Efficacy of lures and hair snares to detect lynx

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Abstract Resource managers lack an inexpensive and quantifiable method to detect lynx presence across large landscapes. We tested efficacy of a protocol based on hair snagging to detect presence of lynx (*Lynx canadensis*). We tested 2 key elements of the protocol: 1) a hair-snaring device and 2) commercial lures used to attract and elicit rubbing behavior in lynx. The commercial lures we tested included: 1) beaver (*Castor canadensis*) castoreum and catnip oil, 2) Cat Passion™ 3) Pacific Call™ 4) Hawbacker's Cat lure #1™ and 5) BB1™ To compare detection rates among lures, we randomly placed lures at scent stations along 78 transects; each transect contained all 5 lures. We detected lynx at 45% of transects, and detections varied significantly among lures ($\chi_4^2 = 13.4$, $P = 0.009$). Hair snares baited with castoreum and catnip oil were used significantly more than expected ($P = 0.002$). The relatively high overall detection rate demonstrated that deploying an effective lure along transects is an effective method to detect presence or absence.

Key words attractant, bait, detection, hair-snares, lures, lynx, scent stations, survey design

The United States Fish and Wildlife Service (1998) has proposed listing the lynx (*Lynx canadensis*) as "threatened" under the Endangered Species Act. The "take" provisions of the Act require that management agencies determine whether their actions impact lynx populations. However, biologists lack a quantifiable and inexpensive method to determine the presence of lynx. Given their low density and secretive nature (Kohler and Aubrey 1994), traditional surveys are unreliable and costly to implement across large landscapes. Snow track surveys are useful to detect lynx (Halfpenny et al. 1995), but are difficult to use in roadless areas. In addition, snow tracks do not provide irrefutable evidence of lynx occurrence. Likewise, reported sightings of lynx are prone to misidentification, especially when bobcats (*L. rufus*) are present. Remote cameras or track plates at scent stations can provide standardized detection methods, but are too costly to be used to monitor large areas (Kucera et al. 1995, Zielinski 1995).

Various methods have been used to collect hair from wild animals (Suckling 1978, Barrett 1983, Jones et al. 1991), and collecting hair at hair-snare stations is a promising technique to detect lynx and other carnivores (Raphael 1994, Foran et al. 1997). Hairs provide physical evidence that is not subject to observer bias and may be useful for genetic analyses of population structure (Foran et al. 1997). Hair-snare stations can be deployed over large areas at minimal costs compared to other techniques. However, the efficacy of the technique for lynx depends on eliciting rubbing. Although various scent compounds cause rubbing behavior in animals (Reiger 1979), we do not know which compounds are most effective for lynx. Therefore our objectives were to 1) determine the best commercial lure to attract and cause lynx to rub and 2) evaluate overall efficacy of the method.

Methods and study area

We tested 5 scent lures: 1) beaver (*Castor canadensis*) castoreum and imitation catnip oil (1:32 ratio mix), 2) Hawbacker's Lure #1, 3) Cat Passion, 4) Pacific Call, and 5) BB1. We tested

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Hair-snare station with baited hair snare attached to tree and pie pan dangling from a scented pad.

Hair snare that was rubbed by lynx in Yukon, 1998.

beaver castoreum and catnip oil based on the successful use of this lure to capture 100 lynx in southern Yukon and British Columbia (Garth Mowatt, Timberland Consultants Ltd. BC, personal communication). We tested Hawbacker's Lure #1 because it was reported to contain decomposed cat glands and therefore is similar to a very effective lure used to trap lynx in Alaska and Yukon (Kim Poole, Timberland Consultants Ltd., personal communication). Cat Passion was tested because it was advertised to elicit a rubbing response in felids. BB1 was tested because it was advertised to attract and cause lynx to rub (Brian Baxter, Silver Cloud Associates L.L.C., personal communication). Finally, we tested Pacific Call because it was used successfully by trappers in Montana.

We conducted tests near Kluane National Park, Yukon, Canada, from mid-September to mid-October 1998. This area is part of the northern boreal zone (Douglas 1974), with an average elevation of approximately 900 m. The area is mostly white spruce (*Picea glauca*) forest, with an understory of willow (*Salix* spp.) and birch (*Betula glandulosa*). We selected this area because it is relatively homogenous and supports a high density of lynx (Elizabeth Hofer, Arctic Research Institute, personal communication).

Lures were tested using a system of transects. We located 78 line-transects 2.5-5 km apart. Each transect consisted of 5 scent stations spaced 100 m apart. We placed stations more than 200 m from major roads and avoided placement in open meadows or near human developments. Most transects (57%) were perpendicular to and within 500 m of paved roads.

We randomly placed 5 lures on hair snares along each transect. Extensive work has been conducted in the design of scent stations and hair snares to attract and cause lynx to rub (John Weaver, Wildlife Conservation Society, personal communication). We followed Weaver's basic design with some modifications. We constructed hair snares of carpet squares (10 cm × 10 cm) with approximately 10 5-cm nail-gun nails pushed through the pad. Small wires (8 mm) already attached to the shaft of these nails by the nail-gun helped snag hairs. At each station, we nailed 2 hair snares to trees (>5 cm diameter and <10 m apart) that had their lower branches (<1.5 m) removed. Felids prefer to scent-rub in the cranial body areas (Reiger 1979). Therefore, we located hair snares 0.5 m from the ground to facilitate this behavior. We baited hair snares with 9.8 ml (0.3 oz) of lure and sprinkled dried catnip onto the carpet squares to encourage rubbing by lynx. Lures were mixed in a 6:1:1 ratio of lure, propylene glycol, and glycerin to increase absorption of bait into the carpet fibers and to reduce drying or freezing.

We hung aluminum pie pans, shaped to rotate in the wind, on a tree branch 1 m from the ground to visually attract lynx. We also hung a carpet square (5 cm × 5 cm) baited with lure from a branch 1.5 m from the ground to increase scent range. Based on Foran et al.'s (1997) use of glue to collect hairs, we tested how lynx responded to Tree Tanglefoot™, a glue-like substance that could be applied directly to the carpet pads, by putting it on one of the 2 hair snares, in addition to the shingle nails, at each station.

We checked hair snares at least 2 and not more than 4 weeks after deployment. We stored collect-
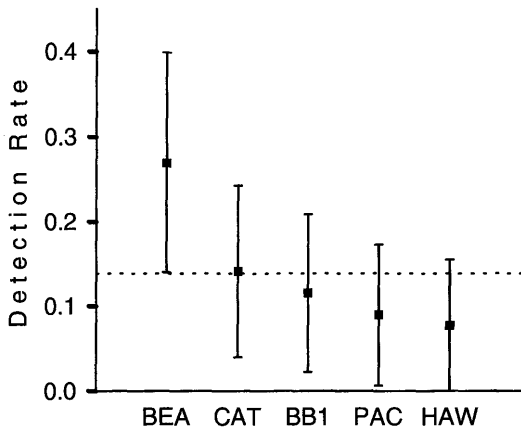
Figure 1. Lynx detection rate with 95% Bonferroni confidence intervals using beaver castoreum and catnip oil (BEA), Cat Passion™ (CAT), BB1™, Pacific Call™ (PAC), and Hawbacker's Lure #1™ (HAW) on hair snares in the Yukon, 1998. A dashed line represents the expected detection rate.
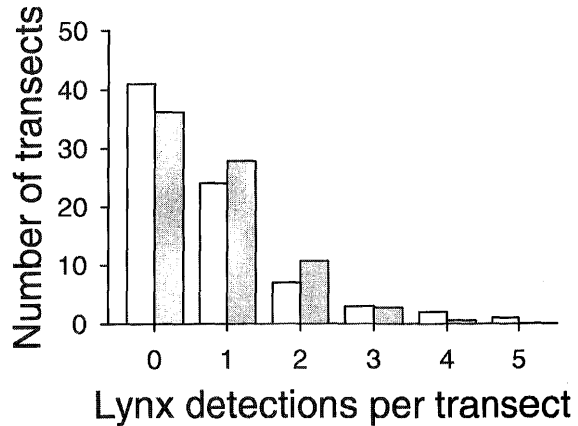

Figure 2. Observed (open) and expected (dark) number of lynx detections per transect at hair-snare stations in the Yukon, 1998.

ed hairs in sealed plastic vials containing desiccant. Other species on the study area included wolves (*Canis lupus*), wolverines (*Gulo gulo*), bears (*Ursus* spp.), and coyotes (*C. latrans*); felids other than lynx were not present. Hairs were identified to species based on physical characteristics and microscopic analysis of internal structures (Moore et al. 1974).

The analysis of lure efficacy is complicated if there are between- or within-transect patterns that condition the probability of detection at a particular hair snare. We therefore tested for non-random patterns in detections per transect, location within transect, and patterns of adjacency where we had multiple detections. If the probability of detection is uniform, both within and among transects, then number of lynx detections at each transect should follow a Poisson distribution (Zar 1984). For transects with 2 detections, we compared observed patterns of adjacency (adjacent, 2, 3, or 4 stations apart) against random expectations (40-10% respectively). In addition, for those transects that were perpendicular to roads, we tested whether lynx detections and distribution of lures along tran-

sects followed a uniform distribution. We used chi-squared goodness-of-fit test to evaluate these assumptions.

We tested the hypothesis (H_0) that lynx selected lures in proportion to their availability using the chi-squared goodness-of-fit test (Zar 1984). If H_0 was rejected, we determined preference for a given lure using multiple Bonferroni confidence intervals (Neu et al. 1974). We used a 5 × 2 contingency table to test whether Tree Tanglefoot influenced lynx detections.

Results

We collected hair samples on 45% (*n*=35) of the transects. Lynx were selective (χ^2_4=13.4, *P*=0.009) in their use of hair-snaring stations. Hair snares baited with castoreum and catnip oil were used significantly more than expectation (39%, *P*=0.002, Figure 1). Lynx avoided hair snares with Tree Tanglefoot (25%, χ^2_4=20.5, *P*<0.001, Table 1).

Lynx detections per transect followed a truncated-Poisson distribution (χ^2_3=4.5, *P*=0.211) probabilities of 3 or more detections were grouped because individual expectations were less than 1.0 (Figure 2, Zar 1984:49). Adjacency patterns were not different than expected (χ^2_3=2.8,*P*=0.430), and distance to paved roads did not significantly affect detection rates (χ^2_4=2.0,*P*=0.570). Though not significant, lynx were more frequently detected at stations nearest paved roads (Figure 3). Lures were distributed evenly relative to

Table 1. Number of hair snares found with lynx hair at hair-snare stations in southern Yukon, 1998.

	Beaver castoreum and catnip oil	Pacific Call™	Hawbacker's Lure #1™	BB1™	Cat Passion™
Tree Tanglefoot™	7	1	1	2	4
No Tree Tanglefoot™	17	6	5	8	9

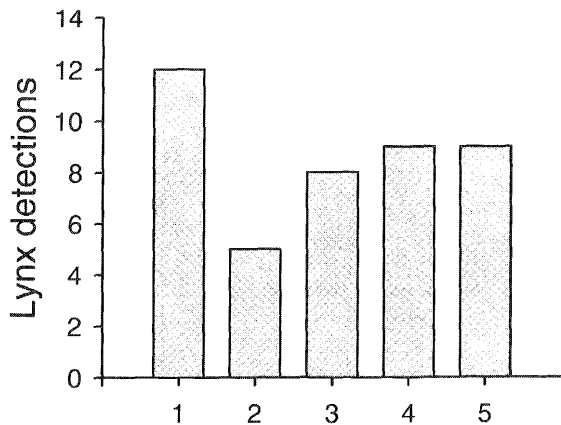Figure 3. Number of lynx detections at each station position relative to category of distance from paved roads (1=12, 2=5, 3=8, 4=9, 5=9) in theYukon, 1998.

paved roads (χ^2_{16}=10.6, P=0.831), including beaver castoreum and catnip oil (χ^2_4=1.6, P=0.665).

Hair-snares on 38% of transects (n = 30) were rubbed by either coyote (15%) or bear (27%). Most bear detections occurred on hair snares baited with Cat Passion (41%). Coyotes appeared to have no preference among lures (Table 2).

Discussion

All lures induced rubbing behavior by lynx, and overall, lynx rubbing was common. Hair-snaring stations were in place for a fairly short period of time, yet nearly half of transects had hair samples. We believe that linear transects of hair-snaring stations directed perpendicular to expected line of lynx travel act as baffles that intercept moving lynx and provide an effective sampling unit that efficiently detects lynx. The mixture of beaver castoreum and catnip oil was clearly the most effective lure. Lynx avoided hair snares with Tree Tanglefoot. The additional hairs collected on hair snares with Tree Tanglefoot did not compensate for the decrease in efficacy and additional problems associated with extracting hair from the glue (Foran et al. 1997).

Use of hair snares by species other than lynx, particularly bears, is problematic. It is important to select lures that attract few non-target species when conducting lynx surveys. Hairs from non-target species are costly to identify, introduce potential errors in identification, and may deter use of stations by lynx. It is therefore notable that beaver castoreum and catnip oil not only produced the greatest number of lynx detections, but also was less attractive to non-target species than some of the other lures.

Management implications

We recommend that managers use beaver castoreum and catnip oil as a lure at hair-snaring stations to detect lynx. Tree Tanglefoot should not be used on hair snares.

Where bobcats are present, DNA analysis is required to distinguish between lynx and bobcat hairs (Foran et al. 1997) because their physical characteristics are similar (Moore et al. 1974). However, cost of DNA and microscopic analyses are similar; we know of at least 2 labs that will conduct DNA analysis, and hair samples for DNA analysis are relatively easy to store.

Using this basic protocol, we have successfully detected lynx at varying densities in Montana, Washington, and Wyoming (where lynx densities are low), but additional research is necessary to determine the probabilities of detection in low-density areas. Estimates of the probability of detection will be needed to determine amount of effort, in time and space, required to reliable determine the presence or absence of lynx.

Table 2. Number of transects where lynx, coyote, and bear hairs were found using various lures at hair-snare stations in southern Yukon, 1998.

Species	BB1™	Cat Passion™	Pacific Call™	Hawbacker's Lure #1™	Beaver Castoreum and Catnip Oil
Lynx	9	11	7	6	21
Coyote	3	2	3	3	1
Bear	4	9	4	2	2

Literature cited

BARRETT, R. H. 1983. Smoked aluminum track plots for determining furbearer distribution and relative abundance. California Fish Game 69: 188–190.

DOUGLAS, G. W. 1974. Mountain zone vegetation of the Alsek River region, southwestern Yukon. Canadian Journal of Botany 52: 2505-2532.

FORAN, D. R., S. C. MINTA, AND K. S. HEINEMEYER. 1997. DNA-based analysis of hair to identify species and individuals for population research and monitoring. Wildlife Society Bulletin 25: 840-847.

HALFPENNY, J. C., R. W. THOMPSON, S. C. MORSE, T. HOLDEN, AND P. REZENDES. 1995. Snow tracking. Pages 91-164 *in* W. J. Zielinski and T. E. Kucera, editors. American marten, fisher, lynx, and wolverine: survey methods for their detection. United States Forest Service General Technical Report PSW-GTR-157.

JONES, L. L. C., L. F. RUGGIERO, AND J. K. SWINGLE. 1991. Ecology of martin in the Pacific Northwest: technique evaluation. Page 532 *in* L. F. Ruggiero, K. B. Aubry, A. B. Carey, and M. H. Huff, technical coordinators. Wildlife and vegetation of unmanaged Douglas-fir forests. United States Department of Agriculture General Technical Report PNW-285.

KOEHLER, G. M., AND K. B. AUBRY. 1994. Lynx. Pages 74-98 *in* L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, editors. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine. United States Forest Service General Technical Report RM-254.

KUCERA, T. E., A. M. SOUKKALA AND W. J. ZIELINSKI. 1995. Photographic bait stations. Pages 25-66 *in* W. J. Zielinski and T. E. Kucera, editors. American marten, fisher, lynx, wolverine: survey methods for their detection. United States Forest Service General Technical Report PSW-GTR-157.

MOORE, T. D., E. S. LITER AND C. E. DUGNOLLE. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Wyoming Department of Game and Fish, Cheyenne, USA.

NEU, C. W., C. B. BYERS, AND J. M. PEEK. 1974. A technique for analysis of utilization-availability data. Journal of Wildlife Management 38: 541-545.

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, Ithaca, New York, USA.

REIGER, I. 1979. Scent rubbing in carnivores. Carnivores 2: 17-25.

SUCKLING, G. C. 1978. A hair sampling tube for the detection of small mammals in trees. Australian Wildlife Research 5: 249-252.

UNITED STATES FISH AND WILDLIFE SERVICE. 1998. Endangered and threatened wildlife and plants: proposal to list contiguous United States distinct population segment of the Canada lynx; proposed rule. Federal Register 63(130): 36994-37013.

ZAR, J. H. 1984. Biostatistical Analysis. Second edition. Prentice-Hall, Englewood Cliffs, New Jersey, USA.

ZIELINSKI, W. J. 1995. Track plates. Pages 67-89 *in* W. J. Zielinski and T. E. Kucera, editors. American marten, fisher, lynx, and wolverine: survey methods for their Detection. United States Forest Service General Technical Report PSW-GTR-157.

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