Live capture of denning mammals using an improved box-trap enclosure: kit foxes as a test case

Adam J. Kozlowski, Tim J. Bennett, Eric M. Gese, and Wendy M. Arjo

Abstract The ability to capture and recapture animals efficiently is an integral part of many wildlife studies. For many species of small terrestrial carnivores, the baited box trap has been a staple of live-capture trapping efforts. Combined with an enclosure, the box trap is especially effective on species with a den or refuge that can be encircled. However, increased trapping success of these enclosure designs often is offset by increased cost, labor, and awkwardness of transporting and establishing the enclosure trap. We describe a new enclosure design, the tunnel trap, which improves on the mobility and effectiveness of previous enclosure designs. We tested the tunnel trap on the fossorial kit fox (*Vulpes macrotis*) on the United States Army's Dugway Proving Ground, Utah, from January 1999–September 2001. Over a period of 18 separate trapping events, 15 resulted in capture of a kit fox. We calculated trapping success to be 83%, and we captured an average of 0.6 kit foxes per trap-night. The trap effectively captured kit foxes of different age classes in a variety of terrains and seasons.

Key words box trap, kit fox, tunnel trap, *Vulpes macrotis*

The capture and marking of animals often is a necessary practice to acquire reliable estimates on population size and demographics of a wildlife species (Bookhout 1994,Thompson et al. 1998) and is particularly important when attempting to monitor or census carnivore species that are nocturnal, secretive, low-density, and far-ranging (Gese 2001). A common method for capturing small carnivore species, such as kit foxes (*Vulpes macrotis*) and swift foxes (*V. velox*), has been the use of a baited box trap (Covell 1992, White et al. 1994, Cypher 1997, Kitchen et al. 1999, Schauster et al. 2002*a*). Although the method is normally successful, animals that are captured easily once can quickly develop trap-aversion behavior (Cypher et al. 2000, Schauster et al. 2002*b*). This makes repeated captures difficult and impedes studies that require an individual to be recaptured to change radiocollars (Egoscue 1962, 1975; Covell 1992; Schauster et al. 2002*a*) or resampled for physiological studies (e.g., Golightly and Ohmart 1984, Covell et al. 1996), disease monitoring, or growth-rate measurements. Seasonally induced behavioral changes also may reduce trapping success of some species (Zoellick and Smith 1986, Schauster et al. 2002*b*). Incorporating box traps with enclosure fencing has been the most common strategy used to increase capture success at a fox den site (Foreyt and Rubenser 1980, O'Farrell 1987, Covell 1992). Present fence-enclosure systems trade increased trap success for decreased mobility, increased weight and setup time, and higher cost than

Address for Adam J. Kozlowski: Department of Forest, Range, and Wildlife Sciences, Utah State University, Logan, UT 84322-5230, USA; present address: Utah Division of Wildlife Resources, 515 East 5300 South, Ogden, UT 84055, USA. Address for Tim J. Bennett and Wendy M. Arjo: AGEISS Environmental, Inc. Dugway Proving Ground, P.O. Box 463, Dugway, UT 84022, USA; present address for Arjo: United States Department of Agriculture, Wildlife Services, National Wildlife Research Center, 9730-B Lathrop Industrial Drive SW, Olympia, WA 98512, USA. Address for Eric M. Gese: United States Department of Agriculture, Wildlife Services, National Wildlife Research Center, Department of Forest, Range, and Wildlife Sciences, Utah State University, Logan, UT 84322-5230, USA; e-mail: egese@cc.usu.edu.

conventional box traps (Covell 1992). We made modifications to the method described by Zoellick and Smith (1986) to create a tunnel-trap design for capturing kit foxes that is extremely effective, mobile, easy to set up, and a low-cost alternative to bulky enclosure designs. This trap design has applications for trapping most small carnivore species that utilize dens or other places of refuge.

Study area and methods

We trapped kit foxes 128 km southwest of Salt Lake City on the 3,330-km^2 Dugway Proving Ground, a United States Army testing facility in Tooele County, Utah. Dugway's vegetation community, typical of the Great Basin, was classified as cold northern desert shrub (Emrick and Hill 1998). Topography consisted of flat playas interspersed with mountain ranges. Substrate and accessibility of fox den sites varied considerably. Mean temperatures ranged from 25.5°C in July to -2.8°C in January. Mean annual precipitation was 20.07 cm.

We trapped kit foxes using unmodified and tunnel-enclosure box traps. We used unmodified No. 107 Tomahawk box traps (80 × 25 × 25 cm; Tomahawk Live Traps Co., Tomahawk, Wisc.) baited with chicken or bacon for initial captures of kit foxes. Methods of trapping and handling followed the procedures described by McCue and O'Farrell (1987), Cypher et al. (2000), and Schauster et al. (2002*a*). As individuals were captured and radiocollared, we shifted trapping efforts to target den sites with tunnel traps to ensure capture of family groups. Limited battery life of our radiotelemetry collars and periodic blood sampling further necessitated the frequent recapture of kit foxes at den sites.

To capture and recapture foxes, we enclosed one or, more often, 2 den openings of an occupied kit fox den site complex with tunnel traps and blocked the remaining openings with sandbags. We constructed tunnel box traps in advance of the trapping effort by wiring a 120 × 120-cm sheet of chicken-wire mesh around the entrance to the trap. This produced a trap with a malleable skirt, allowing us to form it to enclose any refuge entrance (Figure 1). One individual could then easily carry 2 tunnel traps and materials needed to make a set at a den site. Once on site, setup time varied from 15–20 minutes, depending on number of den openings to be blocked.

Variation of the substrate at each den site required 3 different methods of affixing the mesh skirt to the ground. Tent stakes worked well for soil dens. We used on-site rocks to enclose cliff and hillside dens. We carried in and filled empty sandbags to enclose dens constructed in loose substrate (e.g., sand). We invariably blocked excess den entrances with the least effort by using materials on site. Rocks or sandbags filled with loose substrate found at the trap site worked well. We took considerable care not to disturb immediate landscape features of the den area in utilizing local substrates to secure the trap. In all cases our goal was to leave no trace after the trap had been removed, to reduce the impact of the trapping event on subsequent animal behavior.

Results and discussion

From January 1999–September 2001, 38 kit foxes (27 adults, 11 pups) were known to be enclosed within 18 den sites (i.e., 18 set-nights) using the

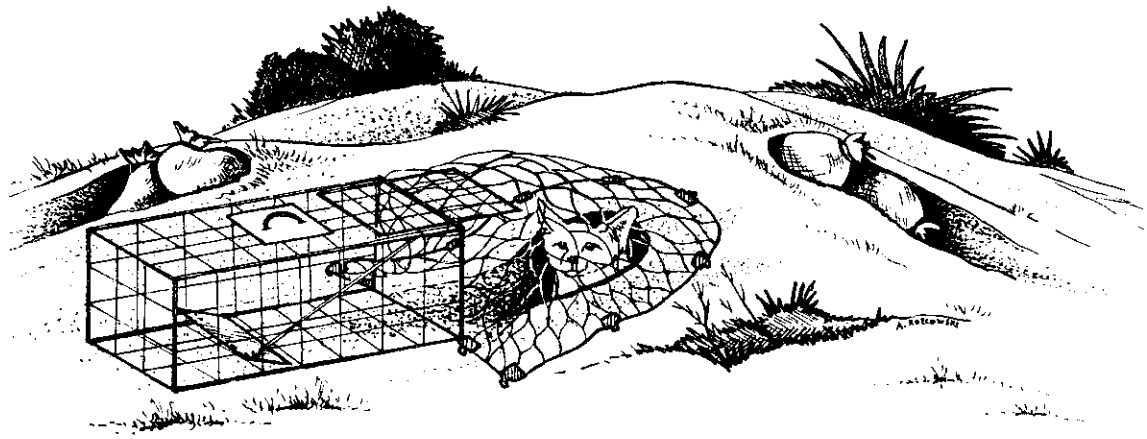

Figure 1. Box-trap enclosure system affixed with tent stakes at a kit fox den site, United States Army Dugway Proving Ground, Utah, 1999–2001. To complete the set, the remaining openings are carefully blocked with sand- or soil-filled bags.

tunnel-enclosure trap system. Each enclosure set represented one night, and 89% (n = 16) of the sets involved 2 traps (2 other sets were one trap). Since 16 sets had 2 traps (32 traps) and 2 sets had one trap (2 traps), a total of 34 trap-nights were available to capture foxes; thus, only 34 of the 38 enclosed kit foxes actually were available for capture. We captured 20 kit foxes (17 adults, 3 pups) using our tunnel-trap design; 13 of these were recaptures. We calculated effort to be 1.11 foxes per set-night (20 foxes captured in 18 set-nights) and 0.59 foxes per trap-night (20 foxes captured in 34 trap-nights). Percent success for catching at least 1 fox each night in an enclosure set was 83%. In addition, percent success for filling all available traps for each night at a den site was 61%. By comparison, Covell (1992) reported a 22% (n = 118 attempts) success when trapping swift foxes with double-trap enclosures, while Zoellick and Smith (1986) reported a 43% (n = 28 attempts) combined success for their single- and double-trap enclosures when capturing kit foxes. These results contrast markedly with unmodified box-trapping surveys conducted at all 3 study areas (Table 1). Covell (1992) reported a 6% success rate over 1,040 trap-nights on swift foxes, while Zoellick (1985) reported a 5% success over 770 nights when trapping kit foxes. We were successful on only 1% of 770 trap-nights (Table 1). Although unmodified box-trap surveys were not designed to be identical, they give some indication of each study's fox population and susceptibility to capture.

Failure of the tunnel-trap design almost invariably came not from the trap itself but from improperly sealing excess den entrances. Failure to completely block incoming light into excess den entrances often would help the animal dig out of the blocked entrance. Sandbags proved to be the best tool for sealing entrances. The soft bags adjusted their shape to fit the opening and would reform themselves if the animal made an attempt to dig around them.

Two kit foxes at den entrance, Dugway Proving Ground, Utah.

Pen enclosures with attached box traps are typically designed to allow the animal to move once it is above ground but before it is in a trap (e.g., Covell 1992). This flexibility often allows an animal to elect not to enter the trap but instead to climb over the enclosure, dig under it, or prematurely trigger the trap in its effort to escape. The design of this particular enclosure trap creates a short tunnel of wire leading from the den opening directly to the trap. In contrast to classic den-enclosure designs, our unit virtually restricts animal movements to either the den or the trap. The design proved so successful across seasons and terrains that it even became unnecessary to bait the traps.

Although the tunnel trap was designed for and tested on kit foxes, we designed our enclosure trap to take advantage of denning behavior, thereby extending its feasible use to any animal utilizing an enclosed refuge. Tunnel traps maintain (or exceed) high success rates of classic enclosure designs but have the advantages of reduced effort, disturbance, weight, and cost. Their mobility and effectiveness make them especially suited to remote terrain or sensitive species, and for situations where time spent at the refuge site needs to be limited.

Table 1. Setup times and trap success of comparable methods for capturing kit and swift foxes from 3 different studies.

	Trap success						
	Unmodified box traps		Enclosure trap sets		Foxes caught/ set/night		
Setup time	%	(n)[a]	%	(n)[b]	$\bar{x}$	(n)[c]	Study
15–20 min	1	(770)	83	(18)	1.11	(20)	This study
30–60 min	6	(1,040)	22	(118)	0.22	(26)	Covell 1992
2–4 hours	5	(770)	43	(28)	0.43	(12)	Zoellick and Smith 1986

[a] n = number of trap-nights for box traps.
[b] n = number of enclosure trap sets constructed.
[c] n = number of foxes captured in enclosure trap sets.

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Adam Kozlowski (left), a sensitive-species biologist in the Northern Region for the Utah Division of Wildlife Resources, is completing his M.S. in wildlife biology in the Department of Forest, Range, and Wildlife Sciences at Utah State University. His thesis involves examining the interactions between kit foxes and coyotes on the Dugway Proving Ground in western Utah. Adam received his B.S. in ecology and systematics from Cornell University. ***Tim Bennett*** received his B.S. from the University of Montana and served as a wildlife biologist with AGEISS Environmental, Inc. He then moved on to become a wildlife biologist with the National Wildlife Research Center in Olympia, Washington. ***Eric Gese*** (center) is a research wildlife biologist with the National Wildlife Research Center and a research associate professor in the Department of Forest, Range, and Wildlife Sciences at Utah State University. He received his Ph.D. from the University of Wisconsin–Madison. ***Wendy Arjo*** is a research wildlife biologist for the National Wildlife Research Center's Olympia Field Station. She received her Ph.D. from the University of Montana in 1998. Thereafter, Wendy was a wildlife biologist and program manager for AGEISS Environmental, Inc. consulting firm. She spent 3 years working with various mammalian species at the U.S. Army's Dugway Proving Ground. Her research interests include behavioral ecology of meso-carnivores, especially interactions between carnivores, and the interaction between forest practices and mammal populations.

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