (0.00-0.38)
Females (n = 6)	0.00	0.00	0.00
Known dispersers (n = 5,4M:lF)	0.38 (2) (0.00-0.80)	0.00	0.19 (1) (0.00-0.53)
Overall (n = 15)	0.18 (2) (0.00-0.40)	0.09 (1) (0.00-0.25)	0.09 (1) (0.00-0.25)
Adults[c]			
Males (n = 8)	0.24 (2) (0.00-0.52)	0.00	0.24 (2) (0.00-0.52)
Females (n = 4)	0.00	0.25 (1) (0.00-0.66)	0.00
Known l-yr olds (n = 6, 4M:2F)	0.17 (1) (0.00-0.46)	0.00	0.17 (1) (0.00-0.46)
Overall (n = 12)	0.16 (3) (0.00-0.36)	0.08 (1) (0.00-0.23)	0.16 (3) (0.00-0.36)

[a]Mortality rate estimates as determined using Micromort computer software (Heisey and Fuller 1985). "Unknown" mortalities are suspected to include additional vehicle collision deaths and disease (mange) related deaths. "Other" mortalities include one dog attack (fox #16) and one suffocation, in a tar pit (fox #7).
[b]Juvenile mortality estimates were based on a 250 day survival interval (9 Jul. - 14 Mar. for both 1990 and 1991 combined).
[c]Adult mortality rate estimates were based on a 365 day interval from 15 Mar. 1991 - 14 Mar. 1992.

Table 11. Dispersal data for radio-collared red foxes in Orange County, California, 1990-1992.

Fox	Date	Age	Sex	Direction (in degrees)	Distance[a] (km)
Successful Dispersers[b]					
#9	15 Dec. 1990	juv	M	NNE (27)	10.8
#3	15 Dec. 1990	ad	M	WSW (245)	13.8
#23	--	juv	F	NW (301)	4.9
#1	24 Nov. 1991	ad	M	WSW (255)	9.8
Unsuccessful Dispersers[c]					
#10	28 Nov. 1990	juv	M	ENE (75)	0.7
#22	12 Aug. 1991	juv	M	NW (310)	10.8
#15	3 Jan. 1992	juv	M	NW (303)	10.5
#15	5 Jan. 1992	juv	M	SSW (211)	1.7

[a] From natal den site or mean UTM coordinate of home range to a subsequent home range center or whelping den, or location of mortality during dispersal.

[b] Successful dispersers were foxes that survived dispersal to establish (or initiate) a home range. Fox #3 was considered a successful disperser due to length of time (325 days) between dispersal initiation and subsequent road-kill mortality. Fox #23's dispersal consisted of a series of exploratory movements between 22 Aug. and 27 Nov. 1991.

[c] Unsuccessful dispersers were foxes that died during dispersal. On 3 Jan. 1992 fox #15 made an exploratory foray from Mile Square Park to Seal Beach Naval Weapons Station and back to Mile Square Park (a 21 km straight-line movement). On 13 Jan. 1992 fox #15 dispersed south from Mile Square Park and presumably died. The radio collar signal was located in an inaccessable location and did not move for four months.

Table 12. Home range estimates using Minimum Convex Polygon (MCP) and Harmonic Mean Transformation (HMT) methods for radio-collared foxes in Orange County, Calif., Jun. 1990 - Dec. 1991.

Fox	Sex	Site[a]	No. Locations	Range Estimate (km^2) MCP	Range Estimate (km^2) HMT[b]
Adults[c,d]					
1 (PRE-DISP)	M	Bristol	106	16.04	12.34
(POST-DISP)		Huntington	78	8.66	7.25
2	F	Crescent	90	0.49	0.56
3	M	Crescent	38	0.40	0.61
4	M	LAAFRC	46	2.90	3.39
5	M	LAAFRC	48	2.91	3.46
6	M	MSP	140	0.56	0.48
7	F	OCSTP	13	1.72	1.02
8	F	SCEP	40	3.70	4.75
9 (POST-DISP	M	APL	58	1.77	1.63
11	M	MSP	166	0.54	0.45
12	F	MSP	121	0.78	0.69
13	F	MSP	89	0.93	0.59
14	M	MSP	161	0.86	0.83
17	M	LAAFRC	69	3.31	2.26
18	F	LAAFRC	82	2.23	1.63
20	M	BCER	90	9.92	9.06
21	F	BCER	94	10.12	10.35
23	F	SCEP	163	12.21	11.24
Mean			67	4.26	3.82
Standard error			13	1.07	0.94
Juveniles					
9 (PRE-DISP)	M	MSP	31	0.71	0.97
10	M	MSP	27	0.98	1.13
11	M	MSP	50	0.48	0.35
12	F	MSP	46	0.55	0.44
13	F	MSP	53	0.60	0.83
14	M	MSP	50	0.48	0.35
15	M	MSP	55	0.62	0.63
16	F	MSP	66	0.33	0.31
17	M	LAAFRC	45	3.02	1.02
18	F	LAAFRC	56	2.23	1.79
19	M	LAAFRC	17	0.77	0.69
20	M	BCER	70	9.60	9.19
21	F	BCER	94	10.11	9.00
22	M	OCSTP	17	2.80	1.42
23	F	SCEP	123	12.18	21.80
Mean			53	3.03	3.33
Standard error			7	1.05	1.52

[a]Cresent Ave. site, Bristol is Bristol St. site, MSP is Mile Square Park, LAAFRC is Los Alamitos Armed Forces Reserve Center, OCSTP is Orange Co. sewage treatment plant #2, APL is Anaheim powerline site, BCER is Bolsa Chica State Ecological Reserve, SCEP is the Southern California Edison Plant.
[b]HMT estimates for 15 grid division and 95% of the locations.
[c]Pre-disp referes to data collected before dispersal. Post-disp refers to data collected after dispersal.
[d]Includes animals initially captured as juveniles and matured with radio collar intact.

Table 13. Land parcel types used by radio-collared red foxes in Orange County, California.

Land Parcel Types	Percent of Home Ranges With Type
Undeveloped land, vacant fields, disturbed land	100
Athletic fields, parks, golf courses	96
Flood control channels, riparian	68
Residential tracts, retail business	37
Agriculture land (includes fallow land)	29
Wetlands, estuaries	21
Railroad tracks, major highways	21
Industrial land	21
Beaches	12

[a]Number of home ranges that incorporated a land parcel type divided by the number of home ranges (n = 24) examined.

Table 14. Descriptions of movements from continuous relocations of radio-collared red foxes in Orange County, California. Means between different following episodes are followed by ± standard error.

Fox	n[a]	Travel rate (km/hr)	Street crossings per hour[b]	Number of land parcel types used per hour[c]
#1	6	3.30 ± 0.46	4.30 ± 1.40	3.8 ± 1.4
#4	2	0.76 ± 0.33	--	1.7 ± 0.96
#8	4	1.10 ± 0.33	1.10 ± 0.62	2.5 ± 0.67
#9	1	2.30	0.00	4.4
#15	1	0.58	--	1.1
#17	1	1.70	0.26	1.5
#18	1	1.80	0.00	1.5
#23	4	1.80 ± 0.54	2.00 ± 0.82	4.9 ± 0.42
Mean		1.66 ± 0.33	1.30 ± 0.52	2.7 ± 0.43

[a]n=number of independent following episodes.
[b]Foxes #4 and #15 do not have streets within their home ranges.
[c]Land parcel types include: beaches, parks, golf courses, fairgrounds, residential areas, powerline right-of-ways, high schools, pasture, industrial lands, disturbed fields, eucalyptus groves; vegetated dunes, railroad right-of-ways, airfields, and agricultural lands.

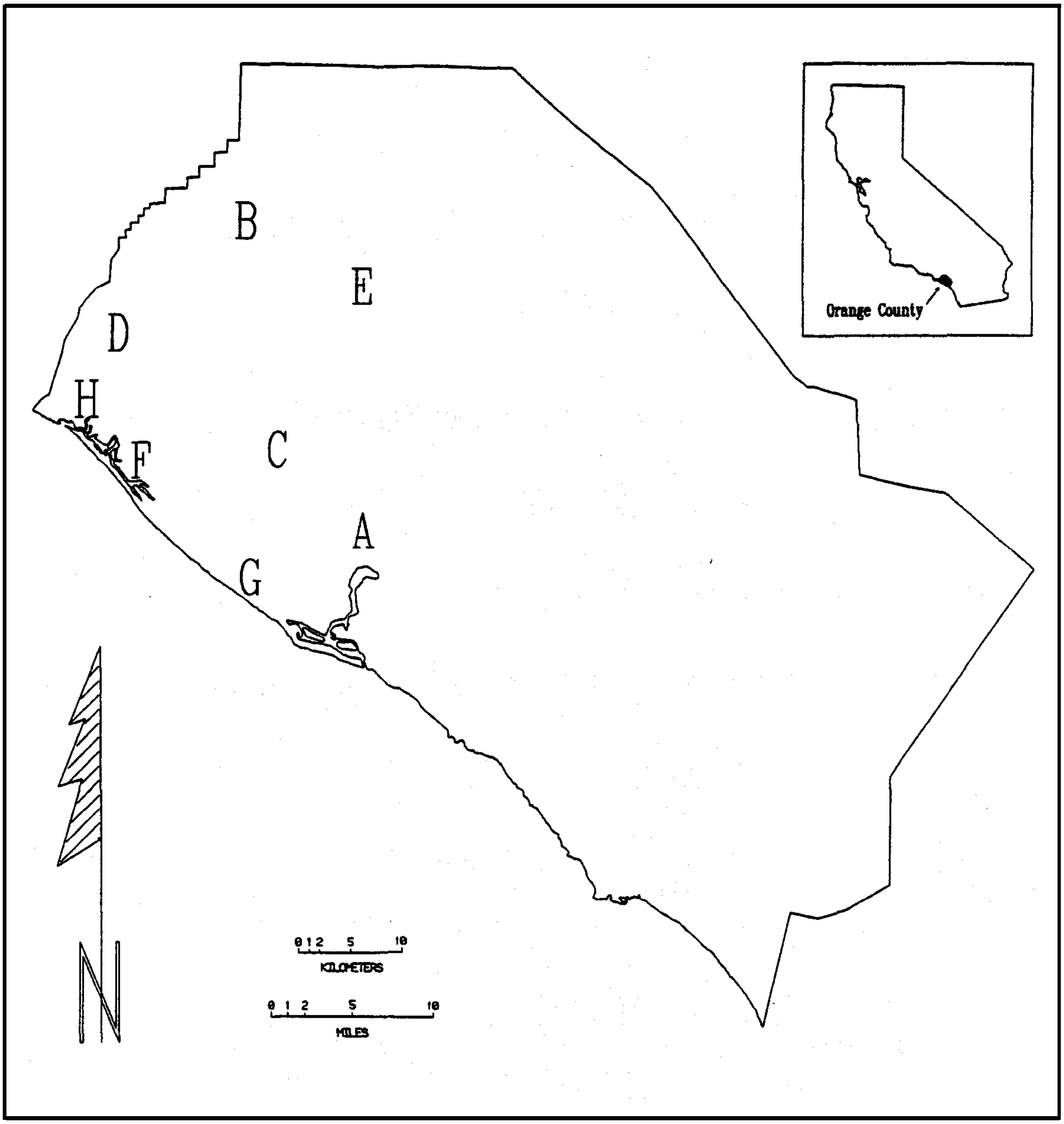

Figure 1. Study area for northwestern Orange County, California. A = Bristol Street site, B = Crescent Avenue Site, C = Mile Square Park Site, D = Los Alamitos Armed Forces Reserve Center site, E = Anaheim Powerline site, F = Bolsa Chica Ecological Reserve site, G = Huntington Beach site, H = Seal Beach NWR and NWS.

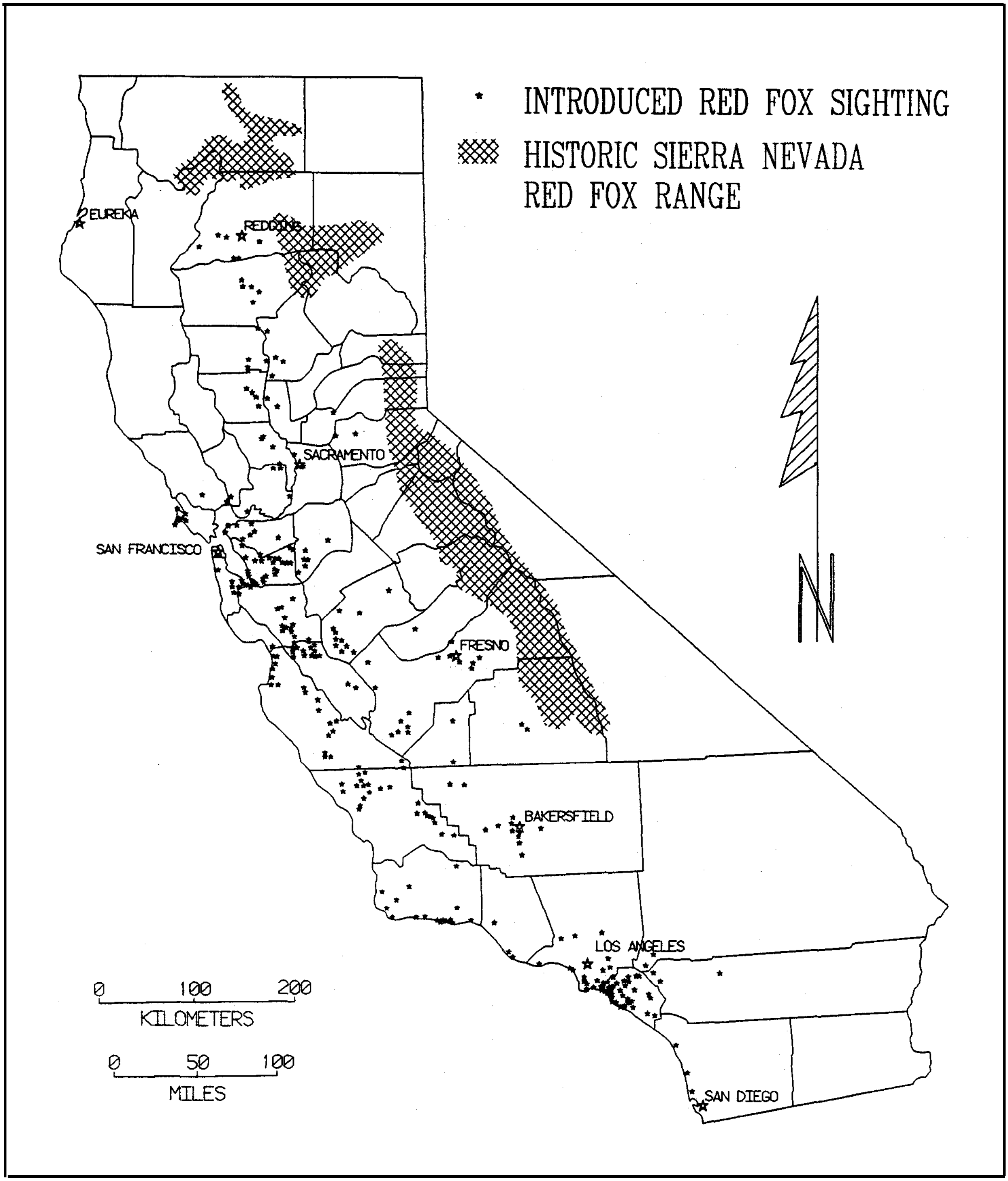

Figure 2. Red fox sightings (319) for California acquired from telephone interviews. Each solid black star represents one or more sightings at a site (sightings > 1.6 km apart are considered independent); open stars indicate cities. The range of Sierra Nevada red fox was summarized from Grinnell et. al. (1937).

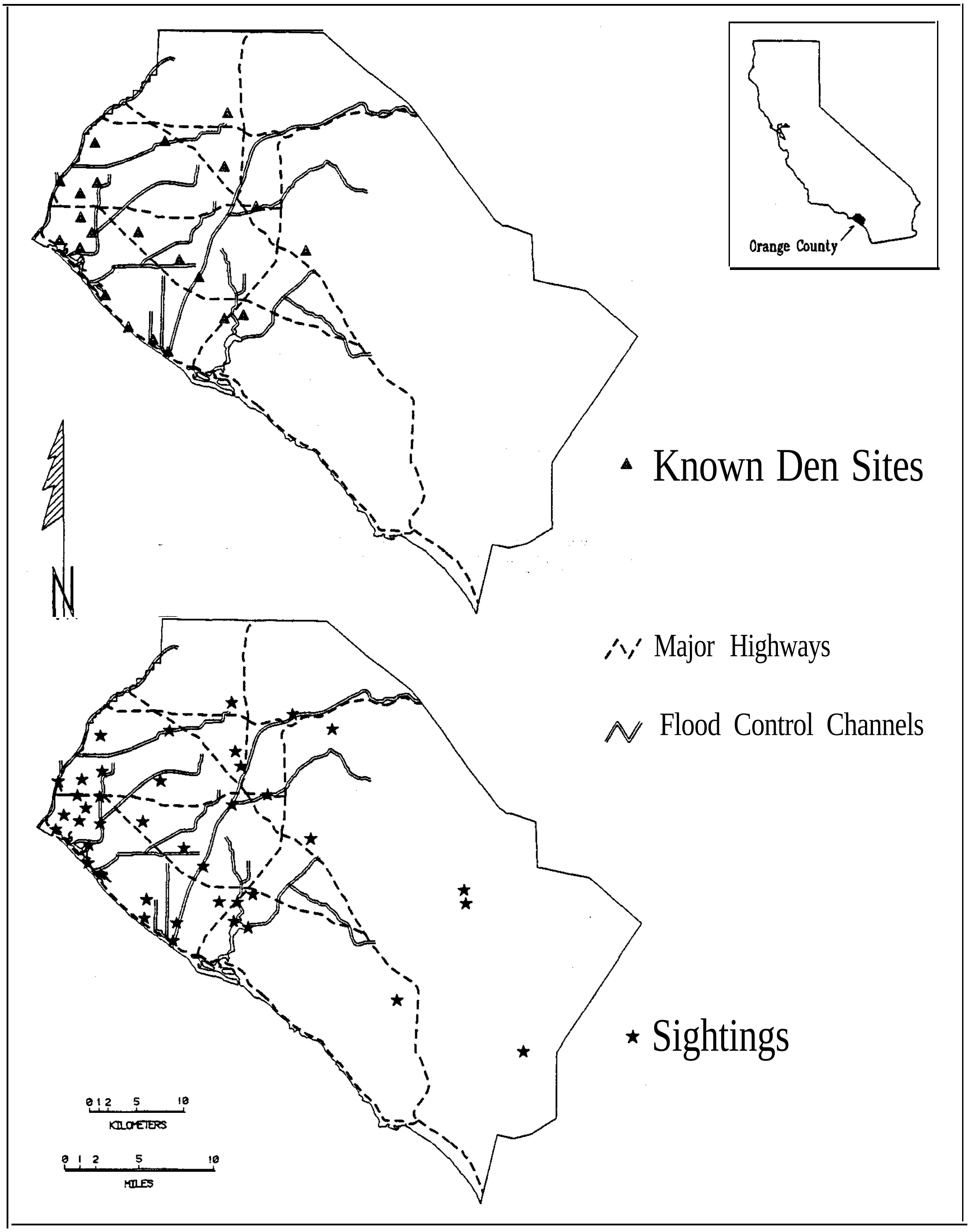

Figure 3. Known den sites (22) and sightings (39) in Orange county, California from 1992 and earlier. Den sites (triangles) on the map represent one or more den locations. Sightings (stars) represent one or more observations of foxes at a location. Den site and sighting locations > 1.6 km (1 mile) apart are considered independent.

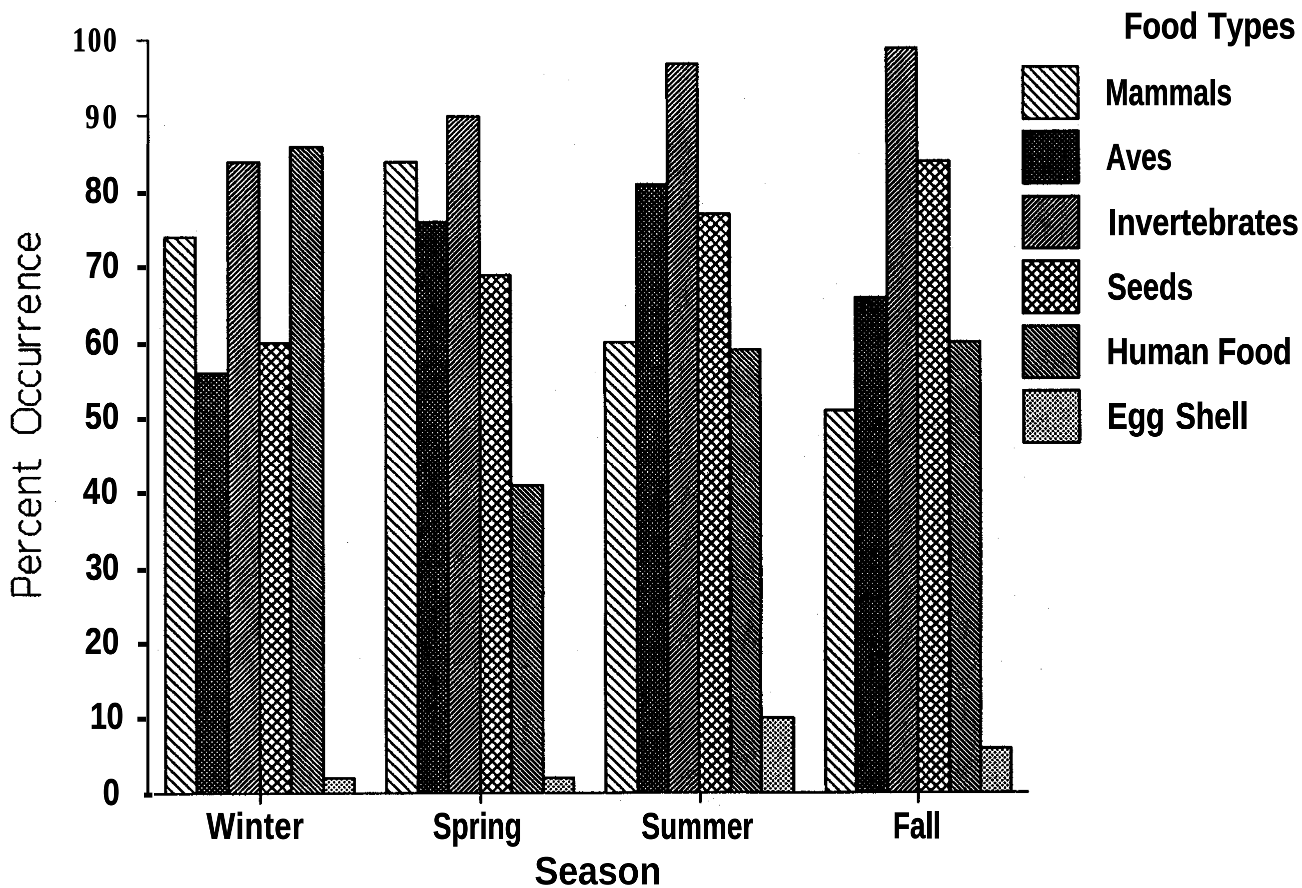

Figure 4. Percent occurrence of major food types found seasonally in scat samples collected in Orange County, California 1990-1991.

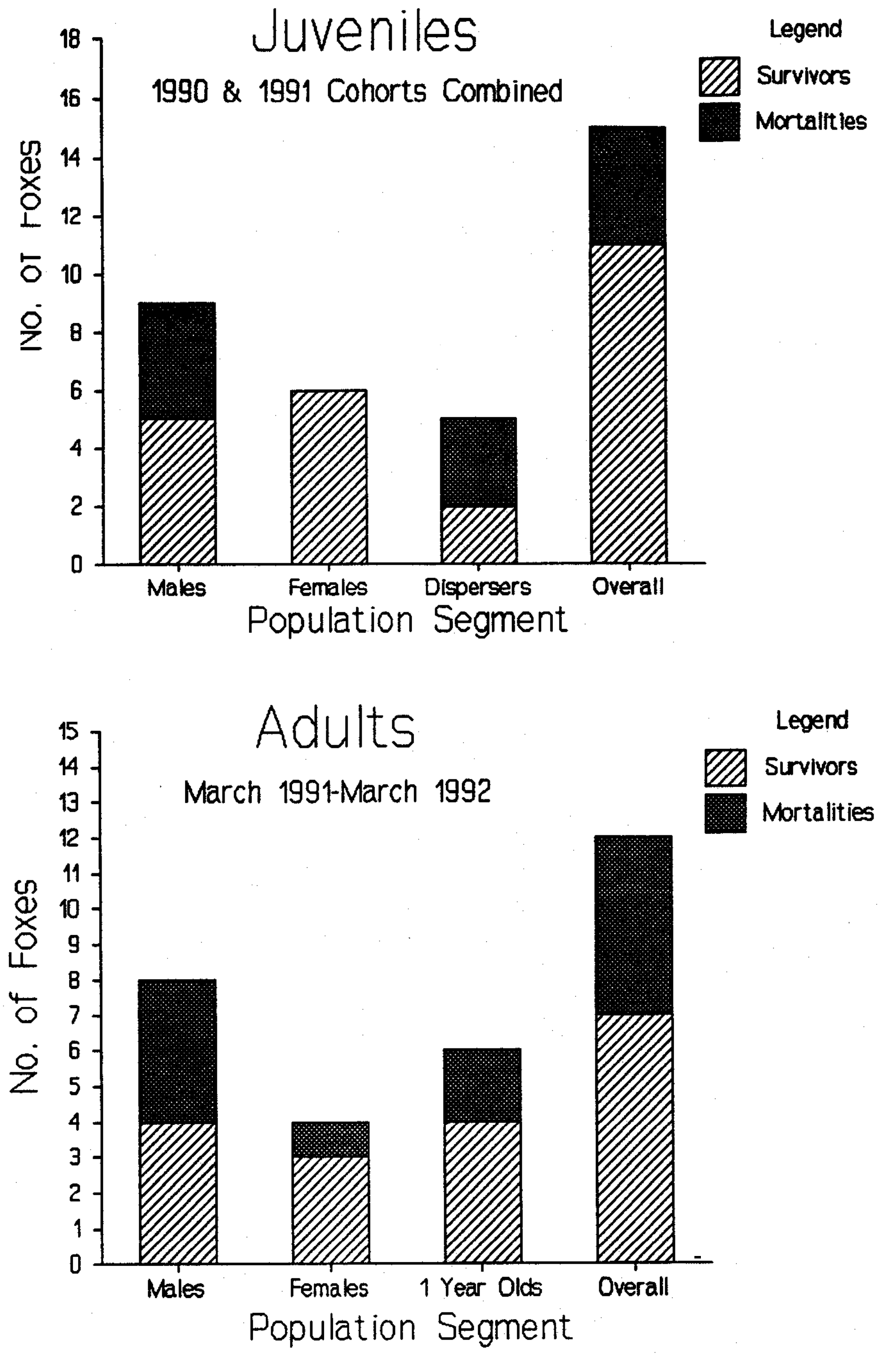

Figure 5. Survival and mortality of radio-collared foxes in Orange County, California, 1990-1992. Juvenile dispersers included 3 males and 1 female. One-year-old adults included 4 males and 2 females.

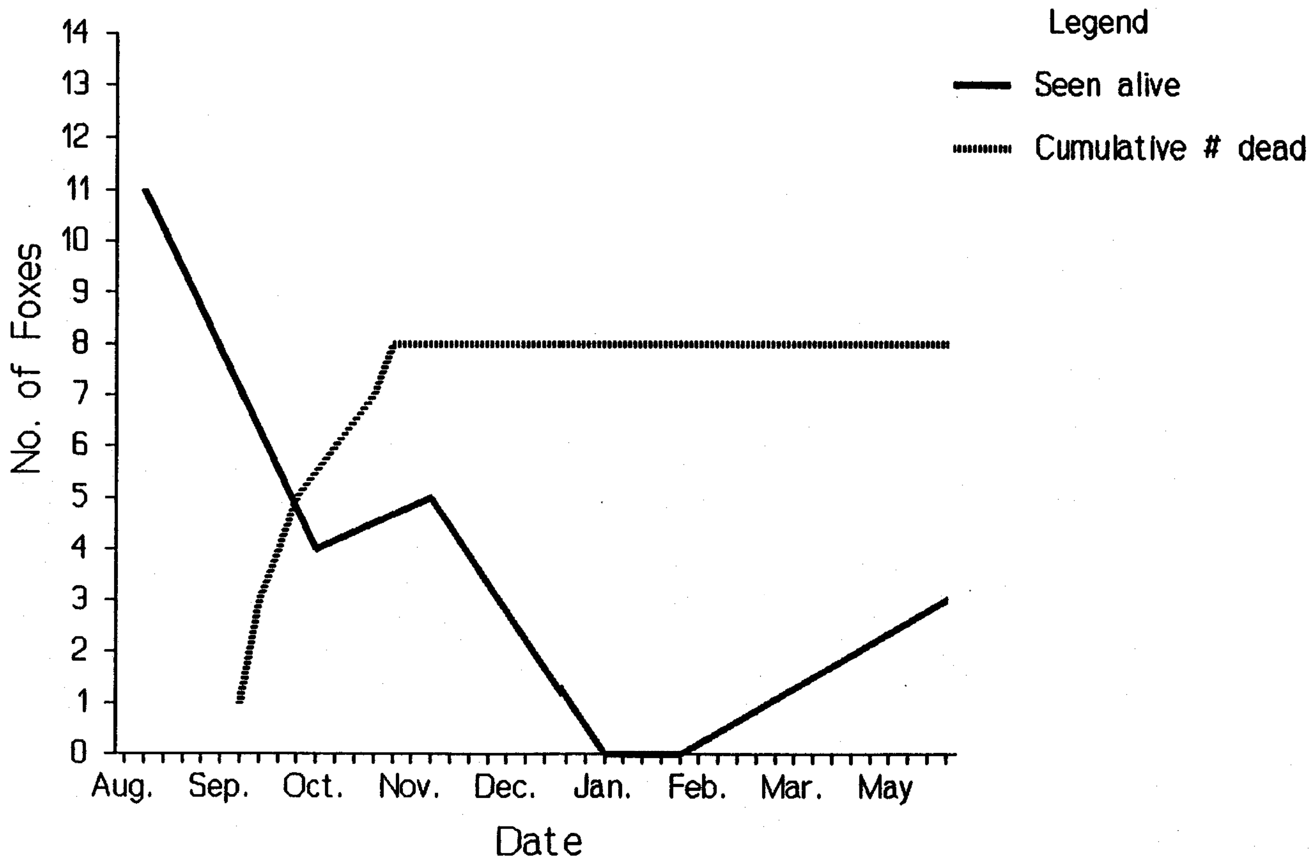

Figure 6. Relationship between the number of live foxes seen and the cumulative number of dead foxes retrieved at Los Alamitos Armed Forces Reserve Center.

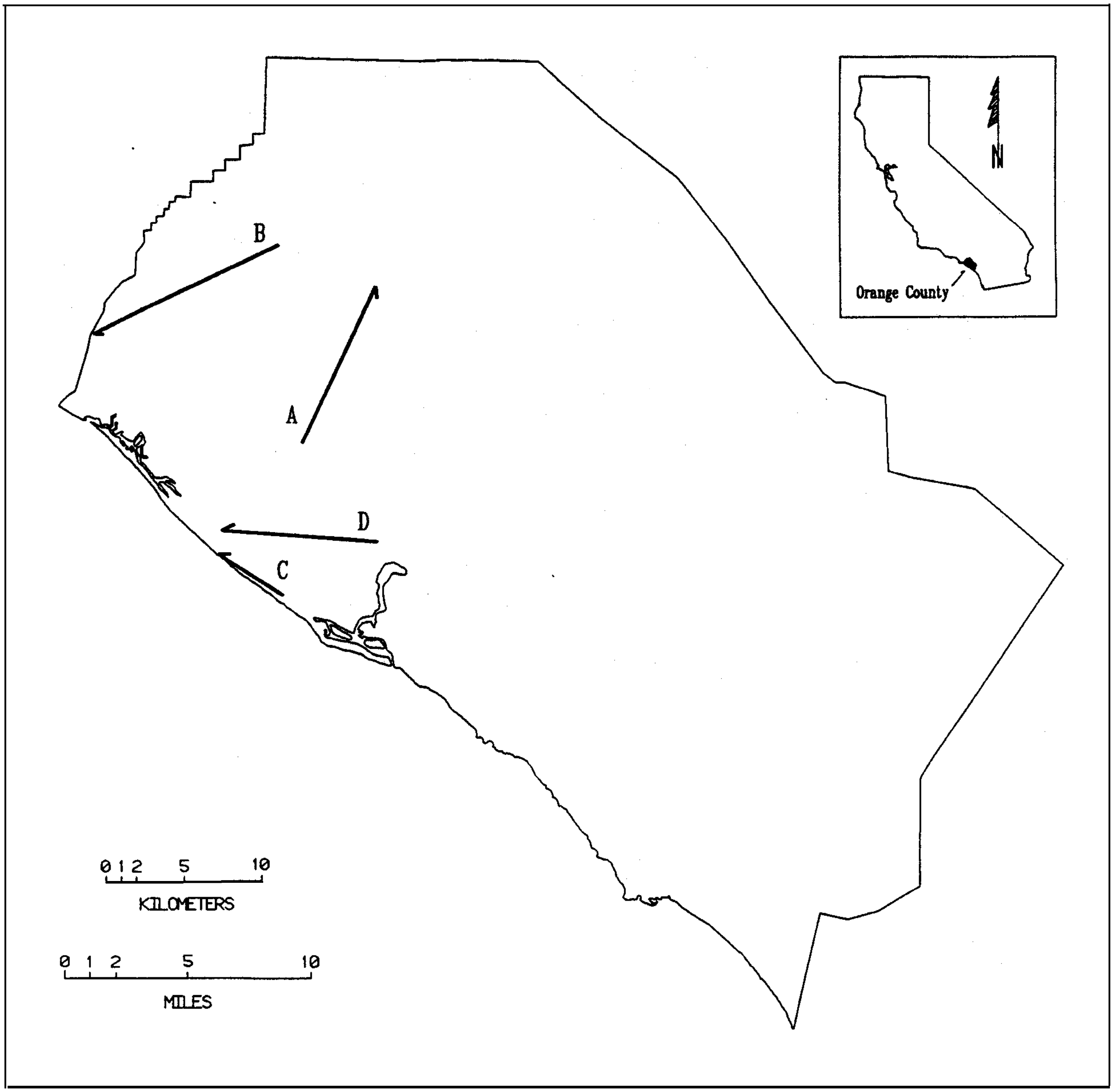

Figure 7. Straight-line dispersal distances of radio-collared red foxes that established home ranges after dispersal in Orange County, California, 1990-1992. **A** = fox #10's (juv. male) dispersal from Mile Square Park in Fountain Valley to Anaheim. B = fox #3's (ad. male) dispersal from Crescent Avenue. site in Anaheim to Rossmoor. C = fox #23's (juv. female) dispersal from Orange County Sewage Treatment Plant #2 to Huntington Beach. D = fox #l's (ad. male) dispersal from Bristol Street site in Costa Mesa to Huntington Beach.

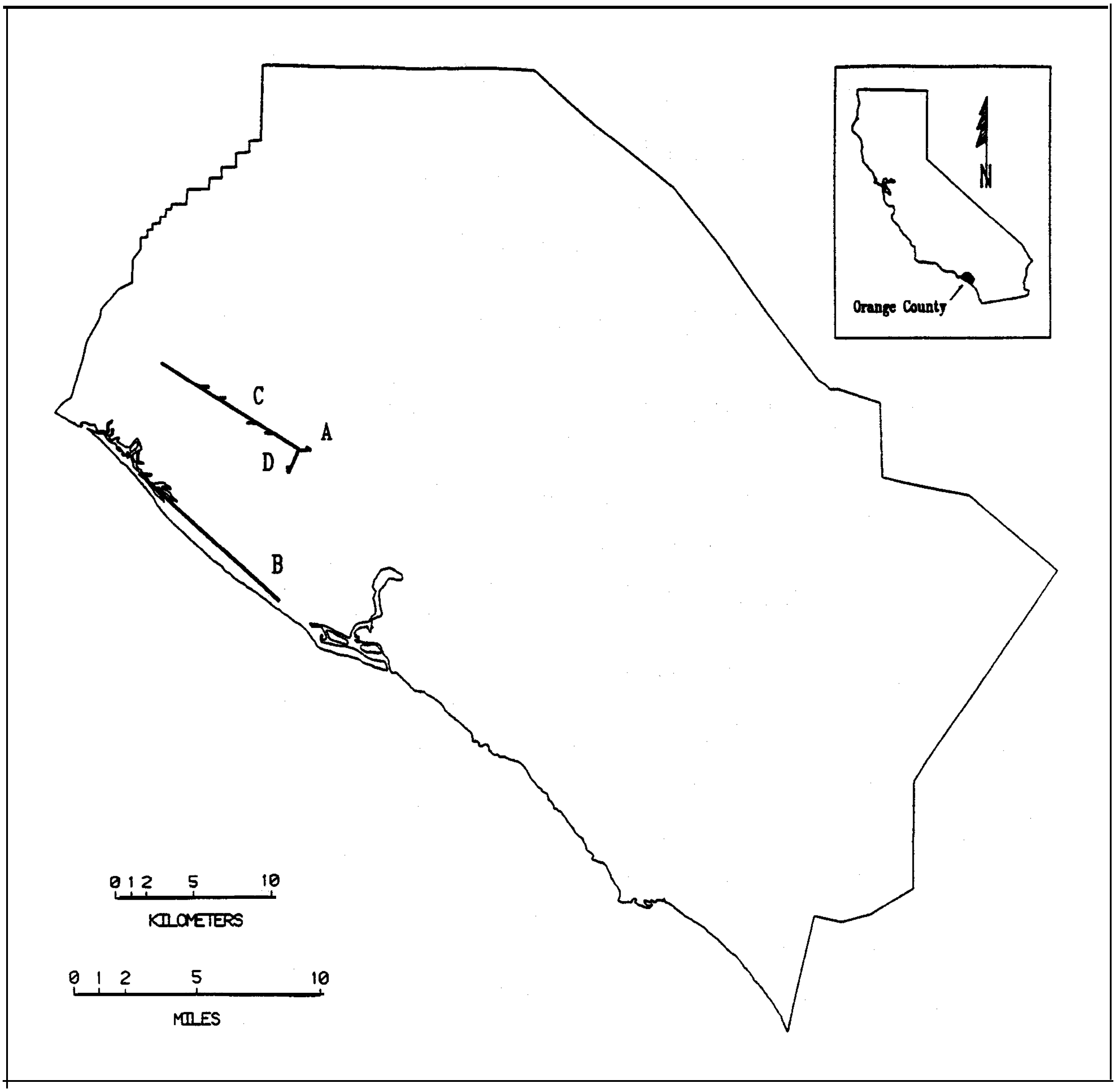

Figure 8. Straight-line dispersal distances of radio-collared red foxes that died during dispersal in Orange County, California, 1990-1992. A = fox #11's (juv. male) dispersal from Mile Square Park to Euclid Ave., Mile Square Park's eastern boundary. B = fox #22's (juv. male) dispersal from Orange County Sewage Treatment Plant #2 to the jct. of Warner Ave. and Pacific Coast Highway in Sunset Beach. C = fox #15's (juv. male) 21 km round-trip exploratory movement to Seal Beach Naval Weapons Station and back to Mile Square Park. D = fox #15's (juv. male) dispersal from Mile Square Park to the jct. of Alameda Ave. and Brookhurst St. in Fountain Valley.

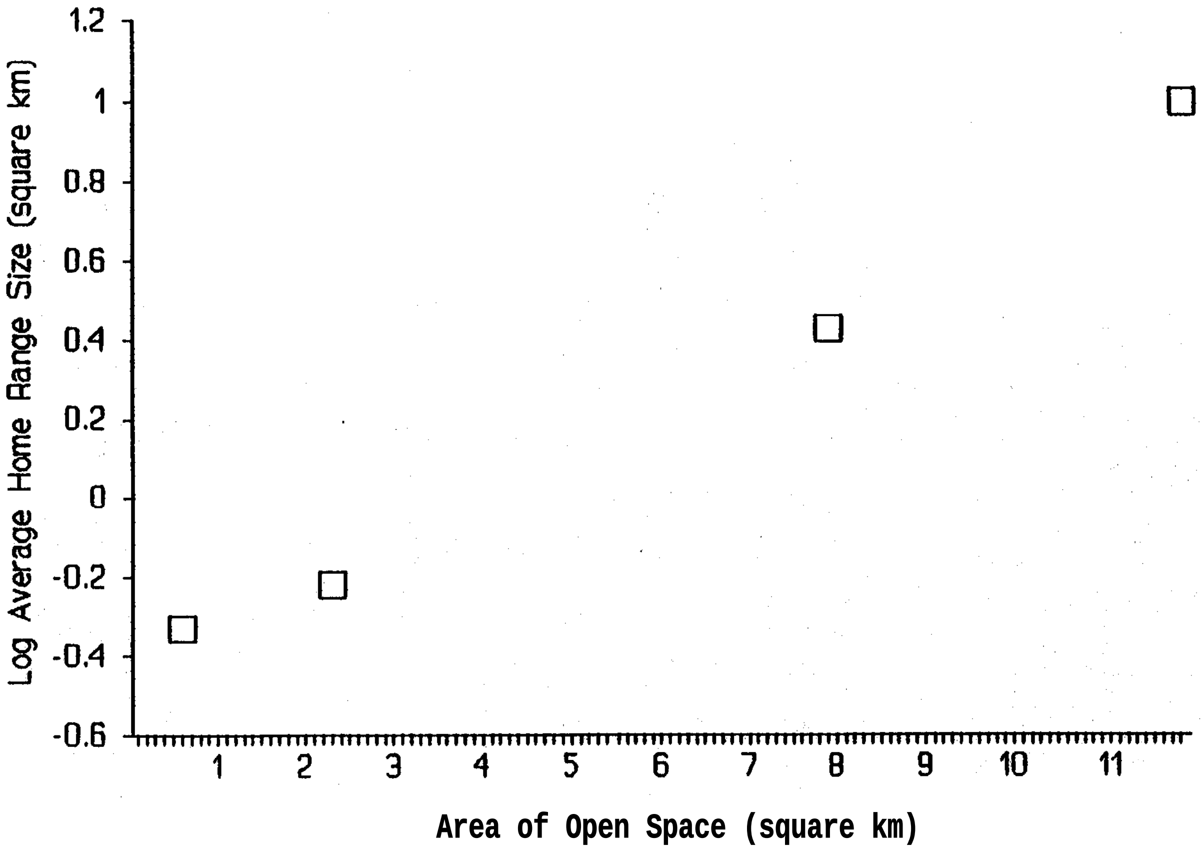

Figure 9. Relationship of $\log_{10}$ home range size (HMT) and the area of available continual open space (at 4 sites). The correlation coefficient is statistically significant (r=84, $p<0.05$).

Appendix 1. Sighting data for state-wide distribution of introduced red foxes in California for 1992 and earlier.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
Alameda County							
C. Machado	-	01/01/79 - 01/01/91	5894	41737	200-300	GR,OW,R	good
S. Orloff	BI	01/01/83	6258	41792	50-150	GR	excellent
T. Palmisano	CDFG	01/01/87	5960	41759	100-150	GR,R	excellent
T. Palmisano	CDFG	11/01/89	6098	41732	150-200	GR,R	excellent
T. Palmisano	CDFG	01/01/89	6060	41660	150-200	GR,OS	excellent
S. Orloff	BS	01/01/89	6039	41747	150-200	GR	excellent
P. Lacy	ADC	01/01/89 - 01/01/92	6090	41633	300-400	OW,SB	excellent
P. Lacy	ADC	01/01/89 - 01/01/92	5992	41520	650-750	OW,SB	excellent
B. Stafford	CSC	04/01/89	6246	41744	200-250	GR	excellent
J. Didonato	EBRPD	01/23/90	5763	41652	0-10	TSM	excellent
T. Palmisano	CDFG	04/01/90	5762	41605	0-10	TSM	excellent
L. Briden	CDFG	03/01/90	6163	41731	200-250	GR	excellent
J. Didonato	EBRPD	08/09/90	5750	41679	0-10	TSM,R	excellent
J. DiDonato	EBRPD	10/16/90	5838	41719	50-100	OW,PW	excellent
S. Orloff	BI	01/01/91	6146	41722	150-200	GR	excellent
P. Lacy	ADC	01/01/91	6083	41592	200-250	GR,OW	excellent
B. Stafford	CSC	04/01/91	6245	41801	50-100	GR	excellent
K. Bates	PI	04/15/91 - 05/01/91	6120	41730	0-10	NA	excellent
K. Bates	PI	04/25/91	5980	41680	90-100	U	excellent
C. Pelles	USFS	12/01/91	5750	41637	0-10	TSM,GR	excellent
J. DiDonato	EBRPD	12/23/91	5678	41910	200-400	NA	excellent
E. Harding-Smith	USFWS	01/01/92 - 02/01/92	5794	41461	0-10	TSM,GR	excellent
E. Harding-Smith	USFWS	01/01/92 - 02/01/92	5733	41503	0-10	TSM,GR	excellent
P. Lacy	ADC	01/02/92	5962	41567	150-250	OW,SB	excellent
E. Harding-Smith	USFWS	01/05/92	5704	41536	0-10	TSM	excellent
P. Lacy	ADC	01/08/92	5977	41582	100-150	OW,SB	excellent
E. Harding-Smith	USFWS	02/01/92 - 06/01/92	5795	41515	0-10	TSM,SP	excellent
E. Harding-Smith	USFWS	03/01/92	5848	41510	0-10	SP	excellent
E. Harding-Smith	USFWS	03/01/92 - 06/01/92	5891	41485	0-10	TSM,SP	excellent
E. Harding-Smith	USFWS	03/12/92	5827	41427	0-10	GR,SM	excellent
C. Rosen	PI	07/29/92	5907	41797[e]	200-250	SU	excellent
E. Harding-Smith	USFWS	06/10/92	5820	41510	0-10	TSM,SP	excellent
E. Harding-Smith	USFWS	06/19/92 - 06/24/92	5783	41551	0-10	TSM,SP	excellent
Butte County							
D. Johnson	CDFG	01/01/78	6170	43668	30-40	R	excellent
J. Snowden	CDFG	01/01/80 - 01/01/85	6071	43680	25-30	AG,R	excellent
J. Snowden	CDFG	01/01/81	5895	44015	40-50	AG	excellent
M. Garrette	PI	11/01/91	5982	43530	20-25	W,GR	excellent
Colusa County							
J. Parriott	ADC	01/01/63 - 01/01/87	5640	43305	40-50	R,GR,SB	excellent
J. Parriott	ADC	01/01/63 - 01/01/87	5661	43580	30-40	R,GR,SB	excellent
G. Trapp	CSU	11/27/76	5773	43435	10-20	W	excellent
J. Parriott	ADC	01/01/78 - 01/01/92	5725	43547	20-30	AG,R	excellent
J. Parriott	ADC	01/01/80 - 12/01/88	5860	43340	10-20	R,AG	excellent
G. Mensik	CDFG	01/01/85 - 01/01/91	5826	43281	10-20	GR,R	excellent
G. Mensik	CDFG	01/01/89	5699	43458	20-30	AG	excellent
P. Hoffman	CDFG	01/01/89	5775	43436	10-20	R,W,GR	excellent
P. Hoffman	CDFG	03/21/89	5849	43294	10-20	AG,GR,R	excellent

Appendix 1. Continued.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
Contra Costa County							
M. Flynn	UCS	01/01/75	5748	41982	250-350	PW,R,SB	excellent
M. Flynn	UCS	01/01/75	5833	42029	0-10	R,SU	excellent
S. Orloff	BI	01/01/83	6148	41923	30-60	GR	excellent
P. Duda	CH	01/01/84 - 03/21/92	5639	42068	0-50	R	excellent
J. DiDonato	EBRPD	01/01/89 - 01/01/91	5561	42063	0-20	TSM,EW	excellent
P. Duda	EBRPD	01/01/89 - 03/21/92	5520	41985	0-10	TSM,R	excellent
J. DiDonato	EBRPD	05/17/90	5775	41958	200-300	NA	excellent
T. Palmisano	CDFG	07/01/90	5815	42111	0-10	TSM,R	excellent
J. DiDonato	EBRPD	04/18/91	5685	41927	350-450	OW	excellent
El Dorado County							
M. Van Herin	ASRE	01/01/89	6678	42965	250-300	NA	excellent
C. Pelles	USFS	03/01/90	7023	42798	500-600	GR,OS	good
Fresno County							
D. McFadden	FAC	01/01/79	2790	40667	100-150	R,GR	excellent
D. McFadden	FAC	01/01/81	2811	40688	100-150	R,GR	excellent
D. McFadden	FAC	01/01/85	2562	40740	100-150	GR	excellent
D. McFadden	FAC	01/01/86	2533	40899	50-100	R,AG	excellent
R. Jones	UCS	01/01/88	7455	40036	160-180	R,SB	excellent
R. Jones	UCS	05/01/88	7365	40011	210-220	AG,SB,W	excellent
R. Jones	UCS	09/01/88	7109	40481	400-450	GR,OPW	excellent
R. Jones	UCS	01/01/89	7039	40724	100-150	AG,GR	excellent
G. Gerstenberg	CDFG	07/01/89	3105	40703	750-800	CH,OW	excellent
R. Jones	UCS	07/01/89	7451	40205	140-150	GR,SB,AG	excellent
R. Rempel	CDFG	09/01/89	2622	40688	100-110	AG	excellent
D. McFadden	FAC	12/01/89 - 06/07/92	2879	40697	250-300	AG,GR,OS	excellent
D. Williams	CSU	03/01/90	7420	40110	230-250	GR	excellent
D. Williams	CSU	04/01/90	7316	36971	250-300	OS,GR,AG	excellent
R. Jones	UCS	07/01/90	7458	39988	190-200	AG,SB,R	excellent
D. McFadden	FAC	05/01/91	2460	40763	50-100	NA	excellent
Glenn County							
G. Trapp	CSU	05/27/52	5719	43624	30-40	W	excellent
D. Hinz	CDFG	01/01/55 - 01/01/75	5679	43883	50-60	AG,GR,R	excellent
J. Parriott	ADC	01/01/63 - 01/01/87	5602	43655	60-100	AG,R,GR	excellent
B. Holtz	CDFG	01/01/76	5829	44038	40-50	AG,R	excellent
P. Hoffman	CDFG	03/21/90	5672	43585	20-30	AG,GR,R	excellent
P. Hoffman	CDFG	01/01/90	5967	43677	20-30	GR,R,AG	excellent
Kern County							
L. Spiegel	CEC	01/01/86	2626	39506	60-80	GR	excellent
B. Asserson	CDFG	03/21/89	3130	39200	120-140	AG,GR,U	excellent
J. Bennett	ADC	03/01/89	3155	39046	100-110	AG,SU	excellent
J. Bennett	ADC	06/01/89	3170	38990	90-110	AG	excellent
S. Tabor	BI	11/01/89	3160	39080	100-120	AG	excellent
B. Asserson	CDFG	06/21/90	3123	39065	100-120	AG,U	good
J. Bennett	ADC	08/01/90	3120	39240	140-160	AG,SU	excellent
B. Asserson	CDFG	09/21/90	3073	39102	100-120	AG,U	good
J. Bennett	ADC	10/01/90	3075	39171	110-120	SU	excellent
R. van de Hoek	BLM	11/01/91	3186	38878	70-80	AG	good
S. Fitton	BLM	02/17/92	2800	38977	160-180	SB,AG,U	excellent
S. Fitton	BLM	03/09/92	2954	39056	90-110	AG,GR	excellent
S. Fitton	BLM	09/23/92	3360	39113	250-260	AG	excellent
M. Bradbury	CDWR	07/22/92	2513	39509	90-110	AG	excellent
Kings County							
J. Shelton	CDWR	01/01/86	2598	40105	60-70	AG,GR	excellent
J. Shelton	CDWR	01/01/87	2554	39670	50-70	R,SB	excellent
Los Angeles County							
P. McMonagle	CSUS	01/01/59	4058	37564	50-70	U	good
J. Nishidia	CSU	11/17/68	3602	37843	220-230	NA	good
V. Bleich	CDFG	01/01/70	3802	37302	0-40	AG,U	excellent

Appendix 1. Continued.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
Los Angeles County, cont.							
V. Bleich	CDFG	01/01/70	3996	37418	0-10	U	excellent
R. Golightly	PI	01/01/73	3762	37408	40-60	U	excellent
D. Zembal	USFWS	01/01/75 - 12/31/75	3937	37359	0-10	U	excellent
L. Heitz	CDFG	01/01/80	3934	37423	0-10	U	excellent
R. Mattoni	AI	01/01/84	3679	37570	60-80	U	excellent
V. Bleich	CDFG	09/15/86	3774	37382	80-120	U	excellent
P. Rose	NPS	09/21/89	3332	37635	60-70	SB,SU	excellent
J. Lewis	CSUS	05/01/90	3761	37409	20-40	U	excellent
--	AAC	08/20/90	3328	37638	0-50	SU	excellent
E. Burdett	PI	09/21/90	3982	37535	20-40	U	excellent
D. Creeth	PI	09/21/90	3932	37907	900-1000	CH,SB	good
R. Jillson	PI	04/01/91	4029	37657	60-70	R,U	excellent
D. Creeth	PI	09/01/88 - 01/01/91	3675	37593	0-10	TSM,W	excellent
W. Wright	MNP	01/01/92	3758	37435	20-30	TSM,U	excellent
Madera County							
D. Williams	CSU	07/01/84	7467	41099	50-100	AG	excellent
Marin County							
G. Fellers	NPS	01/01/83 - 10/01/85	5035	42281	50-150	GR	excellent
R. Henton	NPS	01/01/86 - 01/01/90	5027	42047	0-50	GR	excellent
R. Henton	NPS	01/01/90	4985	42051	100-150	GR	excellent
R. Henton	NPS	01/01/86 - 01/01/91	5032	42099	50-60	GR	excellent
G. Fellers	NPS	06/05/86	5119	42118	50-100	SB	excellent
R. Henton	NPS	01/01/90	5011	42078	50-60	GR	excellent
C. Dickie	CCW	01/12/91	5288	43250	50-100	GR,R	excellent
Merced County							
S. Melanson	USFWS	03/20/86	6897	41211	0-25	W,GR	excellent
S. Melanson	USFWS	02/26/87	6900	41282	0-25	GR,R	excellent
J. Beam	CDFG	03/21/87	6769	41033	70-90	GR	excellent
F. Warnette	CDFG	01/01/87	6842	40962	100-150	GR	excellent
F. Warnette	CDFG	06/21/87	6818	40875	200-300	GR	excellent
R. Rempel	CDFG	06/01/88	7244	41353	50-60	AG,U	excellent
D. Williams	CSU	06/01/89	6757	41083	40-60	AG	excellent
J. Single	HA	11/01/89 - 04/01/90	6787	41008	100-150	GR,AG	excellent
D. Williams	CSU	01/01/90	6757	41037	70-90	GR,EW	excellent
G. Gerstenberg	CDFG	06/01/90	6750	41032	50-70	GR,W	excellent
G. Gerstenberg	CDFG	08/01/90	6833	40990	50-100	GR,AG	excellent
J. Shelton	CDWR	11/01/90	6708	41240	40-60	GR,AG	excellent
J. Shelton	CDWR	03/19/91	6960	40840	110-130	GR,AG	excellent
G. Gerstenberg	CDFG	04/01/91	6992	41043	25-50	AG	excellent
G. Gerstenberg	CDFG	05/20/91	6886	41077	20-40	AG	excellent
Monterey County							
D. Pine	CDFG	12/01/78	6741	40055	50-150	GR	excellent
K. Moore	CDFG	09/01/80	6124	40747	0-50	GR,OS,OW	excellent
D. Pine	CDFG	05/01/84	6659	40168	50-150	AG,GR	excellent
D. Pine	CDFG	06/01/85	6613	40138	130-150	AG,R	excellent
D. Pine	CDFG	05/01/86	6635	40116	50-150	GR,AG	excellent
B. Elliot	CDFG	01/01/87	6102	40763	0-50	TSM,GR	excellent
D. Pine	CDFG	08/01/87	6730	39735	270-290	OS,SB	excellent
D. Pine	CDFG	10/01/87	6400	40400	40-60	AG,R	excellent
F. Scaroni	MAC	01/01/88	7423	39720	450-550	GR	excellent
S. Orloff	BI	01/01/88	6793	40017	150-200	GR	excellent
F. Scaroni	MAC	04-01/88	7457	39665	450-550	GR	excellent
B. Berry	DOD	07/01/89	7037	39631	200-250	OS,U	excellent
S. Kempel	CDFG	01/01/90 - 05/01/91	6125	40760	0-50	GR,OS,TSM	excellent
F. Scaroni	MAC	05/01/90	6596	40218	70-80	SU,GR	excellent
R. Parker	ADC	06/21/90	6747	39765	250-300	GR,OS,CH	excellent
M. Littlefield	DOD	09/01/90	6697	39787	250-300	GR,OS	excellent
M. Littlefield	DOD	09/21/90	6140	40568	0-50	OW,GR	excellent
M. Littlefield	DOD	04/01/91	6037	40541	0-50	D,CH	excellent
M. Littlefield	DOD	04/01/91	6062	40596	0-50	CH,D	excellent

Appendix 1. Continued.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
Monterey County, cont.							
D. Renshaw	PC	06/01/91	6678	40032	130-150	GR,OS,OW	excellent
M. Casey	MAC	06/01/91	6551	40312	50-150	GR,AG	excellent
M. Casey	MAC	06/01/91	6420	40432	50-150	AG,GR	excellent
M. Flynn	UCS	11/16/91	6086	40865	0-50	AG	excellent
Napa County							
J. Swanson	CDFG	10/10/70 - 01/01/92	5602	42272	0-10	TSM,GR,U	excellent
Orange County							
C. Carisoza	PI	01/01/42 - 01/01/89	4421	37281	250-350	GR,OW,SB	excellent
C. Carisoza	PI	01/01/65 - 06/21/92	4142	37296	0-20	U	excellent
D. Proud	PI	01/01/70	4173	37473	50-70	AG,U	excellent
M. Bereki	OC	03/01/72	4124	37319	0-10	U	excellent
R. Landry	PI	01/01/74 - 01/01/75	4031	37354	0-10	AG,U	excellent
K. Novick	CDFG	04/01/80	4046	37277	0-10	TSM	excellent
J. Beruman	PI	01/01/82	4080	37345	10-20	AG,U	excellent
G. Campbell	PI	01/01/85 - 01/01/86	4195	37264	10-30	U	excellent
G. Gerstenberg	CDFG	01/01/87	4214	37375	40-60	R,U	excellent
D. Proud	PI	01/01/88	4171	37419	40-60	U	excellent
G. Gerstenberg	CDFG	06/21/88	4237	37464	50-100	R,U	excellent
S. Haggadorn	OC	09/01/88	4489	37103	120-140	OW,SB	excellent
L. Fiorillo	CDFG	01/01/89	4025	37439	20-40	U	excellent
J. Anderson	OC	01/01/89	4258	37334	0-50	R,U	excellent
C. Knight	ADC	06/01/89	4002	37345	0-10	TSM,U	excellent
E. Burkett	CDFG	06/01/89	4175	37365	20-40	U	excellent
J. Lewis	CSUS	01/01/90	4034	37397	0-10	U	excellent
J. Lewis	CSUS	01/01/90	4026	37391	0-10	U	excellent
M. Kinney	USFWS	01/01/90	4351	37154	50-150	R,SU	excellent
S. Linsmeier	OC	03/21/90 - 03/01/92	4281	37444	150-200	GR	good
E. Burkett	CDFG	05/01/90	4095	37392	10-30	U	excellent
J. Lewis	CSUS	06/01/90 - 05/15/92	4177	37256	0-50	AG,U	excellent
J. Lewis	CSUS	06/01/90 - 03/01/92	4110	37445	25-50	R,U	excellent
J. Lewis	CSUS	09/01/90 - 01/15/92	4112	37219	0-10	R,U	excellent
B. Cahill	LAAC	12/01/90	4437	37247	300-400	OW,SU	good
C. Knight	ADC	03/01/91	4014	37365	0-10	GR	excellent
L. Dawes	PI	03/01/91	4192	37230	0-50	TSM,U	good
J. Kapus	PI	06/01/91 - 05/01/92	4161	37260	10-20	AG,U	excellent
S. Huebner	OC	06/27/91	4084	37260	0-10	U	excellent
M. Faulhaber	PI	08/25/91	4019	37300	0-10	U	excellent
L. August	PI	10/22/91	4022	37317	0-10	U	excellent
J. Evans	PI	11/07/91	3990	37386	0-10	U	excellent
--	OC	11/25/91	4117	37237	0-10	U	excellent
F. Selby	PI	02/01/92	4177	37237	10-20	U	excellent
C. Knight	ADC	03/01/92	4007	37322	0-10	U,TSM	excellent
Placer County							
B. Sanderson	PI	11/01/92	6730	43200	500-550	OW,SB	good
Riverside County							
L. Armstrong	PI	10/01/87	5112	37484	900-1100	CH	excellent
G. Bell	NC	01/01/88	4532	37405	250-300	GR,R,SB	excellent
K. Pope	PI	06/01/91 - 07/01/92	4470	37490	180-220	U	excellent
Sacramento County							
E. Koford	PC	01/01/65 - 01/01/89	6496	42743	30-40	GR,SB	excellent
L. Manger	ADC	03/01/89	6273	42760	0-50	R	excellent
L. Manger	ADC	03/01/89	6415	42670	0-50	QU,W	excellent
San Benito County							
D. Pine	CDFG	09/01/78	6494	40732	150-200	GR	excellent
R. Hopkins	CDFG	01/01/82 - 01/01/83	6268	40807	100-150	GR,OS	excellent
D. Pine	CDFG	09/01/84	6941	40489	350-450	GR,AG	excellent
D. Pine	CDFG	10/01/85	6425	40772	50-100	GR,SU	excellent
D. Renshaw	PC	12/01/85	6383	40802	50-100	GR,R	excellent

Appendix 1. Continued.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
San Benito County, cont.							
D. Renshaw	PC	12/01/85	6481	40831	100-150	GR,SU,R	excellent
D. Pine	PC	07/01/86	6942	40483	350-450	GR,AG	excellent
S. Orloff	BI	01/01/88	6458	40770	100-150	GR	excellent
M. Schauss	PC	01/01/88 - 01/01/90	6320	40889	40-50	GR,AG	excellent
D. Pine	CDFG	03/01/88	6581	40728	300-400	GR,R	excellent
D. Pine	CDFG	07/01/88	6382	40775	50-100	GR,R	excellent
J. Beam	CDFG	07/01/89	6900	40529	400-450	GR,AG	good
D. Renshaw	PC	10/01/90	6416	40821	50-100	GR,SU	excellent
M. Schauss	PC	02/01/91	6373	40868	50-100	AG,GR	excellent
D. Renshaw	PC	03/01/91	6476	40732	100-200	GR,R,SU	excellent
M. Schauss	PC	04/01/91	6296	40848	150-200	GR	excellent
San Bernardino County							
J. Shows	ADC	01/01/75	4507	37707	250-300	SU	excellent
J. Shows	ADC	01/01/89 - 02/01/90	4449	37689	250-300	AG,U	excellent
San Diego County							
B. Kristan	CSUS	01/01/79	4749	36490	0-50	TSM,U	excellent
M. Small	ADC	04/01/89	4620	36772	0-50	AG,TSM	excellent
R. Patton	SDC	09/01/90	4782	36508	50-100	SB,EW	excellent
M. Small	ADC	04/01/91	4801	36275	0-50	NA	excellent
San Joaquin County							
T. Kidder	PI	01/01/84	6412	41822	0-10	AG,R	good
S. Orloff	BI	01/01/83	6351	41690	50-150	GR	excellent
D. Williams	CSU	06/01/90	6522	41843	0-10	AG,W	excellent
S. Orloff	BI	01/01/91	6288	41675	100-200	GR	excellent
L. Feeney	PC	09/08/91	6392	41776	10-20	AG,SU	excellent
D. Mcgeein	PI	10/19/91	6348	41778	10-20	AG	excellent
San Luis Obispo County							
J. Lidberg	CDFG	09/21/83	7145	39492	200-300	GR,OS,AG	excellent
J. Lidberg	CDFG	01/01/84 - 01/01/86	2277	39110	550-650	GR	excellent
J. Lidberg	CDFG	01/01/84 - 01/01/86	7706	39150	600-650	GR,AG	excellent
J. Lidberg	CDFG	06/21/84	6891	39350	300-350	GR,OW	excellent
B. Berry	DOD	08/01/87	7047	39598	200-250	OS	excellent
B. Berry	DOD	01/01/89	7355	39484	300-350	AG,GR,R	excellent
D. Williams	CSU	03/21/89	2528	38987	700-750	SB,GR	excellent
J. Cochran	SI	06/01/89	7670	39180	600-650	AG	excellent
R. Parker	ADC	06/01/89	7645	39287	650-700	GR	excellent
C. Warner	NC	10/01/89	2402	38985	550-600	GR,SB	excellent
B. Berry	DOD	01/01/90	7087	39343	200-250	R,AG	excellent
M. Small	ADC	01/01/90	2278	39120	550-650	AG	excellent
B. Berry	DOD	01/01/90	7045	39521	200-250	OW,R	excellent
B. Vanherweg	BI	06/01/90	7151	39455	200-250	R	excellent
R. Parker	ADC	08/01/90	7257	39464	300-350	GR,OS	excellent
B. Vanherweg	BI	09/01/90	7149	39507	200-250	AG,R,OS	excellent
J. Lidberg	CDFG	10/01/90	6936	39437	450-550	GR,AG,OW	excellent
R. Parker	ADC	11/01/90	7598	39169	400-450	CH,R,OW	excellent
B. Berry	DOD	12/01/90	7052	39562	250-300	OW,AG	excellent
D. Cappelli	ADC	04/01/91	7089	39413	200-250	OW,OS,AG	excellent
B. Berry	DOD	05/01/91	7067	39612	150-200	OS,AG	excellent
B. Berry	DOD	05/17/91 - 05/30/91	7084	39526	200-250	OS	excellent
D. Cappelli	ADC	06/01/91	7059	39267	400-500	CH,OS	good
R. van de Hoek	BLM	01/21/92	7690	39175	600-650	AG	excellent
San Mateo County							
P. White	UCS	01/01/77	5445	41595	0-50	SB,SU	excellent
B. Boeddiker	ADC	01/01/86	5678	41450	30-40	U	excellent
B. Boeddiker	ADC	01/01/87	5662	41424	100-150	RF,SU	excellent
B. Boeddiker	ADC	01/01/87	5702	41365	150-200	RF,SU	excellent
B. Boeddiker	ADC	10/01/91	5525	41615	30-50	SU	excellent

Appendix 1. Continued.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
Santa Barbara County							
S. Sweet	UC	01/01/78 - 01/01/79	2374	38133	0-50	GR,W	excellent
W. Robertson	ADC	02/01/80	7297	38211	0-40	GR,SB	excellent
W. Robertson	ADC	01/01/81	7412	38339	40-80	AG,GR	excellent
P. Collins	SBNHM	03/22/82	2401	38122	0-10	B,GR	excellent
P. Collins	SBNHM	01/26/84	2469	38147	0-50	NA	excellent
C. Morris	DOD	01/01/85	7240	38383	0-40	CH,GR	questionable
S. Sweet	UC	01/01/85 - 01/01/88	7713	38172	0-40	GR,SB	excellent
P. Collins	SBNHM	05/20/87	2332	38134	0-20	U	excellent
P. Collins	SBNHM	01/06/87	2481	38127	40-50	U	excellent
S. Sweet	UC	09/01/88	7613	38182	0-40	CH,SB	excellent
W. Ferren	UC	01/01/89	2661	38100	0-50	TSM,SU,OW	excellent
P. Collins	SBNHM	10/18/89	2507	38729	0-50	NA	excellent
S. Sweet	UC	04/01/90 - 08/04/91	2350	38122	0-50	GR,R,EW	excellent
W. Robertson	ADC	12/01/90	7340	38143	0-40	GR,SB	excellent
Santa Clara County							
M. Schauss	PC	01/01/80 - 01/01/84	5737	41434	20-30	AG,GR,OS	excellent
M. Schauss	PC	01/01/80 - 01/01/84	5740	41370	100-150	GR	excellent
C. Pelles	USFS	01/01/84	6110	41289	150-200	GR	excellent
J. Beam	CDFG	03/21/87	6425	40921	100-150	GR,OS	excellent
D. Pine	CDFG	08/01/87	6153	41152	80-100	GR,R	excellent
M. Schauss	PC	01/01/88	6229	41000	90-110	OS,SU	excellent
D. Renshaw	PC	10/01/88	6171	41105	150-200	GR,AG,SU	excellent
D. Renshaw	PC	10/01/88	6195	41089	100-150	GR,SU	excellent
D. Renshaw	PC	10/01/88	6211	41095	100-110	GR,SU	excellent
R. Hopkins	HA	01/01/89	6171	41174	200-300	AG,GR,R	excellent
M. Schauss	PC	05/01/89	6295	40906	40-50	GR,AG	excellent
M. Schauss	PC	11/01/89	6257	41106	300-350	GR	excellent
M. Schauss	PC	01/01/90	6245	41077	90-100	SU	excellent
M. Schauss	PC	01/01/90	6246	40957	80-100	GR	excellent
R. Hopkins	HA	02/01/90 - 03/01/91	6056	41288	40-50	GR,R,SU	excellent
B. Elliot	CDFG	04/01/91	6213	41301	750-800	OS,CH	excellent
Santa Cruz County							
M. Flynn	UCS	10/01/90	6102	40700	0-50	AG	excellent
Shasta County							
V. Bisnett	ADC	01/01/45 - 01/01/85	5225	44830	650-750	OW,SB	excellent
V. Bisnett	ADC	01/01/50 - 01/01/85	5945	45292	900-1000	PW,SB	excellent
V. Bisnett	ADC	01/01/50 - 06/01/91	5527	44737	190-210	SB	excellent
V. Bisnett	ADC	01/01/50 - 06/01/91	5572	44730	190-210	OW,SB	excellent
V. Bisnett	ADC	01/01/76 - 01/01/85	5397	44907	250-400	OW,SB	excellent
T. Stone	CDFG	01/01/82	5773	44190	150-250	OW,GR	excellent
Solano County							
B. Berry	DOD	09/21/80	6036	42645	0-50	R,AG	excellent
K. Leverich	PI	01/01/87 - 01/01/89	6163	42386	0-10	AG	excellent
D. Becker	CDFG	01/01/90	5786	42152	0-10	W,GR	excellent
R. Jones	UCS	04/01/91	6052	42643	0-50	R,AG	excellent
Sonoma County							
J. Swanson	CDFG	01/01/70 - 01/01/92	5552	42302	0-10	AG,GR,W	excellent
H. Eedsneed	PAC	11/12/91	5291	42349	0-50	GR	questionable
Sutter County							
E. Kammerer	CDFG	01/01/70 - 01/01/75	6082	43267	0-100	R,AG	excellent
E. Kammerer	CDFG	01/01/70 - 01/01/75	5974	43361	0-100	R,GR	excellent
Tehema County							
J. Bendinger	PI	01/01/68 - 01/01/92	5652	44386	200-300	GR,R	excellent
T. Stone	CDFG	01/01/74	5850	44341	125-175	R	excellent
T. Stone	CDFG	05/01/74	5752	44388	60-80	R	excellent
T. Stone	CDFG	09/21/74	5772	44190	50-60	R	excellent

Appendix 1. Continued.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[c,d]	Reliability
Tehema County, cont.							
H. Hill	TAC	10/01/91 - 01/14/92	5765	44400	50-100	GR,AG	excellent
H. Hill	TAC	01/01/92	5642	44495	50-150	SU,OS	excellent
Tulare County							
R. Hansen	PI	05/01/88	3126	39954	130-150	AG	excellent
J. Hawkins	PI	01/01/89	3295	40332	400-500	GR,OW	excellent
J. Crew	CDFG	03/01/91	3196	39915	130-150	AG,U	excellent
Ventura County							
R. Dow	DOD	01/01/81	3052	37753	0-50	TSM,SB	excellent
M. Bouke	CDFG	10/01/90	2886	38092	140-160	SB,R,AG	excellent
D. Ledig	USFWS	12/01/90	3009	37775	0-10	TSM,AG	excellent
Yolo County							
R. Cole	UC	01/01/75 - 01/01/92	6065	42756	0-100	AG,R	excellent
G. Trapp	CSU	02/26/76	5961	42848	100-200	NA	excellent
R. Scoonover	CDFG	01/01/88 - 01/01/91	5877	42926	200-300	GR	excellent
R. Scoonover	CDFG	01/01/91	5906	42930	100-200	GR	excellent

[a]AAC = Agoura Animal Control, ADC = USDA Animal Damage Control, AI = Agresearch Inc., ASRE = Auburn State Recreational Area, BI = Biosystems Analysis, BLM = Bureau of Land Management, CCW = California Center for Wildlife, CDFG = California Department of Fish and Game, CDWR = California Department of Water Resources, CEC = California Energy Commission, CSC = Computer Systems Corporation, CSU = California State University, CSUS = California State University student, DOD = U.S. Department of Defense (includes all military personel), EBRPD = East Bay Regional Park District, FAC = Fresno Agricultural Commission, HA = Harvey and Associates, LANHM = Los Angeles County Natural History Museum, MAC = Monterey County Animal Control, NC = Nature Conservancy, MNP = Madron Nature Preserve, NPS = USDI National Park Service, OC = Orange County, PAC = Petaluma Animal Control, PC = private consultant, PI = private individual, RF = Redwood Forest, SAC = Shasta County Animal Control, SB = Sacramento Bee, SBNHM = Santa Barbara County Natural History Museum, SDC = San Diego County, SI = Smithsonian Institute, TAC = Tehama County Animal Control, UC = University of California, UCS = University of California student, USFS = U.S. Forest Service, USFWS = U.S. Fish and Wildlife Service.

[b]The sighting dates are rounded off to the first of the month when only the month was known and to the first of the year when only the year was known. When only the season was given the following dates were used: Winter = 12/21, Spring = 03/21, Summer = 06/21, and Fall = 09/21

[c]AG = agricultural, B = beach, CH = chapparal, D = dunes, EW = Eucalyptus woodland, GR = grasslands, NA = information not available, OPW = oak-pine woodland, OS = oak savana, OW = oak woodland, PW = pine woodland, QU = gravel quarry, R = riparian, RF = redwood forest, SB = scrub, SM = salt marsh, SP = salt ponds, SU = suburban, TS = tidal slough, TSM = tidal salt marsh, U = urban, W = freshwater wetlands.

[d]Habitat types are listed in the approximate order of dominance at the red fox sighting location.

[e]Approximate location within 1 km of true location.

Appendix 2. Sighting data for Orange County, California, distribution of introduced red foxes in California for 1992 and earlier.

Observer	Affiliation[a]	Sighting Dates[b]	UTM X	UTM Y	Elevation (m)	Habitat[cd]	Reliability
Orange County							
C. Carisoza	PI	01/01/42 - 01/01/89	4421	37281	250-350	GR,OW,SB	excellent
C. Carisoza	PI	01/01/65 - 06/15/92	4142	37296	0-20	U	excellent
D. Proud	PI	01/01/70	4173	37473	50-70	AG,U	excellent
M. Bereki	OC	03/01/72	4124	37319	0-10	U	excellent
R. Landry	PI	01/01/74 - 01/01/75	4031	37354	0-10	AG,U	excellent
K. Novick	CDFG	04/01/80	4046	37277	0-10	TSM	excellent
J. Beruman	PI	01/01/82	4080	37345	10-20	AG,U	excellent
G. Campbell	PI	01/01/85 - 01/01/86	4195	37264	10-30	U	excellent
USFWS	EIS	01/01/86	3988	37335	0-10	AG	excellent
USFWS	EIS	01/01/86	4032	37371	0-10	AG	excellent
USFWS	EIS	01/01/86	4010	37372	0-10	AG	excellent
USFWS	EIS	01/01/86	4022	37358	0-10	AG	excellent
USFWS	EIS	01/01/86	4012	37344	0-10	AG,TSM	excellent
USFWS	EIS	01/01/86	3997	37350	0-10	AG	excellent
USFWS	EIS	01/01/86	4006	37327	0-10	TSM	excellent
G. Gerstenberg	CDFG	01/01/87	4214	37375	60-70	R,U	excellent
D. Proud	PI	01/01/88	4171	37419	40-60	U	excellent
G. Gerstenberg	CDFG	07/01/88	4237	37464	50-100	R,U	excellent
S. Haggadorn	OC	09/01/88	4489	37103	120-140	OW,SB	excellent
L. Fiorillo	CDFG	01/01/89	4025	37439	20-40	U	excellent
J. Anderson	OC	03/01/89	4258	37334	0-50	R,U	excellent
E. Burkett	CDFG	06/01/89	4175	37365	20-40	U	excellent
J. Lewis	CSUS	01/01/90	4034	37397	0-10	U	excellent
J. Lewis	CSUS	01/01/90	4026	37391	0-10	U	excellent
M. Kinney	USFWS	01/01/90	4351	37154	50-150	R,U	excellent
S. Linsmore	OC	04/01/90 - 03/01/92	4281	37444	150-200	GR	excellent
E. Burkett	CDFG	05/01/90	4095	37392	10-30	U	excellent
J. Lewis	CSUS	06/01/90 - 05/15/92	4177	37256	0-50	AG,U	excellent
J. Lewis	CSUS	06/01/90 - 03/01/92	4110	37445	25-50	R,U	excellent
J. Lewis	CSUS	09/01/90 - 01/15/92	4112	37219	0-10	R,U	excellent
B. Cahill	LAAC	12/01/90	4437	37247	300-400	OW,SU	good
L. Dawes	PI	03/01/91	4192	37230	0-50	TSM,U	good
J. Kapus	PI	06/01/91 - 06/01/92	4161	37260	10-20	AG,U	excellent
S. Huebner	OC	06/26/91	4084	37260	0-10	U	excellent
M. Faulhaber	PI	08/25/91	4019	37300	0-10	U	excellent
L. August	PI	10/22/91	4022	37317	0-10	U	excellent
J. Evans	PI	11/07/91	3990	37386	0-10	U	excellent
--	OC	11/25/91	4117	37237	0-10	U	excellent
F. Selby	PI	02/01/92	4177	37237	10-20	U	excellent

[a]ADC = USDA Animal Damage Control, CDFG = California Department of Fish and Game, CSUS = California State University student, EIS = Seal Beach Env. Impact Statement (U. S. Fish and Wildlife Service and U. S. Navy 1990) LAAC = Los Angeles Animal Control, OC = Orange County, PC = Private Consultant, PI = Private Individual.
[b]The sighting dates are rounded off to the first of the month when only the month was known and to the first of the year when only the year was known. When only the season was given the following dates were used: Winter = 12/21, Spring = 03/21, Summer = 06/21, and Fall = 09/21
[c]AG = agricultural, GR = grasslands, OW = oak woodland, R = riparian, SB = scrub, TSM = tidal salt marsh, U = urban.
[d]Habitat types are listed in the approximate order of dominance at the red fox sighting location.

Appendix 3. Percent occurrence[a] of invertebrate prey items in red fox scat samples by season in Orange County, California, 1990-1991.

Prey Item	Winter (n=104)	Spring (n=52)	Summer (n=111)	Fall (n=124)
Coleoptera	51	15	79	b
Orthoptera	28	12	48	49
Lepidoptera	3	6	18	14
Hymenoptera	4	4	9	8
Dermaptera	10	0	17	8
Scorpiones	11	0	7	26
Arachnida/Siphonaptera	0	0	1	SA
Cocoon	3	0	2	SA
Crustacea	6	8	0	6
Molluska	10	15	0	2

[a]Percentage occurrence was calculated by dividing the number of samples containing an invertebrate prey item by the number of samples containing invertebrates. Sample sizes (eg. Winter, n=104) included only samples that contained invertebrates.
[b]Awaiting final analysis.

Appendix 4. Percent occurrence[a] of seeds in red fox scat samples by season in Orange County, California, 1990-1991.

Seed Family:Genera	Winter (n=74)	Spring (n=40)	Summer (n=89)	Fall (n=131)
Aizoaceae				
Mesembryanthemum sp.	0	3	0	0
Apaceae	0	0	1	0
Arecaceae				
Phoenix sp.	0	0	15	10
Washingtonia sp.	12	5	0	27
Unid. Arecaceae	4	0	0	0
Asteraceae				
Carthamus sp.	0	5	0	0
Centaurea sp.	0	3	0	0
Unid. Asteraceae	0	0	0	1
Brassicaceae	0	3	2	0
Cataceae	0	3	0	0
Chenopodiaceae				
Atriplex sp.	0	0	2	0
Unid. Chenopodiaceae	0	0	1	0
Compositae	0	0	0	1
Convolvulaceae				
Cressa sp.	0	3	0	0
Corporalaceae	0	0	1	0
Cucurbitaceae				
Citrullus sp.	0	0	0	1
Cyperaceae	0	3	2	0
Euphorbiaceae				
Euphorbia sp.	0	0	0	1
Fabaceae				
Acacia sp.	1	0	1	0
Caesalpinia sp.	0	0	3	2
Medicago sp.	0	0	8	3
Phaseolus sp.	0	0	2	0
Unid. Fabaceae	1	0	0	2
Geraniaceae				
Geranium sp.	5	13	10	4
Hordeae	3	0	3	1
Malvaceae	0	0	0	1
Moraceae				
Ficus sp.	22	10	46	61
Myoporaceae				
Myoporum sp.	28	18	0	0
Myrtaceae				
Eucalyptus sp.	0	0	1	0
Pinaceae	1	0	4	2

Appendix 4. Continued.

Poaceae				
Agrostis sp.	0	0	0	1
Avena sp.	0	0	11	5
Bromus sp.	0	5	23	1
Cenchrus sp.	0	0	0	1
Panicum sp.	0	10	0	0
Paspalum sp.	0	0	4	0
Phalaris sp.	0	5	0	0
Sorghum sp.	0	3	2	0
Unid. Poaceae	7	8	2	1
Polygonaceae				
Polygonurn sp.	0	0	4	0
Rumex sp.	1	3	3	3
Rosaceae				
Frageria sp.	3	5	0	0
Malus sp.	0	0	10	3
Pyrus sp.	0	0	1	1
Rubiaceae	0	0	1	0
Solanaceae				
Solanum sp.	0	0	0	2
Unid. Solanaceae	0	0	0	1
Taxaceae				
Taxus sp.	0	0	1	0
Vitaceae				
Vitis sp.	1	5	1	1
Other Genera				
Koelreuteria sp.	0	0	1	0
Copsicum sp.	0	0	3	0
Caryopsis sp.	0	3	1	0
Carum sp.	0	0	1	0
Siverse sp.	0	0	1	0

[a]Percent occurrence was calculated by dividing the number of samples containing a specific seed type by the number of samples containing seeds.

Appendix 5. Capture data on radio-collared and ear-tagged red foxes in Orange County, California, June 1990 - January 1991.

Age	Sex	Capture Date	Site[a]	Ear-tags (color and #) Right, Left	Radio-collars colors, frequency
Ad	F	6/29/90	Crescent	red #7, blue #18	orange-R/white-L, 148.800
		8/24/91	Crescent (recapture)		orange-R/white-L
Ad	M	6/29/90	Bristol	white #19, yellow #15	yellow-R/white-L, 148.601
		4/10/91	Bristol (recapture)		green-R/blue-L, 148.700
Juv	M	7/16/90	MSP	yellow #21, green #12	yellow-R/blue-L, 148.551
		10/09/90	MSP (recapture)		white-R/green-L, 148.551
Juv	F	07/19/90	MSP	red #14, orange #17	red-R/blue-L, 148.750
		02/20/91	MSP (recapture)		yellow-R/orange-L, 148.950
Juv	M	07/20/90	MSP	yellow #22, green #36	orange-R/yellow-L, 148.650
Juv	M	07/25/90	MSP	blue #6, white #10	orange-R/blue-L, 148.701
		02/22/91	MSP (recapture)		yellow-R/blue-L, 148.650
Ad	M	08/06/90	Crescent	green #37, red #13	green-R/red-L, 148.951
Juv	F	09/22/90	LAAFRC	orange #39, yellow #38	yellow-R/green-L, 148.650

Appendix 5. Continued.

Juv	M	09/23/90	LAAFRC	blue #32, orange #34	blue-R/white-L, 148.800
Ad	F	10/01/90	OCSTP	red #43, green #40	green-R/yellow-L, 148.950
Ad	M	10/01/90	LAAFRC	green #41, red #42	red-R/orange-L, 148.600
Juv	F	10/09/90	MSP	yellow #44, white #33	white-R/red-L, 148.501
Juv	M	10/09/90	MSP	white #47, red #46	red-R/yellow-L, 148.851
		02/22/91	MSP (recapture)		red-R/yellow-L, 148.851
Ad	M	10/09/90	MSP	orange #50, blue #52	blue-R/yellow-L, 148.901
		11/11/91	MSP	orange #50, blue #52	blue-R/orange-L, 14
Ad	M	10/13/90	LAAFRC	blue #49, green #48	white-R/blue-L, 148.501
		09/05/91	LAAFRC (recapture)		orange-R/green-L 12
Juv	M	10/14/90	LAAFRC	yellow #35, blue #45	green-R/orange-L, 148.751
Juv	M	01/01/91	BCER	white #55, blue #54	blue-R/white-L, 148.800
Juv	F	01/06/91	BCER	yellow #53, red #51	green-R/white-L, 148.850
Ad	F	02/22/91	MSP	red #07, yellow #31	
Ad	M	02/22/91	MSP	yellow #30, red #25	
Juv	M	02/22/91	MSP	yellow #28, red #01	

Appendix 5. Continued.

Ad	F	02/22/91	MSP	red #06, yellow #29	
Ad	M	02/22/91	MSP	yellow #63, red #08	
		11/11/91	MSP	red #63 yellow #65	(recapture)
Ad	F	02/22/91	MSP	red #09, yellow #64	
Juv	M	07/09/91	OCSTP	red #26 red #27	orange-R/red-L, 148.850
		07/20/91	SCEP	(recapture)	orange-R/red-L, 148.850
Juv	F	07/13/91	SCEP	Blue #56 White #57	Blue-R/White-L 148.800
		11/21/91	OCAS	(recapture)	Blue-R/White-L 148.800
Juv	M	07/21/91	MSP	White #58 Blue #59	Yellow-R/White-L 11
Ad	F	07/28/91	SCEP	Orange #24 Blue #23	red-R/green-L 15
Juv	F	11/11/91	MSP	Green #17 Red #18	orange-R/green-L 12
Ad	M	11/11/91	MSP	yellow #63 yellow #8	
Juv	F	11/11/91	MSP	yellow #69	
Juv	F	11/11/91	MSP	yellow #20	
Ad	F	11/11/91	MSP	yellow #66	

[a]Bristol is Bristol St. site, Crescent is Crescent Ave. site, MSP is Mile Square Park, LAAFRC is Los Alamitos Armed Forces Reserve Center, OCSTP is Orange County sewage treatment plant #2, BCER is Bolsa Chica State Ecological Reserve, SCEP is the Southern California Edison Plant between Newland and Magnolia Ave. OCAS is the Orange County Animal Shelter.