

## A Single-Sampling Hair Trap for Mesocarnivores

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**ABSTRACT** Although techniques to analyze and quantify DNA-based data have progressed, methods to noninvasively collect samples lag behind. Samples are generally collected from devices that permit coincident sampling of multiple individuals. Because of cross-contamination, substantive genotyping errors can arise. We developed a cost-effective (US\$4.60/trap) single-capture hair trap for American martens (*Martes americana*). In the field, traps effectively targeted martens; >75% of all hair samples were identified as marten. Eighty percent of marten hair ( $n = 180$ ) contained sufficient quality for DNA-based analyses. This effective and affordable trap can be used by managers to monitor mesocarnivore populations noninvasively. (JOURNAL OF WILDLIFE MANAGEMENT 72(7):1650–1652; 2008)

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Wildlife ecologists are increasingly using DNA-based techniques to quantify distribution, abundance, and population dynamics of wide-ranging or elusive species. Noninvasive collection of hair or scat for DNA is replacing other monitoring techniques, including track counts and camera stations, because resulting data provide more information for similar or less effort (McKelvey and Schwartz 2004). Indeed, DNA can be used to determine individual identity and sex of animals, and population attributes: survival, density, sex ratio, dispersal rates and distances, kinship, and paternity (DeYoung and Honeycutt 2005). Because of low densities and elusive behavior, which make live capture impractical, DNA-based approaches have been particularly useful for studying wide-ranging carnivores (Mills 2007).

Generally, fresh scat or hairs are collected in the field and brought into the laboratory for extraction, polymerase chain reaction amplification, and genotyping. Although more DNA can be extracted from feces (Broquet et al. 2007), hair samples are of better quality and, therefore, less expensive to amplify (Bremner-Harrison et al. 2006). To date, most researchers have collected hair from snares or traps that allow >1 capture, which is problematic because of potential cross-contamination from multiple animals visiting the device. Thus, when genotyping, researchers risk pooling alleles from >1 individual in one sample or limiting DNA extractions to one hair per sample. Because DNA yields from one hair are low, they often lead to allelic dropout or false alleles (Goosens et al. 1998), causing a positive bias in the estimated number of individuals identified (Mills 2007). Such genotyping errors can be particularly consequential when used in capture–recapture models (Lukacs and Burnham 2005). These problems can be avoided, however, by using single-capture hair traps, although few have been developed. Herein, we describe an effective, low-cost, single-capture hair trap for mesocarnivores. Used for free-ranging American martens (*Martes americana*) inhabiting remote areas of southeast Alaska, USA, we designed traps to

be inexpensive, highly portable, and durable. Prior to deploying hair traps in the field, we tested their efficacy on captive martens.

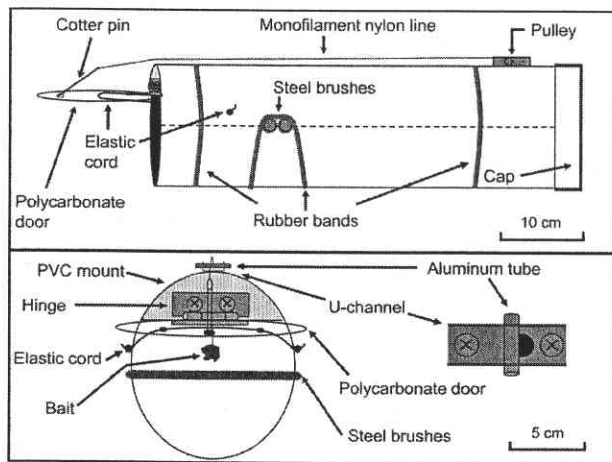
### STUDY AREA

We used 5 martens held at Red Buttes Environmental Facility (University of Wyoming; 41°10'12"N, 105°34'48"W) in trials to evaluate our hair traps. We furnished pens (2.1 × 3.0 × 3.7 m) with polyvinyl chloride (PVC) tubes, nest boxes, branches, and small trees as environmental enrichment to minimize stress associated with captivity. We fed martens ad libitum and they had continuous access to water. We assessed hair traps in the field on Admiralty Island in southeast Alaska (57°43'12"N, 134°22'48"W), one of 3 large northern islands of the Alexander Archipelago. Specifically, we used traps within forests and along shorelines at 4 locations: Mole Harbor, Hawk Inlet, Mitchell Bay, and Gambier Bay.

### METHODS

We constructed traps primarily from PVC (Fig. 1). We cut crescent-shaped PVC mounts (1.9 cm thick) from 10.2-cm-diameter PVC rods and glued them within a 10.2-cm-diameter, 35-cm-long PVC tube (white sewer pipe, 0.2-cm wall thickness). We cut doors from a polycarbonate sheet (0.3 cm thick) and bolted them to a 3.8-cm hinge, which we screwed to the PVC mount. We tied a monofilament nylon line (approx. 50 cm) to bait (meat scrap) and a cotter pin (5.1 cm long), which we used to hold the door open. We used polypropylene-covered elastic cord (0.5 cm diam) as a spring to close the door, feeding it through 2 holes in the door and knotting it to the PVC tube. We used stainless steel tube brushes (12.7 cm long, 1.9 cm diam; Papa John's Toolbox, Brooklyn, NY) as the device for collecting hair, which we placed between halves of the split PVC tube. Rubber bands secured the brushes and held the trap together. We drilled 0.6-cm holes in the sides and bottom of aluminum channel (0.6 cm wide × 4.5 cm tall) and bolted it on top of the PVC tube. We cut aluminum tubing (0.6 cm

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**Figure 1.** Schematic of the single-capture hair trap used for American martens, Admiralty Island, Alaska, USA, 2007 (PVC = polyvinyl chloride).

diam) into 2.5-cm-long sections and secured these within the drilled holes on the sides of the channel and fed the monofilament line through the hole on the bottom of the channel. For caps, we glued PVC foam sheets (0.3 cm thick) to the belled (female) end of the PVC tube (Fig. 1). The cost of constructing 200 hair traps was US\$4.60/trap. When assembled in bulk, construction time was approximately 15 minutes/trap. Each trap weighed 590 g; one person was capable of hiking with 20 traps on an external-frame pack.

For 5 consecutive days, we presented a hair trap to each captive marten and recorded with a video camera whether traps were used and if martens attempted to reenter tripped traps. For field evaluation, we collected data in autumn (Aug–Oct 2007), placing hair traps every 0.5 km along 11 transects 5–20 km long. We checked hair traps every fifth day for 5 weeks. When traps were tripped, we removed the steel brushes from the trap, temporarily storing them in a sterilized labeled toothbrush holder (19.0 cm long, 2.5 cm diam), and placed new, sterile brushes inside the trap. After returning from the field each day, we removed hair from the brushes using sterile forceps, identified samples to species based on dorsal guard hair characteristics (Moore et al. 1974), and stored hair samples frozen in a labeled 1.5-mL microcentrifuge tube containing silica bead desiccant. We used QIAamp tissue extraction kit (Qiagen Inc., Valencia,

CA) and standard protocols to extract DNA from collected hair follicles. We obtained animal handling and housing permits through the Wyoming Game and Fish Department; all methods were approved by the Institutional Animal Care and Use Committee at the University of Wyoming.

## RESULTS

When presented with a hair trap all captive martens ( $n = 5$ ) entered, tripped, and left substantial quantities of hair on the brushes within 24 hours. The door mechanism successfully prevented martens from reentering the trap; 4 of the martens attempted to reenter the tripped trap at least once. In August 2007, we deployed 135 hair traps on 4 sites (Gambier Bay,  $n = 27$ ; Mole Harbor,  $n = 34$ ; Hawk Inlet,  $n = 36$ ; Mitchell Bay,  $n = 38$ ) across Admiralty Island. In total, we collected 225 hair samples from martens. Traps effectively targeted martens, with 76.3% of all hair samples coming from that species (Table 1). Quantities of extracted DNA were  $\geq 2.0$  ng/ $\mu$ L, a sufficient amount for high genotyping success (Gagneux et al. 1997), for 80% ( $n = 180$ ) of marten hair samples. High extraction success rates were due to the traps protecting samples in the field; only 2 marten hair samples ( $< 1\%$ ) were damaged by moisture. Additionally, hair traps minimized the potential for cross-contamination; of the 225 marten samples collected only 11 were from traps where either the end cap was removed (5 or 2.2%) or the door failed to shut completely (6 or 2.7%). Hair traps were also durable; during 3,375 trap-nights 2 traps were irreparably damaged.

## DISCUSSION

Behavioral observations confirmed that the door prevented animals from reentering hair traps and the narrow opening of the trap prevented  $> 1$  animal to enter at the same time. Field data also demonstrated that the trap excluded other animals from accessing the trap. Martens visiting the traps deposited sufficient quantities of hair to yield useful amounts of DNA. Although our capture rate (6.7 captures/100 trap-nights) was comparable to those previously published for live-capturing martens (range = 1.6–12.0 captures/100 trap-nights; Raphael 1994), our extraction success was higher than previously reported (Mowat and Paetkau 2002, Johnson 2006). This was, in part, due to traps keeping hair samples in good condition;  $< 1\%$  of samples were damaged from exposure to moisture. Tempo-

**Table 1.** Number of samples collected from single-capture hair traps by species and location from Admiralty Island, Alaska, USA, August–October 2007. We checked hair traps every fifth day for 5 consecutive weeks. When a hair trap was active,  $> 50\%$  collected hair from American marten.

Activity	Gambier Bay	Mole Harbor	Hawk Inlet	Mitchell Bay	Total	Proportion of total
American marten ( <i>Martes americana</i> )	45	75	45	60	225	0.52
American mink ( <i>Neovison vison</i> )	0	0	3	1	4	0.01
Brown bear ( <i>Ursus arctos</i> )	6	18	19	3	46	0.11
Ermine ( <i>Mustela erminea</i> )	1	2	0	1	4	0.01
Small rodent ( <i>Tamiasciurus hudsonicus</i> , <i>Peromyscus keeni</i> )	2	7	2	5	16	0.04
Unknown trap disturbance	23	30	33	29	115	0.26
Trap misfire	8	9	1	7	25	0.06

rarily storing brushes in a toothbrush holder and processing the hair indoors also contributed to the high quality of our collected samples. The ability to keep samples dry in southeast Alaska is particularly noteworthy inasmuch as the region experiences such high precipitation (approx. 150 cm annually).

Only a handful of single-capture hair devices have been developed: for bears (*Ursus* spp.; Beier et al. 2005, Lemieux and Czetwertynski 2006), river otters (*Lontra canadensis*; DePue and Ben-David 2007), foxes (*Vulpes macrotis*; Bremner-Harrison et al. 2006), and martens (*Martes* spp.; Messenger and Birks 2000, Belant 2003). Few of these devices have been used in field studies, however, probably owing to per-trap cost and time investment. Previously developed single-capture hair devices are more expensive (Messenger and Birks 2000, Lemieux and Czetwertynski 2006) or are built from devices like live traps (Belant 2003), foot-holds (DePue and Ben-David 2007), or snares (Beier et al. 2005), which if not already owned are expensive items to purchase. In addition to being effective, our hair snare is affordable (US\$4.60), quick to assemble, and lightweight.

#### Management Implications

Our hair trap is an efficient device to collect hair from American martens and minimizes the potential to coincidentally collect hair from multiple, unknown animals. By simply using a different diameter PVC tube and with very little modification, this trap could be used for monitoring other species of mesocarnivore. Our results show that a carefully designed hair trap, with an inside diameter chosen for a target species, can also limit the capture of other, nontarget animals. Managers and researchers interested in quantifying population dynamics, distribution, or dispersal of American martens or other elusive mammals via DNA-based techniques should consider using this single-capture device.

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## LITERATURE CITED

- Beier, L. R., S. B. Lewis, R. W. Flynn, G. Pendleton, and T. V. Schumacher. 2005. A single-catch snare to collect brown bear hair for genetic mark-recapture studies. *Wildlife Society Bulletin* 33:766–773.
- Belant, J. L. 2003. A hairsnare for forest carnivores. *Wildlife Society Bulletin* 31:482–485.
- Bremner-Harrison, S., W. R. Harrison, B. L. Cypher, J. D. Murdoch, J. Maldonado, and S. K. Darden. 2006. Development of a single-sampling noninvasive hair snare. *Wildlife Society Bulletin* 34:456–461.
- Broquet, T., N. Ménard, and E. Petit. 2007. Noninvasive population genetics: a review of sample source, diet, fragment length and microsatellite motif effects on amplification success and genotyping error rates. *Conservation Genetics* 8:249–260.
- DePue, J. E., and M. Ben-David. 2007. Hair sampling techniques for river otters. *Journal of Wildlife Management* 71:671–674.
- DeYoung, R. W., and R. L. Honeycutt. 2005. The molecular toolbox: genetic techniques in wildlife ecology and management. *Journal of Wildlife Management* 69:1362–1384.
- Gagneux, P., C. Boesch, and D. S. Woodruff. 1997. Microsatellite scoring errors associated with noninvasive genotyping based on nuclear DNA amplified from shed hair. *Molecular Ecology* 6:861–868.
- Goosens, B., L. P. Waits, and P. Taberlet. 1998. Plucked hair samples as a source of DNA: reliability of dinucleotide microsatellite genotyping. *Molecular Ecology* 7:1237–1241.
- Johnson, L. 2006. Assessing the feasibility of using hair snares and DNA analysis to determine the dispersal of American martens among old-growth reserves on Prince of Wales Island, Alaska. Thesis, University of Wyoming, Laramie, USA.
- Lemieux, R., and S. Czetwertynski. 2006. Tube traps and rubber padded snares for capturing American black bears. *Ursus* 17:81–91.
- Lukacs, P. M., and K. P. Burnham. 2005. Estimating population size from DNA-based closed capture-recapture data incorporating genotyping error. *Journal of Wildlife Management* 69:396–403.
- McKelvey, K. S., and M. K. Schwartz. 2004. Genetic errors associated with population estimation using non-invasive molecular tagging: problems and new solutions. *Journal of Wildlife Management* 68:439–448.
- Messenger, J. E., and J. D. S. Birks. 2000. Monitoring the very rare pine marten populations in England and Wales. Pages 217–230 in H. I. Griffiths, editor. *Management and conservation aspects of small carnivores: human interactions*. Backhuys, Leiden, Netherlands.
- Mills, L. M. 2007. *Conservation of wildlife populations: demography, genetics, and management*. Blackwell, Malden, Massachusetts, USA.
- Moore, T. D., L. E. Spence, C. E. Dugnolle, and W. G. Hepworth. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Wyoming Game and Fish Department Research Paper Bulletin 14, Cheyenne, USA.
- Mowat, G., and D. Paetkau. 2002. Estimating marten *Martes americana* population size using hair capture and genetic tagging. *Wildlife Biology* 8:201–209.
- Raphael, M. G. 1994. Techniques for monitoring populations of fishers and American martens. Pages 224–240 in S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. *Martens, sables, and fishers: biology and conservation*. Cornell University Press, Ithaca, New York, USA.

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