United States
Department of
Agriculture

Forest Service

**Pacific Southwest
Forest and Range
Experiment Station**

P.O. Box 245
Berkeley
California 94701

Research Note
PSW-384

June 1986

Smoked Aluminum Track Stations Record Flying Squirrel Occurrence

Martin G. Raphael **Cathy A. Taylor** **Reginald H. Barrett**

Raphael, Martin G.; Taylor, Cathy A.; Barrett, Reginald H. *Smoked aluminum track stations record flying squirrel occurrence*. Res. Note PSW-384. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1986. 3 p.

Smoked aluminum track stations are a useful technique for studying patterns of abundance and distribution of northern flying squirrel *(Glaucomys sabrinus).* They are easily transported to remote field sites, allow permanent preservation of tracks, and yield frequency-of-occurrence information. A study in Douglas-fir *(Pseudotsuga menziesii)* forests of northwestern California illustrates the use of the track stations, methods of data analysis, and habitat associations of the northern flying squirrel.

Retrieval Terms: Douglas-fir forest, *Glaucomys sabrinus,* Douglas-fir habitat selection, northern flying squirrel, track stations, California

Public and scientific concern about the harvest of mature and old-growth timber in the Pacific Northwest is due, in part, to the potential for population declines of those wildlife species that find optimum habitat in old timber.[1,2] The northern flying squirrel *(Glaucomys sabrinus)* has been listed among these species,[1,3] but data on the distribution of flying squirrels among forest age classes is scarce. This lack of information is probably due to the squirrel's arboreal and nocturnal habits, and to its apparent avoidance of traps. Thus, an efficient technique is needed to study patterns of distribution of the northern flying squirrel and to monitor populations.

During a survey of carnivores in northwestern California,[4] tracks of the flying squirrel were frequently observed. We used smoked aluminum track stations to record presence of carnivores and squirrels.[5] These track stations proved useful to measure large-scale patterns of flying squirrel distribution. They were easily transported to field sites, could be used repeatedly, allowed the preservation of track impressions for permanent records, and yielded frequency-of-occurrence estimates among habitats. This note describes our field procedures, data analyses, and results.

STUDY AREA

All study sites were within the Trinity and Klamath River drainages in Humboldt, Trinity, and Siskiyou counties, in northwestern California. Forest cover was dominated by Douglas-fir *(Pseudotsuga menziesii)* in association with tanoak *(Lithocarpus densiflora)* and Pacific madrone *(Arbutus menziesii).* Elevation ranged from 472 to 1372 m. Weather in this area is characterized by cool, wet winters and warm, dry summers.

STUDY DESIGN

One track station was placed within each of 331 study sites (165 in 1982, 166 in 1983). Sites were at least 360 m apart; most were separated by several kilometers. Sites were chosen within separate stands representing six seral stages of Douglas-fir forest:

Forest stage	Description	Sites
Early clearcut	Brush and seedlings ≤ 2 m tall	20
Late clearcut	Brush and saplings >2 m tall	20
Pole	Trees <28 cm d.b.h.[1]	20
Small sawtimber	Trees 28-53 cm d.b.h.	70
Medium sawtimber	Trees 54-91 cm d.b.h.	123
Large sawtimber	Trees >91 cm d.b.h.	78

[1]d.b.h. = diameter at breast height

Stations were deployed and checked in three 8-day sessions from 9 August to 15 September 1982 and from 25 July to 31 August 1983. Sites were randomly allocated (with respect to seral stage) to one of these sessions.

With minor exceptions, the track stations were similar to those described by Barrett.[5] A station consisted of two adjacent aluminum sheets, each 814 by 407 by 0.6 mm, that were covered with a thin layer of kerosene soot and baited with a perforated can of tuna pet food. At each field site, an area of about 1 m^2 was cleared of debris and leveled. The two sheets were placed on the cleared area, and the bait was placed at the center. Each station was checked every other day for 8 days. Any tracks found were collected by pressing transparent tape over the track, lifting it off the sheet, and then mounting the tape with its track impression onto a white sheet for later measurement and identification. Stations were replaced with fresh sheets as necessary, but at least every 4 days. Squirrels were recorded as present or absent within the entire 8-day sample; multiple tracks were counted as one observation.

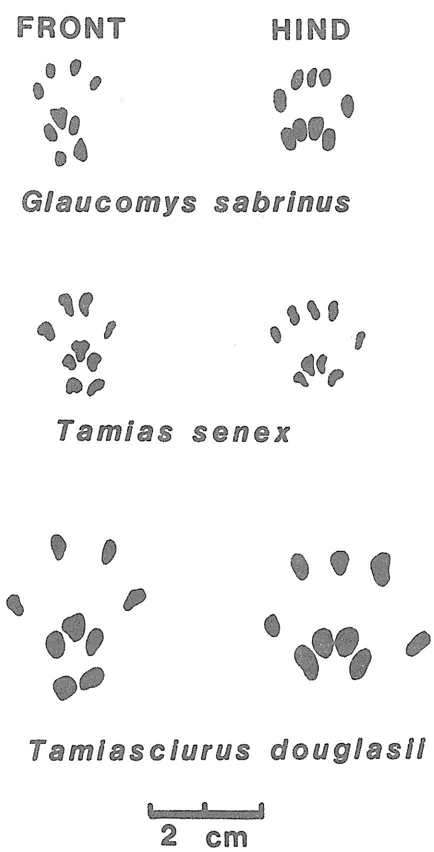

Figure 1—Front and hind footprints of northern flying squirrel *(Glaucomys sabrinus)*, Allen's chipmunk *(Tamias senex)*, and Douglas' squirrel *(Tamiasciurus douglasii)*, from sooted-aluminum sheets.

DATA ANALYSIS

Because of their structural similarity, we pooled data from the early and late clearcut sites, and from the pole and small sawtimber sites. We calculated the proportion of sites that were visited over both years as an index of relative abundance,[6] and we tested for equality of these proportions among the four pooled stages using Cohen's test.[7] This test, based on an arcsine transformation of the proportions, is superior to the usual chi-square and binomial tests of homogeneity for two reasons: it provides variance estimates of proportions even if they are 0 or 1, and it allows multiple comparisons among proportions.

IDENTIFICATION OF TRACKS

Tracks of the northern flying squirrel were easily distinguished from those of Allen's chipmunk *(Tamias senex)* and Douglas' squirrel *(Tamiasciurus douglasii) (fig. 1)*. Chipmunk and flying squirrel tracks were of similar dimensions, but the hind footpads of the flying squirrel were distinctly oval compared with the rather uneven shape of the chipmunk pads. In addition, the middle toeprints of the flying squirrel tended to be aligned in a tight linear array and evenly spaced when compared with those of the chipmunk. Douglas' squirrel tracks, although similar in shape to those of the flying squirrel, were significantly larger.

PATTERNS OF OCCURRENCE

Over the 2 years of the study we recorded 43 occurrences of flying squirrel *(table 1)*. None were found in clearcut sites; other forested stages were used nearly equally *(table 2)*. Overall, the hypothesis of equal proportions was strongly rejected ($U = 14.69$, $P = 0.002$). Comparisons of each pair of arcsine transformed proportions showed significantly different rates between the clearcut stages and each forest stage. None of the differences among forest stages were significant *(table 2)*.

The northern flying squirrel avoided seedling-sapling stages but occurred with equal frequency in all older seral stages of Douglas-fir forest. In the Pacific Northwest, flying squirrels occur in pine, true fir, mixed conifer, Douglas-fir, hemlock, and spruce forests.[3,8,9,10] Medium and large sawtimber stands within each of these types are reported to be optimal habitat.[9,10,11] However, the results of the study reported here suggest that small sawtimber stands are equally important habitat for northern flying squirrels in the Douglas-fir forest.

Table 1—*Occurrence of northern flying squirrels among seral stages of Douglas-fir forest, northwestern California, 1982-83*

Stage	Description	Stations	Stations with squirrels	Proportion
1	Clearcut	40	0	0
2	Pole, small sawtimber	90	11	0.122
3	Medium sawtimber	123	19	0.154
4	Large sawtimber	78	13	0.167

Table 2—*Pairwise contrasts of proportions of flying squirrel occurrence among seral stages of Douglas-fir forest, northwestern California, 1982-83*

Contrast between stages[1]	Absolute difference between proportions[2]	Estimated variance	Simultaneous 95 pct confidence limits[3]	
			Lower	Upper
1 and 2	0.122*	0.035	0.025	1.087
1 and 3	.154*	.033	0.141	1.159
1 and 4	.167*	.038	0.139	1.227
2 and 3	.032	.019	–0.294	.482
2 and 4	.045	.024	–0.306	.560
3 and 4	.013	.021	–0.372	.438

[1]See *table 1* for description of stages.

[2]From values reported in *table 1*. Contrasts are statistically significant (*) if confidence interval does not include 0.

[3]Confidence intervals were calculated using twice the arcsine of the square root of the difference between proportions.

Because this study originally was designed to sample carnivores, the attractiveness of the stations to squirrels was unanticipated. Therefore, the bait was not necessarily optimum for squirrels. Further studies are needed to identify the most attractive bait for flying squirrels, and establish the relationship between frequency of occurrence and relative abundance among habitats. We found that smoked track stations are an effective technique for surveys of flying squirrel occurrence. These stations are also cost-effective for large-scale surveys.[12] With further refinement, the technique might also be effective for monitoring population trends over time.

ACKNOWLEDGMENTS

This study was supported by the Pacific Southwest Region, and Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; and by Agricultural Experiment Station Project AES 3501 MS, University of California. We thank Paul Barrett, John Brack, Cathy Brown, Lawrence Jones, Ronald LeValley, Kenneth Rosenberg, and Hartwell Welsh for field assistance, and Keith Aubry, Arlene T. Doyle, and Thomas R. McCabe for comments on earlier drafts of the manuscript.

REFERENCES

[1]Meslow, E. Charles; Maser, Chris; Verner, Jared. *Old-growth forests as wildlife habitat.* Trans. N. Amer. Wildl. and Natur. Resour. Conf. 46:329-335; 1981.

[2]Harris, L. D.; Maser, C.; McKee, A. *Patterns of old-growth harvest and implications for Cascades wildlife.* Trans. N. Amer. Wildl. and Natur. Resour. Conf. 47:374-392; 1982.

[3]Franklin, J. F.; Cromack, K., Jr.; Denison, W.; McKee, A.; Maser, C.; Sedell, J.; Swanson, F.; Juday, G. *Ecological characteristics of old-growth Douglas-fir forests.* Gen. Tech. Rep. PNW-118. Olympia, WA: Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1981. 48 p.

[4]Raphael, M. G.; Barrett, R. H. *Methodologies for a comprehensive wildlife survey and habitat analysis in old-growth Douglas-fir forests.* Cal-Neva Wildl. Trans. 1981:106-121; 1981.

Raphael, Martin G.; Barrett, Reginald H. *Diversity and abundance of wildlife in late successional Douglas-fir forests.* In: New forests for a changing world. Proceedings of the 1983 convention of the Society of American Foresters; 1983 October 16-20; Portland, OR. SAF Publ. 84-03. Soc. Am. For. 1984:352-360.

[5]Barrett, R. H. *Smoked aluminum track plots for determining furbearer distribution and relative abundance.* Calif. Fish and Game 69:188-190; 1983.

[6]Caughley, G. *Analysis of vertebrate populations.* New York: John Wiley & Sons; 1977: 20.

[7]Marascuilo, L. A.; McSweeney, M. *Nonparametric and distribution-free methods for the social sciences.* Monterey, CA: Brooks/Cole; 1977: 147.

[8]Gunther, K.; Kucera, J. E. *Wildlife of the Pacific Northwest: Occurrence and distribution by habitat, BLM district, and National Forest.* Pacific Northwest Region, Forest Service, U.S. Department of Agriculture; 1978. 128 p.

[9]Marcot, B. G. *California wildlife/habitat relationships program: North Coast/Cascades Zone.* Vol. III: The Mammals. Six Rivers National Forest. Eureka, CA: Forest Service, U.S. Department of Agriculture; 1979. 260 p.

[10]Verner, Jared; Boss, Allan S. *California wildlife and their habitats: western Sierra Nevada.* Gen. Tech. Rep. PSW-37. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1980. 439 p.

[11]Airola, D. A. *California wildlife/habitat relationships program: Northeast, interior zone.* Vol. IV: Mammals. Lassen National Forest, Chester, CA; 1980. 255 p.

[12]Raphael, Martin G.; Rosenberg, Kenneth V. *An integrated approach to wildlife inventories in forested habitats.* In: Bell, John F.; Atterbury, Toby, editors. SAF 83-14. Renewable resource inventories for monitoring changes and trends. Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. Corvallis: College of Forestry, Oregon State University; 1983: 219-222.

The Authors:

MARTIN G. RAPHAEL is leader of the unit studying the effects of multiple-use management on wildlife at the Rocky Mountain Forest and Range Experiment Station, in Laramie, Wyoming. He earned degrees from the University of California, Berkeley: B.A. (1972) in conservation and natural resources, and M.S. (1976) and Ph.D. (1980) in wildland resource science. **CATHY A. TAYLOR** has been a wildlife biologist with the Pacific Southwest Forest and Range Experiment Station at Arcata, California since 1984. At the time of the study reported here, she was research assistant, University of California, Berkeley. She holds a B.A. (1976) in biology and an M.S. (1979) in wildlife ecology from the University of Tennessee, Knoxville. **REGINALD H. BARRETT** is an associate professor of wildlife management, University of California, Berkeley. He has a B.S. (1965) in game management from Humboldt State University, an M.S. (1966) in wildlife management from the University of Michigan, and a Ph.D. (1971) in zoology from the University of California, Berkeley.