# Habitat Connectivity Planning for Selected Focal Species in the Carrizo Plain

Revisions to Sections 4, 5.1 and 6.1 associated with Task 1 Baseline Conditions Of Habitat Suitability And Connectivity For Each Focal Species (June 2009)

Response to Comments on the April 2009 Draft Report of Baseline Conditions are included as Appendix C

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*Draft Outline of Full Report*

1. Executive Summary
2. Introduction
   2.1. Background and Project Need
   2.2. Objectives of the Project
3. Project Setting
   3.1. The Study Area
   3.2. The Proposed Energy Projects
4. The Focal Species
   4.1. Pronghorn antelope
   4.2. Tule elk
   4.3. Kit fox
5. Methods
   5.1. Task 1: Modeling Baseline Conditions Of Habitat Suitability And Connectivity For Each Focal Species
      5.1.1. Compilation And Refinement Of Digital Data Layers
      5.1.2. Modeling Habitat Suitability
      5.1.3. Modeling Habitat Permeability
      5.1.4. Species-Specific Model Input Data And Conceptual Basis For Model Development
         5.1.4.1. Pronghorn Antelope
         5.1.4.2. Tule Elk
         5.1.4.3. Kit Fox
   5.2. Task 2: Evaluating The Potential Impacts Of Three Proposed Solar Projects To Baseline Conditions Of Habitat Suitability And Connectivity.
   5.3. Task 3: Modeling Proposed Mitigation Strategies And Evaluation Of Their Effectiveness To Offset Habitat Loss And Fragmentation
6. Results and Discussion
   6.1. Task 1: Baseline Conditions Of Habitat Suitability And Connectivity For Each Focal Species
      6.1.1. Habitat Suitability
         6.1.1.1. Pronghorn Antelope
         6.1.1.2. Tule Elk
         6.1.1.3. Kit Fox
      6.1.2. Habitat Permeability
         6.1.2.1. Pronghorn Antelope
         6.1.2.2. Tule Elk
         6.1.2.3. Kit Fox
   6.2. Task 2: Potential Impacts Of Three Proposed Solar Projects To Baseline Conditions Of Habitat Suitability And Connectivity.

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6.3. Task 3: Proposed Mitigation Strategies And Their Effectiveness To Offset Habitat Loss And Fragmentation
7. Summary
8. Literature Cited

Appendices
Appendix A: Digital Data Sources Used
Appendix B: Species-specific Model Input
*(other appendices to be added as other tasks are completed)*
Appendix C: Response to Comments on the April 2009 Draft Report of Baseline Conditions

## 4.1 Pronghorn antelope

**Distribution and Status:** Pronghorn antelope (*Antilocapra americana*) are widely distributed in the western United States, Canada, and Mexico. In 1997, it was estimated that there were nearly one million pronghorn distributed among 15 U.S. states and two Canadian provinces (Byers 1997). Historically, pronghorn were common in southern, central, and northeastern California (Yoakum 2004a), and grasslands of the San Joaquin Valley once supported exceptional numbers (Newberry 1855, cited in Yoakum 2004b). Brown et al. (2006) reported that pronghorn were once widely-distributed in plains and valleys on both sides of the Coastal and Peninsular ranges, from Monterey south as far as the Magdalena Plain in Mexico. According to ranchers, pronghorn herds once numbered in the hundreds at the north end of Carrizo Plain (Koch and Yoakum 2002).

However, pronghorn disappeared from many parts of California, including the Carrizo Plain, by the 1940s due to over-hunting and the conversion of native grasslands to croplands (Yoakum 2004b). California Department of Fish and Game (CDFG) has since reintroduced pronghorn throughout portions of their historic range, including the Carrizo Plain. In 1987, 1988, and 1990, a total of over 200 pronghorn were translocated from the shrub-steppes of northeastern California to the Carrizo Plain and surrounding rangelands (Koch and Yoakum 2002, Yoakum 2004b, Longshore and Lowrey 2008). Koch and Yoakum (2002) estimated population size to fluctuate around 50 animals during 1999-2003. In 2008, the population was estimated at approximately 100 animals (R. Stafford, CDFG, unpublished data). The herd objective for Carrizo National Monument is 250 animals and the greater herd goal (including the solar project areas) is 500 (R. Stafford, CDFG, personal communication).

Whereas pronghorn of the Sonoran Desert (*A. a. sonoriensis*) are Federally listed as endangered, pronghorn in some portions of California are a game species subject to regulated hunting. Limited (bucks only) pronghorn hunting occurred on Carrizo Plain during 1996-2001 (Koch and Yoakum 2002) but the season was discontinued in 2002 due to low numbers.

**Habitat Associations:** Pronghorn avoid predators by visual detection and speed, and therefore prefer open grasslands and shrub communities with good horizontal visibility, gentle slopes, and few movement obstacles. They inhabit a variety of low-growing vegetation communities, including sagebrush, bitterbrush, grassland, open pinyon-juniper, and alkali desert scrub. Although they typically occupy open, gentle terrain (<10% slope; Ockenfels et al. 1994), pronghorn require some rolling topography or shrubs for cover from inclement weather and concealment of young (Barrett 1981, Ryder and Irwin 1987, Yoakum 2004a). In general, preferred vegetation height averages 38-61 cm, and shrublands with vegetation >88 cm are used less frequently than areas with shorter vegetation (Yoakum 2004a). Based on a literature review, Longshore and Lowrey (2008) suggested that high quality habitat is characterized by slopes ≤ 5%, medium quality habitat typically includes slopes between 5% and 20%, and areas with

slopes >20% are low quality. Pronghorn have been documented at elevations from below sea level to 3,353 meters (Yoakum 2004a).

Pronghorn are opportunistic feeders that select forage based on nutritional value, availability, and palatability (Yoakum 2004d). In grasslands, they generally prefer forbs and shrubs over grasses (Yoakum 2004d). Optimal habitat has been described as approximately 40-60% grass, 10-30% forbs, and 5-20% shrubs (Sundstrom et al. 1973, Autenrieth 1978, Yoakum 1978). Pronghorn have been documented to feed on alfalfa and other cultivated plants in California (Hopkins, No date). Use of agricultural fields appears to depend on their proximity to natural lands (Sexton et al. 1981). Pronghorn in Montana were observed to use grain fields within 0.8 km (0.5 mi) of natural rangelands more frequently than grain fields farther from natural rangelands (Cole and Wilkins 1958). ~~In the Carrizo Plain,~~ CDFG biologists also observed pronghorn to restrict use of irrigated agricultural fields in the Salinas Valley and other areas in the northern part of the range to areas within about 0.8 km (0.5 mi) of suitable natural habitat (R. Stafford, CDFG, personal communication).

Pronghorn water requirements are not well understood, and it is likely that needs are related to forage quality and moisture content (Yoakum 2004a). Yoakum (2004a) stated that rangelands with year-round surface water every 1.6 – 3.2 km will support higher densities than areas with fewer water sources. Fences can impede movements, reduce habitat quality, and cause mortalities, depending on fence design, because pronghorn do not readily jump fences (Byers 1997, Yoakum 2004c). Pronghorn movement in Arizona was not impacted by unfenced, paved two-lane roads, but fenced rights-of-way including two- and four-lane roads and railroads acted as barriers and influenced shapes of pronghorn home ranges (Ockenfels et al. 1997). In the Carrizo Plain, types of fences vary but fence breaks are frequent enough to make barrier quality difficult to define with certainty. Typically, pronghorn find openings or locations where the bottom fence wire is high enough off the ground to allow passage underneath. This is why pronghorn are observed moving between parcels surrounded by four- and five-strand fences. These fences do inhibit movements, but they are not complete barriers (D. Hacker and R. Stafford, CDFG, personal communication).

**Spatial Patterns:** Pronghorn are gregarious animals found in a wide range of group sizes, depending on such factors as forage quality and quantity, population density, season, and predation risk. On the Carrizo Plain, pronghorn tend to be most gregarious during winter, and are observed in smaller groups during the remainder of the year (R. Stafford, CDFG, unpublished data). The degree of territoriality among males varies among populations, and may be influenced by habitat quality, density, and home range size. Maher (1994) found males on the Carrizo Plain to be less territorial than those in a second research population in Nevada, possibly because the Carrizo Plain population was small, widely dispersed, and recently introduced.

Home range size varies considerably with habitat quality. Annual home range estimates of eight male pronghorn monitored in the rolling plains of Texas ranged from 600 to 1,800 ha (Aiken 2005), whereas another study in semi-desert shrub/grassland habitat in western Texas reported average 3-year home range sizes of 2,509 ha and 4,238 ha for 8 males and 28 females, respectively (Canon 1993). In grassland and juniper habitat in northern Arizona, home ranges of

20 radio-collared animals averaged 8,200 ha for 5 males and 12,400 ha for 15 females (Ockenfels et al. 1997). Although home range estimates are not available for individual pronghorn on the Carrizo Plain, herd range size was estimated at 13,000 ha, based on flight surveys conducted during 1999-2008 (R. Stafford, CDFG, unpublished data). In some populations, territorial males use smaller home ranges than females, and female ranges may overlap multiple male home ranges. For example, in semi-desert shrub/grassland habitat in western Texas, Canon (1993) observed significantly larger home ranges among females than males. In other areas, no gender-based home range differences were detected (O'Gara 2004).

Dispersal distances are not available for individual pronghorn on the Carrizo Plain, but translocated animals in other populations have been documented to travel 50 km and swim across a river to return to their natal ranges (Byers 2003). Pronghorn are seasonally migratory in some regions, and have been reported to move up to 258 km between seasonal ranges (Sawyer et al. 2005).

### 4.2 Tule elk

**Distribution and Status:** The tule elk (*Cervus elaphus nannodes*) is the smallest of all elk subspecies in North America. Although the species as a whole is widespread throughout north temperate zones of the world, tule elk are endemic to valleys and foothills of coastal and central California, including the Carrizo Plain. In the early 1800s, tule elk were found in large numbers in the Sacramento Valley as far north as Red Bluff (Maloney 1945, cited in McCullough 1969) and in large valleys to the west of the Sacramento Valley (McCullough 1969). Along the coast, they were documented in the San Francisco Bay region and in the southern Coast Range, with abundant records in the Monterey Bay area. Historically, elk also occurred in large numbers in the San Joaquin Valley, in particular in the Sacramento-San Joaquin Delta. Tule elk occurred as far south as the Tehachapi Mountains, which apparently form the southern boundary of their distribution, and east to the foothills of the Sierra Nevada (McCullough 1969).

Historically, tule elk were reported to be the predominant herbivore of California's grasslands, sharing the range with deer (*Odocoileus hemionus*), pronghorn antelope, and domestic cattle. Herds of 2000 animals were reported, and it was estimated that 500,000 tule elk may have inhabited the State (McCullough 1969). However, a combination of competition from domestic livestock, market hunting, and land conversion to agriculture caused their numbers to decline precipitously. By 1870, tule elk were nearly extinct, with only one small population remaining in the Buena Vista Lake area in the San Joaquin Valley (McCullough 1969). Subsequent translocations were able to save this subspecies from extinction, and by 1969 three small populations existed in California. By 1996, additional translocations had resulted in 22 populations, distributed primarily across the coastal regions of central California, with one population in Owens Valley to the east (McCullough et al. 1996). In 2007 the state-wide estimate was 3,800 animals (Greco et al. 2009). Tule elk have become a popular game animal in the State, and hunting is allowed at a number of locations, including Carrizo Plain National Monument.

**Habitat Associations:** In terms of habitat use, tule elk are a specialized subspecies because they inhabit open habitat in semi-arid environments, whereas the species has a whole typically

inhabits temperate climates and uses areas of heavy vegetation at least seasonally (McCullough 1969). Typical habitat of tule elk includes large grassland areas, which range from grasslands interspersed with marshy habitats in floodplains to relatively xeric rolling grasslands interspersed with trees and brush stands (McCullough 1969). Tule elk use brush and chaparral habitats if they are in proximity to grasslands (McCullough 1969). Historical records described elk habitat as consisting of "open lands," including extensive plains with rich alluvial soil, interspersed with limited numbers of oaks, sycamores, and ash, and with grasses sometimes knee- or breast-height (McCullough 1969). McCullough (1969) further noted that this subspecies is typically found in areas subject to periodic drought.

Greco et al. (2009) modified existing elk habitat suitability ratings presented in the California Wildlife Habitat Relationships System (CDFG 2009) to specifically address tule elk habitat needs. They identified annual grasslands, fresh emergent wetlands, and valley foothill riparian habitats as having the highest suitability for tule elk. Other important habitat types included irrigated hayfields, grain crops, row and field crops, and pastures—used primarily for feeding—as well as eucalyptus groves—used primarily for cover. ~~On the Carrizo Plain,~~ CDFG biologists observed tule elk using irrigated agricultural fields in the Salinas Valley and other areas in the northern part of the range within about 0.8 km (0.5 mi) of suitable natural habitat (R. Stafford, CDFG, personal communication).

Tule elk feed on a wide variety of plant species, including annual forbs and grasses, perennial forbs, grasses, and grass-like plants, browse, and even acorns (McCullough 1969). Annual forbs are an important diet item in the spring and early summer, and grasses and sedges are eaten throughout the year (McCullough 1969). Tule elk also eat aquatic vegetation when available. Water requirements likely vary with season, temperature, and moisture content of vegetation.

The impact of fences on tule elk distribution is not well understood. Elk can cross over or go under fences, depending on fence design; however, elk have been known to run into and damage fences when alarmed (McCullough 1969, Ferrier and Roberts 1973). On the Carrizo Plain, as in other tule elk habitat in California, paved roads appear to hinder elk movement, with the result that they often delimit herd ranges (R. Stafford, CDFG, personal communication). Only 13 out of more than 30,000 point locations gathered using ~~GPS collars~~ standard telemetry showed that elk had crossed paved roads, and nearly all observed road crossings occurred immediately after translocated elk were released (R. Stafford, personal communication).

**Spatial Patterns:** Home range size depends on habitat quality, gender, and annual precipitation (McCullough 1969, Peek 2003). O'Connor (1988) reported mean home range of nine tule elk females in Cache Creek to range from 2,309 to 4,141 ha depending on analysis method used. In comparison, tule elk herds in Contra Costa County (central California) and at Point Reyes National Seashore were reported to use areas of 869 ha and 359 ha, respectively (Pomeroy 1986, Gogan 1986, cited in O'Connor 1986). On the Carrizo Plain, home ranges of radio-collared females ranged from 3,618 ha to 12,640 ha based on minimum convex polygons (R. Stafford, CDFG, unpublished data).

Tule elk are highly social, and may be found in large groups that are dynamic in terms of size and composition (McCullough 1969). Group size depends on season, sex, population, and

vegetation density, with the largest groups often observed in open habitats (Knight 1970). Tule elk exhibit pronounced periods of sexual segregation, with males segregated from females for most of the year outside of the autumn breeding period (Peek and Lovaas 1968). Females may be found in large groups with calves and young animals for most of the year, but disperse into smaller groups of 2-10 animals during the spring parturition season (McCullough 1969).

Tule elk do not exhibit the extensive seasonal ranges shifts observed in some other elk subspecies, and are thus not typically considered to be migratory (McCullough 1969). However, herds may exhibit seasonal shifts in response to local forage conditions and annual patterns of plant productivity (McCullough 1969).

Tule elk are capable of moving great distances in short time periods. McCullough (1969) reported that bull elk introduced near the center of the Owens Valley in the 1930s were observed at the north and south ends of the valley, approximately 230 km apart, within one year of release, indicating dispersal of approximately 115 km. On the Carrizo Plain, elk in established herds were observed to move 20 km during a 2-year period, whereas some animals were observed to move 40 km after their initial release (D. Hacker, CDFG, personal communication).

### 4.3 San Joaquin kit fox

**Distribution & Status:** Historically, San Joaquin kit foxes were distributed throughout the San Joaquin Valley and adjacent low foothills, from the vicinity of Byron in Contra Costa County to the foothills of the Tehachapi Mountains (Grinnell et al. 1937). By 1930, their range had been reduced by more than half due to habitat conversion to agriculture and other uses, with the largest areas of occupied habitat remaining in the southern and western portions of their original range (Grinnell et al. 1937). By 1975 the pre-1930 estimate of population size (about 8,700 to 12,100) was reduced by 20-43% (USFWS 1983). San Joaquin kit foxes were Federally-listed as endangered in 1967 and State-listed as threatened in 1971, and the population is believed to have declined even more since the 1970s (USFWS 1998). Currently, kit foxes have a very limited range, mostly in foothill areas and arid valleys of the coastal ranges, in foothills and arid valleys below about 914 m in the western Sierra Nevada, and the Tehachapi Mountains foothills (USFWS 1998, Koopman et al. 1998, Thelander et al. 1994). The largest extant populations are in western Kern County in the vicinity of the Elk Hills and Buena Vista Valley, and in the Carrizo Plains area of San Luis Obispo County (USFWS 1998). The Carrizo Plain population is one of three populations designated a high priority for enhancement and protection by the U.S. Fish and Wildlife Service (USFWS 1998).

**Habitat Associations:** Kit fox distribution is strongly influenced by topography, vegetative cover, prey availability, and predator densities (Grinnell et al. 1937, Egoscue 1962, Daneke et al. 1984, cited in Warrick and Cypher 1998; Haight et al. 2002, Zoellick et al. 1989). Kit foxes primarily inhabit annual grasslands and sparsely vegetated scrub habitats such as alkali sink scrub, saltbush scrub, and chenopod scrub. Other habitats such as open oak savannah, vernal pools, perennial grasslands, alkali meadows and playas are also used (USFWS 1998, B. Cypher, California State University, Stanislaus, personal communication). Kit foxes prefer areas with abundant rodent populations and open environments where they can detect and evade coyotes and other predators (Warrick and Cypher 1998). High kit fox capture rates have been

documented in recently burned areas, which was attributed to the openness of the habitat and its affect on predator evasion (Zoellick et al. 1989). Kit foxes can also persist in and adjacent to agricultural areas, such as row crops, irrigated pastures, orchards, and vineyards, as well as vacant lands or open spaces (e.g., parks, golf courses, and flood control areas) within urban areas (USFWS 1998, Cypher and Frost 1999). Warrick et al. (2007) documented use of agricultural lands for foraging up to 1 kilometer from adjacent suitable natural habitats. Among grasslands, kit foxes prefer more open, low-growing, and sparsely vegetated areas, such as *Bromus*-dominated grasslands in drier regions, and tend to avoid taller, denser grasslands such as *Avena*-dominated communities in moister areas (B. Cypher, personal communication).

Kit foxes use dens year-round to escape predators, bear young, and as daytime resting places. Kit foxes may be found on a wide variety of soils, but they prefer loose-textured soils (USFWS 1998) which facilitate burrow construction and tend to support more rodents that are kit fox prey.

San Joaquin kit foxes are typically associated with low elevations on valley floors. Grinnell et al. (1937) placed the upper elevation limit at about 1,200 feet (366 m), but Laughrin (1970) observed kit foxes at 2,400-ft (732 m) elevations during spotlighting surveys, and estimated that kit foxes in the southwestern portion of their range, south of Highway 46, range up to about 2,500 feet (762 m). They are mainly associated with gently sloping and flat terrain. The literature suggests that slopes of 0-5% are ideal, slopes of 5-15% provide fair habitat, and areas with slopes >15% are largely unsuitable (B. Cypher, personal communication). Warrick and Cypher (1998) found a negative relationship between topographic ruggedness and capture rates of kit foxes in Elk Hills and Buena Vista Hills of the Temblor Range.

**Spatial Patterns:** Kit fox pairs remain together all year and share a home range (USFWS 1998). Home range estimates vary from less than 260 ha to approximately 3,100 ha (Morrell 1972, Knapp 1978, cited in USFWS 1998, Zoellick et al. 1987, Spiegel and Bradbury 1992, White and Ralls 1993). Home range sizes at the Naval Petroleum Reserve averaged 460 ha (Zoellick et al. 2002), whereas home range size of 21 animals on the Carrizo Plain averaged 1,160 ha (White and Ralls 1993). Home range size is largely dependent on prey availability, which can vary annually in relation to precipitation (Haight et al. 2002). The sexes typically do not differ in home range size (White and Ralls 1993, Zoellick et al. 2002). Haight et al (2002) assumed two kit foxes per home range, which they estimated to average 390 ha in good habitat and 780 ha in fair habitat. In optimal habitat, each kit fox family requires approximately 486 ha, with larger space requirements in suboptimal habitats (Cypher et al. 2007).

Dispersal distances vary widely, with male foxes known to travel over 40 km (Haight et al. 2002) and juvenile dispersal from natal dens documented to range from 8 to 96 km (Thelander et al. 1994). Mean dispersal distance of 48 kit foxes at the Naval Petroleum Reserves was 7.8 $\pm$ 1.1 km, with no sex-based differences observed (Scrivner et al. 1987 cited in Koopman et al. 2000). Koopman et al. (2000) found that 33% of animals dispersed from their natal territory, and significantly more males (49%) dispersed than females (24%). Average nightly distance moved during the breeding period (14.6 $\pm$ 1.1 km) was greater than during the pup-rearing (10.7 $\pm$ 1.0 km), and pup dispersal periods (9.4 $\pm$ 1.1 km; Zoellick et al. 2002).

Adult and juvenile kit foxes are known to move through disturbed habitat, including agricultural fields, oil fields, and rangelands, and across highways and aqueducts (Haight et al. 2002). However, major highways and heavily traveled road are obstacles to movement (Cypher et al. 2000). Vehicles are the greatest source of mortality in urban areas, whereas predation, primarily by coyotes, is the primary cause of mortality in most other areas (Cypher et al. 2000, B. Cypher, personal communication). Cypher et al. (2005) examined the effects of 2-lane highways on kit foxes in the Lokern Natural Area, and found no significant negative effects on fox demography or ecology. However, the authors cautioned that increased road density could have a negative impact, citing studies that reported increased swift fox (*Vulpes velox*) mortality with increasing road density (Cypher et al. 2005), selection by bobcats of habitat with lower road density (Lovallo and Anderson 1996), and declining gray wolf habitat suitability with increased road density (Thiel 1985, Jensen et al. 1986).

## 5.1 Modeling baseline conditions of habitat suitability and connectivity for each focal species

### 5.1.1 Compilation and refinement of digital data layers

We compiled GIS data layers for the study area, including the following (see Appendix A for details concerning the source, type, scale, and date of each data layer):

- recent high-resolution aerial photos,
- digital elevation models,
- roads,
- vegetation (including crop and agriculture data from San Luis Obispo and Kern counties),
- protected lands,
- species occurrence data from wildlife agencies, Endangered Species Recovery Program, and California Natural Diversity Database, and
- project boundary data from project proponents.

We manually updated the road and vegetation layers within the study area to be as up-to-date and accurate as possible. For the refined vegetation layer (Figure 1), we compiled vegetation data available from the County of San Luis Obispo website, crop data from San Luis Obispo and Kern counties, and regional vegetation data compiled by the state (CalVeg). We evaluated this compiled vegetation layer in relation to recent high-resolution aerial imagery and made changes where necessary to reflect the most recent land use status. Particular emphasis was placed on agricultural and urban land cover types. For example, we corrected the vegetation classification of some lands that had recently been converted to agriculture or urban but were still shown as natural vegetation in the compiled vegetation data layer. Conversely, areas shown as agriculture or urban within the compiled vegetation layer that had not actually been converted to either land use were changed back to the vegetation type in either the CalVeg or County Vegetation data layer.

Further refinements were made to the vegetation layer based on input received during the January 27, 2009 comment period on the input data layers:

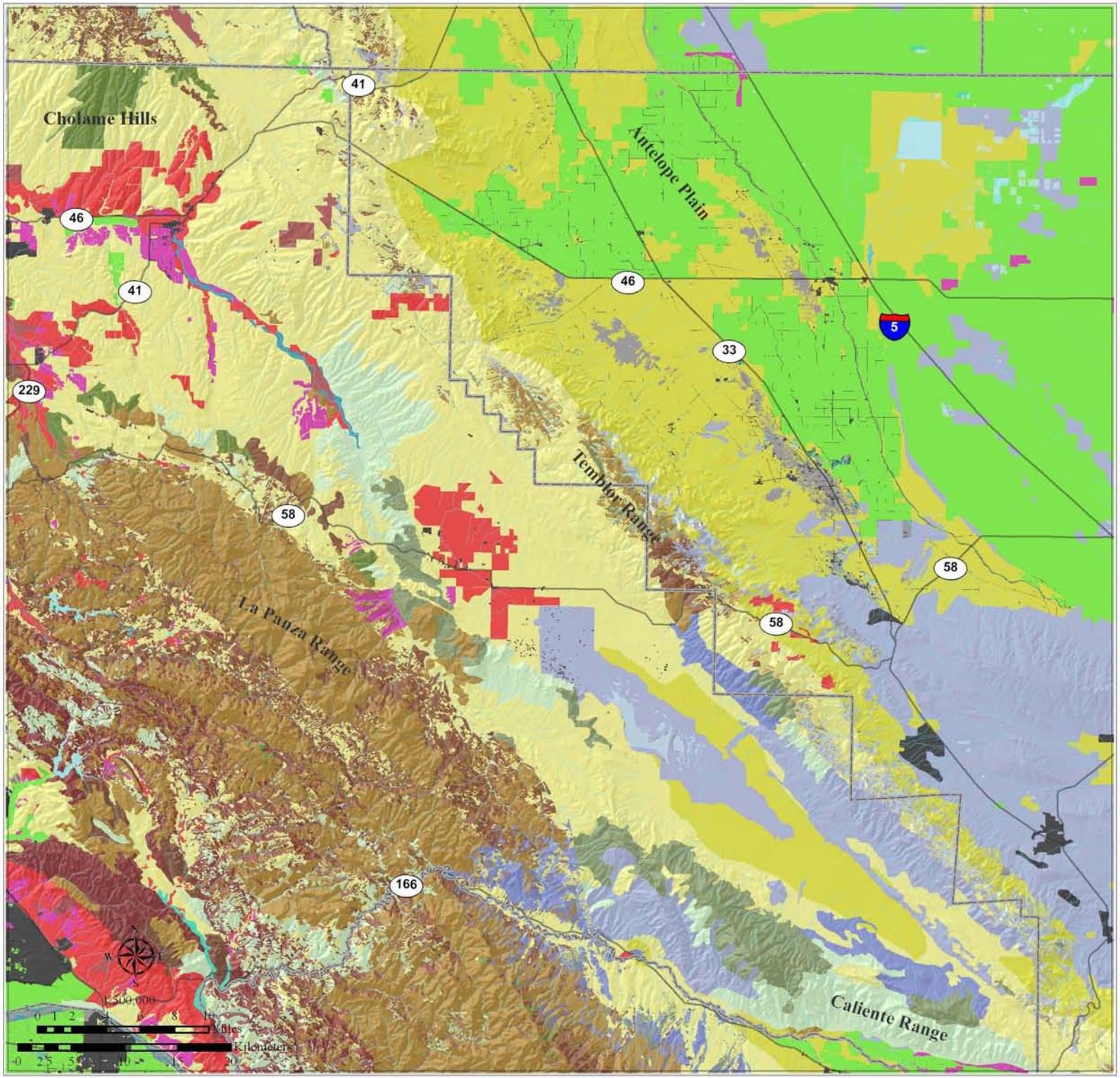
- Polygons identified as "undefined agriculture" were assigned specific categories, such as dryland grain crops, irrigated row and field crops, vineyards, and orchards based on aerial imagery and review by CDFG biologists familiar with the area.
- Polygons defined as pasture were examined using imagery to determine if they were irrigated or non-irrigated. All non-irrigated pasture polygons were changed to annual grassland; all irrigated pasture polygons remained as pasture.
- Based on input from field biologists familiar with vegetation in the study area, (B. Cypher, personal communication) we differentiated *Avena*- and *Bromus*-dominated grasslands using precipitation data. Cypher and colleagues (personal communication) had found the 9-inch annual precipitation isocline to be a good threshold for

**Figure 1.**
**Vegetation**
**in the Study Area**

Vegetation
Name
- Alkali Desert Scrub
- Annual Grassland - Avena
- Annual Grassland - Bromus
- Barren
- Blue Oak Woodland
- Blue Oak-Foothill Pine
- Chamise-Redshank Chaparral
- Closed-Cone Pine-Cypress
- Coastal Oak Woodland
- Coastal Scrub
- Desert Riparian
- Desert Wash
- Dryland Grain Crops
- Eucalyptus
- Freshwater Emergent Wetland
- Irrigated Row and Field Crops
- Juniper
- Lacustrine
- Mixed Chaparral
- Montane Chaparral
- Montane Hardwood
- Montane Hardwood-Conifer
- Orchard and Vineyard
- Pasture
- Perennial Grassland
- Pinyon-Juniper
- Sagebrush
- Sierran Mixed Conifer
- Urban
- Valley Foothill Riparian
- Valley Oak Woodland
- Vineyard
- Wet Meadow
- Highways
- Rivers & Streams
- Hydrography
- County Boundaries

Map Produced By:

SC Wildlands
Science & Collaboration for Connected Wildlands



differentiating denser, taller grasses, usually dominated by *Avena*, and generally considered less than optimum for ~~avoided by~~ kit fox, from sparser, shorter grasslands, typically dominated by *Bromus*, and generally favored by kit foxes. We therefore downloaded and processed PRISM precipitation data (gridded 30 arc-second [800m] annual normals) for 1971-2000 and classed annual grassland vegetation as *Bromus*-dominated (< 9 inches precipitation) or *Avena*-dominated (≥ 9 inches precipitation).

Additional updates to the vegetation layer were made in response to comments received on the April 2009 draft report of baseline conditions. These updates include information from California Department of Fish and Game who recently did a flyover of the study area to ground truth the vegetation layer and comments received from Carrisa Alliance for Responsible Energy.

To create and update the road layer, we first downloaded 2007 Tiger Line road data and evaluated them using recent high-resolution aerial imagery, adding dirt roads not captured by the 2007 Tiger Line data. To delineate paved roads, we used Caltrans highway data and input from CDFG biologists. We then re-evaluated the study area using recent high resolution aerial imagery to identify other paved roads not captured in the Caltrans data. All other roads in the 2007 Tiger Line Data were delineated as dirt roads (Figure 2).

### 5.1.2 Modeling habitat suitability

We created habitat suitability models for each species by estimating how the species responded to different habitat factors that were mapped at a 30 x 30-m cell resolution. The actual spatial data layers used in each habitat suitability model depended on the species. For example, factors incorporated into the pronghorn antelope model were vegetation type, slope, and road density. (Details of the species-specific models are described in Section 5.1.4.) Within each factor, suitability scores were assigned to each category (e.g., each vegetation type) on a scale of 0 (unsuitable) to 1 (most suitable). ~~For pronghorn and tule elk,~~ Habitat suitability was calculated for each 30-$m^2$ pixel using a Weighted Geometric (Multiplicative) Mean:

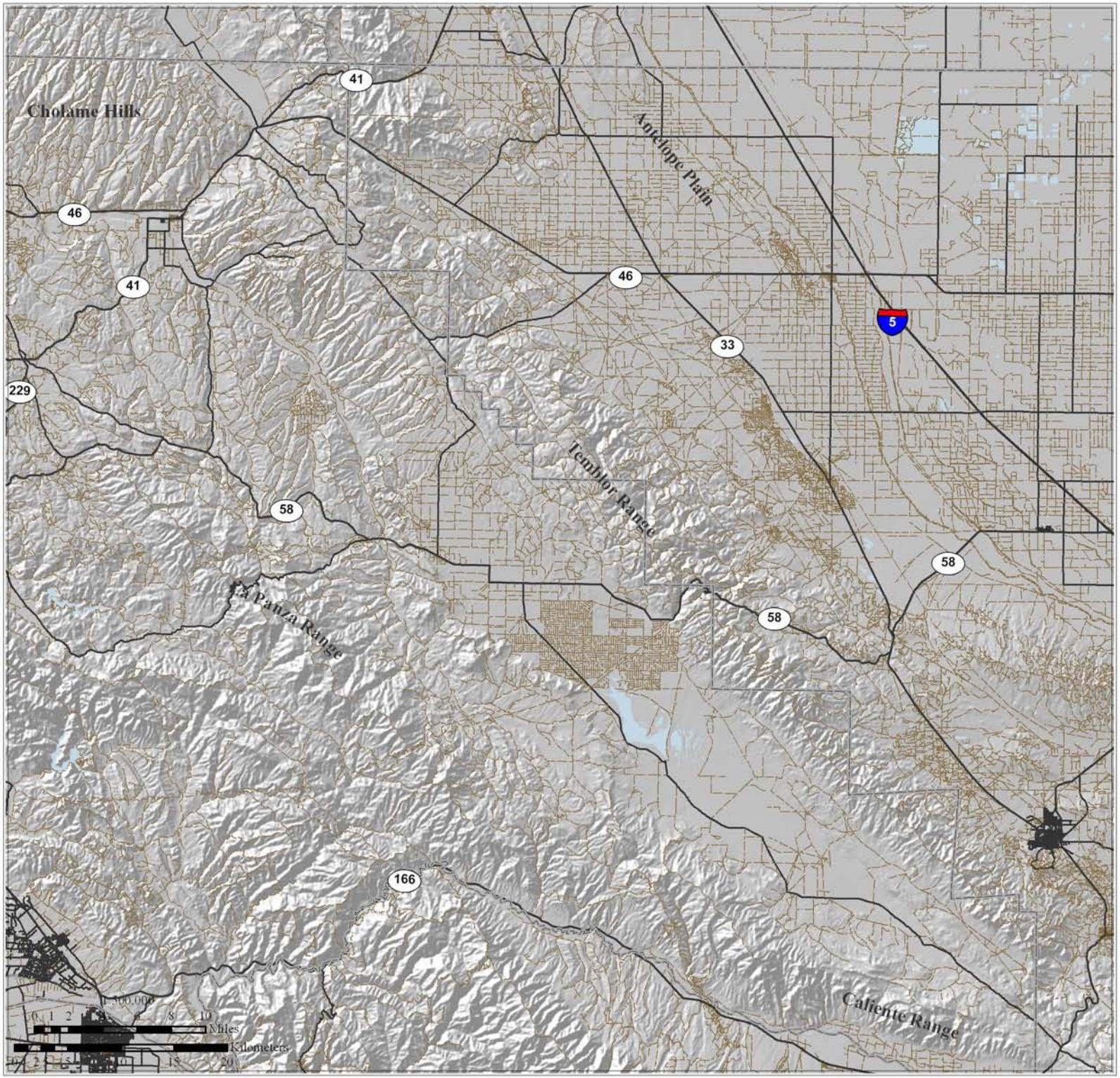
$$\text{Suitability} = (S_A^{WA}) * (S_B^{WB}) * (S_C^{WC})$$

where $S_A$, $S_B$, and $S_C$ are suitability ratings for factors A, B, and C, respectively, and WA, WB, and WC are the factor weightings.

The Weighted Geometric Mean is strongly influenced by low suitability ratings, such that if a score for any class is 0, then suitability of the pixel remains 0 regardless of factor weight or scores for other factors. We divided the resulting suitability values ~~using natural breaks~~ into five classes (low, low to medium, medium, medium to high, and high) using natural breaks for pronghorn and tule elk, and quantile classification for kit fox. ~~both species.~~ Additional details concerning habitat suitability analyses are in Section 5.1.4 and Appendix B.

~~The habitat suitability model for San Joaquin kit fox applied the model structure and values of Cypher et al. (2007) using our refined map layers. This model used a Weighted Arithmetic (Additive) Mean:~~

**Figure 2.**
**Roads in the Study Area**




**Roads**

- Highway
- Other Paved Roads
- Dirt Roads
- County Boundaries
- Hydrography

N
W E
S

Map Produced By:

SC Wildlands
Science & Collaboration for Connected Wildlands

~~Suitability = ($S_A$ * WA) + ($S_B$ * WB) + ($S_C$ * WC).~~

~~The Weighted Arithmetic Mean is more compensatory than the Weighted Geometric Mean in that factors with low values can be offset by factors with higher values. Following Cypher et al. (2007) the output was divided into three defined classes: high (≥0.9); medium (≥0.6 but <0.9); and low (<0.6). We divided the resulting suitability values using natural breaks into five classes (low, low to medium, medium, medium to high, and high), to better reflect the nuances in the intensity of land uses in the study area. Additional details concerning habitat suitability analyses are in Section 5.1.4 and Appendix B.~~

Lands rated as medium to high by each habitat suitability model were used to identify species-specific habitat *patches* and habitat *cores* based on contiguous area. *Potential core areas* were defined as the amount of contiguous suitable habitat necessary to sustain at least 50 individuals (Beier et al. 2006). Potential cores are probably capable of supporting the species for several generations. A *patch* was defined as the area of contiguous suitable habitat needed to support at least one male and one female, but less than the potential core area. Patches can support at least one breeding pair of animals (perhaps more if home ranges overlap greatly) and are probably useful to the species if the patch can be linked via dispersal to other patches and core areas.

To determine whether the distribution of suitable habitat allows species to disperse among patches and core areas, we conducted a configuration analysis to identify which patches and core areas were functionally isolated by distances too great for the focal species to traverse. Because the majority of methods used to document dispersal distance underestimate the true value (LaHaye et al. 2001, Beier et al. 2006), we assumed each species can disperse twice as far as the longest documented dispersal distance.

### 5.1.3 Modeling landscape permeability

Landscape permeability analysis is a GIS technique that models the relative cost for a species to move between target areas based on how each species is affected by habitat characteristics, such as topography, elevation, vegetation composition, and road density. This analysis identifies a least-cost corridor, or the best potential route for each species between targeted areas (Craighead et al. 2001, Singleton et al. 2002). The purpose of the analysis is to identify land areas which would best allow the focal species to live in or move through the linkage (Beier et al. 2006).

For each species, the relative cost of travel was calculated using habitat factors considered most influential on that species' movements (selected from among the factors vegetation type, vegetation density, road density, elevation, topographic position, and terrain ruggedness). The factors, class rankings, and weighting values may therefore differ from those used for each species in determining habitat suitability. We derived four topographic classes from elevation and slope models: canyon bottoms, ridgelines, flats, or slopes. Terrain ruggedness was measured as the variance in elevation between each grid cell and its neighboring cells. For tule elk and kit fox, road density was measured as kilometers of paved road per square kilometer (averaged over a 1-$km^2$ moving window), whereas for pronghorn, road density was measured using both paved and dirt roads. Vegetation density was based on reflectance data derived from satellite imagery (see Section 5.1.4.3 for additional details on this index).

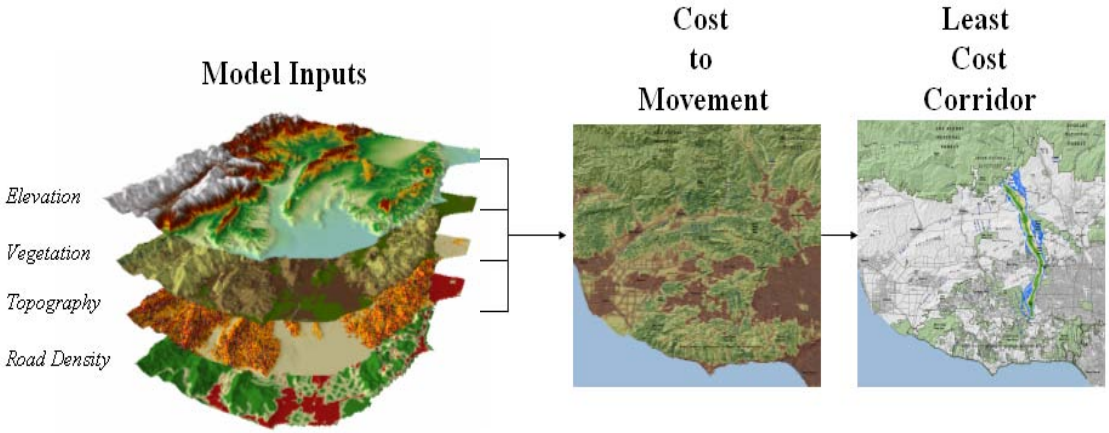



**Figure 3.** Example permeability model inputs: elevation, vegetation, topography, and road density. Landscape permeability analysis models the relative cost for a species to move between target areas based on how each species is affected by various habitat characteristics.

Within each factor, experts assigned each category (e.g., various vegetation categories or categories of road density) a rating between 1 (preferred) and 10 (avoided) based on each species ability to move through areas with these characteristics, as determined from available literature and expert opinion. Cost to movement was then calculated as the Weighted ~~Arithmetic~~ Geometric Mean for each species (where cost of movement can be thought of as the inverse of permeability). A unique ~~cost~~ resistance surface (cost raster) was thus developed for each species. The least-cost corridor analysis then maps the relative degree of permeability for a species based on the cumulative travel cost calculated using the cost raster and distance between targeted core areas. We then used a "slice" (or cost contour) of the resulting cost surface based on expert opinion to delineate a least cost corridor that is biologically meaningful for the species.

Performing permeability analyses requires identifying the endpoints (or targets) to be connected. For pronghorn and tule elk, Target Zones were identified at the southern and northern extent of the study area, and target endpoints were selected as medium to high suitable habitat for each focal species within each Target Zone. ~~We used the same Target Zones for all three species. However, we tested some alternative target endpoints within the southern Target Zone for kit foxes.~~ For kit fox, three Target Zones were identified at the northern extent of the study area (i.e., Salinas River Watershed, Palo Prieto-Cholame Valley, and Western Kern County in the vicinity of the Antelope Plain) to better reflect the goals outlined in the recovery plan for this species (USFWS 1998). Within these three Target Zones, target endpoints were selected as medium to high suitable kit fox habitat. In the southern Target Zone, target endpoints were selected as habitat of medium to high suitability on the Carrizo Plain side of the Temblor Range. ~~our original southern target endpoint included medium to high quality habitat on both sides of the Temblor Range, which strongly influenced predicted movement corridors to cross from the Carrizo Plain over the Temblor Range to include large swaths of the San Joaquin Valley floor. Kit fox biologists found this result biologically untenable, as they consider the Temblor Range a strong obstacle to kit fox movement, and no kit foxes have ever been observed crossing the range~~

~~during telemetry studies. We therefore modified the southern target by using only high suitability contiguous core kit fox habitat in the southern Target Zone, and modified the factor ratings and weightings to better reflect kit fox avoidance of very rugged terrain.~~

Appendix B and Section 5.1.4 describe species-specific model input data and additional details concerning the habitat suitability and landscape permeability analyses.

### 5.1.4 Species-specific model input data and conceptual basis for model development

#### 5.1.4.1 Pronghorn antelope

**Habitat Suitability:** We developed a Weighted Geometric (Multiplicative) Mean GIS habitat suitability model using vegetation type, slope, and road density as primary variables, based on information summarized in Section 4.1 and discussions with species experts. The model reflects that pronghorn prefer open terrain, short vegetation, few barriers, and gentle slopes. Because pronghorn use a wider range of elevations (0 to 3,353 meters) than occurs in the study area, elevation was not an input factor.

Habitat suitability ratings (from 0 to 1, with 1 being most suitable and 0 being unsuitable) for individual vegetation, road density, and slope classes were provided by CDFG biologists most familiar with this species on the Carrizo Plain (R. Stafford and D. Hacker; Appendix B). Suitability ratings shown in Appendix B were further refined as follows:

- Within the factor "Slope", categories were based on recommendations by Longshore and Lowrey (2008): slopes > 5% and ≤ 20% were rated as medium suitability (rating = 0.6) and slopes > 20% were rated as low suitability (rating = 0.3). "Flats," ≤ 5% slope by definition, were rated as high suitability (rating = 1.0).
- Irrigated row and field crops ~~agricultural lands~~ within 0.8 km (0.5 mi) of suitable natural habitat areas (suitability ≥ 0.5) were rated as shown in Appendix B; but irrigated row and field crops ~~agriculture~~ more than this distance from suitable natural habitat was rated as unsuitable (rating = 0), based on observations that pronghorn only use such fields in proximity to suitable natural habitats (Cole and Wilkins 1958, R. Stafford, CDFG, personal communication).

Habitat use by pronghorn on the Carrizo Plain may not be directly affected by roads, per se, but habitat use may be adversely affected by fences (Ockenfels et al. 1997). Because many roads in the study area, both paved and unpaved, are accompanied by fences, and because a comprehensive fence data layer was not available, the pronghorn habitat suitability model considered areas with a high road density to be less suitable than less-roaded areas, and this factor did not differentiate between paved and unpaved roads.

Although distance to water may influence pronghorn habitat suitability, especially during summer (Yoakum 2004a; Section 4.1), a complete map of water sources (including both natural and artificial water sources) was not available for this study area and we thus did not include water in our model.

Appendix B lists the category scores and factor weights for each factor, provided based on expert opinion by R. Stafford and D. Hacker (CDFG, personal communication). Each factor was weighted from 0% to 100%, such that all weights must sum to 100%. Habitat suitability was calculated for each 30-$m^2$ pixel in the study area as the weighted geometric mean of scores for that pixel:

(Vegetation $\text{Score}^{0.35}$) * (Road Density $\text{Score}^{0.10}$) * (Topography $\text{Score}^{0.55}$) = Habitat Suitability.

**Habitat Patches and Cores:** Potential Habitat Patches and Cores were identified as contiguous polygons of medium, medium-high, and high suitability habitat meeting the following size criteria. Minimum patch size (defined as the area of suitable habitat capable of supporting at least two individuals) was estimated as 13,000 ha based on estimated herd range size on the Carrizo Plain as determined from flight data gathered between 1999 and 2008 (R. Stafford, CDFG, unpublished data). Core areas (defined as areas potentially supporting 50 or more individuals) were estimated to be ≥ 65,000 ha (herd range x 5) based on expert opinion (R. Stafford and D. Hacker). Thus, patch size was defined as ≥ 13,000 ha but < 65,000, and core areas were defined as ≥ 65,000 ha. Any suitable habitat < 13,000 ha was defined as less than a patch. These areas may serve as stepping stones between potential patches and core areas. Dispersal distance was defined as 100 km for the patch configuration analysis for pronghorn.

**Landscape Permeability:** For permeability analysis, we identified areas to be connected as habitat of medium to high suitability within two Target Zones: one in the southeastern portion of the study area (including Carrizo Plain National Monument [CPNM], Carrizo Plain Ecological Reserve, Bureau of Land Management parcels contiguous with the National Monument and Ecological Reserve, and small portion of the Bittercreek National Wildlife Refuge) and one in the northwestern portion of the study area, north of the westernmost extent of State Route 46 and west of State Route 33. These Target Zones were selected to represent large intact landscapes that included important habitat for each species and that should remain connected to assure long-term population viability. The Target Zone in the southeast is known to support a population of pronghorn, and current pronghorn distribution is known to extend from this area northwest beyond the State Route 46-State Route 41 intersection. Although the Target Zone in the northwestern portion of the study area is not currently protected (with the exception of the Palo Prieto Conservation Bank), it represents a large intact landscape that connects to intact lands beyond the northwest extent of our study area. As such, maintenance of connectivity from CPNM to the northwestern zone is assumed to provide pronghorn with important connectivity to areas beyond this zone.

Permeability ratings were provided by CDFG biologists most familiar with pronghorn on the Carrizo Plain (R. Stafford and D. Hacker; Appendix B). They were combined using the following Weighted ~~Arithmetic~~ Geometric Mean equation, which represents cost of movement (the inverse of permeability):

~~(Vegetation Score * 35%) + (Road Density Score * 10%) + (Topography Score * 55%) = cost.~~
(Vegetation $\text{Score}^{0.35}$) * (Road Density $\text{Score}^{0.10}$) * (Topography $\text{Score}^{0.55}$) = Resistance.

The equation reflects that pronghorn are most likely to move through open terrain, with short vegetation, few barriers, and gentle slopes, but that these variables may influence pronghorn movements in a more compensatory way than was assumed for defining suitable habitat for foraging, breeding, etc. Because pronghorn use a wider range of elevations (0 to 3353 meters) than occur in the study area, elevation was not an input factor into the permeability model.

#### 5.1.4.2 Tule elk

**Habitat Suitability:** We developed a Weighted Geometric (Multiplicative) Mean GIS habitat suitability model using vegetation type and road density as primary variables, based on information summarized in Section 4.2 and discussions with species experts. The model reflects that tule elk prefer large grassland areas, freshwater emergent wetlands, and valley foothill riparian habitat, but that they also use a wide variety of other habitats including agricultural lands, open brush habitats, and dispersed stands of oaks, sycamore, eucalyptus and other trees. The presence of paved roads influences tule elk movement and appears to delimit some herd ranges on the Carrizo Plain (Section 4.2); thus the model includes density of paved roads as a key input. The habitat suitability model considered areas with a high road density to be less suitable than less-roaded areas.

Habitat suitability ratings (from 0 to 1, with 1 being most suitable and 0 being unsuitable) for individual vegetation and road density classes were provided by CDFG biologists most familiar with this species on the Carrizo Plain (R. Stafford and D. Hacker; Appendix B). Suitability ratings shown in Appendix B were further refined as follows:

- Irrigated row and field crops ~~agricultural lands~~ within 0.8 km (0.5 mi) of suitable natural habitat areas (suitability $\geq$ 0.3) were rated as shown in Appendix B; but irrigated row and field crops ~~agriculture~~ more than this distance from suitable natural habitat was rated as unsuitable (rating = 0), based on observations that tule elk only use such fields in proximity to suitable natural lands (R. Stafford, CDFG, personal communication).

Tule elk use a variety of topographic land forms and a wide range of elevations relative to areas available within our study area, so topographic position and elevation were not included in the model. Because the impact of fences on tule elk habitat suitability is not well understood, and a comprehensive fence data layer was not available for the study area, we did not include fences as an input to our model. Similarly, because water needs of tule elk are not well understood, and a complete map of water sources (including both natural and artificial water sources) was not available for this study area, we did not include water in our model.

Appendix B lists the category scores and factor weights for each factor, provided based on expert opinion by R. Stafford and D. Hacker (CDFG, personal communication). Each factor was weighted from 0% to 100%, such that all weights must sum to 100%. Habitat suitability was calculated for each 30-$m^2$ pixel in the study area as the weighted geometric mean of scores for that pixel:

$$(\text{Vegetation Score}^{0.50}) * (\text{Road Density Score}^{0.50}) = \text{Habitat Suitability}$$

**Habitat Patches and Cores:** Habitat Patches and Cores were identified as contiguous polygons of medium, medium-high, and high suitability habitat meeting the following size criteria. Minimum patch size (defined as the area of suitable habitat capable of supporting at least two individuals) was estimated as 3,600 ha based on the minimum home range size observed for female elk on the Carrizo Plain (R. Stafford, CDFG, unpublished data). Because elk are gregarious, and home range estimates come from animals living in natural groups, we assumed that one home range could support at least two individuals. Core areas (defined as areas potentially supporting 50 or more individuals) were estimated to be ≥ 63,000 ha (the largest home range observed on the Carrizo Plain x 5) based on expert opinion (R. Stafford and D. Hacker). Thus, patch size was defined as ≥ 3,600 ha but < 63,000, and core areas were defined as ≥ 63,000 ha. Any suitable habitat < 3,600 ha was defined as less than a patch; these areas may serve as stepping stones between potential patches and core areas. Dispersal distance was defined as 80 km for the patch configuration analysis for tule elk.

**Landscape Permeability:** For permeability analysis, we identified areas to be connected as habitat of medium to high suitability within two Target Zones: one in the southeastern portion of the study area (including Carrizo Plain National Monument [CPNM], Carrizo Plain Ecological Reserve, Bureau of Land Management parcels contiguous with the National Monument and Ecological Reserve, and small portion of the Bittercreek National Wildlife Refuge) and one in the northwestern portion of the study area, north of the westernmost extent of State Route 46 and west of State Route 33. These Target Zones were selected to represent large intact landscapes that included important habitat for each species and that should remain connected to assure long-term population viability. The Target Zone in the southeast is known to be used by tule elk, and elk distribution extends from this area northwest beyond the State Route 46-State Route 41 intersection. Although the Target Zone in the northwestern portion of the study area is not currently protected (with the exception of the Palo Prieto Conservation Bank), it represents a large intact landscape that connects to intact lands beyond the northwest extent of our study area. As such, maintenance of connectivity from CPNM to the northwestern zone is assumed to provide tule elk with important connectivity to areas beyond this zone.

Permeability ratings were provided by CDFG biologists most familiar with tule elk on the Carrizo Plain (R. Stafford and D. Hacker; Appendix B) and combined using the following Weighted ~~Arithmetic~~ Geometric Mean equation, which represents cost of movement (the inverse of permeability):

~~(Vegetation Score * 50%) + (Road Density Score * 50%) = cost.~~
$(\text{Vegetation Score}^{0.50}) * (\text{Road Density Score}^{0.50}) = \text{Resistance.}$

The equation reflects that elk movement will mostly be influenced by vegetation and density of paved roads and that the influence of these two factors should be relatively equal and compensatory. Because tule elk use a wide range of elevation and topographical terrain types, relative to what is available in our study area, elevation and topographical position were not used as input factors into the permeability model.

#### 5.1.4.3 San Joaquin Kit fox

**Habitat Suitability:** We determined habitat suitability for San Joaquin kit fox using methods similar to those developed by Cypher et al. (2007). This habitat suitability model was found to have good predictive power when compared to field data on fox distribution (B. Cypher, personal communication). The model, which was based on the Weighted Geometric Mean ~~sum~~ of vegetation type, topographic ruggedness, and vegetation density, reflects that kit foxes use gentle open terrain, primarily within grasslands and open scrub habitats, and that they select sparse versus dense grasslands (Section 4.3).

Habitat suitability ratings (from 0 to 1, with 1 being most suitable and 0 being unsuitable) for individual vegetation classes in the study area were provided by kit fox expert, B. Cypher (personal communication; Appendix B). Suitability ratings shown in Appendix B were further refined as follows:

- Dryland grain crops within 1 km (0.62 mi) of suitable natural habitat areas (suitability ≥ 0.5) were rated as 0.4; but dryland grain crops more than this distance from suitable natural habitat was rated as shown in Appendix B, based on observations that kit fox will occasionally forage in such fields in proximity to suitable natural lands (Warrick et al. 2007, B. Cypher, personal communication).
- Irrigated row and field crops within 1 km (0.62 mi) of suitable natural habitat areas (suitability ≥ 0.5) were rated as 0.3; but irrigated row and field crops more than this distance from suitable natural habitat was rated as shown in Appendix B, based on observations that kit fox will occasionally forage in such fields in proximity to suitable natural lands (Warrick et al. 2007, B. Cypher, personal communication).

In addition to vegetation community classes, the model weighted suitability of natural lands by terrain ruggedness (Valentine et. al. 2004, Cypher et al. 2007). Research on kit foxes at Naval Petroleum Reserves in California has shown terrain ruggedness as a "consistent factor that affected capture rates of kit foxes," with foxes most abundant in areas of low topographic ruggedness (Warrick and Cypher 1998). Terrain ruggedness was classified using a 30-m digital elevation model and classifying areas as rugged according to elevation differences between each grid cell and its neighboring cells. The resulting values were then reclassed into four classes with values of 0 to 1 with high values (lowest ruggedness) being the most suitable.

The model used reflectance data based on satellite imagery in the form of a Normalized Difference Vegetation Index [NDVI] as an index of vegetation density. The NDVI was derived from remote sensing imagery that compares visible and near infrared radiation to estimate "greenness" or vegetation density relative to bare ground. Each cell was assigned a value based on a composite dataset of mean values from 2001-2006. NDVI values were then reclassed to suitability values ranging from 0 to 1 with high values being most suitable, using known locations of kit fox to guide classification (Cypher et al. 2007, S. Phillips, California State University, Stanislaus, personal communication).

Although San Joaquin kit fox distribution may be influenced by elevation, we assumed that inclusion of vegetation type and terrain ruggedness in the suitability model would likely account for elevational influences.

Habitat suitability was calculated for each 30-$m^2$ pixel in the study area using the following weighting equation, based on expert opinion (B. Cypher, personal communication):

~~(Vegetation Score * 50%) + (Terrain Ruggedness Score * 25%) + (Vegetation Density Score * 25%) = Habitat Suitability.~~
(Vegetation Score $^{.50}$) * (Terrain Ruggedness Score $^{.25}$) * (Vegetation Density Score $^{.25}$) = Habitat Suitability.

We divided the resulting suitability values into five classes (low, low to medium, medium, medium to high, and high) using quantile classification , to better reflect the nuances in the intensity of land uses in the study area. ~~Following Cypher et al. (2007) we reclassed the continuous habitat suitability scores into three suitability classes: low, medium, and high.~~

**Habitat Patches and Cores:** Potential Habitat Patches and Core Areas were identified as contiguous polygons of medium to high suitable habitat meeting the following size criteria. Minimum patch size (defined as the area of suitable habitat capable of supporting at least two individuals) was estimated as 486 ha, based on the estimate that this area could support one kit fox family in optimal habitat (Cypher et al. 2007). Core areas (defined as areas potentially supporting 50 or more individuals) were estimated to be ≥ 12,150 ha (family area x 25). Thus, patch size was defined as ≥ 486 ha but < 12,150, and core areas were defined as ≥ 12,150 ha. Any suitable habitat < 486 ha was defined as less than a patch; these areas may serve as stepping stones between potential patches and core areas. Dispersal distance was defined as 192 km for the patch configuration analysis for kit fox.

**Landscape Permeability:** For the landscape permeability analysis, we identified areas to be connected as habitat of medium to high suitability ~~core~~ on the Carrizo Plain side of the Temblor Range within the Target Zone in the southeastern portion of the study area (including Carrizo Plain National Monument [CPNM], Carrizo Plain Ecological Reserve, Bureau of Land Management parcels contiguous with the National Monument and Ecological Reserve, and small portion of the Bittercreek National Wildlife Refuge), and medium to high suitable habitat within the three Target Zones in the northwestern portion of the study area, generally north of the westernmost extent of State Route 46 and west of State Route 33. These Target Zones were selected to represent large intact landscapes that included important habitat for kit fox (i.e., Salinas River Watershed, Palo Prieto-Cholame Valley, and Western Kern County in the vicinity of the Antelope Plain)~~each species~~ and that should remain connected to the Carrizo Plain Natural Area to assure long-term population viability. The Target Zone in the southeast is known to support kit foxes, and their distribution is known to extend from this area northwest beyond the State Route 46-State Route 41 intersection. Although the Target Zones in the northwestern portion of the study area are~~is~~ not currently protected (with the exception of the Palo Prieto Conservation Bank), ~~it~~ they represent~~s a~~ large intact landscapes that connect~~s~~ to intact lands beyond the study area. As such, maintenance of connectivity from CPNM to the northern zones is assumed to provide kit foxes with important connectivity to areas beyond this zone.

Permeability ratings were provided by kit fox expert, B. Cypher (personal communication; Appendix B) and combined using the following Weighted Geometric Mean equation, which represents cost of movement (the inverse of permeability):

(Vegetation Score $^{.40}$) * (Road Density Score $^{.05}$) * (Terrain Ruggedness Score $^{.50}$) * (Vegetation Density Score $^{.05}$) = Resistance.

Three analyses were run from the southern Target Zone to each of the three northern Target Zones. The results of each analysis were then overlaid to create a union of the three least-cost corridors for kit fox.

Our model for habitat permeability for kit foxes is based on vegetation, terrain ruggedness, vegetation density, and road density to reflect that kit foxes use areas of gentle terrain in open vegetation associations such as grasslands and open scrub habitats, and that they tend to avoid densely vegetated areas. Furthermore this model reflects that increased road density may reduce permeability.

~~*We ran two versions of the landscape permeability model for kit fox, one using factor ratings for habitat suitability, and one using ratings specifically developed for permeability. These sets of ratings can differ because, for example, kit fox may easily move through some habitats they don't generally use for denning or foraging (B. Cypher, personal communications). The suitability and permeability ratings were both provided by kit fox expert, B. Cypher (personal communication; Appendix B). Previous research conducted by Cypher et al. (2007) used permeability ratings rather than habitat suitability ratings for conducting landscape permeability analyses for kit fox. Both versions combined the ratings using the following weighting equation, which represents cost of movement (the inverse of permeability):*~~

~~(Vegetation Score * 40%) + (Road Density Score * 5%) + (Terrain Ruggedness Score * 50%) + (Vegetation Density Score * 5%) = cost.~~

## 6.1 Task 1: Baseline conditions of habitat suitability and connectivity for each focal species

### 6.1.1 Habitat Suitability

#### 6.1.1.1 Pronghorn antelope

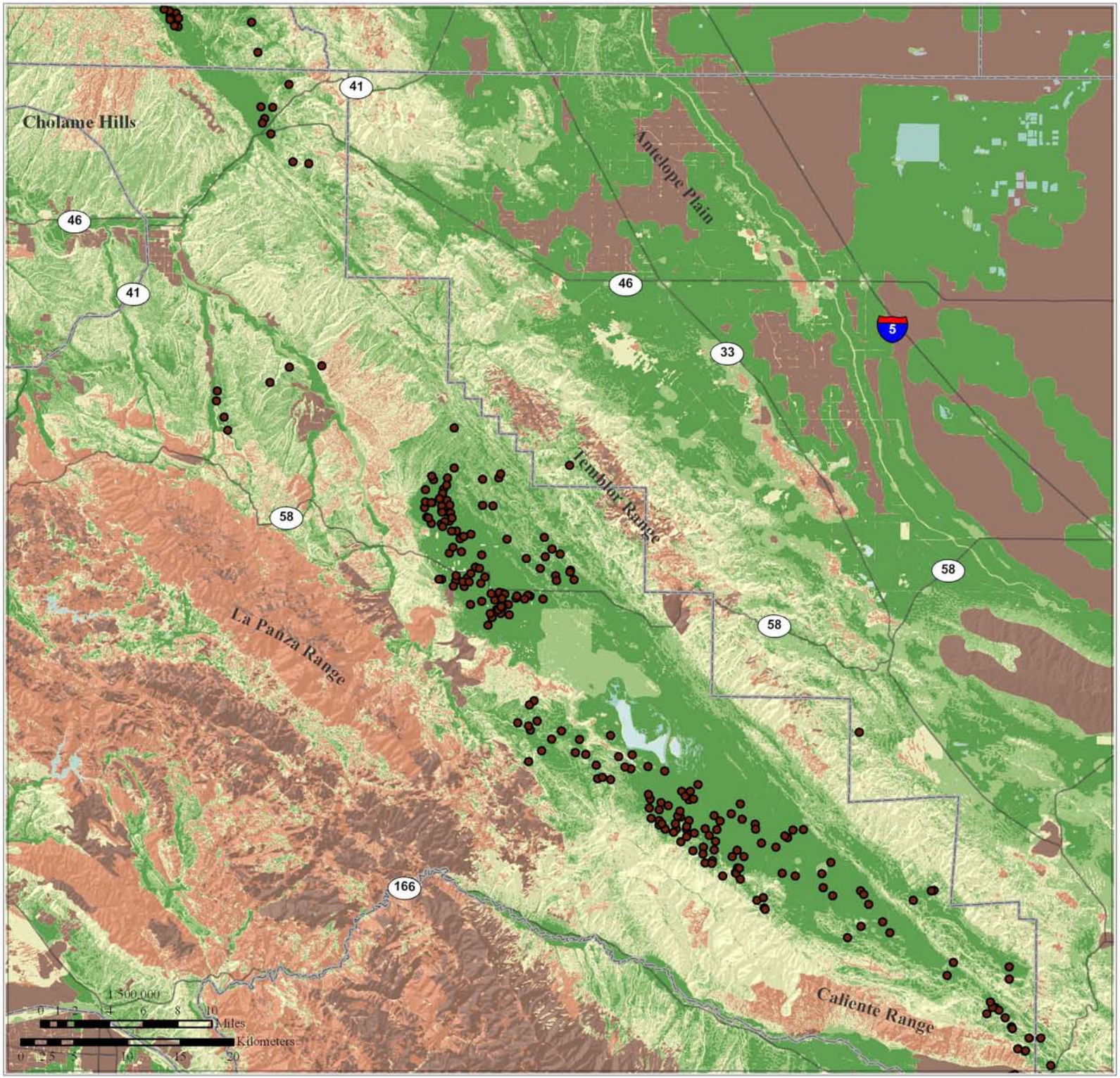
Suitable habitat for pronghorn antelope in the study area is largely restricted to open vegetation communities in gentle terrain. The model identified abundant medium to high suitable habitat for this species on both sides of the Temblor Range (Figure 4). The most extensive areas of highly suitable habitat are in the open grasslands and alkali desert scrub habitats on the floor of the Carrizo Plain and San Joaquin Valley. Modeled high-value habitat corresponds well with the distribution of sightings in the Carrizo Plain, ~~and~~ Cholame Valley, and Navajo and San Juan creeks. Some agricultural lands were also identified as medium to high suitability, with irrigated row and field crops becoming unsuitable more than 0.8 km from natural suitable lands with suitability ≥ 0.5. Highly roaded portions ~~of the~~ in the community of California Valley ~~Carrizo Plain~~, which would otherwise be modeled as high-value habitat, appear as medium-high. Habitat for pronghorn antelope generally becomes ~~less~~ unsuitable southwest of the La Panza Range in the southwestern portion of the study area and unsuitable in the dense agriculture lands on the San Joaquin Valley floor and in the Santa Maria Valley in the southwestern portion of the study area.

The patch size analysis identified the majority of medium to highly suitable habitat in the study area as potential core areas for pronghorn, with a few patches delineated in the southwestern and northeastern portions of the study area (Figure 5). All potential core areas and habitat patches are within the species dispersal distance (figure not shown), although barriers to movement may exist between areas of suitable habitat.

#### 6.1.1.2 Tule elk

Suitable habitat for tule elk is widespread in the study area in grassland, meadow, scrub, brush, woodland, and riparian communities as well as some agricultural types, such as dryland grain crops and irrigated row and field crops. The most highly suitable habitat primarily follows the *Avena*-dominated annual grasslands and those irrigated row and field crops within 0.8 km of other natural habitats suitable (≥ 0.3) for tule elk (Figure 6). The majority of medium to high suitable habitat occurs ~~in a wide swath from the northwest to southeast of the study area~~ between the La Panza Range and Interstate 5 and largely follow the *Bromus*-dominated grassland, coastal scrub, juniper, and dryland grain crop habitats. Other suitable habitats of note occur at the north end of the Caliente Range near Carrizo Canyon; at the base of the La Panza Range on the coastal side along the Salinas River; and along the Cuyama River, Alamo Creek, Nipomo Valley, and Canyon de los Alisos in the southwestern portion of the study area. Areas of medium to high suitable habitat are consistent with collared and flight sightings of tule elk. Chaparral, montane

**Figure 4.**
**Habitat Suitability**
**for**
**Pronghorn antelope**



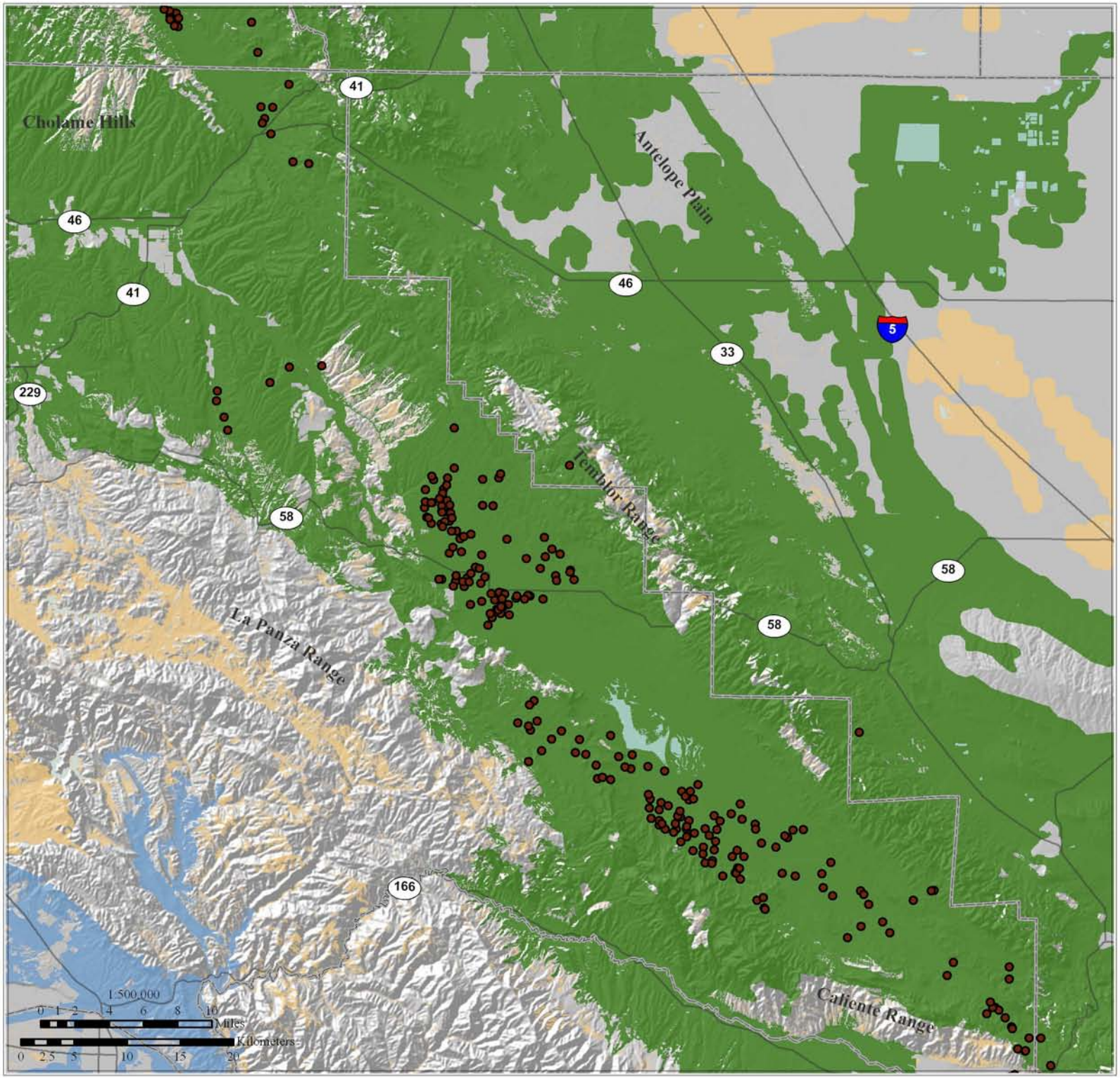

Degree of Suitability
- High
- Med-High
- Med
- Low-Med
- Low
- Pronghorn Sightings
- Highways
- County Boundaries
- Hydrography

N
W E
S

Map Produced By:

SC Wildlands
Science & Collaboration for Connected Wildlands

**Figure 5.**
**Potential Cores & Patches**
**for**
**Pronghorn antelope**



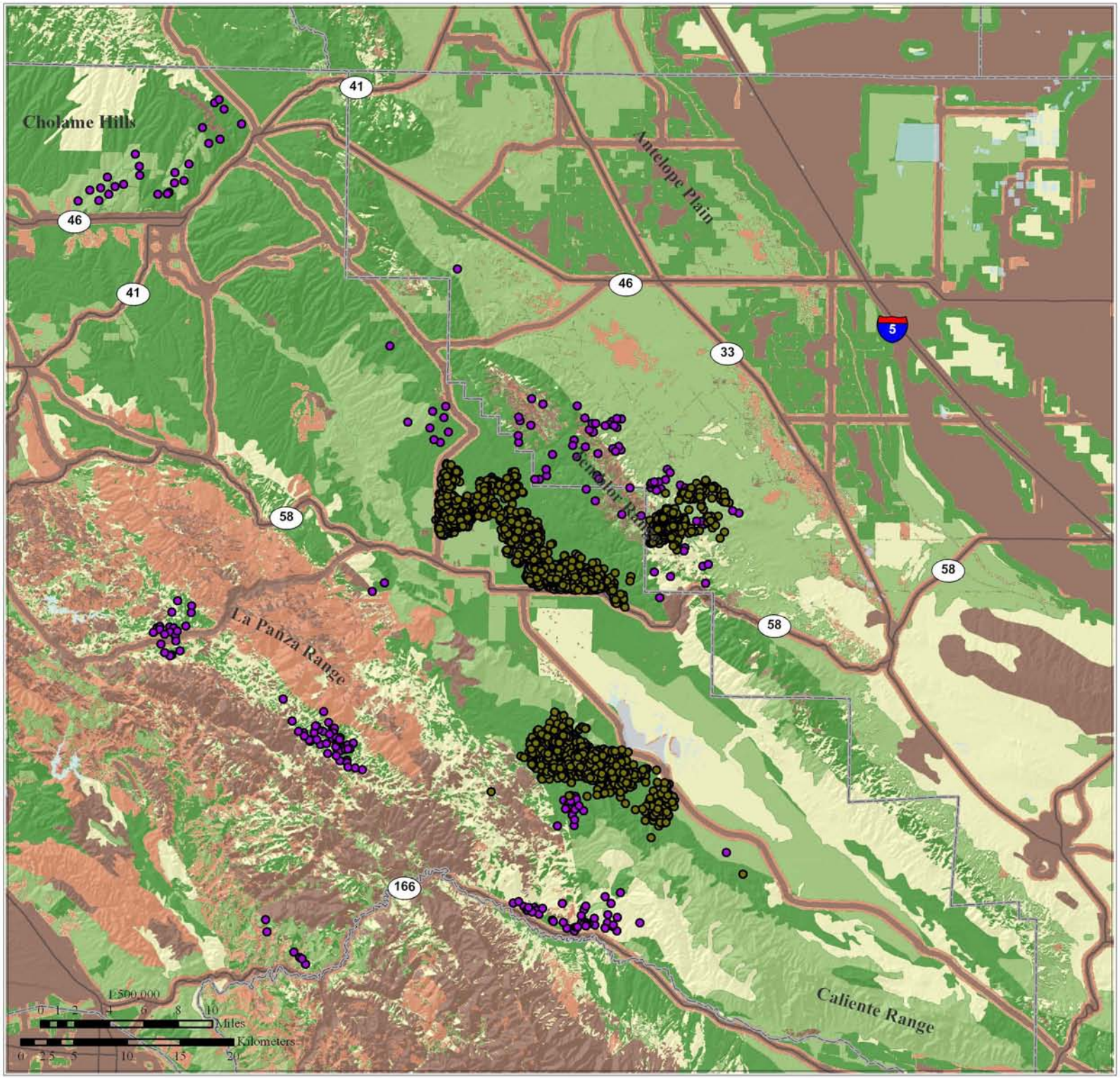

- Core
- Patch
- < Patch
- Pronghorn Sightings
- Highways
- County Boundaries
- Hydrography

N
W E
S

Map Produced By:

SC Wildlands
Science & Collaboration for Connected Wildlands

**Figure 6.**
**Habitat Suitability**
**for**
**Tule elk**




Degree of Suitability
- High
- Med-High
- Med
- Low-Med
- Low
- Collared Sightings
- Flight Sightings
- Highways
- County Boundaries
- Hydrography

N
W E
S

Map Produced By:

SC Wildlands
Science & Collaboration for Connected Wildlands

hardwood and conifer habitats are less suitable for tule elk, as are orchards, vineyards, and dense irrigated agriculture beyond 0.8 km of other suitable natural habitats. Paved roads and habitats in the immediate vicinity of these roads ~~are also~~ were considered unsuitable for tule elk and appear to restrict some herd ranges on the Carrizo Plain, which is evident in the road-constrained distribution of telemetry points on Figure 6.

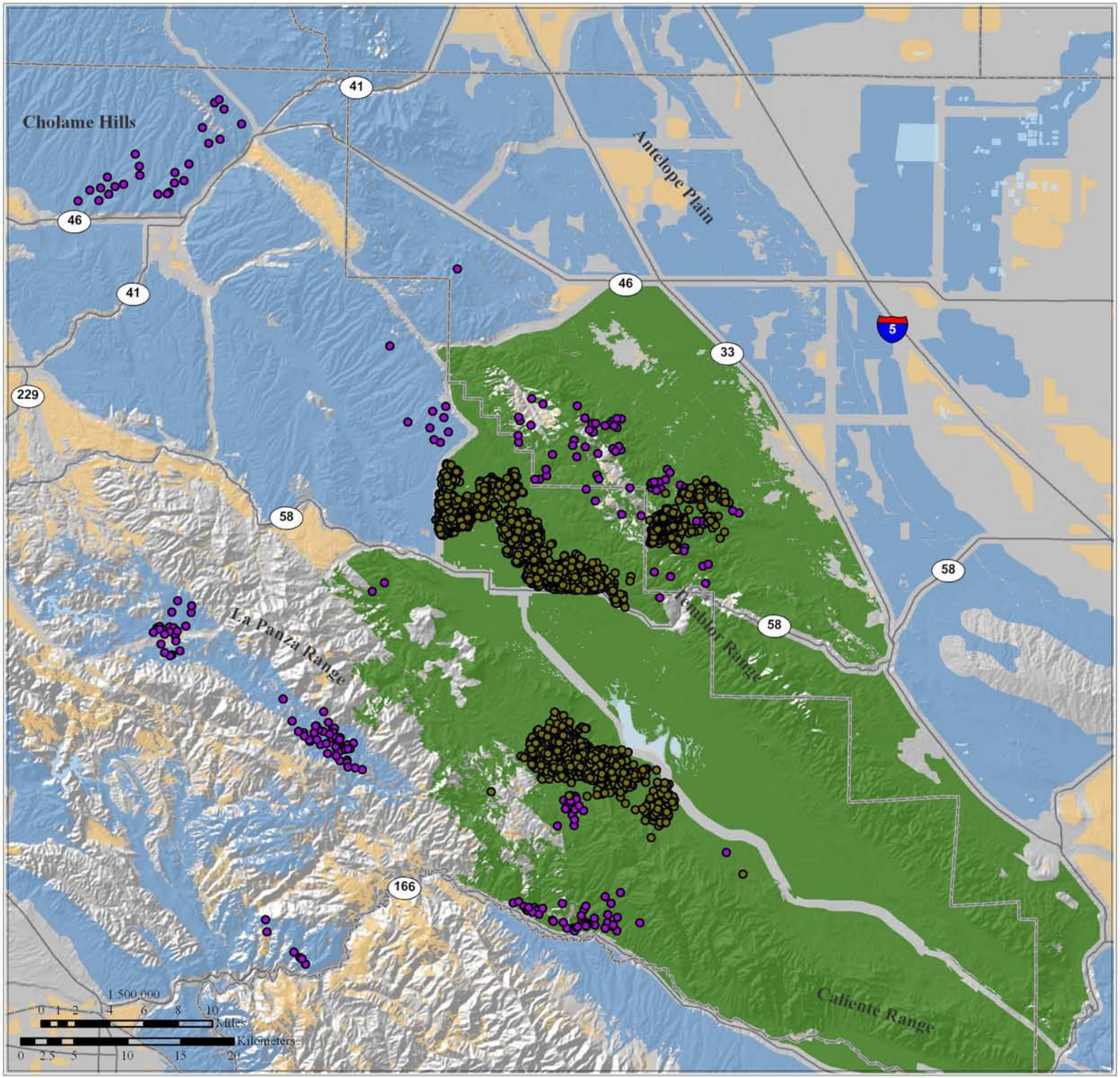
The patch size analysis identified one potential core area within the analysis extent that is generally bound on the north by State Route 46 and Bitterwater Valley Road, on the east by State Route 33, on the south by State Route 166, and on the west by the La Panza Range (Figure 7). Lands northwest of the State Route 46 and 41 intersection, currently identified as a patch, would also be considered a potential core area if the analysis window extended beyond the study area (R. Stafford, personal communication). Other significant patches occur in between these two core areas, between State Route 33 and Interstate 5 and south of State Route 166, which would have been contiguous with the core areas if not for the paved roads that fragment these areas of medium to high suitable habitat. Additional patches were delineated to the southwest of the La Panza Range and to the east of Interstate 5. All potential core areas and habitat patches are within the species dispersal distance (figure not shown), although barriers to movement may exist between areas of suitable habitat.

#### 6.1.1.3 San Joaquin kit fox

Suitable habitat for kit fox in the study area is somewhat limited, being primarily restricted to grassland and scrub habitats in gentle terrain on valley floors. The most highly suitable habitat largely follows the drier, *Bromus*-dominated annual grassland and alkali desert scrub habitats in the Carrizo Plain south of State Route 58 and on the San Joaquin Valley side of the Temblor Range (Figure 8). Areas identified as medium to high suitability for kit fox are primarily *Avena*-dominated grassland and alkali desert scrub habitats with low topographic ruggedness. These habitats generally occur on the lower slopes and at the base of Temblor Range, around the base ~~of the northern extent~~ of the Caliente Range, straddling State Route 58 in the Carrizo Plain, in the Cholame Valley, and in scattered patches on gentle terrain between State Routes 58 and 46. Areas identified as medium suitability for kit fox are largely restricted to dryland grain crops and irrigated row and field crops within a kilometer of contiguous suitable natural habitat areas (suitability $\geq$ 0.5). These areas generally occur in Shandon, Camatta Canyon, San Juan Valley, straddling State Route 58 primarily west of Simmler Bitterwater Road, Cuyama Valley, and in the northeastern part of the study area generally north of State Route 46 and east of State Route 33. Brian Cypher (personal communication) said these areas are used for foraging at certain times of the year and that the buffers into these agricultural lands from contiguous suitable natural habitats present a more realistic depiction of habitat suitability. He cautioned that seasonal use will vary with crop phenology, and that annual use will vary depending upon whether fields are tilled annually or allowed to go fallow for some years (B. Cypher, personal communication). If fields are tilled every year, they are not typically used for denning, but if left fallow for a year or two then dens can more easily become established. All other portions of the study area were considered largely unsuitable for kit fox.

The majority of medium to high suitable habitat in the study area is in large enough continuous areas to serve as potential core areas for kit fox (Figure 9). These areas correspond well to

**Figure 7.**
**Potential Cores & Patches**
**for**
**Tule elk**




- Core
- Patch
- < Patch
- Collared Sightings
- Flight Sightings
- Highways
- County Boundaries
- Hydrography

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**Figure 8.**
**Habitat Suitability**
**for**
**San Joaquin kit fox**

Degree of Suitability
- High
- Med-High
- Med
- Low-Med
- Low
- Moonjian Sightings
- ESRP Sightings
- Spotlight observations
- Incidental observations
- Telemetry locations
- Car Sightings
- CNDDB <= 0.32 km precision
- CNDDB > 0.32 km precision
- Highways
- County Boundaries
- Hydrography

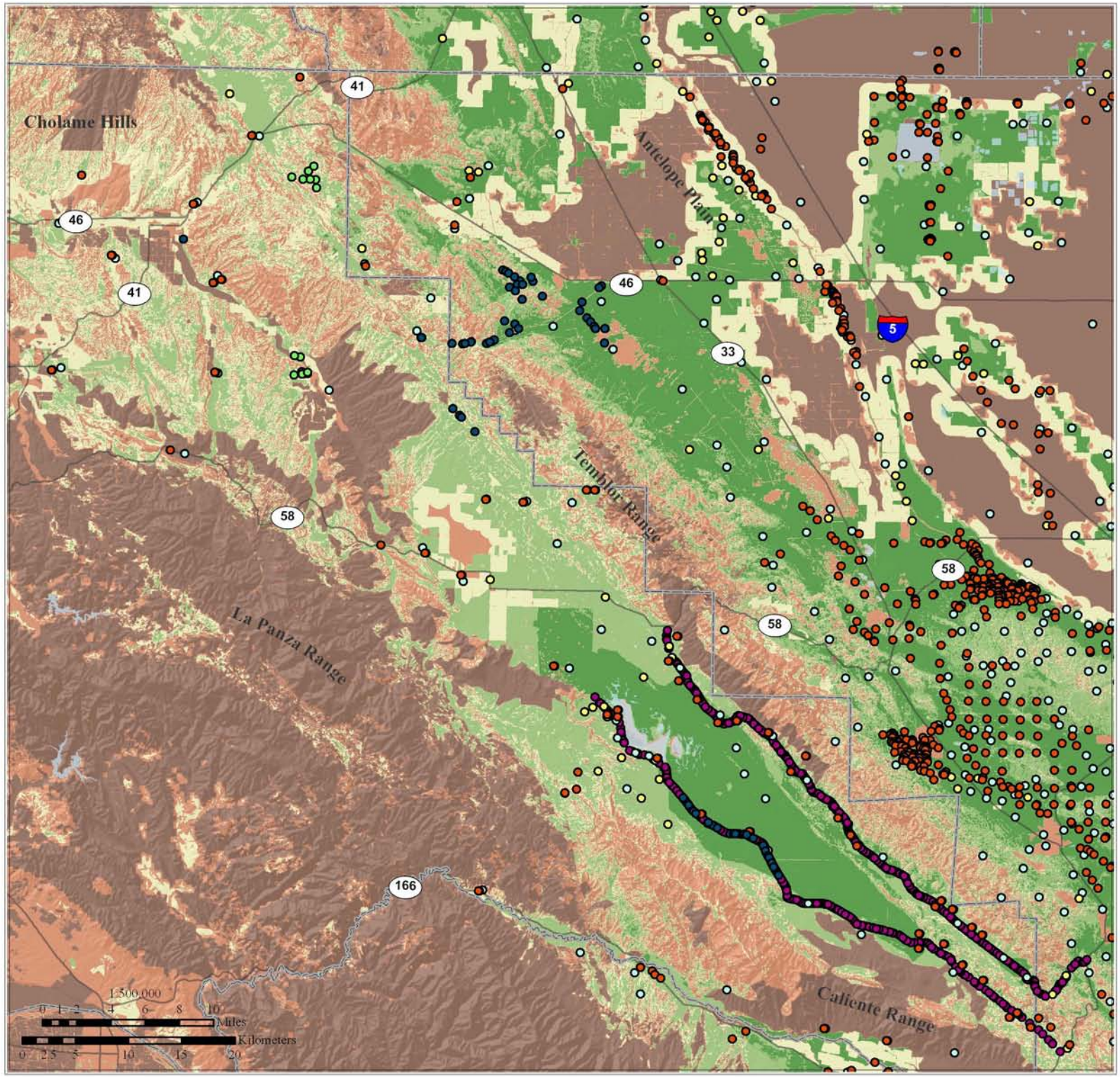


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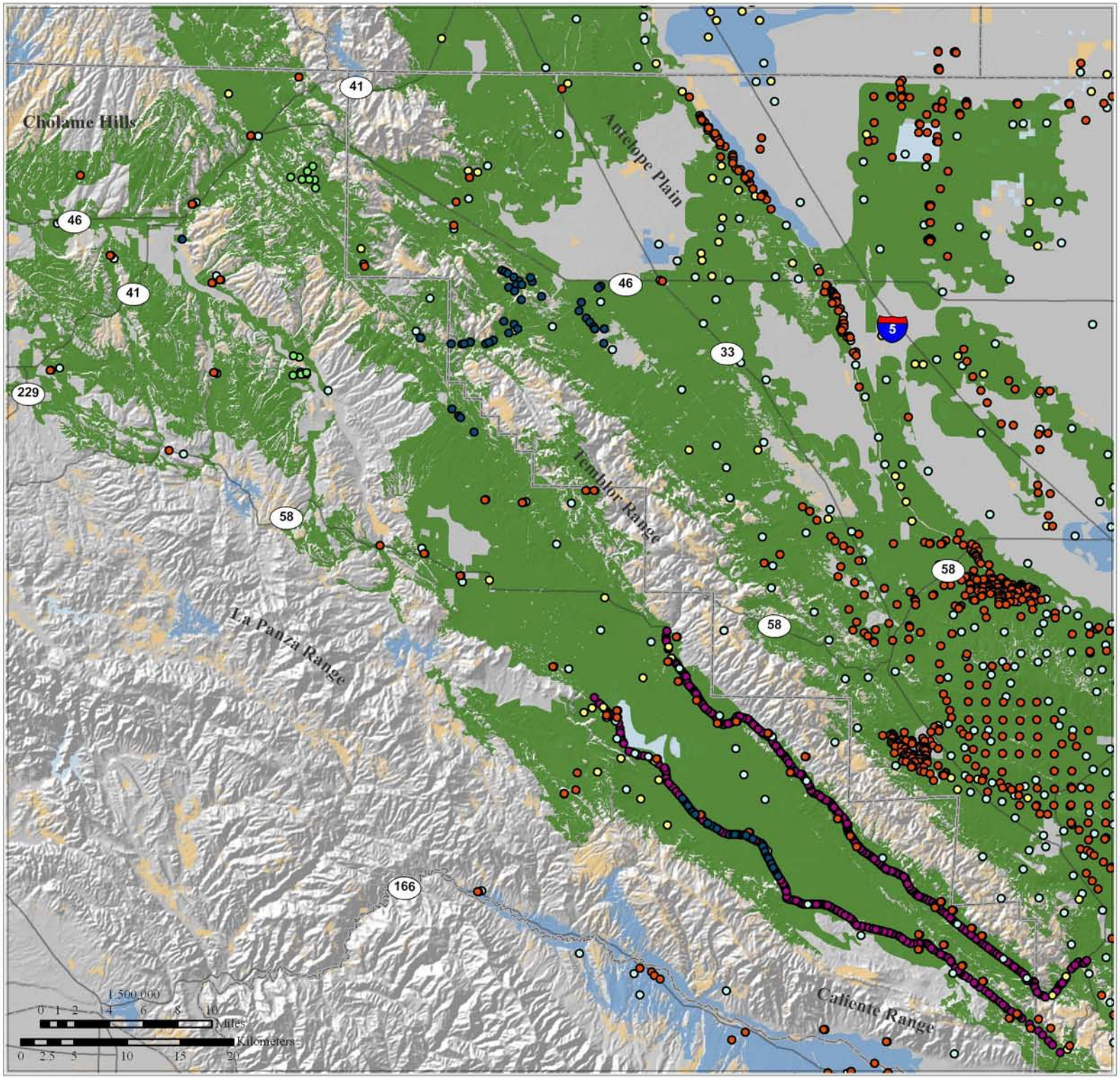
**Figure 9.**
**Potential Cores & Patches**
**for**
**San Joaquin kit fox**

- Core
- Patch
- < Patch
- Moonjian Sightings
- ESRP Sightings
- Spotlight observations
- Incidental observations
- Telemetry locations
- Car Sightings
- CNDDB <= 0.32 km precision
- CNDDB > 0.32 km precision
- Highways
- County Boundaries
- Hydrography



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recorded kit fox observations. The two largest contiguous core areas are in the Carrizo Plain and the Central Valley, and are largely separated by the Temblor Range. In the Central Valley, contiguous core habitat extends all along the base of the Temblor Range, from the Antelope Plain area to south of Lokern. Some significant patches of suitable habitat were also delineated in the Cuyama Valley. ~~to the west of Simmler Bitterwater Road and to the northeast of the junction of State Routes 46 and 33.~~ All potential core areas and habitat patches are within the species dispersal distance (figure not shown), although barriers to movement may exist between areas of suitable habitat.

### 6.1.2 Habitat Permeability

#### 6.1.2.1 Pronghorn antelope

The least-cost corridor for pronghorn antelope between the northern and southern Target Zones varies in width from approximately 19 to 26 km using the most permeable 5% portion of the landscape (Figure 10). The most permeable path extends through highly suitable habitat (mostly *Avena*-dominated annual grassland and dryland grain crops on gentle terrain) from the western portion of the southern Target Zone to the central region of the northern Target Zone. The most permeable path also corresponds to an observed herd crossing across State Route 58 (Figure 10). There are many fences through this area (Figure 10 inset). In the Carrizo Plain, types of fences vary but fence breaks are frequent enough to make barrier quality difficult to define with certainty. It is possible that pronghorn may be able to negotiate many of these fences but without more details about their design (height, wire spacing, etc) it is difficult to say anything conclusive. Ongoing efforts, such as those by CDFG and volunteers, to make fences more "pronghorn-friendly" (by raising the bottom wires) and to remove old field fencing, should be continued and expanded. A second moderately permeable path branches off to~~ward~~ the north over the Temblor Range, where grasses predominate south of State Route 46 and irrigated row and field crops dominate north of the highway, toward the easternmost part of the northern target zone.

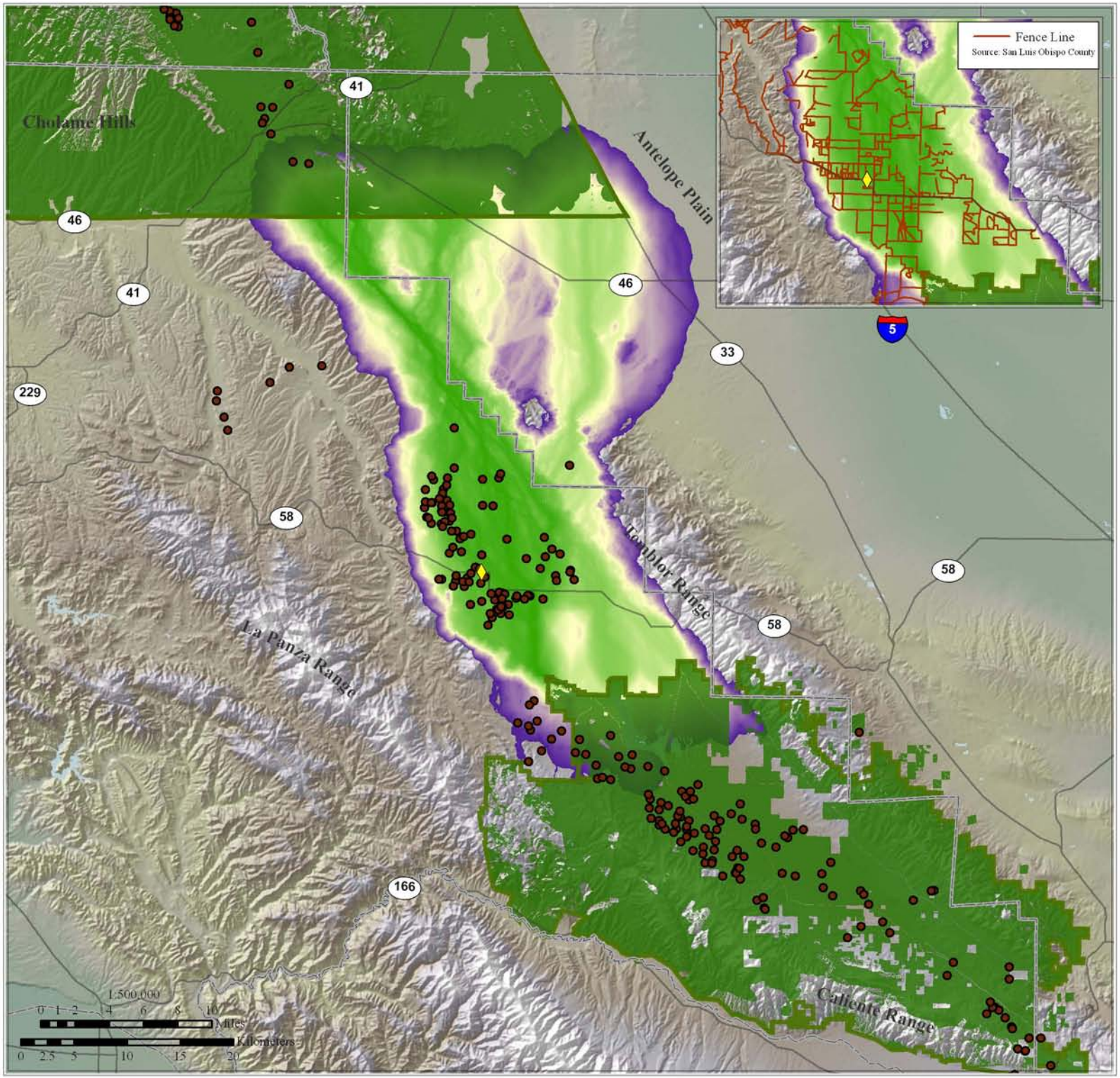
#### 6.1.2.2 Tule elk

The least-cost corridor for tule elk between the northern and southern Target Zones varies in width from about 9 to 17 km using the most permeable 2% portion of the landscape (Figure 11). It is generally bound by the Temblor Range on the east and by the La Panza Range ~~and Bitterwater Road~~ on the west. The most permeable path extends from the center of the southern Target Zone and follows the highest quality habitat between the two Target Zones; it occurs entirely to the east of Simmler Bitterwater Road, Annette Road, and Palo Prieta Cholame Road. A secondary route of moderate permeability follows highly suitable habitat to the west of Simmler Bitterwater Road.

#### 6.1.2.3 San Joaquin kit fox

Three Target Zones were identified at the northern extent of the study area (i.e., Salinas River Watershed, Palo Prieto-Cholame Valley, and Western Kern County in the vicinity of the

**Figure 10.**
**Landscape Permeability**
**for**
**Pronghorn antelope**




Least-Cost Corridor (5%)

- Highly Permeable
- Less Permeable
- Target Zone
- Medium-High Suitable Habitat*
- Pronghorn Sightings
- Pronghorn Crossing
- Highways
- County Boundaries
- Hydrography

* This analysis was run from Medium to High Suitable Habitat within each Target Zone.

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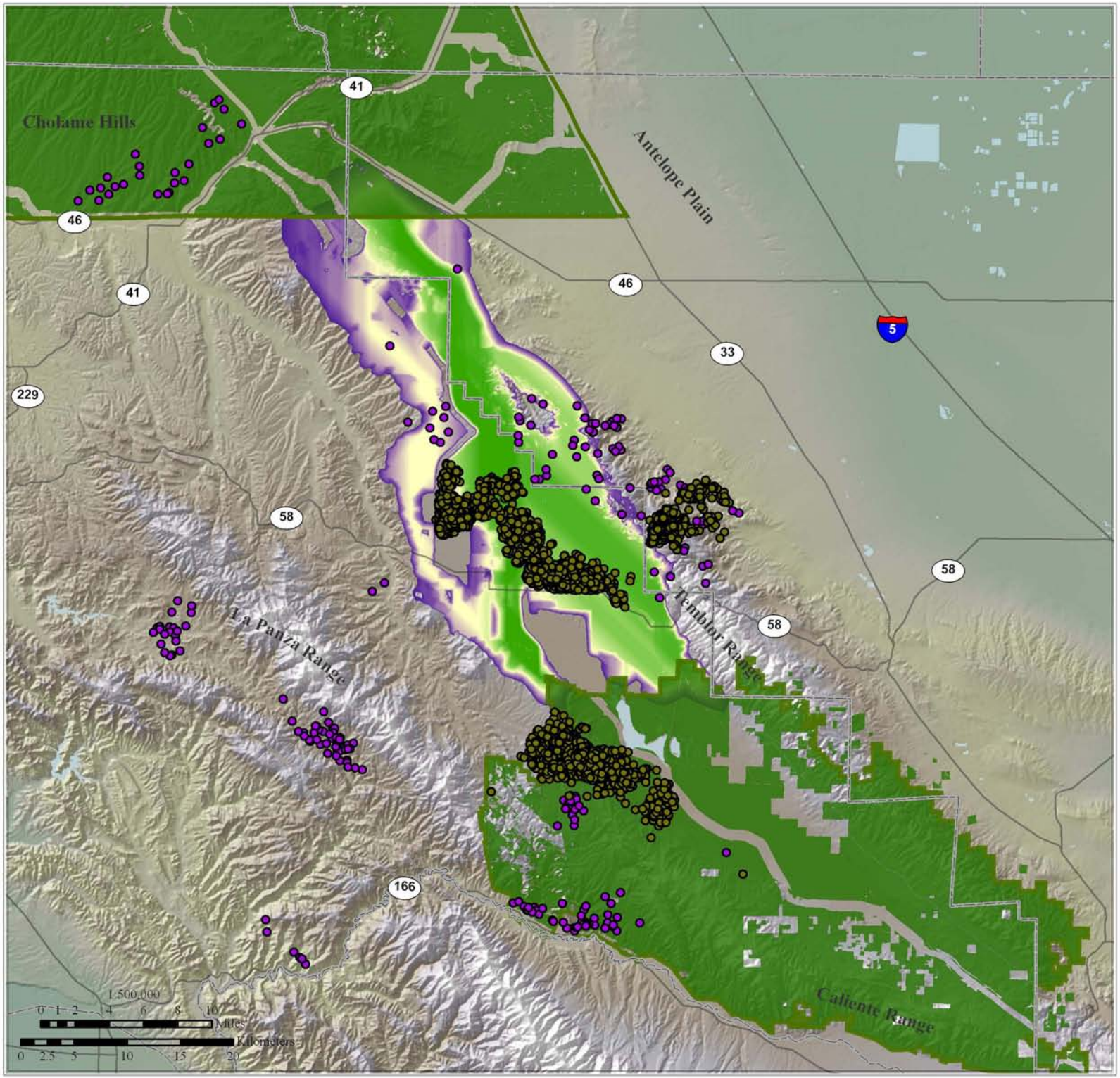
**Figure 11.**
**Landscape Permeability**
**for**
**Tule elk**




Least-Cost Corridor (2%)
- Highly Permeable
- Less Permeable
- Target Zone
- Medium-High Suitable Habitat*
- Collared Sightings
- Flight Sightings
- Highways
- County Boundaries
- Hydrography

* This analysis was run from Medium to High Suitable Habitat within each Target Zone.

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Antelope Plain) that should remain connected to the Carrizo Plain Natural Area to assure long-term population viability and to better reflect the goals outlined in the recovery plan for this species (USFWS 1998).

The least-cost corridor for kit fox between the northern Target Zone in Western Kern County in the vicinity of the Antelope Plain and the southern Target Zone ranges in width from approximately 8 to 27 km using the most permeable 3% portion of the landscape (Figure 12). The most permeable route follows the alkali desert scrub habitat north out of the Carrizo Plain National Monument in the southern Target Zone and then heads in a northwesterly direction following the Carrizo Plain proper, traveling through alkali desert scrub, dryland grain crops, and *Avena*-dominated grassland. About 5 km north of State Route 58 it starts to head almost due north and then heads east to follow Bitterwater Valley Road to *Bromus*-dominated grasslands in the Shale Hills and Antelope Valley to reach the Palo Prieto-Cholame Valley Target Zone. Another less permeable route extends out from the southern end of the CPNM and follows Elkhorn Grade Road near Highway 166 into the San Joaquin Valley and then follows alkali desert scrub and *Bromus*-dominated grassland through Midway Valley, McKittrick Valley, Temblor Valley, and the Antelope Plain and Valley. This output corresponds well with the kit fox experts' belief that any significant interchange between the Carrizo Plain and the San Joaquin Valley would likely be along Routes 46 or 166 (B. Cypher, personal communication).

The least-cost corridor for kit fox between the northern Target Zone in the Palo Prieto-Cholame Valley and the southern Target Zone ranges in width from approximately 9 to 25 km using the most permeable 3% portion of the landscape (Figure 13). The most permeable route closely follows the results of the analysis to the northern Target Zone in Western Kern County but the least-cost corridor forks with one path following Bitterwater Valley Road to *Bromus*-dominated grasslands in the Shale Hills and Antelope Valley to reach the Palo Prieto-Cholame Valley Target Zone through Polonio Pass and Raven Pass and another highly permeable route following Palo Prieto Pass through *Avena*-dominated grassland to reach the Target Zone.

The least-cost corridor for kit fox between the northern Target Zone in the Salinas River Watershed and the southern Target Zone ranges in width from approximately 1.5 to 15 km using the most permeable 3% portion of the landscape (Figure 14). The most permeable route follows the alkali desert scrub habitat out of the southern Target Zone and then meanders along State Route 58 through *Avena*-dominated grassland and dryland grain crops, taking Navajo Creek up to the San Juan Valley to reach the Salinas River Watershed Target Zone. About halfway up Navajo Creek, two moderately permeable branches take in upper San Juan Creek and Camatta Canyon. A less permeable route heads due north from State Route 58 and then follows Palo Prieto Pass to Cholame Creek to reach the Target Zone.

Figure 15 displays the union of the results of the least-cost corridor analyses for kit fox.

~~The least-cost corridor for kit fox based on habitat suitability ratings between the northern and southern Target Zones ranges in width from approximately 5 to 20 km using the most permeable 1% portion of the landscape (Figure 12). The most permeable route follows the alkali desert scrub habitat out of Carrizo Plain National Monument in the southern Target Zone and then heads in a northeastern direction over the Temblor Range following Carneros Canyon to high~~

**Figure 12.**
**Landscape Permeability for San Joaquin kit fox between the Southern Target Zone and the Northern Target Zone in Western Kern County**

Least-Cost Corridor (3%):
- Highly Permeable
- Less Permeable
- Target Zone
- Medium-High Suitable Habitat*
- Moonjian Sightings
- ESRP Sightings
- Spotlight observations
- Incidental observations
- Telemetry locations
- Car Sightings
- CNDDB <= 0.32 km precision
- CNDDB > 0.32 km precision
- Highways
- County Boundaries
- Hydrography

* This analysis was run from Medium to High Suitable Habitat within each Target Zone.

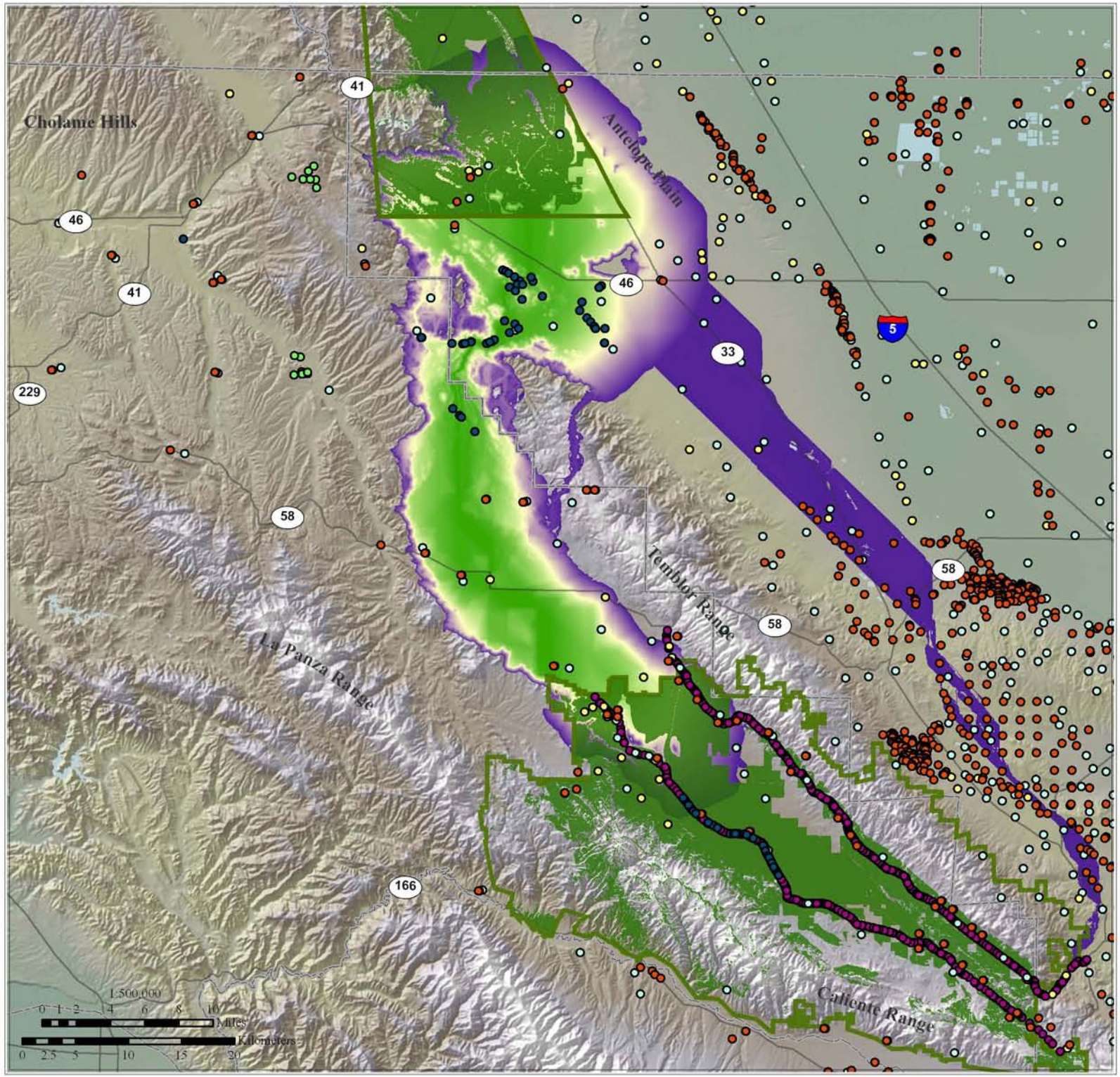

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**Figure 13.**
**Landscape Permeability for San Joaquin kit fox between the Southern Target Zone and the Northern Target Zone in Palo Priteto-Cholame Valley**

Least-Cost Corridor (3%)
- Highly Permeable
- Less Permeable
- Target Zone
- Medium-High Suitable Habitat*
- Moonjian Sightings
- ESRP Sightings
- Spotlight observations
- Incidental observations
- Telemetry locations
- Car Sightings
- CNDDB <= 0.32 km precision
- CNDDB > 0.32 km precision
- Highways
- County Boundaries
- Hydrography

* This analysis was run from Medium to High Suitable Habitat within each Target Zone.

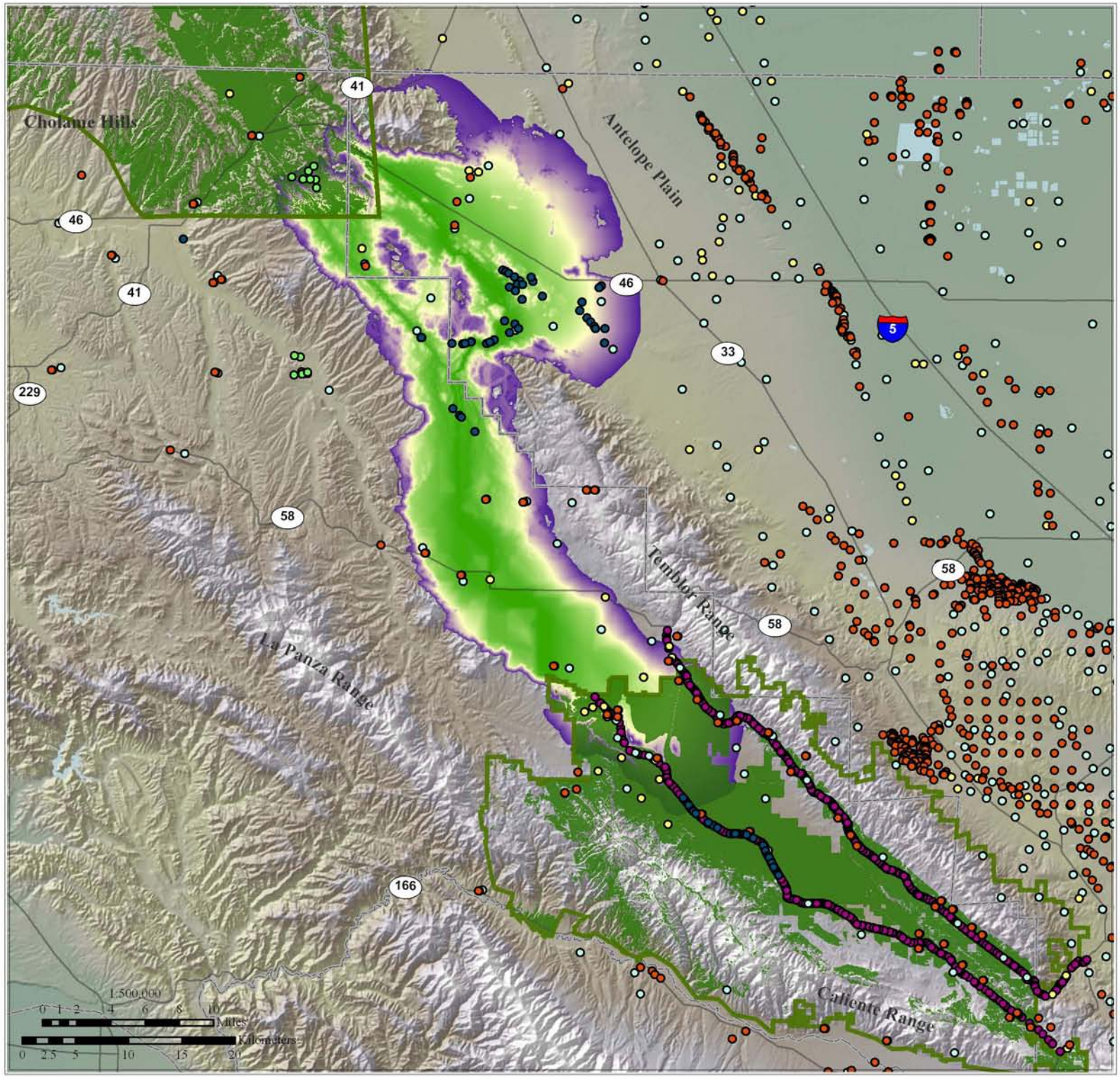

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**Figure 14.**
**Landscape Permeability for San Joaquin kit fox between the Southern Target Zone and the Northern Target Zone in Salinas River Watershed**

Least-Cost Corridor (3%)
- Highly Permeable
- Less Permeable
- Target Zone
- Medium-High Suitable Habitat*
- Moonjian Sightings
- ESRP Sightings
- Spotlight observations
- Incidental observations
- Telemetry locations
- Car Sightings
- CNDDB <= 0.32 km precision
- CNDDB > 0.32 km precision
- Highways
- County Boundaries
- Hydrography

* This analysis was run from Medium to High Suitable Habitat within each Target Zone.

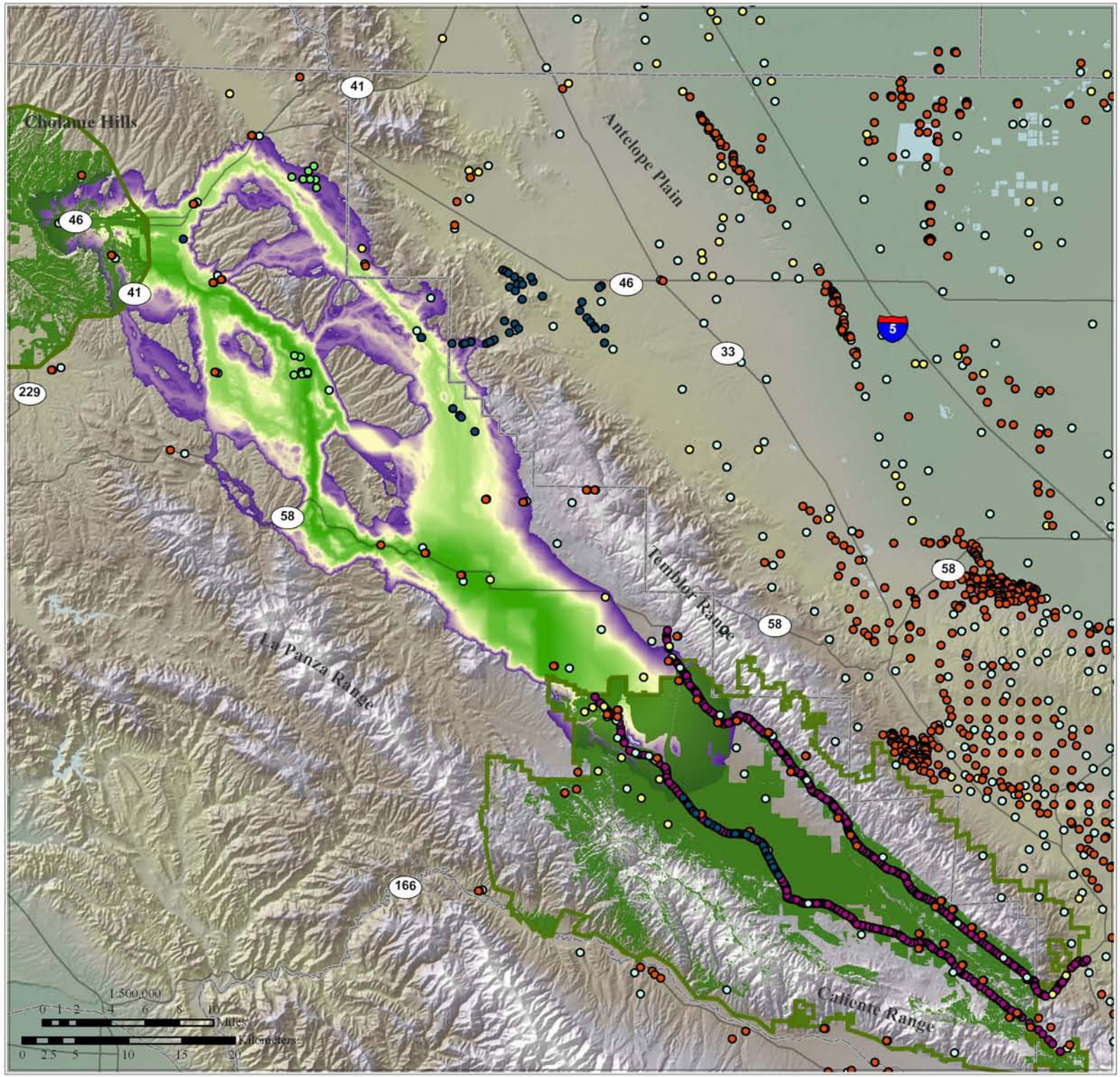

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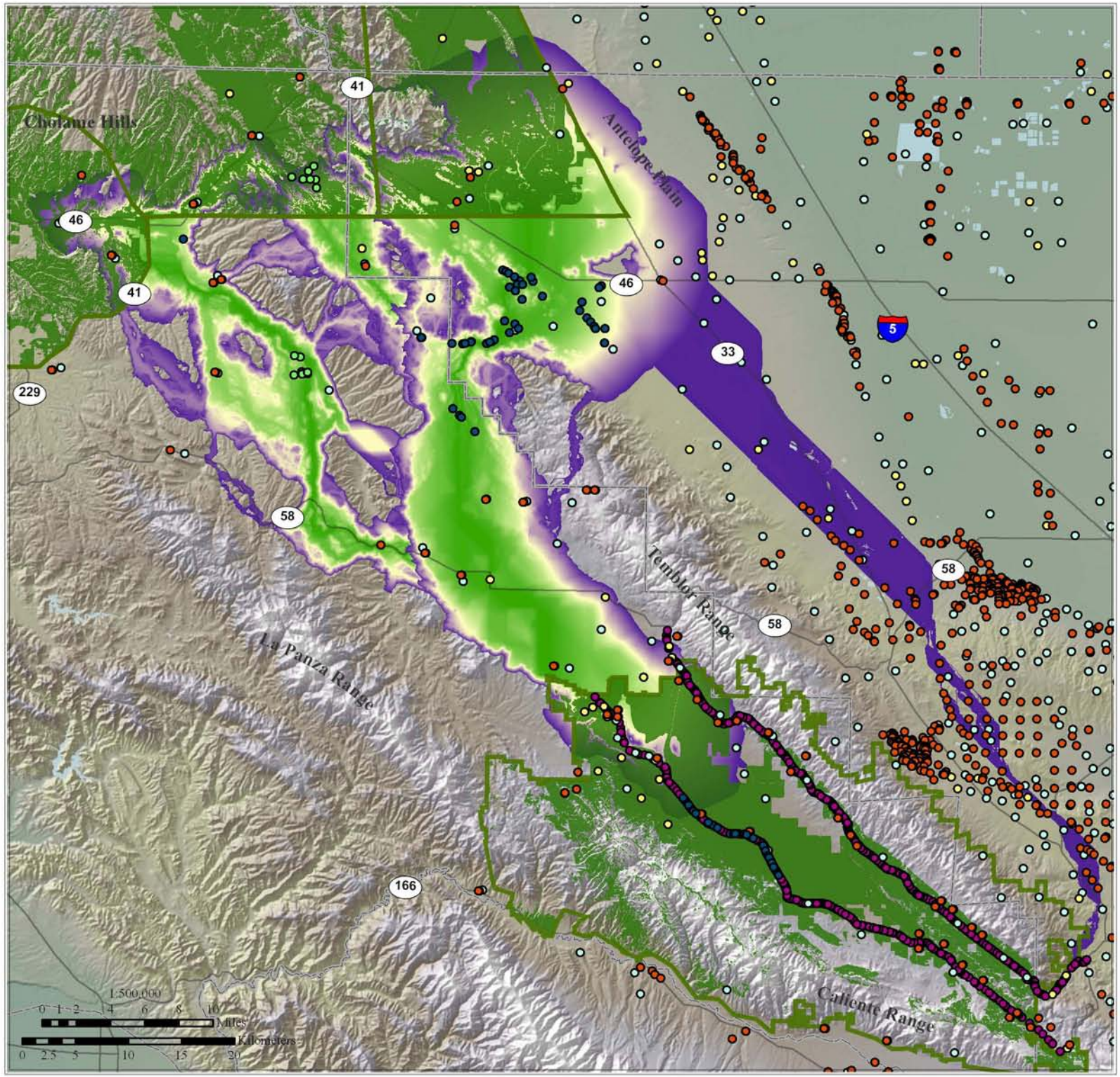
**Figure 15.**
**Union Displaying Overlap of Three Least Cost Corridors for San Joaquin kit fox (Fig. 12, 13, & 14)**

Least-Cost Corridors
- Highly Permeable
- Less Permeable
- Target Zone
- Medium-High Suitable Habitat*
- Moonjian Sightings
- ESRP Sightings
- Spotlight observations
- Incidental observations
- Telemetry locations
- Car Sightings
- CNDDB <= 0.32 km precision
- CNDDB > 0.32 km precision
- Highways
- County Boundaries
- Hydrography

* These analyses were run from Medium to High Suitable Habitat within each Target Zone.



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~~quality habitat on the San Joaquin Valley side of the Temblors. A secondary route of moderate permeability extends from the eastern side of the southern Target Zone over the Temblor Range via a dirt road called Hurricane Road to high quality habitat on the San Joaquin Valley side of the Temblor Range, which joins the most permeable route. Kit fox biologists found the results of the permeability analysis based on habitat suitability ratings biologically untenable, as they consider the Temblor Range a significant barrier to kit fox movement, and no kit foxes have ever been observed crossing the range during telemetry studies.~~

~~*The least cost corridor for kit fox based on permeability ratings between the northern and southern Target Zones ranges in width from approximately 7 to 20 km using the most permeable 2% portion of the landscape (Figure 13). The most permeable route follows the alkali desert scrub habitat out of the Carrizo Plain National Monument in the southern Target Zone and then heads in a northwesterly direction following the Carrizo Plain proper. About 5 km north of State Route 58 it starts to head almost due north and then appears to follow Bitterwater Valley Road east into the Shale Hills and then to the Antelope Valley beyond. Kit fox biologists concur that these results are much more biologically meaningful and reflect the most probable route for kit fox traveling between the northern and southern Target Zones.*~~

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# Appendix A
# Digital Data Sources Used

| Name | Data Type | Scale | Date | Source |
|---|---|---|---|---|
| San Louis Obispo Vegetation | Polygon | 1:100,000 | 1998 | County of San Luis Obispo |
| CALVEG Vegetation | Polygon | 1:24,000 | 1997, 2000, 2002 | U.S. Forest Service |
| San Luis Obispo Crops | Polygon | | 2008 | County of San Luis Obispo |
| Kern Crops | Polygon | | 2005 | County of Kern |
| TIGER Roads | Line | 1:100,000 | 2007 | U.S. Bureau of the Census |
| California Highways | Line | | 2001 | California Department of Transportation |
| National Elevation Dataset | Raster | 10 meter | 1999 | U.S. Geological Survey |
| Conservation Lands (CPAD) | Polygon | | 2008 | GreenInfo Network |
| Counties | Polygon | 1:24,000 | 2004 | California Department of Forestry and Fire Protection |
| Precipitation Normals | Raster | 800 meters | 1971-2000 | PRISM Group, Oregon State University |
| National Hydrography Dataset | Line and Polygon | 1:100,000 | 2007 | U.S. Geological Survey |
| San Luis Obispo Aerial Photos | | | 2007 | San Luis Obispo County |
| Terrain Ruggedness | Raster | 30 meter | 2007 | Endangered Species Recovery Program |
| Vegetation Density | Raster | 30 meter | 2001-2006 | Endangered Species Recovery Program: Generated from Global Land Cover Facility MODIA Normalized Difference Vegetation Index [NDVI] |

## Tule Elk Model Inputs

| Variable | Permeability | Suitability |
|---|---|---|
| **Factor Weights (100%)** | | |
| Vegetation | 50% | 50% |
| Road Density | 50% | 50% |
| **Vegetation** | | |
| Alkali Desert Scrub | 6 | 0.4 |
| Annual Grassland (Avena) | 1 | 0.9 |
| Annual Grassland (Brome) | 4 | 0.6 |
| Barren | 9 | 0.1 |
| Blue Oak-Foothill Pine | 7 | 0.3 |
| Blue Oak Woodland | 6 | 0.4 |
| Chamise-Redshank Chaparral | 9 | 0.1 |
| Closed-Cone Pine-Cypress | 9 | 0.1 |
| Coastal Oak Woodland | 9 | 0.1 |
| Coastal Scrub | 4 | 0.6 |
| Deciduous orchard | 10 | 0 |
| Desert Riparian | 10 | 0 |
| Desert Scrub | 6 | 0.4 |
| Desert Wash | 10 | 0 |
| Dryland Grain Crops | 4 | 0.6 |
| Eucalyptus | 10 | 0 |
| Evergreen orchard | 10 | 0 |
| Freshwater Emergent Wetland | 2 | 0.8 |
| Irrigated Grain Crops | 2 | 0.8 |
| Irrigated Hayfield | 3 | 0.7 |
| Irrigated Row and Field Crops | 2 | 0.8 |
| Juniper | 4 | 0.6 |
| Lacustrine | 6 | 0.4 |
| Mixed Chaparral | 10 | 0 |
| Montane Chaparral | 9 | 0.1 |
| Montane Hardwood | 10 | 0 |
| Montane Hardwood-Conifer | 10 | 0 |
| Orchard-Vineyard | 8 | 0.2 |
| Pasture (Irrigated) | 1 | 0.9 |
| Perennial Grassland | 1 | 0.9 |
| Pinyon-Juniper | 10 | 0 |
| Rice | n/a | n/a |
| Sagebrush | 7 | 0.3 |

| | | |
|---|---|---|
| Sierran Mixed Conifer | 10 | 0 |
| Urban | 10 | 0 |
| Valley Foothill Riparian | 5 | 0.5 |
| Valley Oak Woodland | 6 | 0.4 |
| Vineyard | 8 | 0.2 |
| Wet Meadow | 1 | 0.9 |
| **Road Density** | | |
| 0 – 0.5 km/km$^2$ | 1 | 0.9 |
| 0.5 – 1 km/km$^2$ | 8 | 0.2 |
| 1 – 2 km/km$^2$ | 10 | 0 |
| 2 – 4 km/km$^2$ | 10 | 0 |
| 4 – 6 km/km$^2$ | 10 | 0 |
| 6 – 8 km/km$^2$ | 10 | 0 |
| 8 – 10 km/km$^2$ | 10 | 0 |
| 10 km/km$^2$ and above | 10 | 0 |

**Pronghorn Antelope Model Inputs**

| **Variable** | **Permeability** | **Suitability** |
|---|---|---|
| **Factor Weights (100%)** | | |
| Vegetation | 35% | 35% |
| Road Density | 10% | 10% |
| Topography | 55% | - |
| Slope | - | 55% |
| **Vegetation** | | |
| Alkali Desert Scrub | 3 | 0.7 |
| Annual Grassland (Avena) | 1 | 0.9 |
| Annual Grassland (Brome) | 3 | 0.7 |
| Barren | 9 | 0.1 |
| Blue Oak-Foothill Pine | 7 | 0.3 |
| Blue Oak Woodland | 7 | 0.3 |
| Chamise-Redshank Chaparral | 9 | 0.1 |
| Closed-Cone Pine-Cypress | 9 | 0.1 |
| Coastal Oak Woodland | 9 | 0.1 |
| Coastal Scrub | 6 | 0.4 |
| Deciduous orchard | 10 | 0 |
| Desert Riparian | 10 | 0 |
| Desert Scrub | 3 | 0.7 |
| Desert Wash | 10 | 0 |
| Dryland Grain Crops | 2 | 0.8 |
| Eucalyptus | 10 | 0 |
| Evergreen orchard | 10 | 0 |
| Freshwater Emergent Wetland | 2 | 0.8 |
| Irrigated Grain Crops | 2 | 0.8 |
| Irrigated Hayfield | 1 | 0.9 |

| | | |
|---|---|---|
| Irrigated Row and Field Crops | 2 | 0.8 |
| Juniper | 5 | 0.5 |
| Lacustrine | 6 | 0.4 |
| Mixed Chaparral | 10 | 0 |
| Montane Chaparral | 8 | 0.2 |
| Montane Hardwood | 10 | 0 |
| Montane Hardwood-Conifer | 10 | 0 |
| Orchard-Vineyard | 10 | 0 |
| Pasture (Irrigated) | 1 | 0.9 |
| Perennial Grassland | 1 | 0.9 |
| Pinyon-Juniper | 10 | 0 |
| Rice | n/a | n/a |
| Sagebrush | 3 | 0.7 |
| Sierran Mixed Conifer | 10 | 0 |
| Urban | 8 | 0.2 |
| Valley Foothill Riparian | 6 | 0.4 |
| Valley Oak Woodland | 7 | 0.3 |
| Vineyard | 10 | 0 |
| Wet Meadow | 1 | 0.9 |
| **Road Density** | | |
| 0 – 0.5 km/km$^2$ | 1 | 0.9 |
| 0.5 – 1 km/km$^2$ | 2 | 0.8 |
| 1 – 2 km/km$^2$ | 2 | 0.8 |
| 2 – 4 km/km$^2$ | 6 | 0.4 |
| 4 – 6 km/km$^2$ | 7 | 0.3 |
| 6 – 8 km/km$^2$ | 8 | 0.2 |
| 8 – 10 km/km$^2$ | 9 | 0.1 |
| 10 km/km$^2$ and above | 10 | 0 |
| **Topography** | | |
| Canyon bottoms | 7 | |
| Ridgetops | 10 | |
| Flats | 1 | |
| Slopes | 4 | |
| **Slope** | | |
| 0-5% | | 0.99 |
| 5-20% | | 0.66 |
| >20% | | 0.33 |

**Kit Fox Model Inputs ~~Permeability and Suitability~~**

| **Variable** | **Permeability ~~based on Permeability~~** | **~~Permeability based on Suitability~~** | **Suitability** |
|---|---|---|---|
| **Factor Weights (100%)** | | | |
| Vegetation | 40% | ~~40%~~ | 50% |
| Road Density | 5% | ~~5%~~ | - |

| | | | |
|---|---|---|---|
| Terrain Ruggedness | 50% | ~~50%~~ | 25% |
| Vegetation Density | 5% | ~~5%~~ | 25% |
| **Vegetation** | | | |
| Alkali Desert Scrub | 1 | ~~1~~ | 0.9 |
| Annual Grassland (Avena) | 4 | ~~5~~ | 0.5 |
| Annual Grassland (Brome) | 1 | ~~1~~ | 0.9 |
| Barren | 1 | ~~8~~ | 0.2 |
| Blue Oak-Foothill Pine | 10 | ~~10~~ | 0 |
| Blue Oak Woodland | 10 | ~~10~~ | 0 |
| Chamise-Redshank Chaparral | 10 | ~~10~~ | 0 |
| Closed-Cone Pine-Cypress | 10 | ~~10~~ | 0 |
| Coastal Oak Woodland | 8 | ~~8~~ | 0.2 |
| Coastal Scrub | 10 | ~~10~~ | 0 |
| Deciduous orchard | 3 | ~~9~~ | 0.1 |
| Desert Riparian | 9 | ~~10~~ | 0 |
| Desert Scrub | 1 | ~~1~~ | 0.9 |
| Desert Wash | 1 | ~~1~~ | 0.9 |
| Dryland Grain Crops | 1 | ~~9~~ | 0.1 |
| Eucalyptus | 10 | ~~10~~ | 0 |
| Evergreen orchard | 3 | ~~9~~ | 0.1 |
| Freshwater Emergent Wetland | 10 | ~~10~~ | 0 |
| Irrigated Grain Crops | 1 | ~~10~~ | 0 |
| Irrigated Hayfield | 2 | ~~10~~ | 0 |
| Irrigated Row and Field Crops | 1 | ~~10~~ | 0 |
| Juniper | 3 | ~~4~~ | 0.60 |
| Lacustrine | 10 | ~~10~~ | 0 |
| Mixed Chaparral | 10 | ~~10~~ | 0 |
| Montane Chaparral | 10 | ~~10~~ | 0 |
| Montane Hardwood | 10 | ~~10~~ | 0 |
| Montane Hardwood-Conifer | 10 | ~~10~~ | 0 |
| Orchard-Vineyard | 4 | ~~10~~ | 0 |
| Pasture (Irrigated) | 7 | ~~7~~ | 0.3 |
| Perennial Grassland | 1 | ~~5~~ | 0.5 |
| Pinyon-Juniper | 10 | ~~10~~ | 0 |
| Rice | 10 | ~~10~~ | 0 |
| Sagebrush | 10 | ~~10~~ | 0 |
| Sierran Mixed Conifer | 10 | ~~10~~ | 0 |
| Urban | 1 | ~~9~~ | 0.1 |
| Valley Foothill Riparian | 10 | ~~10~~ | 0 |
| Valley Oak Woodland | 8 | ~~8~~ | 0.2 |
| Vineyard | 4 | ~~10~~ | 0 |
| Wet Meadow | 10 | ~~10~~ | 0 |
| **Road Density** | | | |
| 0 – 0.5 km/km$^2$ | 1 | ~~1~~ | |
| 0.5 – 1 km/km$^2$ | 1 | ~~1~~ | |

| | | | |
|---|---|---|---|
| 1 – 2 km/km$^2$ | 1 | ~~1~~ | |
| 2 – 4 km/km$^2$ | 3 | ~~3~~ | |
| 4 – 6 km/km$^2$ | 3 | ~~3~~ | |
| 6 – 8 km/km$^2$ | 5 | ~~5~~ | |
| 8 – 10 km/km$^2$ | 8 | ~~8~~ | |
| 10 km/km$^2$ and above | 10 | ~~10~~ | |
| **Terrain Ruggedness** | | | |
| 5 | 10 | ~~10~~ | 0.05 |
| 50 | 10 | ~~10~~ | 0.50 |
| 85 | 3 | ~~3~~ | 0.85 |
| 100 | 1 | ~~1~~ | 1.00 |
| **Vegetation Density** | | | |
| 0-9 | 10 | ~~10~~ | 0.00-0.09 |
| 10-19 | 9 | ~~9~~ | 0.10-0.19 |
| 20-29 | 8 | ~~8~~ | 0.20-0.29 |
| 30-39 | 7 | ~~7~~ | 0.30-0.39 |
| 40-49 | 6 | ~~6~~ | 0.40-0.49 |
| 50-59 | 5 | ~~5~~ | 0.50-0.59 |
| 60-69 | 4 | ~~4~~ | 0.60-0.69 |
| 70-79 | 3 | ~~3~~ | 0.70-0.79 |
| 80-89 | 2 | ~~2~~ | 0.80-0.89 |
| 90-99 | 1 | ~~1~~ | 0.90-0.99 |

# Appendix C
# Response to Comments on the April 2009 Draft Report of Baseline Conditions

## Habitat Connectivity Planning for Selected Focal Species in the Carrizo Plain

## I. Introduction and Purpose of Draft Report

This Habitat Connectivity Study has been undertaken to assist California Energy Commission Staff, California Department of Fish and Game (CDFG) and U.S. Fish and Wildlife Service (FWS) in assessing the potential impacts and mitigation options of the proposed Carrizo Energy Solar Farm (CESF), a proposed 177 MW solar thermal power plant sited off of SR-58 in the northern portion of the Carrizo Plain. The study will also be used to assess cumulative impacts of CESF with two proposed photovoltaic power plants in the Carrizo Plain, the Topaz Solar Farm (TSF) and the California Valley Solar Ranch (CVSR). This study does not create a wildlife corridor, but is intended to provide insight into the existing landscape, and how that landscape provides habitat and movement opportunities for wildlife. Task 1 of this study shows baseline, pre-project conditions, Task 2 will model project impacts, and Task 3 will model potential mitigation strategies.

The California Energy Commission ("CEC" or "the Commission") published the Draft Summary Report for Task 1 – Model Baseline Conditions on March 26, 2009, and published a revised report on April 2, 2009. In its Revised Notice of Wildlife Corridor Study Teleconference Workshop issued March 26, 2009, Energy Commission staff requested written comments to the Draft Summary Report by April 8, 2009. Staff and consultant Science & Collaboration for Connected Wildlands ("SC Wildlands") has responded to comments received, as detailed below.

*Note: All references to Figures in the response to comments are in reference to the Task 1 - Draft Summary Report ("Draft Report") released on April 2, 2009.*

## II. Responses to Comments by the Applicant for the Proposed Topaz Solar Farm

### A. General Comments

1. *Please explain why the substantially revised habitat suitability rankings and results were not distributed prior to the teleconference for review by participants?*

The teleconference was held April 2, 2009. The Task 1 – Model Baseline Conditions Draft Summary Report was originally posted to the CEC's website and distributed by

email to all working group participants on March 26, 2009. The report was subsequently revised and distributed at the earliest opportunity on April 2, 2009. The habitat suitability rankings were not revised, but supplemented. The revised report added Figure 13; a new column of rankings for kit fox based on permeability in Appendix B; and additional text, which was highlighted in italics.

2. *When can we expect to review the supporting documentation justifying the revised rankings?*

As stated above, rankings based on habitat permeability for kit fox were added and no information was changed. The text in italics explains how and why the new permeability rankings and maps were produced.

Extensive research regarding habitat suitability and potential kit fox corridors in the region by Dr. Brian Cypher of the Endangered Species Recovery Program, California State University, Stanislaus supports adding these supplemental rankings (Cypher, B. L., S. E. Phillips, and P. A. Kelly, 2007). SC Wildlands also directly consulted with Dr. Cypher regarding specific issues associated with this project.

3. *How does SC Wildlands propose to preserve the credibility of the model when the inputs are created with the desired result already in mind?*

That is entirely inaccurate. No aspect of SC Wildland's work has been, is or will be biased toward achieving a "desired result." Rather, new, valid, and pertinent information was added. SC Wildlands determined that the results shown in Figure 12 are biologically untenable. When a model's predictions fail to align with known results in the field as well an alternative model would, the first model is appropriately rejected, refined, or replaced.

4. *SC Wildlands and the agencies chose to use site permeability as the key parameter in place of the habitat suitability parameter preferred by kit fox experts. Please explain the rationale behind this change.*

SC Wildlands ran the permeability analysis for kit fox using both habitat suitability and permeability rankings to create the movement cost raster. Least-cost movement modeling has usually relied on habitat suitability only because, for most species, biologists have a more complete understanding of how animals select habitats than how they move through them (Beier et al. 2006, 2008). However, Dr. Cypher and his colleagues have specific experience and observations concerning the characteristics of kit fox live-in habitat (areas used for denning and foraging) versus move-through habitat (areas that foxes may travel through but do not use for denning and foraging). Based on this knowledge, Dr. Cypher originally provided rankings based on movements, because he believed that he could confidently rank permeability for this species and that permeability modeling would be more scientifically justifiable and accurate for this study. SC Wildlands advisors Dr. Wayne Spencer, Dr. Paul Beier, and Dr. Esther Rubin agreed that this approach is sound. Therefore, after first running the model using habitat

suitability rankings (for consistency with the Tule elk and pronghorn models), SC Wildlands also ran the kit fox model using permeability rankings. Upon reviewing the results, Dr. Cypher, California Department of Fish and Game biologists, and SC Wildlands advisors concurred that the model based on permeability rankings was more scientifically accurate than the one based on habitat suitability. It was therefore added to the report in addition to the suitability version.

5. *Does the CEC intend to conduct all discussion sessions of the SC Wildlands Habitat Connectivity without maintaining a transcript or other form of publicly-available record of the event?*

The CEC routinely records and prepares transcripts for hearings, but not for workshops. Records of the event are evident from the workshop notice, workshop slides, other written materials presented during the workshop, and from our response to written comments provided during each stage of the study. The phone conferences conducted by the Wildlife Corridor Working Group are also open to public participation.

6. *Why was Dr. Cypher not a participant in the teleconference?*

Dr. Cypher is not a formal participant in the Working Group. He has generously volunteered his independent scientific expertise to ensure our analyses of the kit fox are biologically meaningful, but his schedule does not allow him time to participate in Working Group teleconferences.

7. *Please clarify which experts provided the habitat suitability rankings for the Tule elk and pronghorn antelope models.*

SC Wildlands consulted with California Department of Fish and Game biologists Dave Hacker and Bob Stafford. They have extensive knowledge of those species, as well as experience monitoring, tracking, and managing tule elk and pronghorn herds in the Carrizo Plains area and statewide.

8. *The SC Wildlands model has many deficiencies. In spite of these deficiencies, it seems to be viewed by some as the "answer" to assessing project impacts and applying mitigation requirements.*

The comment confuses scientific uncertainty with deficiency. Every model has some uncertainties, but good models capture enough reality to serve as useful tools for formalizing the understanding of systems, and for making useful predictions or comparing alternative scenarios. Experts consider the kit fox model based on permeability ratings to be a reasonable depiction of those areas most likely to be used by the foxes. It is not meant to provide an "answer"; rather it provides a tool for quantifying relative comparisons between alternative scenarios (e.g., different project footprints or mitigation options).

The agencies and SC Wildlands are making every effort to ensure that the data layers are as accurate as possible. In our collective experience (including that of our science advisors), inaccuracies in vegetation mapping of the sort and amount likely here will have minor effects on overall patterns of modeled habitat permeability across a broad landscape.

It is important to keep in mind that this is a regional analysis, and that these model results provide a regional perspective not accounted for by the descriptions and maps of individual project sites provided by the project proponents. Particularly regarding impacts to wildlife movement, the SC Wildlands modeling process allows for assessment of direct, project-specific impacts as well as potential cumulative impacts by the three solar projects proposed for the Carrizo Plain.

9. *The specific definitions of corridors must also be reconciled to the proposed use in a specific setting. Corridor Designer defines corridors as "a swath of land that is best expected to serve movement needs of an individual species after the remaining matrix has been converted to other uses." In the Carrizo Plain, there is no plan under consideration to convert remaining land areas to other uses..*

There are indeed plans to convert remaining land. The three proposed solar projects, CESF, TSF, and CVSR collectively would convert approximately 9,420 acres of land to other uses. The projects would cause direct habitat loss and fragmentation of currently occupied habitat. The corridors help preserve the species by connecting habitats. Least-cost corridor models convey the impacts on movement by focal species, as well as the relative benefits of alternative project designs and mitigation plans.

10. *Will the model's inherent uncertainties be taken into consideration in the agencies' use of the model for evaluating project impacts and mitigations? How will SC Wildlands qualify the results of the corridor study in order to take any deficiencies into consideration?*

Analysis of potential impacts to wildlife movement is being conducted using the best available science and information. Any uncertainties in the results of SC Wildland's analysis will be taken into account in how FWS, CDFG and CEC utilize the corridor study results.

SC Wildlands sees no need to qualify the results of the corridor study. However, to aid replication of results, SC Wildlands continues to provide the data layers used in the analyses, the formula for each analysis, and the rankings and weightings applied to each analysis..

### B. Additional Responses to Comments by Applicant for Topaz Solar Farm on the March 17, 2009 Responses to Input Data Questions

11. *Why [should] a connectivity study... be done when the... land around the project sites is very large and usable by the target species?*

Not all undeveloped lands are equally permeable to the focal species. The project areas comprise a sizeable portion of the Carrizo Plain's gentle slopes, with steeper hills on either side that support different vegetation than the Plain supports. The connectivity models quantify the relative permeability of sites across the landscape based on multiple factors that may affect wildlife movement (e.g., vegetation type, slope, roads).

12. *There is no isolation of usable habitat; the entire matrix surrounding the project is usable habitat either for movement or residency.*

On the contrary, the three proposed solar projects would cover the majority of the width of the valley, potentially reducing movement between habitats north and south of the proposed projects. It is the objective of connectivity modeling to determine if and how connectivity may be impacted.

13. *Reviewers said that the populations studied appear to primarily move within home ranges, and that movement outside of the Carrizo Plain appears to be infrequent.*

Genetic connectivity doesn't require frequent movements.

14. *There still has not been a thoughtful justification presented to support conducting a corridor modeling exercise that assumes the concept of a discrete corridor across the Carrizo Plain with two fixed end points is valid. Movement can occur across large areas, and would not in any case be confined to a specific path.*

SC Wildlands did not assume a discrete corridor with two fixed endpoints. Wildlife moves relatively freely on the Carrizo Plain. Corridor modeling addresses to what degree this movement may be compromised by proposed projects, and what may be the relative effects of alternative configurations or mitigation options. In the case of the three currently proposed solar projects, movements could potentially be confined to a specific path between the proposed projects. The landscape permeability analysis is being used in conjunction with habitat suitability, patch size, and patch configuration analyses to determine the best potential movement routes.

15. *It is more likely that exchange between populations occurs in stages of dispersal movements, rather than an individual animal trotting from the Carrizo Plain National Monument to north of Highway 46.*

Known movement distances for all three focal species (50 km for pronghorn antelope, 40 km for tule elk, and 96 km for kit fox) suggest that an individual could move between the Carrizo Plain National Monument to habitats north of Highway 46. Nevertheless, there is no assumption in the modeling that movements need to be made by a single individual traversing the study area. The concern is connectivity for individual animals moving within home ranges, dispersing to new home ranges, or passing their genes along over multiple generations as a corridor-resident species.

16. *Will SC Wildlands respond to our comments above on their March 17 Responses to Comments?*

Yes, see above.

### C. Reponses to Comments on Kit Fox Corridor Results

The developers of the TSF provided kit fox corridor maps they developed using the Corridor Designer program (available at corridordesign.org) with data supplied by SC Wildlands. The maps showed kit fox crossing the Temblor range and travelling along the eastern side of the Temblors through western Kern County, and are referenced in the following comment.

17. *As an example of how different outcomes can be with small differences in data, the outcome shown in Figure 1 used the same ranking information, weighting, and vegetation layers as the SC Wildlands Figure 13. Slope rather than ruggedness was used, and the Normalized Difference Vegetation Index (NDVI) data was for a shorter period than five years. The model found a movement corridor for kit fox over the Temblor Range that is through widely spaced scrub and grassland habitat with an elevation change of about 900 feet from Elkhorn Road to the dividing ridge. The slope to the east is gradual sloping grassland. The distance across "rugged" land is about 4.5 miles, a distance a kit fox could travel in under two hours. data, the outcome shown in Figure 1 used the same ranking information, weighting, and vegetation layers as the SC Wildlands Figure 13. Slope rather than ruggedness was used, and the Normalized Difference Vegetation Index (NDVI) data was for a shorter period than five years. The model found a movement corridor for kit fox over the Temblor Range that is through widely spaced scrub and grassland habitat with an elevation change of about 900 feet from Elkhorn Road to the dividing ridge. The slope to the east is gradual sloping grassland. The distance across "rugged" land is about 4.5 miles, a distance a kit fox could travel in under two hours.*

The map comparisons presented in the comment are invalid because it appears they used different targeted end points, neither of which appears to have been selected with biological justification. This change can have a large impact on modeled least-cost corridors. In keeping with published recommendations (Beier et al. 2008), SC Wildlands did not fix "end points" but rather used medium to high suitable habitat areas within broad target "zones" as anchors for least-cost corridor modeling.

18. *We requested the data files utilized and a thorough discussion of methods. Data files were finally received at 9 p.m. the night before these comments were due.*

SC Wildlands never received a request from the TSF applicant as directed at the April 2 teleconference, thus it was never provided to the TSF applicant.

Additionally, in the Draft Report, SC Wildlands provided a thorough discussion of methods, including the data layers used in Appendix A and the specific rankings and

weightings for each analysis in Appendix B. SC Wildands continues to offer the data layers directly on request, such that complete replication of each model is possible.

19. [*Topaz ran*] *a second model... using all of the data layers provided by SC Wildlands, including the ESRP data for NDVI and ruggedness. The model was run using Corridor Designer tools, and the result (Figure 2) was dramatically different than the SC Wildlands Outcome. Because specific methods still have not been provided, it is unclear why the outcomes are so different. Please advise as to what specific methods are being used by SC Wildlands in the modeling process, so that we can again attempt to replicate the results presented on the April 2 teleconference.*

SC Wildlands is not using a model called "Corridor Design". Corridor Design tools available at Corridordesign.org are based on the methods developed by SC Wildlands, but they are not identical. The results may differ because the second model run in the TSF comments (Figure 2) used different target areas than either Figure 12 or Figure 13 of the Draft Report; or perhaps because the model used habitat suitability rankings instead of permeability rankings.

Here are the specific steps SC Wildlands used for kit fox:

1. Model habitat suitability (see 5.1.2 Modeling Habitat Suitability; 5.1.4 Species-specific model input data and conceptual basis for model development; and Appendix B).
    - Data acquired from Scott Phillips (NDVI and ruggedness)
    - Converted both raster datasets to float (geoprocessing tool: Float)
    - Divided values by 100 (geoprocessing tool: Divide)
    - Calculate suitability scores for the vegetation feature class
    - Convert vegetation suitability to raster (geoprocessing tool: Polygon to Raster)
    - Run a weighted sum model (Veg * 0.5) + (TRI * 0.25) + (NDVI * 0.25) (this can be done using model builder, scripting, or raster calculator)

2. Use the medium to high suitability output to delineate patches and cores (see 5.1.4 for definitions of size classes for what constitutes cores and patches for each species).
    - Create a Boolean raster with only Medium and High scores (geoprocessing tool: Reclassify)
    - Create a Boolean raster with only High scores, for southern target zone (geoprocessing tool: Reclassify)
    - Convert the Boolean raster datasets to Polygon (geoprocessing tool: Raster to Polygon)
    - Calculate areas in hectares for each record
    - Assign Patch and Core classification based on size classes

3. Select target zones
    - Create polygons for target areas

4. Within target zones, use medium to high suitable habitat for each species as target endpoints for the analysis for that species. For kit fox, only high suitability contiguous core kit fox habitat was used in the southern Target Zone.
    - Clip the Patch/Core size polygons with the target zones (geoprocessing tool: Clip)
    - Remove all non-contiguous highly suitable core areas from the southern target zone for kit fox.
    - Convert to raster (geoprocessing tool: Raster to Polygon)

5. Use weightings and rankings in Appendix B to develop the cost surface for each species (see 5.1.3 Modeling Landscape Permeability; and Appendix B).
    - Reclass the permeability scores to each of the input raster datasets (NDVI, ruggedness, road density) according to the values in Appendix B (geoprocessing tool: Reclassify)
    - Calculate the Permeability scores for vegetation as listed in Appendix B
    - Convert vegetation permeability to raster (geoprocessing tool: Polygon to Raster)
    - Create the weighted cost raster (Veg * 0.40) + (TRI * 0.50) + (NDVI *0.05) + (Rd Dens *0.05) (this can be done using model builder, scripting, or raster calculator)

6. Run cost weighted distance from medium to high suitable habitat within both target zones.
    - Create cost weighted distance 2 times one from each target (geoprocessing tool: Cost Weighted Distance)

7. Run least cost corridor
    - Create the corridor using the cost weighted distance output (geoprocessing tool: corridor)
    - Generate slices of the corridor (geoprocessing tools: Slice, Extract, Times, Reclassify)

8. Evaluate different slices (e.g., 1%, 2%, 3%, 4%, 5%).

*20. Specifically, the modelers should investigate if there are areas across the Temblors that kit fox can use, and if the data layers are correct.*

Kit fox can easily be confused with coyote pups or gray foxes. However, extensive telemetry work in the Carrizo Plain and Elk Hills did not record kit fox attempts to go into or over the Temblor Range (B. Cypher, personal communication). In the Carrizo Plain, Linda Spiegel, CEC, telemetered 60 to 70 kit fox between 1988 and 1992 with no attempts to cross over the Temblor Range. In the Elk Hills, Dr. Brian Cypher telemetered over 1,000 kit fox between 1980 and 1997, and found no attempts to go over the Temblor Range. Some kit fox in the Elk Hills used fairly steep slopes when the population was

high and individuals were pushed into marginal habitats, but they dropped out of the high slopes due to predation. (B. Cypher, personal communication).

California Department of Fish and Game recently did a flyover of the study area to ground truth the vegetation layer. As needed, SC Wildlands adjusted the vegetation layer accordingly, then reran the analyses for baseline conditions.

21. *The reason the suitability model placed a corridor through the Temblors 1.8 miles northwest of Carneros Canyon is because the vegetation layer is incorrect in a relatively small area. It shows a continuous grassland across the ridge and down into the valley. In actuality, a juniper/blue oak woodland and thick scrub occur on the east side. There are other locations that do have grasslands across the top of the Temblors and down both sides, including south of Highway 58 and the Temblor range for miles to the north beginning three miles north of the SC Wildlands model crossing site. It is critical to realize that small errors in the data layers can produce large differences in the model outcome.*

The landscape permeability model placed a corridor over the Temblor Range following Carneros Canyon because, based on suitability scores, the cumulative cost of travel between target zones costs less, even though the model crossed high cost pixels to get over the Temblor Range. If one compares the most permeable (darkest green) route in Figure 12 with the Vegetation map in Figure 1, the most permeable route does not follow the continuous grassland across the ridge and down into the valley – it crosses through woodland and scrub.

As stated above, California Department of Fish and Game recently did a flyover of the study area to ground truth the vegetation layer, and SC Wildlands adjusted the vegetation layer accordingly.

22. *The validity of the model results provided in the SC Wildlands draft report posted March 26, 2009 was apparently discounted because: 1) there is not tracking data for kit fox movement across the Temblors; and 2) there is a large elevation drop across this path. However, there is also no tracking data for kit fox movement north of the Carrizo Plain into the Bitterwater Valley area. The same argument regarding lack of tracking data would apply to movements north from the Carrizo Plain as was applied to the model results showing movement across the Temblors. Regarding elevation, just an increase in elevation would not be a barrier to movement, because, as is explained in the SC Wildlands response letter dated March 17, 2009, response 26, the "species expert does not consider elevation to be a significant factor in kit fox movement and gave elevation no weighting in the kit fox model." Ruggedness was accounted for in the model, and a path across the Temblors was delineated. Please respond with an explanation for these apparent inconsistencies...*

The model results for kit fox based on habitat suitability were discounted not because of a lack of tracking data, but because they conflicted with known patterns of kit fox

movement. Elevation and ruggedness are not synonymous. Elevation was not used as a model parameter, ruggedness was.

23. *Please confirm whether kit fox sighting data was erroneously used as a justification for the modification of the model presented in the April 2 teleconference.*

Kit fox sighting data were not erroneously used and the model was not modified. As mentioned above, an additional model run was performed based on previous research (B. Cypher et al. 2007), which also used rankings based on permeability rather than suitability for the landscape permeability model. Species location data were overlaid onto the results of the models to aid with interpretation of the results. Sighting data were not used to illustrate or validate kit fox movement patterns, or as an input to the permeability model. The sighting data is derived from numerous sources, and is not based on a standardized, systematic, or statistically valid sampling protocol, and thus has descriptive but not predictive value.

24. *Please clarify that corrections to the vegetation layer will encompass the entire study area.*

All corrections to the vegetation data layer provided by commenters and from CDFG's flyover have been incorporated into the model as appropriate. Any additional inaccuracies in the vegetation data layer of the type and degree that could be remaining would have minor effects on the regional model outputs.

25. *The solar project footprints do not become important inputs to the model until Task 2, and the baseline conditions must be established without bias.*

The three proposed solar project footprints have not been included in any analyses or on any maps to date. The baseline conditions are being established in a transparent, objective, and scientific manner.

26. *Please describe the plan for addressing these inaccuracies in the model's input data.*

The rankings for agricultural types used in the model results depicted in Figure 13 were based on expert opinion of kit fox movement through these vegetation types. With respect to the seasonal component, the following excerpt is taken from comments received on Task 1 from California Department Fish and Game:

"In addition, the timing of disking and sowing (fall) and harvest (spring or summer) even in continuously cultivated dryland crop areas, is such that disking does not generally occur during the pup rearing season. This allows any dens that are established after fall sowing to remain undisturbed through the entire period of rearing and dispersal." Thus, while dryland grain crops may be a barrier to movement for portions of the year, it is not an absolute barrier year round... individuals could move through these areas."

### D. Reponses to Comments Regarding Inputs to Task 2

27. *Please address in detail how the Topaz project will be modeled with respect to permeability in Task 2.*

The project design features described (e.g., passageways through the perimeter fence, site taken out of active agriculture) of the TSF project will not be incorporated into the models for Task 2. They will be addressed in Task 3, which focuses on potential mitigation measures.

## III Response to Comments by the California Department of Fish and Game

28. *We are concerned with the defensibility of the dryland crop habitat suitability rating for kit fox. We encourage further discussion with the species expert to reconsider the rating. The rating should consider habitat suitability implications of inherent differences between dryland grain crops and irrigated row crops, as well as the location of the Carrizo Plain dryland crops relative to natural lands with a kit fox source population.*

SC Wildlands worked with the species expert to address the dryland crop rating for kit fox habitat suitability, with the most suitable habitat receiving a score of 1, and unsuitable habitat receiving a 0. Dryland grain crops were given a score of 0.1 in the Draft Report, while irrigated row and field crops were given a score of 0 in the draft report. Warrick et al. (2007) documented use of agricultural lands for foraging up to one kilometer from adjacent suitable natural habitats. Dr. Brian Cypher (personal communication) said these areas are used for foraging at certain times of the year. He therefore suggested we refine the model to use a suitability score of 0.4 for dryland grain crops and 0.3 for irrigated row and field crops within one kilometer of suitable contiguous natural habitat (suitability score >.50) and a score of 0.1 for dryland grain crops and 0 for irrigated row and field crops more than one km from natural habitat. Kit fox may also den in agricultural lands if fields are left fallow for a year or two.

29. *We encourage reconsidering the inputs which result in potential kit fox linkages over the Temblors. In light of these results, we would like to discuss further the use of the weighted geometric mean for kit fox.*

SC Wildlands agrees that the results of Figure 12 in the draft report are untenable, and that the most permeable path shown in Figure 13 of the draft report is highly defensible. Our science advisors agree that geometric mean may be more useful than arithmetic mean for permeability analyses. SC Wildlands ran the analyses for baseline conditions again based on vegetation updates, and used a weighted geometric mean for the permeability analyses for all three focal species.

30. *Since the conservation goals for this species include maintaining and enhancing the Carrizo Plain core areas connectivity with suitable habitat in both the San*

*Joaquin Valley and the Salinas River watershed, it may be worthwhile to consider* ***a northern target zone which captures these other significant cores and patches.***

SC Wildlands considered multiple target zones (Western Kern County in the vicinity of Antelope Plain and Lokern, Palo Prieto-Cholame Valley, and Salinas River Watershed) to detect the likely linkages from the north end of the Carrizo Plain core area, and more accurately reflect the goals outlined in the recovery plan (USFWS 1998).

*Section 4.2 Tule Elk*

31. *Habitat Associations, 2nd paragraph, last line. The use of irrigated ag fields has been observed in the Salinas Valley and other areas in the northern part of the range, but not in the Carrizo Plains area. This sentence should reflect the actual location of thse observations***.**

    *Habitat Associations, 4th paragraph, last line. The report incorrectly cites the GPS collar study regarding elk movements after translocations. These observations were actually derived from monitoring elk with standard telemetry after a capture and release.*

SC Wildlands appreciates the comments, and will incorporate the suggested changes in the revised report.

32. *Section 4.3 San Joaquin kit fox – Distribution and Status. The text should be changed to reflect that kit foxes inhabit the foothills and arid valleys of the western Sierra Nevada and Tehachapi Mountain foothills below a certain elevation (3,000 ft at most).*

SC Wildlands appreciates the comments, and will incorporate the suggested changes in the revised report.

33. *Section 5.1.1. Compilation and refinement of digital data layers. There is a good discussion about using the PRISM precipitation data for modeling kit fox habitat (Bromus spp. vs. Avena spp.) Why wasn't this used (or was it?) for the other species (elk in particular).*

The PRISM precipitation data was used to delineate *Avena* versus *Bromus* dominated grasslands in the vegetation layer, which was an input to all of the analyses for all focal species. The NDVI data was only used for the kit fox analyses.

34. *There should be a citation to support the idea that dispersal should equal twice the longest documented dispersal distance.*

SC Wildlands included this citation: "Because the majority of methods used to document dispersal distance underestimate the true value (LaHaye et al. 2001), we assumed each species could disperse twice as far as the longest documented dispersal distance." This assumption is conservative in the sense that it retains habitat patches as potentially

important to dispersal for a species even if they may appear to be isolated based on known dispersal distances. SC Wildlands also cites Beier et al. (2006) for rationale supporting this assumption.

35. *Section 5.1.4.1 Pronghorn Antelope Habitat Patches and Cores. It should be stated more clearly that herd range size was determined from flight data gathered between 1999 and 2008.*

The suggested changes will be made.

36. *Section 6.1.1.1. Change highly roaded areas of the Carrizo Plain to "…California Valley". Change wording from "habitat for pronghorn becomes less suitable southwest of the LaPanza Range" to "habitat for pronghorn becomes unsuitable".*

The suggested changes will be made.

37. *Section 6.1.1.2 Tule Elk. Remove "habitats in the immediate vicinity of roads are also unsuitable". The data do not show this.*

The suggested changes will be made.

38. *Figure 12 and 13. These figures should be renamed to reflect the percentages (1% vs. 2%) used in the least cost corridor analyses.*

SC Wildlands will include the percentage used on the landscape permeability figures for all species.

## IV Response to Comments from Roger Gambs, Professor of Biology (emeritus), Friends of the Carrizo Plain

### A. San Joaquin Kit Fox Connectivity

39. *[Expressing ] concern that study area excludes kit fox habitat and populations in Monterey and San Luis Obispo Counties; specifically kit fox interchange between the Carrizo Plain core area, the Salinas –Pajaro region and the San Joaquin Valley.*

In response to this and a similar comment from the California Department of Fish and Game regarding interchange between the Carrizo Plain core area, the San Joaquin Valley and the Salinas River Watershed, SC Wildlands ran additional models for baseline conditions with multiple northern target zones that capture these other significant cores and patches.

### B. GIS Layers for San Joaquin Kit Fox

40. *Expressing concern that there are no habitat layers reflecting: (a) the presence and density of potential predatory and competing species, (b) the presence and density of potential prey species, and (c) the presence, frequency, timing and intensity of various disturbances that could influence residence and movement of kit fox in patches and through potential connecting wildlife linkages (e.g. agricultural, fire prevention, dust control, sound, light, electromagnetic fields, cleaning, pest and weed control and other activities).*

Kit fox was selected as an umbrella species, such that identifying habitat and connectivity among habitat patches and core areas for kit fox should capture potential prey species habitat. SC Wildlands has not found comprehensive, accurate data layers depicting the presence or density of potential [predatory] or competitor species for the three focal species. The vegetation layer captures agricultural and urban land cover types, which indicate the presence and intensity of various human disturbances.

### *C.* "Live in" Corridors

41. *Corridors that possess "live in" qualities would promote actual biological connectivity more than corridors possessing only "move through" qualities.*

The goal is to maintain connections that provide both live-in and move-through habitat. The combination of habitat suitability maps and permeability maps will be used to inform the impact and mitigation analyses to help reach this goal.

### D. Metapopulation Dynamics Analysis

42. *When applied to wildlife populations, GIS analytical methods are often combined with or compared to results from Metapopulation Dynamics Analyses with the aim of evaluating Genetic Effective Size of focal metapopulations, developing Extinction Models for local populations, analyzing Metapopulation Transfer parameters, etc. Although these latter levels of analysis usually require additional computational tools and extensive life history data from the focal metapopulation, I believe they are extremely valuable because they focus more directly on the long-term viability and persistence of the target species.*

Agreed; However, Metapopulation Dynamics Analyses and Extinction Models are beyond the scope of this project, and although they would be very informative for conservation planning, they are not necessary for evaluating project impacts and mitigation actions for environmental documentation and permitting processes.

### E. Kit Fox Patches

43. *The April 2, 2009, definition of a patch still seems vague because it does not include a specific temporal duration for the habitat to support at least one male and one female. Furthermore, a patch for a Kit Fox breeding unit would require a*

*larger prey base and presumably a larger parcel of contiguous habitat than that needed to support one male and one female.*

The specific length of time for habitat patches is largely irrelevant for modeling purposes, but can be thought of as the short term, not accounting for population changes. Potential habitat patches and core areas for kit fox were identified as contiguous areas of medium to high suitable habitat of a certain size. Minimum patch size was estimated as 486 ha (hectares), based on research that this area can support one kit fox family in optimal habitat (Cypher et al. 2007). This estimate is also based on empirical data from home ranges that likely included breeding individuals, which represent a family rather than one male and one female.

**F. Core Areas** –

44. *The absence of a "protected" core area North of the projects is problematic from a long-term perspective because, like a patch, the period of time that the 50 individuals would be sustained in a core area is not specified.*

Agreed; The period of time is not relevant to defining this spatial parameter for modeling purposes, but it can be thought of as "over the near term" (i.e., not accounting for long term dynamics, vegetation changes, etc.).

**G. Focal Species**

45. *Unfortunately, only three focal mammal species with good movement capabilities were selected for baseline connectivity evaluation. A more comprehensive connectivity plan would include other terrestrial species with more restricted movement capabilities such as Giant Kangaroo rats (identified as a keystone species in the SJVMRP) and a number of DFG "Special Animal" species likely to occur in the area (e.g. Western Spadefoot Toad, Silvery Legless Lizard, San Joaquin Whipsnake, and other sensitive species including kangaroo rat, pocket mouse, and grasshopper mouse). These latter species are important to the kit fox because they form a significant part its prey base.*

Agreed; However, the scope of this project is restricted to planning for three focal species, with the kit fox acting as the umbrella species for associated burrowing species.

**H. Buffer Areas**

46. *Buffer areas around corridors are obviously important and buffer width is mentioned in Task 3; however, it is not clear how buffer widths and shapes would be determined.*

Agreed; The goal of determining buffer width is to maintain sufficient dispersal opportunities to prevent local extinctions and maintain genetic diversity.

## V Responses to Comments by the Canyons and Streams Alliance

47. *It is much more reasonable to assume that for kit fox living nearly adjacent to each other in the Valley and Carrizo Plain, they would disperse between the two areas much more directly where Highway 58 quickly crosses the Temblors.*

Brian Cypher (personal communication) said that the chances are very low that kit fox would cross the Temblors around Highway 58. Any significant interchange between the Carrizo Plain and the San Joaquin Valley would likely be along Routes 46 or 166.

However, in response to this and similar comments regarding interchange between the Carrizo Plain core area, the San Joaquin Valley, and the Salinas River Watershed. SC Wildlands ran additional models for baseline conditions with multiple northern target zones that capture these other significant cores and patches.

48. *In reference to highways as barriers to Tule elk. On two occasions about five years ago, I saw tule elk just south of the south fence line along highway 58 in the eastern Carrizo Plain. The first occasion was daytime when I saw a cow and large calf about 50 yards south of highway 58 and its south fence lines. At the same time, I saw about 6 elk about 100 yards north of highway 58 and its north fence lines in the same general area. The second occasion was at night during a full moon. I was driving with lights off using moonlight to help spot bull elk I could hear calling. I spotted two bellowing elk on the north and one south of the highway. Based on my observations on these two occasions, I conclude that for at least this strength of highway 58 in the eastern Carrizo Plain, neither the highway nor its fence lines are barriers to movement of elk.*

SC Wildlands considers highways as strong filters to tule elk movement but not complete barriers to movement. During the April 2 teleconference, a California Department of Fish and Game biologist noted that long distance movements such as highway crossings have taken place, particularly after reintroduction.

It is encouraging to hear of recorded occurrences of tule elk in the eastern Carrizo Plain so close to Highway 58, as this is the area identified as the best potential movement route for this species between the two target zones described above. We encourage you to submit these observations to the California Natural Diversity Database at your earliest convenience.

49. *Irrigated farmland in Carrizo Plain is not good wildlife habitat.*

The areas along Highway 58 where you observed Pronghorn antelope were delineated as dryland grain crops in the vegetation layer. Figure 1 of the Task 1 Baseline Conditions Review Draft Report only shows irrigated row and field crops in the northeastern portion of the study area in the Antelope Plain and Central Valley, in the southwestern portion of the study area in the Nipomo Valley, and some relatively small areas in between Highways 41 and 46. However, SC Wildlands, Energy Commission staff, and the

California Department of Fish and Game found that irrigated row and field crops can provide wildlife habitat, depending on their distance from natural habitat. Habitat suitability analyses for tule elk and pronghorn antelope incorporated irrigated agricultural lands within 0.8 km (0.5 mi) of suitable natural habitat areas (suitability ≥ 0.5), rated as shown in Appendix B. Irrigated agriculture farther than 0.8 km from suitable natural habitat was rated as unsuitable (rating = 0), based on observations that pronghorn only use such fields in proximity to suitable natural habitats (Cole and Wilkins, 1958; R. Stafford, CDFG, personal communication).

## VI Response to Comments by URS, Biological Consultant to Applicant

50. *The April 2, 2009 Modified Report omits significant, relevant kit fox sighting data,particularly in the areas associated with SR 41, SR 46, and SR 58 where these highways pass over the Temblor Range. The complete sighting data indicate the location of likely crossing areas over the Temblor Range (see attached URS figure). While the results of the habitat suitability modeling are consistent with these data, the permeability modeling is inconsistent with these data. Accordingly, consideration of the complete data setindicates the habitat suitability model is more accurate than the permeability modeling.*

SC Wildlands ran the analyses for baseline conditions again and used the most up to date sighting data. However, the attached URS figure does not include "complete sighting data," it includes only data from the California Natural Diversity Database.

As explained above under the TSF comments section, SC Wildlands disagrees with your interpretation that the habitat suitability model is more accurate than the permeability model. In fact, the two northern areas identified in the URS figure as areas where kit fox likely cross over the Temblors correspond well with the most permeable routes identified in Figure 13 of the draft report for Task 1.

51. *The Report ignores evidence that the Carrizo National Monument is strongly connected to the Kern County population east of the Temblors. There is nearly a continuous scatter of kit fox sightings between the monument and populations in the Kern*

*County portion of the western Central Valley (see attached URS figure).*

*As stat*ed above, the landscape permeability analyses for the three focal species were conducted to identify the best potential movement routes for these species between northern and southern target zones, not connectivity between the Carrizo Plain and the San Joaquin Valley. This conforms to the scope of the proposed project.

However, in response to this and similar comments regarding interchange between the Carrizo Plain core area, the San Joaquin Valley and the Salinas River Watershed, SC Wildlands ran additional models for baseline conditions with multiple northern target zones that capture these other significant cores and patches.

52. *The Report's conclusion is contrary to the Recovery Plan's determinations that there are two routes connecting the northern core area to the Central Valley populations (see URS figure showing Recovery Plan recommended natural lands to be conserved and linkage area in the Central Valley).*

*The Recovery Plan for Upland Species of the San Joaquin Valley (USFWS, 1998) does n*ot describe routes connecting the Carrizo Plain core population with the Western Kern "Central Valley" populations. The areas shown as proposed linkages on the URS map correspond to the proposed areas where connectivity and linkages should be promoted in the Recovery Plan. These proposed, conceptual, multi-species linkage planning areas cross the floor of the San Joaquin Valley, and are irrelevant to the current assessment of connectivity for kit foxes on the Carrizo Plain.

53. *The Report assumes that the absence of telemetered fox documentation equates to certainty that the fox does not move over the Temblor Range. In fact, the absence of such data is likely a false negative resulting from the fact that a positive result would require a much larger sample of dispersing juvenile foxes than has occurred (a Type II error situation).*

The report did not assume that the absence of telemetered fox documentation equates to certainty that the fox does not move over the Temblor Range. Based on data from more than 1,100 kit foxes on either side of the Temblor Range, Dr. Cypher (personal communication) believes that "on occasion" he could conceive of kit foxes crossing the Temblor Range, but that any significant interchange between the Carrizo Plain and the San Joaquin Valley would likely be along Routes 46 or 166.

54. *The Report's permeability rankings of agricultural lands appear to be too high and do not reflect seasonal variability. Summer and early Fall seasons would be less permeable than late Fall through early Spring, due to higher vegetation height during the period of juvenile dispersal. Post harvest conditions would make crop lands less suitable for kit fox.*

As stated above, the rankings for agricultural types used in the model results depicted in Figure 13 were based on expert opinion of kit fox movement through these vegetation types. With respect to the seasonal component, the following excerpt is taken from comments received on Task 1 from CDFG:

"In addition, the timing of disking and sowing (fall) and harvest (spring or summer) even in continuously cultivated dryland crop areas, is such that disking does not generally occur during the pup rearing season. This allows any dens that are established after fall sowing to remain undisturbed through the entire period of rearing and dispersal." Thus, while dryland grain crops bar movement for portions of the year, the crops do not form an absolute barrier year round.

55. *In contrast to the permeability model, the habitat suitability analysis (Figure 12 in the SC Wildlands [Draft] Report) supports the assertion by Ausra project biologists that kit fox habitat quality is poor within and surrounding the CESF Project area. Dr. Cypher, a recognized expert on kit fox, also agreed that the habitat at the CESF site is of poor quality for kit fox and was pleased with the results of the model. The area has been used as dry land farming for many years; one fallow year does not make it a grassland habitat, as it can and will be reestablished as dry land farming at any time. The history of land use on the site is available from the County of San Luis Obispo Land Use Department, the County Agriculture Department, and is described in the Land Use sections of the CESF AFC and CEC PSA. Discussions regarding the need to reassess the vegetation layer for the baseline in the study area during the April 2, 2009 teleconference are unnecessary and excessive. The comment period ended in January, and SC Wildlands should not be expected to repeat the lengthy process that was undertaken to update the vegetation analysis. The vegetation in the vicinity of the CESF site is correctly represented in the SC Wildlands model.*

Figure 8 is actually the habitat suitability model for kit fox. Figure 12 is the landscape permeability model results based on habitat suitability, while Figure 13 is the landscape permeability model results based on landscape permeability rankings.

In response to several comments, SC Wildlands updated the vegetation layer and reconducted the analyses for baseline conditions using this updated layer.

56. *In sum, any differences between the two models (habitat suitability vs. permeability) for kit fox need to be compared for consistency with the full database of fox sightings, not the truncated version shown in the document. The [Draft] Report's dismissal of the habitat suitability model appears to be arbitrary and contrary to the sighting data available as well as the analysis provided in the Recovery Plan, and relies upon faulty assumptions.*

SC Wildlands respectfully disagrees. The preference for analyzing kit fox movements based on landscape permeability rankings rather than habitat suitability is based on years of research on kit fox (Spiegel, et al., 1996; Warrick & Cypher, 1998; Cypher, et al, 2007).. The allegation that kit fox sighting records disprove the model results is incorrect. The sighting records in the CNDDB (and from various other sources) as a whole were not collected in a systematic, controlled, standardized or randomized way, and thus have limited utility for proving (or disproving) a predictive model of kit fox behavior in the landscape. This anecdotal evidence neither bolsters nor subtracts from the results obtained in properly conducted scientific studies, which SC Wildlands based the model on.

Additionally, this comment ascribes precision to the kit fox sighting CNDDB points that may not reflect the data behind the "point". Many sighting points are simply the center of non-distinct polygons that result from imprecise records. The kit fox points on SR-58

are precise (recent roadkills), others are non-specific, and the ones along the top of the Temblors are described as 2/5 mile accuracy and are attributed to 1975.

## VII Responses to Comments of Carrisa Alliance for Responsible Energy

57. *After an initial review of the modeling of the baseline conditions, I am concerned about the accuracy of Figure 1, Vegetation Study in the Area. My concern is particularly focused on the project area of the Ausra and Optisolar projects. The vegetation map in the input data showed much of the area around these projects in a yellow color. This color was identified as Agriculture, Cropland and Dryland Grain Crops. I assumed, as per much of our discussions in this permitting process, the term Agriculture included cattle grazing. However, in the Baseline Conditions Modeling Figure 1, the area that was previously shown in yellow is now red and is designated as Cropland or Dryland Grain Crop. This designation is inaccurate on approximately 30% of the land indicated. Some of the mistakes are extremely obvious such as the outline of the California Valley Airport Runway as Cropland. To verify this, I physically reviewed the areas indicated on the attached map. The hatched areas indicate parcels that Figure 1 shows are Cropland or Dryland Grain Crops which are not. In reality, they are grassland. Some are grazed and some are not. Some have been farmed in the past but for the majority it has been many years since.*

SC Wildlands appreciates the submittal of the Site Survey Results depicting grasslands that were incorrectly identified in Figure 1 of the Draft Report. We used this information, along with the results of the recent flyover conducted by California Department of Fish and Game, to update the vegetation layer and performed the analyses for baseline conditions again with this updated layer.

58. *I am alarmed that neither the Applicant, URS, the CEC nor SC Wildlands sought to obtain accurate farming records in their classification of land vegetation and in the determination of actual parcel use.*

SC Wildlands appreciates the suggestion to obtain farming records from the U.S. Department of Agriculture Farm Service Agency. We evaluated crop data from both Kern and San Luis Obispo Counties and incorporated this data as appropriate.

59. *It is my hope that in the next phases of the study, a method could be found to distribute data in a more accessible format such as the Google Earth.*

SC Wildlands will circulate the updated vegetation layer in kmz format, viewable in Google Earth.

60. *Since the fence data does not indicate type of fencing or information on permeability for Pronghorn Antelope, and because of its close proximately to the CESF site, it may be important to note the north western portion of section 28 is fenced with 8' high chain link.*

SC Wildlands appreciates receiving details on the fence surrounding the CESF site. Although a detailed fencing layer is not available, we will address fencing issues more directly under Task 3.

61. *It is apparent many urban areas near the project site are not indicated on the vegetation map.*

SC Wildlands appreciates receiving the map showing urban areas and chain link fence. We updated the vegetation layer accordingly.

## VIII Response to Comments by Michael Strobridge

62. *Various parcels of land are being classified as cropland such as the entire section 21 and section 16. This is incorrect as the southern half of section 21 is not farmed and section 16 is not farmed at all. The map provided to the CEC by Robin Bell of the Carrisa Alliance for Responsible Energy depicts a much more accurate account of current cropland.*

SC Wildlands used the information submitted by CARE, along with the results of the recent flyover conducted by the California Department of Fish and Game, to update the vegetation layer. We performed the analyses for baseline conditions again with this updated vegetation layer.

63. *Residential development does not seem to be addressed.*

The updated vegetation layer includes these areas.

64. *A more accurate picture of the types and locations of these fences need to be presented.*

Although a detailed fencing layer is not available, SC Wildlands will address fencing issues more directly under Task 3.

65. *I strongly believe water sources need to be addressed as they attract and sustain Pronghorn, Kit Fox, and Tule Elk.*

While SC Wildlands agrees that water is important to sustain these species, a detailed water source data layer is not available, which is why this parameter was not included as an input to the models. Water may not be highly relevant to movement in some seasons. For example, animals may move through an area completely void of surface water during cool wet months, when water is otherwise available.

## IX Response to Comments by Sunpower – Applicant for CVSR

## A. General Comments

*66. Changing model inputs achieves different model results.*

As described above, model inputs were not changed or manipulated. The revised report added additional information. The analysis of potential impacts to wildlife movement is being conducted using the best available science and information, and any uncertainties in the results of SC Wildland's analysis will be incorporated into the Final Staff Assessment.

*67. Using the Corridor Design model to assess project-specific and cumulative impacts is unprecedented and inappropriate.*

SC Wildlands is not using a model called "Corridor Design". The Corridor Design tools available at Corridordesign.org are based on the methods developed by SC Wildlands but they are not identical.

While it may be unprecedented to use SC Wildlands methods to identify specific or cumulative impacts, it is entirely appropriate. Permeability modeling is a more objective, transparent, and biologically accurate tool for evaluating cumulative impacts and assessing mitigation strategies. Cypher et al (2007) similarly applied a least-cost path analysis to evaluate baseline conditions and the effects of the preferred alternative for a Bureau of Reclamation project.

*68. Ground-truthing shows that the Draft [Report] Outlines' landscape permeability predictions are highly inaccurate.*

SC Wildlands respectfully disagrees. The results of the landscape permeability analysis for tule elk showing the top 2% of the output captured the majority of flight and collared sightings north of Highway 58.

*69. The modeling exercise must incorporate updated and accurate baseline vegetation and fencing Data.*

SC Wildlands updated the vegetation layer and reran the analyses for baseline conditions using this updated vegetation layer.

Although a detailed fence layer is not available, we will address fencing issues more directly under Task 3. Unlike fences in urban areas, fences in this area are not considered permanent features of the landscape.

*70. The modeling exercise requires independent review by impartial experts.*

That is exactly the process engaged by CEC biologists, other staff, and consultants when conducting environmental review for this or any other power plant siting project. CEC siting review is certified under CEQA (see California Code of Regulations, title 20,

section 15251, subsection (j).) SC Wildlands is acting as an independent consultant to the CEC for this project. Furthermore, SC Wildlands is not an advocacy group. It is a science-based non-profit focused on connectivity conservation. If needed, the CEC and/or SC Wildlands may engage other experts to review analyses for the Tule elk, Pronghorn antelope, or other species.

### B. Comments Regarding the Pronghorn antelope

71. *Is there a formalized or accepted management plan by the CDFG for this species? If so, does this include the entire study area, BLM [lands] , and/or privately owned lands?*

California Department of Fish and Game biologists are checking for a management plan, but none is available at this point. Any such plan is likely to be old and probably not useful. Currently, Fish and Game biologists have set the Pronghorn antelope herd objective for Carrizo National Monument at 250, and the greater herd goal (including the solar project area) at 500.

72. *What is the current hunted status of the Carrizo Plain population of pronghorn?*

They are not hunted. Per CDFG biologists, pronghorn antelope on the Carrizo Plain were hunted between 1996 and 2001. There has not been a season since due to low numbers. In 1996, there were 5 buck tags, that number was reduced to 2 tags in 2000, and the season was discontinued in 2002.

73. *It should also be noted (and included in the model) that the type of fence also has an effect on "barrier quality." Four- and five-strand ranch fencing is not penetrated or jumped by pronghorn and pose an absolute barrier to movement.*

SC Wildlands will incorporate the suggestion to note type of fence on barrier quality in the next revision of the document. However, it is unlikely that this parameter will be included in the model due to the lack of detail in the fence data layer. Typically, pronghorn find openings or locations where the bottom fence wire is high enough off the ground to allow passage underneath. This is why pronghorn are observed moving between parcels surrounded by four- and five-strand fences. These fences do inhibit movements, but they are not complete barriers.

74. *There should be some discussion on the effect of fence design on restricting movement. Then follow up with at least a general statement about the type of fences found in the Carrizo Plain area.*

SC Wildlands has incorporated this suggestion in the current revision of the report.

75. *The availability of water could be a very important factor in the model. What about a review of water impoundments from aerial photos and the collective knowledge of Stafford and Hacker?*

While we agree that water is important to sustain these species, a detailed water source data layer is not available, which is why this parameter was not included as an input to the models.

76. *What do "more gregarious" and "smaller groups" mean in terms of numbers of pronghorn? Can estimates or ranges of numbers of animals be included?*

The herds east of the Temblors and west of Shandon are considered smaller groups. These herds have at most 20 animals with group size usually less than 10. The others are all gregarious depending upon season. They are most gregarious during the winter/spring (prior to fawning). Herd sizes at this time range from 15 to 60. They break up into smaller groups during summer/fall. There were 89 animals in the largest single group (#33) in the California Valley herd this February.

77. *Should [the Spatial Patterns section discuss]"home range size" instead of "herd range size?"*

No, the draft report correctly described herd range size, though they may be better described collectively. This has been clarified in the revised report. Herd range size estimates come from California Department of Fish and Game data, which include herd ranges but not home ranges.

78. *Please note that pronghorn antelope are not migratory in the Carrizo Plain.*

Yes, thank you for the clarification.

79. *What is known about seasonal movement, if any, of pronghorn on the Carrizo Plain?*

There are no regular seasonal movements. Movements appear to encompass the valley floor and surrounding foothills to utilize all accessible forage.

80. *Was an independent mammalogist, with a specialty in ungulates, consulted to review their ratings, category scores, or factor weights? It is highly recommended that the ungulate biologist have substantial experience with pronghorn antelope and Tule elk.*

Jim Yoakum, a leading pronghorn expert, reviewed the pronghorn ratings. SC Wildlands may have the tule elk program manager at the California Department of Fish and Game review the tule elk ratings.

81. *The inclusion of road density doesn't seem to fit. Moreover, I think the connection between fences and roads might be overstated. Is there any quantification? Some simple survey perhaps, XX miles of roads driven and XX miles of fencing found to be adjacent to roads?*

A weighted road density of 10% was used in the equation for the habitat suitability analysis of pronghorn antelope.

82. *Note there is a strong reliance on CDFG observations, and much less on peer-reviewed publications.*

The CEC and SC Wildlands routinely rely on current California Department of Fish and Game data as best available science for project review. CDFG information is professional, objective, accurate, convenient, useful, and understandable to the public. In addition, site-specific observations were available and therefore used as appropriate in concert with cited publications.

83. *Please define north end of Carrizo Plain. Is this considered north of Highway 58 and south of Bitterwater Valley?*

The Draft Report refers generally to the north end once, in the quote, "According to ranchers, pronghorn herds once numbered in the hundreds at the north end of Carrizo Plain," attributed to Koch and Yoakum (2002). For their definition of what constitutes the north end, please refer to this paper, which SC Wildlands can provide upon request.

84. *From a comparison of Figure 1 and Figure 4, pronghorn have been observed in fallow and irrigated agriculture field in the Carrizo Plain greater than 0.8 km from suitable natural habitat. Actually, the majority of the area around the "irrigated agriculture fields" is not "suitable natural habitat," but instead contains dry farmed fields. It appears that these referenced CDFG observations do not support aerial observations that were mapped by CDFG utilizing GPS technology.*

To clarify, Section 5.1.4.1., Habitat Suitability bullet two now reads:

**Irrigated row and field crops** within 0.8 km (0.5 mi) of suitable natural habitat areas (suitability ≥ 0.5) were rated as shown in Appendix B; but **irrigated row and field crops** more than this distance from suitable natural habitat were rated as unsuitable (rating = 0), based on observations that pronghorn only use such fields in proximity to suitable natural habitats (Cole and Wilkins 1958, R. Stafford, CDFG, personal communication).

The majority of irrigated row and field crops are in the northeast portion of the study, with other fairly good size patches at the base of southfacing slopes of the Caliente Range, in the Cuyama Valley, and between Highways 41 and 46. None of the referenced CDFG observations came from irrigated row and field crop areas.

85. *Please change "high quality habitat" to "high quality foraging habitat."*

Foraging is not the sole factor when considering habitat suitability.

86. *It is erroneous to accept road density as an indicator of fences and permeability for pronghorn antelope. In addition, most parcels in community of California Valley do not have fencing adjacent to the [dirt] roads.*

SC Wildlands appreciates Sunpower's observation that most parcels adjacent to dirt roads in the California Valley do not have fencing. However, twelve years of aerial monitoring has found that pronghorn generally do not use the subdivided area south of 58 despite the available forage and the lack of fencing. The dense road network here is presumed to discourage pronghorn use. There is consensus that even perceived linear barriers can limit pronghorn movement.

87. *It is important for that the fence data be current and correct for the pronghorn antelope model to be useful.*

Fence data is not being used as an input parameter to the model due to the lack of detail in the fence data layer. Furthermore, fences are not considered permanent features of the landscape and are generally not complete barriers to movement. As stated in the Draft Report, section 6.1.2.1,"Ongoing efforts, such as those by CDFG and volunteers, to make fences more "pronghorn friendly" (by raising the bottom wires) and to remove old field fencing, should be continued and expanded."

88. *The presence of a fence is a determining factor for habitat use by pronghorn antelope. More important is fence type (R. Stafford, CDFG, personal communication). Some fence types form absolute barriers to pronghorn antelope, while others pose less constraint to permeability.*

Agreed. If one compares the inset of Figure 10 of the draft report, displaying the fence data developed by San Luis Obispo County, with the pronghorn sightings shown on Figure 10, it appears that many of the fences within the most highly permeable route pose less of a constraint to pronghorn antelope habitat use and movement.

89. *There are also established pronghorn antelope crossings locations along SR-58 in the western portion of the Carrizo Plain. These should be identified by CDFG staff and included in the model.*

SC Wildlands has identified any established pronghorn antelope crossing locations on revised maps for this species. However, specific crossings cannot be directly factored into the model.

90. *The distance to water source(s) was not factored in. This may pose to be a shortcoming of the model.*

As stated above, SC Wildlands agrees that water is important to sustain this species. However, a detailed water source data layer is not available, which is why this parameter was not included as an input to the model.

91. *We believe the equation should weigh more on fencing. We also understand that topography should continue to be weighted heavily. We would propose the following equation:*

*(vegetation score* $^{0.30}$*) + (fencing/fence type* $^{0.30}$*) + (topography score* $^{0.40}$*)=habitat suitability*

Fence data is not being used as an input parameter to the model due to the lack of detail in the fence data layer. SC Wildlands consulted with the species experts to evaluate this proposed modification to the model.

92. *Estimated herd range size was used for patch and core size. How did Mr. Stafford estimate this? By aerial over-flight data? By observations on the ground that were mapped? By reviewing vegetation cover types? Or maybe a combination of all?*

Herd range size was determined from flight data gathered between 1999 and 2008.

93. *[In the landscape permeability] equation, [r]oad density still doesn't fit very well. Even more emphasis should be placed on fencing. Suggest following equation:*

*(vegetation score *20%) + (Fencing/fence type *40%)(topography score *40%)=cost*

Fence data is not being used as an input parameter to the model due to the lack of detail in the fence data layer. SC Wildlands consulted with the species experts to evaluate this proposed modification to the model.

**C. Comments Regarding Tule Elk**

94. *Were Tule elk endemic to the Carrizo Plain? Please include response in revised draft report.*

SC Wildlands has included a response in the revised draft report.

95. *Include reason for Tule elks introduction into the Carrizo Plain (i.e., hunting interest facilitated a translocation of Tule elk onto the Carrizo Plain).*

See the Draft Report, section 4.2, Distribution and Status for the best explanation for the elk's presence on the Carrizo Plain.

96. *To what degree is this a hunted species in the Carrizo Plain area (how many per year)?*

Currently, the bag limit for La Panza Tule Elk is one per season, with up to six bull and six antlerless tags. Please see California Code of Regulations, title 14, section 364, subsection (j) for more information.

97. *Please reconfirm with Mr. Stafford that "…CDFG biologists observed Tule elk using irrigated agricultural fields within about 0.8 km (0.5 mi) of suitable natural habitat." This distance was also used for pronghorn, a much different type of animal. We believe that much more precise data is available from published literature. In addition, many landowners plant annual grain crops to attract Tule elk to their properties. These individuals also have hunting tags for this species. It appears that the Tule elk may be managed by the landowners who have a substantial monetary interest in this game animal.*

SC Wildlands has confirmed this with Mr. Stafford.

98. *There were published accounts of pronghorn using ag[ricultural] lands within 0.5 mile of natural habitats. This same distance is mentioned for Tule elk, but with reference only to observations by CDFG biologists. Are there published accounts/observations of Tule elk using such ag lands – either in the Carrizo Plain or elsewhere?*

SC Wildlands has searched the literature for published accounts/observations of Tule elk using irrigated row and field crops within 0.5 mile of natural habitats. No literature was found, thus this parameter was included based on observations by CDFG biologists.

99. *Again, it appears that availability of water might be an important factor. Another reason to try to map locations of water sources.*

As stated above, while SC Wildlands agrees that water is important to sustain this species, a detailed water source data layer is not available, which is why this parameter was not included as an input to the model.

100. *Paved roads are a barrier to herd movement. Translocated individuals may have crossed a paved road (0.94% of GPS collar data support this movement), but the data collected by CDFG biologists suggest that the herd does not move across paved roads. In addition, R. Stafford confirmed that established Tule elk herds in the Carrizo Plain have not been observed crossing paved roads.*

As stated in the Draft Report, section 4.2, Habitat Associations, "On the Carrizo Plain, as in other tule elk habitat in California, paved roads appear to hinder elk movement, with the result that they often delimit herd ranges (R. Stafford, CDFG, personal communication). Only 13 out of more than 30,000 point locations gathered using GPS collars showed that elk had crossed paved roads, and nearly all observed road crossings occurred immediately after translocated elk were released (R. Stafford, personal communication)."

Connectivity is important even if it only facilitates rare or occasional movements out of a home range. It is also important to allow for dispersal of juveniles.

Furthermore, while paved roads are an important factor in Tule elk movement they are not absolute barriers to movement. CDFG has documented movement of Tule elk under at least one major paved road, using a bridge originally designed to facilitate stream flow.

*101. Were other literature resources that discussed paved road crossing by Tule elk reviewed? SC Wildlands and CDFG indicate that Tule elk don't cross roads elsewhere in California; but there's no citation to support that statement.*

There is no available literature; this is based on site-specific GPS collar data. However, in searching for literature SC Wildlands found this video of tule elk crossing paved roads near Pt. Reyes *http://www.youtube.com/watch?v=2qOW1cokHrw&NR=1* .

*102. Note that current Tule elk herds are stable and additional translocation of elk are not proposed, therefore, Tule elk are not expected to cross paved roads.*

Tule elk occasionally cross paved roads, including long after translocations, although roads strongly influence spatial use patterns. In the future as populations expand, we expect more movements across roads and exchange between subherds.

*103. Is there a formalized or accepted management plan by the CDFG and Game for this species? If so, does this include the entire study area? Or all privately owned lands?*

As stated on the CDFG website, "The goals of the California Department of Fish and Game Elk Management Program are to maintain healthy elk herds, reestablish elk in suitable historic range, provide public educational and recreational opportunities involving elk, and to alleviate conflicts involving elk on private property." Please see http://www.dfg.ca.gov/wildlife/hunting/elk/ for more details.

*104. How many radio-collared females?*

Points shown in the Draft Report are for two radio collared cow elk. CDFG has additional data from eight other cows in nearby subherds, and two bulls.

*105. Were there any seasonal trends associated with Tule elk movements on the Carrizo Plain?*

As stated in the Draft Report, "Tule elk do not exhibit the extensive seasonal ranges shifts observed in some other elk subspecies, and are thus not typically considered to be migratory (McCullough 1969). However, herds may exhibit seasonal shifts in response to local forage conditions and annual patterns of plant productivity (McCullough 1969)."

*106. The inclusion [in Figure 2] of all those old California Valley development roads (mostly dirt) gives readers the impression of very high road density and potential for a lot of vehicular traffic. Of course, neither impression is correct.*

Dirt roads were not included in the road density analysis for Tule elk.

107. *We concur that density of paved roads restrict the presence of suitable habitat for this species, perhaps the factor weight for suitability of ≤ 40% for vegetation and ≥ 60% for road density is more realistic.*

SC Wildlands consulted with the species experts to evaluate this proposed modification to the model.

108. *Road density should have a much higher percentage for permeability than for habitat suitability. As indicated above, only 0.04% of radio collared Tule elk have crossed a paved road. The factor weights for road density as they apply to permeability should be at least 70% for baseline conditions (cost).*

SC Wildlands consulted with the species experts to evaluate this proposed modification to the model.

109. *Please identify other experts in addition to CDFG representatives that provided input into the model.*

CDFG representatives were the primary experts that provided input into the model. However, their rankings and weighting were compared to that used in Greco et al. 2009 and were found to be comparable.

110. *"Maintenance of connectivity from [the Carrizo Plain National Monument] to the northwestern zone is assumed to provide Tule elk with important connectivity. " If these elk do not cross paved roads (once established) and are not known historically to venture into these areas, why is this now considered a goal for CDFG? Other measures such as proper wildlife crossing (overland bridges, culverts) would potentially meet this goal.*

Tule elk have been recorded in both target zones and within the least cost corridor delineated by the landscape permeability analysis, thus they do venture into these areas. As stated above, connectivity is important even if it only facilitates rare or occasional movements.

Measures such as installation or improvement of crossing structures will be addressed in Task 3. Although some documents refer to such structures as “corridors” or even “linkages,” SC Wildlands uses these terms in their original sense to describe the entire area required to link the landscape and facilitate movement between target zones. Crossing structures represent only small portions, or choke points, within an overall habitat linkage or movement corridor. Investing in specific crossing structures may be meaningless if other essential components of the linkage are left unprotected. Thus it is essential to keep the larger landscape context in mind when discussing existing or proposed structures to cross movement barriers. This broader context also allows awareness of a wider variety of options for maintaining functional linkages.

111. *We believe the equation should weigh more on the road density and less on vegetation since the paved roads are the primary restriction to movement of the Tule elk throughout the Carrizo Plain. Suitable foraging habitat is plentiful for this species. We propose the following equation (Please note that we have not attempted to run the models at this time).*

*(Vegetation Score *40%) + (Road Density Score *60%) = cost*

SC Wildlands consulted with the species experts to evaluate this proposed modification to the model.

**D. Comments Regarding San Joaquin Kit Fox**

112. *SC Wildlands stated that the "Carrizo Plain [kit fox] population is one of the three populations designated as high priority for enhancement a protection by the USFWS (1998)." Although we understand the importance of this species throughout the Carrizo Plain, isn't this core population defined as the area included in the Carrizo Plain National Monument? As stated in the 1998 Recovery Plan (6. Recovery Strategy, Level A Strategy [page 132], the Carrizo Plain National Monument [Natural Area] in San Luis Obispo County is one of the three core populations. This does not indicate areas of the Carrizo Plain north of the monument as a core population; however, it does state to "Protect and enhance corridors for movement of kit foxes through the Salinas-Pajaro Region and from the Salinas Valley to the Carrizo Plain and San Joaquin Valley."*

The Recovery Plan (USFWS 1998; 6. Recovery Strategy, Level A Strategy, p. 132), defines the Carrizo population as "Carrizo Plain Natural Area in San Luis Obispo County," not the "Carrizo Plain *National Monument* [Natural Area] in San Luis Obispo County." Thus, it does indicate areas to the north of the monument would also be included in the core population.

113. *The-Carrizo Plain core population is, therefore, protection. The connections between core and satellite populations are what affect recovery of the SJ kit fox in the northern portion of the plain (USFWS 1998).*

The Carrizo Plain core population is not entirely protected (see above response). SC Wildlands agrees that connections between core and satellite populations affect recovery of the SJ kit fox in the northern portion of the plain (USFWS 1998).

114. *Is it possible to quantify "abundant rodent populations?"*

No, not with available data. This was a relative term used in describing general habitat associations of kit foxes.

115. *We noted that Warwick and Cypher (1998) found a negative relationship between topographic ruggedness and capture rates of kit foxes in Elk Hills and Buena Vista Hills of the Temblor Range.*

Yes, that is correct.

116. *White and RaIls established that SJ kit fox home ranges averaged 1,160 ha (2,886 acres) home range for 21 pairs. Was this for males or pairs of foxes? Other home range statistics were also stated, but no comparable methodology was presented to understand the extreme differences between studies.*

The Draft Report, Section 4.3, Spatial Patterns, says the home range size of 21 *animals* [individual foxes] on the Carrizo Plain averaged 1,160 ha (White and Ralls 1993), not pairs. This home range estimate was for individual foxes. The 21 animals were apparently a mix of males and females (ratios not specified) because White and Ralls note that "sizes did not differ among sexes." White and Ralls also give the mean home-range size of fox *social* groups (pairs and trios) which are a bit larger, but they say that social groups did not differ significantly from individual home ranges.

SC Wildlands suggests going to literature cited to understand the extreme differences between studies; we can provide any papers requested.

117. *[Section 4.3, Spatial Patterns]. This [first] paragraph is confusing as many different numbers are cited and a conclusion sentence of what is an appropriate home range for the Carrizo Plain core population of the SJ kit fox is absent.*

Section 4.3, Spatial Patterns of the San Joaquin kit fox, cites various studies conducted on kit fox home range size, with estimates ranging from less than 260 ha to approximately 3,100 ha (Morrell 1972, Knapp 1978, cited in USFWS 1998, Zoellick et al. 1987, Spiegel and Bradbury 1992, White and Ralls 1993). The conclusion sentence is as follows, “In optimal habitat, each kit fox family requires approximately 486 ha, with larger space requirements in suboptimal habitats (Cypher et al. 2007).” This estimate is considered conservative and the 486 ha was used as the basis for calculating minimum patch size and core areas in Section 5.1.4.3.

118. *Is the list of home ranges... (Haight et aI, 2000 and Cypher et al 2002) for SJ kit foxes in Kern County or the Carrizo Plain?*

The Haight et al. 2002 home ranges estimates were for the Panoche area in central California, while the Cypher et al. 2002 home range estimates were for the Naval Petroleum Reserves in California.

119. *"Cypher et al. (2005) examined the effects of 2-lane highways on kit foxes in the Lokern Natural Area, and found no significant negative effects on fox demography or ecology." SR-58 is a light[ly] traveled 2-lane highway that experiences substantially less vehicular traffic than SR-46 or SR-166. This is*

*likely due to lack of services along SR-58. We would consider SR-58, Soda Lake Road, Elkhorn Road, and Bitterwater Road very minor constraints to SJ kit fox movement, although we do understand that these roads on occasion allow for SJ kit fox mortality.*

Agreed; this is likely the case for baseline conditions. However, the authors cautioned that increased road density could have a negative impact, citing studies that reported increased swift fox (*Vulpes velox*) mortality with increasing road density (Cypher et al. 2005), selection by bobcats of habitat with lower road density (Lovallo and Anderson 1996), and declining gray wolf habitat suitability with increased road density (Thiel 1985, Jensen et al. 1986).

120. *Regarding "the authors cautioned that increased road density could have a negative impact," high road density is most obvious in the defunct community of California Valley; however, the dirt roads do not restrict movement of SJ kit fox. In addition, the increased road density associated with the solar projects [consist of] maintenance roads not utilized by the public. These roads will be traveled in daylight when the SJ kit fox is least active. An increase in nighttime traffic would have the greatest impact on SJ kit fox mortality. It is difficult to conclude that nighttime traffic would increase during development and/or operation of the solar projects.*

It is SC Wildlands' understanding that the three proposed projects would cause a substantial increase in vehicular traffic not just during daylight hours but also at dawn and dusk, which could impact San Joaquin kit fox and other species.

121. *In Appendix B, the Suitability rankings of 0.5 for both Annual Grassland (Avena spp) and Perennial Grassland are perplexing. Perennial grasslands are usually more open (greater distance between "Nassella" clumps) and shorter than Avena-dominated grasslands and may be dominated by Nassella or Distichlis, the later being a prostrate grass found on alkali soils and sinks, often associated with moist desert scrub habitats. [Native] Perennial Grasslands should receive a higher habitat ranking that Avena, when appropriate (i.e., always for Distichlis, but only for Nassella when coverage is less than 25%).*

SC Wildlands consulted with the kit fox expert to evaluate this proposed modification to the ranking for perennial grasslands. However, this habitat type is so restricted in the study areas that it will likely have very little influence on the output of the models.

122. *We concur that terrain ruggedness is a substantial parameter that affects movement of SJ kit fox. We support terrain having a greater percentage (40 %) than vegetation (50%), vegetation density (5%) and road density (5%).... The draft model should increase the percentage of terrain ruggedness (i.e., 70%) if this is the greatest factor limiting habitat suitability and permeability.*

Section 5.1.4.3,paragraph 3, in regards to the habitat suitability model for kit fox, used the following equation:

(Vegetation Score * 50%) + (Terrain Ruggedness Score * 25%) + (Vegetation Density Score * 25%) = Habitat Suitability.

The landscape permeability analyses used the following equation, in which terrain ruggedness was weighted highest:

(Vegetation Score * 40%) + (Road Density Score * 5%) + (Terrain Ruggedness Score * 50%) + (Vegetation Density Score * 5%) = cost.

SC Wildlands consulted with the kit fox expert to evaluate this proposed modification to increase the weighting factor for terrain ruggedness. However, the use of the weighted geometric mean, rather than the arithmetic mean, was found to address the terrain ruggedness better than increasing the weight of that factor, and this geometric mean approach was used in the revised Report.

*123. With respect to [D]r. Cypher, doesn't terrain ruggedness have a greater influence on habitat than vegetation, especially in the Carrizo Plain? Would you consider a barren valley floor better habitat than a steep hillside (i.e., near the summit of the Temblor Range) covered with Bromus hordeaceus).*

According to Dr. Cypher (personal communication) kit foxes would probably stick to the valley floor in this comparison. If the vegetation on the valley floor is too dense, then the habitat suitability would go down.

*124. Target zones indicated in the draft report are 1) the Carrizo Plain National Monument to the south and 2) an area to the north of SR-46 and east of SR-33 (Kern County). We feel this would partially satisfy the Recovery Strategy 6.a.xiii in the Recovery Plan for Upland Species of the San Joaquin Valley.Recovery Strategy 6.a.xiii states: Protect and enhance corridors for movement of kit foxes through the Salinas-Pajaro Region and from the Salinas Valley t6 the Carrizo Plain and San Joaquin Valley. The draft model attempts to determine the most appropriate corridor between the Carrizo Plain and San Joaquin Valley. Based on Figure 13, the natural. "dispersal or movement" corridors are Bitterwater Valley and an area across the Temblor Range. The second option appears to be much less of an option for the SJKF. Has a second model been considered that would identify a target area to the northwest of the site towards the Salinas River region (Paso Robles, Camp Roberts, Hunter-Liggett, etc.)? The San Juan Valley may also provide a critical dispersal corridor, regardless if habitat within the study area portion [of San Juan Valley] is only· considered a patch. This area may be critical for the dispersal of SJKF, especially in a good reproduction year(s).*

SC Wildlands received a similar comment from CDFG regarding interchange between the Carrizo Plain core area, the San Joaquin Valley and the Salinas River Watershed. SC

Wildlands ran additional models for baseline conditions using multiple northern target zones that capture these other significant cores and patches.

125. *Road density doesn't necessarily take into account the less-used nature of the Carrizo Plain roads, nor the fact that many of the roads are traveled at lower speeds (if at all).*

Since road density was only given a factor weight of 5%, it didn't have much influence on the output of the model results in the draft report.

126. *Regarding the vegetation layer, SunPower's biologists (URS Corporation, Santa Barbara Office) are 'in the middle of their first spring survey season for SunPower's California Valley Solar One Ranch. URS expect to refine the vegetation mapping shortly and can supply you with a more accurate representation of rangeland (grasslands) located on-site.*

SC Wildlands appreciates Sunpower's willingness to provide the refined vegetation layer from URS Corporation's Santa Barbara Office. We look forward to receiving this data.

127. *Please define the smallest polygon (vegetation unit) used for the data collected by SC Wildlands. Although. the California Valley Solar Ranch site is dominated by annual forbs and short grasses (Bromus spp), there are significant areas of taller grasses (Avena spp), especially between hillsides and on favorable aspects (north/west). Knowing the vegetation unit size used for the model would be helpful.*

All data layers used in the analyses were converted to 30 X 30 meter raster grid cells. To delineate annual grasslands into *Avena* and *Bromus* dominated vegetation types, SC Wildlands used precipitation normals from PRISM and used the 9" isocline.

128. *The grassland defined polygons (Bromus and Avena) should be field verified. The effort involved would be minimal. I propose windshield and binocular surveys on accessible parcels.*

The vegetation data has been verified and updated as necessary by aircraft observations conducted using GPS positioning.

129. *The data provided in the report does not indicate that rural (and often private) dirt 'roads in the Carrizo Plain influence the pronghorn antelope, Tule elk, or San Joaquin kit fox. Currently, some of these "roads" have been overgrown by non-use and can hardly be considered roads anymore.*

The dirt roads identified in Figure 2 of the draft document were only included in the road density analysis for pronghorn antelope.

130. *It is mentioned that "Patches can support at least one breeding pair of animals ..... and are probably useful to species if the patch can be linked via dispersal to*

*other patches and core areas." This statement is especially true for the SJ kit fox and is part of the recovery plan for this species. Why didn't a model include a target to the north/northwest of the Carrizo Plain where patches are common?*

SC Wildlands received similar comments from other reviewers regarding interchange between the Carrizo Plain core area, the San Joaquin Valley and the Salinas River Watershed. SC Wildlands ran additional models for baseline conditions that used target zones that capture these other significant cores and patches.

*131. Why wasn't a west/northwest target area selected 'for potential route(s) to the Salinas-Pajaro watershed? This was a primary goal in the recovery plan and should be identified in the modeling exercise, perhaps as a separate model.*

As stated above, SC Wildlands received similar comments from other reviewers regarding interchange between the Carrizo Plain core area, the San Joaquin Valley and the Salinas River Watershed. SC Wildlands ran additional models for baseline conditions using target zones that capture these other significant cores and patches.

## X References Cited


Beier, P., D.R. Majka, and W.D. Spencer. 2008. Forks in the road: Choices in GIS procedures for designing wildland linkages. Conservation Biology 22:836-851.

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**BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA**
**1516 NINTH STREET, SACRAMENTO, CA 95814**
**1-800-822-6228 – WWW.ENERGY.CA.GOV**

**APPLICATION FOR CERTIFICATION FOR THE *CARRIZO ENERGY SOLAR FARM PROJECT***

**Docket No. 07-AFC-8**

**PROOF OF SERVICE**
**(Revised 6/5/2009)**

APPLICANT

Sean Kiernan
Development Director
Ausra, Inc.
303 Ravendale Drive
Mountain View, CA 94043
sean.kiernan@ausra.com

APPLICANT CONSULTANT

Angela Leiba, GISP
Senior Project Manager
GIS Manager/Visual Resource Specialist
URS Corporation
1615 Murray Canyon Road, #1000
San Diego, CA 92108
angela_leiba@urscorp.com

Kristen E. Walker, J.D.
URS Corporation
1615 Murray Canyon Road, #1000
San Diego, California 92108
kristen_e_walker@urscorp.com

COUNSEL FOR APPLICANT

Jane E. Luckhardt
DOWNEY BRAND
621 Capitol Mall, 18th Floor
Sacramento, CA 95814
jluckhardt@downeybrand.com

INTERESTED AGENCIES

California ISO
e-recipient@caiso.com

San Luis Obispo County
John McKenzie
976 Osos Street, Rm 300
San Luis Obispo, CA 93408
jdmckenzie@co.slo.ca.us

INTERVENORS

Mr. John A. Ruskovich
13084 Soda Lake Road
Santa Margarita, California 93453
agarnett@tcsn.com

Mr. Michael Strobridge
9450 Pronghorn Plains Road
Santa Margarita, California 93453
mike_76@live.com

California Unions for Reliable Energy (CURE)
c/o Tanya Gulesserian
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Suite 1000
South San Francisco, CA 94080
tgulesserian@adamsbroadwell.com

John Burch
Traditional Council Lead
Salinan Tribe
8315 Morro Road, #202
Atascadero, California 93422
salinantribe@aol.com

*Robin Bell
Carrisa Alliance for Responsible Energy
P.O. Box 4280
Paso Robles, California 93447
robin@midstateexpo.com

Environmental Center of San Luis Obispo (ECOSLO)
c/o Babak Naficy
P.O. Box 13728
San Luis Obispo, California 93406
babaknaficy@sbcglobal.net

ENERGY COMMISSION

JEFFREY D. BYRON
Commissioner and Presiding Member
jbyron@energy.state.ca.us

JULIA LEVIN
Commissioner and Associate Member
jlevin@energy.state.ca.us

Gary Fay
Hearing Officer
Gfay@energy.state.ca.us

John Kessler
Project Manager
jkessler@energy.state.ca.us

Caryn Holmes
Staff Counsel
cholmes@energy.state.ca.us

Michael Doughton
Staff Counsel
mdoughto@energy.state.ca.us

Elena Miller
Public Adviser
publicadviser@energy.state.ca.us

*indicates change

## DECLARATION OF SERVICE

I, Hilarie Anderson declare that on June 22, 2009, I served and filed copies of the attached Revised Draft Summary Report for Task 1 – Model Baseline Conditions The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[http://www.energy.ca.gov/sitingcases/carrizo/index.html]**. The document has been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

**(C*heck all that Apply*)**

**For service to all other parties:**

_x_ sent electronically to all email addresses on the Proof of Service list;

_x_ by personal delivery or by depositing in the United States mail at Sacramento, California with first-class postage thereon fully prepaid and addressed as provided on the Proof of Service list above to those addresses **NOT** marked "email preferred."

***AND***

**For filing with the Energy Commission:**

_x_ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below **(preferred method);**

***OR***

___depositing in the mail an original and 12 paper copies, as follows:

**CALIFORNIA ENERGY COMMISSION**
Attn: Docket No. 07-AFC-8
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512

docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct.

**Original Signature inDockets**
**Hilarie Anderson**