Ear Tag Loss in Gray Squirrels and Fox Squirrels

Philip A. Tappe, *School of Forest Resources, University of Arkansas at Monticello, Monticello, AR 71656*

John W. Edwards, *Department of Forest Resources, Clemson University, Clemson, SC 29634*

David C. Guynn, Jr., *Department of Forest Resources, Clemson University, Clemson, SC 29634*

Abstract: Wildlife population studies that involve marking of animals assume that the "mark" will remain with the animal for the duration of the study. Violations of this assumption may contribute to biased estimates of population parameters. Thirty-six gray squirrels (*Sciurus carolinensis*) and 16 fox squirrels (*S. niger*) were marked with ear tags and toe-clipped to study ear tag loss in these species. Forty-nine percent of all squirrels lost at least 1 ear tag, whereas 15% lost both tags. Fox squirrels lost ear tags at twice the rate of gray squirrels. Female fox squirrels lost ear tags at a rate greater than gray squirrels and male fox squirrels. Studies that depend on identification of individual squirrels may be significantly affected by ear tag loss.

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Wildlife population studies that involve marking of animals assume that the "mark" will remain with the animal for the duration of the study. Marking methods for mammals can be either permanent or semipermanent. Permanent markings include freeze branding (Farrell 1966), tattoos (Thompson and Armour 1954), toe clipping (Blair 1941), and passive integrated transponders (Fagerstone and Johns 1987, Schooley et al. 1993). Markings, such as neck collars (Progulske 1957), foot tags (Evans et al. 1971), wing bands (Bonaccorso and Smythe 1972), and ear tags (Day 1973) are considered semipermanent.

Permanent markings such as toe clipping enable individuals to be recognized, with rare exception, throughout the life of the animal. Semipermanent markings such as ear tags place a physical "mark" on the animal which can be retained or lost during the animal's life depending on individual and environmental factors. The decision to use either type of marking should be based on the target species, purpose of marking (e.g., visual sighting), difficulty in attaching the mark, potential effect of the mark on the animal, and retention of

the mark. The objective of our study was to determine rate of ear tag loss in southeastern fox squirrels (*Sciurus niger*) and gray squirrels (*S. carolinensis*).

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Methods

This study was conducted on the Piedmont National Wildlife Refuge, Jasper County, Georgia. Topography is characterized by rolling hills typical of the southern Piedmont Plateau Region. Pine (*Pinus* spp.) and mixed pine-hardwood forest with several narrow hardwood drains typify the study area.

A 121-ha trapping grid was established which consisted of 144 Mosby-type box traps (Day et al. 1981) spaced 100 m apart. Trapping was conducted for 5 14-day periods in January, March, May, and June 1988; in January, March, May, and November 1989; and in January and May 1990. Each captured squirrel was tagged (No. 1, style 4-1005, Natl. Band and Tag Co., Newport, Ky) in each ear and toe-clipped (Baumgartner 1940) for individual identification. Sex, weight, and capture location were recorded, and each squirrel was released at the capture site. Most animals also were fitted with radio transmitters as part of another study and, thus, were anesthetized. Nine fox squirrels were ear tagged on the front edge of the ear near the base of the skull; 4 were tagged on the rear edge. Twelve gray squirrels were tagged on the front edge and 14 on the rear edge of the ear. These procedures were defined under Animal Use Protocol No. 348 as approved by the Clemson University Animal Research Committee. Tag retention was noted each time an individual was recaptured. Tag loss probabilities, assuming independence, for a 1-year period were calculated by dividing number of tags lost by number of tags applied for each species. These probabilities were compared based on mean number of tags lost per individual by species and sex using Mann-Whitney *U*-tests.

Results

We captured and tagged 52 individuals (36 gray squirrels and 16 fox squirrels). Of these, 13 (25%) were not recaptured, or were recaptured only once within a few days of their initial capture. Thirty-nine squirrels (26 gray squirrels and 13 fox squirrels) were recaptured over an adequate period of time to evaluate ear tag loss. Thus, 26 ear tags were applied to 13 fox squirrels (6 males and 7 females), and 52 ear tags were applied to 26 gray squirrels (12 males and 14 females). Over a period of 365 days, 42% (11) of the gray squirrels, 62% (8) of the fox squirrels, and 49% (19) of all squirrels lost at least 1 ear tag. Eight percent of the gray squirrels, 38% of the fox squirrels, and 15% (6) of all squirrels lost both ear tags. In addition to marks from toe clipping, all animals that lost tags were recognizable by a rip in the ear where the tag came off.

Thirteen individual tags were lost by gray squirrels, resulting in an estimated probability of tag loss of 0.25. Thirteen tags also were lost from fox squirrels, resulting in an estimated probability of tag loss of 0.50, twice as high as that of gray squirrels. Mean number of tags lost (Table 1) by an individual fox squirrel was twice as great as that lost by an individual gray squirrel over a period of 1 year ($U = 117.0$, $P = 0.09$). There was no difference in mean tag loss between male and female gray squirrels ($U = 60.5$, $P = 0.17$); however, mean tag loss was greater in female fox squirrels than in male fox squirrels ($U = 9.0$, $P = 0.07$). Tag loss in male and female gray squirrels did not differ from male fox squirrels ($U = 29.5$, $P = 0.50$; $U = 39.0$, $P = 0.76$, respectively), but was less than female fox squirrels ($U = 19.5$, $P = 0.04$; $U = 16.0$, $P = 0.01$, respectively). Distributions of tag loss (i.e., numbers of individuals losing 0, 1, or 2 tags) indicate that female fox squirrels tended to lose both ear tags more often than gray squirrels or male fox squirrels (Table 1). This suggests that ear tag loss in female fox squirrels may not be independent (i.e., if 1 tag is lost, there is a high probability that the second tag will be lost). However, small sample sizes precluded testing this hypothesis.

Discussion

Rate of tag loss was highest for female fox squirrels. This may be related to behavioral characteristics of female fox squirrels that differ from gray squirrels and male fox squirrels (e.g., time spent on the ground or in a nest, presence of parasites, grooming habits). However, due to small sample sizes, whether tag loss is independent requires additional investigation. Regardless, the rates of tag loss observed in this study have important implications for many population studies. A fundamental assumption in all capture-recapture experiments is that animals do not lose their marks. For ear-tagged squirrels, this assumption may be reasonable for relatively short-term experiments (i.e., < 1 year) but it is less likely to be valid for long-term studies. In this study, 38% of female squirrels lost

Table 1. Ear tag loss over 1 year of fox squirrels and gray squirrels, by sex, captured on the Piedmont National Wildlife Refuge, Georgia.

	N tags lost				
Sex	0	1	2	$\bar{x}$	SE
Fox squirrel					
Male	4	1	1	0.50	0.342
Female	1	2	4	1.43	0.297
Combined	5	3	5	1.00	0.253
Gray squirrel					
Male	5	6	1	0.67	0.188
Female	10	3	1	0.36	0.169
Combined	15	9	2	0.50	0.127

both ear tags within 1 year of tagging. This represents a substantial violation of the mark retention assumption. Unless tag loss can be adjusted for, or a more permanent mark used, the violation of the mark retention assumption may contribute to biased estimates of population size and survival. Thus, the robust *K*-sample capture-recapture experiment design (Pollock 1982) for estimating population size and survival rates may be more appropriate than the traditional Jolly-Seber model (Jolly 1965, Seber 1965).

Additionally, any study that depends on positive identification of individual squirrels over an extended period of time may be substantially affected by ear tag loss. Though this study did not evaluate tag loss beyond 1 year, it is likely that additional tags were later lost. Given that 49% of all squirrels lost at least 1 tag within a year, implications for longer-term studies could be significant. Thus, marking methods, such as toe clipping (Wood and Slade 1990) and passive integrated transponder tagging (Fagerstone and Johns 1987, Schooley et al. 1993) may be the only acceptable alternatives for many long-term investigations.

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