A Comparison of Survey Methods for Detecting Bobcats

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Abstract

Population trends in bobcats (Lynx rufus) have been difficult to monitor because traditional field survey methods usually produce very low detection rates. However, new methods of detecting bobcats have been developed. I compared the rate of detection, cost, and time required for automatic cameras, hair-snares, scent stations, and a detector dog trained to find bobcat scats. The detector dog produced nearly 10 times the number of bobcat detections as the other methods combined. The detector dog was the most expensive method and, depending upon weather and number of scats required, required more field time than the other methods. However, use of detector dogs requires only one visit to each survey site. Hair-snares and scent stations were the cheapest methods but produced the least detections. Field time for hair-snares, cameras, and scent stations was similar. Use of detector dogs has the potential to consistently achieve sufficient detection rates to provide useful indices for population monitoring of bobcats. (WILDLIFE SOCIETY BULLETIN 34(2):548–552; 2006)

Key words

Monitoring populations is one of the most important aspects of wildlife management. Monitoring becomes especially important for species that are managed to sustain harvestable surpluses and are subject to fluctuations in public demand. For example, in recent years, demand for fur by the fashion industry has increased dramatically, especially for pelts of bobcats (*Lynx rufus*; Dozhier 2003). Bobcat populations have been particularly difficult to monitor independently of harvest statistics. Many wildlife management agencies use scent stations (scented tracking surfaces) to monitor furbearer populations, but visitation rates by bobcats reported in the literature have rarely exceeded 10% (Harrison 1997, Sargeant et al. 1998). This is the minimum threshold above which scent station indices may be useful for population trend analyses with practical sample sizes (Sargeant et al. 2003). However, new methods of detecting bobcats have been developed which may increase detection rates. These include the use of detector dogs, automatic cameras, and hair-snares.

Detector dogs trained to find scats have been used in studies of kit foxes (*Vulpes macrotis*; Smith et al. 2003), grizzly and black bears (*Ursus arctos, U. americanus*; Wasser et al. 2004), forest carnivores including bobcats, black bears, and fishers (*Martes pennanti*; R. Long, University of Vermont, Burlington, USA, personal communication), and other species. Automatic cameras have been used extensively in wildlife studies (see review in Cutler and Swann 1999) but have not been used specifically as a tool for large-scale surveys for bobcats. Hair-snares are scented devices upon which animals deposit hair (McDaniel et al. 2000, Mowat and Strobeck 2000).

I compared the rate of detection, time required, and cost of detector dogs, automatic cameras, hair-snares, and scent stations for surveys of bobcats. The study consisted of 2 segments: an initial study of hair-snares alone, followed by a comparative study of detector dogs, automatic cameras, hair-snares, and scent stations.

Study Area

I used 2 study areas. The initial study of hair-snares alone occurred within United States Department of Agriculture National Forest lands in the Sandia and Manzano Mountains in central New Mexico (counties of Bernalillo, Sandoval, and Torrance). Habitat was primarily hilly coniferous woodland dominated by piñon pine (*Pinus edulis*) and junipers (*Juniperus monosperma, J. deppeana*), with ponderosa pine (*P. ponderosa*) at higher elevations (Dick-Peddie 1993). Elevations ranged from 2,000–2,500 m. Annual precipitation varied from 25–50 cm (Dick-Peddie 1993). The second, comparative study occurred on the Armendaris Ranch, a privately owned ranch located in south-central New Mexico immediately east of Elephant Butte Lake in Sierra County. Habitat on the Armendaris Ranch study area consisted primarily of 2 types, Chihuahuan desert scrub and desert grassland, as classified by Dick-Peddie (1993). Chihuahuan desert scrub occurred on hilly areas bisected by dry creekbeds and was dominated by creosotebush (*Larrea tridentata*), honey mesquite (*Prosopis glandulosa*), desert sumac (*Rhus microphylla*), and other shrubs, with velvet ash (*Fraxinus velutina*) and Frémont cottonwood (*Populus fremontii*) along creekbeds, and one-seed juniper (*J. monosperma*) in isolated stands. Desert grassland occurred on flat areas and was dominated by black grama (*Bouteloua eriopoda*), alkalai sacaton (*Sporobolus airoides*), galleta (*Hilaria jamesii*), and stands of honey mesquite and desert sumac. In addition, dense stands of dead tamarisk (*Tamarix ramosissima*) occurred along high water levels of Elephant Butte Lake. Elevations of the Armendaris Ranch study area ranged from 1,500–1,700 m. Annual precipitation varied from 15–30 cm.

Methods

For the initial study of hair-snares only, I placed hair-snare stations along creekbeds, trails, irrigation ditches, edges of meadows, and unpaved roads from September 2002 to June 2003, following the procedures of McDaniel et al. (2000). I placed stations ≥500 m apart. Each station consisted of 2 snares nailed to 2 separate trees, no more than 1 m apart. Snares consisted of equal numbers of 10 × 10-cm patches of carpet with 10 nail-gun nails driven through the uncarpeted side and mending plates backed by carpet patches. Mending plates, purchased from a hardware store, were 7.5 × 12-cm pieces of sheet metal punched to create 120 sharp points. At each station, I nailed a 2.5 × 2.5-cm piece of

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paper with tacky glue (obtained from glue-based insect traps) on one snare. I scented carpet patches with 30 ml of beaver castor (Sterling Fur, Sterling, Ohio), 15 ml of crushed, dried catnip leaves (The Herb Store, Albuquerque, New Mexico), and 5 drops of catnip oil (United States Department of Agriculture Wildlife Services Pocatello Supply Depot, Pocatello, Idaho). I placed 2–3 strips of flagging tape on nearby branches and hung an additional carpet patch scented with beaver castor, and a swiveling pie tin, over the snares. In areas of extensive public use, it was necessary to place the snares 1–3 m off roads to avoid vandalism. I collected deposited hairs and placed them in small paper envelopes after 2 and 4 weeks. Species were identified using mitochondrial DNA analysis (Wildlife Genetics International, Nelson, British Columbia, Canada).

I conducted field work for the comparison of detector dogs, automatic cameras, hair-snares, and scent stations from September 2004 to March 2005. I conducted tests of each method along 3.2-km transects. Transects followed dry creekbeds, roads, or brushy areas. I hired a detector dog-and-handler team (Packleader Detector Dogs, Gig Harbor, Washington). Beginning at dawn, the dog-and-handler team searched each transect for bobcat scats for 3–5 hours. The length of time the dog was able to work was limited by temperature and insolation (see Discussion). The dog was unleashed while he searched but was kept within approximately 15 m of the handler. The handler kept the dog within sight as much as possible. When the dog located a potential bobcat scat, he stopped, stood over the scat, and looked at the handler. The handler would then examine the scat and determine if it was a potential bobcat scat based upon his personal knowledge of the ranges of sizes and shapes of bobcat scats. If the handler accepted the scat, he rewarded the dog with a tennis ball and play. I collected all scats identified as potential bobcat by the dog-and-handler team, and did not limit the number of scats collected. I collected and stored scats in paper bags at ambient temperatures without additional drying or freezing, assuming scats were already adequately dried due to the arid climate (Piggot and Taylor 2003).

I did not assume that scats collected in the field were correctly identified as bobcat by the dog-and-handler team. I identified species depositing scats by 2 methods: mitochondrial DNA analysis (Wildlife Genetics International) and Comparable Species Differentiation (CSD) tests (Smith et al. 2003). The CSD tests were conducted at the facilities of Packleader Detector Dogs (Gig Harbor, Wash.) and followed a procedure similar to that of Smith et al. (2003). For these tests 2 additional dogs were trained to identify bobcat scats, utilizing 10 scats from the Armendaris study area identified as bobcat by DNA analysis, plus additional known bobcat scats provided by Packleader. A variation on a standard compartmentalized scent box was utilized. The scent box configuration consisted of a wooden box with holes that accommodated wide-mouth canning jars and a separate target box containing the target odor (known bobcat). The scat sample to be tested and 3–4 other known, nonbobcat scat samples were placed randomly in the jars. Nonbobcat scats were from coyotes (*Canis latrans*), cougars (*Puma concolor*), and jaguars (*Panthera onca*). At the beginning of each test, the target odor was reinforced to the dog and then the dog was presented with the samples in the scent box. The dog would indicate either a match or no match to the

target. The procedure was then repeated with the second dog. Sample scats which were matched by both dogs were not tested further. Scats which were not matched by both dogs were tested a second time.

For the comparative study, I alternatively placed hair-snare and scent–camera stations at 0.35-km intervals along transects, for a total of 5 hair-snare and 5 scent–camera stations on each transect. I constructed hair-snares in a manner different from that of the study of hair-snares alone. Due to rocky substrates in some areas and lack of trees on the Armendaris Ranch, I constructed snares by nailing single carpet patches (described above) to 45-cm-long × 12-cm-diameter logs, which were each nailed to 2 10 × 40-cm boards to prevent the logs from rolling. Bobcats have been observed to rub on objects at low heights (R. L. Harrison, University of New Mexico, Albuquerque, USA, personal observations; E. Ruell, Colorado State University, Fort Collins, USA, personal communication). I did not use mending plates and glue patches but used lures, flagging, and pie tins as described above. I also placed 4 white feathers between each carpet patch and log. I collected deposited hairs and placed them in paper envelopes after 2 weeks. Species were identified using mitochondrial DNA analysis (Wildlife Genetics International).

Scent stations consisted of a 1 × 1-m area cleared of vegetation and covered with a sifted 32:1 mixture of dried plaster sand and mineral oil. I placed a lure consisting of a plaster of paris tablet (USDA Wildlife Services Pocatello Supply Depot) soaked in beaver castor (Sterling Fur) in a white, perforated plastic capsule (38 × 10 mm; Tissue-Tek, Baxter Scientific Products, McGaw Park, Illinois), stapled it to a tongue depressor, and inserted it vertically in the center of the scent station. I placed flagging on nearby shrubs. I hung one small pie tin and a carpet patch scented with beaver castor over each scent station. At each scent station, I placed a Trailmaster 1500 active infrared camera (Goodson and Assoc., Lenexa, Kansas) with the infrared beam passing over the center of the scent station. I set cameras to take 2 photographs between 1700 and 0900 hours when the infrared beam was broken. I attached camera and infrared units to stakes 25 cm above ground level. I checked scent stations for tracks for 2 nights and removed cameras after 2 weeks.

Results

During the initial study of hair-snares only, I established 631 hair-snare stations and retrieved hair from 100 stations. I identified hair samples as 1 bobcat, 50 gray foxes (*Urocyon cinereoargenteus*), 18 coyotes, 16 dogs (*C. familiaris*), and 3 humans. Thirteen samples could not be identified by DNA analysis. I collected 50% of hair samples from carpet patches, 39% from mending plates, and 11% from the bark of trees upon which the snares were located. Although not quantified, carpet patches with nails driven through the uncarpeted side appeared to collect larger amounts of hair than did mending plates, due to snagging of hair on barbs attached to protruding nails. Glue patches did not provide any useful amounts of hair beyond that collected by snares.

I surveyed 10 transects for the comparison of detector dogs, hair-snares, automatic cameras, and scent stations, including 700 hair-snare nights, 140 camera nights, and 100 scent-station nights. The detector dog produced the greatest number of detections and was

Table 1. Comparison of detection rate, cost, and estimated time required for presence–absence surveys of bobcats by a detector dog, automatic cameras, hair-snares, and scent stations on 10 transects in southern New Mexico (Sept 2004–Mar 2005).

Method	No. of bobcat detections[a]	Percentage of transects with detections (%)	Cost[b] ($)	Field time required (days)
Detector dog				
DNA verification	56 (72%)	100	4,900	5–10
CSD[d] verification	62 (91%)	100	5,400	5–10
Automatic cameras	5	50	≤2,275/transect	3–5[c]
Hair-snares	1	10	277	3–5[c]
Scent stations	0	0	<200	3–5[c]

[a] Percentages of total numbers of scats tested are in parentheses.
[b] Costs include DNA analysis of collected samples but not travel expenses.
[c] Times do not include return travel time to transects.
[d] Comparable Species Differentiation.

the most expensive method (Table 1). The detector dog located 78 potential bobcat scats. The DNA analysis confirmed that bobcat scats were found on 100% of transects (Range 1–13 confirmed bobcat scats per transect). The DNA analysis identified 72% of the scats as bobcat, 6% as coyote, 3% as gray fox or kit fox, and failed for 19%. Of those 63 scats with a DNA identification, 89% were bobcat, 8% were coyote, and 3% were gray or kit fox. Of the 68 potential bobcat scats tested through CSD, during the first trial 81% were identified as bobcat, 7% were identified as non-bobcat, and 12% were matched by one dog but not the other dog. During the second trial, 88% of the mismatched scats were matched by both dogs as bobcat, and 12% were matched by one dog but not the other dog. Overall, using CSD tests, 91% of scats were identified as bobcat, 7% as nonbobcat, and 1% as undetermined. Of the 62 scats identified as bobcats by the CSD test, DNA analysis succeeded for 48. Of the latter 48 scats, DNA analysis identified 88% as bobcat, 8% as coyote, and 4% as gray or kit fox. Of the 5 scats identified as nonbobcat with CSD tests, DNA analysis found 60% to be bobcat, 20% to be coyote, and failed for 20%.

Of those 56 scats which were identified by DNA analysis as bobcat, the average ±1 SD maximum diameter was 2.0 ± 0.2 cm (range: 1.5–2.5 cm). The colors of these scats were black (7%), brown (4%), dark gray (12%), gray (36%), light gray (20%), and white (21%). Of those 15 scats for which DNA analysis failed, 20% were light gray, 20% were gray, and 60% were white. The shapes of the ends of the scats were blunt (52%), pointed (21%), or indeterminate (27%). The shapes of the main portions of the scats were segmented (84%), not segmented (4%), and indeterminate (12%). Bobcat scats that were both blunt and segmented comprised 48% of the sample, and bobcat scats that were pointed and segmented comprised 16% of the sample.

Automatic cameras recorded bobcats at 1 station each on 5 transects. Photographs of kit foxes, black-tailed jackrabbits (*Lepus californicus*), American bison (*Bison bison*), and striped skunks (*Mephitis mephitis*) also were obtained. I collected hair samples from 10 hair-snares during the comparative tests. Species identified were bobcat (1), gray or kit fox (2), coyote (4), and American bison (3). I observed no tracks of bobcats on scent stations during the 2-night observation period, although bobcats were photographed on scent stations on 4 transects after that period.

The detector dog was the most expensive method (Table 1). The cost of hiring the detector dog-and-handler team was approximately $3,000 (USD) for 2 5-day work periods, 1 2-day rest period, meals, and lodging, but not including travel expenses between Packleader headquarters and the study site. The DNA analysis cost $23.35/scat, not including the costs of packaging and shipping. The DNA analysis was performed in Canada, and the cost of the services of Wildlife Genetics International to U.S. customers will vary with exchange rates. The CSD tests cost $2,240 ($1,500 for training and set-up of CSD dogs, plus $10/scat), plus an additional $233.50 to provide 10 scats for training confirmed to be bobcat by DNA analysis, but not including packaging and shipping. Altogether, use of the detector dog-and-handler team for this study cost approximately $4,900 to locate bobcat scats and confirm their species of origin with DNA analysis, and $5,400 to locate bobcat scats and confirm their species of origin with CSD tests. At current prices, confirmation of species of origin for scats is less expensive using CSD tests than DNA analysis if the number of scats to be tested exceeds approximately 112–130, depending on whether training scats must be confirmed by DNA analysis prior to CSD tests.

Automatic camera units cost from <$300 to >$600 (Swann et al. 2004). At an average price of $450, cameras for 1 transect of 5 stations would cost $2,275, including the cost of stakes, film, and film processing, if necessary. Cost of the comparative hair-snare study was approximately $250 for materials, assuming that all 50 hair-snare stations were set at once, plus DNA analysis at $27.37/hair sample, not including tools and shipping. Materials for scent stations cost <$200 for 10 transects.

The detector dog required the most field time (Table 1). Depending upon weather, intensity of searching, and number of scats required, detector dogs may search for up to 6 hours, 3–5 km per day, or 1–2 transects per day. The amounts of time required to set transects of camera, hair-snares, or scent stations are similar to each other. Setting 10 transects of five stations each would require 1–2 days, plus a return trip of 1–2 days to collect results, plus 1 day to prepare materials and handle samples, for a total of 3–5 days, not including travel time between transects or to and from the study area.

Discussion and Management Implications

The detector dog provided the most evidence for the presence of bobcats in the comparative study. This method generated nearly

10 times the number of bobcat detections obtained from hair-snares, automatic cameras, and scent stations combined. In general, I found the detector dog to be very efficient and easy with which to work. The dog found many more scats than a human observer would have (Smith et al. 2003), especially given the brushy nature of bobcat habitat. Hair-snares and automatic cameras provided much less evidence, and scent stations provided none at all. Although the sample size of the comparative study was limited, the relative rates of bobcat detection found here are similar to results obtained from an unpublished comparative study of detector dogs, cameras, hair-snares, and bobcats in Vermont (R. Long, personal communication), and results typically reported from studies using individual detection methods (e.g., Foresman and Pearson 1998, Moruzzi et al. 2002, Smith et al. 2003).

Scats persist for a long time in the field, do not require that bobcats visit any particular site or station, and do not require that bobcats perform a particular behavioral response to an anthropogenic object. Hair-snares and cameras collect data over periods of a few weeks or less. While obtaining photographs relies upon bobcats simply walking in front of cameras, obtaining hair requires that bobcats rub upon snares. Scent stations usually are monitored for, at most, a few nights, and require that bobcats approach within a few steps of a lure. The amount of evidence produced by the 4 methods was positively correlated to the length of time over which evidence accumulated, and negatively correlated with the level of behavioral response required of bobcats.

The length of time that bobcat scats remain recognizable in the field, to either humans or dogs, is unknown, and may be a confounding factor for the use of scats for indices (Harrison et al. 2004, Sanchez et al. 2004). Precipitation is a significant factor in the disappearance of scats and in arid regions scats may persist for long periods (Flinders and Crawford 1977). Use of fresh scats and removal of older scats may alleviate this problem. At present, it is impossible to determine the ages of scats more than a few days old, and research in this area would be valuable.

The scats located in this study were not all from the target species, unlike Smith et al. (2003). Postcollection verification of species of origin is essential. There were discrepancies between DNA and CSD tests on species identification of individual scats. Although laboratory errors can occur, dogs likely are more susceptible to errors which are difficult to control. For example, in laboratory tests, Smith et al. (2003) found that dogs were more likely to err if scats of the target species were not present. In the field dogs may become frustrated when scats of the target species are not present and may, instead, locate nontarget scats in order to get their reward. The level of frustration and hence, errors, likely will increase when dogs become tired, hungry, or hot. It is important that the dog handler be constantly aware of the mental and physical state of the dog, as well as its general personality and limitations. Handlers must watch their dog very closely, as subtle changes of behavior may indicate the presence of a target scat or that the dog has become distracted by a novel scent. Handlers also should be knowledgeable and wary of preconceptions of the range of appearances and sizes of target scats. Coyote and gray fox scats can be very similar in appearance to bobcat scats. The diameters of confirmed bobcat scats found here overlap the reported ranges of coyote and gray fox scats (Danner and Dodd 1982). Confirmed bobcat scats had a variety of colors, and completely white scats, while possibly old, may still be confirmed as bobcat. Bobcat scats sometimes are described as blunt-ended and segmented (e.g., Rezendes 1992), but many confirmed bobcat scats in this study did not have these shapes. If such characteristics must be used, segmentation is the most reliable characteristic of potential bobcat scats.

The failure of hair-snares to detect bobcats in the initial portion of this study is difficult to explain. Bobcats were known to be in the study areas (Harrison 1998, and observations of residents). While some studies have reported good success with hair-snares and felids (e.g. McDaniel et al. 2000, Shinn 2002), others have not (E. Lindquist, United States Department of Agriculture Forest Service; R. Long, personal communication). Gray foxes have been found to readily leave hair on snares (P. Beier, Northern Arizona University, Flagstaff, USA; P. Downey, University of Oklahoma, Norman, USA, personal communication; this study), and may prevent bobcats from rubbing, or confound the subsequent DNA analysis. Gray foxes were not present in McDaniel's study area (McDaniel et al. 2000). However, gray foxes were present in south Texas, where Shinn (2002) collected bobcat hair from 12% of his hair-snare stations. Shinn (2002) attributed the success of his snares to use of a proprietary lure, which is not always available in sufficient quantities for statewide surveys (J. Weaver, Wildlife Conservation Society, USA, personal communication). The habitat in Shinn's (2002) study area consisted of dense brush, forcing bobcats to follow roads and well-defined trails where they could encounter survey stations easily. In contrast, my study areas generally were very open, and bobcats were not restricted in their movements. Other types of hair-snares and lures may be more effective than those of McDaniel et al. (2000; E. Ruell, personal communication).

Detector dogs are the most expensive method of the 4 tested here. However, since I did not know what percentage of collected scats would be confirmed as bobcat prior to the final analysis, I collected more scats than necessary to confirm the presence of bobcats on most transects. Given this knowledge, the transects could have been surveyed in much less time, and additional transects could have been surveyed. Purchasing a detector dog instead of hiring one can also reduce costs. The initial expense of purchasing automatic cameras for a statewide survey would be considerable, but, since cameras may be reused, over time the cost per transect would be reduced. However, the potential for theft precludes the use of cameras for extensive surveys. Hair-snares and scent stations are much cheaper than detector dogs and cameras but were much less effective.

The detector dog required more field time than the other 3 methods. Field time for hair-snares, cameras, and scent stations was similar. However, whereas detector dogs visit a transect only once, cameras, hair-snares, and scent stations require multiple visits to survey sites, and travel time between office and survey sites may be significant, especially in large states. Temperature limitations may decrease the time a dog can work each day. The average minimum and maximum temperatures during the detector dog surveys for this study were approximately 11°C (51°F) and 23°C (73°F). Although we began at dawn, the dog began to overheat within a few hours. Smith et al. (2003) also reported problems with overheating in southern California. Dogs may still

be used in warm climates and seasons, but they must be habituated and used carefully.

Pending tests of detector dogs in other habitats, detector dogs appear to be the best available method for statewide surveys of bobcats in New Mexico. Although expensive, use of detector dogs has the potential to consistently achieve sufficient detection rates to provide useful indices for population monitoring of bobcats (Sargeant et al. 2003). Detector dogs may be especially valuable for searches for rare animals, including endangered small felids such as oncillas (*Leopardus tigrinus*), Bornean bay cats (*Catopuma badia*), and Andean mountain cats (*Oreailurus jacobita*).

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