

FOXES IN FARMLAND:

RECOVERY OF THE ENDANGERED SAN JOAQUIN KIT FOX ON PRIVATE LANDS IN CALIFORNIA

FINAL REPORT SUBMITTED TO THE
NATIONAL FISH AND WILDLIFE FOUNDATION
PROJECT NUMBER 2000-0129-012



Prepared by:

Brian L. Cypher, Patrick A. Kelly, Daniel F. Williams, Howard O. Clark, Jr., Alexander D. Brown,
and Scott E. Phillips

California State University, Stanislaus
Endangered Species Recovery Program
1900 Gateway Blvd. Suite 101
Fresno, CA 93727

Prepared for:

National Fish and Wildlife Foundation

June 27, 2005

**FOXES IN FARMLAND:
RECOVERY OF THE ENDANGERED SAN JOAQUIN KIT FOX ON
PRIVATE LANDS IN CALIFORNIA**

Executive Summary i

Acknowledgments i

Introduction..... 1

 Information Need 1

 Private Lands Issue and Safe Harbor Agreement..... 2

 Study Area 2

Methods..... 3

 Artificial Refugia 3

 Monitoring 7

Results 7

 Track stations 7

 Spotlight surveys..... 8

 Live trapping..... 8

Discussion, Summary Of Achievements, And Future Efforts..... 9

Literature Cited..... 12

TABLE OF TABLES

Table 1. Species other than kit foxes observed during track station checks and spotlight surveys on Paramount Farm Company lands in Kern County, California, during February 2002-December 2004. 8

LIST OF FIGURES

Figure 1. Map of Paramount Farming Company property in Kern County, California..... 3

Figure 2. Locations of artificial dens on Paramount Farming Company property in Kern County, California. 4

Figure 3. Single-entrance surface den installed on Paramount Farming Company property in Kern County, California..... 5

Figure 4. Double-entrance surface den being installed on Paramount Farming Company property in Kern County, California..... 5

Figure 5. Chambered den being installed on Paramount Farming Company property in Kern County, California. 6

Figure 6. Locations of San Joaquin kit foxes observed during spotlight surveys on and near Paramount Farming Company property in Kern County, California. 9

EXECUTIVE SUMMARY

San Joaquin kit foxes (*Vulpes macrotis mutica*) are at risk of extinction primarily due to profound habitat degradation, fragmentation, and loss. Although industrial and urban development are contributing factors, agricultural development is the primary factor responsible for impacts to kit fox habitat. As a result of habitat fragmentation, natural lands in some locations are separated by agricultural lands. Based on recent research, kit foxes exhibit only limited capacity to utilize agricultural lands. Therefore, agricultural lands appear to constitute effective barriers to kit fox movements, which decreases genetic exchange and increases extinction risk in isolated habitat patches.

The goal of our project was to determine whether enhancement strategies would be effective in facilitating movements of kit foxes across agricultural lands. We installed refugia for kit foxes on agricultural lands owned by the Paramount Farming Company in Kern County, California. In total, 4 chambered and 21 surface dens were installed during November-December 2000, and these dens were uncapped in February 2002. Use of the dens was monitored from February 2002 to December 2004. Kit fox sign was observed at artificial dens on at least 6 occasions suggesting that foxes are indeed using the dens. Kit foxes were frequently observed on or near Paramount Farms property during spotlight surveys indicating a high probability for movements across agricultural lands.

Although we have been able to demonstrate that kit foxes will use the artificial refugia that we installed in agricultural lands, we have not yet conclusively demonstrated that these refugia are facilitating movements by foxes across agricultural lands. Such evidence would require intensive monitoring of telemetered foxes, but that was not possible with the available funding through 2004. However, the significant achievements attained in this project in conjunction with the importance of this issue have resulted in our receiving substantial new funding, which will allow us to intensively monitor telemetered foxes on the study site and to determine whether foxes are successfully crossing agricultural lands, and if so, whether the artificial refugia are facilitating such crossings.

ACKNOWLEDGMENTS

Funding for this project was provided by a grant from Environmental Defense and matching funding from the National Fish and Wildlife Foundation and PG&E Corporation through a Nature Restoration Trust grant. Additional supporting funds were provided by the U.S. Bureau of Reclamation and the California Department of Fish and Game. The Paramount Farming Company provided access to its property as well as extensive logistical support both prior to and during this project. Paramount also provided assistance with installation of artificial dens. We thank the following individuals for their assistance on this project: Michael Bean, Environmental Defense; Scott Hamilton, Paramount Farming Company; Jed Murdoch, Endangered Species Recovery Program; Christine Van Horn Job, Endangered Species Recovery Program; and Jennifer Clark.

INTRODUCTION

Information Need

The San Joaquin kit fox historically occupied arid upland habitats throughout the San Joaquin Valley. Former and current conversion of these habitats to agricultural, industrial, and urban uses has resulted in profound habitat degradation, fragmentation, and loss. As a result, the San Joaquin kit fox was listed as Federally Endangered in 1967 and California Threatened in 1973 (U.S. Fish and Wildlife Service 1998).

Kit foxes currently persist in a metapopulation consisting of 3 large “core” and a number of smaller “satellite” populations. Movement of foxes between these populations is important for maintaining gene and avoiding inbreeding effects. Furthermore, kit fox populations exhibit marked population fluctuations from natural as well as anthropogenic processes (e.g., Cypher et al. 2000). Small populations in particular are subject to increased risk of extinction due to catastrophic or random demographic events. Thus, fox movements, such as dispersal, may be necessary to prevent local extinctions or to recolonize lands where foxes are extirpated.

Throughout the existing range of the San Joaquin kit fox, natural habitat frequently is bordered by agricultural lands. In some cases, the pattern of agricultural development has resulted in habitat fragmentation with habitat areas being separated by croplands. Based on recent research conducted by the Endangered Species Recovery Program, kit foxes exhibit limited capacity to use agricultural lands. Agricultural practices such as cultivation, irrigation, chemical treatments, harvest, and control of vertebrate pests result in high levels of anthropogenic disturbance and also limit denning opportunities and food availability. Thus, kit foxes occasionally forage in croplands, but do not appear able to permanently occupy such lands (Warrick et al. in prep.).

Although kit foxes may not be able to occupy agricultural lands, such lands may not constitute impenetrable barriers to fox movements. Indeed, recent research also indicated that kit foxes occasionally travel up to 1.5 km out into croplands (Warrick et al. in prep.). Thus, kit foxes potentially can cross croplands to travel between areas of more suitable habitat. Because kit foxes are nocturnal, such travel likely would occur at night. This would allow foxes to avoid most human activities. However, because of absence of dens in agricultural lands, kit foxes would be subject to an increased risk of predation while crossing such lands. Kit foxes rely on dens to avoid or escape from predators (Cypher and Spencer 1998, Koopman et al. 1998) such as coyotes (*Canis latrans*) and non-native red foxes (*Vulpes vulpes*). Thus, the absence of escape cover could discourage foxes from attempting to cross croplands, and reduce the success rate of foxes that do attempt to cross.

Our goal was to determine whether artificially created refugia could facilitate crossing of agricultural lands by kit foxes. We installed artificial dens in agricultural lands and monitored these dens to determine whether kit foxes would use them. This was a preliminary step to determining whether such dens would facilitate movements of kit foxes across croplands.

Private Lands Issue and Safe Harbor Agreement

A significant issue regarding endangered species conservation on agricultural lands is that the majority of agricultural lands are privately owned. On-going agricultural activities potentially could result in a “taking” of a listed species through mortality, injury, or harassment. Unauthorized takings are illegal under the Federal Endangered Species Act (ESA) and the California Endangered Species Act. As a result, most farmers are understandably reluctant to encourage listed species to use their property.

In recognition of this risk and because private lands can contribute to the conservation and recovery of listed species, the ESA includes a process to protect landowners, subject to certain conditions. Under Section 10(a)(1)(A) of the ESA, a private landowner can enter into a Safe Harbor Agreement with the U.S. Fish and Wildlife Service (Federal Register 1999). Under this agreement, the landowner agrees to enhance habitat for listed species on their property, and in return, the landowner receives protection against take prohibition in the event that a listed species is killed, harmed, or harassed during authorized activities conducted by the landowner. Such Safe Harbor Agreements have been used in other states to benefit a variety of species (Environmental Defense 2005).

One of the land holdings of the Paramount Farming Company (Paramount) in Kern County, California separates 2 areas of natural habitat occupied by kit foxes. Paramount was willing to allow the use of its lands to test the strategy of installing refugia for kit foxes in crop lands as long as they received protection against accidental take of kit foxes. With the assistance of Environmental Defense, Paramount entered into a Safe Harbor Agreement with the U.S. Fish and Wildlife Service in 2002. This constituted one of the first Safe Harbor Agreements to be executed in the state of California.

Study Area

The study area is located approximately 10 km north of the town of Lost Hills in Kern County, California. The area of interest included approximately 675 ha (1,668 ac) of agricultural lands owned by Paramount (Figure 1). Primary crops grown on the property included cotton, barley, almonds, and pistachios. Annual crops were typically planted in spring and harvested in the fall. After harvesting, the ground was disked and left bare until the following spring. Nut orchards were drip-irrigated and harvested in September or October of each year. The agricultural lands were bordered on the east by the California Aqueduct (Figure 1). Both sides of the aqueduct right-of-way (ROW) include a relatively undisturbed strip of land (approximately 60 m wide on each side) typical of the Valley Grassland vegetation type (Heady 1977). Herbaceous vegetation was dominated by red brome (*Bromus madritensis*) and filaree (*Erodium spp.*), and the most common shrub species is desert saltbush (*Atriplex polycarpa*). To the west, the agricultural lands are bordered by the Lost Hills Oil Field, which is primarily owned and operated by private oil companies. Although some portions of the Lost Hills Field are heavily developed as a result of oil and gas production, there are significant expanses of natural vegetation typical of the Valley Grassland type throughout much of the field. Although somewhat variable, the width of the agricultural lands between the Aqueduct and oil field generally is about 1.5 km.

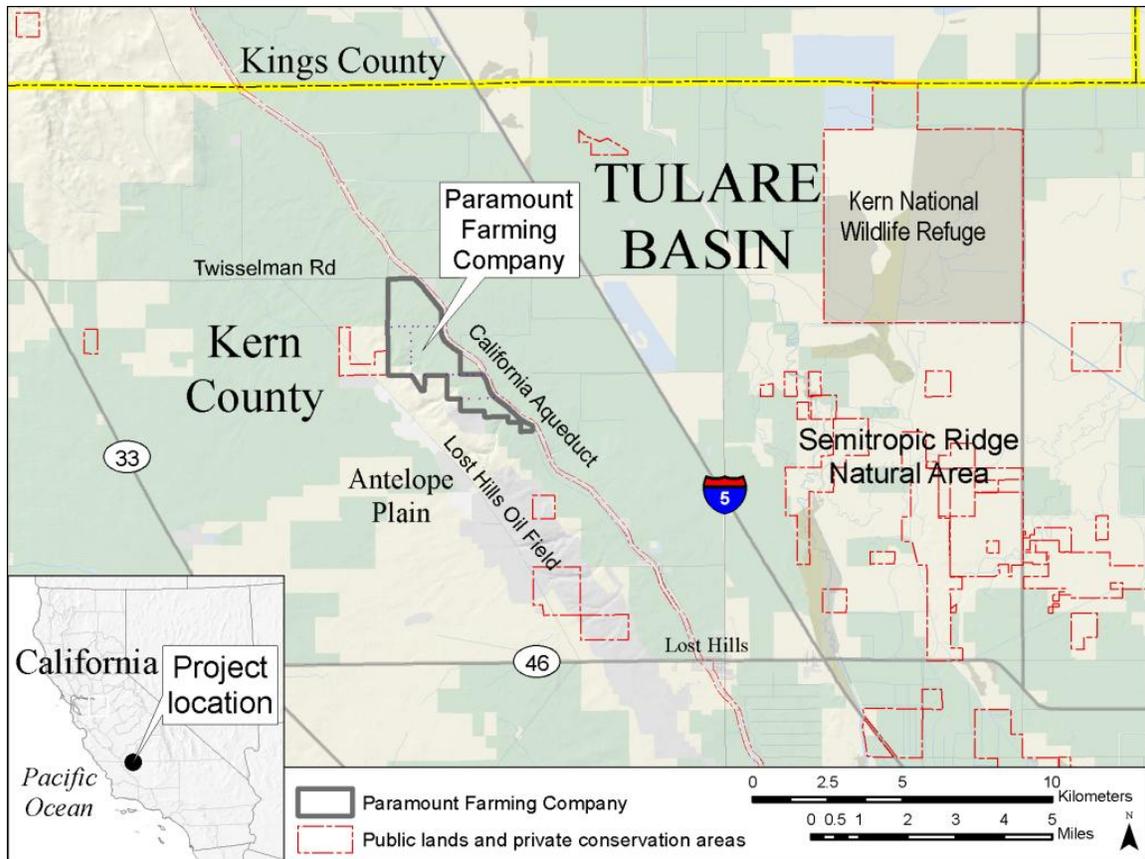


Figure 1. Map of Paramount Farming Company property in Kern County, California.

The study area is predominately flat with elevations ranging from approximately 80 m in the east to approximately 150 m along the Lost Hills anticline. The Lost Hills are gentle, rolling hills that run in a northwest/southeast direction paralleling the California Aqueduct.

Climate for Lost Hills, California is characterized by hot, dry summers, and cool, wet winters, with thick fog during the winter months (National Climatic Data Center 2000). Weather data recorded 40 km east of Lost Hills in Wasco, California indicate that average daily maximum temperatures range from 13.4°C in December to 37.5°C in July and average daily minimum temperatures range from 2.1°C in December to 18.7°C in July. Precipitation during the growing season (October to March) averaged 13 cm annually.

METHODS

Artificial Refugia

Refugia in the form of artificial dens were installed on Paramount property in 2000 along dirt roads through agricultural fields (Figure 2). Two types of dens were used: surface and chambered. Surface dens consisted of 3-m (10 ft) and 6-m (20 ft) lengths of 20-cm (8 in) diameter polyvinyl chloride (PVC) pipe placed on the surface of the ground and

covered with 1-2 m of soil (Figure 3 and Figure 4). A front-end loader provided by Paramount was used to cover the dens with soil. For 11 of these surface dens (3-m length), only one end was left exposed and the other was covered with soil, while both ends were left exposed for the other 10 surface dens (6-m length). A total of 21 surface dens was installed.

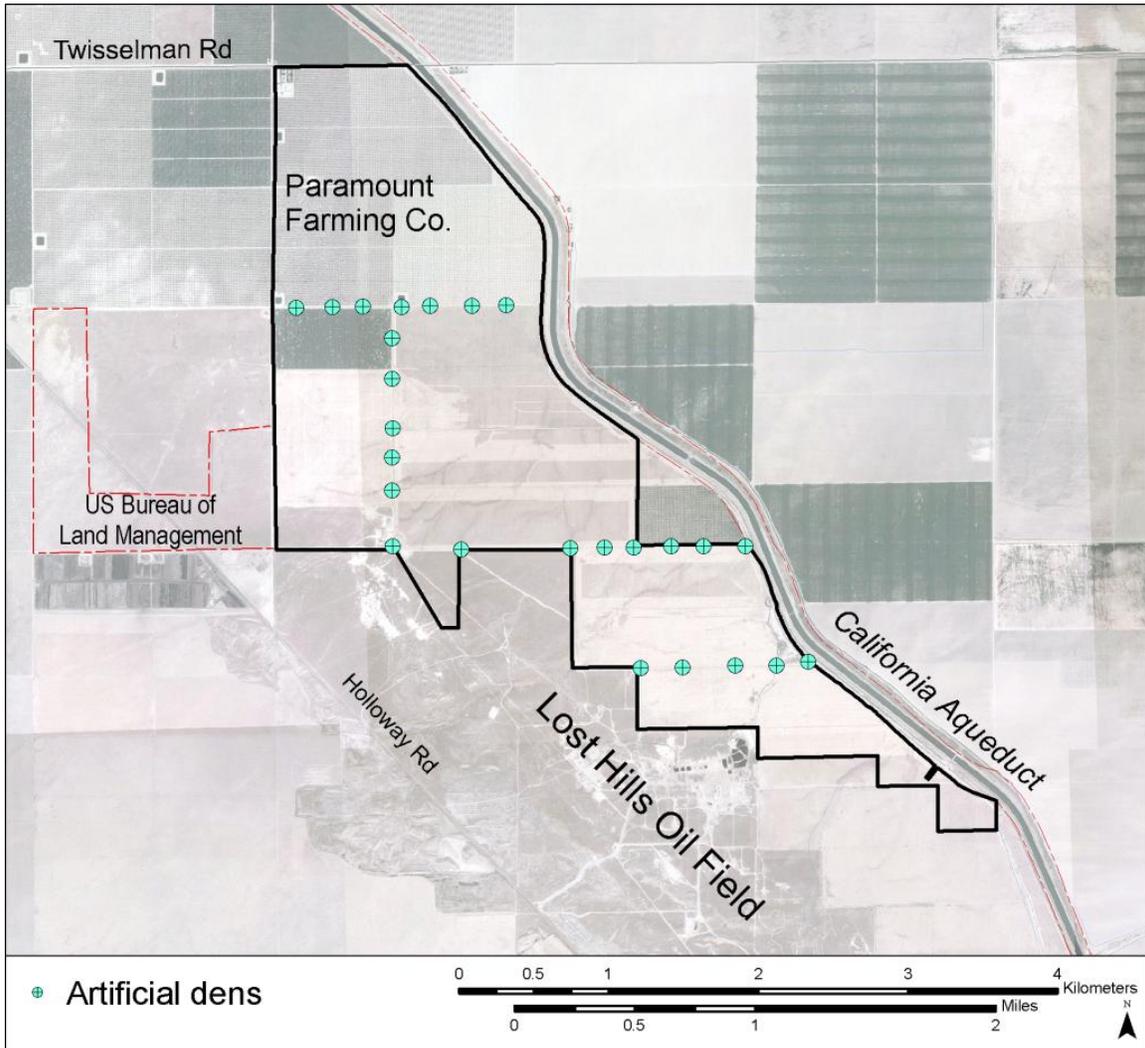


Figure 2. Locations of artificial dens on Paramount Farming Company property in Kern County, California.



Figure 3. Single-entrance surface den installed on Paramount Farming Company property in Kern County, California.



Figure 4. Double-entrance surface den being installed on Paramount Farming Company property in Kern County, California.

Chambered dens consisted of a 3-m length of pipe (either PVC or galvanized metal) leading down to a subterranean chamber. The chambers were approximately 1 m in diameter, 1 m tall, and constructed of high-density polyethylene plastic (Figure 5). The open tops of the dens were covered with plywood. The chambers were placed below ground such that the top of the chamber was approximately 1 m deep. A total of 4 chambered dens was installed.



Figure 5. Chambered den being installed on Paramount Farming Company property in Kern County, California.

Initially, caps were placed on the den entrances to prevent use by kit foxes. These caps were left in place pending the approval of a formal Safe Harbor Agreement between Paramount Farms Company and the U.S. Fish and Wildlife Service. Capping the dens discouraged kit fox use and reduced the potential for an accidental death of a kit fox in the absence of incidental take authority. The Safe Harbor Agreement was approved in early 2002, and the entrances to all dens were uncapped on 13 February 2002. In July 2002, the den entrances were modified to restrict access by red foxes and young coyotes, both of which had been observed in the area. Two 25-cm long reinforcement bars (“rebar”) were hammered into the ground flush against the den entrances. These bars were spaced approximately 15 cm apart, which would still permit kit foxes to enter the dens, but would exclude entry by coyotes and adult red foxes.

Monitoring

Track stations

Track stations were constructed in front of each den entrance to detect use by kit foxes and other species. These stations were created by smoothing the ground surface, and then sifting a 2-5 mm layer of fine, dry soil over an approximately 0.25-m² area. The stations were examined at least weekly, and animal tracks were identified to species.

Spotlight surveys

Spotlight surveys were conducted approximately monthly on and in the vicinity of the Paramount lands. Although kit foxes were the target species, sightings of any other species observed also were recorded. Two observers in a vehicle drove a route through the study site at 15-25 km/hr and each observer panned with a spotlight. Any animals observed were identified to species (using binoculars if necessary), and the location of all canid species was recorded. The spotlight route varied from about 15-25 km in length.

Capture and radio telemetry

An attempt was made to capture kit foxes and place radio collars on them to track movements on and near the study site. Wire-mesh traps (38 x 38 x 107 cm) baited with mackerel, wieners, bacon or chicken were set on lands on and adjacent to Paramount property. Traps were covered with cloth tarps to protect animals from inclement weather and direct sun. Captured foxes were ear-tagged, sexed, aged, and fitted with a radiocollar (Advanced Telemetry Systems, Isanti, Minnesota) containing a mortality sensor. Each radio collar weighed approximately 40 g. Captured animals were released at the capture site after processing. Endangered kit foxes were captured and handled per protocols established in permits TE023496-1, TE825573-2, and TE from the U.S. Fish and Wildlife Service and in a Memorandum of Understanding from the California Department of Fish and Game.

RESULTS

Track stations

From February 2002 through December 2004, 103 track station checks were conducted. Definitive kit fox tracks were detected at dens on 6 occasions, and potential kit fox tracks were observed on 2 occasions. Kit fox tracks were found at 6 dens on 1 or more occasions. Tracks from a variety of other species also were observed at the stations (Table 1), including tracks of coyotes, red foxes, and domestic dogs. A few animals were directly observed using the dens, including side-blotched lizards (*Uta stansburiana*), jackrabbits (*Lepus californicus*), deer mice (*Peromyscus maniculatus*), and burrowing owls (*Athene cunicularia*). Use of the dens by burrowing owls was significant because these birds are California Species of Special Concern. Other sign found near dens (within 2 m) included coyote and fox scat, rabbit pellets, and rodent droppings.

Table 1. Species other than kit foxes observed during track station checks and spotlight surveys on Paramount Farm Company lands in Kern County, California, during February 2002-December 2004.

Species	Observed during	
	Track stations	Spotlight surveys
Coyote (<i>Canis latrans</i>)	X	X
Red fox (<i>Vulpes vulpes</i>)	X	X
Raccoon (<i>Procyon lotor</i>)	X	X
Badger (<i>Taxidea taxus</i>)		X
Striped skunk (<i>Mephitis mephitis</i>)	X	X
Jackrabbit (<i>Lepus californicus</i>)	X	X
Cottontail (<i>Sylvilagus audubonii</i>)	X	X
California ground squirrel (<i>Spermophilus beechyi</i>)	X	
Kangaroo rat (<i>Dipodomys spp.</i>)	X	X
Mice ^a	X	X
Pocket gopher (<i>Thomomys bottae</i>)		X
Domestic dog (<i>Canis familiaris</i>)	X	
Domestic cat (<i>Felis catus</i>)	X	X
Great horned owl (<i>Bubo virginianus</i>)		X
Barn owl (<i>Tyto alba</i>)		X
Burrowing owl (<i>Athene cunicularia</i>)	X	X
Unknown bird	X	
Lizard (<i>Uta stansburiana</i>)	X	
Unknown snake	X	

^a Species could not always be identified but included deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), and San Joaquin pocket mouse (*Perognathus inornatus*).

Spotlight surveys

From February 2002 to December 2004, 25 spotlight surveys were conducted. Kit foxes were observed on 15 occasions during the surveys. Of these observations, 12 were on Paramount property (Figure 6), while 4 were on adjacent properties (within 1 km). Additionally, kit foxes were observed on 39 occasions on the nearby Antelope Plain, and these observations ranged from 2-10 km from the study site. Various other wildlife species were observed during the spotlight surveys including coyotes and red foxes (Table 1).

Live trapping

Due to limited resources, live trapping was only conducted for 5 nights in December 2002 and January 2003. A juvenile female kit fox was captured on 14 January 2003 and radio-collared approximately 0.5 km from Paramount property. Unfortunately, this fox was found dead just 10 days later on 24 January 2003. The mortality site was approximately 1 km from the capture site, and the cause of mortality was a predator, probably a coyote. Thus, limited information was gathered from this individual.

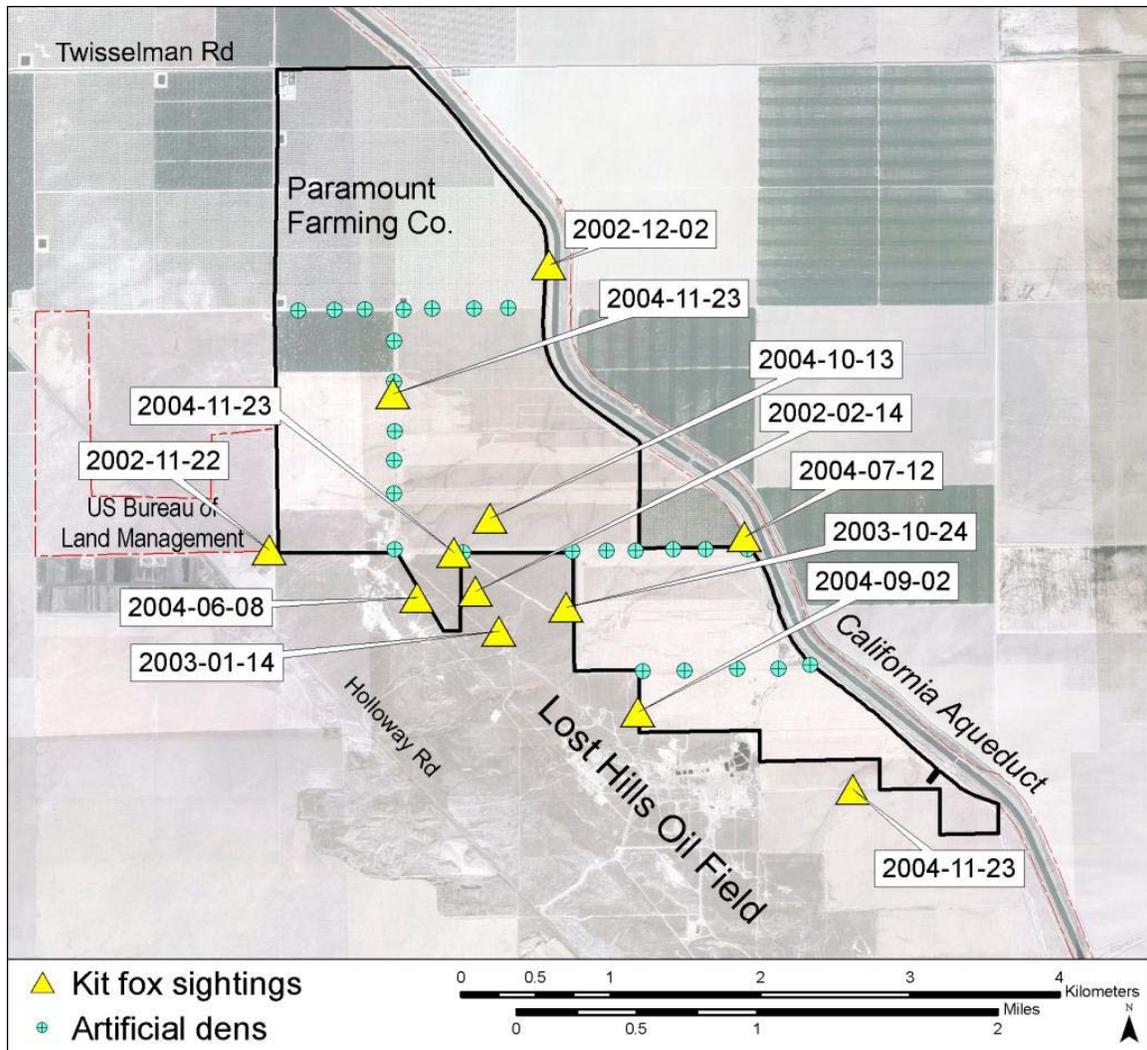


Figure 6. Locations of San Joaquin kit foxes observed during spotlight surveys on and near Paramount Farming Company property in Kern County, California.

DISCUSSION, SUMMARY OF ACHIEVEMENTS, AND FUTURE EFFORTS

Presence of kit fox tracks and other sign at the artificial dens indicated that the foxes will indeed use these refugia. This is consistent with results from a recently completed investigation in which kit foxes were found to readily use artificial dens for daytime resting, avoidance of temperature extremes, rearing young, and possibly avoidance of predators (B. Cypher, unpublished data). Thus, the use of artificial dens appears to be an effective strategy for providing refugia for kit foxes in agricultural lands.

The importance of such refugia was strongly emphasized by the frequent observations of coyotes, red foxes, and domestic dogs on and near the study site. All of these species are known to kill kit foxes (Disney and Spiegel 1992, Ralls and White 1995, Cypher et al. 2000, Clark 2001). The potential for predation by these predators may be substantially

higher near agricultural lands compared to the risk in natural habitats. Coyotes are common in both natural lands and agricultural landscapes, and therefore are a potential threat in both habitats. However, the risk of coyote predation in agricultural lands appears to be significantly greater due to the low availability or absence of dens that kit foxes can use as escape cover. Also, red foxes and domestic dogs are rarely observed in natural lands, but are much more commonly observed in agricultural landscapes. Dogs tend to be closely associated with human presence. Red foxes appear to be dependent upon the presence of water (Cypher et al. 2001); water sources are abundant in agricultural landscapes but are rare in the arid uplands in the San Joaquin Valley that are the preferred habitat for kit foxes. Thus, artificial refugia may significantly enhance kit fox conservation efforts in and near agricultural lands, particularly in situations such as that at Paramount where kit foxes may attempt to cross agricultural lands to access natural lands.

Kit foxes were commonly observed on or near Paramount property during spotlight surveys. Thus, this increases the probability that kit foxes will attempt to cross those croplands to access natural lands on the opposite side. This in conjunction with the presence of kit fox predators emphasizes the potential value of installing artificial refugia to assist kit foxes in crossing agricultural lands.

We were not able to demonstrate that kit foxes used the artificial dens to cross agricultural lands. This would have required the use of telemetry or some other technique to track movements by individual foxes. The available funding was not sufficient for such intensive monitoring. Also, we felt that it would be more productive to extend the project period, and thus we were able to monitor den use and kit fox activity in the area for 34 months instead of the <24-month period that was originally proposed. This decision was influenced in part by the prospect of securing additional funding to conduct the intensive monitoring described above (see below). Thus, we wanted to extend the Nature Restoration Trust funding to ensure continuous monitoring. Indeed, 2 project extensions were request and approved by NFWF.

Another significant achievement of this project was the development, approval, and implementation of the first Safe Harbor Agreement in California. These agreements have the potential to contribute significantly to the conservation and recovery of listed species. They also have an immense added benefit in that they are effective in involving private lands and landowners in conservation efforts. In areas such as the San Joaquin Valley where the vast majority of lands are in private ownership, inclusion of private lands in the conservation of listed species is not only beneficial, but may be crucial. Thus, the successful implementation of the Safe Harbor Agreement with the Paramount Farming Company will serve as an example that may encourage other landowners to follow suite.

The results of this project to date have been sufficiently encouraging to attract interest by other potential funding sources. In 2002, the U.S. Fish and Wildlife Service made funding available through a program to monitor the efficacy of Safe Harbor Agreements. This funding is being channeled through the California Department of Fish and Game, and will be provided to the Endangered Species Recovery Program through a Section 6 grant. The funding is expected by late spring 2005 and will be used to conduct the intensive monitoring of kit foxes that was alluded to previously. Currently, monitoring

activities initiated with NFWF funds are being continued with support provided by the U.S. Bureau of Reclamation.

Monitoring activities will continue for another 2 years. These activities will include continued den monitoring and spotlight surveys, as well as tracking kit fox movements through radio telemetry. The goal of the continued project is to determine whether foxes are successfully crossing agricultural lands, and whether they are using the artificial dens during such crossings. Upon completion of the field data collection, the results will be analyzed and 1 or more manuscripts will be prepared for submission to scientific journals. The National Fish and Wildlife Foundation and PG&E Corporation, as well as Environmental Defense, will be acknowledged in any presentation, report, or publication resulting from this project.

LITERATURE CITED

- Clark, H. O., Jr. 2001. Endangered San Joaquin kit fox and non-native red fox interspecific interactions. Masters Thesis, Fresno State University, Fresno, CA.
- Cypher, B. L., H. O. Clark, Jr., P. A. Kelly, C. Van Horn Job, G. D. Warrick, and D. F. Williams. 2001. Interspecific interactions among mammalian predators: implications for the conservation of endangered San Joaquin kit foxes. *Endangered Species Update* 18:171-174.
- Cypher, B. L., and K. A. Spencer. 1998. Competitive interactions between coyotes and San Joaquin kit foxes. *Journal of Mammalogy* 79:204-214.
- Cypher, B. L., G. D. Warrick, M. R. M. Otten, T. P. O'Farrell, W. H. Berry, C. E. Harris, T. T. Kato, P. M. McCue, J. H. Scrivner, and B. W. Zoellick. 2000. Population dynamics of San Joaquin kit foxes at the Naval Petroleum Reserves in California. *Wildlife Monographs* 145. 43pp.
- Disney, M., and L. K. Spiegel. 1992. Sources and rates of San Joaquin kit fox mortality in western Kern County, California. *Transactions of the Western Section of the Wildlife Society* 28:73-82.
- Environmental Defense. 2005. Safe Harbor agreements by state. <http://www.environmentaldefense.org/article.cfm?ContentID=602>.
- Federal Register. 1999. Announcement of final Safe Harbor policy. *Federal Register* 64:32717-32726.
- Heady, H. F. 1977. Valley Grassland. Pages 491-514 *in* M.C. Barbour, and J. Major, editors, *Terrestrial vegetation of California*. John Wiley and Sons, New York, NY.
- Koopman, M. E., J. H. Scrivner, and T. T. Kato. 1998. Patterns of den use by San Joaquin kit foxes. *Journal of Wildlife Management* 62:373-379.
- National Climatic Data Center. 2000. Local climatological data, Wasco, California, USA. National Climatological Data Center, Asheville, NC.
- Ralls, K, and P. J. White. 1995. Predation on San Joaquin kit foxes by larger canids. *Journal of Mammalogy* 76:723-729.
- United States Fish and Wildlife Service. 1998. Recovery plan for upland species of the San Joaquin Valley, California. United States Fish and Wildlife Service, Region 1, Portland, Oregon. 319 pp.