COMPARISON OF PROPOSED SURVEY PROCEDURES FOR DETECTION OF FOREST CARNIVORES

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Abstract: American marten (*Martes americana*), fisher (*M. pennanti*), wolverine (*Gulo gulo*), and lynx (*Lynx lynx*) are forest carnivores believed threatened by disturbance of late-successional forests. To manage forested ecosystems for these species, effective methods for their detection must be available. Recently, the U.S. Forest Service proposed standardized survey procedures for the detection of forest carnivores; this report presents the first critical assessment of these protocols. We compared dual-sensor remote cameras and soot-coated open and covered track plates in the same study areas over an 8-month period. Of the 4 species targeted by these procedures, we detected 3 (American marten, fisher, wolverine). The remote camera method ranked highest with respect to ease of use, effectiveness, and accuracy of identifications. However, track plates performed well for 2 species and, under certain circumstances, may be the method of choice. We suggest improvements for each method and encourage that such standardized procedures be applied over wide regions.

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Several species of midsized forest carnivores thought threatened by disturbance of late-successional forests occur in the northwestern United States. The fisher, wolverine, lynx, and marten are all classified as "sensitive" species within 1 or more regions of the U.S. Forest Service (Ruggiero et al. 1994). Petitions have been submitted to the U.S. Fish and Wildlife Service for listing of the wolverine, lynx, and fisher under the endangered species act (L. Nordstrom, U.S. Fish and Wildlife Service, personal communication). Although petitions for listing of the fisher and wolverine have been denied as unwarranted, the lynx is currently recognized as a candidate species for listing and is expected to be proposed for listing by the U.S. Fish and Wildlife Service in June 1998.

Numerous efforts over the past 20 years have been made to identify populations of forest carnivores and determine changes in their distributions over time (Barrett 1983, Thompson et al. 1989, Kucera and Barrett 1993, Zielinski and Truex 1995, Zielinski et al. 1995, Zielinski and Stauffer 1996, and others). However, lack of broad-scale coordination in these efforts has produced fragmented data derived from a myriad of sampling methods, making it difficult to draw meaningful conclusions about species distributions throughout the region.

Recently, an attempt was made to develop standardized protocols to detect midsized forest carnivores (Zielinski and Kucera 1995). Suggested protocols cover 3 methods of detection: remote cameras, sooted track-plates, and snowtracking. Although others have compared snowtracking, track-plate boxes, and line-trigger cameras for detecting American marten (Bull et al. 1992), our study is the first to compare remote cameras and track plates via a standardized protocol applied to the suite of forest carnivores (American marten, fisher, wolverine, lynx). Because standardization of survey techniques is critical to their broad-scale application, survey methods must be compared based on these formalized protocols.

We compared remote cameras, track plates, and snowtracking for the detection of American marten, fisher, wolverine, and lynx via the protocol outlined by Zielinski and Kucera (1995). We contrasted performance of these methods based on species detection, latency to first detection (LTD), species identification, implementation effort, and cost. In making this comparison, we attempted to test the basic assumptions underlying the protocol: ". . .effort is equivalent among methods and is sufficient to determine the presence of target species in a survey area during the survey period" (Zielinski and Kucera 1995:5).

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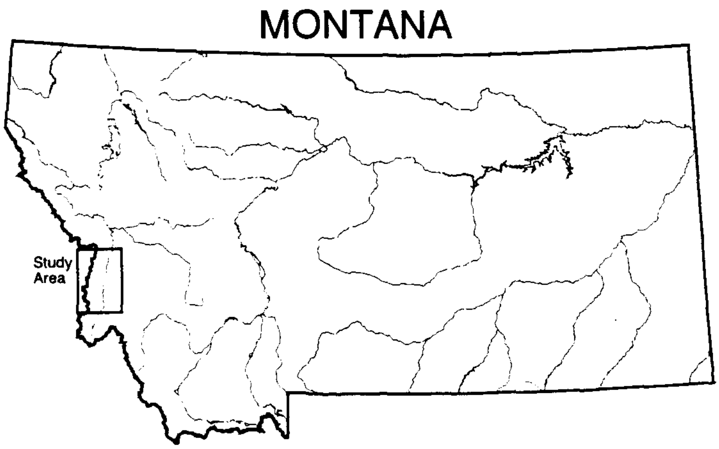

Fig. 1. Study area in the Bitterroot Mountains, western Montana.

METHODS

We worked within the Bitterroot Mountains on the Bitterroot National Forest of westcentral Montana (Fig. 1). Our study site encompassed 4 east–west drainages spread 24 km north to south. We established 2 10.36 km^2 sample units within each drainage; hence, we tested each method within each of 8 sample units. We followed survey protocols as detailed by Zielinski and Kucera (1995), using remote cameras and track plates.

Because the sample unit in this study was the 10.36-km^2 survey unit, sample size for many comparisons was limited to $n = 8$. To address the problems associated with small sample size encountered using traditional statistical tests such as assumptions of normality, homogeneity of variance, and loss of power (Zar 1984), we used multiresponse permutation procedures (MRPP) and permutation tests for matched pairs (PTMP) (BLOSSOM software; Slausen et al. 1994). These distribution-free techniques maintain high power given small sample sizes (Zimmerman et al. 1985, Mielke 1986, Edgington 1987, Potvin and Roff 1993). Permutation techniques allow analyses to be conducted in the data space or Euclidian space rather than with squared metrics; they thereby satisfy the congruence principal (Zimmerman et al. 1985, Mielke 1986). All analyses were conducted in Euclidian space (i.e., $v = 1$).

Remote Cameras

Three camera systems are described by Kucera et al. (1995*a*) for use in survey studies. We chose a dual-sensor remote camera system because of its wider detection capabilities. We placed 2 Manley camera systems (Tim Manley, Kalispell, Montana, USA) approximately 0.8 km apart in each 10.36-km^2 sampling unit (Fig. 2). Cameras were triggered by sensors that detected motion and heat. We baited camera sets with deer (*Odocoileus virginianus*) quarters in a "nonreward" manner by suspending the bait between trees, and we scented sets with commercial trapping lures (Kucera et al. 1995*a*).

We conducted camera surveys from 30 November 1994 to 28 March 1995. To achieve the 28-day survey period (Kucera et al. 1995*a*), it became necessary to extend camera surveys beyond the 28-day period to account for camera malfunctions and battery problems. After cameras were set, we checked them at 4–7-day intervals. We calculated LTDs based on sample units, not by individual cameras or track plates. We followed additional procedures outlined by Zielinski and Kucera (1995).

Track Plates

We placed 3 open and 3 covered track stations alternately in each 10.36-km^2 sample unit, for a total of 12 stations/drainage (Fig. 3). We spaced stations at approximately 0.54-km intervals from west to east and as far apart from north to south as canyon width would allow, up to 0.54 km. Stations were set on opposite sides of each creek and roughly paired on a north–south line. We scented track-plate stations with commercial trapping lures and baited each with a chicken wing or leg. We checked stations every other day for ≥12 days and rescented them

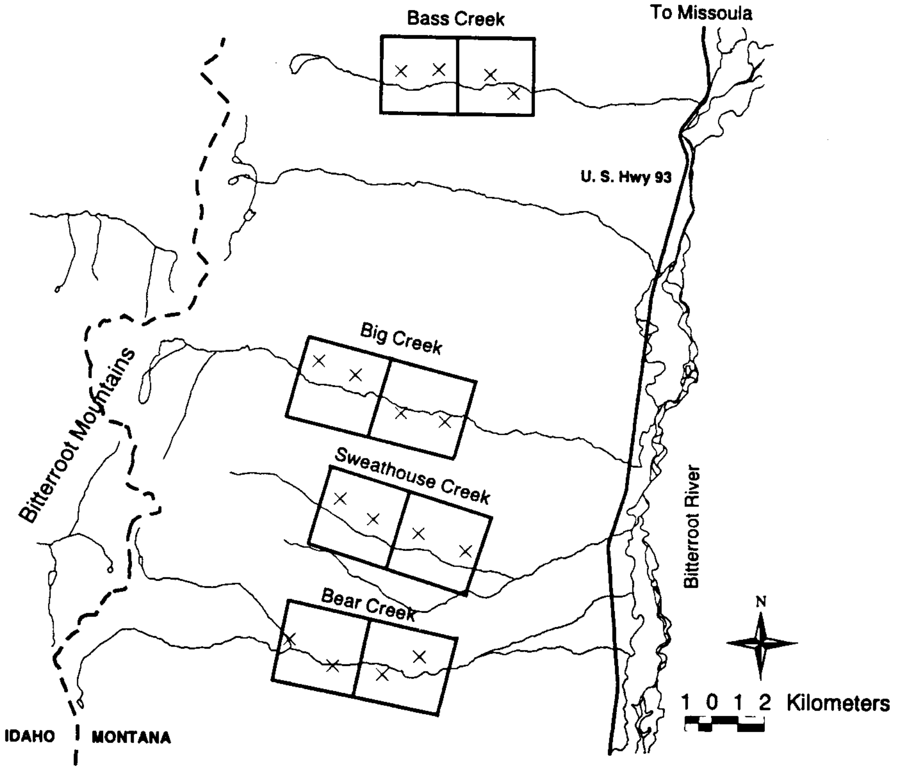

Fig. 2. Sample units (boxes) surveyed in relation to drainages in the Bitterroot Mountains, western Montana. An X indicates camera placement relative to streams and sample units.

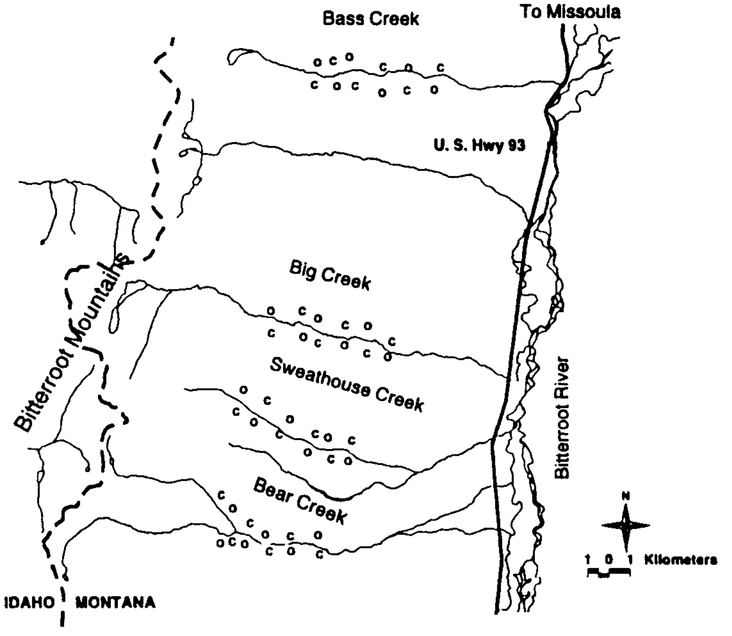

Fig. 3. Placement of open and covered track plates within 4 drainages in the Bitterroot Mountains, western Montana. Sample units as delineated in Figure 2.

on the second and fourth visits (days 4 and 8; Zielinski 1995).

We modified track-plate construction and use from the protocol. The roof of covered track plates was constructed of 3.30-mm PVC flat stock instead of 1.52 mm and was screwed to the base plate. The heavier gauge PVC increased rigidity of the roof. We used a portable acetylene welding torch to soot track-plate surfaces on-site, rather than precoat them.

We made measurements from original tracks while in polypropylene covers rather than from photocopies, as recommended by Zielinski and Truex (1995). Although others have determined that photocopying does not significantly distort track images (W. J. Zielinski, U.S. Forest Service, personal communication), we found it difficult to decipher edges of prints from other marks due to the "flat" 2-dimensional images generated from photocopies. Measurements were made to the nearest 0.01 mm with digital electronic calipers under a stereomicroscope.

We used 3 measurements (width of interdigital pad 3 [WI3], length of interdigital pad 3 [LI3], length of interdigital pad 4 [LI4]) to distinguish fisher and American marten via the discriminant function classification algorithm developed by Zielinski and Truex (1995):

$$(4.595 \times \mathrm{WI3}) + (3.146 \times \mathrm{LI3}) + (0.906 \times \mathrm{LI4}) - 80.285.$$

When the result is >0, the track is assigned to a fisher, and where <0, it is assigned to an American marten. We applied the same algorithm to negatives of tracks taken from open track plates, under the assumption that inside measurements taken from negatives were equivalent to outside measurements taken from positive contact prints. We used all prints that showed sufficient detail to apply the classification algorithm.

Track-plate surveys occurred from 24 April 1995 to 5 June 1995. We recorded LTD for each target species for each track station and calculated means (± SE).

Comparison of Methods

We ranked methods by 5 performance categories: (1) species detected, (2) LTD, (3) ease of species identification, (4) implementation effort, and (5) cost. Cost estimates reflect expenses incurred for equipment, expendable materials, and labor to establish and maintain stations for the required survey period. Four of the categories (species detection, LTD, species identification, cost) produced a quantitative, objective result for assignment. To assess implementation effort, which was more subjective, we broke this category into 3 subcategories (no. field days required, effort to deploy, necessary training), assigned a rank to each, and summed the ranks by method to determine the overall rank for the implementation category. These 5 categories were then used to assess the relative merits of each method both overall and by category.

RESULTS

Remote Cameras

Camera surveys recorded 3 of 4 target species: American marten, fisher, and wolverine. American martens were photographed in all 8 sampling units. Mean LTD was 13.5 ± 4.9 days (n = 8). Fishers were photographed in 2 of 8 sample units, in separate drainages; mean LTD was 9.0 ± 7.0 days (n = 2). A wolverine was photographed by both cameras in the upper sample unit of 1 drainage; the LTD was 13 days (n = 1).

The LTD for American marten differed by survey period. In the first period, mean LTD was 24.0 ± 6.3 days. In the second survey period (in the remaining 2 drainages), mean LTD was 3.0 ± 1.1 days (MRPP = 4.04, P = 0.006).

Significant down time at the camera stations occurred due to camera malfunctions (electronic problems in the camera advance function, broken contacts between camera and sensor, frozen shutters), battery problems (associated with either the 3-V lithium battery operating the camera or the 12-V battery operating the sensors), and exposure of all film prior to subsequent checks. Most important was battery failure, which accounted for 147 days (49%) of the down time. On average, 18 additional days were required to achieve the minimum 30-day survey. Overall, cameras effectively monitored bait stations 62% of the time (497/797 days, sampling period per camera = 49.8 ± 2.8 days, active period per camera = 31.1 ± 1.9 days).

Track-Plate Surveys

Track plates detected 2 of the 4 species targeted: American marten and fisher. American martens were detected in 6 of the 8 units (75%) surveyed, and fishers were detected in 3 of 8 (38%). Mean LTD for American martens was 3.3 ± 0.4 days for covered track plates and 2.3

± 0.3 days for open track plates. For fishers, mean LTD for covered track plates was 5.3 ± 1.8 days; an LTD was not determined for fishers recorded at open track plates, because presence was determined from print stains on plates during rainy periods when plates were not checked. Mean LTD for American marten at track plates (open and covered; 2.3 ± 0.3 days) was not lower than that for cameras (8.2 ± 3.5 days) when compared via a matched pairs *t*-test for the 6 units where both detected American marten (PTMP = 0.93, $P = 0.17$).

Although there were 152 detection opportunities for open plates during the entire sampling period (track plates were set for a total of 304 days but checked at 2-day intervals), on 99 occasions (65%) heavy rains rendered them useless. Of the remaining 53 opportunities for open plates, American martens were detected 26 times (49%). Additionally, we obtained 6 indirect American marten detections at track plates: 5 by presence of scat on plates and 1 by presence of fresh tracks in the snow and absence of bait on the plate. Open plates detected fishers 2 times (4%).

Rain did not appear to adversely affect covered track plates. Of 152 detection opportunities for covered stations, we detected American marten 28 times (18%) and fisher 14 times (9%). One additional fisher observation was based on tracks near the plate and removal of bait.

In both units where American martens were not recorded at track plates, remote cameras photographed American martens on 7 occasions. We also photographed fishers at camera stations on 3 occasions in 1 sample unit where no detection was made by track plate.

Sixteen of 18 sets of prints left by at least 3 fishers in 2 different drainages provided sufficient detail and sample size for measurements necessary to apply the classification algorithm of Zielinski and Truex (1995). Means and standard deviations of discriminant function scores for the larger of 2 fishers in 1 drainage (clearly identified as a unique individual by scars on 2 pads) were 58.1 ± 4.7 ($n = 4$) for right feet and 44.5 ± 8.0 ($n = 6$) for left feet. Values for the smaller fisher in this same drainage (also thought to be from a single individual due to relative size and the spatial and temporal overlap of occurrence with the large male) were 14.8 ± 7.2 ($n = 6$) for right feet and 15.8 ± 9.3 ($n = 6$) for left feet. Discriminant scores for the single individual in the second drainage were 7.1 ± 8.4 ($n = 2$) for right feet and 10.9 ± 0.0 ($n = 2$) for left feet.

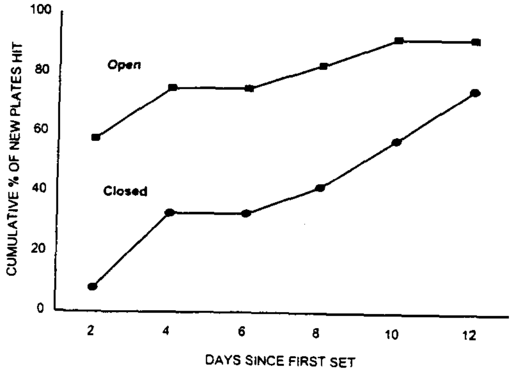

Fig. 4. Open versus covered track-plate visitation by American marten over 12-day sampling periods in the Bitterroot Mountains of western Montana, 1994 and 1995.

We obtained 22 of 26 American marten prints of sufficient quality for discriminant function analyses. We did not average data, because individuals could not be reliably separated. Scores ranged from −10.05 to −43.58 for right forefeet and −16.21 to −30.24 for left forefeet.

American martens visited open track stations more rapidly, and thus open stations attained a higher percentage of success during the 12-day sampling period (Fig. 4). After 2 days, 67% of open stations had been visited versus 11% of covered stations. At termination, 92% of open stations had been visited compared to 75% of covered stations. Of initial visits to covered plates by American marten, 36% resulted in no image on the contact paper. These American marten left scat at the entrance or stepped only on the sooted plate. Other initial visits to covered plates by American marten likely went undetected. Furthermore, we observed no American martens at covered track stations where fishers were detected ($n = 5$), despite photographing American martens in these units with remote cameras both before and after the track-plate survey. One of 3 (33%) fisher visits also resulted in the individual only partially entering the set on the first recorded visit.

Implementation Effort

Based on our recommendations, cameras require 5 field days/survey, and track-plates require 7 (Table 1). Although we checked camera sets on day 2, as per the protocol, we have omitted this check from the effort analysis because

Table 1. Ranks assigned to 3 categories used to determine implementation effort necessary to execute remote camera and track-plate surveys for midsized forest carnivores in the Bitterroot Mountains of western Montana, 1994 and 1995.

	Implementation effort				
Survey method	Field days	Effort to deploy	Training	Total	Overall rank
Camera	1 (5 days)	1	2	4	1
Track plate	2 (7 days)	2	1	5	2

Table 2. Summary of success for 2 survey methods used to detect midsized forest carnivores in the Bitterroot Mountains of western Montana, 1994 and 1995. Numbers indicate sample units in which the species was detected over the number of units sampled. Percentages are given in parentheses.

	Detection rate by method	
Species detected	Camera	Tracking plate
American marten	8/8 (1.00)	6/8 (0.75)
Fisher	2/8 (0.25)	3/8 (0.38)
Wolverine	1/8 (0.13)	0/8 (0.00)

we feel it is unnecessary. Track-plate surveys require the greatest effort because of equipment mass and time spent in each survey unit to check stations. Given that Manley cameras are extremely heavy, our comparison is based on our subsequent recommendation that the Trailmaster TM500 (Goodson & Associates, Lenexa, Kansas, USA) or a similar, lighter unit be used.

Cameras ranked better in detection success, species identification, and implementation effort (Table 2, 3). Track plates scored better in LTD and cost.

DISCUSSION

Cameras detected more target species, provided a simpler means of identification, and required less implementation effort than tracking plates for determining presence of forest carnivores on our study area when considering species detection, LTD, species identification, implementation effort, and cost. If categories were weighted to reflect the greater importance of detection and positive identification, cameras would have ranked even higher relative to tracking plates, based on these data. However, in making our determination, we did not weight rankings by category, because we acknowledge that weighting may change depending upon project-specific goals (Zielinski and Kucera 1995). Our breakdown of performance by category allows researchers to choose the best method based on goals specific to their project.

Effectiveness of each method differs by season, and the suggested protocol recommendations reflect this difference (Zielinski and Kucera 1995). We chose to follow the suggested implementation of both methods (cameras during winter and track-plates in spring) rather than test both procedures simultaneously, because our objective was to test the methods as set forth in the protocol. Since evidence exists that American marten–fisher behavior may change between these time periods (Marshall 1942, Zielinski et al. 1983, Arthur and Krohn 1991), it should not be inferred from these data that outcomes would be the same given simultaneous comparison of remote cameras and tracking plates.

Detection

Cameras photographed 3 of 4 targeted species (American marten, fisher, wolverine), while track plates detected American marten and fisher. Zielinski (1995) reported that neither lynx nor wolverines have been detected with track plates, but it was unclear whether these species were present on surveyed study areas. However, wolverines have since been shown to readily use track plates (W. J. Zielinski, U.S. Forest Service, personal communication). Given the methods tested did not detect lynx, we could not determine whether lynx were present on our study area.

Cameras also provided valuable information

Table 3. Ranks assigned to 5 performance categories to compare relative effectiveness of remote camera and track-plate surveys for detection of midsized forest carnivores in the Bitterroot Mountains of western Montana, 1994 and 1995.

	Rankings by category						
Method	Detection	LTD[a]	Species identification	Implementation effort	Cost	Total	Overall rank
Camera	1	2	1	1	2	7	1
Track plate	2	1	2	2	1	8	2

[a] LTD = latency to detection (days).

on presence and activity patterns of important prey species such as snowshoe hares (*Lepus americanus*) and red squirrels (*Tamiasciurus hudsonicus*; K. R. Foresman and D. E. Pearson, unpublished data). However, although some prey species can be identified based on tracks (W. J. Zielinski, U.S. Forest Service, personal communication; K. R. Foresman and M. T. Maples, unpublished data), many cannot be identified to species.

Latency to Detection

Zielinski et al. (1995) summarized LTDs for 207 track plate and line-trigger camera surveys. The longer LTDs they reported for camera surveys suggest track plates may consistently produce shorter LTDs. However, no study has compared both methods for the same location, and few studies have reported LTDs for the more advanced dual-sensor cameras.

In this study, track-plate LTDs were lower than camera LTDs for both American marten and fisher. Much of this difference for American marten was due to the high LTDs (24 days) for the first camera survey period, which we attribute to unusually deep, soft snow restricting movements of American marten (Raine 1981, 1983; Krohn et al. 1995). We conclude that LTDs for these 2 methods may not differ as dramatically as these results suggest, but the LTDs we observed are consistent with results reported elsewhere for track plates, line-trigger, and single-sensor cameras (Kucera et al. 1995*b*, Zielinski et al. 1995).

We could only compare between open and covered track-plate LTDs for American marten during the second survey period due to heavy rains during the first period. Open plates produced lower LTDs than covered plates during this period and received higher visitation overall. This visitation rate occurred even though open and covered plates were alternated so that American martens encountering a plate of 1 type would likely encounter a plate of the other type during the same 2-day period. Furthermore, scats found at covered plates and prints on the entrance of these plates indicated American martens were visiting them but not entering them on the first visit. We conclude the differences in LTDs and percentage of plates detecting American marten were due to American marten's hesitancy to enter covered track plates. Although this behavior does not preclude American marten from entering covered plates, it may increase LTDs; if LTDs exceed the survey period of 12 days, detections will be missed.

Although American marten were observed at all camera stations where fishers were observed and photographed before and after the track-plate surveys in 2 survey units, we recorded no American martens at covered tracking plates where fishers were recorded. Such apparent avoidance behavior may be due to interspecific interactions (de Vos 1952, Raine 1981) and may lead to reduced detection of American martens where sympatry occurs.

Although differences between LTDs for open and covered plates (encompassing all detections) were marginally significant based on a paired test for 6 of the 8 sample units (PTMP = 1.73, $P = 0.062$), this difference could be biologically important if the result sometimes leads to nondetection with covered plates.

Species Identification

Camera observations allowed confident species identification nearly 100% of the time. Individual American martens and fishers sometimes could be identified by size and markings. One felid photographed at night could not be distinguished from a juvenile cougar (*Puma concolor*) or an adult bobcat (*Lynx rufus*).

Track plates allowed confident identification of most high-quality tracks, but many lesser-quality tracks could not be measured properly. Zielinski and Truex (1995) reported 100% success in distinguishing American marten and fisher tracks with a discriminant function algorithm developed from images collected under controlled conditions. However, the accuracy they reported was based on a selected subset of high-quality tracks obtained from adult individuals. Twenty-five percent of tracks collected under their controlled conditions were omitted because they were too poor for identification. Under field conditions, we found that 87% of tracks collected were not of sufficient quality for confident identifications. Because juvenile fishers do not attain adult body size until nearly 6 months old (Powell 1982), and thus are not thought to attain this size by early fall in Montana, size overlap due to age will further confound discrimination of American marten and fisher tracks. Therefore, the true error for distinguishing these 2 species via track plates is unknown, but some discrimination error will likely exist when applying this algorithm to field data. We feel this algorithm can be applied equally well to open track-plate negatives, but obtaining good prints and identifying foreprints on plates from which to make measurements can be quite difficult.

Identification of individual animals was possible via covered track plates when unique features existed (e.g., scars on feet), and the quality of some prints was such that forensic fingerprinting techniques might allow identification of individual animals. However, it should be noted that the size dimorphism between left and right feet of a given fisher can be so dramatic as to conclude the measurements come from a different animal. Although foot size may provide a clue as to the number of fishers or martens visiting a station, observers should be cautious about using foot size alone to discriminate between individuals within a species. Such comparisons should be based on measurements taken from the same foot.

Implementation Effort

Cameras demanded the least implementation effort. More surveys could be run per unit time with cameras due to fewer units required and lower monitoring demands. Measuring tracks from track-plates and applying the discriminant function algorithm requires more skill than photo interpretation, especially when using open track plates.

For surveys in remote locations where equipment must be packed in, pack mass for camera and track-plate surveys rapidly become limiting. Trailmaster TM500 remote cameras provide an excellent alternative to the Manley camera for such situations. The Trailmaster weighs only 0.8 kg compared to the Manley camera-setup, which weighs 13.6 kg. The Trailmaster therefore overcomes much of the mass constraints associated with camera implementation.

Camera surveys require training to address the dangers of winter fieldwork. This training is not necessary for tracking plates, which are deployed during spring and fall (Zielinski 1995), but track-plate interpretation for species identification requires some training, albeit less expensive.

Cost

Costs have been estimated at $7,448 for camera surveys and $5,936 for track-plate surveys (Kucera et al. 1995*a*, Zielinski 1995). We found estimates for camera surveys and track-plate surveys to be approximately correct.

Recommendations

When compared with Manley dual-sensor cameras in paired field tests, the TM500 was more effective at obtaining photographs of subjects that entered the viewing field and had a lower rate of system malfunctions (K. R. Foresman and D. E. Pearson, unpublished data). We recommend Trailmaster cameras over the heavier, less efficient Manley cameras.

As previously suggested (K. R. Foresman and D. E. Pearson, unpublished data) and incorporated into the survey methods (Zielinski and Kucera 1995), we recommend camera surveys be run for 28 days, and cameras be checked every 7 days. Three-volt lithium batteries lasted about 7 days and so should be changed on every visit. Film should be replaced whenever half or more of a roll has been exposed in any 7-day period. Although Manley camera systems are no longer available, they are still commonly used. If Manley cameras are used, the 12-V batteries should be replaced with a fully charged battery every 14 days.

Kucera et al. (1995*a*) suggested cameras be placed at 3–4 m aboveground. However, 4 m exceeds the effective flash distance of the Yashika AW-mini camera using 100 ASA film. Because most observations of target species in this study occurred at night (72% overall; 73% for American marten, 100% for fisher, 0 for wolverine), we recommend camera sets be configured based on the limitations incurred by nocturnal visitation. Exceptions to this would be when bears or humans pose a significant threat to cameras.

In most cases, detection with tracking plates occurred within the recommended 12-day survey period, but animals were not detected at 6% (3/48) of the tracking stations until day 14. In these cases, following the protocol would have resulted in 2 fisher and 3 American marten observations being missed. We observed a consistent increase in the detection rate up to the termination of the track-plate survey, which supports previous observations that 12 days is sufficient (Raphael and Barrett 1981). However, open plates neared saturation (92%) by termination of the survey, whereas only 75% of covered plates had received visits. Although some individual track-plates did not detect an animal until after the 12-day sampling period, detection within the sample units occurred during this period.

Open tracking plates are ineffective under wet conditions. However, under good conditions, these plates generate higher detection rates and lower LTDs than covered plates, which American marten may initially avoid. Covered plates, based on the current design, also probably preclude lynx and wolverine, although captive adult wolverines in 1 instance have been documented to enter covered plates (J. Lewis, Washington Department of Fish and Game, personal communication). We recommend open plates be used when weather allows. When weather is not favorable, we recommend use of both types of track plates simultaneously. If only covered plates are used, it may be necessary to increase survey duration to produce detection results comparable to those achieved with open plates. Larger-covered tracking plates may effectively detect wolverine and lynx as suggested by Zielinski (1995) and may overcome the avoidance behavior described here for American marten.

When possible, we suggest measurements to discriminate fisher and American marten be made from original tracks rather than from photocopies (Zielinski and Truex 1995). Application of the Zielinski and Truex (1995) algorithm to tracks taken under natural conditions at track stations monitored by remote cameras would provide an assessment of the algorithm under field conditions and a means of estimating the error associated with assignment based on use of this function in the field.

MANAGEMENT IMPLICATIONS

Cameras generally performed better than tracking plates for detecting forest carnivores in our study area. However, choice of survey method may be based on specific project goals and limitations. The 5 categories used in this study to evaluate both survey methods should provide a guide for biologists to choose the method best suited to their specific project goals. However, we recommend that the protocols outlined by Zielinski and Kucera (1995) be followed based on the modifications suggested here to provide a cohesive methodology for surveying for midsized forest carnivores. Such a unified approach will result in a better understanding of local and regional distributions of these rare species.

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