RESPONSE OF SAN JOAQUIN KIT FOXES TO ROAD CONSTRUCTION SITES

(Images provided by Erika Noel)

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SUMMARY

The California Department of Transportation (Caltrans) occasionally conducts construction projects within the range of the San Joaquin kit fox (*Vulpes macrotis mutica*), which is a Federally Endangered and California Threatened species. Caltrans routinely implements mitigation measures to avoid or minimize adverse impacts to kit foxes. However, kit foxes have been known to access construction sites despite the associated habitat disturbance and ongoing construction activities. The appearance of kit foxes on the construction sites, and particularly the establishment of dens, can cause delays in the work sometimes lasting weeks or even months.

The goal of this project was to (1) gather information from the literature and conduct interviews with knowledgeable individuals regarding kit fox visits to project sites and the efficacy of any mitigation strategies attempted, and (2) monitor kit foxes on and around construction project sites to better understand the response of foxes to the sites and their activities while on the sites.

Literature related to this issue was reviewed including monitoring reports, incident reports, post-construction reports, biological opinions, letters of concurrence, mitigation plans, research reports, and published articles. Also, 16 individuals with experience with kit foxes on construction projects were interviewed. A summary report was produced and is included as an appendix to this report.

We intensively monitored radio-collared kit foxes on study sites encompassing two large construction project sites in Bakersfield, CA. One project was the Centennial Corridor (CC) road construction project and the other was the Mercy Southwest Hospital (MSH) expansion construction project. Kit foxes were present in the area encompassing both projects before and during the active construction work.

Camera station surveys were conducted on 10 occasions at the CC site and kit foxes were detected using the site in nine of the ten surveys, including the last one. Four of the five foxes captured at the CC site were radio-collared and all four were detected using the site. Of the 2,402 locations collected, 29.5% were on the site. At the MSH site, 21 of the 38 foxes captured were radio-collared and 15 of these were detected using the site. Of the 15,379 locations collected, 7.8% were on the site. Survival probability for foxes with >5% of their locations on the MSH site (n = 10) and <5% of their locations on the site (n = 10) was 0.81 and 0.79, respectively, and did not differ significantly. Two foxes tracked for most of the study gradually decreased use of the MSH site as construction activities increased, but then suddenly increased their use of the site toward the end of the study.

Based on our results, resident kit foxes will continue using a construction site despite extensive disturbance and intensive construction activities occurring on the site. Excluding kit foxes from accessing a construction site is extremely difficult, if not impossible. Thus, we highly recommend site inspections prior to the initiation of work each day to ensure that foxes are not present and that new dens are not being created. Any new dens should be removed using approved methods as soon as possible. Foxes should be discouraged from denning in materials stored on site using fencing or by elevating the materials off the ground. All workers should receive training in identifying foxes and their sign.

ACKNOWLEDGEMENTS

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INTRODUCTION

The California Department of Transportation (Caltrans) is responsible for constructing, maintaining, and improving roads throughout the state. Furthermore, these activities must be conducted in a manner that avoids or minimizes adverse impacts to California's natural resources, particularly rare animal and plant species. Fulfilling these responsibilities is particularly challenging in locations where rare species are present.

One of the many rare species of concern to Caltrans is the San Joaquin kit fox (*Vulpes macrotis mutica*). This species is at risk of extinction primarily due to profound habitat degradation, fragmentation, and loss throughout its range in central California (U.S. Fish and Wildlife Service 1998). The remaining kit foxes may number less than 3,000 (Cypher et al. 2013). Thus, avoiding losses of individuals from anthropogenic activities, including those of Caltrans, is a paramount concern.

Avoiding impacts to kit foxes can be particularly challenging compared to other species given that foxes are extremely mobile and can easily adapt to their changing environments. They can travel miles in just one night, and therefore can appear on a project site even if they were not originally detected on the site prior to the start of the project. Also, kit foxes are obligate denning animals, meaning that dens are a critical aspect of their natural history. Indeed, kit foxes, which are primarily nocturnal, use a den every single day of the year for diurnal resting. They also use dens for thermal and moisture regulation, eluding predators, and bearing and rearing young (Cypher 2003). Kit foxes can rapidly excavate a den during just one night. Also, they will readily use anthropogenic structures for denning, many of which are commonly found on construction project sites such as culverts, pipes, seatrain containers, portable buildings, and stacks of materials with spaces within or under them. Thus, kit foxes visiting a project site also may attempt to take up residence. Foxes occurring on active work sites are at risk of harm from vehicle and equipment strikes, accidental entombment and entrapment, and exposure to harmful substances. Also, the presence of kit foxes potentially can cause significant delays in the project schedule and increased costs.

The goal of this project was to collect and synthesize information on the response of kit foxes to Caltrans project sites where active construction was in progress and potential mitigation measures that might to avoid occupation of the sites as well as prevent impacts to kit foxes using the sites. Specific objectives were to:

1. Gather information from the literature and conduct interviews with knowledgeable individuals regarding kit fox visits to project sites and the efficacy of any mitigation strategies attempted.
2. Monitor kit foxes on and around both urban and non-urban project sites to better understand the response of foxes to the sites and their activities while on the sites.
3. Summarize and synthesize the information collected above into a summary report that includes recommendations for potential mitigation strategies.

Objective 1 was addressed previously and the findings from the literature reviews and interviews were summarized in a report submitted to Caltrans in August 2022. That

report, *San Joaquin Kit Foxes and Road Construction Sites: Information Review and Synthesis*, is included as an appendix to this final report.

STUDY SITES

The original study proposal included conducting investigations on kit foxes at two study sites, one urban and one non-urban. The sites needed to satisfy a number of criteria. Of paramount importance, the sites needed to be located in an area where kit foxes were present. Construction activities on the sites needed to commence in 2022 or earlier and extend through most or all of 2023 to provide sufficient time to gather data on use of the sites by foxes. The sites also needed to have relatively secure locations to set live-traps to capture foxes. Ideally, lands surrounding the sites would be accessible to track foxes when they were not using the construction sites.

A Caltrans construction project in an urban area, the Centennial Corridor (CC) project, was quickly identified. However, Caltrans staff were unable to identify a second construction project, either non-urban or urban, that satisfied the criteria above. Thus, a non-road construction project that also happened to be in an urban environment, the Mercy Southwest Hospital (MSH) project, was selected as the second study site.

Centennial Corridor – Mainline Phase

The CC study site consisted of a portion of the project connecting the existing Westside Parkway in Bakersfield to State Route 99 in Bakersfield, CA. The study site encompassed areas of active construction from the interchange of the new highway with Truxtun Avenue to about the Marella Way overcrossing (Fig. 1). This site was selected because kit foxes were known to be present in the area around the interchange based on previous studies conducted by the Endangered Species Recovery Program (ESRP) and based on pre-actively surveys and monitoring conducted by McCormick Biological, Inc. (MBI). The site was approximately 14.2 ha (35.0 ac) in size. Considerable construction work had already been completed on this project prior to the initiation of the kit fox investigation. This work included most of the earth-moving, preparation of the road bed, construction of overpasses and underpasses, and laying of the highway surface. Work conducted during the kit fox investigation consisted of shoulder finishing, embankment work, clearing construction materials, cleaning up construction debris and waste materials, and finish work on the newly constructed roadway.

Mercy Southwest Hospital Expansion Project

The MSH study site was located in western Bakersfield, CA. The project consisted of constructing a 208,000 ft^2 addition to the existing hospital. The study site consisted of an approximately 5.0 ha (12.7 ac) area where construction activities were occurring and a nearby 1.9 ha (4.8 ac) fenced materials storage yard (Fig. 2). The project had many of the same elements of a Caltrans construction project including extensive earth-moving and ground disturbance, on-site staging of large quantities of construction materials, heavy equipment operation, and large numbers of construction workers on the site daily. The site was located in an area where a dense population of kit foxes was known to be present. A further advantage associated with using this site was that in May 2022, ESRP had initiated a research project on the California State University-Bakersfield (CSUB)

campus located immediately adjacent to the MSH site. The research project included the deployment of GPS radio-collars on kit foxes and intensive monitoring of the foxes.

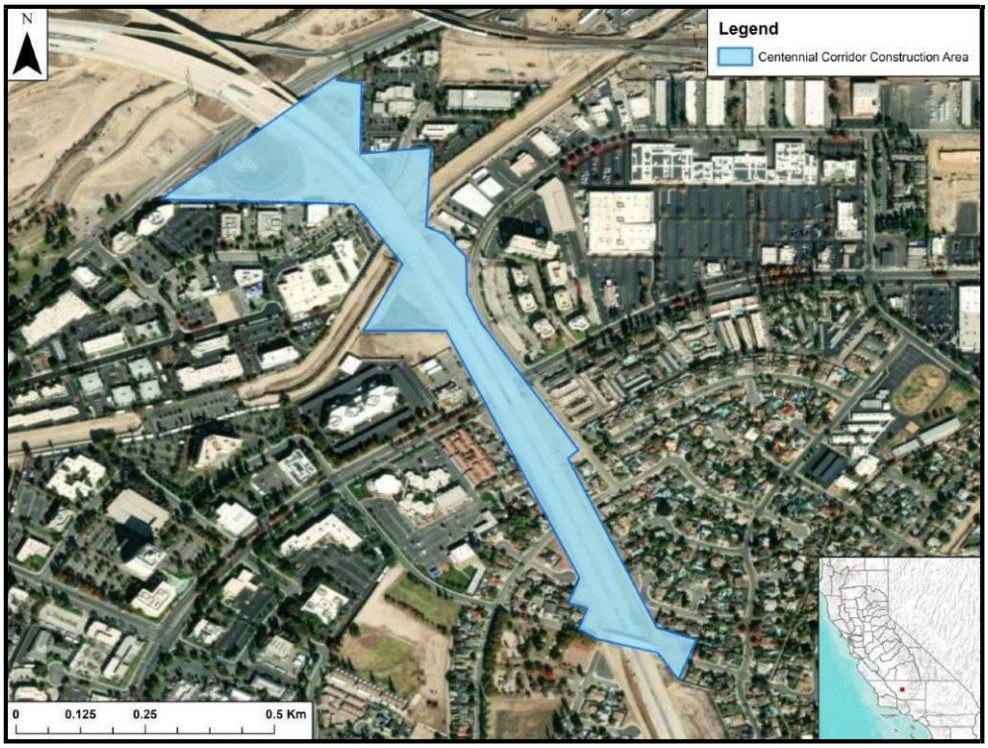

Figure 1. Centennial Corridor Mainline Phase study site in Bakersfield, CA.

Figure 2. Mercy Southwest Hospital Expansion study site in Bakersfield, CA.

METHODS

Camera station surveys

Kit fox presence and activity were monitored using automated camera stations. We used Cuddeback Digital Black Flash IR cameras (Model 1255, Non Typical Inc., Green Bay, WI) that take high-resolution images (20 megapixels) and that employ a "black flash" infrared LED flash that is not visible to humans. The cameras were secured to 1.2-m U-posts using zip-ties. At locations where cameras might be more easily discovered by the public, we placed the cameras in protective cases ("CuddeSafe" Model 3327, Non Typical Inc., Green Bay, WI) that were secured with a cable lock to fences, trees, or other immobile structures. To attract SJKF and other mesocarnivoes to the camera stations, several drops of a scent lure (Carman's Canine Call Lure, New Milford, PA) were placed in front of the camera and on surrounding vegetation. A 163-ml can of cat food was staked to the ground approximately 2 m in front of each camera using 30-cm nails, and the cans were perforated to allow scent to void. Animals could not access to the food in the can. Because 97.1% of the first detections of a kit fox at camera stations typically occur within six nights (Westall and Cypher 2017), cameras were deployed at each location for at least seven nights. Images were then downloaded from each camera and examined to determine whether kit foxes had been detected by the cameras.

Kit fox live-trapping and radio-collaring

Live-trapping for kit foxes was initiated in June 2022. An additional trapping effort was conducted in late fall 2022 to collar additional foxes, particularly young-of-the-year that were too light in weight in June to wear a radio-collar. Kit foxes were captured using wire-mesh live-traps (38 x 38 x 107 cm) baited with a protein item (e.g., hot dogs, canned cat food, hardboiled eggs) and covered with tarps to provide protection from inclement weather, sun, and irrigation sprinklers. Traps were set in late afternoon or early evening and then checked beginning around sunrise the next morning. Captured kit foxes were coaxed from the trap into a denim bag and handled without chemical restraint. Data collected for each fox included date, location, sex, age (adult or juvenile), mass, and dental condition, and a uniquely numbered tag was placed in one ear.

Foxes that were sufficiently large (i.e., females > 2 kg, males > 2.4 kg) were fitted with collars (Quantum 4000E Micro Mini Collars, Telemetry Solutions, Concord, CA) equipped with a GPS tracking unit and a VHF transmitter with a mortality sensor. The GPS units were programmed to collect four locations per night at varied times each night. Each unit included a UHF download function so that data could be downloaded remotely using a base station (4000ER Base Station, Telemetry Solutions, Concord, CA). All foxes were released at the capture site. All fox trapping, handling, and collaring were consistent with guidelines for the use of wild animals in research established by the American Society of Mammalogists (Sikes et al. 2016), and conducted in accordance with conditions and protocols established in the research permit (TE825573-6) held by California State University at Stanislaus-Endangered Species Recovery Program from the

U.S. Fish and Wildlife Service and a Memorandum of Understanding from the California Department of Fish and Wildlife.

Kit fox monitoring

Each morning before construction work began, we attempted to locate the VHF signal of each radio-collared fox on both study sites using a telemetry receiver (Model R1000, Communications Specialists, Inc., Orange, CA). Telemetry signals were detected using a 3-element handheld Yagi antenna (Model RA-150, Communications Specialists, Inc., Orange, CA). If the signal appeared to be coming from one of the construction sites, the signal then was tracked to the source location, which might be a den or a resting place not in a den such as under construction materials, a portable building, or some other structure. We also attempted to download location data from the collars each week to identify areas being used by collared foxes and the frequency of use.

Location data from the GPS collars and den locations gathered during fox monitoring were mapped in ArcMAP (ver. 10.6, ESRI, Redlands, CA). For each fox, we determined the proportion of locations that were on the construction sites. Two foxes at the MSH site were monitored for almost the entire study. For these foxes, we determined the proportion of locations on the construction site during two-month intervals to determine whether use of the site by the foxes declined as construction progressed and the site was increasingly altered.

At the MSH site, we compared survival rates between foxes that frequently used the construction site and those that used it rarely or not at all. We calculated the number of days that each fox was known to be alive based on radio telemetry monitoring. The fate of each fox monitored was recorded as survived, died, or fate unknown. Fate was considered unknown in situations where telemetry transmitters expired and contact was lost with an animal, the fox dispersed out of the study area, or a radio-collar was removed. Data from unknown fate foxes was treated as truncated or "right-censored" for survival analyses. Survival probabilities were calculated using Program Micromort (Heisey and Fuller 1985). Micromort produces a maximum likelihood estimate of the probability of surviving ($\hat{S}_i$) for a specified interval of time based on the number of days collared foxes survived. Use of number of days as the metric for survival allowed staggered entry of individuals (Pollock et al. 1989). The interval of time used was 300 days, which was the about the estimated life expectancy of the radio collars. Survival probabilities were compared between the two fox groups using a *z* test (Heisey and Fuller 1985):

$$z = \frac{\hat{S}_1 - \hat{S}_2}{\sqrt{var\ \hat{S}_1 + var\ \hat{S}_2}}$$

where $var\ \hat{S}_i$ is the variance for survival probability *i* as calculated by Micromort. For this test, an α value of 0.05 was used to determine significance.

RESULTS

Field data for this project were collected from June 2022 to August 2023.

Camera station surveys

Camera station surveys primarily were used to determine whether unmarked foxes were present in the vicinity of the two construction sites. At the MSH site, live-trapping was conducted on numerous occasions as part of a companion research project (e.g., see Cypher et al. 2023*b*) and foxes were being intensively monitored via radio-telemetry and camera monitoring for this same project. These activities provided abundant information on foxes using the site and the surrounding area. Thus, specific camera station surveys were not conducted at this site.

Camera station surveys were conducted at the CC site, largely to determine whether unmarked foxes were present. If unmarked foxes were detected near the site, then live-trapping was initiated to attempt to capture and mark these foxes. Surveys were conducted on 10 occasions at the CC site and foxes were detected during nine of the surveys including the last one.

Table 1. Results for camera station surveys conducted at the Centennial Corridor construct study site in Bakersfield, CA during June 2022-August 2023.

Date set	Nights	Stations	Stations with foxes	No. foxes	Unmarked foxes
6/28/22	7	7	2	3	3
8/23/22	7	6	3	3	0
9/20/22	7	6	4	4	0
10/19/22	7	7	2	2	1
12/15/22	7	5	2	4	1
1/25/23	7	6	2	3	0
2/23/23	12	7	1	2	0
4/5/23	6	7	2	2	0
5/24/23	7	5	0	0	0
8/4/23	10	6	4	3	0

Kit fox live-trapping and radio-collaring

Live-trapping for kit foxes was conducted on four occasions on the CC study site. Five kit foxes were captured and four of these were fitted with radio-collars. One fox was too small to collar and was just ear-tagged. In an effort to recapture and recollar foxes, trapping was conducted at a site approximately 2 km east of the CC site. Four new foxes were captured at this site, but all were too small to be collared.

Live-trapping was conducted at the MSH study site on 10 occasions and 38 kit foxes were captured. Of these, 21 received radio-collars and 17, mostly young-of-the-year, were just ear-tagged and dye-marked.

Kit fox monitoring

At both the CC and MSH sites, searches were conducted each morning via radio-telemetry to determine whether any radio-collared foxes were on either of the sites. Areas where active construction work was going to be conducted also were searched on foot for foxes and for any signs of den digging.

Foxes were never detected on the CC construction site during the day, although they were occasionally detected in areas adjacent to the site. Foxes were frequently detected on the MSH site, sometimes in the construction area and commonly in the materials yard (Figs. 3-5). The ones in the construction area usually moved off at daybreak. Those in the materials yard sometimes moved off the site but other times moved into or under material being stored in the yard.

Figure 3. San Joaquin kit fox visiting a camera station under the new freeway on the Centennial Corridor study site, Bakersfield, CA, June 2023. (Photo by CSUS ESRP)

Six kit fox dens were located at the CC site (Fig. 6). Four of these were earthen dens (Fig. 7), one was a location under a Baker tank, and one was within a stack of I-beams. The earthen dens were present prior to the initiation of construction and were avoided during construction. Six dens also were located on the MSH site (Fig. 8). Five were earthen and were present prior to the initiation of construction. One den site was under a stack of I-beams in the materials yard. One den on the CC site and four dens on the MSH

site (Fig.9) were temporarily covered to exclude kit foxes while work was being conducted near the dens.

Figure 4. Three San Joaquin kit foxes (circled in red) on the construction site at the Mercy Southwest Hospital study site, Bakersfield, CA, August 2023. (Photo by E. Noel)

Figure 5. San Joaquin kit fox in the materials staging yard at the Mercy Southwest Hospital study site, Bakersfield, CA, August 2023. (Photo by E. Noel)

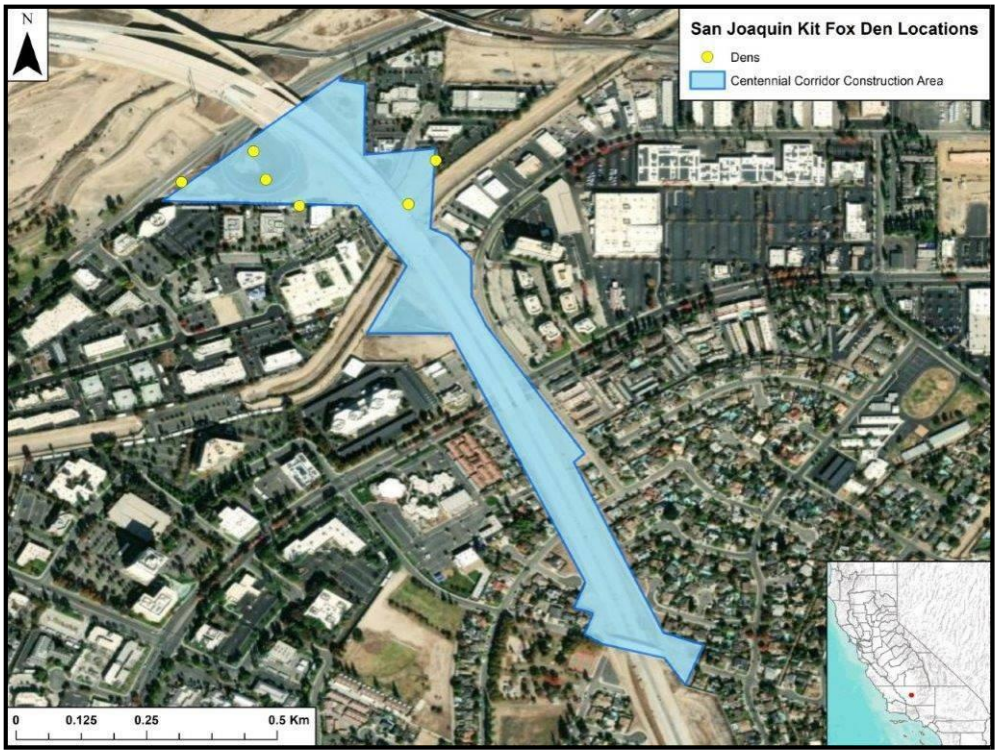

Figure 6. San Joaquin kit fox den locations on the Centennial Corridor study site, Bakersfield, CA.

Figure 7. Earthen San Joaquin kit fox den on the Centennial Corridor study site, Bakersfield, CA, June 2023. (Photo by E. Noel)

Figure 8. San Joaquin kit fox den locations on and near the Mercy Southwest Hospital study site, Bakersfield, CA, May 2024.

Figure 9. Covered San Joaquin kit fox dens on Mercy Southwest Hospital study site, Bakersfield, CA, August 2023. (Photo by E. Noel)

On the CC study site, 2,402 locations were collected on four collared kit foxes by the GPS collars. Of these locations, 709 (29.5%) were on the study site (Fig. 10). All four collared foxes had a least one location on the study site. The mean proportion of locations on the site for the four foxes was 24.7 ± 0.1% (range 7.1-34.3%). However, most of the fox locations on the site were in non-work areas and few of the locations were in areas where work was being conducted.

On the MSH study site, 15,379 locations were collected on 20 collared kit foxes. Of these locations, 1,194 (7.8%) were on the study site (Fig. 11). Of the 20 foxes, 15 had a least one location on the study site. The mean proportion of locations on the site for the 15 foxes was 10.3 ± 0.1% (range 0.6-26.8%). All of the locations on site were in the active construction area or the materials yard; the study site boundary did not include areas where work was not being conducted.

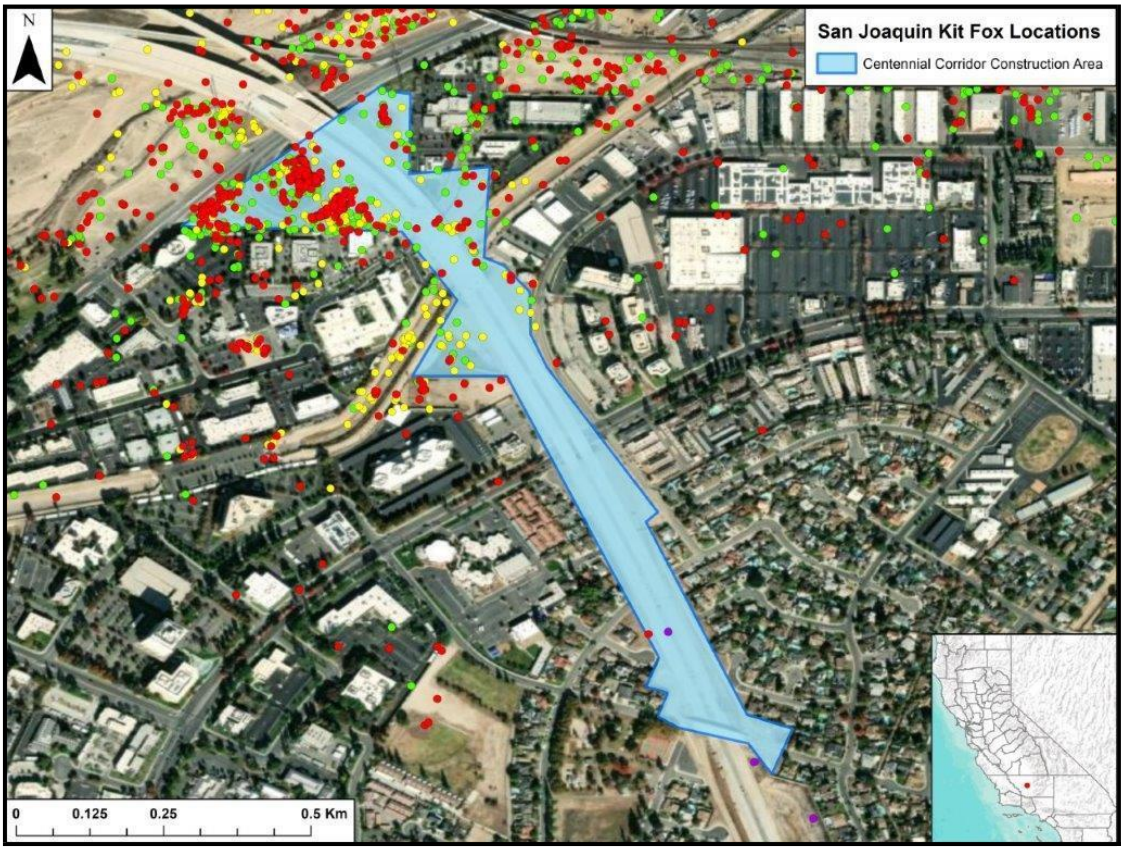

Figure 10. Telemetry locations for four San Joaquin kit foxes on the Centennial Corridor study site, Bakersfield, CA, June 2023-May 2024. Each color represents a different fox.

Two foxes using the MSH site were tracked for almost the entirety of the study. The proportions of locations for these two foxes that were on the construction site varied over time (Fig. 12-17). The proportions declined over time as construction activities increased, but then the proportions suddenly increased toward the end of the study (Fig. 18).

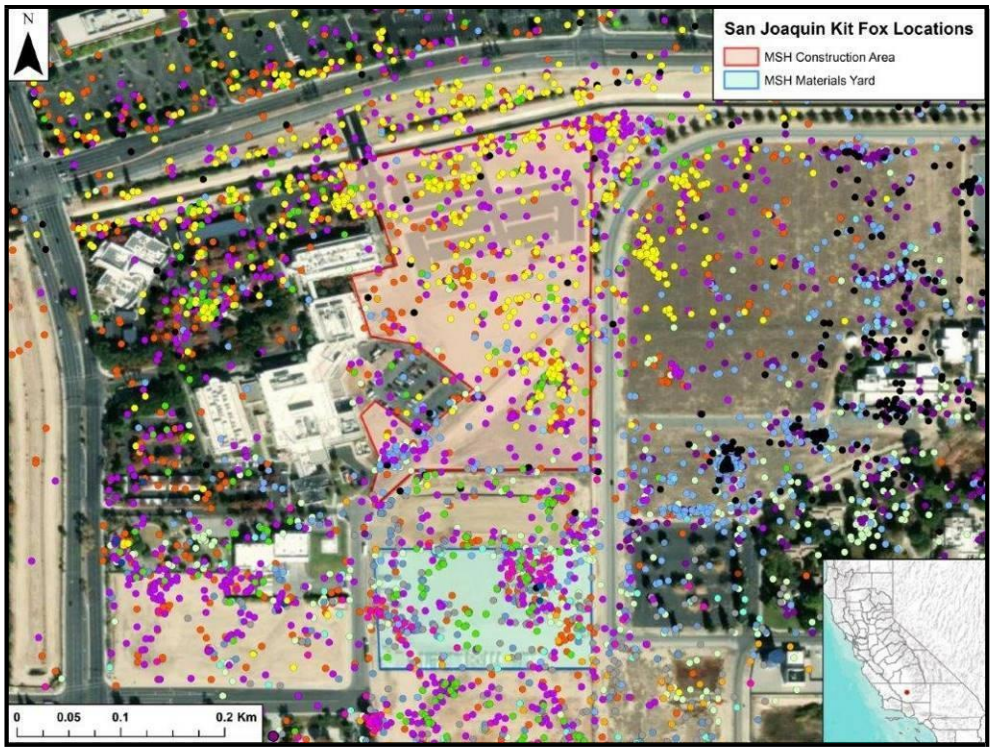

Figure 11. Telemetry locations for twenty San Joaquin kit foxes (each a different color on the Mercy Southwest Hospital study site, Bakersfield, CA, June 2023-May 2024.

On the MSH study site, 10 foxes had >5% of their locations on the construction site or materials yard and 10 foxes had <5% of their locations in these areas. The survival probability to 300 days was 0.81 (var = 0.01) for the former and 0.79 (var = 0.02) for the latter and these probabilities were statistically similar ($z = 0.1159$, $p = 0.908$).

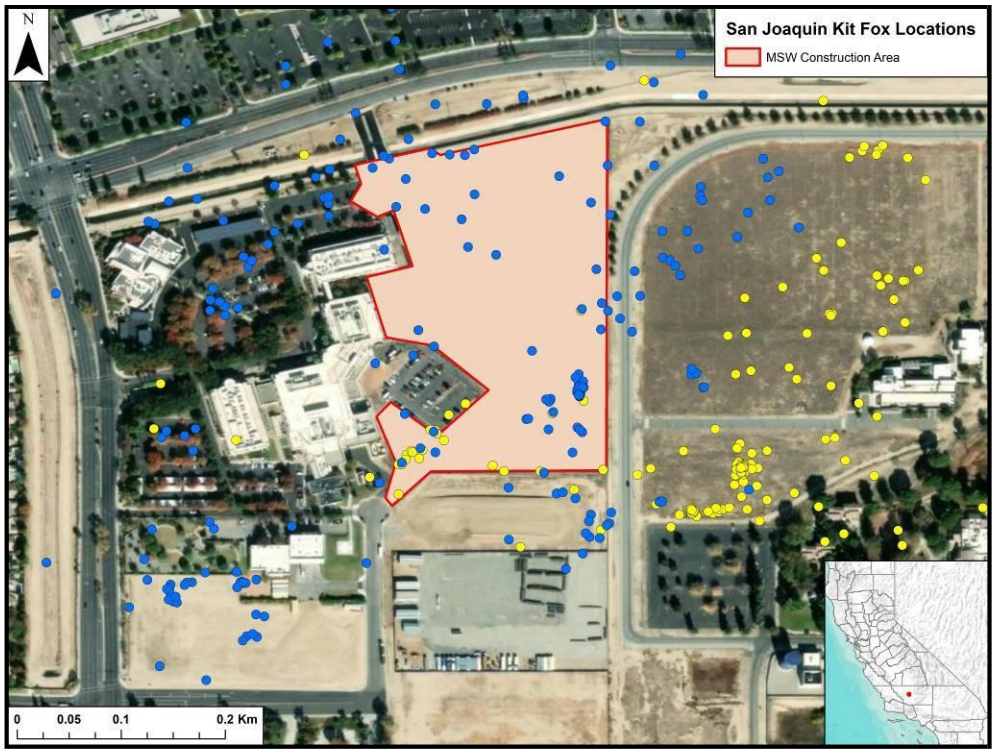

Figure 12. Telemetry locations for two San Joaquin kit foxes on the Mercy Southwest Hospital study site during September-October 2022, Bakersfield, CA.

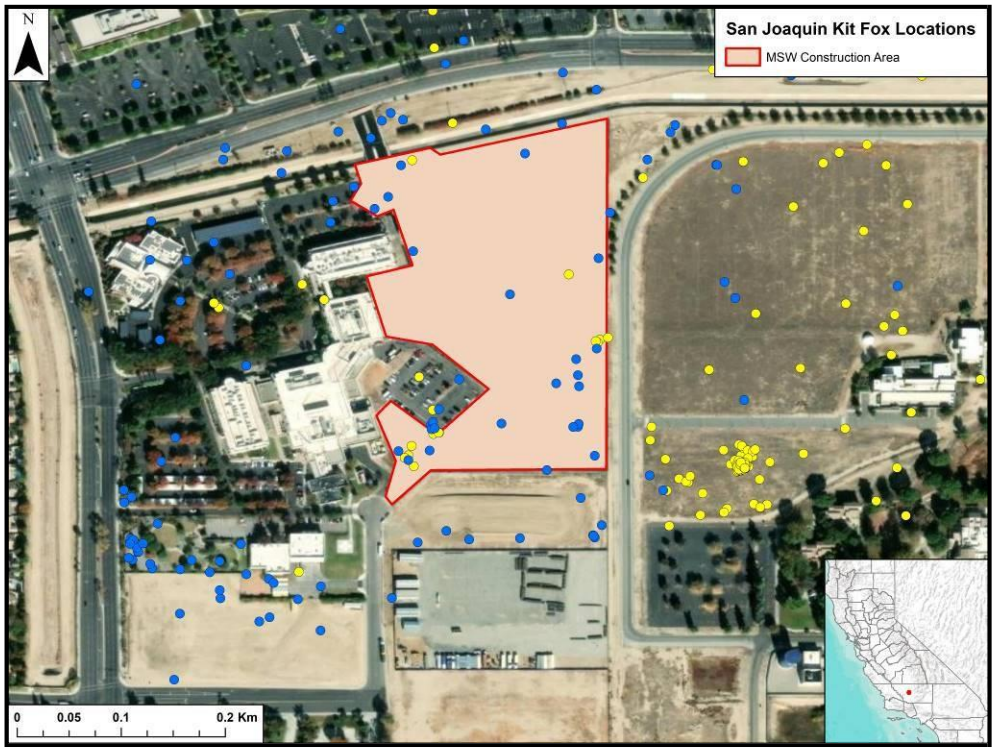

Figure 13. Telemetry locations for two San Joaquin kit foxes on the Mercy Southwest Hospital study site during November-December 2022, Bakersfield, CA.

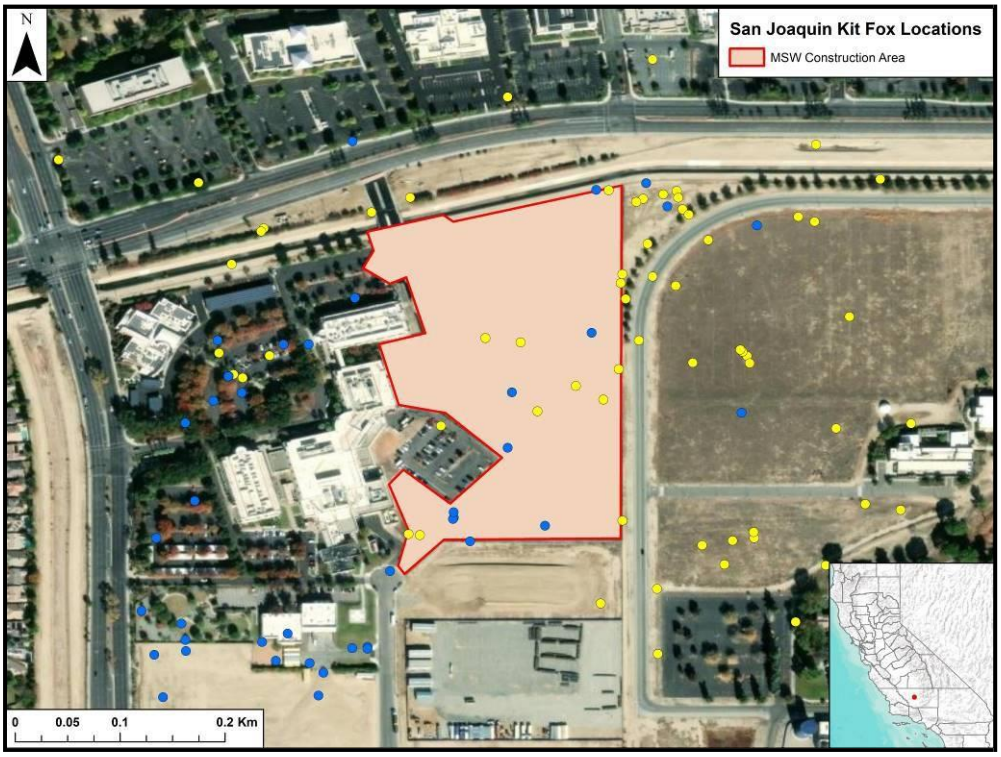

Figure 14. Telemetry locations for two San Joaquin kit foxes on the Mercy Southwest Hospital study site during January-February 2023, Bakersfield, CA.

Figure 15. Telemetry locations for two San Joaquin kit foxes on the Mercy Southwest Hospital study site during March-April 2023, Bakersfield, CA.

Figure 16. Telemetry locations for two San Joaquin kit foxes on the Mercy Southwest Hospital study site during May-June 2023, Bakersfield, CA.

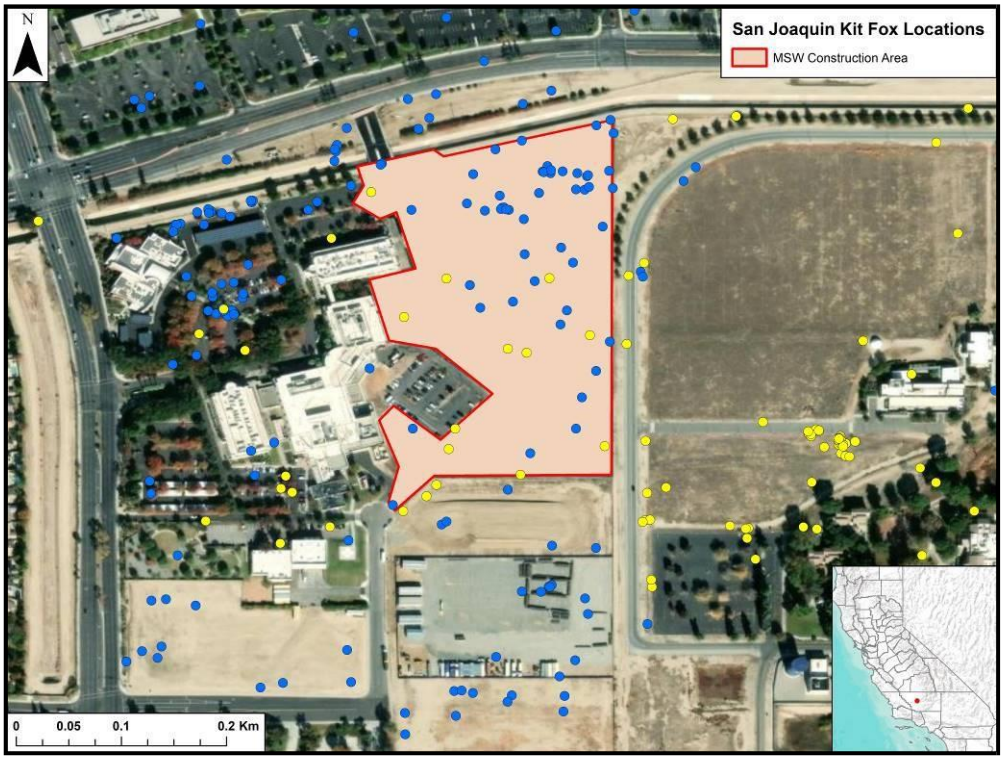

Figure 17. Telemetry locations for two San Joaquin kit foxes on the Mercy Southwest Hospital study site during July-August 2023, Bakersfield, CA.

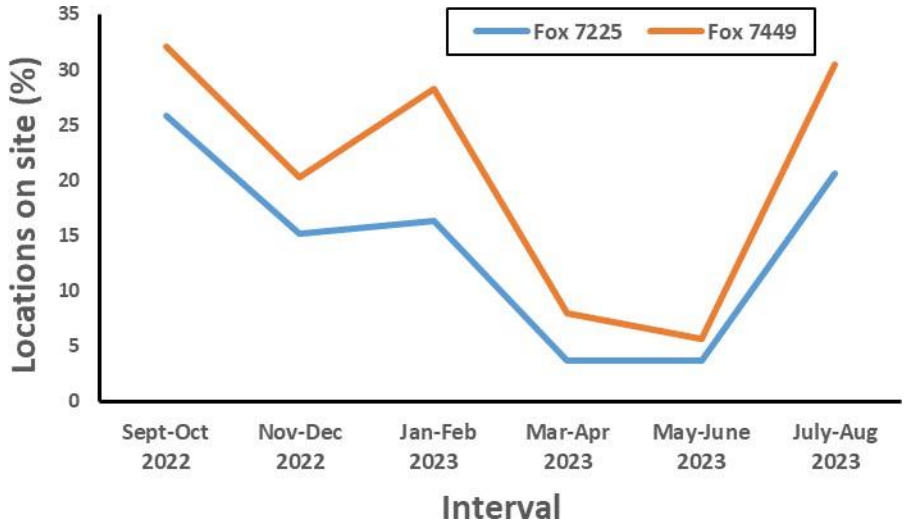

Figure 18. Proportion of locations on the Mercy Southwest Hospital construction site for two San Joaquin kit foxes during six two-month time intervals in Bakersfield, CA.

DISCUSSION

The main findings from this project regarding kit foxes and Caltrans construction sites can be succinctly summarized as follows:

1. Resident kit foxes will continue using a construction site and nearby kit foxes will access and explore a construction site despite extensive disturbance to the site and intensive construction activities occurring on the site.

2. Excluding kit foxes from accessing a construction site is extremely difficult, if not impossible.

3. To avoid work delays and increased costs attributable to kit fox presence on construction sites, it is imperative that kit foxes be prevented from establishing dens on the sites.

Kit foxes frequently visited and extensively used the two construction sites assessed in this study. The CC site continued to be used although the construction work was nearing completion. Extensive earth moving had been conducted, a road bed had been laid, lanes had been paved, overpasses had been constructed, and retaining and sound walls had been completed. However, kit foxes still regularly visited and used the site, although they only infrequently were located in active work areas or the highly developed portions of the site. They primarily used areas adjacent to the work areas, but their presence so close to the work areas still had the potential to impact work on the site.

At the MSH site, resident foxes and foxes from nearby habitats visited the site regularly during the project despite increasingly intensive construction activities and ground disturbance. The two foxes that were monitored at the site for most of the study did exhibit a reduction in their use of the site as the construction work progressed. However, their use of the site increased substantially toward the end of the study. Both foxes were

adult females. One was confirmed to have produced a litter of pups in spring 2023 and the other served as a "helper" fox and assisted another fox (likely her mother) in raising a litter of pups that spring. The decline in use of the construction site coincided with the period when these foxes would have been concentrating their activity around natal den sites, none of which were located on the study area. The increase in activity toward the end of the study coincided with the period when pups have become independent and adults are expanding their foraging areas again. Thus, the progression of work at the construction site did not seem to affect use of the site by kit foxes. Also, foxes using the construction site did not exhibit any difference in survival rates when compared to foxes that used the site very little or not at all.

Several factors may be responsible for continued use of construction sites by kit foxes. Kit foxes have high fidelity to familiar sites even when disturbance is extensive and dens have been destroyed. Kit fox home ranges in urban areas average 0.78 km^2 and those in good quality natural habitat average 5.44 km^2 (Cypher et al. 2023*a*), and home ranges are likely even larger in lower quality habitat. Construction projects, particularly long linear ones typical of highway construction, are unlikely to affect all of the habitat within the home range of a given fox. Thus, even with some habitat disturbance or loss associated with construction projects, much of the home range of a given fox will still be intact and considerable familiar habitat may still be available for use by the fox.

Although remaining in an area of active construction has risks for resident foxes, abandoning a familiar area and dispersing through unfamiliar areas also has considerable risk. Mortality rates for dispersing animals generally are high because they are unfamiliar with the locations of dangers, protective cover (e.g., dens in the case of kit foxes), and resources, particularly food (Koopman et al. 2000). Also, particularly in urban habitats where fox survival and density typically are higher (Cypher et al. 2023*a*), there may be very few vacant home ranges into which a fox might disperse.

Kit foxes also may continue to use an active construction site or even be drawn to the site due to curiosity and opportunism. Kit foxes seem to be attracted to novel situations and will explore these seeking foraging and denning opportunities. If such exploration is rewarded by the discovery of food, such as any food stuffs dropped by workers, then this will reinforce efforts by foxes to visit a site. Similarly, if denning opportunities are found, foxes will take advantage of them. Denning opportunities can be found in stacks or piles of construction materials or under structures and equipment. Even disturbed, uncompacted soils that are common on construction sites may be attractive to kit foxes due to the ease of digging new dens in such soils.

Preventing access to a site by kit foxes will be extremely difficult for a number of reasons. Kit foxes are relatively small animals and therefore are able to squeeze through relatively small spaces. Being very slender, kit foxes are able to pass through gaps as small as 3.5 inches wide. Constructing a "fox proof" fence is difficult if for no other reason than because the gaps associated with gates through the fence typically are 3.5 inches or wider. Even if the bottom of the fence is flush with the ground, kit foxes can easily dig holes under the fencing. Burying the bottom of the fence to some depth or adding an "apron" that extends out 2-3 ft along the ground from the bottom of the fence can help discourage attempts to dig under. Also, any fencing should minimally be at least 4 ft tall to prevent kit foxes from jumping or climbing over.

The configuration of many Caltrans construction sites enhances the difficulty of excluding foxes. Many of the sites are long and linear in shape. This configuration results in a site having an extensive edge. Constructing and maintaining fencing and preventing gaps becomes increasingly difficult and expensive as the amount of project edge increases.

The appearance of a kit fox on an active construction site during work hours is likely to cause a pause in work, at least in the area where the fox is present. The pause in the work might be relatively short (a matter of minutes) if the fox is active and mostly passing through the area. The pause may be longer (a matter of hours) if the fox decides to rest on the site. If it remains in a given location for the remainder of the day, the fox likely will move on by dusk when foxes naturally begin to become active and forage for food.

More problematic is when foxes dig a new den on a construction site or choose to den under materials. In essence, they are taking up residence on the site and the duration of this residence is unpredictable. Mitigation measures are available to exclude foxes from earthen dens and eliminate the den, but the process needs to be conducted in coordination with CDFW and FWS and may require a number of days or even weeks. The worst case scenario is when kit foxes occupy a den on a site and then produce pups in that den (Fig. 19). The den then has "natal" status and mitigation measures become much more limited. To prevent "take" under the Endangered Species Act and the California Endangered Species Act, CDFW and FWS will not allow the foxes to be excluded from a natal den and a wide avoidance zone around the den commonly is required. In this scenario, the delay in work in the vicinity of the den could last for months. Work will only be allowed to continue once the foxes move out of the den on their own.

Figure 19. San Joaquin kit fox mother and pups in materials stacks on the Centennial Corridor study site, Bakersfield, CA, May 2023. (Photo by E. Noel)

Summary and Recommendations

To reiterate and reemphasize, kit foxes are likely to access Caltrans construction sizes either because the sites are within the original home ranges of the foxes or the foxes are exploring the sites for foraging and denning opportunities. Preventing the foxes from accessing the sites is extremely difficult. Thus, the main goals should be to implement measures to avoid harm to the foxes while they are on the site and to discourage them from denning on the site. Either of these two scenarios, an accidental taking or creation of a den, are likely to result in significant project delays.

The recommendations and mitigation strategies to avoid the scenarios above essentially are the same as those presented in the summary report produced for Task 1 (included as an appendix to this report). These include:

- Inspect the construction site each day prior to initiation of work to ensure that foxes are not present and to identify evidence of new dens.
- Ensure that all workers on the site are properly trained in identifying kit foxes and are familiar with appropriate procedures in the event that a fox is observed on the construction site.
- If a fox appears on a construction site, have biological monitors on call to track the fox and alert workers to avoid the area where the fox is present.
- If a new den is observed on the site, immediately take appropriate measures to discourage further use by foxes and collapse the den.
- Strive to make staged materials unappealing to foxes and otherwise attempt to inhibit access to the materials, such as with use of exclusion fencing.
- Avoid to the extent possible the presence of any materials, particularly food materials, that would attract foxes.

Depending on the size of the construction site, one or more qualified kit fox biologists should inspect the construction site each morning prior to the initiation of work. They should check under equipment and materials for foxes and also search for signs of digging that may indicate that foxes are attempting to or have already excavated a new den. If foxes are known to be in the area or particularly if they have been observed on the site recently, then automated field cameras might be helpful in determining whether foxes are present on the site on a given day. If foxes or dens are observed on the site, then appropriate mitigation measures should be initiated.

Environmental training for workers now is commonplace. The training varies in details and intensity depending on the location, confirmed presence of kit foxes or other sensitive species in the area, duration of the work to be conducted, and other factors. Minimally, information should be presented that will help workers recognize a kit fox or their sign (e.g., dens, scats) along with instructions for procedures in the event that foxes or their sign are observed.

If a fox is determined to be present on a site, then it would be prudent to have a biologist closely monitor the fox. The monitor can track the movements of the fox and alert workers to the presence of the fox and its activities. Such monitoring hopefully will reduce the potential for harm coming to the fox while it is on the site.

If a new den is observed on the construction site, then it should be monitored to determine if it is currently in use by a fox. In consultation with CDFW and FWS, steps should be initiated to discourage use by foxes, and once it is certain that the den is not occupied it should be excavated and collapsed. While the den is occupied, an avoidance zone should be established around it to exclude construction activity, particularly the use of heavy equipment and vehicle traffic. "Privacy" fencing (Fig. 20) also might be installed to reduce disturbance to foxes using dens near the work area and to discourage foxes from entering the work area. In an unfortunate incident on a construction site (non-Caltrans) in Bakersfield, an exclusion zone of appropriate size was not established around an occupied den nor was fencing installed around the den. The vibrations and noise of heavy equipment operating close to the den caused a fox to bolt out and it was struck and killed by the equipment.

Staged construction materials pose a particular challenge. The stacks or piles commonly have small spaces between or under the individual pieces of materials (Fig. 21) and these spaces are extremely attractive to kit foxes for daytime resting, such as the foxes would do in a den. The situation is exacerbated if each piece of material also inherently has attractive spaces, such as is the case with pipes. Also, the longer the materials sit in one place, the greater the chances that a kit fox will discover and explore the materials for denning opportunities.

Figure 20. Privacy fencing erected around a work area at the Mercy Southwest Hospital study site, Bakersfield, CA, August 2023. Two covered kit fox dens are visible in the image and other active kit fox dens were present nearby. (Photo by E. Noel)

Figure 21. Kit fox near I-beams with small openings that could encourage daytime denning at the Mercy Southwest Hospital study site, Bakersfield, CA, November 2023. (Photo by E. Noel)

Two strategies to prevent foxes from using and occupying materials have had some success. One strategy is to attempt to place fencing around materials or at least to cover up openings. This might require a considerable amount of fencing depending on the dimensions of the staged materials. Then fencing should be at least 4 ft high to prevent foxes from jumping over. Several types of plastic safety fencing (e.g., PVC Vinyl Safety Fence or Heavy Duty Ridged Diamond Safety Fence) were tried around staged materials at the MSH site (Figs. 22-24). However, foxes were able to push under or chew through this fencing (Fig. 25). The addition of a second layer of more rigid material (e.g., chicken wire or hardware cloth) seemed to reduce breaching of the fence by foxes. Experimentation with other types of fencing may identify more effective designs. Small mesh size (Fig. 26) may help reduce incidents of foxes chewing holes in the fencing. For bundles of materials that are sufficiently small (e.g., items on pallets), completely wrapping the bundle in plastic or other material will help exclude access by foxes. The bottom of the fence should be anchored to the ground (e.g., sandbags or stakes) or even buried several inches if feasible to discourage kit foxes from digging under.

Another strategy is to elevate materials off the ground. Even elevating them 1 ft off the ground may be helpful in discouraging foxes from creating resting sites underneath. Kit foxes like to rest in small dark spaces (Fig. 27) and the larger the space and more light that shines in, the less appealing it is to foxes. On the CC site, materials were elevated on k-rails and this prevented use by foxes (Fig. 28).

Figure 22. Plastic fencing around construction materials on the Mercy Southwest Hospital study site, Bakersfield, CA, January 2024. Note the layer of metal fencing inside the plastic fence. (Photo by E. Noel)

Figure 23. Plastic fencing around construction materials on the Mercy Southwest Hospital study site, Bakersfield, CA, January 2024. (Photo by E. Noel)

Figure 24. Plastic fencing around construction materials on the Mercy Southwest Hospital study site, Bakersfield, CA, January 2024. (Photo by E. Noel)

Figure 25. San Joaquin kit fox accessing construction materials through a chewed hole in the plastic fencing around the materials on the Mercy Southwest Hospital study site, Bakersfield, CA, January 2024. (Photo by E. Noel)

Figure 26. Fencing material with small mesh size to discourage chewing by kit foxes. (Photo by E. Noel)

Materials that might be attractive to foxes should be excluded from construction sites or strictly managed to prevent access by kit foxes. In particular, food materials and even food wrappers should not be left on a site. Kit foxes are extremely opportunistic and will take advantage of such foods. Even small amounts or just a single incident could encourage foxes to return to a site repeatedly to search for food.

Finally, the incidental take permits and other documents that authorize projects under the Endangered Species Act and California Endangered Species Act commonly include a list of routine mitigation and conservation measures. Other entities such as county permitting authorities and even Caltrans itself also typically require such measures. These include escape ramps for trenches and holes, speed limits, restrictions on pets and firearms on work sites, and many others. All of these measures should be implemented as required to further reduce the potential for any adverse impacts to kit foxes.

The consistent presence of foxes on a site, the presence of active dens, and particularly the presence of a natal den with pups all can cause disruptions in work potentially resulting in significant project delays and additional costs. All appropriate measures should be taken to discourage foxes from coming onto construction sites, and in particular, to discourage foxes from establishing dens on the site.

Figure 27. San Joaquin kit fox using the space under construction materials on the Centennial Corridor study site, Bakersfield, CA, May 2023. (Photo by E. Noel)

Figure 28. Construction materials placed up on K-rails on the Centennial Corridor study site in Bakersfield, CA, May 2023. (Photo by E. Noel)

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APPENDIX

Report prepared and submitted to Caltrans in August 2022 to fulfill Task 1:

San Joaquin Kit Foxes and Road Construction Sites: Information Review and Synthesis

SAN JOAQUIN KIT FOXES AND ROAD CONSTRUCTION SITES: INFORMATION REVIEW AND SYNTHESIS

(Images provided by Erika Noel)

Prepared for the
California Department of Transportation

By:

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California State University-Stanislaus
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August 2022

INTRODUCTION

The San Joaquin kit fox (*Vulpes macrotis mutica*) is at risk of extinction primarily due to profound habitat degradation, fragmentation, and loss (U.S. Fish and Wildlife Service 1998). The remaining kit foxes may number less than 3,000 (Cypher et al. 2013). Thus, avoiding losses of individuals from anthropogenic activities is a paramount concern. Consequently, great measures are taken to avoid such losses when kit foxes are present. The California Department of Transportation (Caltrans) has a mandate to construct, maintain, and improve roads throughout the state. Kit foxes occasionally visit Caltrans project sites. Foxes visiting active work sites are at risk of harm from vehicle and equipment strikes, accidental entombment and entrapment, and exposure to harmful substances. To avoid harming kit foxes, work may be interrupted resulting in project delays and increased costs.

The factors that attract kit foxes to project sites and their activities on and around the sites are poorly understood. Gathering information on the responses of kit foxes to road construction projects will help with understanding why they visit work sites and is essential for developing mitigation strategies to discourage visits, reduce the duration of visits, and avoid harm to foxes while on the sites. In January 2022, a project was initiated to study the response of kit foxes to Caltrans road project sites and develop potential mitigation strategies. Specific objectives are to:

4. Gather information from the literature and interviews regarding kit fox visits to project sites and the efficacy of any mitigation strategies attempted.
5. Monitor kit foxes on and around both urban and non-urban project sites to better understand the response of foxes to the sites and their activities while on the sites.
6. Summarize and synthesize the information collected above into a summary report that will include recommendations for potential mitigation strategies.

In this report, we summarize information gathered under Objective 1 above. The information is summarized and recommendations are offered based on the information gathered.

METHODS

Task 1.a. Conduct a review of published and other in-print information

Written material relevant to the research topic was identified, reviewed, and summarized. This material included various environmental planning and compliance documents associated with various road construction projects. The documents included monitoring reports, incident reports, post-construction reports, biological opinions, letters of concurrence, mitigation plans, research reports, and published articles. The list of the documents reviewed is provided in Table 1. The documents were reviewed for information regarding kit foxes visiting Caltrans project sites, behavior of kit foxes on construction sites, issues associated with foxes on construction sites, mitigation measures implemented and their efficacy, and effects on project schedules and costs.

Table 1. Documents reviewed to gather information on San Joaquin kit fox presence and issues on California Department of Transportation road construction sites and potential mitigation strategies.

Author	Affiliation	Date	Title
Almaguer, Javier	California Department of Transportation	7 July 2014	2013 Annual Report for Biological Opinions (81420-2010-F-0865-1 and amended 81420-2010-F-0865-2) for the State Route (SR) 178 and Morning Drive Interchange Project EA No. 06-0C9400, 06-KER-178 PM R6.7/T9.2) in Bakersfield, Kern County, California.
Almaguer, Javier	California Department of Transportation	22 May 2017	2016 Annual Report for Biological Opinions (08ESMF00-2013-F-0373-R001 and 08ESMF00-2013-F-0373) for the Beltway Operational Improvement Project (BOIP) (06-Ker-58 PM R52.3 to PM R55.4 06-Ker-99 PM22.1 to PM 22.7) in Bakersfield, Kern County, California
Almaguer, Javier	California Department of Transportation	22 May 2017	2016 Annual Report for Biological Opinions (08ESMF00-2012-F-0258-1; 08ESMF00-2012-F-0258-2; and 08ESMF00-2012-F-0258-3) and 08ESMF00-2013-F-0373) for the State Route (SR) 178 Widening Project (California Department of Transportation EA No. 06-0F350; 06-0000-0075, 06-KER-178-PM R8.4/R10.4) in Bakersfield, Kern County, California
Almaguer, Javier	California Department of Transportation	2 April 2018	2017 Annual Report for Biological Opinions (08ESMF00-2013-F-0373-R001 and 08ESMF00-2013-F-0373) for the Beltway Operational Improvement Project (BOIP) (06-Ker-58 PM R52.3 to PM R55.4 06-Ker-99 PM22.1 to PM 22.7) in Bakersfield, Kern County, California
Almaguer, Javier	California Department of Transportation	11 April 2018	2017 Annual Report for Biological Opinions (08ESMF00-2013-F-0373-R001 and 08ESMF00-2013-F-0373) for the Centennial Corridor Project (California Department of Transportation EA No. 06-KERN-58-PM T31.7 to PM R26.2; EA 06-48460) in Bakersfield, Kern County, California
Almaguer, Javier	California Department of Transportation	29 March 2019	2018 Annual Report for Biological Opinions (08ESMF00-2013-F-0373-R001 and 08ESMF00-2013-F-0373) for the Kern River Bridge Improvements (KRBI) as part of the Centennial Corridor Project, 06-KER-58-PM T31.7-55.6 and 06-KER-99-PM 21.2-26.2; EAs 06-48460, 06-48461, and 06-48462) in Bakersfield, Kern County, California

Author	Affiliation	Date	Title
Almaguer, Javier	California Department of Transportation	1 March 2021	2020 Annual Report for Biological Opinions (08ESMF00-2013-F-0373-R001 and 08ESMF00-2013-F-0373) for the Centennial Mainline Interchange (MLI) as part of the Centennial Corridor Project, 06-KER-58-PM T31.7-55.6 and 06-KER-99-PM 21.2-26.2; EAs 06-48460, 06-48461, and 06-48462) in Bakersfield, Kern County, California
Bjurlin et al.	California State University-Stanislaus, Endangered Species Recovery Program	2005	Urban roads and the endangered San Joaquin kit fox
Bremner-Harrison et al.	California State University-Stanislaus, Endangered Species Recovery Program	2007	Use of highway crossing structures by kit foxes. California State University-Stanislaus, Endangered Species Recovery Program, Fresno, California
Clevenger et al.	Western Transportation Institute	2010	Effects of four-lane highways on desert kit fox and swift fox: inferences for the San Joaquin kit fox population. Western Transportation Institute, Montana State University, Bozeman
Clevenger and Kociolek	Western Transportation Institute	2007	Transportation effects on swift fox (*Vulpes velox*) and study site selection. Report prepared for California Department of Transportation
Cole, Patricia	U.S. Fish and Wildlife Service	11 April 2018	Revision to the Letter of Concurrence for the Cottonwood East Rehabilitation Project, Kern County, California (California Department of Transportation 06-KER-58-PM R55.4/R59.7; EA 06-0S470)
Cole, Patricia	U.S. Fish and Wildlife Service	8 November 2021	Informal Consultation for the Santa Fe Roundabout Project, Kern County, California (California Department of Transportation 06-KER-43-PM 15.6/16.0; EA 06-1A470)
Cypher, Brian	California State University-Stanislaus, Endangered Species Recovery Program	2000	Effects of roads on San Joaquin kit foxes: a review and synthesis of literature. California State University – Stanislaus, Endangered Species Recovery Program, Fresno, California

Author	Affiliation	Date	Title
Cypher et al.	California State University-Stanislaus, Endangered Species Recovery Program	2009	Effects of roads on endangered San Joaquin kit foxes. Journal of Wildlife Management 73:885-893
Forman et al.	-	2003	Road ecology: Science and solutions. Island Press, Washington, DC
Fris, Michael	U.S. Fish and Wildlife Service	7 May 2021	Fourth Reinitiation of Formal Consultation for the Bakersfield State Route 99 Rehabilitation Project (including the Bakersfield Highway Lighting Project and the Bakersfield 99 Rehab Replacement Planting Project), Kern County, California (California Department of Transportation 06-KER-99-PM 23.6/28.4, EA 06-0Q280; 06-KER-99-PM 23.6/23.7, EA 06-0S450; and 06-KER-99-PM 23.6/28.4, EA 06-0Q281)
Horchar, Victor	VHBC, Inc.	21 January 2022	Caltrans 08-1C0824 Section 14-6.03D(1): Biological Resource Incident Report
Johnson, David	California Department of Transportation	31 December 2020	08ESMF00-2018-F-0970-3; Post-construction Report for Biological Opinion for the Golden Empire Capital Preventative Maintenance (CAPM) Overlay Project, Kern County, California (California Department of Transportation 06-KER-204-PM 5.1/6.7; EA 06-0U490)
Moore, Susan	U.S. Fish and Wildlife Service	10 August 2012	Formal Consultation for the State Route 178 Widening Project (part of the Thomas Roads Improvement Program [TRIP]), City of Bakersfield, Kern County, California (California Department of Transportation EA 06-0F350; 06-0000-0075, 06-KER-178-PM R8.4/RI 0.4)
Noel, Erika	McCormick Biological, Inc.	No date (Received April 2022)	SJKF INQUIRY-CALTRANS PROJECTS
Noel, Erika	McCormick Biological, Inc.	21 September 2021	Centennial Mainline San Joaquin Kit Fox "Materials" Den Monitoring Summary AECOM Project Name: Centennial Mainline AECOM Project Number 60606420/PO Number: 114744 City of Bakersfield Thomas Roads Improvement Program (TRIP)

Author	Affiliation	Date	Title
Norris, Jennifer	U.S. Fish and Wildlife Service	27 February 2019	Second Reinitiation of Formal Consultation for the Centennial Corridor Project (part of the Thomas Roads Improvement Program [TRIP]), City of Bakersfield, Kern County, California (California Department of Transportation 06-KER-58-PM T31.7-55.6 and 06-KER-99-PM 21.2-26.2; EAs 06-48460, 06-48461, and 06-48462)
Norris, Jennifer	U.S. Fish and Wildlife Service	22 March 2019	Reinitiation of Formal Consultation for the Hageman Road Extension Project (part of the Thomas Roads Improvement Program [TRIP]), City of Bakersfield, Kem County, California (California Department of Transportation 06-KER-99-PM 26.7 /27.2; 06-KER-204-PM 5.9/6.8; EA 06-48450)
Norris, Jennifer	U.S. Fish and Wildlife Service	4 March 2020	Second Amendment to the Biological Opinion for the Golden Empire Capital Preventive Maintenance (CAPM) Overlay Project, Kern County, California (California Department of Transportation 06-KER-204-PM 5.1/6.7; EA 06-0U490)
Quad Knopf	Quad Knopf	December 2015	San Joaquin Kit Fox Den Replacement Plan CHERRY AVENUE TRUCK CLIMBING LANES PROJECT
Sanchez, Kenneth	U.S. Fish and Wildlife Service	31 July 2015	Reinitiation of Formal Consultation for the State Route 178 Widening Project (part of the Thomas Roads Improvement Program [TRIP]), City of Bakersfield, Kern County, California (California Department of Transportation EA 06-0F350, 06-KER-178 PM T9.05/T9.8 & 8.2/10.4)
Sloan, Justin	U.S. Fish and Wildlife Service	11 February 2021	Informal Consultation for the Taft Left Turn Channelization Project, Kern County, California (California Department of Transportation 06-KER-119-PM 0.2/0.6; EA 06-0X760)
Sloan, Justin	U.S. Fish and Wildlife Service	24 November 2021	Reinitiation of Informal Consultation for the Edison 2R Rehabilitation Project, Kern County, California (California Department of Transportation 06-KER-58-PM 64.4-67.3; EA 06-0X160)
Uptain et al.	California State University-Stanislaus, Endangered Species Recovery Program	2000	Analysis of San Joaquin kit fox movements and their use of crossing structures near the State Route 152/33 interchange, Merced County, California. California State University – Stanislaus, Endangered Species Recovery Program, Fresno, California

Task 1.b. Conduct interviews with individuals knowledgeable about kit foxes using project sites

Individuals with experience or information regarding kit foxes using Caltrans or other construction sites and the efficacy of any mitigation measures implemented were identified and interviewed. These individuals are listed in Table 2 and included:

- Caltrans staff (project managers and biologists)
- Agency liaison staff
- Environmental consultants (consultants who have assisted on Caltrans projects)

During the interviews, the individuals were queried about:

- Type of project being conducted
- Instances of kit foxes visiting project sites
- Behavior of the foxes on the sites
- Problems caused by the presence of the foxes on the sites
- Mitigation measures implemented
- Efficacy of the mitigation measures
- Any adverse effects to foxes visiting the sites
- Ideas on what mitigation strategies worked best and thoughts on other strategies might have worked better

Table 1. Individuals interviewed to gather information on San Joaquin kit fox presence and issues on California Department of Transportation road construction sites and potential mitigation strategies.

Individual	Affiliation	Date	Contact type	Notes
Almaguer, Javier	California Department of Transportation	11 March 2022	Internet meeting	
Boroski, Brian	H.T. Harvey and Associates	13 January 2022	Internet meeting	Also sent a report
Cannizzo, Francesca	(formerly) California Department of Transportation	12 April 2022	Phone, email	
Clark, Howard	Colibri Ecological Consulting	13 January 2022	Phone	
Daniska, Kari	California Department of Transportation	6 April 2022	Internet meeting, email	
Dart, Jason	Althouse & Meade, Inc.	1 February 2022	Internet meeting	Info on other types of construction sites
Dayton, David	Quad Knopf	14 January 2022	Phone	

Espinoza, Nestor	California Department of Transportation	5 April 2022	Phone, email	Also send a report
Fiehler, Kim	West Kern Environmental Consulting	19 January 2022	Phone	
Meade, Daniel	Althouse & Meade, Inc.	1 February 2022	Internet meeting	Info on other types of construction sites
Millan, Amy	California Department of Transportation	24 March 2022	Email	
Moonjian, Jen	California Department of Transportation	18 March 2022	Email	Also sent a report
Noel, Erika	McCormick Biological, Inc.	8 February 2022	Phone, email	Also sent a report
Schofield, Jennifer	U.S. Fish and Wildlife Service	17 February 2022	Email	Also sent multiple reports
Uptain, Curtis	Quad Knopf	14 January 2022	Phone	
Wolfe, Marcia	MH Wolfe and Associates	10 January 2022	Phone	

INFORMATION SYNTHESIS

The occurrence of San Joaquin kit foxes on construction sites is not ubiquitous primarily due to the distribution of kit foxes. Even within the boundaries of the recognized range of the San Joaquin kit fox, suitable habitat is limited and generally occurs in fragments of varying size (Cypher et al. 2013), especially outside of the population core areas identified in the recovery plan that includes kit foxes (U.S. Fish and Wildlife Service 1998). Most of the remaining habitat occurs on the west side of the San Joaquin Valley (Fig. 1), primarily west of I-5, with some habitat patches occurring in the southern and southeastern portions of the valley. Thus, the occurrence of kit foxes on construction sites is limited to areas where projects intersect remaining suitable habitat.

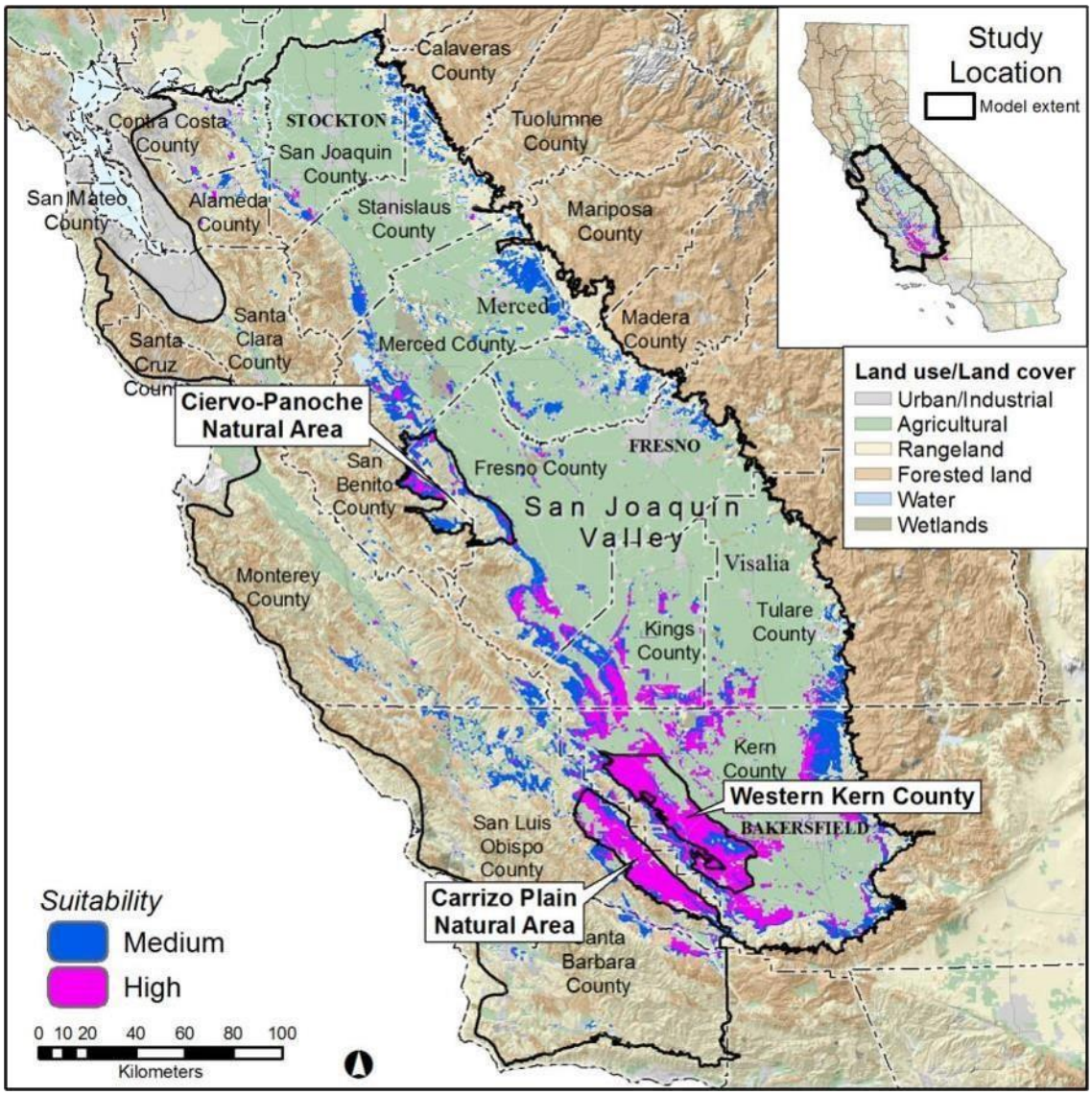

Figure 1. Remaining suitable habitat for San Joaquin kit foxes as modeled by Cypher et al. 2013. Population core areas for kit foxes are labeled.

In situations where kit foxes occur or may occur on construction sites, Caltrans routinely implements measures intended to avoid harm to kit foxes. Some of the measures are provided by regulatory natural resource agencies (i.e., U.S. Fish and Wildlife Service [USFWS], California Department of Transportation [CDFW]), some were developed by Caltrans staff in collaboration with the agencies, and some have been developed by biological consultants under contract with Caltrans. Measures provided by the agencies typically are found in biological opinions, environmental assessments, and incidental take permits.

Based on information provided by individuals interviewed and documents reviewed, several common themes were identified regarding issues involving kit foxes on construction sites:

- den avoidance and mitigation
- kit foxes denning under materials and equipment
- importance of environmental training for workers
- importance of having biological monitors on sites
- hazardous situation posed by on-site water containment basins

Den avoidance and mitigation

Kit foxes are obligatory den users. Unlike most canids, kit foxes (and closely related swift foxes) use a den virtually every single day of the year (Cypher 2003). Dens are used for avoiding extreme temperatures particularly summer heat, conserving moisture, daytime resting, bearing and rearing young, and escaping from larger competitors (Koopman et al. 1998). Thus, dens are an integral and critical aspect of kit fox ecology.

Issues involving kit fox dens on construction site typically arise due to one of two scenarios. The first is that kit fox dens may be present on a site prior to the initiation of the construction project (Fig. 2). If a den is in an area that will be directly affected by the construction, then the regulatory agencies (i.e., USFWS, CDFW) have provided protocols for monitoring the dens for use by kit foxes, and then carefully excavating and eliminating the dens when they are vacant. Sometimes, one-way doors are installed over den entrances, which allows foxes and any other animals to exit a den but prevents re-entry. If a den is in an area that will not be directly impacted by the construction, then two alternative strategies are available. One is to establish an exclusion zone around a den and allow foxes to continue using the den. A second strategy is to ensure that foxes and other animals are not in the den, block the entrances to exclude use while construction work is conducted, and the eventually reopen the den to foxes once construction is completed.

A second scenario involving dens on construction sites arises when foxes move onto a site after construction has commenced and create a new den (Fig. 3). Foxes may do this because they previously had a den on the site that was excavated and they are attempting to reestablish that den. Also, kit foxes sometimes are attracted by the soft, loose soil on sites caused by construction activities. Disturbed, loosened soil is easier for foxes to dig in than is undisturbed, compacted soil. Attractants such as food dropped by workers may increase the desire of foxes to create a den on the site. When such den creation occurs on a construction site, then work in that area usually ceases until the den can be monitored and

safely excavated. Delays associated with these scenarios generally are relatively short (e.g., days).

Figure 2. San Joaquin kit fox dens on sites prior to initiation of construction.

Figure 3. New San Joaquin kit fox dens that were created on construction sites after work was initiated.

Natal dens and litters of kit fox pups present special challenges. In an effort to allow foxes to successfully reproduce, activities near a natal den are strictly limited. When a natal den occurs on a construction site, all work activity in the vicinity of the den typically ceases until the foxes move out of the den. In these situations, work delays can be lengthy (e.g., weeks or even months). Even if a natal den is located off of the construction site, it can still impact work if the exclusion zone around the den extends into the site. The potential for a natal den to occur and the long work delays it may create highlights the importance of thorough surveys and vigilance for dens both before construction begins and even once construction has been initiated. Natal dens have appeared on the Centennial Corridor

project, SR 58 widening project in Bakersfield, and in previous improvement projects along SR 99 in Bakersfield (e.g., projects at the SR 178 and Ming Avenue interchanges). In some of these situations, work was delayed and/or work plans were altered to avoid adverse effects to the kit foxes. In others, exclusion fencing was erected between the kit fox dens and work areas and the work was allowed to continue.

Kit foxes denning under materials and equipment

Not surprisingly, kit foxes opportunistically adopt and use existing structures such as dens or burrows of other species (e.g., California ground squirrels, kangaroo rats, badger digs). Kit foxes also will readily use anthropogenic structures as dens. These include storage containers (e.g., seatrains), pipes, culverts, and piles of rubble or other materials. Staged construction materials and piles of used materials are common on construction sites, including road construction sites (Fig. 4). These constitute an "attractive nuisance" for kit foxes (and other species, such as skunks, opossums, feral cats).

Figure 4. San Joaquin kit fox denning under a pipe rack at the Topaz Solar Farm.

During interviews, a number of individuals expressed that kit foxes using or potentially using staged materials and materials piles was a significant issue. In these situations, it is not always obvious that kit foxes are under the materials. Thus, there is significant potential for harm or even death of kit foxes when the materials are eventually moved for use or disposal. One recent example was from the Centennial Corridor project in Bakersfield where kit foxes took up residence under materials and even reared a litter of pups in the materials area (Fig. 5). An exclusion zone was established around the area and none of the materials could be accessed or moved until the kit foxes eventually moved to another denning location.

Figure 5. San Joaquin kit fox adult and pups in stacks of materials on the Centennial Corridor road construction site in Bakersfield, CA. (Photo by E. Noel)

Mitigation strategies for preventing use of materials by kit foxes primarily include measures to deny access to the materials by the foxes. Fencing (various designs) has been tried but is not always effective because foxes can easily squeeze through gaps as small as 4 inches or dig under the fencing. Also, if the fencing is left down or open for any length of time, particularly overnight, foxes may take advantage of the opportunity to access the materials. A novel and effective strategy employed on the Centennial Corridor project was to place materials up on K-rails (Fig. 6). This eliminated the space, darkened spaces at the bottom of material stacks and piles that kit foxes seek as dens. Another potential strategy, particularly for used materials, is to not let them accumulate on the work site but to move them off the site (and presumably to a disposal or recycling facility) immediately or at least as soon as possible.

Importance of environmental training for workers

Another point mentioned in a number of the interviews was the importance of environmental training for any individuals working on the construction sites. This training commonly includes information on the animal and plant species that may occur on or near a construction site, measures to avoid adverse impacts to those resources, and consequences for non-compliance. The information is particularly important for workers coming from outside the region and who may have no prior knowledge of the species of concern and the laws that protect them. The training commonly is provided by environmental consultants hired by Caltrans to assist with environmental compliance and other issues on work sites. Those presenting the training have expressed that most workers are receptive to the information and do their best to comply with all rules and regulations.

Increased education and awareness on the part of the workers can even produce additional benefits such as workers providing information on sightings of species or alerting Caltrans and the consultants to emerging issues such as a kit fox den that has suddenly appeared on a site or a protected animal entering a work site while work is in progress. Training is of course critical prior to the initiation of work on a given site. However, additional training after work has been initiated also is important just as a refresher and reminder or particularly as new workers join the project. To this end, one strategy employed by some companies is to conduct periodic "tailgate" meetings that include brief reminders about environmental issues and requirements.

Figure 6. Construction materials placed up on K-rails on the Centennial Corridor road construction site in Bakersfield, CA. (Photo by E. Noel)

Importance of having biological monitors on sites

The importance of having biological monitors on the construction sites also was mentioned in a number of the interviews. The monitors typically are environmental consultants that have sufficient training and experience to be designated as "qualified kit fox biologists" by the USFWS and CDFW. Their presence on construction sites provides a number of benefits. They can monitor work activities and ensure that workers are complying with environmental requirements. The monitors can be on the lookout for situations that could become environmental issues (e.g., open trenches, stacks of materials that could be used as dens, animals suddenly appearing on work sites) and correct them before problems occur. On-site monitors also can respond quickly to concerns of or situations identified by workers. The presence of biological monitors on work sites generally results in fewer adverse impacts to species and greater environmental compliance. One final note is that monitors are a must when any work is occurring at night when kit foxes are active.

On-site water containment basins

Water containment basins are sometimes built on construction sites to store water for activities such as dust abatement. The basins commonly are constructed by excavating a depression and then lining them with a water impermeable liner. Although the banks of the basins generally are not steep, the liner can be slippery, particularly to an animal with wet feet. Consequently, kit foxes have drowned in these basins on road construction sites on at least two occasions. (One of these was a desert kit fox on a project site in the Mojave Desert.) A kit fox also was trapped in a basin on the Panoche Solar Farm site during construction (Fig. 7). The fox managed to get out of the water but apparently could not climb up the bank. It was rescued from the basin but died soon after.

Water likely is a strong attractant for animals, particularly in hot, dry environments. Predators like kit foxes also could be attracted to basins if other animals have entered and drowned previously and could serve as a food source. In the desert kit fox incident, there were actually three layers of fencing surrounding the basin. However, as mentioned previously, kit foxes are able to squeeze through very small gaps in fencing or dig under fences. Also, the fencing at the Mojave Desert site may have been compromised by people illegally accessing the site.

Given the difficulty in excluding foxes, other mitigation strategies have been tried. One is to put netting or some other material on top of the lining to give kit foxes traction if they enter the basin. The basin at the Mojave Desert site had steeper sides, and biologists developed "escape ladders" that were installed around the rim of the basin to allow foxes to climb out if they fell in.

Figure 7. San Joaquin kit fox in a water containment basin on the Panoche Solar Farm construction site.

Other topics of potential importance

During the interviews, one or more individuals also mentioned the following issues or concerns regarding kit foxes on construction sites.

Trash: Eliminating trash on construction sites is important. Food trash in particular can attract kit foxes and other animals to a site. Even non-food trash can be an attractant as kit foxes tend to be rather curious and will routinely investigate novel items.

Kit foxes entering construction sites during work: Interestingly, none of the individuals interviewed reported incidents of kit foxes being observed on construction sites while work was in progress. This may largely be a function of the nocturnal habits of kit foxes. During the day, when most work primarily occurs, kit foxes typically are in dens. Kit foxes have been observed on work sites during the day, but the incidents that we are aware of were not road construction sites (Fig. 8 and 9). However, the potential exists highlighting the value of worker training and having monitors present on-site. Also, the potential for kit foxes to appear on work sites increases considerably if work is conducted at night when kit foxes are most active.

Agency coordination: A number of individuals interviewed mentioned the importance of coordination between construction teams, consultants and monitors, Caltrans, USFWS, and CDFW. Ensuring that everyone was "on the same page" was important with regards to preventing issues and facilitating measures to avoid impacts to kit foxes. Some individuals did express that this coordination sometimes required considerable time that resulted in work delays.

Figure 8. San Joaquin kit fox present on a residential construction site during the day.

Figure 9. San Joaquin kit fox resting under a construction vehicle during the day at the Topaz Solar Farm.

K-rail: K-rails (commonly referred to as "Jersey barriers" outside of California) are sometimes used in road construction areas to delineate temporary traffic lanes, prevent collisions, and block vehicle or equipment access to certain areas. The K-rails generally are quite effective in achieving these goals. One drawback mentioned during interviews is that the barriers can impede or restrict animal movements. Animals also sometimes get trapped up against the barriers. Gaps are sometimes left between adjacent K-rails to allow animals to pass through the barriers. Although these gaps permit passage, animals are not able to see traffic on the other side until they pass through. Thus, if animals rush through the K-rail gaps, they may be struck by vehicles on the other side. Two kit foxes were struck by vehicles by the Morning Drive x SR 178 project area (Fig. 10) and K-rails may have had a role in the mortalities.

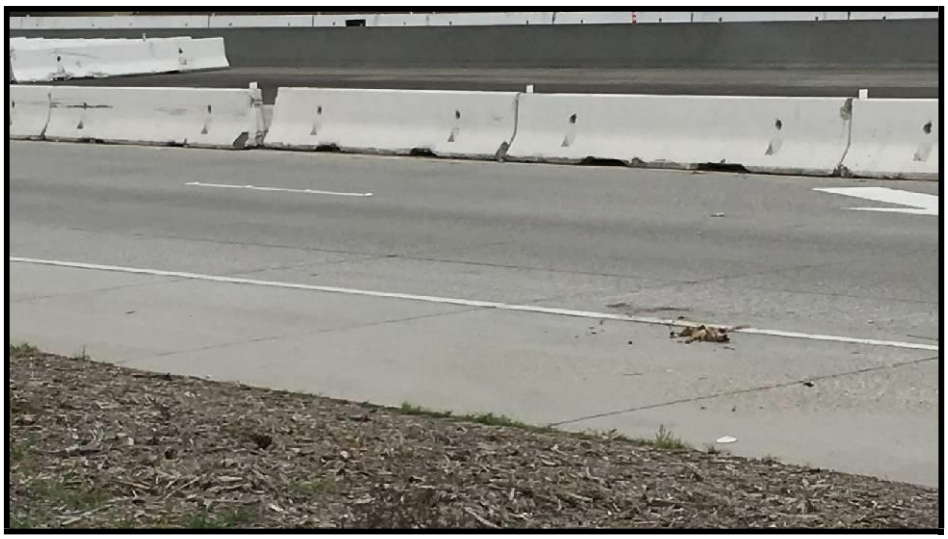

Figure 10. San Joaquin kit fox that was struck and killed by a vehicle. It is unknown whether the line of K-rails contributed to this mortality. (Photo by E. Noel)

Summary

Kit foxes likely appear on construction sites for two primary reasons. The first is that a site is located in an area that has been in use by a given fox or foxes prior to the initiation of the construction. Thus, the foxes are already present and continue to try to use the area. Over time, use of the site may decline as the resident foxes die or as the level of disturbance on the site causes the foxes to abandon the site and shift activities to another area.

A second reason that foxes may appear on a site is that they tend to be curious and opportunistic. They have a propensity for exploring new situations and new items that may lead to new denning opportunities or food sources. If they discover that den sites or food are present, they obviously will continue returning to the site to take advantage of these opportunities. Thus, this highlights the importance of ensuring that denning by kit foxes is discouraged (e.g., expedient excavation of new dens) or that foxes are excluded from accessing potential denning sites (e.g., materials stacks). It also highlights the importance of ensuring that food and food trash are not dropped on the site and that foxes are not being fed by people.

The goal of Caltrans with regards to San Joaquin kit foxes is to avoid adverse impacts to individuals during road construction projects. To achieve this goal, Caltrans and contractors routinely implement a number of mitigation strategies that were developed by Caltrans, the contractors, or the regulatory agencies (i.e., FWS, CDFW). A review of literature and internet searches did not reveal any strategies that were significantly different from those already being implemented.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on information provided by individuals familiar with road and other types of construction sites located in areas occupied by San Joaquin kit foxes, main findings include:

1. Dens

Kit fox dens present a significant challenge. Dens sometimes are present on a site before construction activities commence, but these dens usually are readily dealt with through the implementation of standard mitigation and avoidance measures such as monitoring, exclusion of foxes and other wildlife, and excavation and collapse of the den. Time and effort are required to locate and close the dens, but this rarely results in project delays. More problematic are dens that appear on sites after construction has been initiated. Such dens may cause work delays while appropriate mitigation measures are implemented to close the dens. If a kit fox family with pups moves into one of these dens, then lengthy and costly project delays can result as compliance protocols mandate that no further work can be conducted near these dens until the family relocates out of the area on its own accord.

2. Materials

Stacks or piles of materials also present a challenge in that they are extremely attractive to kit foxes as ready-made shelters. Excluding kit foxes from these stacks and piles can be difficult as usually there are multiple access points. Occupation by kit foxes can result in project delays, particularly if a family with pups moves in. Additionally, if occupation by kit foxes is not detected, then moving the materials could result in injury or death to the animals.

3. Worker awareness

Worker awareness can contribute immensely to the avoidance of kit fox issues on construction sites. The greater the awareness on the part of the workers, the more likely they will be to take actions to avoid situations that will lead to kit fox issues such as not feeding foxes, not leaving trash, obeying speed limits, ensuring that a qualified biologist has inspected materials piles before they are moved, and other actions. Workers also constitute more "eyes in the field" and can alert supervisors or biologists to the presence of new dens, kit foxes coming into work areas, or other potential problem situations.

4. Water containment basins

At least three kit foxes are known to have died in water containment basins, two of which were on Caltrans project sites. Clearly, foxes are attracted to these basins and, for reasons that are not completely clear, at least some foxes have a difficult time escaping from the basins. Fencing and other exclusionary strategies have not consistently prevented foxes from accessing the basins.

Recommendations

Based on the issues identified in the conclusions, the following recommendations are offered:

1. Surveys and training to avoid den establishment

Particularly in areas where kit foxes are known to be present, as much of the construction site as possible should be surveyed each day for the presence of new dens. The daily surveys are advised because kit foxes easily can excavate a new den overnight. The more quickly that a new den can be dealt with, the less likely that project delays will result. Such surveys are particularly advisable in the spring when litters of pups may be present in the area. Kit fox are unlikely to immediately move pups into a newly excavated den. Thus, dealing with a new den before a family has time to relocate pups there is clearly advantageous. A strong environmental awareness program with periodic refreshers can enhance efforts because workers can help identify potential new kit fox dens and report them.

2. Materials stacks

To the extent possible, stacks or piles of materials should be avoided on construction sites in areas where kit foxes are known to occur. Obviously, there are times when materials do need to be staged on site prior to use. Minimizing the staging time will reduce the opportunity for occupation by foxes. If materials will be stage for longer time periods (e.g., greater than one week), then surrounding the materials with some sort of exclusion strategy (e.g., fencing, netting) is advisable. Another strategy would be to elevate the materials such that there are no small spaces underneath that would be attractive to kit foxes. The removal of waste materials as quickly as possible is strongly advised. Waste materials such as forms, pallets, shipping materials, broken equipment usually provide attractive hiding spaces for kit foxes. These materials ultimately need to be removed from construction sites and expedient removal can help to prevent issues with occupation by kit foxes.

3. Worker training

Caltrans already has a strong record of requiring environmental training, including information on kit foxes, for its staff and for contractors working on Caltrans projects. Periodic refresher training, including even simple actions like “tailgate sessions”, can be helpful. Of particular importance is not only informing workers about what information should be reported but also how to report it. Clearly identified communication paths will facilitate reporting.

Another recommendation is to offer some sort of incentives for positive behavior on the part of workers. Awareness programs usually inform workers of the potential consequences for non-compliance. However, positive reinforcement may be equally effective. Some companies have had success offering small rewards such as stickers for hardhats, drink or food treats, gift cards, employee recognition, and other items or incentives to reward and encourage actions and behaviors that contribute to environmental compliance goals.

4. Basins

Clearly, the issue of kit foxes accessing water containment basins would best be avoided by not having the basins present on construction sites. Alternatives are available if having

large quantities of water on a site is necessary (e.g., requirements for fugitive dust control). The alternatives include water storage tanks and bladders (Fig. 11). Some bladders can hold 210,000 gallons of water while rigid tanks can hold even more water. These would not present any risk to kit foxes.

Figure 11. Two 100,000 gallon water storage bladders on a construction site. (https://readycontainment.com/bladder-tank-gallery/)

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