Comparison of Two Hair Snares for Raccoons

JERROLD L. BELANT AND JOANNE E. WOLFORD[1], National Park Service, Pictured Rocks Science Center, P.O. Box 40, Munising, MI.

ABSTRACT. We developed two types of snares incorporating barbed wire for obtaining hair samples from raccoons (*Procyon lotor*) suitable for DNA analyses. The hair snares were a wood box with a single strand of barbed wire positioned 20 cm above the lower edge of the entrance and a 5 gallon bucket with 2 strands of barbed wire in an inverted 'V' position. Snares were placed from August to November 2005 along forested roads in the central Upper Peninsula of Michigan. Both hair snares collected samples suitable for DNA analyses; however, the number of hair samples collected/100 snare nights was greater ($P < 0.001$) for bucket snares ($n = 36$) than for wood box snares ($n = 5$). Capture efficacy was also greater ($P = 0.013$) for bucket snares (91%, $n = 35$) than for box snares (68%, $n = 44$). The overall number of hairs collected at bucket snares was greater ($P = 0.021$) than the number of hairs collected at wood box snares. Barbed wire was an effective medium for obtaining hair samples from free-ranging raccoons. Because of greater performance, low cost, and ease of construction, we recommend use of bucket snares over wood box snares.

OHIO J. SCI 107 (3):44-47, 2007

INTRODUCTION

Monitoring or enumerating abundance of mesocarnivores is often difficult because of their elusive behavior and low relative abundance. Radiotelemetry has often been used to determine carnivore abundance (White and Shenk 2001). However, the difficulty in capturing an adequate number of individuals and the high cost of radiotelemetry studies frequently makes it impractical for use in long-term monitoring programs. Consequently, numerous field techniques that do not require animal capture have been developed and refined such as camera traps, spotlight counts, snow tracking, and track stations (Zielinski and Kucera 1995, Hernandez et al. 1997, Foresman and Pearson 1998, Zalewski 1999).

Advances in the use of DNA has created additional opportunities for noninvasive wildlife research. Use of genetic markers for individual identification has increased considerably in recent years (Parker et al. 1998). Small amounts of tissue are now used in genetic studies for individual identification and determining sex, species, and genealogy (Taberlet et al. 1993, Paetkau and Strobeck 1994, Foran et al. 1997, Haig 1998). Advances in genotyping in conjunction with non-invasive methods of collecting tissue samples (Woods et al. 1999), and mark-recapture modeling (White et al. 1982) have provided an additional means to estimate animal populations with estimates of precision.

Feces and hair are the two types of samples most frequently collected noninvasively for DNA analyses. Feces has been used successfully for individual identification and enumerating abundance for wolves (*Canis lupus*) and coyotes (*C. latrans*) (Creel et al. 2003, Prugh et al. 2005). However, feces typically must be fresh when collected to minimize DNA degradation and increase the likelihood of amplification (Foran et al. 1997). Extraction of DNA appears to be more successful from hair than from scat (Kohn et al. 1999, Creel et al. 2003, Belant et al. 2005, Prugh et al. 2005). Consequently, a majority of ecological studies have used noninvasive hair sampling for ecological studies (Mowat and Paetkau 2002, Belant et al. 2005).

Hair snare devices have been used to detect various carnivores, including ursids, felids, and mustelids (Raphael 1994, Woods et al. 1999, McDaniel et al. 2000, Mowat and Paetkau 2002, Boersen et al. 2003). Devices used to snare hair included curry combs, wire brushes, and nails (Belant 2003*a*, DePue and Ben-David 2006). However, the devices most commonly used are barbed wire or glue traps (Mowat and Paetkau 2002, Belant et al. 2005)

Our objective was to develop an efficient and cost-effective device to noninvasively monitor free-ranging raccoons (*Procyon lotor*) by snaring hair for individual identification. Our long-term goal was to develop a technique that, in conjunction with DNA analyses and mark-recapture analyses could be used to monitor population abundance. We also wanted a device that would not cause trap aversion for 'captured' animals and would allow all individuals to exit the device unharmed. Thus, we compared the efficacy and feasibility of two snare devices using barbed wire for obtaining hair samples from raccoons.

MATERIAL AND METHODS

We conducted the study from August to November 2005 on forested lands administered by Pictured Rocks National Lakeshore in Alger County, central Upper Peninsula of Michigan, USA (46°25'-46°40' N, 86°00'-86°37' W). Upland overstory vegetation was predominantly sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*); lowlands contained spruce (*Picea* spp.), balsam fir (*Abies balsamea*), and white cedar (*Thuja occidentalus*).

Wooden track stations were constructed as described by Zielinski and Kucera (1995). Wood boxes were 81 cm long with 30 cm (height) x 25 cm (width) openings. A single strand of 15-gauge, 4-prong barbed wire was attached by placing the wire through 9-mm holes drilled 20 cm above the inside bottom and 5 cm from the front edges of the boxes (Fig. 1). Each end of the wire was passed through a hole about 5 cm; the two strands were then separated and bent to secure the wire in place. Wire height was determined using shoulder height measurements from 21 live-captured raccoons (Belant 2004). Thus, 3 barbs evenly spaced across the front of the box were available for snagging hair. We used photocopy toner on aluminum track plates placed in the bottom of the box to identify tracks of animals entering the snare (Belant 2003b).

The second type of hair snare was constructed with 5-gallon (22 L) buckets that were 37 cm high and had a 28 cm inside diameter opening. We attached barbed wire by passing the wire ends through drilled 9-mm holes in an inverted 'V' configuration (Fig. 1). The two strands of the wire end were then separated and bent to secure the wire to the bucket. Following the outside perimeter of the bucket, the two lower holes were drilled 34 cm from the upper hole with barbed wire

[1]Corresponding author: Jerrold L. Belant, National Park Service, Pictured Rocks Science Center, Box 40, Munising, MI 49862. Phone: 906-387-4818. Fax: 906-387-2029. E-mail: jerry_belant@nps.gov.

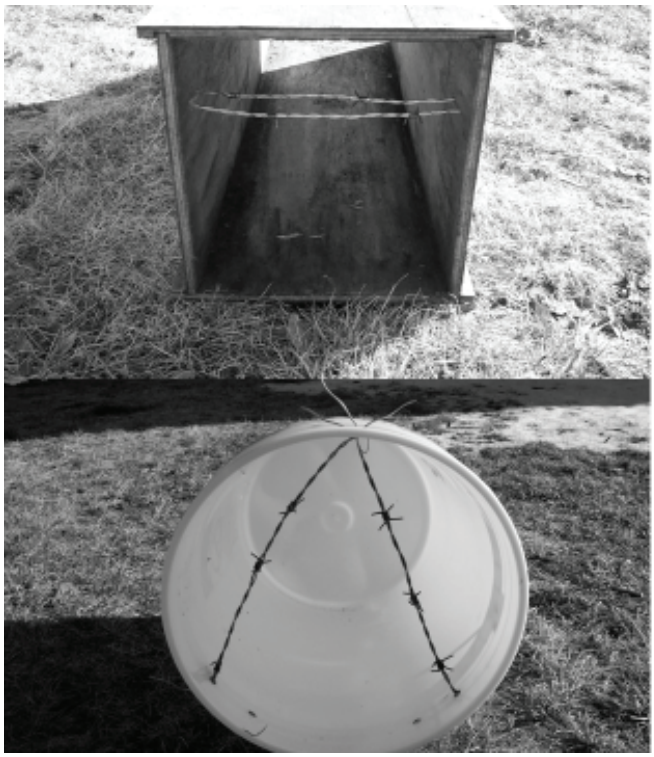

FIGURE 1. Wood box (top panel) and bucket (bottom panel) barbed-wire snares used to snag hair from free-ranging raccoons (*Procyon lotor*), Pictured Rocks National Lakeshore, Michigan, August-November 2005. Inside width of wood box is 25 cm; inside diameter of bucket opening is 28 cm.

attached as described for the wood boxes. The two wires were 10 cm apart 10 cm below the apex of the 'V'. Six barbs (3/strand) were available for snagging hair. Instead of using aluminum track plates, we applied photocopy toner directly to the bottom of the buckets for track identification.

We established 15 stations 0.5-2.0 km apart within 50 m of gravel roads with low vehicle use. At each station we placed a wood box hair snare. One end of wood box snares was placed against a tree or covered with woody debris to prevent animal entry from the rear of the snare. We established stations on 9 August and checked them 2-3 times/week through 19 September when hair snares were removed from the field. Snares were moved to new locations half way through the evaluation. We used chicken wings or bacon and commercial trapping lure (S. Stanley Hawbaker & Sons, Fort Loudon, Pennsylvania, USA) as attractants. We placed bait in plastic mesh bags attached with wire to the top rear of the hair snares. We replaced chicken as necessary and relured hair snares once each week and after heavy rain.

On 27 September we placed 4 bucket hair snares in locations vegetatively similar to wood box snare locations. We also checked these snares 2-3 times each week until 16 November when they were removed. All other procedures were conducted identically to those for bucket hair snares.

We removed all hairs from snares during each inspection. Wires were burned using a disposable butane lighter after hair removal to ensure no hair remained on the barbs. We identified hair to species using reference materials and an identification key (Adorjan and Kolenosky 1969). We classified hair samples as: 0 = less than 1 guard hair; 1 = ≥1 and <2 guard hairs; 2 = ≥2 and <3 guard hairs; and 3 = ≥3 guard hairs. Based on previous work (J. L. Belant, unpublished data), each underfur hair was weighted as 0.25 guard hairs. We assigned categories to hair samples based on approximate probabilities of determining individual genotype from hair samples (Belant et al. 2007). For example, a category 3 hair sample would have >90% probability of obtaining an individual genotype.

During each snare inspection we also identified and recorded carnivore tracks to species. We distinguished raccoon tracks from other species (e.g., American marten [*Martes americana*]) using standard field guides (Murie 1954, Halfpenny 1986, Rezendes 1999). We calculated snare success by determining the number of hair samples collected/100 unadjusted nights snares were available for obtaining hair. We calculated snare efficacy by counting the number of times raccoons entered each snare type and the number of times hair samples were obtained and converted these values to a proportion. We used chi-square statistics (Zar 1984) to compare success and efficacy rates of wood box and bucket snares. We also used chi-square tests to compare the number of hair samples by category and snare type. We assumed statistical significance at $\alpha = 0.05$.

RESULTS

Wood box and bucket hair snares were set for 630 and 98 total snare nights, respectively. Both hair snares collected samples suitable for DNA analyses; however, bucket snares obtained more ($X^2 = 29.48$, 1 df, $P < 0.001$) hair samples per unit effort than did wood box snares. Number of hair samples collected/100 snare nights was greater for bucket snares ($n = 36$) than for wood snares ($n = 5$). Hair snaring efficacy was also greater ($X^2 = 6.24$, 1 df, $P = 0.013$) for bucket snares (91%; $n = 35$) than for box snares (68%; $n = 44$).

On average, more ($X^2 = 9.69$, 3 df, $P = 0.021$) hair (i.e., higher category score) was collected/sample from bucket snares than from wood box snares (Fig. 2). The percentage of category 3 hair samples was almost twice as great for bucket snares (69%) as wood box snares (38%). In contrast, more Category 0 samples were collected from wood box snares (19%) than bucket snares (4%). Based on tracks observed in the photocopy toner, we did not find evidence of multiple raccoons entering hair snares between checks (e.g., numerous tracks or small and large tracks).

Other species detected in wood box snares included American black bear (*Ursus americanus*), American marten, striped skunk (*Mephitis mephitis*), red squirrel (*Tamiasciurus hudsonicus*), and small mammals; hair was obtained only from black bears. The same species were detected in bucket snares with hair snared from black bears and martens. On several occasions, black bears moved hair snares attempting to obtain the bait, making them unavailable for snaring hair.

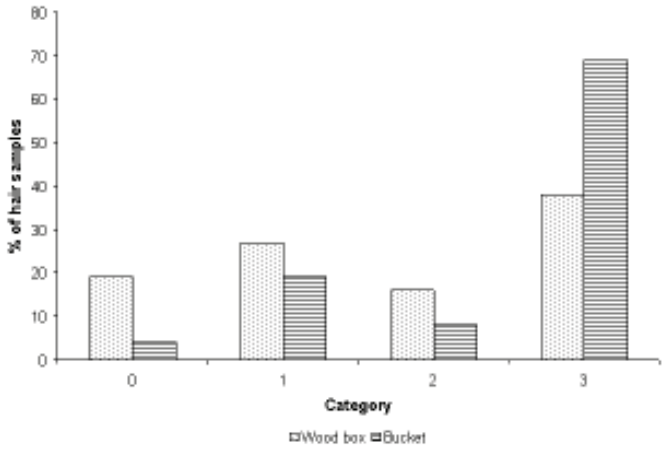

FIGURE 2. Percent of raccoon hair samples collected by category from barbed wire in wood boxes ($n = 30$) and buckets ($n = 32$), Pictured Rocks National Lakeshore, Michigan, August-November 2005.

Cost of materials to construct wood box and bucket hair snares was about US $7.00 and $2.25, respectively. These costs excluded aluminum track plates and copy toner which were used for evaluating efficacy and are not required to snare hair. Time to construct wood box snares, including cutting wood panels was about 30 min; time to construct bucket snares was < 10 min.

DISCUSSION

Both snares collected amounts of hair suitable for macroscopic identification to species and individual identification using DNA analysis. However, the success rate of bucket snares was substantially greater than the success rate for wood box snares. Bucket snares also obtained more hair on average than did wood box snares. Thus, the probability of extracting suitable amounts of DNA to determine genotype was greater for bucket snares. There are several possible reasons why bucket snares performed better than wood box snares. First, bucket snares had twice as many barbs available for snaring hair as did wood box snares. Secondly, the inverted 'V' position of the barbed wire in bucket snares would have made it more difficult for raccoons to enter without snaring hair. Raccoons may have been able to crawl under the single horizontal strand of barbed wire in wood box snares.

A potential shortcoming of these snare designs is that it is possible to obtain hair samples from several individuals of the same species. These mixed samples will confound or preclude determining individual genotype (Belant 2003, DePue and Ben-David 2006). Percentage of mixed samples obtained in field studies will depend in part on the species under investigation, animal density, and frequency of snare checks. In a high density deer herd, Belant et al. (2007) obtained 23% mixed samples with barbed-wire snares checked every 1-3 days. In contrast, barbed wire snares checked every two weeks to estimate abundance of a high density black bear population resulted in 7% mixed samples (Belant et al. 2005). However, because multiple barbs were available for snagging hair, 25% of snares contained hair from 4-6 individuals and 1 snare contained hair from 7 individual bears collected during a single snare check (Belant et al. 2005). In our study we did not find evidence of multiple raccoons entering hair snares between checks. However, based on live trapping studies conducted previously in this same area, raccoon density appeared low. Raccoon densities in more urban areas or in more southerly portions of their range are undoubtedly higher (Sanderson 1987, Prange et al. 2003). Pilot studies to determine overall efficacy of single or multiple capture hair snares will help determine which snare type would be most advantageous.

The proportion of the raccoon population that entered hair snares was unknown in this study. We suspect, however, that the proportion of raccoons entering the snare devices would be at least as great as the proportion that would enter cage live traps. Similarly, we believe that the snares we used would not cause greater avoidance behavior than that caused by other similar devices (e.g., cage live traps). The capture rate in this study was considerably greater than the raccoon capture rate in a live-trapping study of mesocarnivores conducted in the same study area (2 individuals/100 unadjusted trap nights; J. Belant, unpublished data). The raccoon capture rate using live traps included a number of recaptures. Estimating raccoon abundance using live-traps and mark-recapture techniques is commonly employed (e.g., Prange et al. 2003). Also, buckets with body-gripping traps are commonly used by fur trappers to capture raccoons. Because animals were not restrained and received a positive reward (i.e., bait), avoidance behavior could actually be less than that found with cage traps which would improve abundance estimates.

Although these snares were designed originally to obtain hair from raccoons, we successfully collected hair from other carnivore species. Barbed wire has been used in other snare configurations to obtain hair from other free-ranging wildlife species (Raphael 1994; Belant et al. 2005, 2007). These snares, particularly the bucket snare, could potentially be used for sampling hair from other medium-sized mammals.

The cost of materials to construct bucket snares was < 3 times the cost of materials to construct wood box snares. Additionally, time for construction of bucket snares was considerably less than wood boxes. Because of their greater efficacy, lighter weight, ease of construction, and lower cost, we recommend use of bucket hair snares over wood box snares used in this study for obtaining hair samples from raccoons.

ACKNOWLEDGMENTS. We thank K. Anderson, A. Hales, and M. Snively for assistance with field work. Funding for this study was provided by Pictured Rocks National Lakeshore and the National Park Service's Natural Resource Protection and Preservation program.

LITERATURE CITED

Adorjan AS, Kolenosky GB. 1969. A manual for the identification of hairs of selected Ontario mammals. Ottawa: Ontario Department of Lands and Forest Research Report (Wildlife) 90. 64 p.

Belant JL. 2003a. A hairsnare for forest carnivores. Wildl Soc Bull 31:482-485.

Belant JL. 2003b. Comparison of 3 tracking mediums for detecting forest carnivores. Wildl Soc Bull 31: 744-747.

Belant JL. 2004. Field immobilization of raccoons (Procyon lotor) with Telazol® and xylazine. J Wildl Dis 40:786-789.

Belant JL, Seamans TW, Paetkau D. 2007. Genetic tagging free-ranging white-tailed deer with hair snares. Ohio J Sci 107:in press.

Belant JL, Van Stappen JF, Paetkau D. 2005. American black bear population size and genetic diversity at Apostle Islands National Lakeshore. Ursus 16:85-92.

Boersen MR, Clark JD, King TL. 2003. Estimating black bear population density and genetic diversity at Tensas River, Louisiana using microsatellite DNA markers. Wildl Soc Bull 31:197-207.

Creel S, Spong G, Sands JL, Rotella J, Zeigle J, Joe L, Murphy KM, Smith D. 2003. Population size estimation in Yellowstone wolves with error-prone noninvasive microsatellite genotypes. Mol Ecol 12:2003-2009.

DePue JE, Ben-David M. 2006. Hair snaring techniques for medium-sized mammals: a comparison of three trap designs. Wildl Soc Bull 34:in press.

Foran DR, Minta SC, Heinemeyer KS. 1997. DNA-based analysis of hair to identify species and individuals for population research and monitoring. Wildl Soc Bull 29:133-139.

Foresman KR, Pearson DE. 1998. Comparison of proposed survey procedures for detection of forest carnivores. J Wildl Manage 62:1217-1226.

Haig SM. 1998. Molecular contributions to conservation. Ecology 79:413-425.

Halfpenny J. 1986. A field guide to mammal tracking in North America. Second Edition. Boulder, Colorado: Johnson Printing. 161 p.

Hernandez F, Rollins D, Canta R. 1997. An evaluation of Trailmaster® camera systems for identifying ground-nest predators. Wildl Soc Bull 25:848-853.

Kohn MH, York EC, Kamradt DA, Haugt G, Sauvajot RM, Wayne RK. 1999. Estimating population size by genotyping faeces. Proc Royal Soc London B 266:657-663.

McDaniel GW, McKelvey KS, Squires JR, Ruggiero LF. 2000. Efficacy of lures and hair snares to detect lynx. Wildl Soc Bull 28:119-123.

Mowat G, Paetkau D. 2002. Estimating marten Martes americana population size using hair capture and genetic tagging. Wildl Biol 8:201-209.

Murie OJ. 1954. A field guide to animal tracks. Second edition. Boston, Massachusetts: Houghton Mifflin. 375 p.

Paetkau D, Strobeck C. 1994. Microsatellite analysis of genetic variation in black bear populations. Mol Ecol 3:489-495.

Parker PG, Snow AA, Schug MD, Booton GC, Fuerst PA. 1998. What molecules can tell us about populations: choosing and using a molecular marker. Ecol 79:361-382.

Prange S, Gehrt SD, Wiggers EP (2003) Demographic factors contributing to high raccoon densities in urban landscapes. J Wildl Manage 67:324-333.

Prugh LR, Ritland CE, Arthur SM, Krebs CJ. 2005. Monitoring coyote population dynamics by genotyping faeces. Mol Ecol 14:1585-1596.

Raphael MG. 1994. Techniques for monitoring populations of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, and Powell RA (eds). Martens, sables, and fishers biology and conservation. Cornell University Press, Ithaca, New York: pp. 224-240.

Rezendes P. 1999. Tracking and the art of seeing. Second edition. New York: Harper Collins. 336 p.

Sanderson, GC. 1987. Raccoon. In: Novak M, Baker JA, Obbard ME, and Malloch B (eds). Wild furbearer management and conservation in North America. Ontario Trappers Association, Ontario, Canada: pp. 486-499.

Taberlet P, Mattock H, Dubois-Paganon C, Bouvet J. 1993. Sexing free-ranging brown bears *Ursus arctos* using hairs found in the field. Mol Ecol 2:399-403.

White GC, Anderson DR, Burnham KP, Otis DL. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos, New Mexico: Los Alamos National Laboratory LA-8787-NERP.

White GC, Shenk TM. 2001. Population estimation with radio-marked animals. In: Millspaugh JJ and Marzluff JM (eds). Radio tracking and animal populations. Academic Press, San Diego: pp. 329-350.

Woods JG, Paetkau D, Lewis D, McLellan BN, Proctor M, Strobeck C. 1999. Genetic tagging of free-ranging black and brown bears. Wildl Soc Bull 27:616-627.

Zalewski A. 1999. Identifying sex and individuals of pine marten using snow track measurements. Wildl Soc Bull 27:28-31.

Zar JH. 1984. Biostatistical analysis. 2nd ed. Englewood Cliffs, New Jersey: Prentice Hall. 718 p.

Zielinski WJ, Kucera TE, tech eds. 1995. American marten, fisher, lynx, and wolverine: survey methods for their detection. United States Department of Agriculture Forest Service General Technical Report PSW-157. 163 p.