Animal attendance at coyote trap sites in Texas

John A. Shivik and Kenneth S. Gruver

Abstract There is a need to develop alternative selective capture systems for coyotes (*Canis latrans*) and to generate information on the quantity and identity of species that visit locations where coyote traps are set. We used 24-hour video surveillance equipment to monitor coyote trap locations. We observed 564 visits by 20 vertebrate species during 2,822 hours of observation in 144 trap nights at 31 locations. Species other than coyotes were >16 times as likely to enter the area of observation (the trap area), but did not enter the area immediately proximal to the trap (the trap site) as frequently as coyotes. Current trap and lure systems may be more selective than published reports indicate because of the relatively higher abundance and activity of other species in areas where coyote traps are set. Coyotes and noncoyote species visited at different times of day; in the future, diurnally inactivated capture systems could mechanically exclude most noncoyote species and further increase capture-device selectivity.

Key words *Canis latrans*, coyote, snares, trap, video

Traps are commonly used to capture coyotes (*Canis latrans*) for fur, biological research, and depredation and population management. Because of arguments citing nonselectivity and injury, the use of foothold traps and snares has been limited in some areas of the United States (Cockrell 1999). The issue of trap use is also an important international topic (United States of America–European Community 1997, International Organization for Standardization 1999). Continuing international interest in capture-systems technology (Andelt et al. 1999) has promoted recent testing of traditional (Onderka et al. 1990, Skinner and Todd 1990, Phillips et al. 1992), padded (Linhart and Dasch 1992, Phillips and Mullis 1996, Phillips et al. 1996), and otherwise modified traps (Houben et al. 1993, Gruver et al. 1996, Hubert et al. 1997) and snares (Phillips 1996, Shivik et al. 2000).

Typical measures of trap performance include efficiency, selectivity, and injury caused, especially in relation to the mechanical attributes of the trap. However, an understanding of the behaviors that result in capture (or exclusion) of an animal is equally important for the development of improved capture devices. In this study, we quantified visitation by vertebrate species to trap sites set for coyotes. We were concerned with several questions: 1) what animals are visiting coyote trap-site areas versus what animals are attracted to the actual trap site, 2) when are they visiting, and 3) how much time are they spending there?

Camera equipment has been successfully used to gather useful data on coyotes (Peterson and Thomas 1998) and many other species (Kristan et al. 1996, Stewart et al. 1997, Delaney et al. 1998, Davis et al. 1999), and the technology is useful for monitoring animals that visit a trap site. Because of the limitations of movement-activated still pictures or video (Rice et al. 1995, Thompson et al. 1999), we used miniature cameras, infrared illumination, and 24-hour video cassette recorders to constantly monitor trap sites.

Methods

We used 3 capture systems (Belisle®, Edouard Belisle, Sainte-Veronique, Que., Canada; Collarum®,

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Green Mountain Inc., Lander, Wyo.; and one developed by the United States Department of Agriculture, Wildlife Services [USDA-WS]; Shivik et al. 2000), and common coyote lures (Carmen's Canine Call, Pro's Choice, Trails End, and urine [M&M Fur Company, Bridgewater, S.D.] as well as scats found on site) at coyote trap sites on private land in Webb County, Texas. The attributes of each trapping system (selectivity, efficiency, injury data) were presented in detail in a previous publication (Shivik et al. 2000, although the sites used in this study were established with video monitoring equipment and were not the same sites used previously); hence, we have limited this paper to analyses of events at trap sites rather than a study of capture systems *per se*. During February–March 1999, we established traplines along unimproved ranch roads and checked traps in the morning. Field conditions were those of a typical southern Texas ranch, with cattle ranging over unimproved roads and fields containing south-Texas plains vegetation (especially *Prosopis glandulosa* and *Opuntia* spp., Taylor et al. 1997).

We used miniature video cameras arrayed with infrared diodes for night-time illumination (Supercircuits, Leander, Tex. USA). We mounted weatherproof camera housings on tripods approximately 6–8 m from the trap site (e.g., on an opposite side of the road from where a trap was located) and concealed them in vegetation. Video recording equipment (Sony SVT-DL224 24 hr 12V VCR) and batteries (2 deep-cycle 6V batteries wired in series) that supplied power for the system were housed in a weatherproof container at a remote location, approximately 20 m farther away from trap sites, and were connected to the camera units with coaxial cable. We used a remote recorder to minimize human visitation to trap sites, which probably had no more effect than that of trap checks by a trapper in a nonresearch situation. We recharged batteries every 3 days and changed tapes daily.

Data collected included intrusions into the trap area (i.e., within the field of view of the camera, an approximately 4-m-diameter area around the trap), intrusions into the trap site (i.e., one body-length from the trap), time of intrusion, and identity of the species visiting. If an animal sprang a trap, only the observations up to the time of trap activation were included in the analyses. When large groups of a single species entered the frame of observation (e.g., cows, passerines), we treated the group as a single species unit (i.e., herd or flock) for analyses.

For animal visitation analyses, the sample unit was the trap location, and estimates of visitation for each site were based on the number of visits by each species during all days of observation at each location. That is, means and standard errors of visitation rates were based on the number of visits by animals to each trap location rather than on the absolute number of visits by all animals on all nights. We used video data to estimate area rate (number of area intrusions by species/hr of observation), site rate (number of site intrusions by species/hr of observation), and relative selectivity (site visit rate/area visit rate, given that the species intruded into the area). Similarly, we estimated the area time rate (amount of time animals spent in the area/hr of observation), site time selectivity (amount of time animals spent at the trap site/hr of observation), and relative time rate (site time rate/area time rate, given that the species intruded into the area). Relative number of visits and time spent in trap areas versus trap sites indicated attractiveness of trap sites relative to the potential for encountering sites by each species. Because of infrequency of visitation on an hourly scale, rates were scaled per 1,000 hours of observation.

We recorded time of visits by all species to identify temporal trends in visitation to trap sites. For temporal visitation analyses, the sample unit was the individual visit by an animal, based on all hours of observation at all sites. That is, the time of each visit by each animal was recorded and used to examine temporal trends in visitation to trap sites. For analysis, we compared temporal visitation patterns between coyotes and noncoyote species.

Results

We analyzed 2,822 hours of video observations from 144 tapes (1 tape = 1 trap night) set at 31 trap locations. We observed visitation to the trap area by 19 vertebrate species during 564 individual visits (140 visits/trap location, Table 1). Species that we observed in the recordings were armadillos (*Dasypus novemcinctus*), bobcats (*Lynx rufus*), Caracaras (*Caracara cheriway*), domestic cows, coyotes, crows (*Corvus* spp.), white-tailed deer (*Odocoileus virginianus*), domestic dogs, doves (Columbidae), javelina (*Pecari tajacu*), jackrabbits (*Lepus californicus*), mice (Muridae), small birds (Passerines), quail (*Callipepla squamata*), rabbits (*Sylvilagus* spp.), raccoons (*Procyon lotor*), roadrunners (*Geococcyx californianus*), a rattlesnake

Table 1. Animal visitation to coyote trap sites based on 2,822 hrs of 24 hr observation of 31 trap sites, February–March 1999 in Webb County, Texas.

Species	Visits	Area rate[a]	SE	Site rate[b]	SE	Area time[c]	SE	Site time[d]	SE	Relative visits[e]	SE	Relative time[f]	SE
Armadillo	1	0.26	0.26	0.26	0.26	0.01	0.01	<0.00		1		0.5	
Bobcat	2	0.90	0.64	0.90	0.64	0.01	0.01	0.01	0.01	1		1	
Caracara	1	0.56	0.56	0.0		0.01	0.01	0.0		0		0	
Cow	14	23.18	7.69	2.81	1.56	1.21	0.57	0.06	0.05	0.25	0.10	0.18	0.09
Coyote	8	7.15	2.76	4.79	1.61	0.11	0.04	0.08	0.03	0.90	0.19	0.78	0.09
Crow	4	5.19	3.00	1.62	0.97	1.67	1.04	0.01	0.01	0.50	0.70	0.07	0.01
Deer	7	10.48	5.01	1.96	1.29	0.23	0.12	0.02	0.01	0.38	0.28	0.16	0.09
Dog	2	1.29	0.90	0.64	0.64	0.03	0.03	0.01	0.01	0.50	0.50	0.25	0.25
Dove	1	0.30	0.30	0.00		0.00	0.02	0.00		0.00		0.00	
Flock	15	29.38	11.57	7.53	3.39	11.82	5.09	0.36	0.26	0.44	0.23	0.02	0.10
Herd	8	21.52	8.67	15.54	8.17	11.70	6.38	0.34	0.19	0.84	0.32	0.24	0.14
Javelina	7	5.67	2.49	0.61	0.35	0.20	0.13	0.01	<0.01	0.36	0.18	0.21	0.10
Jackrabbit	4	4.36	3.01	0.00		0.10	0.06	0.00		0.00		0.00	
Mouse	4	3.13	1.64	0.15	0.15	0.13	0.08	0.00		0.01	0.01	0.00	
Passerine	23	65.18	12.00	0.09	0.03	4.23	1.32	0.00		0.00		0.00	
Quail	6	4.86	2.10	0.02	0.01	0.15	0.01	0.00		<0.01		0.00	
Rabbit	13	14.40	4.79	3.85	1.71	1.03	0.40	0.16	0.13	0.23	0.10	0.15	0.09
Raccoon	4	3.79	1.80	2.09	1.70	0.07	0.04	0.02	0.01	0.76	0.19	0.56	0.20
Roadrunner	13	9.92	3.06	2.43	1.08	0.15	0.05	0.07	0.01	0.26	0.12	0.18	0.09
Rattlesnake	1	0.58	0.58	0.58	0.58	0.04	0.04	0.04	0.04	1		1	
Skunk	2	0.48	0.33	0.48	0.33	0.01	<0.01	<0.01		1		0.75	0.25

[a] Number of visits by the species to the area proximal to a trap site per 1,000 hrs of observation, based on a sample of 31 trap sites.

[b] Number of visits by the species to the trap site (within 1 body length of the trap) per 1,000 hrs of observation, based on a sample of 31 trap sites.

[c] Amount of time (hrs) spent by the species in the area proximal to a trap site per 1,000 hrs of observation, based on a sample of 31 trap sites.

[d] Amount of time (hrs) spent by the species at the location of a trap site (within 1 body length of trap) per 1,000 hrs of observation, based on a sample of 31 trap sites.

[e] Site rate/area rate (i.e., the proportion of animals entering the area that enter the trap site [n = visits]).

[f] Site time/area time (i.e., the proportion of time animals entering the area that spend time at the trap site [n = visits]).

(*Crotalus* spp.), and skunks (*Mephitis* spp.). Some species, such as spiders (Arachnida), were also observed, but we limited our analyses to identifiable vertebrate species.

It appeared that more noncoyote species had the opportunity to be drawn into coyote trap sites than did coyotes because there were >16 times as many noncoyote visits to the area surrounding individual trap sites than visits by coyotes ($n = 132$ visits by other species and $n = 8$ visits by coyotes to each location). However, relative to the amount of visitation by all species, trap sites were more attractive to coyotes because coyotes investigated trap sites in 90% of their area intrusions, whereas other species were much less likely to investigate sites (Table 1). Similarly, coyotes spent nearly as much time investigating trap sites as they spent in the general area, whereas other species showed much less interest in trap sites (Table 1).

Temporal analyses of visits to trap sites by coyotes and noncoyote species indicated absolute number of visits to trap locations (using the visit as the sample unit) was 564, with 20 of those visits by coyotes. There was a clear temporal partitioning of visitation to trap locations (Figure 1). Forty-five percent of coyote intrusions occurred between 0400 and 0600 Central Standard Time (approximate sunrise 0700, sunset 1900); very few noncoyote species visited during this time frame. Noncoyote visits peaked between 0800 and 1200, with 81% of intrusions occurring between 0600 and 1800 when no coyotes were observed (Figure 1).

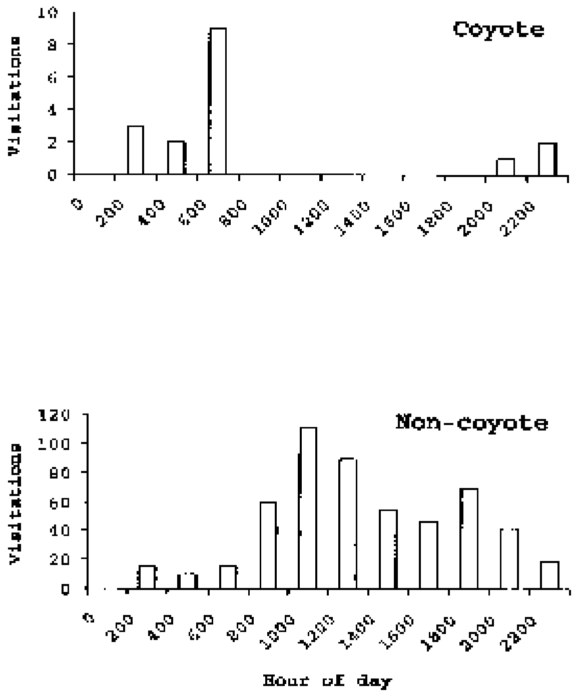

Figure 1. Number of visitations to trap locations by coyote and noncoyote species by hour of day. Data were collected from 2,822 hours of observation from 144 trap nights at 31 trap locations in Webb County, Texas, during February–March 1999, when sunrise occurred at approximately 0700 and sunset at approximately 1900.

Discussion

Phillips and Gruver (1996), by searching trap sites for tracks and sign, reported that 826 nontarget and 902 coyotes visited trap sites, and nearly all noncoyotes were excluded using pan-tension devices. In our study, however, the video equipment used allowed us to detect a wider variety of species and to determine when they had visited the area proximal to the trap location as well as the trap site. Our equipment was sensitive enough to record intrusions by passerine birds, rattlesnakes, and spiders, and provided data that were much more precise and comprehensive than those reported previously. Furthermore, the camera was small and concealed, and the recording system was >26 m from the trap site and did not click, whir, or flash (as still-frame movement-activated systems do). We believe the cameras had minimal influence on the behavior of coyotes or other species.

For coyotes, capture device selectivity is usually thought of as number of coyotes captured relative to number of captured noncoyote species (Linhart and Linscombe 1987). We termed this statistic as overall selectivity. However, overall selectivity can be divided into several biogeographical and biomechanical components. Biogeographical components include: location selectivity (number of coyotes in the trapping area relative to number of noncoyote species in the trapping area, which is related to the relative abundance and activity of each species in the habitat where traps are set), and site selectivity (relative degree of attraction to the trap system by coyote and noncoyote species given that a species has access to the trap site, which is a measure of the attractiveness, or repellency, of the trap and lure system). Biomechanical components of species selectivity for trap systems include the following: activation selectivity (exclusion of a species from triggering devices on occasions when other species would [e.g., due to pan-tension devices], Linhart et al. 1981, Turkowski et al. 1984, Phillips and Gruver 1996), initial capture selectivity (the relative number of individuals of coyote and noncoyote species that activate a restraint system and are restrained by it), and escape selectivity (the relative number of animals held or released after initially being restrained by the system [e.g., by using breakaway snares], Phillips et al. 1990). Shivik et al. (2000) discussed the overall and mechanical selectivity of the Belisle, USDA-WS, and Collarum restraint systems (70% for the Belisle, 70% for the USDA-WS system, and 100% for the Collarum), but they did not detail the biogeographical components of trap selectivity we identified in this study. All components of selectivity are important because a thorough understanding of each will assist with the development of more selective and efficient capture systems for individual species.

We conclude that common lures (e.g., urine, scat, and commercial fetid call lures) and trap systems (i.e., buried footholding devices) for coyotes are very selective for coyotes because, although noncoyote species were 16 times more likely to encounter a trap area than coyotes, they were usually not attracted to the trap site. Thus, because of site selectivity, a capture system in Webb County, Texas that catches fewer than 16 times as many noncoyote species as coyotes exhibits significant selectivity toward the capture of coyotes. Site selectivity is probably due mostly to canid-specific lures, and we hope our data collection methods will be used in the development of selective-capture systems (especially in areas where other canids, such as wolves [*Canis lupus*] are present), including the development of new lures (Kimball et al.

2000) that are attractive only to coyotes or the desired species of capture.

The temporal activity of coyotes and other species suggests improvements in capture-system technology that may further improve selectivity. For coyotes, we suggest that future devices be developed that are active only during the evenings and early mornings, when coyote visitation is greatest and visitation by other species is lowest. Such a time-sensitive device is possible, given readily available electronics and timers, and would help to exclude many potential noncoyote captures while not necessarily decreasing the efficiency of coyote capture. However, seasonal changes in noncoyote and coyote activity (Shivik et al. 1997) occur and should be understood for the proper use of time-activated capture systems.

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Literature cited

ANDELT, W. F., R. L. PHILLIPS, R. H. SCHMIDT, AND R. B. GILL. 1999. Trapping furbearers: an overview of the biological and social issues surrounding a public policy controversy. Wildlife Society Bulletin 27:53–64.

COCKRELL, S. 1999. Crusader activists and the 1996 Colorado anti-trapping campaign. Wildlife Society Bulletin 27:65–74.

DAVIS, R. W., L. A. FUIMAN, T. M. WILLIAMS, S. O. COLLIER, W. P. HAGEY, S. B. KANATOUS, S. KOHIN, AND M. HORNING. 1999. Hunting behavior of a marine mammal beneath the Antarctic fast ice. Science 283:993–996.

DELANEY, D. K., T. G. GRUBB, AND D. K. GARCELON. 1998. An infrared video camera system for monitoring diurnal and nocturnal raptors. Journal of Raptor Research 32:290–296.

GRUVER, K. S., R. L. PHILLIPS, AND E. S. WILLIAMS. 1996. Leg injuries to coyotes captured in standard and modified Soft Catch® traps. Proceedings of the Vertebrate Pest Conference 17: 91–93.

HOUBEN, J. M., M. HOLLAND, S. W. JACK, AND C. R. BOYLE. 1993. An evaluation of laminated offset jawed traps for reducing injuries to coyotes. Proceedings of the Great Plains Wildlife Damage Control Workshop 11:148–153.

HUBERT, G. F., JR., L. L. HUNGERFORD, AND R. D. BLUETT. 1997. Injuries to coyotes captured in modified foothold traps. Wildlife Society Bulletin 25:858–863.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. 1999. Animal (mammal) traps—Part 5: methods for testing restraining traps. International Standard ISO/DIS 10990-5. International Organization for Standardization, Geneva, Switzerland.

KIMBALL, B. A., J. R. MASON, F. S. BLOM, J. J. JOHNSTON, AND D. E. ZEMLICKA. 2000. Development and testing of seven new synthetic coyote attractants. Journal of Agricultural and Food Chemistry 48:1892–1897.

KRISTAN, D. M., R. T. GOLIGHTLY, JR., AND S. M. TOMKIEWICZ, JR. 1996. A solar-powered transmitting video camera for monitoring raptor nests. Wildlife Society Bulletin 24:284–290.

LINHART, S. B., AND G. J. DASCH. 1992. Improved performance of padded jaw traps for capturing coyotes. Wildlife Society Bulletin 20:63–66.

LINHART, S. B., G. J. DASCH, AND F. J. TURKOWSKI. 1981. The steel leg-hold trap: techniques for reducing foot injury and increasing selectivity. Pages 1560–1578 *in* J. A. Chapman and D. Pursley, editors. Proceedings of the Worldwide Furbearer Conference, 3–11 August 1980, Frostburg, Maryland, USA.

LINHART, S. B., AND R. G. LINSCOMBE. 1987. Test methods for steel foothold traps: criteria and performance standards. Vertebrate Pest Control and Management Materials 5:148–158.

ONDERKA, D. K., D. L. SKINNER, AND A. W. TODD. 1990. Injuries to coyotes and other species caused by four models of footholding devices. Wildlife Society Bulletin 18:175–182.

PETERSON, L. M., AND J. A. THOMAS. 1998. Performance of Trail-Master® infrared sensors in monitoring captive coyotes. Wildlife Society Bulletin 26:592–596.

PHILLIPS, R. L. 1996. Evaluation of three types of snares for capturing coyotes. Wildlife Society Bulletin 24:107–110.

PHILLIPS, R. L., F. S. BLOM, G. J. DASCH, AND J. W. GUTHRIE. 1992. Field evaluation of three types of coyote traps. Proceedings of the Vertebrate Pest Conference 15:393–395.

PHILLIPS, R. L., F. S. BLOM, AND R. E. JOHNSON. 1990. An evaluation of breakaway snares for use in coyote control. Proceedings of the Vertebrate Pest Conference 14:255–259.

PHILLIPS, R. L., AND K. S. GRUVER. 1996. Performance of the Paws-I-Trip pan tension device on 3 types of traps. Wildlife Society Bulletin 24:119–122.

PHILLIPS, R. L., K. S. GRUVER, AND E. S. WILLIAMS. 1996. Leg injuries to coyotes captured in three types of foothold traps. Wildlife Society Bulletin 24:260–263.

PHILLIPS, R. L., AND C. L. MITTUS. 1996. Expanded field testing of the No. 3 Victor Soft Catch Trap. Wildlife Society Bulletin 24: 128–131.

RICE, C. G., T. E. KUCERA, AND R. H. BARRETT. 1995. Trailmaster® camera system. Wildlife Society Bulletin 23:110–113.

SHIVIK, J. A., K. S. GRUVER, AND T. J. DELIBERTO. 2000. Preliminary evaluation of new cable restraints to capture coyotes. Wildlife Society Bulletin 28:606–613.

SHIVIK, J. A., M. M. JAEGER, AND R. H. BARRETT. 1997. Coyote activity patterns in the Sierra Nevada. Great Basin Naturalist 57: 355–358.

SKINNER, D. L., AND A. W. TODD. 1990. Evaluating efficiency of footholding devices for coyote capture. Wildlife Society Bulletin 18:166–175.

Stewart, P. D., S. A. Ellwood, and D. W. Macdonald. 1997. Remote video-surveillance of wildlife: an introduction from experience with the European badger *Meles meles*. Mammal Review 27:185–204.

Taylor, R. B., J. Rutledge, and J. G. Herrera. 1997. A field guide to common south Texas shrubs. Texas Parks and Wildlife. Austin, USA.

Thompson, F. R., III, W. Dijak, and D. E. Burhans. 1999. Video identification of predators at songbird nests in old fields. Auk 116:259–264.

Turkowski, F. J., A. R. Armistead, and S. B. Linhart. 1984. Selectivity and effectiveness of pan tension devices for coyote foothold traps. Journal of Wildlife Management 48:700–708.

United States of America–European Community. 1997. Agreed minute and annex: standards for the humane trapping of specified terrestrial and semi-aquatic mammals. Commission of the European Communities, Brussels, Belgium.

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