Track Plates

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Introduction

A carbon-sooted aluminum track surface has been used in a variety of ways to detect mammalian carnivores. The method was developed first to monitor rodent abundance (Mayer 1957) and was adapted for use with carnivores by Barrett (1983) to survey for American martens. This application enclosed an aluminum plate in a plywood box ("cubby") that was attached to the side of a tree. Bait was placed near the back of the box. Track impressions were "negatives," in that they were created when an animal's foot removed soot and revealed the underlying plate surface. A record of the track was created by transferring the track image to transparent tape by pressing the tape onto the track and lifting the tape. The method was also adapted for more general use by placing a larger (162.8 × 81.4 × 0.06-cm) unenclosed plate on the ground with bait attached to the center (Barrett 1983, Raphael and Barrett 1984, Raphael 1988). Marten and fisher were detected using this method, but neither wolverine or lynx has been detected at these stations (M. Raphael, pers. comm.).

In 1991 the technique was significantly improved with the addition of a surface capable of collecting a positive track impression (Fowler and Golightly 1991). A slightly tacky, white paper (commercially available Con-Tact[2] paper used to line cabinets and drawers) was placed across the distal end of a rectangular sheet of sooted aluminum. The plate was inserted into a plywood box to protect it from moisture and debris, and the box was scaled to a size that would permit the entrance of marten and fisher (30.0 × 26.7 × 81.3 cm). The soot that adhered to an animal's foot as it entered the box was transferred to the white paper when the animal walked to the rear of the box. The positive track impression, often transferred in great detail, was cut out from the paper and stored in a clear acetate envelope. The clarity of tracks is sufficient to distinguish the previously confusing male marten and female fisher tracks using discriminant function analyses (Zielinski and Truex 1995).

I will describe the use of two types of sooted aluminum plates. The first is the enclosed plate system that records tracks on white paper. This device has been effective at detecting marten and fisher (Fowler and Golightly 1991; Zielinski and others 1995) and was the detection device recommended in the original USDA Forest Service protocol for detecting these two species in Region 5, California (Zielinski 1992). The second device is the larger, unenclosed plate without the track-receptive paper (Barrett 1983, Raphael and Barrett 1984). Despite this shortcoming, this is the only adequately field-tested track-plate method that is capable of detecting all four species, although neither lynx nor wolverine has been detected. However, it is more likely that they would be detected on the uncovered track plate than on a plate in a relatively small box.

A logical combination of the two approaches is to enclose the large plate, partially covered with Con-Tact paper, in a large box. However, boxes larger than that recommended in the Forest Service, Region 5 protocol have not received much testing. Large plywood boxes (35.6 × 38.1 × 78.7 cm) and even larger cardboard boxes (61.0 × 61.0 × 86.4 cm) were used in a modest pilot test in northern Idaho, where all four species were thought to occur, but each box detected only marten (A. Dohmen, pers. comm.). A 40.6 x 30.5 x 81.3-cm version was used in a study of the mammalian

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[2]The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

carnivores associated with the Sacramento River in California (J. Souza, pers. comm.), but none of our four species of interest occurs at that location.

Description of Devices

Track-Plate Box

This device is composed of a carbon-blackened aluminum plate (20 × 76.2 × 0.1 cm) partially covered with white contact paper that is enclosed in a plywood box with the inside dimensions 25.4 × 25.4 × 81.3 cm (*figs. 1, 2*). Bait is placed at the back of the box, beyond the Con-Tact paper. The box described here is designed to be placed on the ground. Somewhat smaller boxes have been attached to the boles of trees (Barrett 1983, Martin 1987), presumably to dissuade visits by non-target species. However, this assumption has not been tested, and because arboreal plates require more time to install and are more expensive than terrestrial boxes, they will not be described in detail here. Those interested in attaching boxes to trees should consult the references cited above.

The aluminum plate should be about 1 mm thick (0.063 gauge). Thicker material has no advantage and is heavier. Aluminum can usually be acquired as flat stock from a

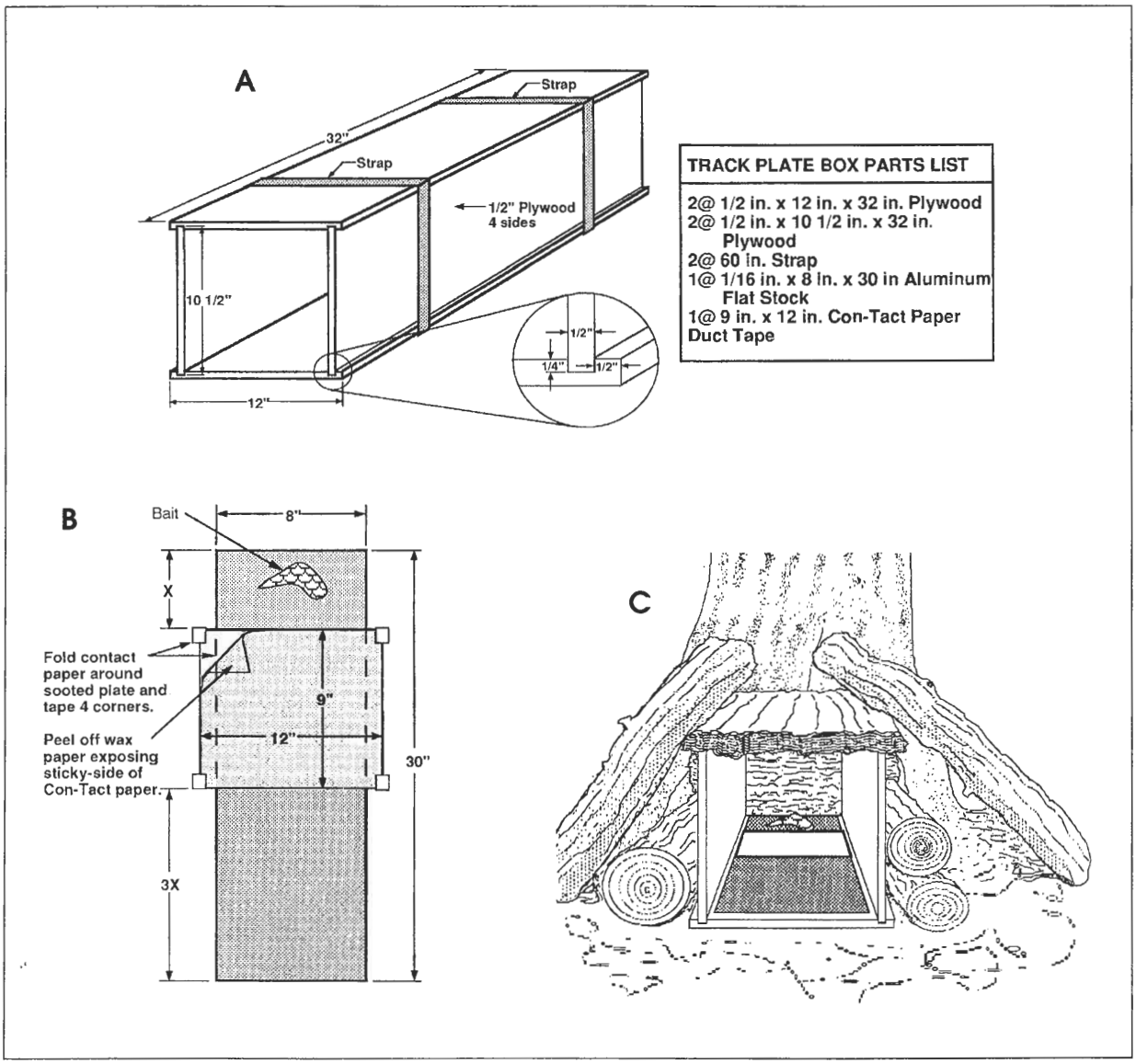

Figure 1—Schematic drawings of a track-plate box station and its components: A) wooden, plywood track box, B) sooted aluminum plate with Con-Tact paper, C) established station in field. (Based on original figure in Fowler and Golightly 1993).

sheet metal shop, but some biologists have received donated aluminum from newspaper publishers (e.g., J. Souza, pers. comm.). The preferred method for applying soot is with acetylene gas from a welding torch. Carbon production is maximized by covering the oxygen intake on the nozzle with duct tape. Alternatively, the soot can be applied from a burning kerosene-dipped wand. Suspend the plates horizontally above the ground between sawhorses (or some similar support), and soot them from below as the soot rises. Soot the plates outdoors in a well-ventilated area. A water source should be available at all times to prevent spread of fire. A half-mask respirator and safety glasses are recommended to minimize inhalation of the soot (see Safety Concerns). If the respirator is not available, wear a dust mask to block large particulates. Soot should cover the plate evenly and lightly; do not oversoot, as excessive soot may produce a poor quality track on the paper. The area of the plate that will be covered with the paper need not be sooted. When learning the process, test that the soot is sufficient by transferring some from the plate to a piece of Con-Tact paper with your finger.

Carpenter's chalk, dissolved and applied in isopropyl alcohol, has also been used as a tracking medium (G. Fellers, pers. comm.; Orloff and others 1993). In the best circumstances, under completely dry conditions, the results can approach the quality of those from a carbon-sooted plate (Orloff and others 1993; W. Zielinski, pers. observ.). However, track quality can be quite poor under even moderately damp conditions, so the use of chalk is not recommended to detect the forest carnivores considered here.

After the plate is sooted, wrap a 31- × 23-cm piece of Con-Tact paper, with sticky side up and backing intact, around the plate, and tape it to the back of the plate using pieces of duct tape. Align the paper so it is slightly rear of the center of the plate but with about 9 cm of exposed plate beyond it where the bait is placed (*fig. 1B*). To save time, prepare the pieces of Con-Tact paper and duct tape in advance. Keep the protective backing on the paper until the plate is placed in the field for use, and then peel it off.

The box is constructed of four pieces of 1/2-inch, medium-grade plywood (*fig. 1A*). The back of the box is open to facilitate construction and transportation and to minimize cost. The top and bottom pieces should have two, approximately $^1/_2$-inch grooves running the length of their inside surfaces into which the two side pieces can be slid or gently hammered. Use no hardware to assemble the box. Rope, strips of tire tubes (often

Figure 2—Track-plate box station in the field. Note how the back of the box is against the base of a tree and how the box is covered with debris to stabilize and camouflage it.

available at no cost from local tire dealers), or plastic banding (applied with a commercial banding tool) can be used to hold the sides together. Cotton clothesline works well and biodegrades if left in the field. Heavy woody debris, placed over the box in the field, will strengthen it further.

A lighter-weight alternative for protecting the track plate uses thin plastic sheets (L. Chow, pers. comm.). The plastic is bent into a half cylinder and the edges are placed inside a raised lip on each of the outer edges of a galvanized steel base (28.0 × 76.0 × 0.1 cm with a 1.0-cm raised lip along the sides) and are kept in place by a combination of the force acting to straighten the plastic and liberal use of duct tape (*figs. 3, 4*). Alternatively, holes can be drilled through the raised lip of the steel base and through the plastic at corresponding locations so that sheet-metal screws can be used to secure the canopy (Foresman and Pearson 1995). Although one large piece of plastic is sufficient, two smaller pieces (each 40.5 × 70.5 × 0.2-cm) can fit in a backpack more easily. At the station location, each piece is bent, positioned in the base, and then taped

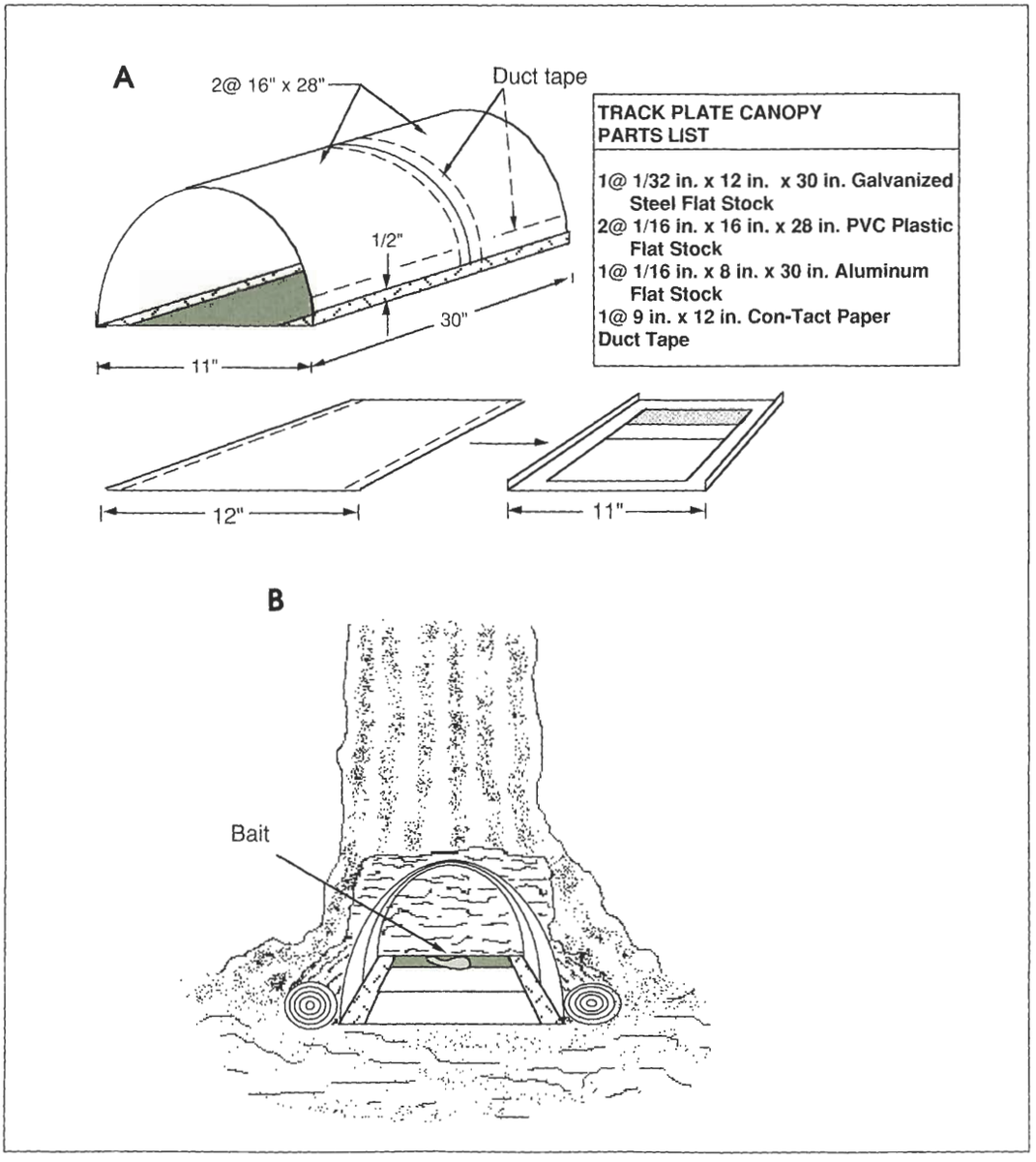

Figure 3—Schematic drawing of a plastic canopy-covered track plate and its components: A) dimensions and construction of the unit, B) established station in the field.

together where they overlap. The sooted aluminum plate with Con-Tact paper is placed on the galvanized base. Track-plate stations with this type of protection have successfully detected marten and fisher. The materials for this design weigh somewhat less than the plywood box, but the structure is much less sturdy. The roof is very flexible and cannot support woody debris that might be used to strengthen and camouflage it. The entire enclosure appears to move more readily when an animal enters it than does the plywood box. In addition, the plate may be less protected from moisture than when the absorbent plywood box is used.

There are several means by which the sooted plates can be transported in the field. For storage in a vehicle, a travel case should be constructed that can accommodate field-ready track plates (sooted, with Con-Tact paper and backing attached) (*fig. 5*). This can

Figure 4—Plastic canopy-covered track plate in the field. Note how the back is against the base of a tree and how the unit is stabilized with bark and logs.

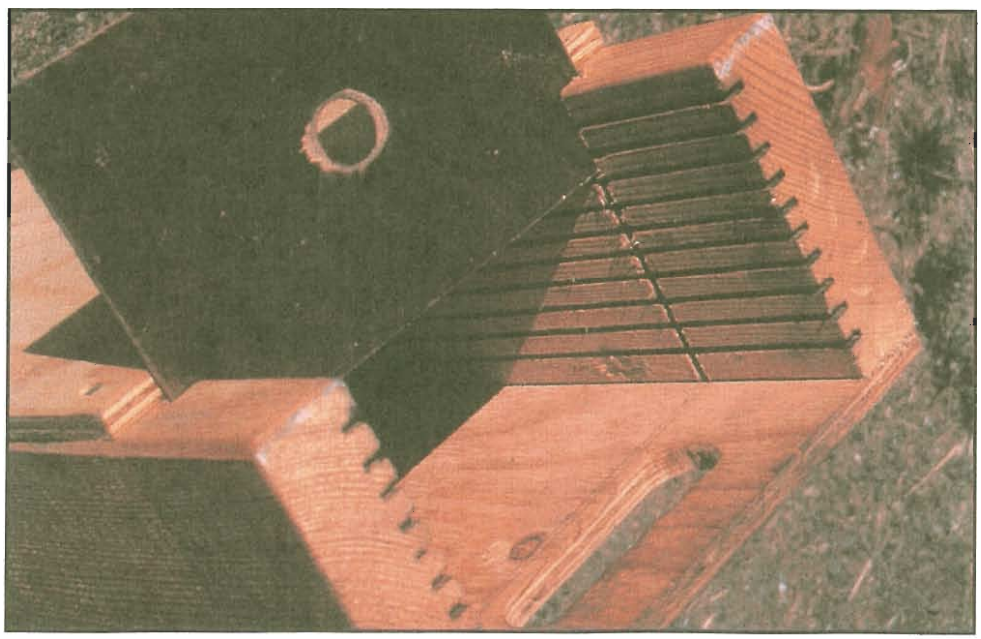

Figure 5—Example of track-plate carrying case designed to be transported in a vehicle.

be a sturdy wood or plastic box with parallel grooves cut on the inside surface of two sides into which the plates can slide. Grooves separated by at least 1/2 inch will keep plates apart during travel, and a box lid will prevent dust from settling on the plates. To protect individual plates from being marred while you walk from the vehicle to the station location, cover the sooted plate(s) with an unsooted one and bind them together tightly with duct tape or welding clips. Alternatively, holes can be drilled in diagonal corners of each plate; a bolt and wing-nut can secure a number of plates firmly together. Nothing need be placed between the plates, provided each Con-Tact paper has its protective cover in place and plates are stacked front to back. This procedure is particularly useful when multiple plates must be back-packed into a roadless area.

Unenclosed Track Plate

This device is an uncovered, carbon-blackened aluminum plate made of the same material described above and sooted in the same fashion. The plate is actually composed of two plates (40.0 × 80.0 × 0.1 cm each), placed side-by-side, to create an 80.0 × 80.0 cm surface (*figs. 6, 7*). Because this method does not involve the use of a white track-receptive surface, it is important that the soot be applied lightly enough so that the feet of visiting animals remove it all and expose the underlying plate. Bait is placed in the center of the two plates.

To prevent the sooted surfaces from rubbing together, carry the plates in wooden boxes bolted to pack boards. Flat, army surplus pack boards made of particle board are the best. The lightest boxes are made of 0.25-inch plywood on the front, back, and the bottom; sides and hinged top are made of 0.5-inch plywood. One box, 41.5 cm long and 135 cm deep, will hold six sets of plates. Cut six slots, 5 mm wide and 5 mm deep, spaced about 12 mm apart, into the interior surfaces of the box. Fit the sheets into the slots back to back. A larger and sturdier box of the same general design that can be carried in a vehicle will be helpful in transporting many plates at once.

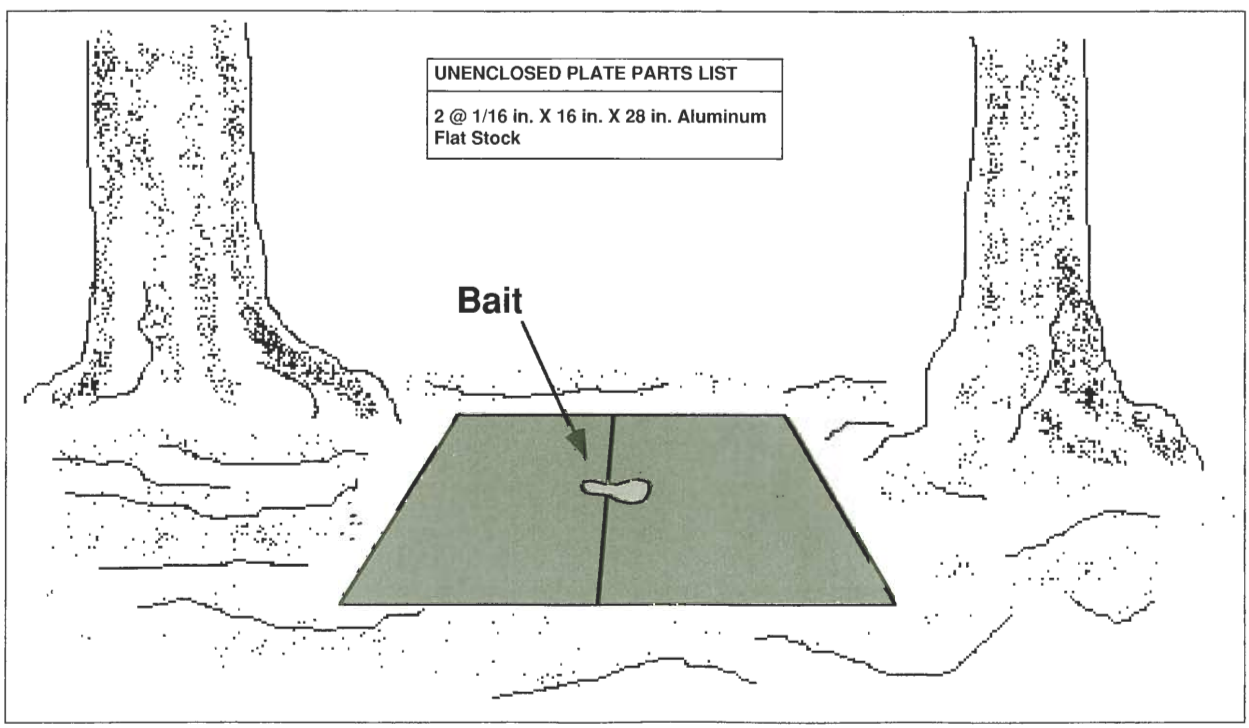

Figure 6—Schematic drawing of an unenclosed track plate and its components.

Baits and Lures

Recommendation: Chicken is the recommended bait. Also use a commercial lure and a visual attractant (e.g. hanging bird wing, large feather, or piece of aluminum foil).

In tests with captive fishers, chicken and tuna were equally attractive, but in the field, chicken elicited significantly more detections of a variety of carnivores, including martens (Fowler and Golightly 1993). Chicken is used exclusively for bait in the original USDA Forest Service, Region 5 protocol (Zielinski 1992) because it is readily available, relatively inexpensive, of a convenient size for use in the boxes, and poses no greater risk of microbial disease than other meats if hands are washed after use (see Safety Concerns). However, other baits have successfully attracted fisher (e.g., fresh fish, deer carrion) and marten (e.g., fresh fish, deer, beef bones, jam). Laymon and others (1993) found that jam did not increase visits to detection stations, and Jones and Raphael (1991) suggested that martens prefer chicken bait without the addition of jam. There is no consensus as to the relative effectiveness of different bait combinations. The unenclosed plates have typically been used with a perforated can of tuna cat food in the center and the excess juices distributed on surrounding vegetation. However, alternative baits were not tested. In the box or canopy-enclosed plate, place the bait behind the paper; with the unenclosed plate, place bait at the union of the two plates (*figs. 1, 3, 6*).

Commercially available trapper lures such as skunk scent may be useful attractants, and we recommend that they be used in addition to chicken bait. Sources for these lures include M & M Fur Company, P.O. Box 15, Bridgewater, SD, 57319-0015, (605-729-2535), and Minnesota Trapline Products, 6699 156th Ave. NW, Pennock, MN 56279, (612-599-4176). Fish emulsion, sold as fertilizer in garden-supply stores, can also be an effective lure, especially when mixed with vegetable oil to retard evaporation.

Visual attractants (e.g., suspended bird wings, aluminum pie tins) are frequently used by commercial trappers, but their effectiveness at increasing detections has received only one modest test, in which they did not increase detections of "carnivores" (a group of species that included marten but excluded lynx, wolverines, and fishers; Laymon and others 1993). This is insufficient evidence to discourage their use, especially in light of their reputed value by trappers (Young 1958, Geary 1984, R. Aiton, pers. comm.). Whenever possible, use a visual attractant, and use it consistently. Suspend either a dried wing, feather, or aluminum foil about 2 m above the ground within 5 m of the station.

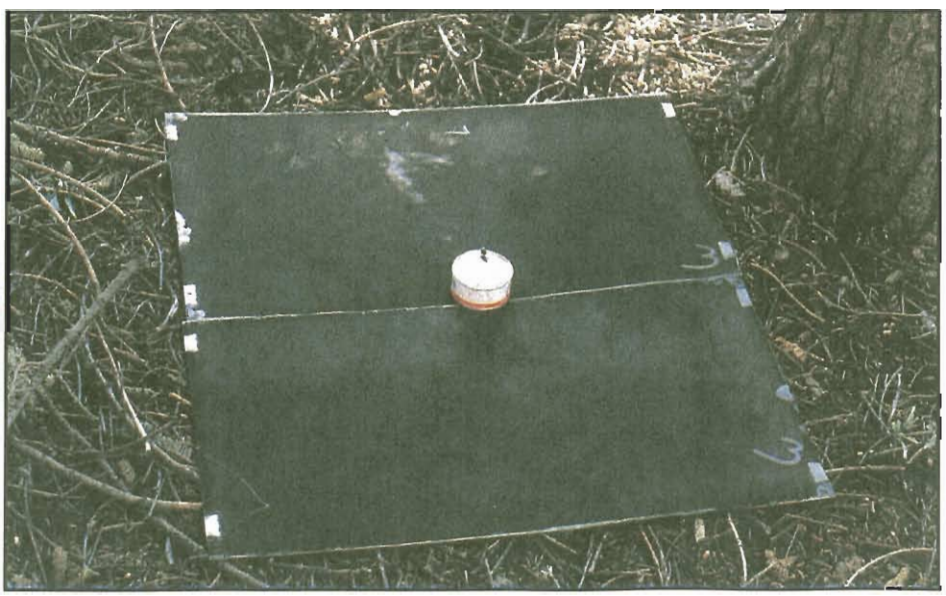

Figure 7—Unenclosed large, sooted track plate in field, with perforated tuna can as bait.

Survey Seasons

Recommendation: Conduct two surveys per year per sample unit, one in spring and one in fall. However, do not conduct the second survey if the target species is detected during the first.

Because both the enclosed and unenclosed plates are placed on the ground where they could quickly be covered with snow, and because of the increased costs of operation, avoid conducting surveys during winter. However, because the target species may be more easily detected during the winter when food may be less available, conduct surveys as soon after snowmelt in the spring and (if necessary) as late as possible in the fall.

Survey Duration

Recommendation: Stations should be set for a minimum of 12 nights and checked every other day for a total of at least six visits (excluding setup). Discontinue the survey when the target species is detected even if this occurs before 12 nights have elapsed. If the target species is not detected during the first 12-day session, run a second session at the same station locations during the alternate season (either spring or fall) for a minimum of 12 days.

Because the objective of the survey is to determine whether a sample unit is occupied, effort need not be expended beyond the detection of the target species. However, the minimum effort without detection is set at 12 nights in response to a number of sources of information on the "latency to first detection" for marten and fishers. In reviewing the results of 207 track-plate and line-trigger camera surveys, Zielinski and others (1995) found that the mean (SD) latency to first detection for surveys that had from 6 to 12 stations (n = 50) was 4.2 (2.4) and 3.7 (2.6) days for fisher and marten, respectively. This estimate is biased downward, however, because it included only those surveys that detected a target species before the surveys were concluded. Raphael and Barrett (1984) recommended that 8 days were sufficient to achieve high detection probabilities when measuring mammalian carnivore diversity at a site. Jones and Raphael (1991), however, discovered that 60 percent (3 of 5) of first detections during marten surveys in Washington occurred after day 8 but before day 11. They concluded that surveys should run more than 11 days. Foresman and Pearson (1995) detected marten after a mean of 3.3 days and 2.3 days at enclosed and open plates, respectively; fishers were detected after a mean of 5.3 days at enclosed track plates. Fowler and Golightly (1993) suggest a 22-day survey duration, but this is with the goal of increasing the number of detections to the point where a statistical decline in detections will be discernible at a subsequent sample. Because the objective of detection surveys is to detect presence only, and because the statistical merit of using number of detections as an index has not been adequately addressed, the 22-day survey duration is probably excessive.

Because lynx and wolverine have not yet been detected on track plates, there are no data on which to base recommendations on survey duration. Until data are collected to suggest otherwise, the 12-day duration, twice per year if necessary, is considered sufficient effort.

Preparations for the Field

Defining the Survey Area

Recommendation: Conduct surveys in 4-mi^2 sample units, as described in Chapter 2, "Definition and Distribution of Sample Units."

The survey approach will be different depending on whether the survey is a "Regional Survey" or a "Project Survey" (see Chapter 2). In each case, however, we recommend the use of separate 4-mi^2 sample units as the basis of the survey. Conduct surveys on as many sample units concurrently as time, personnel and funds permit. If it is a Regional Survey, choose one of the scheduling options suggested in Chapter 2; if it is a Project Survey, focus your attention first on the sample units within the project area.

Station Number and Distribution

Recommendation: Use a minimum of six track-plate stations in each sample unit. Distribute them as a grid, with 0.5-mile intervals, in the area of the sample unit with the most appropriate habitat or where unconfirmed sightings have occurred (see Chapter 2, *fig. 2*).

Detection success increases with an increase in number of stations in the survey (Zielinski and others 1995). Although the data are too few to determine the point of diminishing returns on station number, it seems reasonable to have stations that collectively sample at least 0.5 mi^2 (12.5 percent) of the unit, especially if they are placed in the most appropriate habitat. Six stations provide at least this much coverage if one assumes that a target individual will be detected if it travels within the rectangle created by joining the perimeter stations. Additional stations will provide a greater assurance of detecting occupants, but more than 12 stations (covering 1.5 mi^2, 37.5 percent of the area) would probably be excessive.

If habitat is homogeneous throughout the 4-mi^2 sample unit and there are no previous sightings, center the grid in the middle of the sample unit. If roads are available, the shape of the grid can be adjusted to accommodate road access, but maintain the recommended inter-station distances. If the sample unit is roadless, the track-plate materials will need to be backpacked into the survey area.

Before conducting on-site reconnaissance, study aerial photographs and topographic maps of the sample unit(s) to be surveyed. Station locations should be assigned on maps or photos before conducting any field work.

In the Field

Station Location

First conduct reconnaissance to verify the existence and location of roads and trails that will be used to access the stations. Locate each station at least 50 m perpendicular to the road; placement of stations closer to roads may reduce their attractiveness to target species and increase visibility to people. When possible, mark the station locations with flagging and metal tape or rebar, and identify them using Global Positioning Satellite (GPS) technology. These locations may need to be revisited during a second survey. In roadless areas, record the compass bearings, elevation (using an altimeter), and distances between landmarks used for orientation so others can find the stations with ease.

Station Setup

Set out all the detection stations you plan to check during the survey before baiting them. Because the original location and establishment of the stations will require more time than checking them, it is best to bait them after all have been established. For reference, if there are six stations per sample unit, an experienced 2-person crew can set up about 18 track-plate stations per day; 24 if there are 12 stations per sample unit. Additional time is required for roadless sample units. No more stations should be established than can be checked every other day by available personnel. However, because stations are checked once every 2 days, only half the stations need to be checked on any one day. If this is difficult, then additional crews should be hired, or the number of sample units surveyed during that particular period should be reduced (see Chapter 2 for recommendations on how to survey multiple sample units).

Track-Plate Box

Assemble the box, and place it on level ground so it will not move when entered. Place the baited end of the box against the base of a tree, rock, or log to discourage entry from the rear (*figs. 1C, 2*). Cover the box with heavy debris (e.g., limbs, bark) to secure it in

place and to hide it from passers-by. Remove the protective cover from the Con-Tact paper, and insert the sooted plate in the box. Mark a flag near the box with the station number. Place the bait on the plate behind the Con-Tact paper, using kitchen tongs to minimize contact with meat. Wash hands thoroughly after handling chicken, or wear gloves to prevent contact.

Unenclosed Track Plate

At each station, clear and level an area of about one square meter. A small, folding shovel is a useful digging tool. Place the sooted plates side-by-side onto the cleared spot in a manner that will provide a stable surface for animals to step on. Attach the bait with wire to the center of the sheets. At a conspicuous location, attach the following laminated message to a tree:

> This is part of an important wildlife study being conducted by _____ . Please do not touch. The sooted aluminum plate will record the tracks of animals. It will not harm or entrap them. If you have any questions, please contact _____ .
>
> Thank you.

Checking the Stations

Recommendation: Check the stations every 2 days, including weekends, for a minimum of six checks (12 days). Replace the plates as necessary, either when the soot becomes ineffective (test with finger) or when the tracks of non-target species occupy more than 20 percent of the plate. Rebait at every visit (at least six times), and remove old bait from the station area. Apply lure at least twice during the survey period.

The day a station is baited is Day 0, and the subsequent visits should occur on Days 2, 4, 6, 8, 10, and 12. If there are too many sample units for all stations to be checked on one day, then half of the stations should be run on alternate days. If using the alternate day method, the minimum survey period will be 13 rather than 12 days. If rain or snow renders the stations ineffective (especially common for the unenclosed plates), add additional days to the survey period to compensate for the days during which visits could not be detected.

Survey crews should be familiar with the tracks of potential target species. The track guide of Taylor and Raphael (1988) describes the tracks of species that commonly occur on track plates in the Pacific Northwest, but their key is only for tracks directly on the aluminum plate. Examples of marten and fisher tracks on Con-Tact paper are provided in *appendix A*. Although the tracks of male marten and female fisher can overlap in size (Taylor and Raphael 1988), they can be easily distinguished by using the discriminant function developed by Zielinski and Truex (1995) (*appendix B*). Unfortunately, the tracks of wolverine and lynx on plates or paper have not been described. It is extremely helpful to build a library of life-sized examples of tracks of the common carnivores in the area. These can be used to identify most species quickly.

As the stations are checked, complete the Track Plate Results form (*appendix C*). Make an entry on this form every time a station is checked, regardless of the results. If tracks of the target species are on the paper, cover it with one of the original protective

sheets, and return the plate to the field station. Record the station number and date on the paper and the plate as they are removed from the box (a fingernail can etch these numbers in untracked soot on the plate). Remove the paper from the plate, and cut away the untracked portion of the paper. Record the date, sample unit number, and station number on the paper, and place it in a clear 8 1/2- by 11-inch document protector with perforations for a 3-ring binder. To collect and preserve tracks from the sooted portion of plates, place a wide strip of clear tape over each print. Press the tape on the print with a burnishing tool (the tip of a capped pen will usually do). Carefully peel away the tape, and transfer it onto a sheet of heavy white paper. Practice this procedure on tracks of non-target species before lifting those of potential target species.

Data Management

We recommend three forms for data: Survey Record, Track-Plate Results, and Species Detection form (*appendix C* and in the pocket inside the back cover). We strongly recommend using indelible ink and photocopies of the data sheets (especially the Track-Plate Results form) made on waterproof paper. All forms should be stored in a 3-ring binder as a permanent record of the survey.

Survey Record Form

The Survey Record form contains information on the survey location and its configuration. It is important to identify the legal description *and* the Universal Transverse Mercator (UTM) coordinates at each unit. Collectively, these forms become a record of all the surveys conducted in the administrative area, regardless of their outcome.

Track-Plate Results Form

Use one copy of the Track-Plate Results form for each day in the field. Record information from each track plate station, whether there were tracks on the plate or not. Note the station number, the visit number (1-6), the nights since last visit (should usually be two), whether there were tracks of target species and which ones, the identity of tracks of other species of interest, and general comments. Remember that Visit 1 occurs after the second night the station has been set up; the set-up visit can be referred to as Visit 0. If you are uncertain about the identity of tracks, use track reference materials (especially Taylor and Raphael, 1988), the examples provided in *appendix A*, and the discriminant function in *appendix B* to assist in the identification, *and* ask a biologist who is experienced with tracks to confirm your identification. Tracks from Con-Tact paper can be easily photocopied and sent by FAX to qualified biologists. Make certain to record the season, date, a code for weather since the last visit, and the location of the survey on each copy of the data form. Completed forms and survey maps should be archived at the local administrative office (e.g., Forest Service Ranger District), and a duplicate set should be filed at a second location of your choice.

Species Detection Form

When a survey is successful at detecting lynx, wolverine, fisher, or marten, complete the Species Detection form, submit one copy to the state Natural Heritage office, and archive a copy at the administrative office of the agency that manages the land where the survey was conducted. Most Natural Heritage databases record only positive results from detection surveys. Complete one form for each species detected. This standardized form characterizes successful surveys for marten, fisher, lynx, and wolverine and is used for all methods (camera, track plate, snow track).

Safety Concerns

Sooting the Plates

The use of acetylene to soot plates can expose the operator to carbon monoxide and acetone. Soot the plates outdoors where there is adequate ventilation and where the risk of fire is low. A "Half-Mask Respirator" with organic vapor filter and goggles is recommended. At a minimum, a dust mask should be worn to exclude large particulates. Always receive training in the use of the welding equipment (tank and torch) from an experienced technician. A "Job Hazard Analysis" for sooting plates is available upon request from Bill Zielinski (Redwood Sciences Laboratory, USDA Forest Service, 1700 Bayview Dr., Arcata, CA 95521).

Handling Bait

Uncooked chicken and many other meat baits are a potential source of *Salmonella* bacteria. Contact with both fresh and old bait should be minimized. Chicken pieces should either be individually wrapped in sandwich bags and frozen until the day they are used or be handled using kitchen tongs. Carry soap and water or disposable wipes so that you can wash your hands thoroughly before meals. Careful attention to cleanliness will make the risk of contamination from chicken negligible (Dr. J. Sheneman, pers. comm.). The risk of poisoning the target species with rotting meat baits is also negligible, as most target species regularly consume carrion.

Comparison of Track-Plate Methods

The methods recommended here have not been compared in the same study. However, it is generally agreed that the enclosed-plate method is superior to the open plate because it is protected from moisture and debris, the white surface collects positive track impressions with fine detail, and the track can be easily collected and stored with minimum loss of information. Furthermore, the unenclosed plates require larger and more unwieldy aluminum plates than the enclosed box because an animal is not directed over the plate from a single direction. However, in a recent study where plastic-canopy enclosed plates were alternated with unenclosed plates the latter received first detections by marten earlier than the former (Foresman and Pearson 1995). These authors suggest that some animals man be more reluctant to enter an enclosed area than to walk across an open plate. This conclusion is premature, however, until the unenclosed plate is compared with the *wooden box*-enclosed plate, which is sturdier and can be reinforced with logs and sticks in the field more easily than the plastic canopy version (K. Schmidt, pers. comm.).

Wolverine and lynx will probably step on the unenclosed plate more readily than the plate enclosed in the relatively small box described here. Thus, unenclosed plates should be used when sooted track plates are the chosen device for the detection of wolverine or lynx. Continued experimentation with the use of large (greater than 30.0 × 26.7 × 81.3 cm) boxes is encouraged for the detection of these species. When either wolverine or lynx are the target species, stations with plates enclosed in large boxes should be interspersed with unenclosed-plate stations, or both types of stations should be placed at the same location. This is the only way we will discover whether the larger target species will be successfully detected on box-enclosed plates. A potential advantage of the plastic canopy design is that the enclosure size could be increased to accommodate lynx and wolverine without the additional weight that would be incurred by enlarging the plywood box.

Costs

Assumptions:

- Five adjoining sample units, 4 mi^2 each, are surveyed simultaneously for a total survey area of 20 mi^2.
- There are six stations per sample unit (a total of 30 stations).
- All sample units have adequate road access.
- No target species are detected during the survey and therefore a second survey period is necessary. Because a survey is terminated when the target species is (are) detected, costs can be significantly less if the target species is detected early in the first survey period.
- The work is conducted by a crew of two federal employees paid about $75.00/person/day. No contractors are used.
- Costs for some elements of labor will be less for the unenclosed than for the enclosed plate, but these costs are trivial compared to the balance of the costs so they have not been listed separately.

Season 1

1. Labor

Planning	2 person days (pd) 2 × $75/pd =	$150
Training	2 pd × $75 =	150
Materials acquisition and construction	5 stations/day 6 pd × $75 =	450
Establish stations	10 stations/pd 3 pds × $75 =	225
Station visits (crew members split station checking duties)	6 at 2-day frequency 6 × 30 =180 visits 20 stations/pd = 9 pds (including ≥ 1 Sunday @ time + 1/2) (8 × $75) +(1 × 112) =712	
Station removal, plate cleaning, data analysis	4 pds × $75 =	300
Total Labor		*$1,987*
2. Vehicles and Gas		700
3. Materials		
Track plate stations	$15/station × 30	450
Extra plates	15 @ $2.50 ea. =	37
Acetylene, bait, and miscellaneous supplies		350
Total Materials		$837
Total, Season 1		*$3,524*

Season 2 (if necessary)

1. Labor

Plan, survey, establish, visit, and remove stations		1,387
2. Vehicles and Gas		700
3. Materials		
Track-plates	replace 15 percent of first season's stations; 5 stations × 15 =	75
Acetylene, bait and miscellaneous supplies		250
Total, Season 2		*$2,412*
Grand Total (Two seasons, if both are necessary)		**$5,936**

Equipment

Orientation

- ☐ Maps/aerial photos
- ☐ GPS equipment (if available)
- ☐ Indelible marker
- ☐ Flagging tape
- ☐ Compass
- ☐ Altimeter
- ☐ Metal stakes or tape
- ☐ Backpack

Track-Plate

- ☐ Aluminum plates
- ☐ Con-Tact paper (white)
- ☐ Plate-carrying case(s)
- ☐ Flashers
- ☐ Transparent tape (wide)
- ☐ Sandwich bag
- ☐ Surgical gloves/kitchen tongs
- ☐ Acetylene and torch
- ☐ Plywood box
- ☐ Bait (chicken)
- ☐ Data forms
- ☐ Track ID references
- ☐ Disposable wipes
- ☐ Duct tape
- ☐ Rope, tubing or banding material
- ☐ Commercial lure
- ☐ Document protectors
- ☐ Rags and steel wool to clean plates

General

- ☐ Tool or tackle box
- ☐ Scissors
- ☐ Hatchet or hammer
- ☐ Pliers
- ☐ Small, folding shovel
- ☐ Plastic garbage bags

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Appendix A—Examples of fisher and marten tracks from Con-Tact paper

Fisher Tracks. All are *Martes pennanti pacifica* except G, which is from *M. p. pennanti*.

A. Sequoia National Forest, California (Adult female, left foot).
B. Sequoia National Forest, California (Adult female, right foot).
C. Mountain Home State Forest, California (Adult male, right foot).
D. Sequoia National Forest, California (Adult female, right foot).
E. Six Rivers National Forest, California (Adult female, right foot).
F. Six Rivers National Forest, California (Adult female, right foot).
G. Captive individual; Massachusetts origin (Adult male, right foot).
H. Shasta-Trinity National Forest, California (Adult female, right foot).

Marten Tracks. All are *Martes americana sierrae* except those of Yukon origin which are *M. a. actuosa*.

A. Lassen National Forest, California (Juvenile male, left foot).
B. Captive individual; Yukon origin (Adult female, right foot).
C. Mountain Home State Forest, California (Sex unknown, left foot).
D. Mountain Home State Forest, California (Sex unknown, left foot).
E. Sequoia National Forest, California (Sex unknown, right foot).
F. Captive individual; Yukon origin (Adult male, right foot).
G. Captive individual; Yukon origin (Adult female, left foot).
H. Captive individual; Yukon origin (Adult female, left foot).
I. Captive individual; Yukon origin (Adult female, right foot).
J. Captive individual; Yukon origin (Adult female, left foot).
K. Sequoia National Forest, California (Sex unknown, left foot).

Fisher Tracks. All are *Martes pennanti pacifica* except G, which is *M. p. pennanti.*

A. Sequoia National Forest, California (Adult female, left foot).

B. Sequoia National Forest, California (Adult female, right foot).

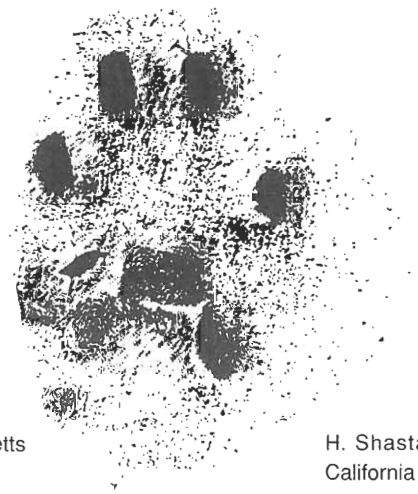
C. Mountain Home State Forest, California (Adult male, right foot).

D. Sequoia National Forest, California (Adult female, right foot).

E. Six Rivers National Forest, California (Adult female, right foot).

F. Six Rivers National Forest, California (Adult female, right foot).

G. Captive individual; Massachusetts origin (Adult male, right foot).



H. Shasta-Trinity National Forest, California (Adult female, right foot).

Marten Tracks. All are *Martes americana sierrae* except those of Yukon origin which are *M. a. actuosa*.

A. Lassen National Forest, California (Juvenile male, left foot).

B. Captive individual; Yukon origin (Adult female, right foot).

C. Mountain Home State Forest, California (Sex unknown, left foot).

D. Mountain Home State Forest, California (Sex unknown, left foot).

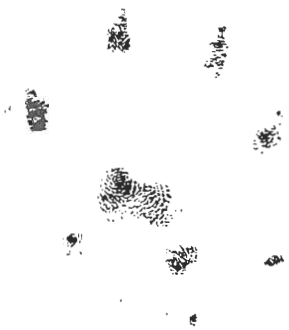
E. Sequoia National Forest, California (Sex unknown, right foot).

F. Captive individual; Yukon origin (Adult male, right foot).

G. Captive individual; Yukon origin (Adult female, left foot).

H. Captive individual; Yukon origin (Adult female, left foot).

I. Captive individual; Yukon origin (Adult female, right foot).



J. Captive individual; Yukon origin (Adult female, left foot).

K. Sequoia National Forest, California (Sex unknown, left foot).

Appendix B—Discriminant function to distinguish marten and fisher tracks

Adapted from "Zielinski, W. J. and R. L. Truex (1995). Distinguishing tracks of marten and fisher at track-plate stations. J. Wildl. Manage." The complete manuscript is available by contacting the authors (Redwood Sciences Laboratory, USDA Forest Service, 1700 Bayview Dr., Arcata, CA 95521; 707-822-3691).

Several problems arise in attempting to distinguish marten and fisher tracks. First, there are no widely accepted qualitative means of distinguishing the tracks. Some biologists have suggested that the shape and connectedness of palm pad segments, hairiness of the track, and absence of particular toe pad impressions may differ between species, but exceptions are not uncommon (Zielinski, pers. observ.). Second, there is overlap in quantitative traits (length and width) of adult animals, much of which is likely attributable to overlap between male marten and female fisher (Taylor and Raphael 1988) due to intraspecific sexual size dimorphism.

A discriminant function was developed using tracks collected from wild and captive individuals of two subspecies of marten (*M. americana sierrae* and *M. a. actuosa*) and two of fisher (*M. pennanti pacifica* and *M. p. pennanti*). The method assumes the track was made by an adult marten or fisher.

Distinguishing Right from Left Feet and Pad Definitions

Before toe and interdigital pads are identified, it is necessary to determine whether the track was made by the right or left foot. This can be assessed by using four rules, presented in order of reliability. First, the medial-most digit (the "thumb"; 1 in *fig. 1*) is generally smaller and posterior to the remaining toe pads and is often even with the largest interdigital pad. Second, a small metacarpal pad (I1) is posterior and lateral to the "thumb," quite close to the main interdigital pads (I2, I3, and I4). The "thumb" (1) and the metacarpal pad (I1) are on the medial side of the track. Thus, if they are on the left side of the track, the track is from a right foot. When both pads are lacking, the location of a heel pad (H), present on forefoot only, is used to determine left or right foot. This pad is posterior to the interdigital pad and is angled such that its anterior margin is directed toward the lateral (outside) portion of the track. If none of the above indicate left or right foot, the relative location of the outermost toe pad (5 in *fig. 1*) and the pad lateral to the "thumb" (2) was assessed. In general, pad 5 is smaller than pad 2, and its anterior margin is posterior to that of pad 2. Once left or right foot is established, identify toe pads as 1, 2, 3, 4, and 5 (medial to lateral), and divide the interdigital pad into three primary pads, I2, I3, and I4 (medial to lateral), and a metacarpal pad, I1. The heel pad, if present, is identified as H (*fig. 1*). These basic track features and foot criteria should be applicable to other mustelids as well.

Reference Point (Origin) Formation

After identifying the pads, create a single reference point that becomes the origin of a Cartesian grid superimposed on the track. The origin is formed by following several simple steps. First, two lines are drawn, one connecting the medial margins of 2 and I3 and one connecting the lateral margins of 5 and I3. Bisecting this angle creates the ordinate. A line drawn perpendicular to the ordinate at the anterior margin of I3 creates the abscissa (*fig. 1*). This coordinate system serves to maintain precision in Cartesian measurements while providing a reference point from which numerous measurements can be derived. Because some measurements based on a Cartesian coordinate system were different for right and left feet, variables collected along the X axis should be standardized to the right-foot condition by recording their absolute value. Measure variables to the nearest 0.01 mm, using digital calipers if possible.

Classification Guidelines

We recommend a three-variable function involving the width of the center palm pad (I3), the length of center palm pad (I3), and the length of lateral palm pad (I4) (*fig. 1*). Use the following classification protocol for unknown tracks suspected to be either marten or fisher collected from contact paper and measured as described above:

If (4.595*width I3) + (3.146*length I3) + (0.906*length I4) - 80.285 > 0, classify the track as fisher; if < 0, classify the track as marten.

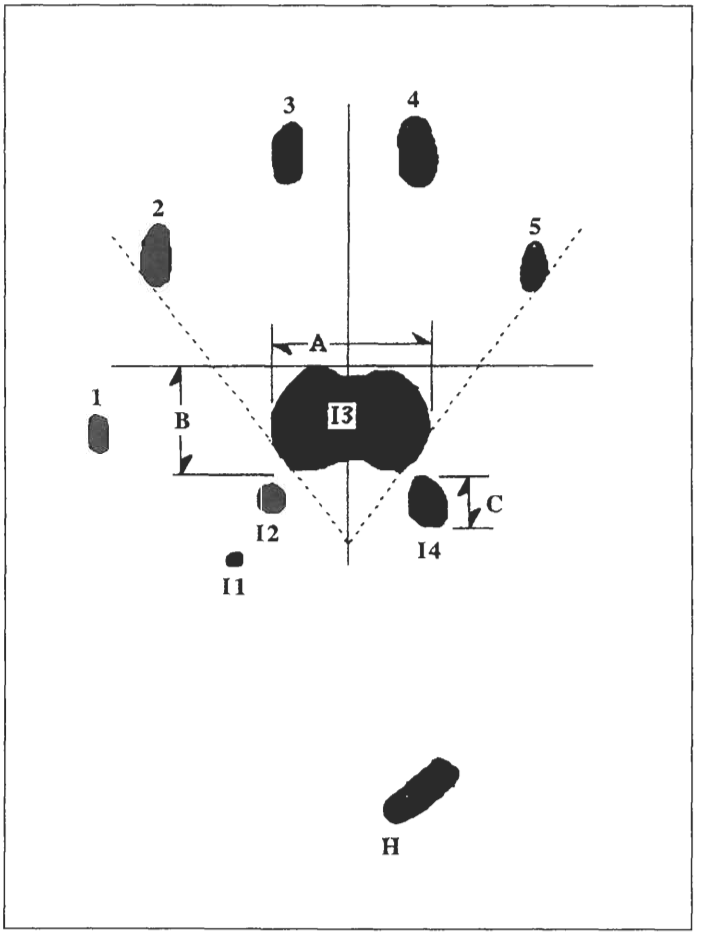


Figure 1—Schematic diagram of right marten or fisher forefoot track collected from sooted track impressions on white Con-Tact paper. Toe pads are identified with numbers (***1–5***) while interdigital pads and the heel pad are represented with letters (***I1–I4, H***). The ordinate of the Cartesian grid is formed by bisecting the angle of intersection created by lines joining the medial margins of *2* and *I3* and the lateral margins of *5* and *I3*. A is the width of *I3*, *B* is the length of *I3*, and *C* is the length of *I4*.

Appendix C—Data forms

SURVEY RECORD FORM

SURVEY TYPE:

CAMERA_____ TRACK PLATE_____ SNOW TRACKING _____

Line Trigger _____ Enclosed _____ Searching for tracks _____

Single Sensor_____ Unenclosed_____ Tracking at bait _____

Dual Sensor _____

Other _____

SAMPLE UNIT NUMBER _____

Number of stations _____ or Distance searching for tracks _____

State _____ County _____ Landowner _____

Location _____ USGS Quad _____

Legal: T _____ R _____ S _____, _____, _____, _____.

STATION LOCATIONS: UTM Zone _____

Station ID	UTM N/S	UTM E/W	Elevation (ft. or m?)

(use another sheet if necessary)

Vegetation type (s) _____

Date installed (or run) _____ Date terminated _____

Type of bait or scent _____

Name, address, and phone of investigator _____

Track Plate Results

Observer _____ Weather[a] ____ Date _____ Page ____ of ____

Location _____

General Comments _____

Station Number	Visit Number	Nights since last visit	Target Species[b]	Other tracks of interest	Comments[c]

[a] Use the following codes: 1= No precipitation since last visit; 2= rain, snow or heavy fog since last visit.

[b] Record the four-letter species code in pencil (eg. MAAM, for marten) until identity is confirmed.

[c] E.g. box rolled, feces collected, bait removed, bait dessicated.

SPECIES DETECTION FORM

Please complete each field after a survey has detected either lynx, wolverine, fisher, or marten, and send a copy to your state's Natural Heritage Division (addresses in Chapter 1) and other appropriate entities. The meaning of each code is explained on the following page. It is important to coordinate with the State Wildlife Agency/Natural Heritage Program within your State to assure uniform codes are used for federal lands, parks, private lands, counties, etc.

1. **SPEC** _____
2. **DATE** _____
3. **STATE** _____
4. **CO** _____
5. **LOC** _____
6. **QUAD** _____
7. **QUADNO** _____
8. **OWN** _____
8a. **FOR/PARK** _____
8b. **DISTRICT** _____
9. **RNG** __
10. **TWN** __
11. **SEC** ____
12. **QSEC** ____
13. **SIXTHSEC** _____
14. **M** ____
15. **Z** ____
16. **UTM_N** _____
17. **UTM_E** _____
18. **OBS** _____
19. **SVTP** __
20. **STA_NO** _____
21. **TR_NO**
22. **ELEV** _
23. **COMMENTS** _____

_____

CODES FOR THE SPECIES DETECTION FORM

1. **SPEC** - Species; 1 letter: L = lynx, W = wolverine, F = fisher, M = marten.
2. **DATE** - Date; year, month, day; e.g., Jan. 12, 1994 = 19940112.
3. **STATE** - State; use 2-letter postal abbreviation, e.g., MT, OR.
4. **CO** - County; use 2-letter code, e.g., AP=Alpine, HU=Humboldt
5. **LOC** - Locale; the most specific names possible using names found on USGS maps, e.g., Grizzly Creek. 20 characters.
6. **QUAD** - Name of USGS topographic quad showing survey area; if >1, use additional sheets, e.g., Ship Mountain. 20 characters.
7. **QUADNO** - USGS quad number utilizing latitude and longitude identification system.

*8. **OWN** - Landowner. 4-letter code, e.g., USFS, NPS, BLM, CA, PVT.

8a. **FOR/PARK** - National or State Forest or Park name. 3 characters.

8b. **DISTRICT** - Subdivision of Forest or Park (e.g., Ranger District if "OWN" = USFS. 3 characters.

9. **RNG** - Range. 3-characters.
10. **TWN** - Township. 3-characters.
11. **SEC** - Section. 2-characters.
12. **QSEC** - Quarter section. 2 characters.
13. **SIXTHSEC** - Sixteenth section. 2 characters.
14. **M** - Meridian. 1-character.
15. **Z** - UTM zone. 2-characters.
16. **UTM_N** - UTM-north coordinate; 7-characters.
17. **UTM_E** - UTM-east coordinate; 6-characters.
18. **OBS** - Observer; last name, first name, middle initial of survey crew leader. 20 characters.
19. **SVTP** - Survey type: SNSS = snow-tracking survey (searching); SNSB = snow-tracking survey (at bait); TRPL = track plate; CAMR = camera (35-mm or 110).
20. **STA_NO** - Station number of detection (if camera or track plate). 2 characters.
21. **TR_NO_** - Number of snow transect where detection occurred. 2 characters.
22. **ELEV** - Elevation at detection site. 5 characters.
23. **COMMENTS** - 30 Characters.

* Each state will need to develop 2-3 character codes for specific forests, parks, private landowners and districts therein.