CONSERVATION STRATEGIES FOR SAN JOAQUIN KIT FOXES IN URBAN ENVIRONMENTS

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Prepared by:
Brian Cypher, Christine Van Horn Job, and Scott Phillips

California State University, Stanislaus
Endangered Species Recovery Program
One University Circle
Turlock, CA 95382

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California State University, Stanislaus
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PURPOSE

The purpose of this booklet is to provide information on techniques and strategies that can be used to help protect and conserve endangered San Joaquin kit foxes living in urban environments. This information hopefully will prove useful to urban planners, city managers and maintenance staff, developers, school campus administrators, golf course managers, canal operators, businesses, private property owners, and anyone else interested in assisting kit foxes living in urban areas. The goal of such efforts is to maintain a healthy and persistent urban kit fox population while minimizing impacts to the daily lives of people.

This booklet begins by providing some basic information about kit foxes, including their natural history and the reasons that they are currently endangered. Information is also provided on kit foxes living in urban areas. Then, various techniques and strategies for avoiding direct impacts to kit foxes and for conserving kit foxes are described in detail. Examples and photographs illustrating these techniques and strategies are provided when available. Finally, sources of assistance and additional information are identified.

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NATURAL HISTORY OF KIT FOXES

The scientific name for kit foxes is *Vulpes macrotis* ("*macrotis*" is latin for "large ears"). Kit foxes are members of the wild dog family (Canidae) and are closely related to swift foxes and red foxes. Kit foxes are among the smallest canids in North America. They are delicate in appearance with slender bodies, large ears, and relatively short fur that is tan to grizzled gray with a black-tipped tail. Full-grown adult kit foxes are about the size of a house cat and measure about 24-33 inches from nose tip to tail tip. Males on average weigh about 5 pounds while females weigh about 4 pounds.

Kit foxes occur in most arid regions west of the Rocky Mountains. They favor desert shrublands and grasslands, and are well adapted to hot, dry environments. Stiff tufts of hair between the toe pads on the soles of the feet improve traction on loose sandy surfaces and may help protect the feet from hot sand. Common among desert animals, kit foxes have large ears that facilitate heat radiation. Also, long dense hairs along the inner edge and base of the ear completely cover the opening to exclude blowing dust and sand. They are able to obtain adequate water from their food, but will drink water when it is available. Kit foxes feed primarily on nocturnal rodents, particularly kangaroo rats and pocket mice. They also will consume rabbits and insects such as beetles, grasshoppers, and Jerusalem crickets.

Home range size for kit foxes ranges from about 500 ac to 3,000 ac (200 ha to 1200 ha) with size increasing as prey availability or habitat suitability decline. Kit foxes will mark home range boundaries, but generally are not strongly territorial and home range overlap can be considerable.

Within home ranges, kit foxes exhibit concentrated use of "core areas", usually centered on favorite dens.

Dens are an extremely important life history component for kit foxes and are used year-round. Dens are used to bear and rear young, escape predators, avoid extreme temperatures, conserve water, and as daytime resting sites. Kit foxes spend most days in dens, although occasionally they will rest or bask above ground outside of den entrances. Although they can excavate their own dens, kit foxes also commonly enlarge badger digs or enlarge burrows of other species such as California ground squirrels and kangaroo rats. Multiple dens are located within the home range of a kit fox, and kit foxes can use a dozen or more different dens in a given year. Many dens are used repeatedly over multiple generations.

Kit fox dens have from 1 to 24 entrances, although most have 2 to 7. Entrances are approximately 20-25 cm high and <20 cm wide, and many have a characteristic "key hole" shape that helps to restrict entry by larger predators such as coyotes and badgers. Natal dens where pups are born and raised typically have multiple entrances and are more complex with multiple tunnels and 1 or more chambers. Den tunnels average 2-6 m in length and can be up to 3 m deep. Kit foxes also may den in man-made structures such as culverts, oilfield pipes, or under buildings, but young are almost always born in earthen dens.

Kit foxes can begin breeding at 1 year of age, but most do not begin breeding until their second year. Kit foxes pair during October-December and breed during December-January. Reproductive success is strongly influenced by food availability. Gestation is 49-55 days, and the pups are born from late January to March. Mean litter size is about 4 pups with a typical range of 1-6. However, litters of 8 and 9 pups have been observed. Pups emerge from the den after about 4 weeks and begin foraging with their parents at 3-4 months of age. Dispersal begins in June and peaks in July, but individuals disperse in almost every month. The mean age at dispersal is 8 months and 87% of juveniles disperse in their first year. Some young, primarily females, delay or forego dispersal, and some of these "helper" individuals may assist their parents in raising the next year's litter. Dispersal movements exceeding 30 miles (50 km) have been documented.

Survival rates of kit foxes vary annually in response to fluctuations in environmental conditions. Estimates of mean annual survival rates for adult kit foxes in California ranged from 44% to 60%. Estimates of mean annual survival rates for juvenile kit foxes in California ranged from 14% to 21%. Kit foxes can live to 7 years in the wild but most do not live past their second year.

Predators, particularly coyotes, are the primary source of mortality for kit foxes in most locations. Other predators known to kill kit foxes include bobcats, red foxes, badgers, feral dogs, and golden eagles. Disease does not appear to be a significant source of mortality for kit foxes, although rabies may have played a role in the decline of one population in San Luis Obispo County. Anthropogenic sources of mortality for kit foxes have decreased in importance, but still can be important in some locations. Historically, many kit foxes died from toxicants distributed for other predators, primarily wolves and coyotes. Rodent control programs can result in the primary or secondary poisoning of kit foxes. Vehicles have been and continue to be an important source of kit fox mortality. Other anthropogenic sources of mortality include illegal shooting and accidental death associated with agricultural and urban development.

SAN JOAQUIN KIT FOX

Although as a species kit foxes occur throughout much of the arid western United States, the San Joaquin kit fox is a distinct subspecies that is restricted to the San Joaquin Valley and a few arid valleys in the adjacent Coast Ranges. The historic range of the San Joaquin kit fox is not well defined. This range likely extended from southern Kern County north to Contra Costa County on the west side of the San Joaquin Valley and Stanislaus County on the east side. Foxes also were known to occur on the Carrizo Plain and Cuyama Valley in San Luis Obispo County, and in the 1950s were documented in the Salinas Valley in San Luis Obispo and Monterey counties. Foxes have been reported from certain valleys in San Benito and Santa Clara counties, but it is unclear whether these represent extant populations or dispersing individuals.

The current boundaries of the range of the San Joaquin kit fox probably are not significantly different from historic boundaries. However, within those boundaries, extensive areas of habitat have been converted to agricultural, industrial, and urban uses. Consequently, within the range boundaries, the remaining habitat is much diminished and is highly fragmented. The largest remaining populations occur in the southern and southwestern San Joaquin Valley and on the Carrizo Plain.

San Joaquin kit foxes prefer well-drained sandy to loamy soils as such soils support higher abundance of preferred prey (kangaroo rats) and facilitate the excavation of new dens. Kit foxes also prefer flat to gently rolling terrain. In areas where average slopes exceed 15%, kit fox abundance usually is considerably lower due to increased predation risk. Certain land uses are compatible with kit foxes, such as cattle and sheep grazing. Kit foxes also readily use areas with low to moderate oil and gas production activities. Use of agricultural lands by kit foxes appears quite limited. Kit foxes may occasionally forage in irrigated crops and orchards, but only when such lands are adjacent to natural habitat. Kit foxes also occur in some urban areas and some of these urban populations may even be persistent and viable.

THREATS AND ENDANGERMENT

Past factors that may have contributed to the decline of kit foxes included fur harvests and predator control programs. However, habitat loss and degradation has been and continues to be the primary threat to the continued existence of the San Joaquin kit fox. This loss and degradation results from conversion of habitat to agricultural, industrial, and urban uses. Approximately one-half of the natural communities in the San Joaquin Valley were converted by 1958. By 1979, of the over 3.4 million ha of historical habitat on the San Joaquin Valley floor, only approximately 149,734 ha (4.4%) was undeveloped, and considerable additional development has occurred since then. Of the remaining habitat, much of it is fragmented into small parcels, many of which are too small to support a kit fox population, and in many cases cannot even support a single kit fox home range. Furthermore, in many locations, the remaining habitat is degraded due to off-road vehicle use, trash dumping, rodent poisoning, domestic dogs, and other adverse impacts.

Habitat loss and associated declines in kit fox numbers resulted in the San Joaquin kit fox being listed as “Endangered” by the federal government in 1967, and as “Threatened” by the state of California in 1971. Recovery plans for the San Joaquin kit fox were completed in 1983 and 1998.

URBAN KIT FOX POPULATIONS

ECOLOGY

Kit foxes occur in several urban areas in the San Joaquin Valley (Figure 1). Cities with kit foxes typically are adjacent to natural habitat. Kit foxes have not been observed in towns completely surrounded by agricultural lands.

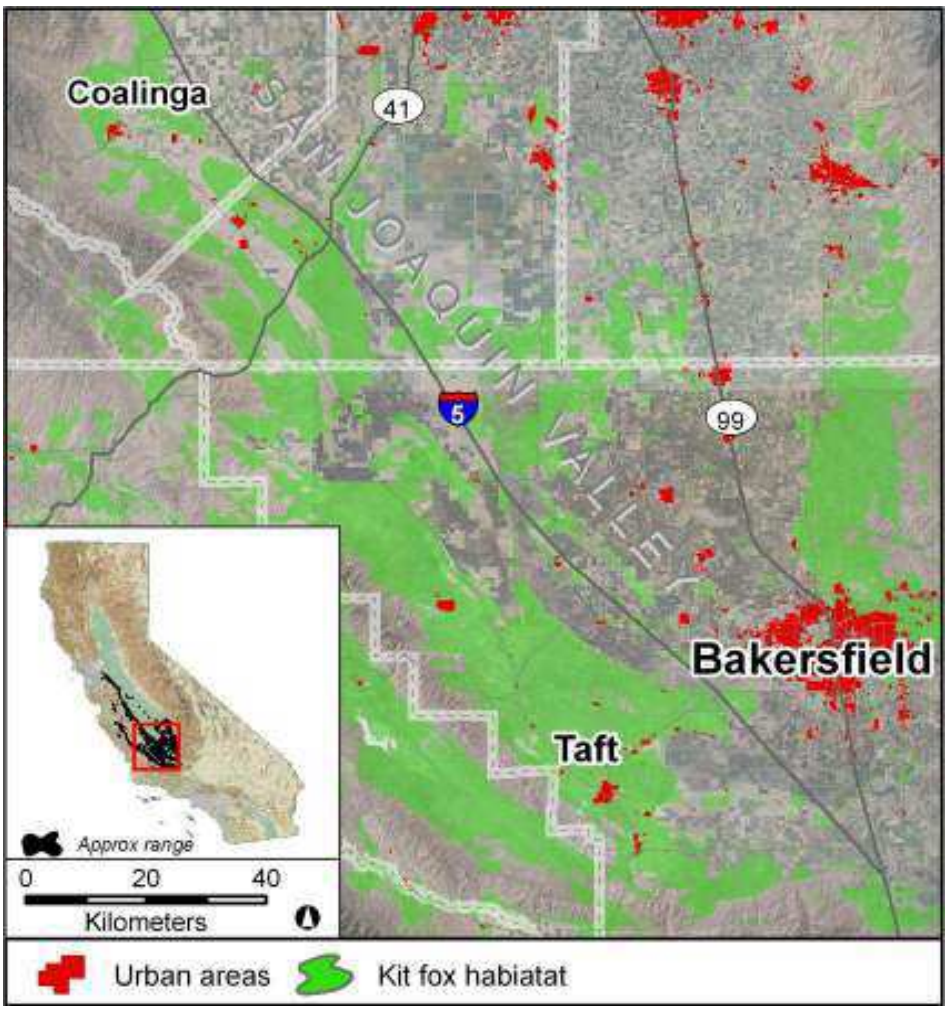

Figure 1. Urban areas with populations of San Joaquin kit foxes in the San Joaquin Valley of California.

Kit fox populations in urban environments seem to be faring quite well. The main predators of kit foxes, coyotes and bobcats, are generally absent from urban areas. However, due to the abundance and diversity of human activities in urban environments, kit foxes in these areas die from a variety of causes. Vehicles are the primary cause of mortality. Other important mortality sources for kit foxes include predators (particularly domestic dogs), poisons, entombment, sports netting, and other miscellaneous causes. Among poisons, rodenticides are a particular concern. Rodenticide exposure has been detected in almost all of the foxes tested in Bakersfield, and several foxes are known to have died as a direct cause of rodenticides. The most common

rodenticides detected in foxes were those sold over-the-counter to control rats and mice. It is unclear whether foxes are consuming the rodenticide-laced baits directly, or are consuming dead or sick rodents. Kit foxes also occasionally have been accidentally entombed when dens have been covered by ground work conducted for construction or maintenance (e.g., canal) activities. Yet, despite the many potential sources of mortality for urban foxes, their survival rates actually tend to be higher than those of foxes in natural habitats.

Kit foxes also apparently readily reproduce in urban environments (Figure 2). Litters of kit fox pups have been observed in the cities of Taft and Coalinga as well as in Bakersfield, where a number of kit fox litters are reported each year from throughout the city. Natal dens have been located in city sumps, golf courses, vacant lots, railroad right-of-ways, canal banks, under portable classrooms at schools, and in many other locations. In urban environments, "helper" foxes are commonly observed with litters. These typically are young females from the previous year that delay dispersal and assist with raising the current year's litter of pups.

Figure 2. Kit fox litter in Bakersfield.

Kit foxes in urban areas commonly use undeveloped lands (e.g., vacant lots, fallow crop fields), storm water catchment basins (sumps), industrial areas (e.g., manufacturing facilities, shipping yards), commercial areas (e.g., office and retail facilities), manicured open space (e.g., parks, school campuses, golf courses), and linear rights-of-way (e.g., canals, railroad corridors, power line corridors). Residential areas are less frequently used as they have consistently high levels of disturbance, and the presence of numerous dogs as well as fences and walls (surrounding individual yards as well as entire neighborhoods) discourage use of these areas by kit foxes. Home ranges of urban foxes are considerably smaller than those of non-urban foxes. Food is more abundant and possibly more concentrated in urban environments, and therefore kit foxes may be able to obtain necessary resources from a smaller area. High densities of foxes in

suitable urban habitats may limit space use. Also, the presence of potential barriers (e.g., large roads, walls, canals) might impede movements resulting in reduced space use.

Dens are found in a variety of sites in the urban environment. Most of these are earthen dens but urban foxes also will use man-made structures such as culverts, pipes, seatrains, portable buildings, junkyard debris, and dumpsters. Kit fox dens in urban areas vary considerably in appearance and are not always easy to recognize. Kit foxes expel dirt when digging dens and also frequently modify dens (e.g., enlarging dens, creating new entrances) resulting in more expelled soil. This excavated soil commonly appears to form an "apron" or a "berm" outside of dens (Figure 3). Freshly dug soil outside a hole of the proper dimensions is an excellent indicator of a possible kit fox den. California ground squirrels also excavate soil out of burrows, and this expelled soil can form an apron, but the entrances of squirrel burrows generally are 4" in diameter or less and are too small for a kit fox to enter.

Figure 3. Urban kit fox dens showing "apron" or "berm" of excavated soil.

In urban environments, various agents can modify the appearance of areas around den entrances and make them more difficult to recognize. These agents include water, vegetation, and human disturbance. Foxes occasionally dig dens in areas subjected to landscape irrigation (i.e., sprinkler systems). This constant sprinkling of water can erode or compact areas around den entrances making them less obvious. Vegetation also can obscure den entrances. Kit foxes occasionally construct dens between exposed tree roots or in lawn areas where grass can grow over entrances (Figure 4, Figure 5). Some dens are located in areas where foot or machinery traffic pass close to entrances, and the compaction and disturbance associated with these activities render dens less obvious. Finally, dens in or under man-made structures may not be immediately recognized as a den. Such structures include portable school classrooms, culverts and pipes, sewer openings, and rubble piles (Figure 6, Figure 7, Figure 8, and Figure 9).

Figure 4. Kit fox dens constructed between tree roots.

Figure 5. Kit fox den on landscaped golf course.

Figure 6. Kit fox den under a sidewalk.

Figure 7. Kit fox den under a portable classroom.

Figure 8. Kit foxes can den in below-ground infrastructure such as pipes or culverts.

Figure 9. Kit foxes can utilize rubble piles for shelter.

Similar to non-urban foxes, prey items consumed by urban foxes consist primarily of rodents and insects. Pocket gophers and California ground squirrels are the primary rodents consumed in urban environments, and insects consumed include beetles, grasshoppers, and cockroaches (Figure 10). Not surprisingly, kit foxes in urban environments opportunistically take advantage of various anthropogenic sources of food. These include trash and discarded food (e.g., fast-food

leftovers), but also pet food left outdoors and occasional handouts (Figure 11 and Figure 12). Kit foxes will routinely visit locations where such foods are consistently available (e.g., dumpsters, feeding stations for feral cats, residences where food is handed out). However, kit foxes in Bakersfield rarely appear to be dependent upon these foods.

Figure 10. Common foods of urban kit foxes in Bakersfield: California ground squirrel, pocket gopher, and beetle.

Figure 11. Urban kit fox scavenging trash.

Figure 12. Urban kit fox eating out of a pet food dish.

Cats, both feral and pets, commonly occur in areas used by kit foxes. However, the two species mostly appear to avoid and ignore each other. Kit foxes and cats are close in size structurally, but cats generally are 2-3 times heavier than kit foxes. Most dogs are larger than kit foxes, and dogs to occasionally kill foxes. Thus, dogs are generally avoided.

Urban kit foxes rarely cause nuisance problems. They are virtually silent, and so noise is not an issue. They do not cause property damage and rarely are nuisances (e.g., spilling trash out of

receptacles). Kit foxes have not been reported to attack pets, although they occasionally will consume food left outside for pets. No instances of kit foxes attacking people have ever been reported. Only 2 instances of kit foxes biting people have been reported. In one instance, an individual was trying to capture a kit fox by hand. In the other instance, a student was attempting to assist a kit fox entangled in a soccer goal net. The most frequent complaint about kit foxes is from golfers who report that foxes occasionally run out and steal their golf balls!

VALUE OF URBAN KIT FOX POPULATIONS

Urban kit fox populations can contribute to conservation and recovery efforts for the species in a number of ways. These populations add to the total number of populations and number of surviving kit foxes, and increase the genetic diversity of San Joaquin kit foxes range wide. Urban environments are less prone to the environmental variation observed in natural habitats (such as annual rainfall fluctuations and the resulting effects on prey availability) and thus, urban populations appear more stable and could serve as a "hedge" against catastrophic events in the natural environment. Urban populations can also provide individuals to repopulate either existing natural lands after such a catastrophic event or newly restored lands within its former range. An additional benefit of urban populations is increased public awareness and interest by local residents due to more frequent observations or encounters with kit foxes. Based on a survey, Bakersfield residents who had observed kit foxes had greater appreciation and knowledge of them and expressed greater support for conserving foxes both in Bakersfield and elsewhere.

REGULATORY REQUIREMENTS

San Joaquin kit foxes are afforded protections under the federal Endangered Species Act (ESA), the California Endangered Species Act (CESA), and the California Environmental Quality Act (CEQA). Both ESA and CESA protect listed species from "take"; under CESA take is defined as direct mortality whereas under ESA take also includes harm and harassment. Under the ESA definition, habitat for listed species is protected from significant modification or degradation. CEQA primarily encourages measures to minimize adverse impacts to species, but does not guarantee that such measures are actually implemented.

The Metropolitan Bakersfield Habitat Conservation Plan (MBHCP) was completed and implemented in 1994. The MBHCP allows kit fox habitat in Bakersfield to be developed in return for protection of natural habitat outside the city. Furthermore, the MBHCP includes a number of mitigation measures to prevent direct mortality of kit foxes during development activities. These measures include the monitoring of potential kit fox dens prior to destruction, the careful excavation of known dens prior to construction, and the notification of either the U.S. Fish and Wildlife Service or the California Department of Fish and Game if a kit fox appears on a construction site where it could potentially be harmed. The MBHCP will expire in 2014 and the development of a new HCP has been initiated.

CONSERVATION STRATEGIES FOR URBAN KIT FOXES

DEN AVOIDANCE

Dens in the urban environment that are actively being used by kit foxes or that are known to have been used by foxes should be protected from damage or destruction. Simply avoiding any destructive or disturbance activities near the den usually is sufficient. However, if the den is in a location with heavy human use, then more aggressive measures may be warranted. Such measures can include posting signs near the dens (Figure 13, Figure 24), encircling the den with caution tape (Figure 14), or even protecting the den with physical barriers, such as fencing (Figure 16).

Figure 13. Sign posted near kit fox den.

Figure 14. Caution tape around den in landscaped area of office complex.

Figure 15. Caution tape and signs surrounding den in office complex landscaping.

Figure 16. Kit fox den protected by permanent iron fencing.

When dens have to be destroyed (e.g., den is in the path of approved development or constitutes a significant danger for people), there are specific protocols for monitoring a den to ensure that it is not occupied and then carefully excavating and collapsing the den. Such den destruction can only be conducted by qualified biologists, and can occur only when a den is on a development site where appropriate mitigation permits have been secured, or when specific permission has been secured from the U.S. Fish and Wildlife Service and/or the California Department of Fish and Game.

ARTIFICIAL DENS

Artificial dens can be installed for kit foxes both to mitigate for the destruction of natural dens and as a proactive habitat enhancement to encourage kit fox conservation. The installation of artificial dens has been required in situations where the destruction of natural dens, in association with development projects, cannot be avoided. Artificial dens also have been voluntarily installed by property owners as a means of promoting the conservation of kit foxes.

Kit foxes will readily use artificial dens. Kit foxes have been documented using a variety of artificial den configurations consisting of various materials. Thus, there are no rigid specifications for the construction of artificial dens. However, based on research, certain configurations and materials may be more appealing to kit foxes and therefore are more likely to be used by foxes. Also, artificial dens can be separated into two types: "escape" dens and "residency" dens (Figure 17, Figure 18, Figure 19, Figure 20, Figure 21). Escape dens can be relatively simple structures that foxes can use as shelter if pursued by a predator. Residency dens can also be used for escape, but also are used by foxes for daytime resting, thermal regulation, and even rearing young. Residency dens consist of 2 parts: tunnels and chambers.

Below are recommendations for choosing locations and constructing residency dens and example den designs are included in Appendix A.

First, location is important. Artificial dens intended for residency should be constructed in locations where disturbance to both dens and foxes will be minimized. Areas with no or infrequent human activity are ideal. Some examples include corners of storm water drainage basins or canal right-of-ways that are not subject to activities such as grading or herbicide applications, or quiet corners of properties including school campuses, golf courses, or businesses. Locations also should not be subject to flooding. Areas subject to periodic (i.e., no more that monthly) vegetation control (e.g., weed-whacking, mowing) are okay, and such management can help to keep den entrances clear.

Second, although a variety of materials can be used to construct artificial dens, some appear to be more attractive to foxes, and some are less expensive and also are easier to work with. Materials that will not rot or corrode are preferable. Dens constructed of metal or concrete appear to be somewhat less attractive to foxes. These materials also are quite heavy and extremely difficult to modify. Foxes seem to view dens constructed of plastic-type materials more favorably. These favorable materials include PVC (polyvinyl chloride) and HDPE (high-density polyethylene). PVC pipes and conduits are readily available from many sources. PVC also is relatively easy to cut into desired lengths and configurations. HDPE pipes and conduits of the appropriate diameter may need to be ordered. HDPE pipes that are corrugated on the inner surface work particularly well as the interior corrugations provide greater purchase for the foxes. HDPE pipes also are flexible, light-weight, and very easily cut into desired lengths and configurations. PVC and HDPE pipes can both be used for den tunnels. For den chambers, plastic-type materials again work well. Irrigation valve boxes and igloo-style dog houses are two readily available (e.g., hardware and pet stores) and relatively inexpensive structures that are easy to work with and appear readily used by foxes. Holes can easily be cut in the sides of these structures to connect them with tunnels.

Third, certain den configurations may have a higher probability of use of kit foxes. Foxes have been documented to use everything from straight lengths of pipe sitting on the ground surface to complex structures buried underground. However, structures that offer greater protection from larger predators, thermal insulation, and seclusion appear to be more attractive to foxes. Pipes of 6-inch diameter work well as den tunnels and pipes of this diameter also are effective in excluding larger predators such as coyotes, bobcats, adult red foxes, and most dogs. These pipes should be 5-10 feet long. Pipes of 8-inch or 10-inch diameter also can be used for tunnels, but then the entrances should be altered to help exclude predators. Strategies to achieve this can include vertically inserting pieces of rebar, metal or wood stakes, or other sturdy structures in front of the entrance to narrow it down to a width of 4-6 inches. To provide thermal insulation, particularly from hot summer temperatures, dens should either be buried or, if placed on the ground surface, covered with a minimum of 2 feet of soil (more is preferable). If buried, the bottom of the den chamber should be 2-4 feet below the ground surface. To increase seclusion, there should not be a direct line-of-sight from tunnel entrances into the den chamber. This can be achieved by bending the pipes (usually only possible with HDPE pipe) between the entrance and the chamber, inserting an elbow piece of 30-45 degrees between the entrance and chamber, or having the tunnel enter the chamber at a 30-45 degree angle (either from the surface if the den is buried, or from the side if the den is constructed on the surface). The den chambers should have open bottoms to facilitate drainage and also allow the foxes an opportunity to expand the

den by digging out from the chamber. Finally, openings (strips or holes) can be cut in the bottom of tunnels to facilitate drainage.

Figure 17. Installation of a *residency* den under school athletic field bleachers.

Figure 18. Post-installation view of *residency* den under school athletic bleachers.

Figure 19. San Joaquin kit fox approaching artificial *residency*-type den.

Figure 20. Installation of artificial single-entrance escape den.

Figure 21. Installed single-entrance escape den.

SIGNAGE

In some situations, simply installing signage can help protect kit fox dens. The signs can be temporary or more permanent. Few people are sufficiently knowledgeable to recognize a fox den, and some fox dens are not obvious (e.g., dens in dense grass). Signs help alert people to the presence of a den and avoid impacting it. One cautionary note is that signs also can draw undesirable attention to a den. Thus, both the potential benefits and detriments need to be considered before installing signs near fox dens.

Figure 22. Sign on golf course to alert people to the presence of a kit fox den.

Figure 23. Sign on golf course to alert people to the presence of a kit fox den.

Figure 24. Sign posted to caution drivers near kit fox den adjacent to office driveway.

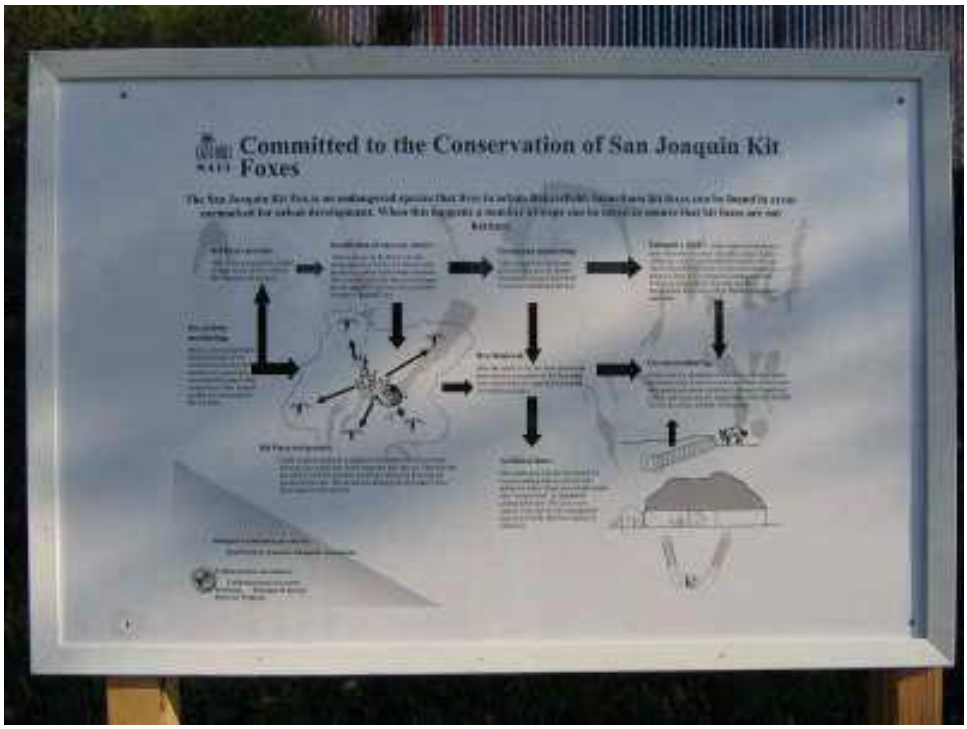

Figure 25. Sign posted in shopping mall landscaped area to educate workers and the public on steps to avoid harm to kit foxes.

PASSAGE THROUGH FENCES AND WALLS

Numerous fences and walls are present in urban environments, with the greatest densities commonly observed in residential areas where each yard may be surrounded by a fence and each neighborhood surrounded by a wall. Kit foxes generally avoid residential areas due to these obstructions as well as the high intensity of human activity and abundance of domestic dogs. However, in areas with non-residential uses (e.g., recreational, open space, commercial, industrial), it is desirable to maintain access and movement corridors for kit foxes. In these areas, fences and walls can be easily designed or modified to allow passage by kit foxes. Fences with openings at least 4 inches wide and 6 inches tall or with a gap of at least 4 inches at the bottom will allow kit foxes to pass through (Figure 26). Likewise, walls with similar sized openings also will be permeable to kit foxes (Figure 27). For both fences and walls, passages can be designed and built into these barriers, and existing barriers can be modified to add passages.

Figure 26. Chain-link Fence with opening on bottom.

Figure 27. Wall designed with opening (b) to allow kit foxes to pass though.

ROAD CROSSING STRUCTURES

The density of roads is extremely high in urban environments and kit foxes frequently cross roads, many on a daily basis. Fortunately, because the foxes are primarily nocturnal, most road crossings occur in the late hours of the evening or early hours of the morning when it is dark and when vehicle traffic volumes are lower. Predicting where foxes will cross roads is difficult, and therefore the installation of crossing structures specifically for foxes usually is not a practical or cost-effective conservation measure. Kit foxes will occasionally use crossing structures (e.g., bridges, tunnels) constructed for vehicles, pedestrians, horses, or bicycles. Less commonly, they will use smaller structures such as culverts to cross roads. Despite the risk of crossing roads directly, kit foxes may be reluctant to use these smaller structures out of fear of ambush by larger predators. Certain design features might encourage use of such structures by foxes. Such features include making the structures as large as possible, ensuring that foxes can see through to the other side, installing grates over the entrances that exclude larger predators, and installing escape dens within the structure.

GROUND DISTURBING ACTIVITIES

Some lands in urban environments are routinely or occasionally subject to ground disturbing activities. These activities include grading and disking, and are conducted for such purposes as repairing water erosion damage, maintaining the integrity of water impoundment banks, suppressing or eliminating vegetation, and decreasing habitat suitability for nuisance animals such as ground squirrels, black rats, and house mice. In particular, such activities are routinely conducted in storm water drainage basins (i.e., sumps), along canals, and on undeveloped lots.

These activities could potentially damage or destroy kit fox dens, as well as harm or even kill kit foxes present within the dens. If grading and disking are conducted in a sufficiently shallow manner (e.g., 1-3 inches for grading, 3-6 inches for disking), they may not pose a great threat to kit fox dens. However, the preferred approach is to survey for dens prior to conducting these activities and then avoiding directly grading or disking over the dens. Furthermore, unless thorough surveys for dens are conducted prior to initiating work, these activities, as well as any other ground disturbing activities, should never be conducted during January to June when young pups may be present in dens. Pups at this age are less capable of digging their way out of collapsed den entrances. But after early June, young kit foxes are better able to escape from dens prior to or after impacts, and the threat of adverse impacts is reduced. Also, mowing is as alternative strategy for controlling vegetation as it would not cause damage to dens.

RODENTICIDE USE

Rodenticides are commonly used throughout urban environments to control undesirable rodents, particularly rats, house mice, ground squirrels, and gophers. Common products used in urban areas to control rats and mice generally consist of a "bait station", usually in some sort of container that presumably excludes non-rodent animal species. Products used to control squirrels and rodents generally consist of a grain-based bait laced with a toxic substance. Common rodenticide products include those with brand names such as d-Con, Tomcat, and Kaput-D. The toxic substances incorporated in the baits generally are anticoagulants that cause mortality by causing internal bleeding. Many gopher baits contain strychnine. Rodenticides pose a risk to kit foxes. A number of kit fox deaths in Bakersfield have been attributed to rodenticides. Furthermore, most kit foxes tested in Bakersfield have exhibited evidence of exposure to rodenticides. It is unclear whether the foxes are consuming the baits directly (i.e., "primary exposure") or are consuming sick or dead rodents that have consumed the baits (i.e., "secondary exposure"). To prevent primary exposures, bait stations should only be placed in locations inaccessible to kit foxes. Gopher bait should be distributed in a manner that also makes it inaccessible to kit foxes (i.e., deep into the ground), per label instructions. Furthermore, any dead or sick rodents should be collected and disposed of so that they are not available for consumption by kit foxes.

Figure 28. Rodenticide bait station near a shopping center parking lot.

URBAN LANDSCAPE PLANNING

The configuration of urban landscapes can significantly influence the ability of kit foxes to persist in such environments. In brief, kit foxes require areas to establish dens, areas to forage, and corridors for safely moving between areas. Kit foxes commonly can utilize areas such as undeveloped lands, commercial and light industrial complexes, golf courses, school campuses, parks, cemeteries, storm water drainage basins, canal banks, power line corridors, railroad yards and right-of-ways, and other open spaces. Residential areas generally receive little use by foxes, probably due to the abundance of fences, walls, dogs, vehicles, and human activities in such areas. Open areas as small as an acre can even be used by foxes if they are connected to other areas by movement corridors. To the extent practical and possible, urban planners could design new developments in a manner that facilitates use by kit foxes. In particular, siting useable areas adjacent to each other increases the space potentially available to kit foxes. For example, in Bakersfield, there are a number of locations where school campuses occur next to storm water drainage basins and city parks, resulting in larger useable spaces for kit foxes. Additionally, such spaces could be connected by movement corridors such as canal, railroad, and power line corridors. Another possibility is to connect areas with recreational corridors that include walking or biking paths for people. Kit foxes will readily use such corridors. Simple measures like those above will significantly facilitate use of urban environments by kit foxes.

SPORTS NETTING

Sports netting constitutes a potential hazard for kit foxes. Such nets include soccer goal nets, baseball batting cage netting, and any other nets hanging at ground level (although tennis court

nets do not appear to be a problem. Each year, there are several instances of kit foxes becoming entangled in these nets, and in many cases, the fox has died while entangled. The reasons that foxes become entangled are unclear. Regardless, these accidents are easily prevented. Soccer nets can easily be taken down when not in use. Alternatively, the bottoms of the nets can be lifted 2-3 feet and secured, thereby allowing foxes to pass underneath them. Batting cage nets constitute a more difficult situation in that the nets are not easily detached. However, it may be possible to raise up the lower portions of the nets or to take measures to exclude foxes from entering batting cages.

Figure 29. Kit fox trapped in sports netting.

PREVENTATIVE MEASURES

Efforts by people to avoid direct interactions with kit foxes will contribute significantly to the conservation of kit foxes in urban environments. Such interactions include touching, feeding, harassing, or disturbing occupied dens. Feeding potentially could be unhealthy for foxes if the foods being fed are of low nutritive value. Feeding also could habituate foxes to people thereby increasing the potential for harm to a fox or person. Attempting to touch a fox also could result in harm to the fox or injury to the person from a bite. Harassing a fox (e.g., attempting to frighten, chase, capture, etc.) could endanger the animal (e.g., by causing it to run into a road) and also is illegal. Disturbing occupied dens also could endanger any foxes within, particularly if the disturbance causes some portion of the den to collapse thereby entrapping the foxes. Kit foxes consistently avoid direct interactions with humans. If people also refrain from directly interacting with foxes, it will help to keep the animals wild and will minimize opportunities for negative interactions that might result in harm to the foxes or people.

INJURED OR DEAD FOXES

Injured or dead foxes are occasionally encountered in urban environments. If an injured fox is found, despite empathetic urges to assist the animal, such assistance could result in a bite. Instead, a trained professional should be notified who can then come and capture the fox and take it for medical attention. Currently, the California Department of Fish and Game is the appropriate contact for injured foxes (see Sources of Assistance).

If a dead fox is found, the California Department of Fish and Game again is the most appropriate contact. If there is any suspicion that the fox was willfully killed by a person, then this situation potentially constitutes an illegal act. In such situations, the fox and area immediately around the carcass should not be disturbed, and either the California Department of Fish and Game or the U.S. Fish and Wildlife Service should be contacted. If a dead fox is found on a road and was most likely struck and killed by a vehicle, then the local Animal Control department may be willing to collect and dispose of the carcass.

SOURCES OF ASSISTANCE

California Department of Fish and Game
1234 East Shaw Avenue
Fresno, CA 93710
559-243-4005

U.S. Fish and Wildlife Service
2800 Cottage Way, W-2605
Sacramento, CA 95825
916-414-6464

California Living Museum
10500 Alfred Harrell Highway
Bakersfield, CA 93306
661-872-2256

California State University – Stanislaus
Endangered Species Recovery Program
P.O. Box 9622
Bakersfield, CA 93389
661-835-7810

GENERAL REFERENCES

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APPENDIX A. ARTIFICIAL DEN DESIGNS

ESCAPE DENS

Designed to provide escape cover for kit foxes. Two different lengths were used to determine whether kit foxes preferred the greater seclusion associated with a longer den.

1. A 10-ft long length of pipe placed on the surface of the ground and covered with several inches of dirt to provide thermal insulation.
2. A 20-ft long length of pipe placed on the surface of the ground and covered with several inches of dirt to provide thermal insulation.

SUBTERRANEAN DENS

Designed to provide escape cover as well as diurnal resting cover for kit foxes. The 2 designs used will determine preference by foxes for 1 versus 2 entrances.

3. A 10-ft length of pipe with one end at the surface and one end buried approximately 3 ft underground. Underground end is open to allow foxes to expand the den and even create new entrances.
4. A 3-ft length of pipe buried approximately 3 ft underground and accessed by 2 5-ft long entrance pipes.

CHAMBERED DENS

Designed to provide escape cover and diurnal resting cover for kit foxes, and also provides a chamber for resting or reproduction. The 2 designs used will determine preference by foxes for 1 versus 2 entrances. Also, 2 different chamber designs were used to determine whether foxes exhibit any preference among designs.

5. A chamber buried approximately 3 ft deep with one 5-ft long entrance pipe.
6. A chamber buried approximately 3 ft deep with two 5-ft long entrance pipes.

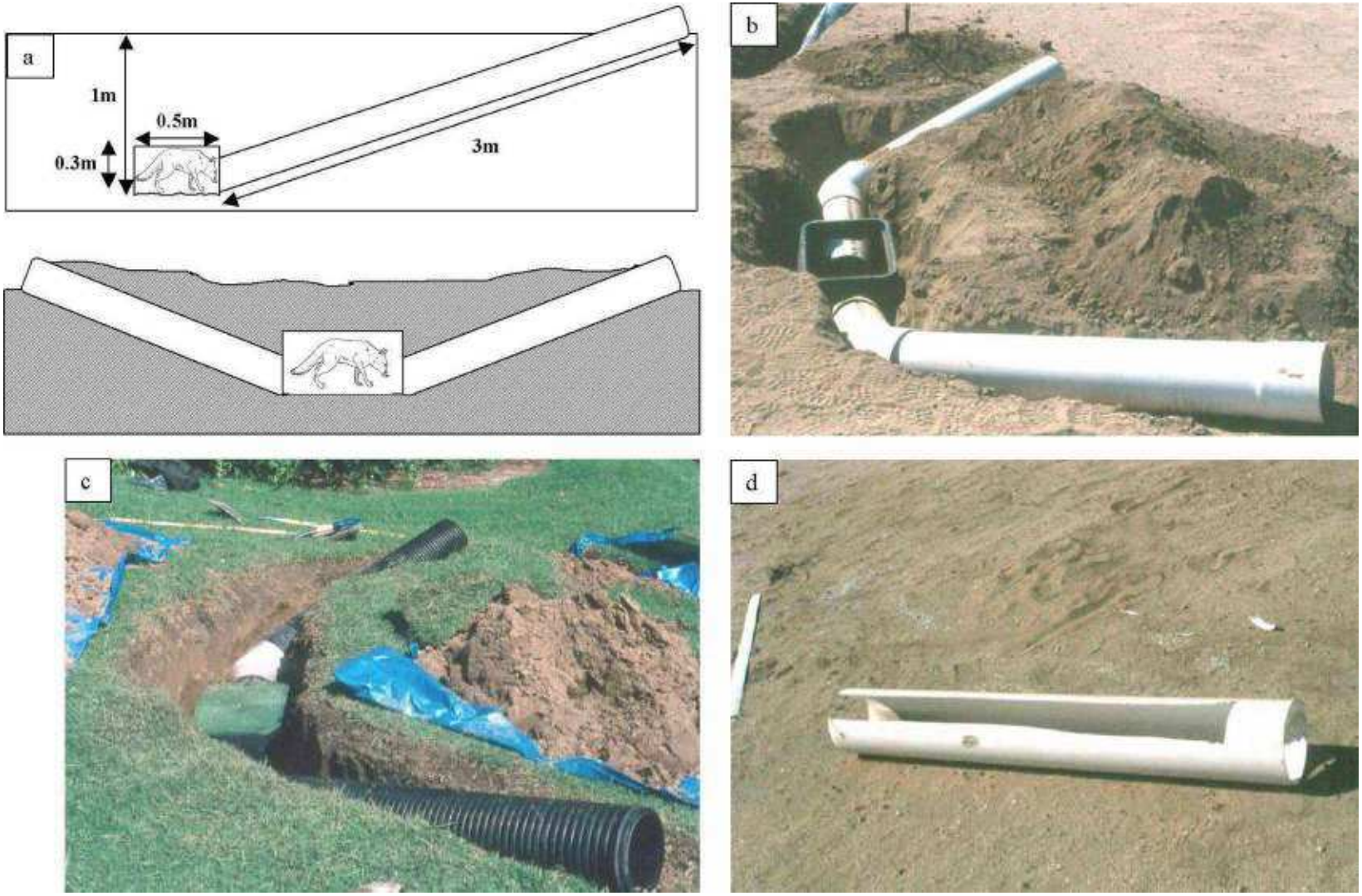

Plate 1. Artificial subterranean dens for San Joaquin kit fox at Bakersfield, CA. a) Artificial den schematic. b) PVC two-entrance chamber den under construction. c) High-density polyethylene two-entrance den. d) PVC tunnel with floor removed longitudinally.

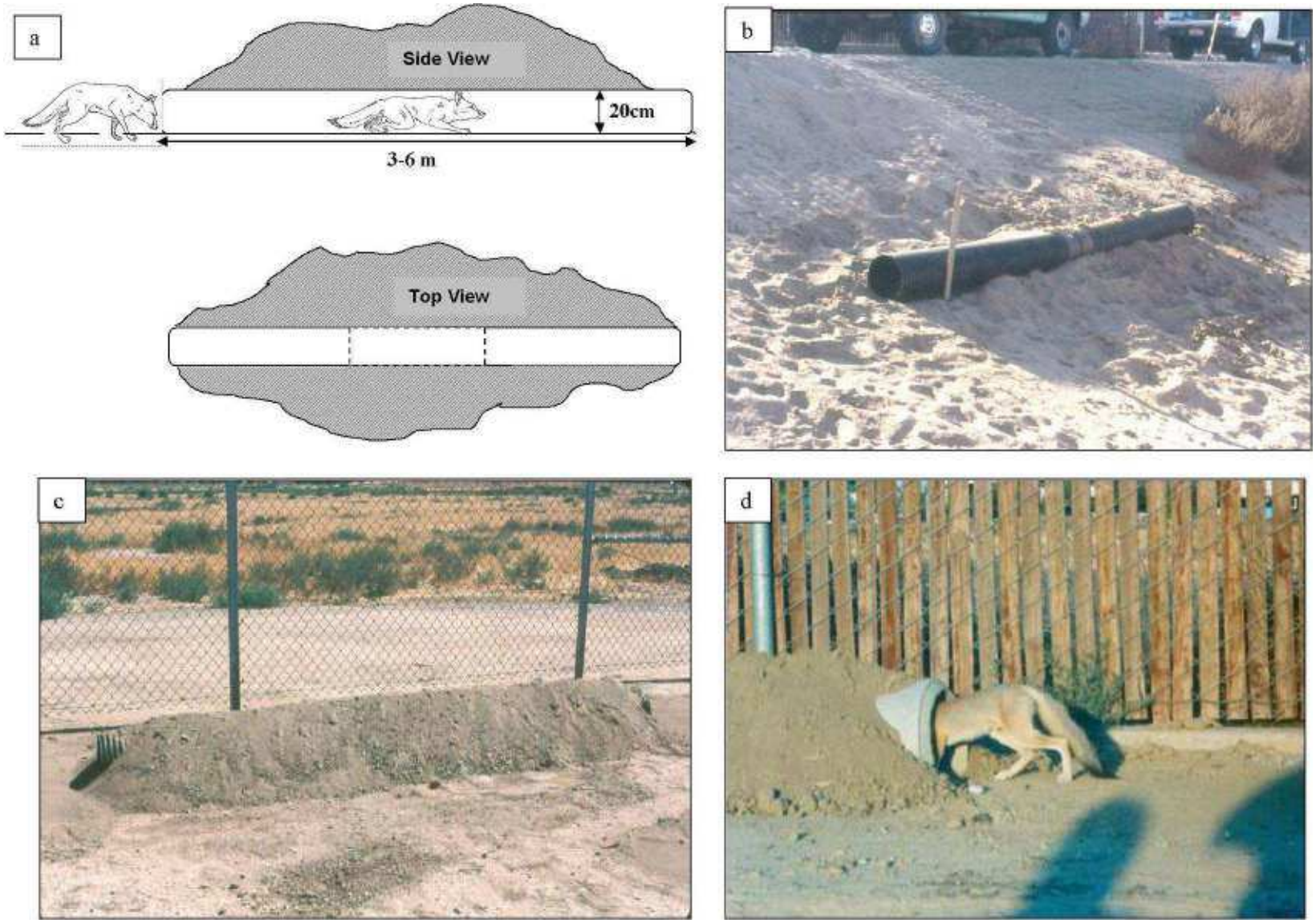

Plate 2. Artificial escape dens for San Joaquin kit fox at Bakersfield, CA. a) Escape den schematic. b) High-density polyethylene escape den under construction. c) Completed den. d) Kit fox entering escape den.

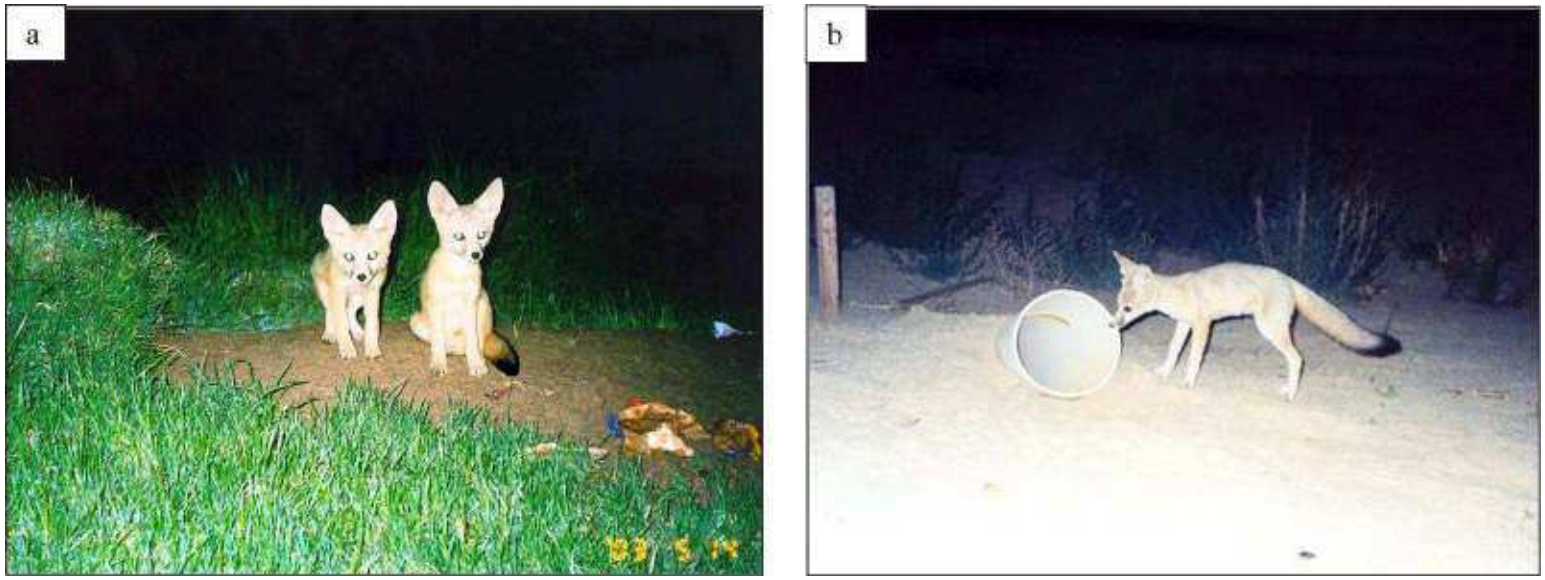

Plate 3. Kit fox pups at artificial subterranean dens at a golf course (a) and drainage basin (b) in Bakersfield, CA.