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Dispersal period in a population of EASTERN FOX SQUIRRELS (*Sciurus niger*)

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TIMING OF THE annual dispersal movement in fox squirrels has important implications in the management of the species, especially in setting harvest regulations. Estimates of squirrel populations are frequently used in setting these regulations. But these estimates may be biased if the dispersal movement is concurrent with the collection of data from which the estimates are made.

The dispersal period in fox squirrels has not been clearly established. It has been reported to occur between 10 August and 15 September in Ohio *(Baumgartner 1943),* from late August to the middle of December in Michigan *(Allen 1943),* and during the fall in Illinois *(Brown and Yeager, 1945).* Though not specifically designed to determine the dispersal period of fox squirrels, these studies have nevertheless been a major source of information on the subject.

This is a report on the results of a more recent study of a fox squirrel population that does pertain to the dispersal movement.

STUDY AREA AND METHODS

The study was conducted in 1954 in a 68-acre oak-hickory woods located near Havana in west-central Illinois. The privately owned woods, roughly rectangular in shape, was bounded on three sides by fields and a fenced pasture, and on the fourth and shortest side by a public road. Opposite this road was another oak-hickory woods and a young pine plantation. More than one-third of the study area was occupied by a stand of old-growth timber; the rest of the area was stocked with a mixture of pole- and sawtimber-size trees. The woods was posted against trespass during the study and was identified as a research study area. It had not been posted previously.

Live-trapping operations were conducted on the study area from 14 January to 21 May and, except for September, from 27 July to 11 November. Average trap density during the study varied from a minimum of one trap per 2 acres to a maximum of one trap per 0.7 acre.

Trapping was carried out on 39 days during the first period (2,415 trap-days) and on 35 days during the second period (2,117 trap-days). Traps were placed in irregular lines across the study area in locations thought most likely to be successful in taking squirrels; their locations were changed often thereafter to increase trap success. The traps used were a modified version of that described by Baumgartner *(1940)*. Bait consisted mainly of papershell pecans; hickory nuts (Carya spp.) and shelled corn were also used.

Captured squirrels were ear-tagged with serially numbered tags. The tags also carried the local telephone number of the Illinois Natural History Survey for use by hunters who bagged tagged squirrels outside the study area. Squirrels were also toe-clipped according to a standard formula for permanent identification.

The sex, age, weight, and condition of squirrels were recorded at the site of capture. Three age classes were used for all squirrels captured from January to May: adult, subadult (summer born, 1953), and juvenile (spring born, 1954). Criteria used in age determination closely followed those described by Brown and Yeager *(1943)* and Shorten *(1951)*. To distinguish between adult and subadult males, observations were made of the color of the scrotum and the extent to which it was covered with hair; the color of the skin on the soles of the feet (gray or black); the relative size of the scrotum, testes, and Cowper's glands; and the weight of the animal. When used collectively, these criteria were thought to be effective even in difficult cases. Age determination in females presented no difficulty.

Squirrels initially captured from July to November were determined to be adults or juveniles (spring-born, 1954). The age characters described above for males were also used to distinguish between adult and juvenile males during the fall season. Obser-

vations of the development of three spring-born males, captured in another area and held in large wire-enclosed pens from April to mid-November, aided in the age determination. Squirrels born in the summer of 1954 were easily distinguished from older squirrels; however, information on summer-born squirrels was not used in determining the dispersal period.

All hunting of squirrels on the study area was done by personnel of the Illinois Natural History Survey during the 61-day open season, 1 September to 31 October *(Jordan 1971)*.

RESULTS AND DISCUSSION

From 14 January to 21 May, 126 fox squirrels were captured. Five died in the traps and 121 were presumed to be available for recapture or hunting during the period 27 July to 11 November. Sixty-two (51 percent) of these squirrels were recaptured or bagged during the latter period.

The rate of return of marked squirrels varied among sex and age classes (table 1). It was higher for males than for females, and progressively higher for older squirrels. Within the three age classes (adult, subadult, and juvenile), the rate of return of males greater among both adult and juvenile squirrels, and about the same as that of females among subadults. Among juveniles, the rate of return of males was 2.8 times that of females. The greatest contrast among all rates of return was that between adult males (74 percent) and juvenile females (22 percent).

Yet tests of chi-square values of 7.42, 5.35, and 4.43 strongly suggested acceptance of the hypothesis that there were no significant differences ($P < .05$) between the numbers of squirrels returned and the numbers expected among, respectively, the six sex-age classes, three age classes of females, and three age classes of males. However, acceptance of this hypothesis would imply that if a dispersal movement, or natural mortality, had occurred within the population on the study area, these events were distributed proportionately among all sex and age classes. The general consistency among the rates of return that favored both males and older squirrels does not support this conclusion.

Table 1.—*Rates of return, by age-sex classes, of fox squirrels marked 15 January to 21 May and recaptured or bagged 27 July to 11 November, 1954*

Item	Adult			Subadult			Juvenile			All age classes		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Number marked	19	34	53	16	7	23	18	27	45	53	68	121
Number returned	14	21	35	7	3	10	11	6	17	32	30	62
Percent returned	74	62	66	44	43	44	61	22	38	58	44	51

The observed rates of return of marked squirrels suggest instead that there was a dispersal movement, that the dispersal was greatest among juvenile squirrels, somewhat less among subadults, and least among adults; and that it also contained a proportionately greater number of females. Also, that while natural mortality within the population undoubtedly occurred, especially among juvenile squirrels involved in the dispersal movement, any differential rate of natural mortality among the sex and age classes probably was largely the result of the hazards of dispersal and was masked by the main effect of dispersal.

If natural mortality had been the main cause of the difference among the rates of return, then natural mortality among juveniles was highly selective against females, but nonselective between juvenile males and adult females, and more selective against subadults than against juvenile males. This seems unlikely. Juvenile males and females appeared to be at similar stages of physical development when initially captured 16 April to 21 May. The average weight of the 45 juveniles was 340 grams or a little less than half the average weight of 735 grams for 26 adult squirrels captured 24 March to 21 May. There was virutally no difference between the average weights of male and female juveniles (345 and 331 grams, respectively) at initial capture. Natural mortality that may have occurred among juveniles before 16 April is, of course, excluded from this discussion.

Five squirrels captured before 22 May were reported bagged outside the study area. One of these was a subadult male, one was a juvenile male, and three were juvenile females. The juvenile male had been recaptured 19 August on the study area.

These results suggest that the main dispersal movement occurred before August, though they do not rule out the possibility that it occurred later. Other results support the view that the movement actually occurred before 1 August.

Of the 121 squirrels captured before 22 May, only 23 were recaptured between 27 July and 25 August. Sixteen (70 percent) of these 23 squirrels were later bagged or recaptured between 1 September and 11 November. Of 18 squirrels that were initially captured from 27 July to 25 August, 16 (89 percent) were

Table 2.—*Rates of return, by age-sex classes, of fox squirrels captured or recaptured 27 July to 25 August and bagged or again taken 1 September to 11 November, 1954*

Item	Adult			Juvenile			Adult and Juvenile		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Number marked	9	11	20	11	10	21	20	21	41
Number returned	6	11	17	8	7	15	14	18	32
Percent returned	67	100	85	73	70	71	70	86	78

Table 3.—*Proportion of marked fox squirrels among all squirrels bagged or recaptured, by age classes, for three periods between 1 September and 11 November, 1954.*

Item	Adult			Juvenile		
	Unmarked	Marked		Unmarked	Marked	
	No.	*No.*	*Percent*	*No.*	*No.*	*Percent*
Shot 1 Sept.-13 Sept.	8	24	75	45	14	24
Shot 16 Sept.-30 Sept.	1	3	75	13	5	28
Shot or trapped 1 Oct.-11 Nov.	9	13	59	34	12	26
Total	18	40	69	92	31	25

bagged or recaptured from 1 September to 11 November. The rate of return among the 41 squirrels livetrapped 27 July to 25 August was 78 percent (table 2).

The rates of return among the sex and age classes (table 2) generally exceeded those among the squirrels marked 14 January to 21 May. The high rate of return of juvenile squirrels, notably that of juvenile females (table 2), was in marked contrast to those of juvenile squirrels captured before 22 May (table 1).

If the two groups of marked squirrels were representative samples of the populations present at the time they were captured, the differences in rates of return indicate that the main dispersal movement occurred sometime between late May and late July.

There was a possibility that the returns among all marked squirrels during the period 1 September to 11 November was completed before the end of that period and that dispersal then occurred and went unnoticed. But the proportion of marked to unmarked squirrels bagged or recaptured did not indicate that this had happened (table 3). The proportion of marked juvenile squirrels bagged or recaptured was fairly constant for three periods between 1 September and 11 November. The proportion of marked adults declined in the last period. However, adult females may have been more vulnerable to the gun during the early part of the hunting season than were other sex and age classes *(Jordan 1971)*. This would tend to inflate the return of adults for the first two periods.

It was not determined whether there was a dispersal period among squirrels born during the summer of 1954. Thirteen were bagged in September and October and 24 others were captured in October and November.

The estimated populations at the beginning and end of the hunting season were 240 and 96 squirrels, respectively *(Jordan (1971)*.

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