EFFICACY OF HELICOPTER NET-GUN CAPTURE ON COYOTES IN ARID SHRUBLAND AND GRASSLAND HABITATS

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Abstract: We used helicopter net-gunning to capture coyotes (*Canis latrans*) in an arid habitat where endangered San Joaquin kit foxes (*Vulpes macrotis mutica*) were present. In 25.1 hr of flight time over 6 days, we captured 10 coyotes of 22 (45%) pursued. Seven coyotes were captured through net-gunning from helicopters while 2 were captured in culverts (1 with chemical immobilization), and 1 was captured by noose after it ran into an aqueduct. Helicopter net-gunning successfully captured coyotes in open shrub and grassland habitat without capture risk to San Joaquin kit foxes.

TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 42:35–39; 2006

Key words: California, capture, coyote, helicopter, net-gun, San Joaquin kit fox.

Coyotes (*Canis latrans*) are widely distributed in North America and have ecological and socio-economical importance (Bekoff 1982, Voigt and Berg 1987). Coyotes are studied for many reasons, including assessing their role in ecological processes, protecting public safety from disease and wildlife–human conflicts, preventing livestock depredation, and mitigating effects on sensitive or endangered species (Carbyn 1989, Ralls and White 1995, Hsu and Hallagan 1996, Conner et al. 1998, Chang et al. 2000). Methods commonly used to capture coyotes include box traps, padded leg-hold traps, snares, and helicopter darting or net-gunning (Baer et al. 1978, Gese et al. 1987, Linhart and Dasch 1992, Way et al. 2002). Each method has advantages and disadvantages that vary depending on factors such as study-site location, habitat, season, and presence of nontarget species.

Box traps are labor intensive and often ineffective at capturing wary animals or family groups (Way et al. 2002). Leg and neck snares are relatively inexpensive but occasionally cause injuries and deaths (Onderka et al. 1990, Pruss et al. 2002). Padded leg-hold traps are relatively inexpensive and are an effective capture method for wild canids, but also cause injuries to coyotes and nontarget species (Linhart and Dasch 1992, Phillips et al. 1996). Researchers have successfully used helicopter capture with darting or netting for many species including golden eagles (*Aquila chrysaetos*) (O'Gara and Getz 1986), large ungulates (Barrett et al. 1982), and several canid species (Van Ballenberghe 1984, Gese et al. 1987, Thomson 1992). Unfortunately, helicopter capture is expensive and, generally, is most successful in open habitats such as rangelands and grasslands (Baer et al. 1978, Barrett et al. 1982).

For a study of interactions between the endangered San Joaquin kit fox (*Vulpes macrotis mutica*) and coyotes, we needed an effective method by which to capture coyotes in a low-density, arid shrubland in addition to open grasslands. Kamler (2002) found leg-hold traps were efficient for capturing coyotes while still excluding swift foxes (*V. velox*). We were unable, however, to use leg-hold traps because of restrictions imposed by California Proposition 4, a law approved in 1998 that banned the use of leg-hold traps except when used by government officials to protect human safety or endangered species (California Fish and Game Code Section 3003.1c). Furthermore, snares are not approved for use within the range of the San Joaquin kit fox because of the potential to harm foxes (J.

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Bennett, U.S. Department of Agriculture, personal communication). For these reasons, we used helicopter net-gunning and followed the methods of Barrett (1982) and Gese (1987) to capture coyotes. With this paper, we evaluate the method's efficacy as a capture method for coyotes in a heterogeneous landscape of arid saltbush shrubland (*Atriplex* spp.) and grassland in central California.

STUDY AREA

We captured coyotes at the Lokern Natural Area in the southern San Joaquin Valley, approximately 70 km west of Bakersfield, Kern County, California. The climate consists of hot, dry summers and cool, wet winters. Elevation of the study site was 100 m. The study area encompassed approximately 100 km^2 and consisted of a checkerboard pattern of various public and private landowners, which resulted in varying land management practices. Land uses included oil and gas production, sheep grazing, hazardous waste disposal, and land conservation. The vegetation community in Lokern was variously classified as Lower Sonoran Grassland (Twisselmann 1969), Valley Grassland (Heady 1977), or Allscale (*A. polycarpa*) Series (Sawyer and Keeler-Wolf 1995). Historical and recent wildfires created a mosaic of grass and shrub habitats. Shrub habitats consisted of arid shrublands dominated primarily by allscale and spinescale (*A. spinifera*). Grasslands were composed of herbaceous groundcover and consisted primarily of forbs and annual grasses dominated by nonnative foxtail brome (*Bromus madritensis*) and redstem filaree (*Erodium cicutarium*).

METHODS

Helicopter net-gunning was done using a capture crew from the Wildlife Investigations Laboratory of the California Department of Fish and Game (CDFG), and a contract helicopter service (Landells Aviation, Desert Hot Springs, California, USA). The captures were done in late January 2003 using a Bell Jet Ranger 3. Captures were done in winter to reduce heat stress on coyotes. The helicopter crew consisted of the pilot, a net-gunner, and a coyote handler. transects were flown approximately 20–30 m above the ground until a coyote was spotted. Once targeted, the helicopter chased the coyote into an open area suitable for netting. We netted coyotes according to Barrett (1982) or manually restrained them as described by Gese and Anderson (1993). We limited chase time in the helicopter to approximately 5 min for each animal to reduce heat stress.

To net a coyote, the gunner fired 1 or more nets (3.6 m x 3.6 m, 10-cm mesh, 336 g) from a net-gun (Coda Enterprises, Mesa, Arizona, USA) out of the back of the helicopter. After netting a coyote, the helicopter landed nearby and the handler and gunner restrained the animal with gloved hands or a Y-stick. We used muzzles with built-in blindfolds on the coyote's head (Four Flags over Aspen, St. Clair, Minnesota, USA), and cotton rope or leather ties on their legs. After the animal was restrained, a 3-person crew processed the animals while the gunner and handler returned to the helicopter to search for more coyotes. Coyotes were processed without chemical restraint for 9 of 10 animals. For 1 coyote that we captured manually, we used a ketamine/xylazine mixture because we were unable to manually remove her from a culvert without chemical restraint. We ear tagged, radio collared, weighed, and drew blood from all coyotes, as well as recorded sex, physical condition, and body temperature. Processing time was approximately 15 min per animal, after which we removed the restraints and released the animal at the capture location.

RESULTS

Over 6 days and 25.1 hr of flight time, we pursued 22 coyotes and caught 10 animals, a 45% capture success rate. This represented a capture rate of 1 coyote for every 2.5 hr of flight time. Of the 10 coyotes captured, we captured 7 by net-gun, 2 manually after they ran into culverts, and 1 by a capture noose when it ran into the California Aqueduct. Of the 7 coyotes captured by net, we captured 5 coyotes with a single net, 1 with 2 nets, and 1 with 3 nets. Twelve animals were not captured because the net-gun jammed (n = 1), a net caught on the helicopter skid forcing a landing (n = 1), animals escaped into natural dens or culverts (n = 5), or coyotes were netted but escaped from the nets (n

= 5). All 5 coyotes that escaped from nets had 3 nets fired at them. Four backed or rolled out of the nets, and 1 chewed out of the net. Chases were aborted with the 5 escapees because of concerns for their welfare from prolonged chase time.

DISCUSSION

Helicopter net-gunning was a successful method of capturing coyotes on our study site, especially given the limited capture methods legally available. We successfully captured 10 animals in 25.1 hr of flight time over 6 days, resulting in a decreased trapping effort than has generally been reported for leg-hold and box trapping studies (Van Ballenberghe 1984, Skinner and Todd 1990, Way et al. 2002). Box trapping has generally been less effective at capturing coyotes because it requires many labor-intensive hours with low capture rates (Way et al. 2000). Leg-hold traps are efficient at capturing canids (Linhart and Dasch 1992, Phillips et al. 1996) but require field crews to monitor traps every few hours, including overnight. Helicopter capture can be successful with a team of 5–6 people, including the pilot and net-gunner. Although box traps, snares, and leg-hold traps may require only a couple of people to process the actual capture, the great number of hours and labor-intensive requirements of these methods may make them less labor efficient than helicopter captures.

Our capture success rate was 45%, which was less than the 72% success rate for manual and net-gun coyote capture reported by Gese et al. (1987). Although our success rate was lower, we concluded that helicopter net-gun captures are effective for capturing coyotes in shrubland habitat. Several studies reported that open-grass habitat or rangeland is optimal for helicopter capture (Baer et al. 1978, Barrett et al. 1982). We found, however, that coyotes were easily captured in low-density shrub habitat, and the shrubs may have slowed running coyotes to facilitate capture. The increased cover of the shrubs did not appear to have any effect on aiding coyote escape because we easily followed coyotes through the shrubs once they were sighted.

This was the first effort by the CDFG to net-gun coyotes with 2 of the failed captures resulting directly from human errors that forced a landing and jammed a net-gun. Additional experience may have prevented several of the other failed attempts (Barrett 1982). We learned that successfully netting coyotes on the first or second attempt was important because coyotes quickly learned how to avoid capture by either escaping into dens or to areas where the helicopter could not fly low enough for netting, such as under power lines. Several coyotes also learned how to roll out of nets. Barrett (1982) similarly noted that coyotes sought cover and learned to avoid the helicopter, and suggested that a net with larger mesh be used because nets with a smaller mesh deployed too slowly to capture the animals. A different net size or weight or mesh size might have prevented coyotes from rolling or chewing out of nets. However, when we tried a larger mesh size (20 cm), 1 coyote chewed out of the net before we reached the animal. We found that smaller mesh prevented coyotes from chewing out quickly. In general, the 10-cm mesh seemed most effective at preventing coyote escapes.

We captured 3 coyotes without nets. These situations required opportunistic and adaptable capture teams. Similarly, Gese et al. (1987) reported capturing several coyotes without nets after the animals took cover in vegetation or rock outcrops. The animals we successfully captured from culverts were in human-made culverts that were short and narrow, which allowed access to the animals to manually restrain them. Although we planned to handle all captures without chemical immobilization, we immobilized 1 animal that escaped into a culvert. Of the 5 coyotes that escaped underground, 4 ran into inaccessible dens and 1 ran into a large culvert where we could not restrain it. We aborted the capture after several hours of unsuccessful capture attempts because of insufficient light and concerns about the welfare of the animal.

No animals or humans were injured during the capture effort, similar to results reported by Barrett (1982). Although Gese et al. (1987) reported 5% mortality of coyotes during net-gun capture, aerial net-gunning generally appears to cause relatively few injuries, whereas other capture methods can have higher injury rates (Van Ballenberghe 1984, Onderka et al. 1990, Phillips et al. 1996). Leg-hold traps and snares also have the potential to capture non-target animals, helicopter net-gunning restricts capture to the target species and individuals animals (Van Ballenberghe 1984, Onderka et al. 1990).

Injuries to non-target animals, especially the endangered San Joaquin kit fox, were of particular concern and helicopter capture allowed us to avoid any captures of these species. Kamler et al. (2002) successfully captured coyotes in padded leg-hold traps while excluding swift foxes, but leg-hold traps also carry higher injury risks to coyotes and use of these traps is prohibited in California.

Safety and expense are issues when considering helicopter capture. For the 6-day effort, helicopter flight time cost $24,274. Also, helicopter capture requires a highly trained team of people composed of an experienced pilot, net-gunner, and handler(s). As with most capture methods, helicopter captures require specialized equipment such as a net-gun and nets. There may be a greater human safety risk with helicopter captures, although this risk can be mitigated with experienced pilots, capture crews that know how to work around helicopters, and good communication. Helicopter capture is also inhibited by inclement weather, even more so than other trapping methods. Our efforts were delayed several hours on most days by dense winter fog that is common in the San Joaquin Valley. Nonetheless, in grasslands or in low, open shrub habitats, helicopter net-gunning was an effective, although expensive, method for capturing coyotes.

ACKNOWLEDGMENTS

The CDFG Wildlife Investigations Laboratory generously provided staff time, materials, and other assistance. Veterinary services and drugs were provided by D. Fritcher and K. Wolf . We thank W. Asserson, C. Bjurlin, A. Brown, A. Chavez, A. Hunter, P. Kelly, J. Murdoch, M. Phillipp, C. Van Horn Job, J. Valenzuela, B. Vanherweg, G. Warrick, and C. Wingert for helping with capture efforts and logistics. We particularly thank S. de Jesus and his team at Landell's Aviation for an excellent and safe capture effort. Funding for this project was provided by the Central Valley Project Conservation Program, California Department of Transportation, U.S. Bureau of Reclamation, and Center for Natural Lands Management. We thank the reviewers for their comments.

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