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YIELD
FROM AN INTENSIVELY HUNTED POPULATION OF
EASTERN FOX SQUIRRELS

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The study reported here was made when the author was a research biologist in the Illinois Natural History Survey, Urbana, Illinois.

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RATES at which Eastern fox squirrels *(Sciurus niger)* are exploited in areas open to public hunting may be useful guides for designing fall hunting seasons that are biologically defensible. However, there is a question whether the harvest of fox squirrels by public hunting will even occasionally be great enough to challenge the limit allowed by the best designed biologically sound hunting season. There seems to be a population level of squirrels—as yet undefined—that strongly resists further exploitation of its members by hunting, thereby preventing over-exploitation.

For example, at the Rose Lake Wildlife Research Station in Michigan, about 91 percent of the total harvest of 203 fox squirrels in 1966 occurred in the first 19 days of a 41-day open season *(Queal and Fouch 1967)*. Only 19 squirrels were taken in the last 22 days of the hunting season. Yet the estimated rate of exploitation of squirrels in 102 acres of woodlot within the general area open to hunting was only 59 percent.

In central Illinois, a 2-month hunting season in the 1950's did not seem to result in overexploitation of fox squirrels. It was thought that further interest in hunting rapidly declined after the first few weeks of the season, when hunting effort produced a low rate of return. If this was the case, then overexploitation might happen only if a hunting effort were applied throughout the season, regardless of a low rate of return from hunting.

In 1954, intensive hunting of fox squirrels was carried out in a 68-acre oak-hickory woods located near Havana in west-central Illinois. The objective was to maximize exploitation of the fox squirrel population by applying a high level of hunting pressure over the 61-day open season (1 September to 31 October) and to evaluate its effect on the size of the residual population. This report concerns that part of the study concerned with hunter success, the sex and age composition of bagged squirrels, and the size of the after-hunting-season population.

Study Area and Methods

The privately owned 68-acre study area 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 an old-growth timber stand; the balance of the area was well stocked with a mixture of pole- and sawtimber-size trees. The woods were posted against trespass during the study and were identified as a research study area. The population of fox squirrels had been under study for 8 months immediately preceding the hunting season.

Hunting was done by research personnel of the Illinois Natural History Survey. Hunting was generally limited to the daily periods of greatest squirrel activity—the early morning hours and late afternoon. Only the actual time spent hunting was recorded. The State game laws were observed. However, for the purpose of this study, the daily bag limit of 5 squirrels was applied to each hunting trip rather than to an individual hunter. Thus a hunter who made two trips on the same day was allowed the daily bag limit for each trip.

The sex, age, weight, and location of kill in the woods were recorded for each squirrel. Female squirrels were examined for evidence of lactation.

Live-trapping operations were conducted in August, October, and November. Trapped squirrels were ear-tagged and toe-clipped for identification and were released at the site of capture.

Results

HUNTING SUCCESS

Squirrels were hunted on 37 days of the 61-day season. Two hunters with an intimate knowledge of the study area did 91 percent of the hunting. In 60 hunting trips, 138 squirrels were bagged (table 1). An additional squirrel was killed but lodged in view at the top of a snag. Two other squirrels fell to the ground after being shot but were not found. An average of 2.3 squirrels were bagged per hunting trip. The time required to bag a squirrel averaged about 1 hour. Recorded kill averaged 2.0 squirrels per acre. A frequency distribution of the 60 hunting trips, by the number of squirrels bagged, is shown in table 2.

Hunting success was higher in the first half of September than in the second half, and lowest in October (table 1). However,

Table 1.—*Fox squirrels bagged and hours hunted, by 3-day periods, in a 68-acre oak-hickory woods near Havana, Illinois, 1 September through 31 October, 1954*

Period	Hunting trips	Squirrels bagged	Hours hunted	Kill per hour	Hunting conditions
	No.	*No.*	*Hours*	*No.*	
September:					
1-3	7	27	21.50	1.26	Excellent
4-6	4	9	8.25	1.09	Excellent
7-9	10	37	30.50	1.21	Excellent
10-12	8	19	16.75	1.13	Excellent
Subtotal	29	92	77.00	1.19	—
13, 16, 17	5	9	10.25	0.88	Poor to excellent
19-21	3	5	6.75	.74	Poor
22-24	5	7	9.25	.76	Poor
27-30	4	7	9.00	.78	Poor to excellent
Subtotal	17	28	35.25	0.79	—
October:					
4, 6, 7	3	3	5.75	0.52	Poor to excellent
8, 13, 15	3	2	5.50	.36	Poor
17-19	5	9	11.50	.78	Excellent to poor
24, 25, 31	3	4	6.25	.64	Excellent to poor
Subtotal	14	18	29.00	0.62	—
Totals	60	138	141.25	0.98	—

Table 2.—*Frequency distribution of hunting trips by the number of fox squirrels bagged in a 68-acre oak-hickory woods near Havana, Illinois, 1 September through 31 October, 1954*

Squirrels bagged	Hunting trips
No.	*No.*
0	8
1	17
2	9
3	10
4	7
5	9

the availability of squirrels to the gun appeared to be confounded with hunting conditions. The woods were quiet during the morning and afternoon hunting periods in the first half of September. But between 15 September and 5 October, with the exception of 2 or 3 days, the leaf litter was dry; and hunter movement through the woods was noisy. Many of the days from 6 October to the end of the month were windy; thus it was difficult to locate squirrels, and the woods were again noisy—so much so on a number of days that planned hunting trips were cancelled. One bag limit of 5 squirrels was taken in a total of 29 hunting trips from 16 September through 31 October.

SEX, AGE, AND WEIGHT OF BAGGED SQUIRRELS

There were more females than males among both adult and juvenile squirrels in the total bag. Of 38 adults bagged, 20 were females; among 100 juveniles bagged, 56 were females. Juveniles (spring- and summer-born, 1954) constituted 72.5 percent of the bagged squirrels. Of the total of 100 juveniles, 13 were from summer litters. There were 5.0 juveniles per adult female in the bag.

Adult females may have been slightly more vulnerable to the gun than were adult males or juvenile squirrels. All of the adult females bagged were taken by 20 September, whereas 67 percent of the adult males and 72 percent of the juvenile squirrels had been taken by the same date. Of the 20 adult females bagged, 17

(85 percent) were lactating, indicating that they had produced summer litters.

The smallest squirrel bagged (0.26 pound) was taken in good condition on 8 September. A second squirrel of about this size was seen at the same time. These squirrels may have been forced out of the nest after the loss of the female to hunting. Three lactating females were bagged before 8 September, within 300 feet of the above kill. The next smallest squirrels (0.44 and 0.45 pound) were bagged on 3 September.

The average weight of 13 summer-born squirrels was 0.68 pound. The average weights of 20 adult females, 18 adult males, and 86 juveniles (excluding summer-born individuals) were, respectively, 1.67, 1.70, and 1.38 pounds.

POPULATIONS

Live-trapping operations were carried out on 13 days between 5 and 29 October and on 5 days between 4 and 12 November. Eighty-three fox squirrels were captured—76 in October and 7 in November. Of those captured in October, 3 were bagged and 5 were found dead in the traps. Thus 68 marked squirrels were available for retrapping in November. Seventeen of these were actually retrapped, in addition to the 7 squirrels first captured in November. The estimated November population of squirrels in the study area, calculated by the Lincoln Index method, was 96 ± 25 (CL 0.95).

By adding together the 139 squirrels harvested during the hunting season, the 5 squirrels that were found dead in the traps, and the estimated November population of 96 squirrels, the total population on 1 September was estimated to be 240 squirrels. This was an average population density in the study area of 3.5 squirrels per acre. The rate of exploitation of the population through hunting was therefore 57.9 percent.

Another estimate of the September population was calculated by the Lincoln Index method. Forty-one individual squirrels were captured in the period 4 to 26 August. Twenty-one of these marked animals were among the total of 120 squirrels bagged 1 to 30 September. Thus, the estimated September population was 234 ± 93 (CL 0.95). This was very close to the previous esti-

mate of 240 squirrels, but the latter estimate was apparently more precise. Also, the validity of the estimate of 240 squirrels was strengthened by its similarity to an independent estimate that was free of the bias of a census derived from capture-recapture data.

Other methods of estimating the November population were investigated. The Schnabel (Krumholtz) procedure *(Davis 1963)* yielded an estimate of 130 squirrels, though the experience of other workers *(Flyger 1959, Edwards and Eberhardt 1967, Nixon et al. 1967,* and *Mosby 1969)* shows that this procedure underestimates the population.

The frequency-of-capture method, using linear regression procedures *(Edwards and Eberhardt 1967),* was rejected partly by inspection of the capture records for October and November. There were 48, 17, 9, and 1 fox squirrels in frequency-of-capture classes 1, 2, 3, and 4, respectively. Approximation of a minimum of 58 squirrels in the 0 frequency-of-capture class indicated a minimum November population of 133 squirrels, well above the upper confidence limit of the Lincoln Index estimate. Also, the use of the above frequency-of-capture method in an intensive long-term study of gray squirrel populations yielded estimates that were 52 to 157 percent higher than those indicated by time specific data and extensive field observations *(Mosby 1969).*

Discussion

If it is assumed that the harvest of 17 lactating females in September did not result in mortality of young in the nest, and that each of these lactating females produced an average of 2.5 squirrels *(Brown and Yeager 1945),* then the production from this source should have been about 42 squirrels. Also, 6 lactating females were livetrapped in October but were not harvested. If it is assumed that each of these females also produced an average of 2.5 squirrels, then the total production from both sources of lactating females should have been 57 summer-born squirrels. Thirty-seven summer-born squirrels were actually handled on the study area; of these, 13 were bagged in September and October and 24 others were trapped in October and November.

The harvest of 139 fox squirrels in the 68-acre woods was greater than the total kill reported for any single year from 1950 to 1966 on the 102-acre study area at the Rose Lake Wildlife Research Station in Michigan *(Queal and Fouch 1967)*. The average kill of 2.0 squirrels per acre also was greater. At Rose Lake, the highest kill of 121 squirrels (average 1.2 per acre) represented an exploitation rate of 65.4 percent, the highest rate for that area in 11 years in which prehunt populations were live-trapped. The average rate of exploitation for the 11 years was 56.1 percent.

In my study, the estimate of a population of 240 squirrels at the beginning of the hunting season requires the assumption of some stability in the population during the period 1 September to 12 November. Actually, there may have been a greater or smaller number of squirrels on 1 September, and either an increase or decrease in their number during September (for reasons other than reductions due to hunting). There is also the possibility that there was an influx of squirrels into the study area in October that partly offset the loss of squirrels through hunting. However, such questions are somewhat academic to the primary objective —to determine the effect of intensive hunting of fox squirrels on the size of the after-hunting-season population in the study area. Calculations showed that it consisted of 96 squirrels, certainly no indication of overexploitation of the population available to hunting. Even if this population estimate was not reliable, the minimum population observed in trapping in October and November was 80 squirrels.

It is likely that the level of hunting pressure applied throughout the 61-day season was greatly in excess of that usually sustained by fox squirrel populations in other areas open to hunting. Also, the efficiency of hunting probably was greater. Those who did most of the hunting were intimately familiar with the area and also had the benefit of knowing the distribution in the woods of the past kill of the current season. And the hunting effort was selective in that it was generally limited to the periods of greatest squirrel activity. There was no relaxation of hunting effort as the population declined, but only with the reduced availability of

squirrels to the gun because of unfavorable hunting conditions. It was reasonably assumed that most hunters would have sought other areas in which to hunt when hunting success dropped to the level of that of the first week of October in the study area.

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