Western Wildlife 3:1–7 • 2016
Submitted: 12 February 2016; Accepted: 21 April 2016.

Efficacy of Three Methods for Collecting Behavioral Data on Urban San Joaquin Kit Foxes, *Vulpes macrotis mutica*

Tory L. Westall[1,3], Brian L. Cypher[1], and Katherine Ralls[2]

[1]Endangered Species Recovery Program, California State University, Stanislaus, Turlock, California 93582
[2]Smithsonian Conservation Biology Institute, Washington, D.C. 20008
[3]Corresponding author, email: twestall@esrp.csustan.edu

Abstract.—Gathering behavioral data on mammalian carnivores is difficult due to their secretive and often nocturnal nature. Many methods are available for collecting behavioral data, but few direct comparisons of their accuracy and efficacy have been conducted. We used proximity logging collars with base stations at dens, direct observations, and remote cameras simultaneously to monitor parental behavior, particularly time spent at the den, in San Joaquin Kit Foxes (*Vulpes macrotis mutica*). Our objective was to compare the accuracy and efficacy of the three methods in describing kit fox behavior. Base stations worked erratically and did not record the presence of collared foxes at the den during any of the direct observation periods, so results could not be compared with other methods. Remote cameras significantly underestimated the time that foxes spent at the den because of the camera's limited field of view and the complex nature of kit fox den sites. Cameras also completely missed some parental behaviors, such as regular patrols around the den site. However, cameras were better than direct observations at capturing rapid events, such as a fox dropping off a small prey item at the den. Direct observation was the most accurate method for collecting most types of behavioral data. This method works well where visibility is good and animals are not unduly disturbed by human presence. Cameras may be a suitable replacement for many studies, especially where only relative measures, such as the relative amount of time spent at the den at different times of the day, are required.

Key Words.—behavior; camera stations; direct observations; kit fox; proximity collars

Gathering behavioral information about mammalian carnivores is essential to understanding their role in an ecological system and facilitating conservation (Caro 1999). Often, even small carnivores play significant roles in ecosystem function despite their relatively low abundance (Gompper et al. 2006). Direct observations can provide information on parental care (Strand et al. 2000; Elmhagen et al. 2014; Poessel and Gese 2013), offspring counts (McGee et al. 2005; Strand et al. 1999), territory defense (Fox 1969; Preston 1975; Iossa et al. 2008), circadian rhythms (Lemons et al. 2003; Poessel and Gese 2013), social interactions (Kitchen et al. 2006; Murdoch et al 2008), competition (Kamler et al. 2004), and resource needs (Tannerfeldt and Angerbjörn 1996; Strand et al. 1999; Elbroch and Allen 2013). However, direct observations are difficult or impossible in some species because small carnivores are often nocturnal and secretive and occur in low densities with relatively large home ranges (Crooks et al. 2008; Balme et al. 2009; Prange et al. 2011; Brawata et al. 2013). Furthermore, some species occupy habitats that are not conducive to observation (e.g., fossorial or arboreal species; Prange et al. 2006; Hauver et al. 2010). To overcome these limitations, many researchers have relied on the use of various modern technologies to enhance visibility of the study subjects (e.g., Brawata et al. 2013) or gather detailed information in other ways such as determining social relationships from proximity logging collar data (e.g., Ralls et al. 2013).

Available technologies include night-vision equipment (Murdoch et al. 2008; Brawata et al. 2013), remote cameras (Cutler and Swann 1999; Swann et al. 2004; Crooks et al. 2008), remote video surveillance (McGee et al. 2005; Brawata et al. 2013), and thermal imaging (Brawata et al. 2013). Recently, proximity logging collars have been used to document social and reproductive behavior in Island Foxes (*Urocyon littoralis*; Ralls et al. 2013) and den attendance patterns and tolerance of den visitations by conspecifics in Raccoons (*Procyon lotor*; Hauver et al. 2010). Each method for recording behavior has advantages and limitations, but few studies have made direct comparisons among the results obtained when several methods are used simultaneously.

San Joaquin Kit Foxes (*Vulpes macrotis mutica*) are small and nocturnal and unusual among canids in that they use earthen or subterranean dens during the daytime (Koopman et al. 1998; Moehrenschlager et al. 2004; Cypher 2010). Kit foxes live in family groups consisting of a mated pair and their current offspring as well as any offspring of the previous year that delayed dispersal and remained in their natal range (Ralls and White 2003; Cypher 2010). During the breeding season, philopatric young often assist the breeding pair by guarding pups and provisioning the mother and pups with food at a den (Moehlman 1989). Kit foxes typically inhabit arid and semiarid habitats in the Central Valley of California (Macdonald and Sillero-Zubiri 2004; Moehrenschlager et al. 2004; Cypher 2010), but have also adapted to living in an urban environment (Cypher 2010). Bakersfield has a substantial population of San Joaquin Kit Foxes living throughout the city (Smith et al. 2006; Cypher 2010).

The close proximity of kit foxes to humans provides a unique and convenient situation to gather behavioral data. We compared the accuracy and efficacy of three methods used to collect data on parental behavior, particularly time spent at the den, in urban San Joaquin Kit Foxes during pup rearing. The three methods were proximity logging collars with base stations, remote cameras, and direct observations. These methods were used simultaneously to monitor family groups at dens during the breeding season so that results could be directly compared among data collection strategies.

Methods

Our study sites were California State University, Bakersfield (CSUB) and Bakersfield College (BC) in Bakersfield, California. All family groups were monitored at college campuses because ambient light was sufficient to detect foxes without the aid of night vision equipment. Foxes living on school sites are relatively accustomed to human presence and binoculars were not even necessary for detection and identification of foxes. College campuses are also relatively safe and quiet at night so observations could be conducted without interference. All dens were located in flower beds and open manicured lawns.

We trapped foxes during late December 2010 to mid-January 2011 and in early January 2012 with wire-mesh box traps (38 × 38 × 107 cm; Tomahawk Live Trap, Hazelhurst, Wisconsin) baited with cat food, hot dogs, and sardines. We placed traps in secure locations away from well-trafficked areas and covered them with oiled cloth tarps to guard against the elements. We evaluated each fox to determine age, sex, and reproductive condition and applied a uniquely numbered ear-tag to every individual. Females were ear-tagged on the right and males were ear-tagged on the left to help distinguish fox sex at a glance. We marked each fox with a unique pattern using a permanent non-toxic dye (Nyanzol-D; Albinal Dyestuff, Inc., Jersey City, New Jersey) to allow for the identification of individuals over the course of the project.

We applied proximity logging collars (Model E2C 162A; Sirtrack, Havelock North, New Zealand) to five foxes belonging to two family groups. Due to budget constraints, we had a limited number of collars, so we only collared adult foxes (> 2 y old) that were exhibiting signs of breeding (e.g., swollen vulva, enlarged testes). The collars consisted of an ultra-high frequency (UHF) transceiver bundled with a very-high frequency (VHF) transmitter (Prange et al. 2006). The VHF signal could be tracked with a receiver (Communications Specialists, Inc., Model R1000, Orange, California) and 3-element antenna (AF Antronics, Inc., Model F150-3FB, Urbana, Illinois) or omni-antenna (Teleonics, Model RA-5A, Mesa, Arizona). Each collar had a mortality sensor that would double the signal pulse rate if the animal remained motionless for more than 8 h. At each den where we had collared foxes and pups, we placed a proximity base station (Models E2C 162A and E2S 181A; Sirtrack, Havelock North, New Zealand) near the center of the den complex. To secure the base station and discourage foxes from moving it, we attached it to a 0.6-m (2-ft) wooden stake and hammered the stake into the ground until the base station was buried just below the surface (approximately 10 cm). The base stations were designed to receive the UHF signal from the collars and log the date, time, and collar ID of any collared animal that came within 10 m. We programmed the collars and base stations to collect data at the farthest range possible and preliminary controlled tests showed that collars and base stations were detecting one another at about 10 m apart.

Once we were reasonably sure that most, if not all, individuals from a natal den were captured, we began collecting data. Our objectives during direct observation periods were to record times when adult foxes were present and absent from the den, as well as to observe behaviors performed at the den. We observed the foxes at each den for a period of 2 h one to two times a week between January and May in 2011 and 2012 for some observa-

Figure 1. Camera station images of adult San Joaquin Kit Foxes (*Vulpes macrotis mutica*) provisioning at dens during the 2012 breeding season in Bakersfield, California. (Photographed by Bushnell Trophey XLT camera).

Figure 2. Camera station image of a San Joaquin Kit Fox (*Vulpes macrotis mutica*) pup at a den entrance and its mother patrolling the area around the den during the 2012 breeding season in Bakersfield, California. (Photographed by Bushnell Trophey XLT camera).

tions. For a given observation session, we tracked target foxes to a specific den at least 0.5 h prior to sunset. After tracking foxes, we found a nearby location from which to conduct observations. Generally, these locations were 10–50 m from the den and we began our 2-h observation session as soon as any foxes emerged from the den. Our study sites had sufficient ambient light to observe fox activity; at all locations foxes were identifiable to the individual without the aid of binoculars or night vision equipment. Only one den had vegetation that might obscure the presence of foxes at the den, but it was located in a stadium and we were able to sit high enough to see the den area clearly. We recorded the amount of time that each adult fox was present and absent from the den as well as other parental behaviors, such as delivering prey items to the den (Fig. 1). A fox was scored as being present anytime it was at the den, including when it was patrolling around the den site. During such patrolling, foxes could be as far as 100 m from the den and occasionally disappeared from sight for a few seconds (Fig. 2). As foxes moved away from the den behavior became an indicator of presence; if the fox was still vigilant and the pups remained outside the den, then the fox was still considered present and guarding.

We set up remote motion sensing cameras (Trophey XLT, Model 119456C; Bushnell Corporation, Hartford, Connecticut) at dens where pups were present and only used cameras with infrared flash to avoid disruption to the foxes. Cameras were attached to a 0.9-m (3-ft) u-post placed approximately 8–10 m from the den and pointed at the den entrance. In cases where there was more than one entrance, multiple cameras were installed to capture all fox activity. Cameras were powered by eight AA batteries and images were recorded on an 8GB SD card. We programmed cameras to take three 8-MP pictures for each trigger with a 1-s interval between triggers.

To compare methods, we conducted observations using multiple methods simultaneously. To standardize the observation time, we only used camera or proximity logger data collected during the 2-h direct observation session. For each individual fox, we tallied the total number of minutes spent at the den during a given 2-h observation session as determined by both direct observations and camera stations. Because cameras capture still frames, we considered foxes present if detections occurred no more than 5 min apart. This criterion was used to simulate patrolling behavior. Because data were non-normal and transformation did not normalize them, we used a Wilcoxon sign rank test ($\alpha = 0.05$) to determine if there were significant differences in the times foxes were present based on the observation method. We also counted the number of provisioning events (i.e., bringing food items back to the den) performed by each adult group member during the session using both direct observation and camera station data. These data allowed us to determine the efficacy of direct observations and camera stations in detecting instantaneous or rapid events that may be difficult to document.

Results

We used proximity collars and base stations on five foxes belonging to two family groups. One group was located at BC and consisted of a father and two helpers

Table 1. Identification number (Fox ID), family group (BC = Bakersfield College, CSUBC = California State University Bakersfield central, CSUBS = California State University Bakersfield south), sex, number of observation periods, and mean ± standard error of the number of minutes present at a den for each San Joaquin Kit Fox (*Vulpes macrotis mutica*) observed during the 2012 breeding season using direct observations and camera station observations in Bakersfield, California.

				Mean minutes	
Fox ID	Family Group	Sex	Number of Observations	Direct	Camera Station
6524	BC	M	6	0.3 ± 0.2	0.7 ± 0.5
6525	BC	F	6	16.7 ± 7.8	13.0 ± 6.1
6566	BC	F	6	13.7 ± 7.4	3.2 ± 0.6
6584	BC	M	6	2.0 ± 1.3	2.5 ± 1.5
6578	CSUBC	M	3	21.0 ± 7.4	12.33 ± 9.4
6592	CSUBC	F	3	25.3 ± 13.0	17.0 ± 14.1
6065	CSUBS	M	5	2.6 ± 1.7	0.6 ± 0.4
6309	CSUBS	F	5	4.2 ± 1.6	1.6 ± 0.5
6585	CSUBS	F	5	1.2 ± 0.6	0.6 ± 0.4
6700	CSUBS	F	5	0.2 ± 0.2	0.4 ± 0.2

who we collared and a mother, two helpers, and three pups who we did not collar. One helper was an offspring from the previous year and the other was an adult offspring from at least two years prior. This group used a total of two dens during the breeding season, both of which were located in an unmaintained slope in the college stadium. The other group was located at CSUB and consisted of a father and a helper who we collared and two mothers and six pups not collared. The helper was an offspring from the previous year. This group used a total of four dens; one under a cement slab, one in a flowerbed, one in a manicured lawn, and one in an unmaintained field. A single base station was deployed at a central location at each den. Unfortunately, the base stations were unreliable and only occasionally recorded the presence of the collared foxes. They did not register any fox activity within the 2-h window used to collect simultaneous data using the other observation methods. Thus, we could not compare data from proximity logging collars with data collected using the other two methods.

We simultaneously collected data using direct observations and camera stations on 14 nights and observed 10 adult foxes from three family groups (Table 1). We usually collected data on more than one fox during each of these sessions, so our total sample size was 50 2-hr observation periods. The mean (± SE) number of minutes spent at the den by each fox was 7.52 ± 1.34 (n = 50) for direct observations and 4.40 ± 1.85 (n = 50) for camera station observations. Mean time present at the den was significantly higher for direct observations than for camera stations (Z = 2.78, df = 12, P = 0.005). Nine provisioning events were documented; seven were detected by cameras and four were detected by direct observations, but only two events were detected by both methods.

Discussion

Proximity logging collars were not a reliable technique in our study of den attendance among urban San Joaquin kit foxes. The collars did not record kit fox presence at any time when kit foxes were known to be present at dens based on observations and cameras. Proximity logging collars have been successfully used to determine den attendance patterns in arboreal species (Hauver et al. 2010). However, controlled studies suggest that the closer the collars are to the ground the less reliable they are in recording contacts because the ground attenuates the signal (Prange et al. 2011). We buried base stations to prevent their removal by kit foxes and ground interference likely prevented the collar signal from reaching the base station. Future studies on den attendance using proximity loggers on fossorial species probably would be more effective if base stations are located above ground (e.g., attached to a post). However, in urban settings this could increase the risk of theft or vandalism.

Another factor that may have limited the effectiveness of proximity loggers to monitor den attendance is the structure of kit fox dens. Kit foxes tend to use large natal dens with multiple entrances (Egoscue 1956; Morrell 1972; McGrew 1979). Installing multiple base stations around the den complex might be necessary to ensure detection of foxes. Kit fox dens can also be deep and complex (Morrell 1972) and it may not be possible to determine kit fox presence if a collared individual is too far underground. With proximity loggers, den attendance information for fossorial species may be limited to time spent above ground at the den because time in the den and away from the den may be indistinguishable.

Finally, a detection distance setting of greater than 10 m should be used because foxes at times were observed to be present at dens but were more than 10 m from a base station (e.g., patrolling, den guarding).

Observing the den directly provides a wide field of view, which allows for documentation of behaviors occurring both at the den and in the surrounding area (Brawata et al. 2013). However, direct observations are limited by the amount of time a person can spend vigilantly watching a den (Weller and Derksen 1972) unless multiple observers are available (e.g., Poessel and Gese 2013). Direct observations are also limited by the distance from the point of interest. The ability of an observer to identify individuals and collect accurate behavioral information may decrease with distance, particularly if there are objects or vegetation obstructing the view (Sundell et al. 2006; Brawata et al. 2013). Conversely, if the observer is too close to a den, he or she could alter the natural behavior of the animal under observation (Brawata et al. 2013). Our observations were performed in an urban setting where animals were habituated to the presence of humans. A study conducted in natural lands would be more difficult due to increased wariness by foxes. In such situations, a blind might facilitate observations (Strand et al. 2000; Poessel and Gese 2013).

Camera stations are an effective method to collect behavioral information continuously over long periods of time (Cutler and Swann 1999). Because cameras can be left out for extended periods (e.g., several days), they can collect continuous data without the limitation of decreasing vigilance due to observer fatigue. Another advantage to using remote cameras is that they can be placed directly in front of the natal den without affecting the behavior of the animals under observation due to rapid habituation (Cutler and Swann 1999; Brawata et al. 2013). Camera stations detected more provisioning events than direct observations and may be better at detecting rapidly occurring events.

While there are several advantages to using cameras, they have some disadvantages. The biggest limitation when using cameras to monitor a den is the restricted field of view. Cameras will only detect activity in a field of view directly in front of the infrared sensor (Cutler and Swann 1999), but as previously stated, kit foxes use large dens with multiple entrances, some of which may be outside the field of view. Also, adult foxes often patrol around the area when guarding young and this behavior was not detected by the cameras (Westall 2015). Unless a camera can be installed at multiple den entrances and in the surrounding area, there is a risk of missing some behaviors. Another concern when using remote cameras is that human activity during deployment and collection of cameras or human scent on cameras or on the route into cameras may attract other species to den sites (Cutler and Swann 1999). This could be detrimental to the study animals if potential predators are attracted to a den area, particularly when vulnerable young are present. Finally, while deployment and operation of cameras is less labor intensive than direct observations, analysis of the resulting photos can be a tedious and time consuming process (Weller and Derksen 1972).

Camera stations significantly underestimated the amount of time kit foxes spent at the den compared to direct observations. This was likely due to the limited field of view of cameras and possible failed triggering. During direct observations, foxes guarding pups would patrol the den area, moving in circles around the den and stopping at regular stations to keep watch (Westall 2015). Without multiple cameras in place, it could appear that a fox on patrol had left the den area when in fact it was still present but simply outside the camera field of view. While camera stations underestimate the amount of time present, they are better at detecting events that happen rapidly. Direct observation of provisioning may be less accurate because distance, obstruction, and the size of the provisioned item may limit visibility.

Direct observations provide the most accurate information on kit fox den attendance and behavior, but are limited to relatively short observation periods unless multiple observers are available (e.g., Poessel and Gese 2013). Camera stations can provide information over longer periods of time, but results are less accurate than direct observations. Either method could be used to gather valuable information, depending upon the study objectives, subject animals, and observation conditions. Direct observations may be used to focus on behaviors that are difficult to detect on camera, like patrolling, territory defense, or social interactions. Conducting direct observations is necessary when determining absolute values, such as the true amount of time devoted to various behaviors. Camera observations can be used to continuously document a wide variety of behaviors and are useful for determining relative behaviors, like the relative degree of activity at different times of day. Cameras could replace direct observations when documenting behaviors that are difficult to see from a distance which could include offspring counts, family group size, provisioning behavior, or types of items provisioned. Although proximity logging collars and base stations were unreliable in our study, proximity loggers could be used on kit foxes to obtain valuable information on social interactions, mating systems, and the potential for disease transmission as has been done with Island Foxes (Ralls et al. 2013; Sanchez and Hudgens 2015) and other species (Prange et al. 2006, 2011).

Acknowledgments.—We thank the Smithsonian Institution for purchasing cameras and proximity loggers, the Western Section and San Joaquin Chapter of The Wildlife Society and the Student Research Scholar Program of California State University, Bakersfield for student grants for funding supplies for camera stations, the

Bureau of Land Management for funding refurbishment of our radio-collars, Scott Westall and Sandra Soles for assisting with camera deployment, and Erica Kelly and Marilyn Naderhoff for assistance with analysis of photos from camera stations. All methods were approved by the California State University, Bakersfield, Institutional Animal Care and Use Committee (Protocol 10-02) and all animals were handled in accordance with protocols established in a research permit (TE825573-2) from the United States Fish and Wildlife Service and a Memorandum of Understanding from the California Department of Fish and Wildlife.

Literature Cited

Balme, G.A., L.T.B. Hunter, and R. Slotow. 2009. Evaluating methods for counting cryptic carnivores. Journal of Wildlife Management 73:433–441.

Brawata, R.L., T.H. Raupach, and T. Neeman. 2013. Techniques for monitoring carnivore behavior using automatic thermal video. Wildlife Society Bulletin 37:862–871.

Caro, T. 1999. The behavior-conservation interface. Trends in Ecology and Evolution 14:366–369.

Crooks, K.R., M. Grigione, A. Scoville, and G. Scoville. 2008. Exploratory use of track and camera surveys of mammalian carnivores in the Peloncillo and Chiricahua mountains of southeastern Arizona. Southwestern Naturalist 53:510–517.

Cutler, T.L., and D.E. Swann. 1999. Using remote photography in wildlife ecology: a review. Wildlife Society Bulletin 27:571–581.

Cypher, B.L. 2010. Kit Foxes (*Vulpes macrotis*). Pp. 49–60 in Urban Carnivores: Ecology, Conflict, and Conservation. Gehrt, S.D., S.P. Riley, and B.L. Cypher (Eds.). John Hopkins University Press, Baltimore, Maryland, USA.

Egoscue, H.J. 1956. Preliminary studies of the kit fox in Utah. Journal of Mammalogy 37:351–357.

Elbroch, L.M., and M.L. Allen. 2013. Prey indices and behaviors at a Gray Fox den in San Mateo County, California. Western North American Naturalist 73:240–243.

Elmhagen, B., P. Hersteinsson, K. Noren, E.R. Unnsteinsdottir, and A. Angerbjörn. 2014. From breeding pairs to fox towns: the social organization of Arctic Fox populations with stable and fluctuating availability of food. Polar Biology 37:111–122.

Fox, M.W. 1969. The anatomy of aggression and its ritualization in Canidae: a development and comparative study. Behaviour 35:242–258.

Gompper, M.E., R.W. Kays, J.C. Ray, S.D. Lapoint, D.A. Bogan, and J.R. Cryan. 2006. A comparison of noninvasive techniques to survey carnivore communities in northeastern North America. Wildlife Society Bulletin 34:1142–1151.

Hauver, S.A., S.D. Gehrt, and S. Prange. 2010. Maternal response to conspecific visits at natal dens in Raccoons (*Procyon lotor*). American Midland Naturalist 163:374–387.

Iossa, G., C.D. Soulsbury, P.J. Baker, and S. Harris. 2008. Body mass, territory size, and life-history tactics in a socially monogamous canid, the Red Fox *Vulpes vulpes*. Journal of Mammalogy 89:1481–1490.

Kamler, J.F., W.B. Ballard, E.M. Gese, R.L. Harrison, S. Karki, and K. Mote. 2004. Adult male emigration and a female-based social organization in Swift Foxes, *Vulpes velox*. Animal Behaviour 67:699–702.

Kitchen, A.M., E.M. Gese, L. P. Waits, S.M. Karki, and E.R. Schauster. 2006. Multiple breeding strategies in the Swift Fox, *Vulpes velox*. Animal Behaviour 71:1029–1038.

Koopman, M.E., J.H. Scrivner, and T. T. Kato. 1998. Patterns of den use by San Joaquin Kit Foxes. Journal of Wildlife Management 62:373–379.

Lemons, P.R., W.B. Ballard, R.M. Sullivan, and M.A. Sovada. 2003. Den site activity patterns of adult male and female Swift Foxes, *Vulpes velox*, in northwestern Texas. Canadian Field-Naturalist 117:424–429.

Macdonald, D.W., and C. Sillero-Zubiri. 2004. Dramatis personae: wild canids - an introduction and dramatis personae. Pp. 3–38 in The Biology and Conservation of Wild Canids. Macdonald, D.W., and C. Sillero-Zubiri (Eds.). Oxford University Press, Oxford, UK.

McGee, B.K., M.J. Butler, M.C. Wallace, W.B. Ballard, and K.L. Nicholson. 2005. A comparison of survey techniques for Swift Fox pups. Wildlife Society Bulletin 33:1169–1173.

McGrew, J.C. 1979. *Vulpes macrotis*. Mammalian Species 123:1–6.

Moehlman, P.D. 1989. Intraspecific variation in canid social systems. Pp. 143–163 in Carnivore Behavior, Ecology, and Evolution. Gittleman, J.L. (Ed.). Cornell University Press, Ithaca, New York, USA.

Moehrenschlager, A., B.L. Cypher, K. Ralls, R. List, and M.A. Sovada. 2004. Swift Foxes and kit foxes: comparative ecology and conservation priorities of Swift and kit foxes. Pp. 185–198 in The Biology and Conservation of Wild Canids. Macdonald, D.W., and C. Sillero-Zubiri (Eds.). Oxford University Press, Oxford, UK.

Morrell, S. 1972. Life history of the San Joaquin Kit Fox. California Fish and Game 58:162–174.

Murdoch, J.D., K. Ralls, B. Cypher, and R. Reading. 2008. Social interactions among San Joaquin Kit Foxes before, during, and after the mating season. Journal of Mammalogy 89:1087–1093.

Poessel, S.A., and E.M. Gese. 2013. Den attendance patterns in Swift Foxes during pup rearing: varying degrees of parental investment within the breeding pair. Journal of Ethology 31:193–201.

Prange, S., T. Jordan, C. Hunter, and S.D. Gehrt. 2006. New radiocollars for the detection of proximity among individuals. Wildlife Society Bulletin 34:1333–1344.

Prange, S., S.D. Gehrt, and S. Hauver. 2011. Frequency and duration of contacts between free-ranging Raccoons: uncovering a hidden social system. Journal of Mammalogy 92:1331–1342.

Preston, E.M. 1975. Home range defense in the Red Fox, *Vulpes vulpes* L. Journal of Mammalogy 56:645–652.

Ralls, K., J.N. Sanchez, J. Savage, T.J. Coonan, B.R. Hudgens, and B.L. Cypher. 2013. Social relationships and reproductive behavior of Island Foxes inferred from proximity logger data. Journal of Mammalogy 94:1185–1196.

Ralls, K., and P. J. White. 2003. Diurnal spacing patterns in kit foxes, a monogamous canid. Southwestern Naturalist 48:432–436.

Sanchez, J.N., and B.R. Hudgens. 2015. Interactions between density, home range behaviors, and contact rates in the Channel Island Fox (*Urocyon littoralis*). Ecology and Evolution 5:2466–2477.

Smith, D.A., K. Ralls, B.L. Cypher, H.O. Clark, Jr., P.A. Kelly, D.F. Williams, and J.E. Maldonado. 2006. Relative abundance of endangered San Joaquin Kit Foxes (*Vulpes macrotis mutica*) based on scat-detection dog surveys. Southwestern Naturalist 51:210–219.

Strand, O., A. Landa, J.D.C. Linnell, B. Zimmermann, and T. Skogland. 2000. Social organization and parental behavior in the Arctic Fox. Journal of Mammalogy 81:223–233.

Strand, O., J.D.C. Linnell, S. Krogstad, and A. Landa. 1999. Dietary and reproductive responses of Arctic Foxes to changes in small rodent abundance. Arctic 52:272–278.

Sundell, J., I. Kojola, and I. Hanski. 2006. A new GPS-GSM-based method to study behavior of Brown Bears. Wildlife Society Bulletin 34:446–450.

Swann, D.E., C.C. Hass, D.C. Dalton, and S.A. Wolf. 2004. Infrared-triggered cameras for detecting wildlife: an evaluation and review. Wildlife Society Bulletin 32:357–365.

Tannerfeldt, M., and A. Angerbjörn. 1996. Life history strategies in a fluctuating environment: establishment and reproductive success in the Arctic Fox. Ecography 19:209–220.

Weller, M.W., and D.V. Derksen. 1972. Use of time-lapse photography to study nesting activities of birds. Auk 89:196–200.

Westall, T.L. 2015. Parental care in urban San Joaquin Kit Fox (*Vulpes macrotis mutica*): relative roles of parents and helpers. M.S. Thesis, California State University, Bakersfield, California. 109 p.

Tory Westall has been working as a Research Ecologist with the Endangered Species Recovery Program of California State University, Stanislaus, since 2009. In that time she has studied various sensitive species in the San Joaquin Desert and surrounding areas. She is interested in the ecology and conservation of endangered species and primarily studies the San Joaquin kit fox. (Photographed by Christine Van Horn Job).

Brian Cypher is the Associate Director and a Research Ecologist with the Endangered Species Recovery Program of California State University, Stanislaus. His primary research interest is the ecology and conservation of wild canids. Since 1990, he has been involved in research and conservation efforts for endangered San Joaquin Kit Foxes and other sensitive species in the San Joaquin Valley of California. (Photographed by Christine Van Horn Job).

Katherine Ralls is a Senior Research Zoologist Emeritus with the Smithsonian Conservation Biology Institute. She is interested in the behavioral ecology, genetics, and conservation of mammals. Since 1980, she has focused on conservation biology, especially the genetic problems of small captive and wild populations, and studies of threatened and endangered mammals, including San Joaquin Kit Foxes and Sea Otters (*Enhydra lutris*). (Photographed by Vickie Pearse).