San Joaquin Kit Fox
(Vulpes macrotis mutica)

Legal Status

State: Threatened

Federal: Endangered

Critical Habitat: No critical habitat has been designated for this species

Recovery Planning: *Recovery Plan for Upland Species of the San Joaquin Valley* (U.S. Fish and Wildlife Service 1998). In 2010, the U.S. Fish and Wildlife Service (USFWS) issued the *San Joaquin Kit Fox (*Vulpes macrotis mutica*) 5-Year Review: Summary and Evaluation* . In the 5-Year Review, USFWS recommended no change to the federal status of the species.

Taxonomy

The San Joaquin kit fox is a subspecies of the kit fox (*Vulpes macrotis*), the smallest member of the dog family in North America. Though there has been some debate as to the taxonomic relationship among North American arid land foxes, the San Joaquin kit fox remains a distinct subspecies due to its limited range in California. The details of this debate are outlined in Dragoo et al. (1990) and Schwartz et al. (2005) (U.S. Fish and Wildlife Service 2010).

The San Joaquin kit fox averages about 30 centimeters (cm) (12 inches) high at the shoulder and weighs 4.6–5.0 pounds (2.1 2.3 kilograms). The general physical characteristics of the San Joaquin kit fox are a small, slim body, relatively large ears set close together, a narrow nose, and a long, black-tipped bushy tail. Adult color and texture vary by geography and season. Typically two coats develop each year: a tan summer coat and a silver-gray winter coat. The undersides vary from light buff to white (U.S. Fish and Wildlife Service 1998).

Distribution

General

Although the precise historical range of San Joaquin kit fox is unknown, it is believed to have extended from Contra Costa and San Joaquin Counties in the north to Kern County in the south. By the 1930s, the range had been reduced to the southern and western portions of the Central Valley (Grinnell et al. 1937). Surveys conducted

between 1969 and 1975 extended the known range of the San Joaquin kit fox back into portions of its historical range in the northern San Joaquin Valley, including Contra Costa, Alameda, and San Joaquin Counties (U.S. Fish and Wildlife Service 1998).

Currently, San Joaquin kit fox occurs in areas of suitable habitat on the floor of the San Joaquin Valley and in the surrounding foothills of the Coast Ranges, Sierra Nevada, and Tehachapi Mountains from Kern County north to Contra Costa, Alameda, and San Joaquin Counties (U.S. Fish and Wildlife Service 1998, 2010). There are known occurrences in Alameda, Contra Costa, Fresno, Kern, Kings, Madera, Merced, Monterey, San Benito, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Stanislaus, and Tulare Counties (California Department of Fish and Game 2012). Three of these counties—Monterey, Santa Clara, and Santa Barbara—are outside the originally defined historical range (U.S. Fish and Wildlife Service 1998).

Distribution and Occurrences within the Study Area

Historical

Based on a search of the California Natural Diversity Database (CNDDB), there are 28 San Joaquin kit fox occurrences (prior to 1990) within the permit area and there are 225 historical occurrences within the larger study area (California Department of Fish and Game 2012).

Recent

There are 44 San Joaquin kit fox occurrences from 1990 to present in the permit area and 114 occurrences within the study area and outside of the permit area (California Department of Fish and Game 2012). All of the occurrences are presumed to be extant. There are also many additional anecdotal reports of San Joaquin kit fox observations in the permit area from bioresource professionals and area residents.

The largest extant populations of San Joaquin kit fox are in western Kern County (Elk Hills and Buena Vista Valley) and San Luis Obispo County in the Carrizo Plain Natural Area (U.S. Fish and Wildlife Service 2010). The San Joaquin kit fox population within the city of Bakersfield is believed to number between 200–400 individuals.

Natural History

Habitat Requirements

San Joaquin kit foxes occur in a variety of habitats, including grasslands, scrublands, alkali meadows and playas, and agricultural areas including row crops, irrigated pastures, orchards, vineyards, and grazed annual grasslands (U.S. Fish and Wildlife

Service 1998). They prefer habitats with loose-textured soils suitable for digging (U.S. Fish and Wildlife Service 2010). Dens are generally in open areas with grass or grass and scattered brush and seldom occur in areas with thick brush. Preferred sites are relatively flat and well-drained. Kit foxes are seldom found in areas with shallow soils due to high water tables or impenetrable bedrock or hardpan layers. However, kit foxes may occupy soils with a high clay content where they can modify burrow dug by other animals, such as California ground squirrels (*Spermophilus beecheyi*) (U.S. Fish and Wildlife Service 1998).

San Joaquin kit foxes also occur in several urban areas in the San Joaquin Valley, including Taft, Coalinga, and Bakersfield. Within urban areas, kit foxes most commonly use undeveloped lands (vacant lots), stormwater retention basins, commercial areas, industrial areas, landscaped open areas (parks, school campuses, golf courses), and linear corridors (canal banks, railroads, and powerline rights-of-way). Residential areas are often avoided because of the consistent high levels of disturbances and the presence of domestic dogs. Fences and walls found in residential areas also present barriers to movement. (Cypher et al. 2012).

Table 1. Habitat Associations for San Joaquin Kit Fox

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Saltbush scrub, Grassland	Breeding, foraging, dispersal	Denning and dispersal	Requires suitable burrows for denning. Must be managed to maintain low vegetation height	Low vegetation is thought to provide clear view of potential predators. Presence of burrowing species provides burrows for refugia and a substantial prey base
Urban	Breeding, foraging, dispersal	Denning and dispersal	Open areas without high-levels of disturbance	High-levels of disturbance within residential areas are often avoided
Agricultural	Foraging and dispersal	Dispersal	Suitability of agricultural areas Improves with the presence of suitable prey and without high levels of disturbance	Periodic disking renders this type of habitat as unsuitable for denning and for some prey species
Oil Field	Breeding, foraging, denning	Denning and dispersal	Light-density oil fields (<25% ground cover) are often utilized by kit foxes. Less abundant in moderate-density (25%-75% ground cover developed). Absent from high-density fields (>75% ground cover developed)	Population densities in oil fields decrease as development density increases. Generally only utilize medium-density oil fields for dispersal.

Sources: U.S. Fish and Wildlife Service 1998; U.S. Fish and Wildlife Service 2010.

Foraging Requirements

The diet of the San Joaquin kit fox varies with season and geography based on local availability of potential prey. In the northern portion of their range, kit foxes most commonly prey on California ground squirrels, cottontails (*Sylvilagus audubonii*), black-tail jackrabbits (*Lepus californicus*), pocket mice (*Perognathus* spp.), and kangaroo rats (*Dipodomys* spp.) (U.S. Fish and Wildlife Service 1998). Secondary prey taken opportunistically may include ground-nesting birds, reptiles, and insects. Kit foxes may occasionally forage in irrigated crop fields and orchards but only when such lands are adjacent to natural habitat (U.S. Fish and Wildlife Service 2010). They are also known to eat old, decaying meat and carrion from roadkill caused by motor vehicles (U.S. Fish and Wildlife Service 1998).

Studies of scat samples from San Joaquin kit foxes that have adapted to living in urban environments show these kit foxes extensively consume anthropogenic food along with natural prey (Newsome et al. 2010). The availability of food, both natural (small mammals, birds, and insects) and anthropogenic has lead to a robust, wide-spread, and persistent San Joaquin kit fox population in Bakersfield (Cypher et al. 2012).

Reproduction

Though they do not always do so, kit foxes can breed their first year. Two to six pups are born per litter sometime between February and late March. The annual reproductive success for adults can range between 20% and 100% (mean: 61%) and 0% and 100% for juveniles (mean: 18%) (Cypher et al. 2000). Population growth rates generally vary positively with reproductive success, and kit fox density is often positively related to both current and the previous year's prey availability (Cypher et al. 2000).Litter size and survival decrease when the density of prey species drops during years of drought or high rainfall.

Kit foxes also readily reproduce in urban areas. Reproductive rates are considerably higher for urban kit foxes compared to nonurban foxes. In urban settings, helper foxes (young female foxes from the previous year that delay dispersing) assist with the rearing of the current year's pups (Cypher et al 2012).

Table 2. Key Seasonal Periods for San Joaquin Kit Fox

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Mating and Conception	✓	✓										
Litters Born		✓	✓									
Rearing (pupping)				✓	✓	✓	✓					
Dispersal							✓	✓	✓			
Denning	✓	✓	✓							✓	✓	✓

Sources: U.S. Fish and Wildlife Service 1998, 2010.

Home Range and Population Density

San Joaquin kit foxes may range up to 20 miles at night during the breeding season and somewhat less (6 miles) during the pup-rearing season. They can readily navigate a matrix of land use types. Home ranges vary from less than 1 square mile up to approximately 12 square miles. The home ranges of pairs or family groups of kit foxes generally do not overlap. This behavior may be an adaptation to periodic drought-induced scarcity in prey abundance. San Joaquin kit foxes in urban settings typically have smaller home ranges because of the availability of food, both natural and anthropogenic (U.S. Fish and Wildlife Service 2010).

Table 3. Movement Distances for San Joaquin Kit Fox

Type	Distance/Area	Location of Study	Citation
Home Range	Generally approximately1.7miles^2 (4.4 kilometers [km]^2) up to 9.0 miles^2 (23.3 km^2). Home ranges of urban kit foxes in Bakersfield have reduced because of availability of natural and anthropogenic food sources	Multiple areas	U.S. Fish and Wildlife Service 2010
Dispersal	Variable, 1.1–20 miles (1.8–32 km). Average 4.8 miles (7.7 km) up to ~50 miles (80 km)	Naval Petroleum Reserve	U.S. Fish and Wildlife Service 2010

Ecological Relationships

San Joaquin kit foxes are subject to predation by such species as coyote (*Canis latrans*), nonnative red foxes, domestic dog, eagles, and large hawks (U.S. Fish and Wildlife Service 1998).

Population Status and Trends

Global: Imperiled (NatureServe 2012)

State: Threatened, Declining (U.S. Fish and Wildlife Service 2010)**Study Area:** Same as above

San Joaquin kit foxes continue to face habitat loss to agricultural and urban development, competitive exclusion by other canid species, a population dynamic that fluctuates from year to year, and populations that are often isolated on smaller and highly fragmented. There has been substantial progress on protecting suitable habitat; however, it is not yet likely that all protected habitat parcels contain the requisite contiguous acreage, vegetative structure, and prey base to adequately sustain kit foxes in the future.

Threats and Environmental Stressors

Historically, the main threat to San Joaquin kit foxes and the reason for population decline has been the loss of habitat due to conversion of native habitat for agriculture, oil and gas development, and urban development (U.S. Fish and Wildlife Service 2010). By the late 1970s, much of the native habitat in the San Joaquin Valley had been developed, with only 370,000 acres out of an estimated 8.5 million acres remaining undeveloped. The conversion of natural habitat to agriculture, urban sprawl, gas and oil extraction, and the siting of solar facilities in core areas remains a significant threat. Land conversion contributes to the decline of kit foxes through direct mortality from anthropogenic causes, reduced suitable denning sites, reduced prey abundance, changes in the distribution and abundance of larger canids that compete for resources, and reduced carry capacity as suitable habitat becomes increasingly fragmented (U.S. Fish and Wildlife Service 2010).

Predation is currently the primary source of mortality for San Joaquin kit fox (Nelson et al. 2007; U.S. Fish and Wildlife Service 2010; Cypher et al. 2012). Coyotes are the primary predator of San Joaquin kit foxes (Nelson 2007; Cypher et al. 2012) and may contribute to the decline of kit foxes (U.S. Fish and Wildlife Service 2010). White et al. (2000) determined that coyotes were responsible for 59% of San Joaquin kit fox deaths during a 4-year telemetry study at Camp Roberts in southern Monterey County. Coyotes have accounted for approximately 75% of San Joaquin kit fox mortalities on the Carrizo Plain and the Naval Petroleum Reserve (Nelson et al. 2007). Other predators of San Joaquin kit foxes include red fox, feral dogs, badger (*Taxidea taxus*), and golden eagles (*Aquila chrysaetos*) (Cypher et al. 2012).

Serological tests for diseases in San Joaquin kit foxes found high numbers of San Joaquin kit foxes have been exposed to canine distemper virus and canine parvovirus (U.S. Fish and Wildlife Service 2010). Though high numbers of San Joaquin kit foxes have been exposed to these pathogens, mortality due to disease does not seem to be an important mortality factor (U.S. Fish and Wildlife Service 2010; Cypher et al. 2012). There is potential for the transmission of rabies and other diseases from urban carnivores, such as skunks, cats, and red foxes, to the high density population of San Joaquin kit foxes in Bakersfield. The transmission of rabies to San Joaquin kit

foxes appears unlikely, however, as the disease has not been documented in urban carnivores in Kern County (U.S. Fish and Wildlife Service 2010). Diseases in general do not appear to be a significant mortality source for San Joaquin kit foxes (Cypher et al. 2012).

Conservation and Management Activities

In 1998, the USFWS completed the *Recovery Plan for Upland Species of the San Joaquin Valley*, *California* (U.S. Fish and Wildlife Service 1998), which included a revised recovery strategy for the San Joaquin kit fox. The goal of this recovery plan is to maintain a viable metapopulation of kit foxes on private and public lands throughout the plan's geographic range. The Recovery Plan identified Western Kern County as a core populations and an area of particular importance for conservation.

Urban kit fox populations can aid in the conservation and recovery efforts of the species. Because urban populations tend to be robust and stable, these populations add to the total number of surviving kit foxes and increase the genetic diversity of San Joaquin kit fox range wide. Because of the relative stability of urban populations compared to those in natural habitats, urban populations can also serve as population reservoirs that can repopulate areas when populations in natural environments experience catastrophic events (e.g., disease epidemics) that cause a severe decline in the local population (Cypher and Van Horn Job in prep.). Also, urban populations serve as ambassadors for the species. Bakersfield residents who had observed kit foxes had greater appreciation for them and were more likely to support the conservation of both urban and nonurban kit foxes (Cypher and Van Horn Job in prep.).

Data Characterization

A fair amount of literature is available for the San Joaquin kit fox because of its state threatened and federally endangered status with numerous studies conducted within the study area. The Endangered Species Recovery Program (ESRP) has conducted considerable research on the current status of San Joaquin kit foxes in the San Joaquin Valley and within the city of Bakersfield. Quantitative data are available on population size, reproductive capacity, mortality, dispersal, home-range movement patterns, and habitat characteristics and requirements. A number of models have been developed to describe the species' population dynamics.

Management and Monitoring Considerations

Management and monitoring considerations for San Joaquin kit fox based on the 5-year review (U.S. Fish and Wildlife Service 2010) include:

- Conduct a census of all areas within the San Joaquin kit fox's range. Population numbers and trends would be used to promote range-wide recovery. Perform tests to determine gene flow between subpopulations.
- Focus acquisition of lands to those that are at least 10,000 acres on the San Joaquin Valley floor and western fringes. Identify lands that are no longer suitable for agriculture that could be acquired from willing sellers and restored and conserved.
- Study the population-level effects of contaminants. Study the correlation between rodenticide use on San Joaquin kit fox population parameters or quantify rodenticide effects on availability of prey.
- Quantify and map the extant of suitable habitat remaining in each core and satellite area identified in the Recovery Plan. Compare the acreage of suitable/native habitat and altered or degraded habitat in the core, satellite, and linkage areas between those identified in the 1998 Recovery Plan and current time. The comparison will assist the U.S. Fish and Wildlife Service and other conservation entities in prioritizing conservation strategies and in determining progress in meeting recovery goals for protection of core and satellite areas.

Predicted Species Distribution in the Study Area

Model Description

To define suitable habitat for kit foxes, habitat attributes relative to the presence and persistence of kit fox populations were assessed. Attributes were assessed in areas within the historic range where kit fox populations were known to be robust and persistent (high suitability), areas where kit fox populations were known to be less dense or intermittently present (medium suitability), and areas where kit fox populations appear to be absent with no or only infrequent observations of individual kit foxes (low suitability). Habitat attributes considered most important to kit foxes included land use/land cover, terrain ruggedness, and vegetation density. Habitat suitability throughout the kit fox range was assessed using a GIS-based map-algebra model. The model was initialized with suitability values of the land use/land cover layer with values from 0-100. Using a conditional operator, each cell with a suitability score of 75 or greater was replaced with a different suitability score based on mean Normalized Difference Vegetation Index resulting in a composite suitability layer. From the composite suitability layer, values (i.e., lowered the suitability score) were subtracted from cells based on regional terrain ruggedness and the number of active oil wells to derive an estimate of habitat quality as a continuous grid (30-m cell size) of values ranging from 0-100 with 100 being most suitable. The output was then categorized into

three suitability classes: high (value > 90), medium (90 >= value > 75), or low (value <= 75).

Model Results

Figure D-10 shows the modeled denning and dispersal habitat for non-urban San Joaquin kit foxes within the Plan Area and the Study Area. Figure D-11 shows the modeled denning and dispersal habitat for urban San Joaquin kit foxes within the Plan Area and the Study Area. CNDDB occurrences of this species fall within the modeled habitat.

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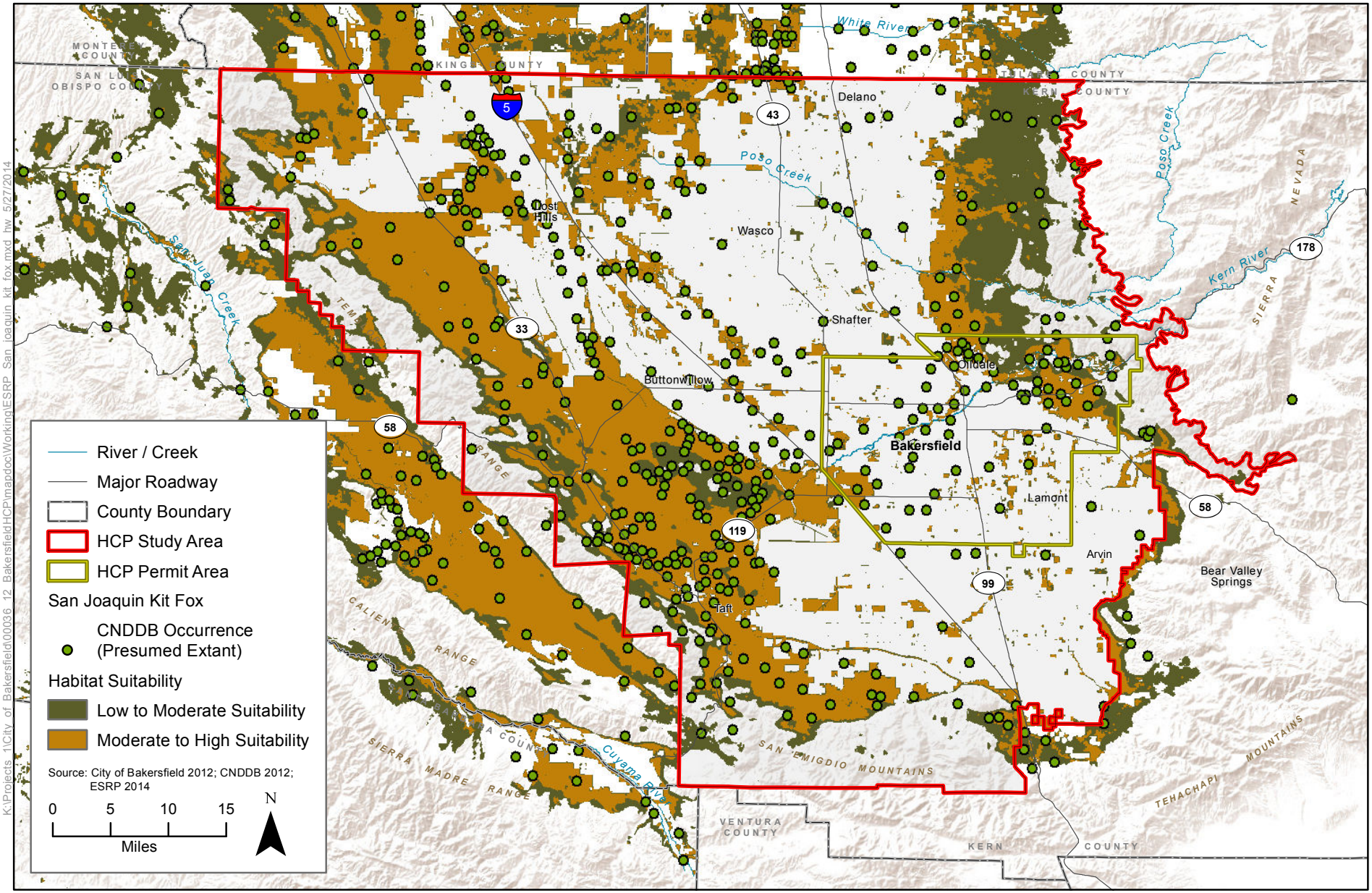

Figure D-10
San Joaquin Kit Fox ESRP Modeled Habitat