J. Field Ornithol. 73(4):392–398, 2002

Quantifying avian habitat use in forests using track-plates

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Received 21 March 2001; accepted 31 December 2001

ABSTRACT. I constructed track-plates resembling short pine branches and attached them to pairs of neighboring pine trees distributed over a 1000-ha area in the Colorado Front Range. I checked track-plates after four and eight days between 24–31 August 2000 and scored each for the presence or absence of tracks. Half of all track plates were marked within four days. I found a positive correlation between scores of paired trees, indicating that track-plating accurately reflected the relative abundance of birds among habitat patches. A power analysis showed that to test for a 15% difference in bird visitation among habitats with a power of 0.75 required a sample size of 25 trees.

SINOPSIS. **Cuantificando el uso de habitat de aves en bosques usando "placas de pisadas"**
Construí "placas de pisadas" semejando pequeñas ramas de pino y las até a pares de pinos cercanos distribuídos a través de cerca de 1000 ha en la "Vertiente Delantera de Colorado." Revisé estas placas a los cuatro y ocho días trás ser colocadas (entre el 24 y el 31 de agosto del 2000) y anoté la evidencia de presencia o ausencia de pisadas en cada una. La mitad de todas las pisadas ocurrieron a los cuatro días. Hallé una correlación positiva entre los valores de árboles pareados, indicando que las "placas de pisadas" reflejan correctamente la abundancia relativa de las aves entre parchos de hábitats. Un análisis de poder estadístico mostró que para poder probar un 15% de diferencias en la tasa de visitas de aves entre hábitats con un poder de 0.75, se requiere una muestra de 25 árboles.

Key words: Parus, ponderosa pine, relative abundance, *Sitta*

Obtaining data on animal habitat usage is a fundamental objective of many ecological field projects, including ornithological research. Mammalogists have used track-plates to assess relative abundance of animals such as martens (*Martes americana*; Zielinski and Truex 1995; Zielinski and Stauffer 1996), fisher (*M. pennanti*), wolverine (*Gulo gulo*), lynx (*Lynx lynx*) (Foresman and Pearson 1998), foxes (*Vulpes macrotis*), and even house cats (*Felis catus*; Orloff et al. 1993). Typically a substrate such as sand or a powder-covered sheet of plastic or metal is left unattended with or without an attracting bait for a standardized length of time. At the conclusion of this sampling period, the track-plate is inspected for tracks from the animal(s) of interest. Data from track-plates distributed among multiple habitats, or within habitats at multiple times, provide estimates of relative abundance.

The principal advantage of track-plating is that it records the presence of all subjects crossing the track-plate over periods of time for which it would be impractical to make direct observations. Some subjects may exhibit more natural patterns of movement in the absence of a human observer. Also, relative to video- and camera-based surveillance techniques, track-plating is inexpensive. It may thus be possible to run simultaneously multiple experimental arrays and generate larger sample sizes.

There are also potential disadvantages to track-plating. Some subjects may exhibit caution when confronted with track-plates and avoid them. In many instances, the specific taxonomic identity of the subject may not be determinable. Finally, track-plates provide no indication of precisely when during the sampling period the subject marked the substrate. These potential drawbacks notwithstanding, track-plating can provide a valuable supplement to direct observation or video- and camera-based surveillance.

Despite their potential utility, track-plating techniques have not been developed for birds. In this paper I describe a track-plating technique I developed to characterize the relative abundance of a guild of tree canopy-foraging birds among patches of forested habitat. I explore the nature of the data generated by this

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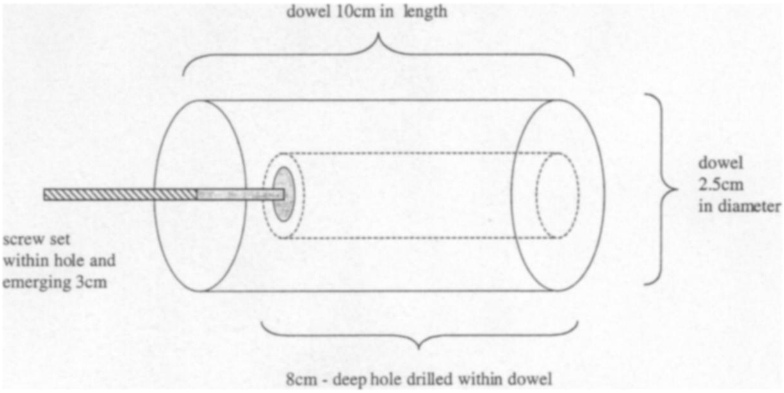

Fig. 1. Schematic diagram of track-plate construction.

method to illustrate its potential utility for other research applications. While I developed track-plating for use in pine forests, it could be adapted for use in any woody vegetation.

METHODS

Study site. This study was conducted at the Manitou Experimental Forest, an administrative unit of the U.S. Department of Agriculture Forest Service Rocky Mountain Experiment Forest in Woodland Park, Colorado (39°06′N, 105°05′W). I worked in mature stands of ponderosa pines (*Pinus ponderosa* Laws. *scopulorum*) at an elevation of approximately 2400 m asl. Over 80% of all canopy foraging was done by Mountain Chickadees (*Poecile gambeli*), Red-breasted Nuthatches (*Sitta canadensis*), White-breasted Nuthatches (*Sitta carolinensis*), and Pygmy Nuthatches (*S. pygmaea*; K. A. Mooney, unpubl. data). My goal was to use track-plating to estimate the relative abundance of this guild of birds among 16 habitat patches distributed across the Experimental Forest.

Track-plate construction. I cut wooden dowels of 2.5-cm diameter into 10-cm long sections and drilled a 1-cm diameter hole 8-cm in depth along the length of each section (Fig. 1). I then set 5-cm wood screws into these holes and drove them until the head of the screw was flush with the bottom of the hole, so that the tip of the screw emerged for 3 cm from the bottom of the dowel. I sanded the dowels and sealed them with water-proof paint.

I covered each dowel with a 1-mm layer of plastic modeling clay (VanAken International, Rancho Cucamonga, California) of color similar to ponderosa pine bark. I weighed out 40–45-g pieces, warmed them in a 40°C oven, smoothed the clay evenly over the entire surface of the dowel, and left the ends clean. I wiped the surface of the clay smooth with a 10 cm × 10 cm piece of clean 5-ml plastic. For storage I screwed rows of the track-plates into lengths of wood planking. In total I constructed 96 track-plates at a cost of approximately $0.75 (U.S.) and 15 min each.

Collecting voucher tracks. To distinguish avian tracks from other markings (e.g., scratches from pine needles), I collected voucher tracks from several birds. I placed birds captured in mist net, in 50 cm × 50 cm × 50 cm open-bottomed wire cages. On the bottom of the cage I placed a 50 cm × 50 cm sheet of the same plastic clay used for track-plate construction. After the captured bird had landed on the clay surface, I removed the cage and inspected, drew, and photographed the markings (Fig. 2). Claw marks were clear and distinct. While I believe taxon-specific track patterns can be distinguished, this level of resolution was beyond my needs for this study, and I did not attempt to identify such characters.

Placement of track-plates. Thirty-two experimental trees were selected as 16 tree-pairs distributed across approximately 1000 ha of the Experimental Forest. Trees within pairs were less than 10 m apart, while trees among pairs were separated by a minimum of 200 m. I placed one track-plate on the trunk (Fig. 3) and two on the branches of each tree. Placements ranged from 1.5 to 4 m in height above

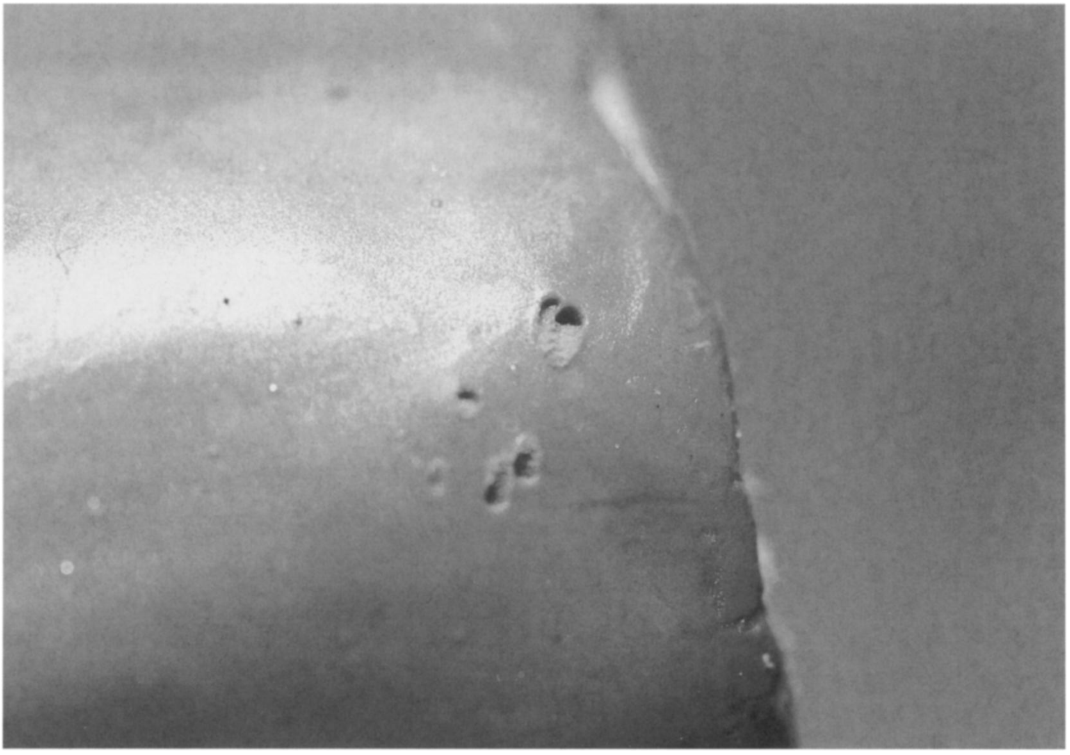

Fig. 2. Claw markings on track-plate.

ground. By inserting a 15-cm long screw-driver into the track-plates to reach the head of the wood screw, I mounted each track-plate flush with the bark surface without touching the modeling clay. I placed each track-plate at a slight upward angle so that rain and resin from the tree wound could not run inside the dowel. From a neighboring tree, I clipped 15-cm long foliated branch tips, stripped the needles away from the proximal 10 cm, and inserted 8 cm of this bare branch into the hole on the distal end of the track-plate until it was flush against the head of the screw. This left 2 cm of bare branch separating the foliage from the track-plate surface and was adequate to keep pine needles from marking the clay. Finally, I smoothed over any markings.

Checking track-plates. For an initial period I examined all track-plates daily to determine the daily rates of track accumulation. From these data I determined that within four days approximately half of all track-plates had been marked at least once. I then let the track-plates accumulate tracks for two consecutive sampling periods of four days each between 24–27 August, and 28–31 August, 2000.

Data treatment. All statistical analyses were conducted with SAS Version 8.1 (SAS Institute 2000). I scored each track-plate as marked or unmarked for each of the two sampling periods. This binomial data treatment is preferable to counting the number of tracks as one bird in a single visit could leave a single or many tracks.

I calculated tree scores within each sampling period with a potential range of 0 (no track-plates were marked) to 3 (all three track-plates were marked). I also calculated pooled scores combining sampling periods with a potential range of 0 (no track-plates marked in either sampling period) to 6 (all track-plates marked in both sampling periods). Both "0–3" and "0–6" data treatments provide discrete data (Stevens 1946) with ranges of four and seven values, respectively. Because these data are not only discrete but also ratio-scale, tree scores are functionally ranks. For this reason all statistical tests are nonparametric and do not carry as-

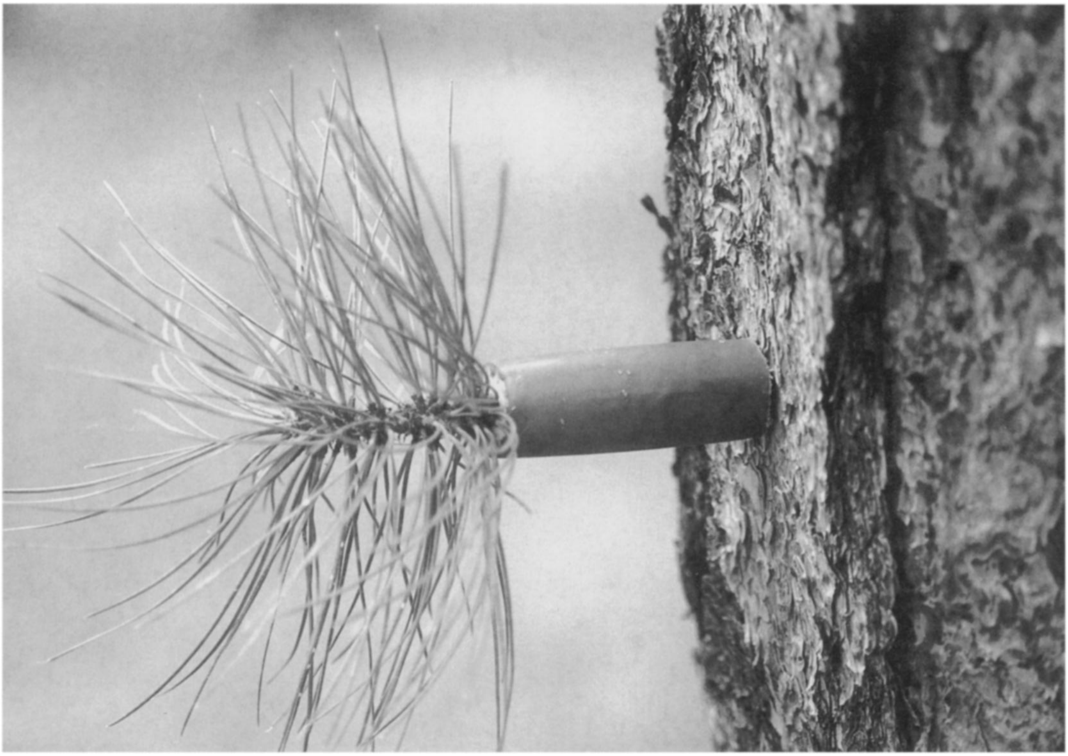

Fig. 3. Track-plate placed on trunk of tree and fitted with a tuft of ponderosa foliage.

sumptions of normality or homoskedasticity (Sokal and Rohlf 1995; Zar 1999).

Independence of sampling periods. To determine whether separate sampling periods provide independent observations, I used chi-square analysis to test for a relationship between each track-plate's score in sampling period one and two. I scored each track-plate as "different" (i.e., marked in only one sampling period) or as "same" (i.e., either marked or unmarked in both sampling periods). The null hypothesis of independence of sampling periods predicts that observations should be evenly divided between "different" and "same." I also determined the Pearson correlation coefficient between sampling period scores (0–3) in sampling periods one and two.

Comparison within pairs. Pairs of pines were adjacent to each other and similar in size, and it is likely that birds that visited one tree also visited the other. To test whether track-plates reflected this, I determined the Pearson correlation coefficients between sampling period scores (0–3) of paired trees.

Relative abundance among habitat patches. To estimate the relative abundance of canopy-foraging birds among the 16 habitat patches, I calculated a "habitat patch score" by combining the scores from both paired trees and for both sampling periods (i.e., four separate 0–3 scores). Habitat patch scores have the potential range of 0 (no track-plates marked on either tree in either sampling period) to 12 (all track-plates marked on both trees in both sampling periods). Because these scores provide a single estimate of relative abundance among patches, these scores are only descriptive and can not be compared statistically.

Power calculations. The probability of accepting a false null hypothesis (i.e., committing Type II error) is β, and statistical power, $1 - \beta$, is the probability of rejecting a false null hypothesis (Zar 1999). The sample size needed to reach a given level of power depends on data variance and the minimum difference among treatments the experimenter wishes to detect. I performed power calculations for analyses comparing tree scores with the pooled (0–6) data

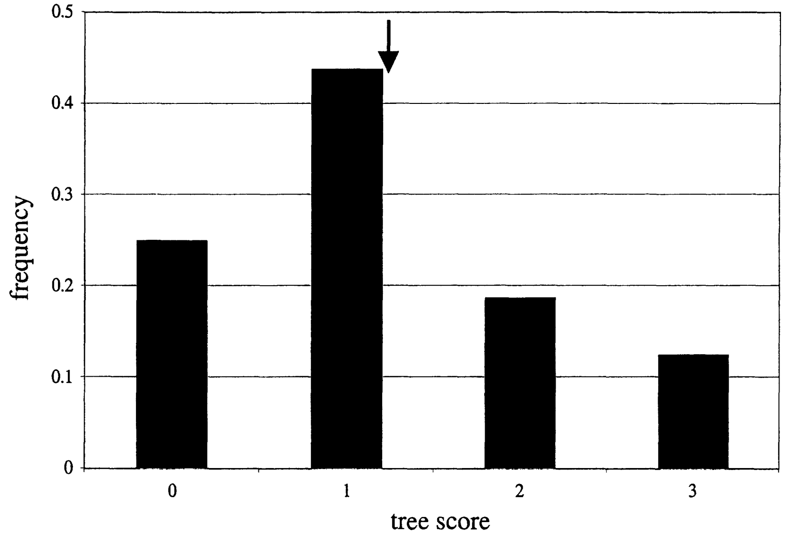

Fig. 4. Frequency distribution of tree scores for sampling periods. Possible scores range from 0 (no track-plates marked) to 3 (all track-plates marked) within a single sampling period. N = 64 tree scores (32 trees for two sampling periods). Mean score shown by arrow.

treatment. I calculated required sample sizes for two levels of power ($1 - \beta = 0.75$ and 0.90) and three levels of minimum detectable differences (δ = 7.5%, 15%, and 30%) based on a two-tailed analysis with risk of Type I error (α) set at 0.05 (Zar 1999).

RESULTS

Sampling period scores ranged from 0 to 3 with a mean of 1.2 ± 1.0 SD. Scores for the pooled data set ranged from 0 to 5 with a mean of 2.3 ± 1.29 SD. The frequency distributions for these data treatments (Figs. 4, 5, respectively) are two-tailed and centered within the possible score ranges.

In the comparison of track-plate scores between the two sampling periods, 51 were scored as "same" while 46 were scored as "different." This did not differ significantly from the null expectation of equal numbers of "different" and "same" scores ($\chi^2_{(1)} = 0.375$, $P = 0.4597$). There was not a significant correlation between tree scores (0–3) in sampling period one and two ($r = 0.179$, $P = 0.33$).

The correlation of sampling period (0–3) scores between paired trees was significant (r = 0.46, $P = 0.0075$).

Habitat patch scores ranged from 2 to 9 with a mean of 4.7 ± 2.09 SD.

Based on the calculated variance of 1.66 tracks^2 in tree-score (0–6) data, a two-tailed null hypothesis, and a probability of Type I error (i.e., α) of 0.05, the sample size needed to detect 7.5%, 15%, and 30% treatment effects with a power of 0.90 are 147, 37, and 11 trees, respectively. Th sample size needed to detect the same treatment effects with a power of 0.75 are 94, 25, and 8 trees, respectively.

DISCUSSION

Track-plates were marked by birds within relatively short time periods. Nearly half of all track-plates were marked at least once within each four-day period. Habitat patch scores showed a wide range of variation. The correlation between scores of neighboring trees within a habitat patch is an encouraging indication that track-plates accurately characterize the relative abundance of birds among tree pairs.

The sample sizes needed to detect relatively small treatment effects with relatively high power are feasible using this technique. Because sampling periods were independent of each other, a single set of track plates could be left in place over multiple sampling periods and large sample sizes could be generated with relatively little effort. It should be noted, however, that this work was conducted well after the

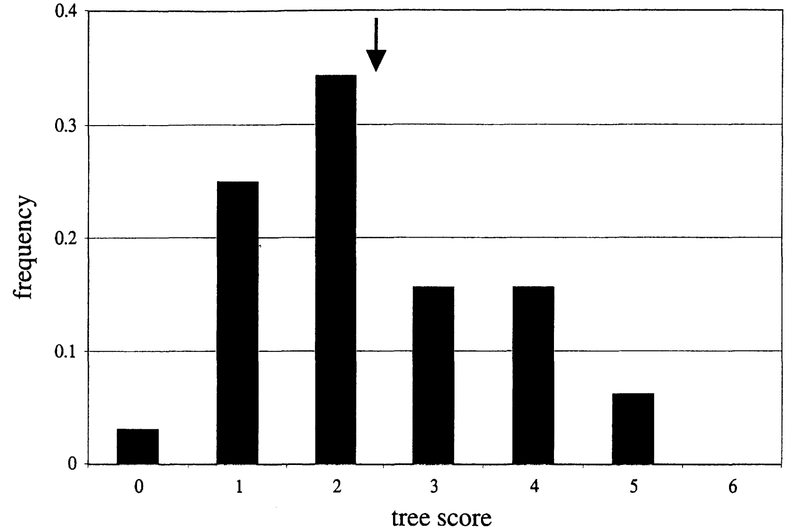

Fig. 5. Frequency distribution of pooled tree scores. Possible scores range from 0 (no track-plates marked) to 6 (all track-plates marked in both sampling periods). $N = 32$ (32 trees). Mean score shown by arrow.

young had fledged and nesting territories had broken down. The large-scale movement patterns of birds at this time were likely an important factor in the independence of sampling periods. Multiple sampling periods may not, in fact, be independent during the nesting season when it is more likely that the same birds would be revisiting the same trees among sampling periods.

I do not have any direct observational records of how the birds at my field site reacted to track-plates. In some instances, marks appeared to be peckings made from individuals resting on the pine adjacent to the track-plate. This suggests that some individuals, or perhaps some species, were reticent to walk on the track-plates. Most track-plate markings were claw marks and did not suggest abnormal reactions by birds to the artificial substrate. The fact that the relatively small surface of a track-plate was marked within an average of four days suggests that foraging birds were not averse to the foreign substrate. I believe the tuft of foliage inserted into the distal end of each track-plate was an important element in the success of this technique. It may have provided an incentive for foraging birds to cross the clay surface, and on several occasions I saw insects and spiders crossing the clay surface of the track-plate as they moved between the pine and the foliage tuft.

My goal in this study was to characterize the relative abundance of canopy foraging birds among habitat patches, and it was beyond the scope of this project to distinguish among species within this canopy-foraging guild. However, it should be noted that tracks were extremely clear in the modeling clay, and I believe that discrimination is possible for certain taxonomic groups. For example, it may have been possible in this study to distinguish the zygodactyl markings of nuthatches from the anisodactyl markings of chickadees.

Whether this technique is used to assess the relative abundance of birds at the guild- or species-level, it has many potential ecological applications. When single estimates of relative abundance are made as they were in this work, tests could be performed to identify correlations between relative abundance and other ecological variables. With experimental replication, track-plating could also be used to test for differences in relative abundance of birds among time periods (e.g., activity on diurnal or seasonal scales), or habitats (e.g., forest edge vs. forest interior) in a manner analogous to, but potentially less expensive than, point counts. Track-plating can also provide information on micro-habitat usage (e.g., upper tree canopy vs. lower) that otherwise would require direct observation or video surveillance. Records of tracks might also provide a useful source of data on the identity of nest predators. Finally, although I developed this method for use in ponderosa pine canopies, the technique can be tailored to shrubs, other trees, or any woody vegetation by choosing appropriate branch diameters and clay colors.

ACKNOWLEDGMENTS

This research was supported by the Rocky Mountain Research Station, Forest Service, U.S. Department of Agriculture and by a Kindig Memorial Fellowship from the Colorado Mountain Club. Yan Linhart and Carl Bock reviewed drafts of this manuscript. Kathy Thomas, Jennifer Rohrs, Riley Pratt, and Mark Gillilan assisted with field work. Funding for Mark Gillilan was provided by the University of Colorado Undergraduate Research Opportunities Program. Brian Geils and Steve Tapia provided logistical assistance.

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