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Notes and Discussion

Using Track-plate Footprints in Fisher Mark Recapture Population Estimation

Abstract.—Obtaining accurate estimates of fisher (*Martes pennanti*) population abundance is challenging to resource management agencies given the large home ranges and low densities at which fisher occur. Current methods for estimating population abundance are expensive in terms of equipment required and hours worked indicating a need for a less labor and equipment intensive method. Track-plate footprinting is a method of individually identifying fisher by the papillae patterns found on the metacarpal pad. We evaluated the technique of track-plate footprinting as a mark-recapture method to estimate population abundance of fisher in the Ottawa National Forest of Michigan's Upper Peninsula. We placed covered track-plates using copy toner and a medium of contact paper as a method of obtaining footprints of fisher for individual identification. Over 1548 trap-nights we identified 24 prints from nine different fisher with four individuals being recaptured. Program Mark produced a population estimate of 13 animals with a 95% confidence interval of 8–20 animals. Our study shows that track-plate footprinting is a viable method for estimating population abundance of fisher under natural conditions.

Introduction

Producing accurate estimates of population abundance in a cost-effective manner of solitary, low density, illusive forest carnivores, such as the fisher (*Martes pennanti*) is difficult. Currently several methods exist for estimating furbearer population abundances, however, most of these methods are expensive and time consuming (*e.g.*, traditional mark-recapture and genetic mark-recapture and mark-resight), or only provide indices of population trends or occurrence data rather than actual estimates of population abundance (*e.g.*, scent stations, track surveys, mandatory carcass collection) (Thompson *et al.*, 1989; Bull *et al.*, 1992; Foresman and Pearson, 1998; Fuller *et al.*, 2001; McKelvey and Schwartz, 2004; Squires *et al.*, 2004; Heilbrun *et al.*, 2006; Jackson *et al.*, 2006). Methodologies exist to resolve most difficulties (Otis *et al.*, 1978; White and Burnham, 1999), however, these methods require increased labor, equipment and logistics costs as well as increase trap related mortality (Strickland, 1994). While genetic methods for estimating carnivore population abundance have become common (*e.g.*, Mills *et al.*, 2000; Pearse *et al.*, 2001; Mowat and Paetkau, 2002), these methods are expensive and have their own problems such as allelic drop-out and addition (Taberlet *et al.*, 1996; Gagneux *et al.*, 1997; Taberlet and Luikart, 1999; Taberlet *et al.*, 1999; Creel *et al.*, 2003; Bjornerfeldt and Vila, 2007; Broquet *et al.*, 2007; Dreher *et al.*, 2007). The problems associated with genetic methods and the traditional field methods highlight the need for new methods to estimate population abundances for carnivores that are both accurate and inexpensive.

Herzog *et al.* (2007) described track-plate footprinting of fishers, a method of individually identifying fisher by the unique pattern of papillae found on the metacarpal pads of their feet. These structures are similar to the more intricate system of ridges that are found in higher primates and increases the friction for mobility or prey handling (Whipple, 1904). Herzog *et al.* (2007) showed that these papillae can be used to identify specific individuals even when examined by multiple investigators. However, papilla size scales isometrically with pad-size, thereby excluding the use of this method on smaller mammals such as marten (*Martes americana*) and weasels (*Mustela spp.*) (Herzog *et al.*, 2007). Track-plate footprinting could become a valuable tool in assessing the status of the difficult to monitor and manage fisher (Powell and Zielinski, 1994).

The need for accurate estimation of fisher populations stems from their decline throughout much of their North American range (Irvine *et al.*, 1964; Graham and Graham, 1994). For example, the Michigan Department of Natural Resources Biennial Report for 1927–1928 describes the status of the fisher at the time as, ''They (marten and fisher) are so nearly exterminated in Michigan that there appears no chance they will ever come back.'' This held true until 1961 when the U.S. Forest Service reintroduced 61 fishers into the Ottawa National Forest in the western Upper Peninsula of Michigan between 1961–1963 (Brander and Brooks, 1973). Since their reintroduction in Michigan, fisher populations have recovered sufficiently to allow reinstatement of a trapping season, making accurate population estimates an important management tool.

The objectives of our study were to (1) assess if track-plate footprinting can generate individual-specific capture data in Michigan forests and (2) if using a modified grid protocol can produce enough capture histories to produce a biologically reasonable estimate of population abundance.

METHODS

Track-plate surveys were conducted on a 434 km^2 area of possible fisher habitat (*i.e.*, excluding water, emergent wetlands, roads and urban areas) of the Bessemer Ranger District in the 405,000 ha Ottawa National Forest on the southwest side of Michigan's Upper Peninsula from 26 May to 08 Jul. 2005. The track-plate boxes were constructed of 88 × 120 cm pieces of coroplast corrugated plastic bent into a 36 cm high triangle with a 5–7 cm overlap which protected the interior from rain. The overlap was fastened to the side of the box with wire. The rear of the box was closed off with a triangular piece of coroplast that also was fastened in place at the site with wire. A crossbar consisting of a 5 cm wide × 33 cm long piece of coroplast was inserted into two horizontal slits on the opposite sides of the box entrance approximately 18 cm above the ground to increase the stability of the box.

The track-plate was a piece of 75 cm × 20 cm piece of 0.063 gauge aluminum plate. An area of copy toner approximately 30 cm × 20 cm was used as the print medium (Belant, 2003), with a 30 × 20 cm area covered with white ConTact brand light tack shelf liner paper (Decora, Inc N. Ridgeville OH 44039) as the adhesive surface for the toner.

Track-plate surveys followed methods similar to those described by Zielinski and Kucera (1995). We examined trapping returns for fisher from the 2001 (Cooley *et al.*, 2002) and 2002 (Cooley *et al.*, 2003) seasons to locate areas with a high concentration of fisher (5% of total harvested fisher) within an approximately 500 km^2 area. Several 500 km^2 sites were evaluated in ArcView 3.2 utilizing land cover/land use data obtained from the Michigan Geographic Data Library to choose the location for our study. Our criteria for the site were >50% of federal land ownership, >70% of mixed hardwood conifer forest, <15% urban area, <15% percentage of water and emergent wetland and ease of road access. Once we had chosen our site we created 21 grid points separated by approximately 5 km and transferred these data points into a handheld GPS unit. The intergrid distance was chosen such that we would be likely to sample all individuals based on the lowest published female home range size we found (Johnson, 1984).

In the field we placed a track-plate within 50 m of the GPS grid point such that the track-plate was in the best available fisher habitat, defined as >30% canopy cover, presence of coarse wood debris and >250 m from any roads (Powell, 1993). We then placed another track-plate at each of three additional subsites forming a 500 m × 500 m square, with a 50 m allowance for habitat quality as described above.

We baited the track-plates with an opened, 85 gm can of chicken based cat food, placed fisher lure (Hawbaker's Fisher Lure, S. Stanley Hawbaker and Sons, Fort Loudon PA 17224) on an overhanging branch and camouflaged the set with natural materials. Every 3 d we checked the grid, at which time we replaced bait, contact paper, toner and lure. The track-plates were checked a total of six times after the initial setup date, resulting in the plates being active for 17 nights. All of our protocols followed the guidelines laid out by the American Society of Mammalogists (1998).

We photographed each print through a Nikon SMZ-2T dissecting scope with a Nikon Crescent 150 light source (Nikon, 1300 Walt Whitman Road, Melville, NY 11747-3064, U.S.A.) using Nikon Coolpix 5700 camera (Nikon, 1300 Walt Whitman Road, Melville, NY 11747-3064, U.S.A.) attached to Optem adaptors 257057 and 257011 (Qioptiq, 78 Schuyler Baldwin Drive, Fairport, New York, USA 14450-9196). These images were then imported into the software package IMAGEJ (http://rsb.info.nih.gov/ij/; Rasband, 2003; Herzog *et al.*, 2007).

We used the method of Herzog *et al.* (2007) to determine which foot produced each print and all individuals were identified off of the same front foot. Two evaluators compared all pairs of prints in a blind format to determine if they matched. To insure objectivity, there was no communication between

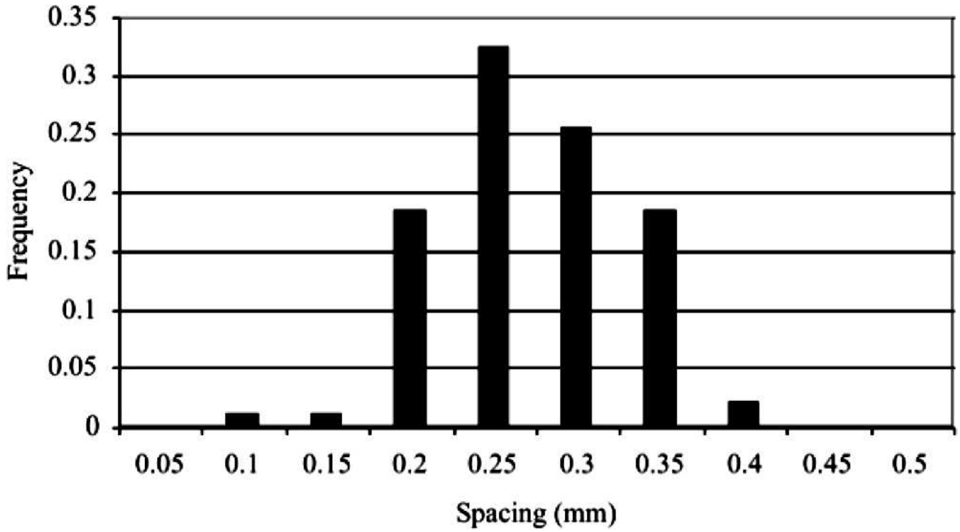

FIG. 1.—Frequency distribution of the interpapillae distances from the nine fisher footprints obtained in this study

the evaluators once the independent evaluator received the print copies. Prior to evaluating the prints each evaluator was trained using a CD-ROM interactive tutorial (R. Kays, pers. comm.). The matching process and estimation of the rarity of the print (likelihood of two animals having the same interpapilla distance) followed the methodology of Herzog *et al.* (2007).

Print captures were run through program Capture (White *et al.*, 1982) as a mark-recapture survey, but with the prints taking the place of both the mark and the recapture of the animal. Capture histories were evaluated under the $M_{(o)}$ model which evaluates the model as having constant capture probabilities over time and the $M_{(t)}$ model which evaluates the model as having change in capture probabilities over time.

RESULTS

We ran our track-plates for 6 wk and totaled 1548 trap-nights. During this period we identified 24 prints as coming from fisher, producing an average of 0.0155 captures per trap night; three of the 24 footprints identified as fisher were of insufficient quality to be identified, resulting in 88% effectiveness. Footprints were considered unusable when there was no distinct papilla pattern (n = 1) or prints were washed away by precipitation (n = 2). Seven of the 21 usable footprints were discarded as they were the result of multiple captures of the same animal in the same 3 d time period at the same track-plate quad. Use of these tracks would have biased our population estimate by including multiple captures of the same individual within one capture period.

After the removal of the seven footprints, our print matching produced a minimum number known alive of nine fisher with a capture history of one animal with four captures, two with two captures and six with a single capture. The distribution of inter-papilla distances did not deviate from a normal distribution ($\bar{x}$ = 0.258, AD = 0.502, P = 0.20; Fig. 1). The rarity estimates for the animals ranged from 2.02×10^{-6} to 5.06×10^{-10} with an average of 1.70×10^{-6}. Using these footprints we calculated population estimates of $\hat{N} = 13$ individuals with 95% confidence intervals of 8 to 20 animals for both $M_{(o)}$ and $M_{(t)}$.

We also had several non-target species detected over the course of the study. The additional species included 28 sets of American marten (*Martes americana*) tracks, 49 sets of raccoon (*Procyon* *lotor*) tracks and numerous small mammal tracks. In no case did non-target species render a fisher print unusable.

DISCUSSION

Our study shows that track-plate footprinting can be used in a field situation to individually identify fishers and estimate their population abundance. The very low values associated with the rarity of the inter-papillae distances indicate that we were unlikely to have two individuals expressing the same footprint in our study. The footprint capture method was also effective with 88% of the prints captured being of high enough quality to use in our analyses. The majority of our print loss was due to intense periods of precipitation (>2 cm) which washed the copy toner off the track-plates and compromised the ConTact paper's ability to pull the toner off of the animal's foot. It is unlikely that these prints were from unsampled individuals though, because none of the unusable prints occurred in grids lacking useable prints. However, due to the overlapping of male and female home ranges it is possible that some of the three unusable tracks were from new fisher. The inability to include these samples in our analysis likely biased our population estimate low, if the prints were from previously unsampled individuals, or inflated the confidence interval about our estimate, if the prints were recaptures. However, the missing of animals due to poor quality data is an inherent risk in all non-invasive sampling procedures and is often at much higher rates in non-invasive genetic studies (*e.g.*, Waits and Paetkau, 2005; Boulanger *et al.*, 2006; Dreher *et al.*, 2007).

Our population estimate of $\hat{N}$ = 13 with a 95% confidence interval of 8 to 20 animals is biologically reasonable for the area in which we were trapping. Our grid encompassed approximately 434 km^2 of useable fisher habitat. Within this area we could fit a maximum of 12 male and 42 female fishers based on an average of male and female (Johnson, 1984; Powell, 1993) home ranges in the Great Lake states and assuming all territories were filled. Our estimate of population abundance converted to density (3/100 km^2) was lower than that reported from some studies (12/100 km^2, Arthur *et al.*, 1989; 19–25/100 km^2 Fuller *et al.*, 2001) and similar to the lower density estimates from other studies (3.3/100km^2, Shea *et al.*, 1985; 5/100 km^2 Arthur *et al.*, 1989). The similarity of our results to the low end of density estimates likely reflects the short duration of our sampling period, that fisher were only reintroduced into the Upper Peninsula 48 y ago, and that the population is harvested (Garant and Crete, 1997).

Nevertheless, there are several techniques that could reduce the confidence interval and improve out population estimate. The most straightforward way to improve our population estimate is to increase the number of recaptures relative to new captures over time. Increasing the recapture rate could be achieved by leaving the track-plates out for a longer period of time or by increasing the number of track-plates set within the region. Similarly, decreasing the percentage of unusable prints (12%) would also decrease the confidence interval about our population estimate, assuming, as was likely, that many of the prints would be recaptures. Decreasing the percentage of unusable prints requires counteracting weather based effects. We suggest that welding the seams of the corrugated plastic together with an epoxy, sealing the back of the trap to the top and sides and extending the roofline beyond the start of the floor could reduce print loss due to precipitation. More frequent checking and replacing of the ConTact paper during humid periods will best ameliorate the impact of humidity on the ConTact paper.

This method has potential as an effective, noninvasive mark-capture tool in a field environment. Software such as IMAGEJ is free on the internet (Rasband, 2003). Digital camera technology or scanner technology (for image capture) is improving and high quality digital cameras and scanners are already a part of most natural resource agencies. The inexpensive corrugated plastic track-plate boxes can be easily repaired unlike wooden boxes or traps even following bear attacks. At the time of publication corrugated plastic could be obtained for $3.00 per sheet, with each sheet yielding one or more traps and waste being converted into extra trap components. The total price for each of our track-plate boxes was under $6.00 (including box, track-plate and contact paper), significantly less than that of conventional live capture traps ($50–$75 dollars per trap; Havaheart, Cumberlands Northwest Trappers Supply and Adirondack Outdoors).

In general our results indicate that track-plate foot printing, used in conjunction with our modified grid trapping procedure, can produce biologically useable estimates of population abundance in a cost effective manner and could lead to more research at a lower cost, providing a better long-term picture of a species that is difficult to observe.

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