SAN JOAQUIN KIT FOX
(*VULPES MACROTIS MUTICA*) DISPERSAL STUDY

MARICOPA SUN SOLAR PROJECT,
KERN COUNTY,CALIFORNIA

April 2012

Quad Knopf

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Maricopa Sun Solar Project, Kern County, California

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EXECUTIVE SUMMARY

The San Joaquin kit fox (*Vulpes macrotis mutica*) is endemic to the San Joaquin Valley, and historically ranged over much of the San Joaquin Valley floor and surrounding foothills and in the Carrizo Plain. The continued conversion of habitat from native Saltbush Scrub, Alkali Sink, and grasslands continues to put this species at risk of extinction. The United States Fish and Wildlife Service listed the San Joaquin kit fox as endangered in 1967 (USFWS 1967) and the State of California listed the fox as threatened in 1971.

The Maricopa Sun Solar project is situated on nine project sites encompassing approximately 6,000 acres in the southern San Joaquin Valley, approximately 5 miles southeast of Taft, Kern County. The project is broadly defined as the construction, operation and decommissioning of PV power generating facilities on approximately 5,853.45± acres. Although the project sites are repeatedly disked for weed control and to maintain the lands in a farm-ready state, the sites may provide some benefit to the San Joaquin kit fox. Extensive biological surveys of the project sites failed to show that the sites are used as breeding or foraging habitat (Quad Knopf 2010), but the sites might be used for dispersal. This study provides an evaluation of the potential for San Joaquin kit foxes to disperse through the project area and the potential value of the Maricopa Sun Solar project sites to the San Joaquin kit fox.

A large block of habitat borders the west and north sides of the westernmost project site (Site 1) that supports many special status species including the San Joaquin kit fox. This habitat block supports the West Kern core population of the San Joaquin kit fox and forms a nearly complete connection to the Bakersfield urban satellite population of kit fox. This connection is located north of the Maricopa Sun Solar project. A secondary corridor linkage between these two populations exists to the south of the project, along the foothills of the Transverse Range then north along the foothills of the Tehachapi Mountains to Bakersfield. The project is located within a large area of intensively farmed agriculture. This agricultural area is devoid of potential kit fox habitat, except for a few, small, isolated remnant patches. Most are not of a sufficient size to support a viable kit fox population. Numerous barriers to kit fox movements occur within this area and the intensive agricultural developments are not conducive to kit fox habitation or movements. Development of the Maricopa Sun project will not affect regional connectivity of kit fox populations, interfere with established or perceived linkage corridors, or affect the potential recovery of the San Joaquin kit fox.

There is a small, isolated, remnant patch of habitat to the east of the project sites that is known to support a small, isolated population of kit fox. The project lies between this site and the West Kern core population of kit foxes to the west. There is no habitat corridor or conduit corridor through this area, but there is a tenuous and unreliable connection between these two populations through the project sites. Measures are included in the project that may encourage the use of the sites by resident kit foxes and contribute to this connection. Development of the project will not affect the local dispersal of kit foxes.

INTRODUCTION

The San Joaquin kit fox (*Vulpes macrotis mutica*) is endemic to the San Joaquin Valley, and historically ranged over much of the San Joaquin Valley floor and surrounding foothills, from southern Kern County north to Tracy, San Joaquin County on the west side of the valley, and near LaGrange, Stanislaus County, on the east side of the valley. The species also occurs in the Carrizo and Elkhorn Plains, San Luis Obispo County, and in the Salinas River watershed, San Benito and Monterey counties. Extensive habitat losses within the San Joaquin Valley from intensive agricultural production, oilfield development, urbanization, and infrastructure development (roads, canals, pipelines) led to the listing of the San Joaquin kit fox as a federally and State endangered species. The continued conversion of habitat from native Saltbush Scrub, Alkali Sink, and grasslands continues to put this species at risk of extinction.

The United States Fish and Wildlife Service listed the San Joaquin kit fox as endangered in 1967 (USFWS 1967) and the State of California listed the fox as threatened in 1971. A Recovery Plan was approved in 1983 (USFWS 1983), and an updated Recovery Plan that covered 34 upland species in the San Joaquin Valley was approved in 1998 (USFWS 1998). The 1998 Recovery Plan identified the San Joaquin kit fox as an umbrella species; recovery actions for the San Joaquin kit fox are critical to the recovery of many other listed species because the kit fox occurs in the same natural communities and requires relatively large areas of natural habitat, thus providing an umbrella of protection for other species that require smaller habitat blocks.

To meet the provisions of various laws and regulations (e.g., National Environmental Policy Act, Federal Endangered Species Act, California Environmental Quality Act, California Endangered Species Act), projects which occur within the range of the San Joaquin kit fox, which are within habitat potentially occupied by the San Joaquin kit fox, and which may adversely affect the San Joaquin kit fox must be fully analyzed to quantify any adverse effects. The Maricopa Sun Solar project is situated on approximately 6,000 acres in the southern San Joaquin Valley, approximately 5 miles southeast of Taft, Kern County. Although the project sites are repeatedly disked for weed control and to maintain the lands in a farm-ready state, the sites may provide some benefit to the kit fox. Extensive biological surveys of the project sites failed to show that the sites are used as breeding or foraging habitat (Quad Knopf 2010).

This study provides an evaluation of the potential for San Joaquin kit foxes to disperse through the project area and the potential value of the Maricopa Sun Solar project sites to the San Joaquin kit fox. Regional background information on known San Joaquin kit fox “core” populations, “satellite” populations, and important linkages and corridors for movement that connect these populations are provided. The linkages and corridors may or may not provide actual linkages, but the maintenance or the creation of those linkages is thought to be essential to the recovery of the fox. The information on populations and linkages were obtained from the Recovery Plan (USFWS 1998) and from the most current five-year status review of the San Joaquin kit fox (USFWS 2010). Information is also provided on the local occurrences and locations of nearby habitat patches that are important for the San Joaquin kit fox. With the knowledge of that existing information, the function and value of the Maricopa Sun project sites to provide opportunities for dispersal and the effects of the project on the ultimate recovery of the species are evaluated in two ways.

First, a regional perspective is employed. The project sites are evaluated for their potential to contribute to regional connections between core populations, satellite populations, and established linkages and corridors. In other words, would development of the project interfere with the regional movements of the fox or hinder the recovery of the fox on a regional basis by reducing dispersal or connectivity among the kit fox metapopulation? Second, the project is evaluated for its effects on the dispersal of kit fox at a local level. In other words, will development of the project effect dispersal of foxes living among local populations?

The contents of this report are organized as follows:

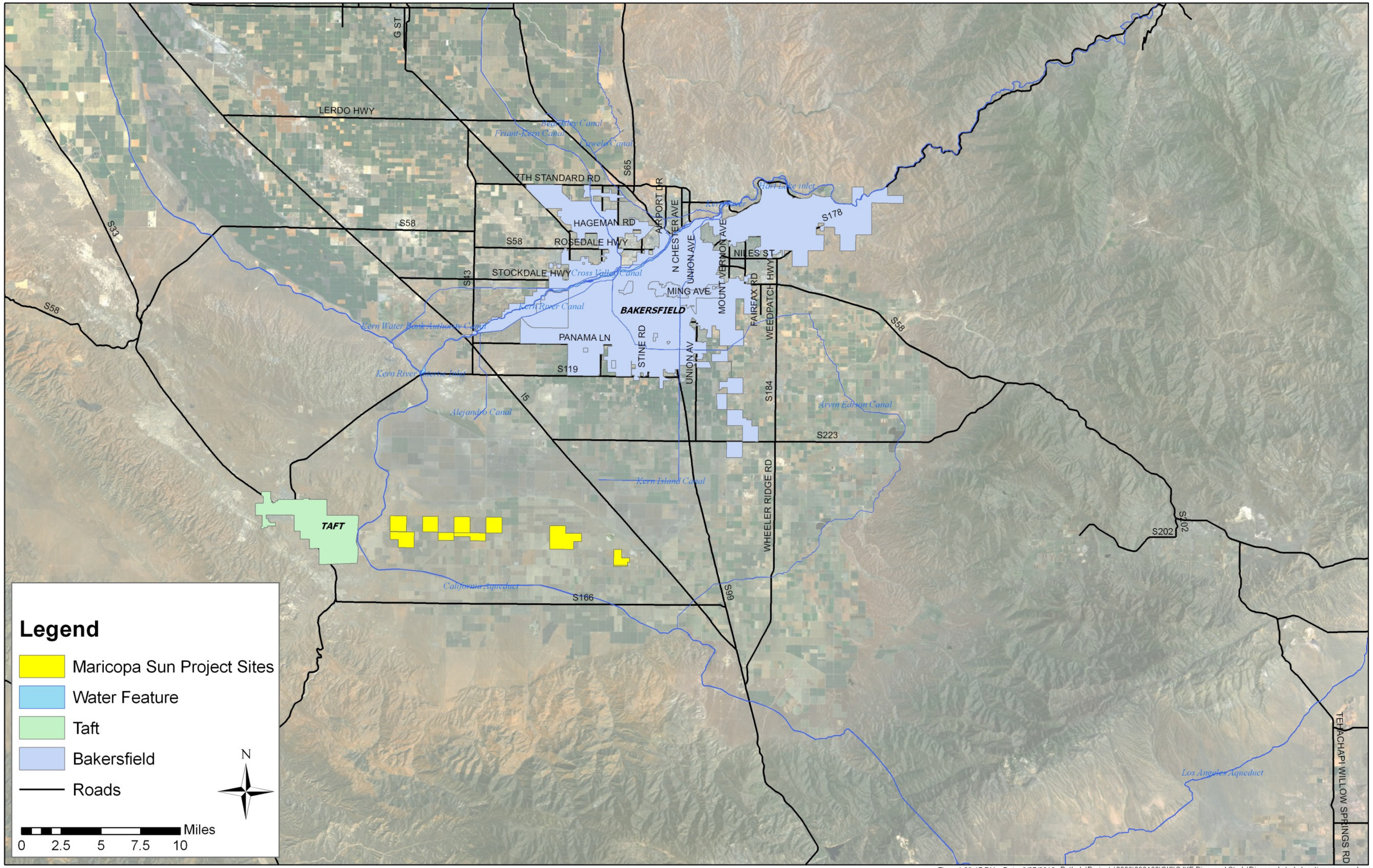
- Project description and biological setting,
- Relevant aspects of the natural history of the San Joaquin kit fox (e.g., home range and demographics, dispersal patterns, use of agricultural environments),
- Functions and values of dispersal corridors,
- Project effects on the regional dispersal of kit fox,
- Project effects on the local dispersal of kit fox, and
- Conclusions

The proposed mitigation to compensate for project effects is presented in a separate document.

PROJECT DESCRIPTION AND BIOLOGICAL SETTING

Project Description

The project is broadly defined as the construction, operation and decommissioning of PV power generating facilities on approximately 5,853.45± acres. The project is located in the southwest portion of unincorporated Kern County (Figure 1). Complete buildout of the Maricopa Sun Solar Complex would produce approximately 700 megawatts (MW) of electricity. Construction of solar facilities on all solar sites is anticipated over an 8 to 10 year period from the commencement of the initial development; however, unknown constraints could extend the development phase to a 10 to 15 year period. It is anticipated that construction of each section (640 acres) within the Maricopa Sun Solar Complex will take 12 to 18 months, dependent upon weather, labor and equipment availability, and time of year. There is a high potential for multiple solar developers to be installing solar facilities at various sites simultaneously.



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Quad Knopf

MARICOPA SUN SOLAR PROJECT, KERN COUNTY, CALIFORNIA

Figure 1

There are a variety of activities that must occur to prepare the sites for construction. Site preparation may consist of the removal of vegetation, minimal site grading, and compaction of soils. No soils shall be exported from the sites. Installation of parking areas and staging and laydown areas for construction materials shall be located inside of the permitted solar field area. Temporary staging areas will be used to position construction management crews, to receive shipments, and inspect and store parts and materials for the solar facilities. Vehicle tire grates, straw bales, and silt fencing will be installed as necessary prior to construction. Construction access roadbeds will typically be 20 to 30 feet wide and consist of compacted earth surfaced with gravel or compacted soil. A stabilized entrance/exit will be provided to clean vehicle wheels prior to exiting construction areas.

Construction of the project will occur in a series of approximately 1-MW blocks, consisting of approximately 5 to 8.64 acres each (depending on technology). Project construction will require the following temporary facilities on site: assembly areas, access roads, parking areas, and staging and lay-down areas. Construction materials will consist of: concrete, pipe, wire and cable, fuels, reinforcing steel, and small tools and consumables. Concrete pads for the drive motors will be poured using a temporary concrete batch plant on site, and electrical equipment for the array will be set in place, usually within trenches.

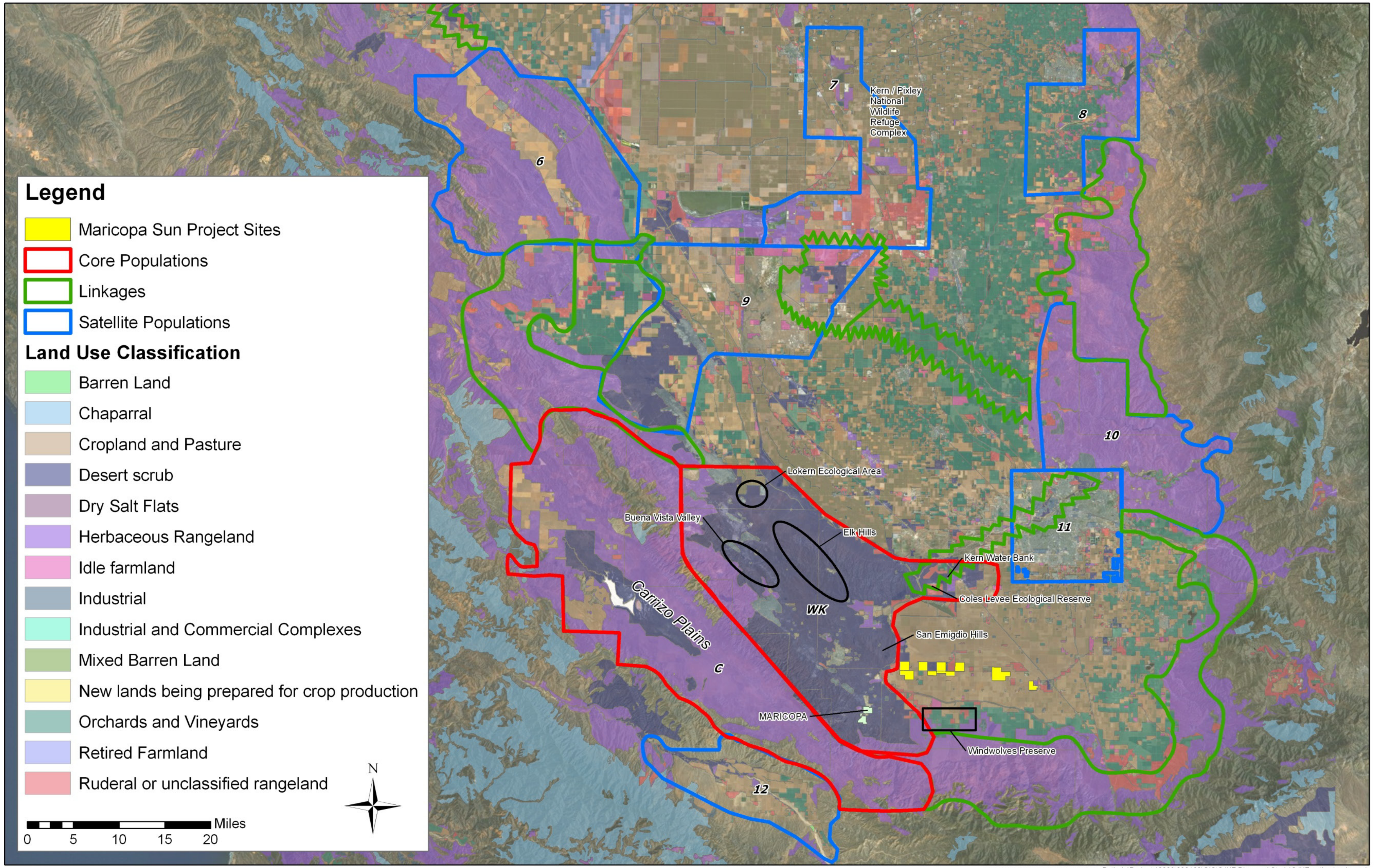
Operational activities are limited to monitoring facility performance, responding to utility needs for facility adjustment; routine cleaning, repairs, and replacement of the solar panels; and on-site security. The on-site O&M buildings will house a minimum of five full-time employees that will perform operational tasks, maintenance tasks, and provide security. Additional personnel may be hired as needed for module cleaning. Security and some maintenance staff may be present on-site on a 24- hour basis. The primary water use during project operation will be for washing of the solar panels, with a minor amount of water use for sanitary requirements. It is presently expected that approximately one gallon would be required for washing each panel. The washing frequency may vary depending upon weather conditions, but it is estimated that the panels will be washed twice per year. At times it may also be necessary to reduce dust emissions by spraying water from a water truck.

The solar operator anticipates a secondary market for PV modules to develop over time. While energy output may diminish, PV modules are expected to continue to have a productive life and can be decommissioned from a prime location or recommissioned in another location. Such a prime location and its infrastructure (racking materials, electrical conduits and wiring, switch yards, inverter pad, etc.) can then be re-used to adopt the latest, most efficient solar energy technologies. Typical activities during solar energy facility decommissioning and site reclamation include removal of all solar electric systems, buildings, cabling, electrical components, breaking up of concrete pads and foundations, and removal of access roads that are not maintained for other uses. The solar facilities will be entirely removed with little impact to the underlying land and the solar sites will be placed in a conservation easement for the benefit of the San Joaquin kit fox and other special status species.

Biological Setting

The project region once supported a wide variety of plant and wildlife species, but much of the diversity and abundance has been reduced and species composition has been altered by dramatic changes in land use. Much of the Valley floor has been converted to agricultural production, but there are still isolated remnants of fallowed lands and disturbed natural lands occurring on the valley floor. Many of these isolated parcels support populations of special status species, but they are susceptible to local extinction from stochastic events, their persistence is tenuous, and their long-term viability is questionable. The ability of species to disperse among these isolated parcels is important for maintaining genetic diversity, allowing for recolonization following local extirpations, and contributing to their long-term persistence. The Maricopa Sun Solar project sites are situated within a matrix of agricultural lands composed of orchards, vineyards, and row crops, and isolated remnants of fallowed and native lands. The native lands occurring in the vicinity of the Maricopa Sun project are composed of Saltbush Scrub or Alkali Sink habitats.

A large block of habitat borders the west and north sides of the westernmost project site (Site 1) that supports many special status species. That habitat block consists of a matrix of Saltbush Scrub and grassland habitats, and extends to the west over the Temblor range into the Carrizo Plain (Figure 2). It extends south to the town of Maricopa, connecting with the Windwolves Preserve. The habitat block extends to the north over the San Emigdio Hills, connecting to Elk Hills, Buena Vista Valley, Coles Levee Ecological Reserve, Tupman Hills, Lokern Ecological Area, and the Kern Water Bank. The habitat block extends to the north along the temblor range to connect with the Kettleman Hills in Kings County, Kreyenhagen Hills in Fresno County, and farther north. This large habitat block supports one of the largest and most important remaining core populations of the San Joaquin kit fox.



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NATIVE LANDS IN THE REGION OF THE
MARICOPA SUN SOLAR PROJECT, KERN COUNTY, CALIFORNIA

Figure
2

Relevant Aspects of San Joaquin Kit Fox Natural History

The San Joaquin Kit fox is an arid-land-adapted species that typically occurs in desert-like habitats composed of sparse or absent shrub cover, sparse ground cover, and short vegetative structure. The kit fox is generally associated with areas of open, level, sandy ground (Grinnell *et al*. 1937) that is relatively stone-free. Kit fox are absent or scarce in areas where soils are shallow due to high water tables, impenetrable hardpans, or proximity to parent material, such as bedrock (Jensen 1972; Morrell 1972, O'Farrell and Gilbertson 1979, O'Farrell *et al*. 1980). The kit fox does not den in saturated soils or in areas subjected to periodic flooding. Habitat with slopes of less than 5 percent is optimal for the kit fox, while habitat with slopes of 5 to 15 percent is suitable and habitat having slopes of greater than 15 percent is unsuitable (Cypher 2006).

The San Joaquin kit fox is primarily nocturnal and subsist primarily on kangaroo rats (*Dipodomys* spp.), but it also preys on white-footed mice and pocket mice (*Peromyscus* spp.), California ground squirrels (*Spermophilus beecheyi*), rabbits (*Sylvilagus* spp.) and hares (*Lepus* spp.), San Joaquin antelope squirrels (*Ammospermophilus nelsoni*), and ground-nesting birds (Scrivner *et al*. 1987). Kit fox populations appear to be most robust where kangaroo rats persist (Cypher *et al*. 2000). The kit fox diet varies geographically, seasonally, and annually. Population abundance of kit fox responds to lower prey abundance by declining, although there generally is a lag-time of one or more years before kit fox declines occur (Cypher *et al*. 2000).

Most female kit fox do not reproduce until 2 years of age although some yearling may produce young (Spencer *et al*. 1992; Spiegel and Tom 1996; Cypher *et al*. 2000). The young are born in natal dens that typically have multiple openings. Young generally disperse in August or September when four or five months old. Reproductive success appears to be correlated with prey abundance (Egoscue 1975) and may be negatively affected by weather conditions that are either too wet or too dry.

Kit fox establish extensive home ranges, but home range sizes vary among locations. Home range size is thought to be related to prey abundance (White and Ralls 1993; White and Garrott 1999). At Elk Hills, Cypher *et al*. (2001) determined the mean adult home range size was 1,071.7 acres, while the mean home range for pups was 525.4 acres. Kit fox on the Carrizo Plains establish home range sizes estimated to average approximately 2,866 acres in size (White and Ralls 1993). In western Merced County, Briden *et al*. (1992) found that denning ranges (the area encompassing all known dens for an individual) average 1,169 acres. At Camp Roberts Army National Guard Training Site, the average home range was found to be 5,782 acres (Root and Eliason 2001).

Reproductive success and average litter size differ between populations and vary with environmental conditions. At Elk Hills, reproductive success of adult females averaged 61 percent, with variation between 20 and 100 percent (Cypher *et al*. 2000). Similar variation in reproductive success has been found at other study sites (Standley *et al*. 1992; Ralls and White 1995; Spiegel and Tom 1996). Average litter size differed by area and ranged from 2.0 pups at the Carrizo Plains to 3.8 pups at Elk Hills (Standley *et al*. 1992; Ralls and White 1995; Spiegel and Tom 1996; Cypher *et al*. 2000).

Predation is a significant cause of kit fox mortality and has strong effects on the demography and ecology of kit fox, at least locally (Cypher and Scrivner 1992). The percentage of mortality due to interactions with predators, primarily coyotes, ranged between 57 percent and 89 percent in the southern San Joaquin Valley (Cypher and Scrivner 1992; Standley *et al*. 1992; Ralls and White 1995; Spiegel and Disney 1996; Spiegel *et al*. 1996; Cypher and Spencer 1998; Cypher *et al*. 2000; Nelson *et al*. 2007). In some locations coyotes only infrequently consume the kit fox they kill, suggesting that coyote attacks are competitive interactions rather than a predator-prey interaction (Cypher and Spencer 1998; Cypher *et al*. 2000; Nelson *et al*. 2007). Kit fox predators also include dogs (*Canis familiaris*), non-native red fox (*Vulpes vulpes*), badgers (*Taxidea taxus*), and golden eagles (*Aquila chrysaetos*) (Briden *et al*. 1992; Cypher *et al*. 2000).

The diets selected by coyotes and kit fox often overlap (Cypher and Spencer 1998; Cypher *et al*. 2001), but they consume prey in different proportions. Shrublands hold higher biomass of prey species than grasslands for both coyotes and kit fox, suggesting that the kit fox may be displaced from shrublands into grassland habitats by coyotes, with diet overlap occurring at an increased mortality cost for the kit fox (Nelson *et al*. 2007). Resource competition may not be significant in all areas or all years (Cypher *et al*. 2001), but may be high when prey resources are scarce (Cypher and Spencer 1998). In some areas, the two species may partition resources adequately to coexist, even with high predation by coyotes (Nelson *et al*. 2007). However, coyote predation on kit fox may reduce population increases of kit fox and accentuate population declines (Cypher and Spencer 1998).

The average dispersal distance of pups has been estimated at 5 miles (± 0.9 miles) at Elk Hills (Scrivner et al 1987), but maximum dispersal distances can vary substantially (Hall 1983). One pup crossed the Temblor Range from Elk Hills into the Carrizo Plains (Scrivner et al 1987), a distance of at least 12 miles. One individual traveled up to 25 miles from its whelping den (V. Getz Pers Comm, *In* USFWS 1998) and an adult male dispersed from Camp Roberts to the Carrizo Plain in 1989 (P.J. White Pers Comm, *In* USFWS 1998). Adult and juvenile kit foxes are known to disperse through disturbed habitats including oil fields, agricultural fields, rangelands, and across highways and aqueducts (USFWS 1998).

Although kit foxes are known to disperse through agricultural fields, intensively farmed lands do not provide suitable habitat for the kit fox for a variety of reasons and kit fox are unable to occupy farmland on a long-term basis. Lands producing row crops are subjected to weekly inundation during irrigation, which impedes kit fox foraging and precludes the establishment, maintenance, and use, of earthen dens (Warrick *et al*. 2007). Prey abundance is relatively low in row crops, prey diversity is reduced, prey species composition changes, and favored prey species such as kangaroo rats disappear (Williams and Germano 1992; Clark 2001; Cypher 2006; Warrick *et al*. 2007). Although kit fox may enter the margins of row crops and may venture into orchards at night from natural lands, there is no evidence that kit fox are able to use farmland, even when it was the predominant available habitat (Warrick *et al*. 2007). It appears that kit fox are permanently displaced from areas where the land is intensively irrigated (Jensen 1972; Morrell 1975; Warrick *et al*. 2007).

Several additional factors reduce suitability of agricultural lands for kit fox. Agricultural lands are used more frequently (in comparison to natural lands) by red fox, coyote, and dogs, which compete with or kill kit fox (Cypher *et al*. 2001; Clark *et al*. 2005; Cypher *et al*. 2005a), potentially making such agricultural lands a mortality sink for the kit fox. Pesticide applications may be harmful to kit fox, while ground squirrel eradication efforts reduce prey availability and may indirectly harm kit fox (USFWS 1993; USEPA 1995; Hosea 2000).

Kit fox movement between parcels of native land may be impeded by the structure of some annual croplands, such as cotton, which forms a dense thicket up to 3 feet tall (Warrick *et al*. 2007). Although there is some evidence that kit fox will use artificial dens placed within agricultural lands, work to date has not demonstrated that kit fox use the artificial dens to cross agricultural lands, even where such lands form a relatively narrow strip between areas of natural habitat (Cypher *et al*. 2005a). Because kit fox exhibit only limited capacity to utilize agricultural lands, agricultural lands also appear to constitute effective barriers to kit fox movements (Cypher *et al*. 2005a).

Orchards and vineyards may provide some habitat value for the kit fox because their open structure and underlying layer of vegetation can support a prey base, but food items are not generally abundant and consist primarily of murid (old world) rodents, in at least some locations (Clark 2001; Warrick *et al*. 2007). Ground squirrels and pocket gophers, which are potential kit fox prey, may be actively poisoned in agricultural areas (Heintz 2000). These factors suggest that kit fox may not have an appropriate prey base for adequate sustenance. Documented use of this habitat by kit fox appears to vary (Clark *et al*. 2005; Warrick *et al*. 2007) and its suitability in supporting kit fox appears limited.

The total of this information demonstrate that kit fox:

- have large home ranges with sizes dependant on local habitat and prey conditions,
- have highly variable survival rates, depending on the population and environmental conditions,
- depend primarily on native prey species
- experience population fluctuations in response to prey levels
- sustain high mortality rates due to coyote predation/competition,
- generally do not occur in rugged terrain or in intensively farmed areas, and
- are reliant on dispersal from population strongholds into suitable habitat in order to sustain subpopulations throughout their range.

Functions and Values of Corridors and Linkages

To determine the effects of the Maricopa Sun solar project on the regional and local dispersal of the San Joaquin kit fox, it is necessary to understand the uses of corridors and the value that corridors provide. Corridors have become an increasingly important concept in conservation biology, and have been shown to have considerable value to some species and populations. There has been substantial debate over the value of corridors, how they should be implemented, and even how they should be defined. A functional approach to corridor design evaluates a corridor in the context of both how it facilitates animal movement and the role that movement plays in the population biology of the species. Functional definitions of corridors are widely used in the application of metapopulation biology, island biogeography, and game management. Structural definitions of corridors arose in the field of landscape ecology, and focus on the existence of a linear strip of habitat within a "matrix-patch-corridor", with no explicit consideration of the function of that strip of habitat on the population biology of the species. The functional definition of a corridor is the appropriate definition to apply when analyzing the potential affect of the Maricopa Sun Project on the kit fox.

There are multiple functions that a corridor can perform, and identifying which functions any particular corridor provides is crucial (Hess and Fischer 2001). Distinguishing whether a corridor serves as a habitat corridor or a conduit corridor is fundamental to defining a corridor's function and analyzing impacts to corridor function (Lindenmayer and Nix 1993, Hess and Fischer 2001). Habitat and conduit corridors are defined as follows (Rosenberg et al. 1995, as described in Hess and Fischer 2001):

> *[A] corridor that provides for movement between habitat patches, but not necessarily reproduction, is performing a conduit function. If a corridor provides resources needed for survivorship, reproduction, and movement, it is performing a habitat function."*

In other words, if an animal's movement is small relative to the width and length of a corridor, it may take several generations for a species to move through the corridor; such species are called "corridor dwellers," and the habitat within such a corridor would have to perform a "habitat" function and provide resources for reproduction (Beier and Loe 1992). Habitat corridors must contain habitat of sufficient quality and quantity to allow for reproduction. Alternatively, if the length of a corridor is traversable for an animal engaging in dispersal, seasonal migration, daily foraging, exploration, or finding a mate, then that species would qualify as a "passage species" with respect to that corridor. In such a situation, the corridor would perform a "conduit" function.

Metapopulation studies that include an evaluation of the benefits of corridors to the abundance and persistence of a population rarely consider the quality of the habitat within the linkage (Henein and Merriam 1990). Likewise, the quality of the habitat within a corridor is not always considered to the degree to which it is warranted (Noss 1987, Henein and Merriam 1990, Hess and Fischer 2001). Corridor quality can be defined by the survival rate of the animals passing through that corridor. High quality corridors have high survival rates for the animals that use them, and low quality corridors have low survival rates for the animals that enter them (Henein and Merriam 1990). The corridor quality model developed by Henein and Merriam (1990) indicates that metapopulations with exclusively high-quality corridors have a larger population size than those with one or more low quality corridors, but that the size of the metapopulation declines as the number of low quality corridors increase.

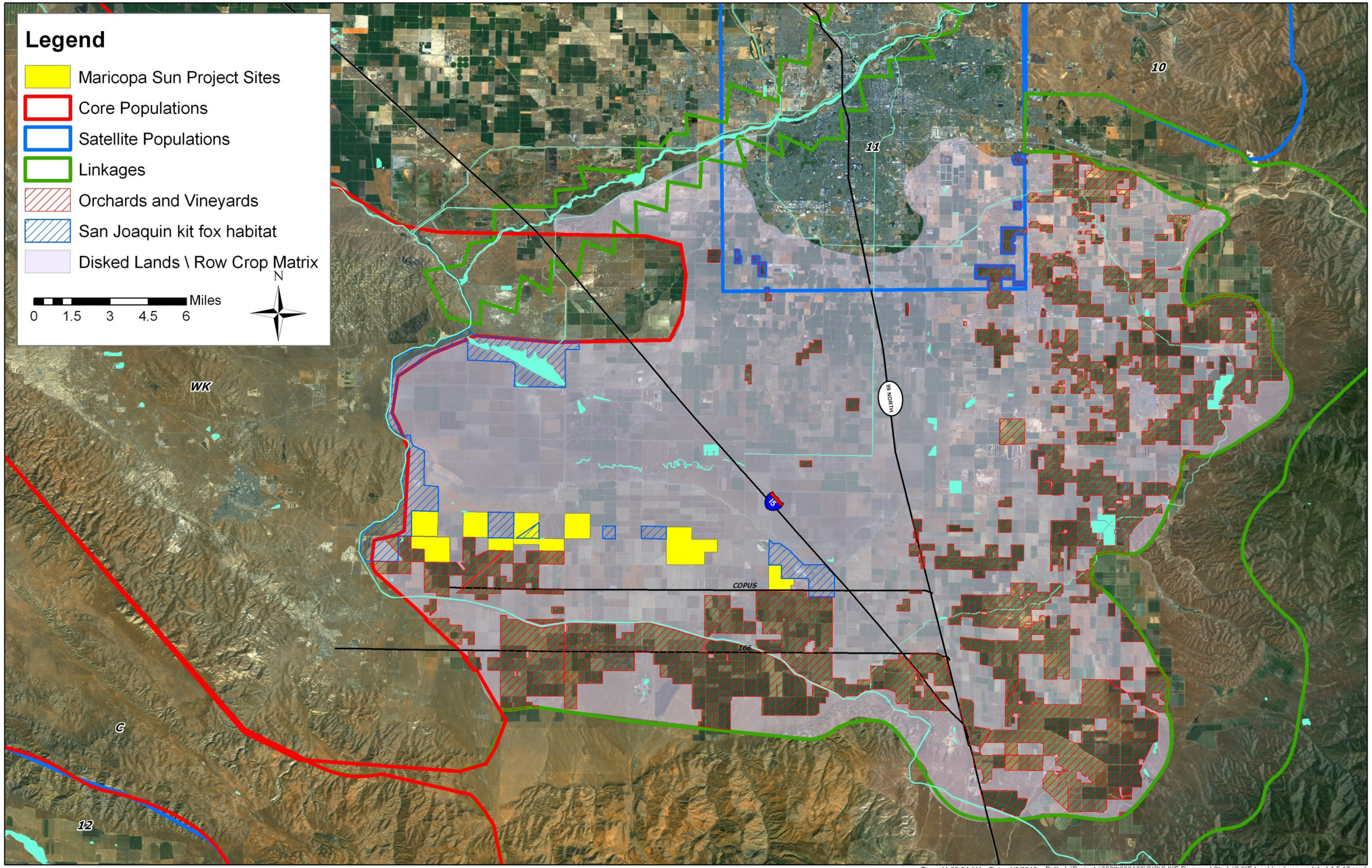
Connecting corridors must provide ecological services sufficient to enable the target species to survive in that space for at least a portion of their life. Types of habitat, terrain, and presence and extent of barriers affect the permeability of corridors. Anthropogenic features including high density roads, urbanized areas, and large expanses of agriculture may be impassable barriers to kit fox, although kit foxes are known to move through a variety of partially disturbed habitats such as farm lands, oil fields, and areas with low density roads and highways (Haight *et al.* 2002). Steep topography probably impedes the movement of kit fox greater than any other natural barriers (Warrick and Cypher 1998).

The functions and values of the Maricopa Sun project as a corridor for San Joaquin kit fox was evaluated based upon the described parameters including:

- type of corridor (habitat vs. conduit)
- land use and presence of habitat,
- terrain,
- presence of barriers including agricultural lands, roads, canals, and
- distance to kit fox core populations, satellite populations, and linkages.

Project Effects on the Regional Dispersal of the San Joaquin Kit Fox

The project sites are situated immediately east and somewhat south of a fingerlike projection of the West Kern core population of the San Joaquin kit fox (Figure 3). This population is one of two primary core population areas, the other being the Carrizo Plain core population. A satellite population, which is an urban population of kit fox inhabiting the City of Bakersfield, occurs approximately 9 miles to the northeast of the easternmost project site. Other satellite populations occur to the north of the project site at the Pixley National Wildlife Refuge, Kern National Wildlife Refuge, and Semi-tropic Ridge Ecological Area. These core and satellite populations are connected by a series of identified corridors and linkages, whose primary purpose is to allow for the continued dispersal of kit foxes among these populations. The recovery of the San Joaquin kit fox is considered to be closely tied to the long-term maintenance of these populations and linkages (USFWS 1998, USFWS 2010).



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Quad Knopf

LAND USES, SAN JOAQUIN KIT FOX POPULATIONS, AND LINKAGE CORRIDORS
IN THE REGION OF THE MARICOPA SUN SOLAR PROJECT, KERN COUNTY, CALIFORNIA

Figure
3

The Maricopa Sun project sites are not located within any core population, satellite population, or identified linkage corridor (Figure 3). Development of the project sites will not remove suitable kit fox habitat from these highly prized population centers or the identified corridors and linkages connecting population centers. However, the sites are situated between the West Kern core population and the Bakersfield satellite population. Linkages between these core and satellite populations occur on all sides of the Maricopa Sun project. One other important corridor that is not identified as a linkage is a habitat corridor that is associated with the California Aqueduct. San Joaquin kit foxes are known to use the small strip of habitat occurring within the Aqueduct Right-of-Way, which is approximately 100 feet wide on each side of the Aqueduct. This habitat corridor extends from the West Kern core population to the Edmonston Pumping Plant at the base of Tejon Ranch, to the southeast of the project sites. In the vicinity of the project sites, the California Aqueduct mostly lies to the south of the sites and provides a corridor along the southernmost portion of the San Joaquin Valley. Development of the project may have the potential to reduce the dispersal of kit foxes among these areas, primarily along two geographic orientations:

1) along a north-south axis between a linkage corridor to the south of the project sites near Windwolves Preserve and a fingerlike projection of the West Kern core population to the north (see Figure 3), and
2) along a southwest-northeast axis between the West Kern core population and a satellite population at Bakersfield (see Figure 3).

North-south Axis

The north-south distance between the southern linkage along the base of the Transverse Range and the fingerlike projection of the West Kern core population to the north of the project site is approximately 23 miles. This is an uncharacteristically far distance for a single kit fox to disperse, particularly because the majority of that distance does not contain kit fox habitat and consists of matrix of intensively farmed row crops, orchards, and vineyards. There are substantial barriers to the north-south movements of kit foxes through this area that are independent of the Maricopa Sun project. These existing barriers include Highway 166, the California Aqueduct, and an expanse of approximately 94,907 acres of agricultural orchards and vineyards (Figure 3). These barriers are all south of the project sites. Most of the land to the north of the project sites and south of the West Kern Core population consist of a matrix of agricultural row crops and fields that are routinely fallowed. These lands are also a significant barrier to the movements of the San Joaquin kit fox. Although these barriers may be somewhat permeable to kit fox movements, there are factors that further reduce the potential for movements through this area. Coyotes, a known competitor and predator on the San Joaquin kit fox are plentiful in this area (Quad Knopf unpubl data), there are no native lands or fallowed lands which would support escape dens, and there is a lack of available prey. Because of these issues, there is no viable north-south conduit corridor or habitat corridor that would be affected by the Maricopa Sun project.

The best and most useful corridor for the north-south movements of kit fox is the West Kern core population site itself. Kit fox occupy that broad expanse of habitat to the west of the project, and there is a clear and open habitat corridor between the linkage corridor to the south of the sites (including Windwolves Preserve) and the portion of the West Kern core population to the north of the sites. The distances involved are relatively great, and it is unlikely that a single kit fox would traverse that distance. Instead, the connection between the southern linkage and the West Kern core area to the north of the sites (and satellite populations beyond) would be a genetic linkage.

Southwest-northeast Axis

The West Kern core population of the San Joaquin kit fox and the satellite population that occurs within the urban area of Bakersfield are connected by several identified corridors. The highest value corridor between these two areas follows the Coles Levee Ecological Reserve, the Kern Water Bank, and the Kern River Parkway in Bakersfield. A secondary corridor follows the transverse range to the east, and then the foothills of the Tehachapi Mountains north to Bakersfield. The California Aqueduct also provides a partial corridor between these areas.

The project occurs between these two populations, but south of the high value corridor, and north of the southernmost corridor and the California Aqueduct corridor. The Bakersfield satellite population occurs to the northeast of the project, and foxes would need to travel southwest to northeast through the project sites, a distance of approximately 23 miles. This is an uncharacteristically far distance for a single kit fox to disperse, particularly because the majority of that distance does not contain kit fox habitat. There are small patches of remnant habitat that occur among and to the east of the project, but those habitat patches are small relative to the typical home ranges of foxes. The habitat patch to the east of the project near Interstate 5 supports foxes. One San Joaquin kit fox was observed on that site (Quad Knopf 2010) and an old natal den was identified within that patch in 2010 (C. Uptain unpubl data). There is no evidence that San Joaquin kit foxes occur in or use the other habitat patches. The majority of the area between the West Kern population and the Bakersfield population is not suitable to support foxes. To the east of Interstate 5, there is an expanse of approximately 12 miles of agricultural lands, roadways, irrigation ditches, and other infrastructure. These large expanses of agricultural lands represent an impenetrable barrier to kit fox movements, thus a habitat corridor or a conduit corridor is virtually non-existent.

Two identified corridors connect the West Kern core population to the Bakersfield satellite population. These are primarily habitat corridors that are nearly intact. These corridors have a high value to the recovery of the San Joaquin kit fox, whereas the project sites have virtually no value for connectivity through the area.

Project Effects on the Local Dispersal of the San Joaquin Kit Fox

Project effects on the local dispersal of the San Joaquin kit fox is directly dependant upon the presence of resident populations in the area, presence and distribution of habitat patches capable of supporting kit foxes, the presence of alternative corridors for the movement of kit foxes, and the relative contributions of the project sites to allow fox movements. Other factors to be considered are existing barriers to movements and the presence of prey, competitors, and predators. The Maricopa Sun Solar project sites occur within a matrix of active farmlands, fallowed farmlands, and small remnant patches of Saltbush Scrub and Alkali Sink habitats

(Figure 3). The agricultural matrix consists of approximately 400,681 acres of land. Most of the habitat patches occurring within this area are small and are of insufficient size to support even a small population of San Joaquin kit fox.

During protocol-level surveys for kit foxes conducted in 2009 (Quad Knopf 2010) there was no diagnostic signs of kit foxes using the project sites and the repeated disking of the project sites has eliminated virtually all habitat value aside from the potential for foxes to disperse across the sites. There are patches of habitat that support rodents and other potential prey species along some roadsides and in native and ruderal habitat patches near the project sites that could provide limited foraging potential. The only evidence of kit foxes in the vicinity of the project sites that were found included a skull that was found to the west of Site 1, which is within the West Kern core population area, and a kit fox was observed during a night spotlighting effort to the east of the project sites in Alkali Sink habitat. Although the West Kern core population of kit fox covers a very large area and is robust, the population to the east of the project sites occurs in a very limited area of approximately 1,732 acres. This habitat patch is currently extremely isolated, with virtually no connection to other areas of suitable habitat. Because of the lack of a connecting corridor, a high potential for habitat degradation over time, and the likelihood of low numbers of foxes at that site, this population may not be sustainable and has a high risk of extirpation.

The project sites do not currently provide a habitat corridor or conduit corridor between the West Kern core population and this isolated population of kit foxes and construction of the solar facility will not impact local kit fox dispersal. However, the project sites may contribute to a tenuous and unreliable connection between the West Kern population and the small, isolated habitat patch to the east of the project sites. Improvement of this connection may not be advisable because the presence or creation of a corridors leading to unsuitable habitat could produce a “population sink” effect.

The project includes measures that will enhance the potential for kit foxes to reside on the project sites and in the immediate vicinity, which is preferable to simply improving connectivity. Integrated movement corridors will be provided along the edges of the project sites and escape dens will be provided along these corridors to reduce the potential for mortalities due to competition and predation by coyotes, and enhance the potential for survival of foxes. The project sites will be fenced with a security fence that will be raised above ground level, thus the sites will be permeable to kit foxes movements and escape dens will be provided within the solar fields. It is anticipated that there will be some encroachment and use of the project sites by kit fox prey species, which could lead to an improvement of the survivorship of kit foxes using the project sites and movement corridors. Finally, the project includes the establishment of conservation easements and habitat improvement of several blocks of land occurring among the project sites. There are four blocks totaling approximately 400 acres that are strategically located to enhance the movements of kit foxes along this conduit corridor. These blocks are located within site 1 (20 acres), Site 3 (150 acres), west of site 3 (80 acres) and site 16 (160 acres). Together, these enhancements far outweigh any effects that the project may have on local or regional kit fox dispersal.

CONCLUSIONS

The Maricopa Sun solar project will not affect the regional dispersal of San Joaquin kit foxes. The project sites are located within an area that does not provide regional habitat corridors or conduit corridors. The high degree of intensive agricultural development in the area along with other risk factors for the San Joaquin kit fox (e.g., lack of prey, high incidence of predators and competitors) substantially reduce the potential for foxes to move through the area. Similarly, on a local level, the project sites do not currently contribute to a habitat corridor or conduit corridor. A tenuous and unreliable connection exists between the West Kern core population and a small, isolated habitat patch that currently supports kit fox. Measures are included in the project that may encourage the use of the sites by resident kit foxes and contribute to this connection. Development of the project will not affect the regional or local dispersal of kit foxes and will not diminish the potential for recovery of the San Joaquin kit fox in the southern San Joaquin Valley.

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