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## OBSERVATIONS AND SUGGESTED MANAGEMENT PRACTICES FOR THE ENDANGERED DELMARVA FOX SQUIRREL

*by*

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### ABSTRACT

The Delmarva fox squirrel (*Sciurus niger cinereus*) and the gray squirrel (*Sciurus carolinensis*) occupied nest boxes placed in four separate woodlots on Maryland's Eastern Shore. During each season, a large proportion (42%-58%) of the boxes were not occupied, indicating that a lack of nesting sites is not limiting the abundance of Delmarva fox squirrels. The status of the Delmarva fox squirrel at all four sites is precarious. Management of the Delmarva fox squirrel must be based on the best available knowledge. Data pertaining to this squirrel are limited because of its scarcity and, until recently, a lack of interest in the animal by management agencies. Information concerning litters, nest box utilization, and habitat relationships is the basis for a discussion of management strategies. These include reduction of underbrush by light burning or cattle grazing and selective removal of gray squirrels to reduce interspecific competition.

### INTRODUCTION

The range of the Delmarva fox squirrel has progressively decreased in recent years. Within historic times this squirrel was found throughout the Eastern Shore of Maryland (Mansueti 1952; Paradiso 1969) as well as Southeastern Pennsylvania (Rhoads 1903; Poole 1944) Delaware (Mansueti 1952; Barkalow 1956) possibly New Jersey (Abbott 1890; Rhoads 1903) and the Virginia section of the Delmarva Peninsula (Handley and Patton 1947; Taylor 1973; Taylor and Flyger 1974). However, its present distribution (Figure 1) is limited to portions of only four counties on the Eastern Shore of Maryland (Taylor and Flyger 1974). In 1964, the United States Bureau of Sport Fisheries and Wildlife evaluated the animal's status as precarious (U. S. Bureau of Sport Fisheries and Wildlife 1964) and placed the species on its first published list of endangered fauna (U. S. Bureau of Sport Fisheries and Wildlife 1966). Pursuant to the passage of the Endangered Species Preservation Act of 1966 (80 Stat. 926), the species was placed on the first official "Endangered Species List" (Federal Register 1967). It has continued to appear on all subsequent federal endangered species lists. The state of Maryland has forbidden the hunting of the animal since 1971.

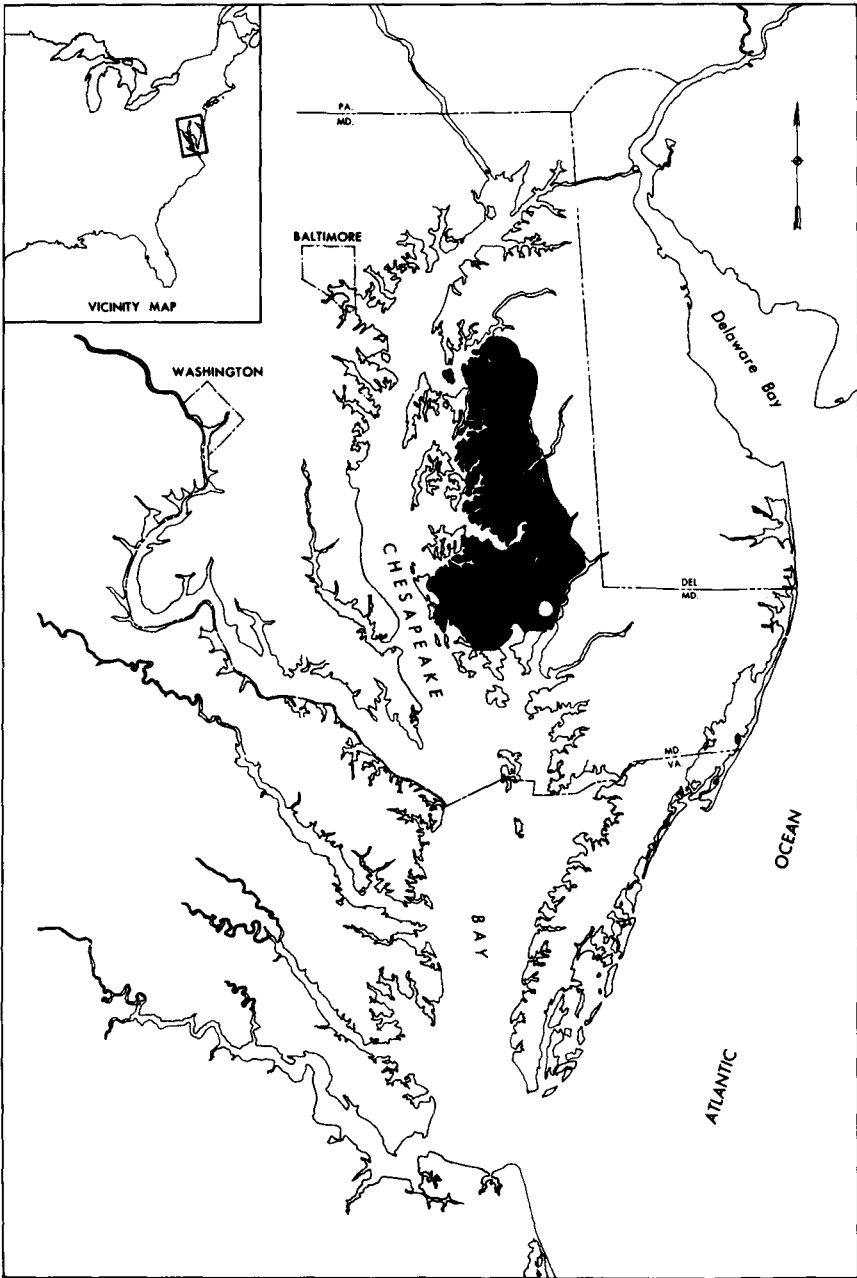


Figure 1. Present Range of the Delmarva Fox Squirrel O denotes LeCompte Wildlife Refuge.

With the exception of only one location (The Eastern Neck Wildlife Refuge) the range of the Delmarva fox squirrel lies within that of the gray squirrel (Taylor 1973). This situation results in competition between the two species. This study was conducted to determine the status of the Delmarva fox squirrel on four sites where it coexists with the gray squirrel. It was carried on in conjunction with a study of the reproductive seasons of the gray squirrel (Flyger and Cooper 1967). On one site, the LeCompte Wildlife Refuge, the relative abundance of Delmarva fox squirrels was compared with that of gray squirrels. Each of the four sites was characterized as a mature forest, with mixed hardwoods and conifers and a minimum of understory. This type of habitat was classified as good Delmarva fox squirrel habitat (Taylor 1973).

## METHODS

Data were obtained (for periods of up to eleven years) on the four study areas by examination of squirrel nesting boxes (Table 1). These boxes were hung and examined as described by Flyger and Cooper (1967). The species, sex, and age of the squirrels occupying the boxes were noted. An analysis of nest box utilization was made on the four study areas to determine whether a lack of suitable nesting sites was a factor in the decline of the Delmarva fox squirrel. The analysis has also reflected fluctuations in relative abundance of the two squirrel species on the LeCompte Wildlife Refuge.

## RESULTS

On the basis of 5307 nest box examinations, 26 Delmarva fox squirrel adults and 840 gray squirrel adults were found to be utilizing the nest boxes. Twelve Delmarva fox squirrel litters were obtained, eight from the spring litter survey and four from the fall one. Concurrently, 161 gray squirrel litters were found, 79 from the spring litter period and 82 from the fall one. Table 2 contains a summary of the Delmarva fox squirrel litter data. The mean Delmarva fox squirrel litter size of 2.25 differs markedly from Dozier and Hall (1944) who estimated the average litter size as four.

## DISCUSSION

In the analysis of nest box utilization, four basic categories were established to determine the parameters of nest box usage (Table 1). The data demonstrate that nest boxes were utilized most in the spring (February, March, and April) during which time tree squirrels bring forth and rear their young. Since both fox squirrels (Bakken 1952; Packard 1956; Bernard 1972) and gray squirrels (Flyger 1955; Bakken 1959) display a social hierarchy rather than a territorial system in intraspecific relationships, the large percentage of nest boxes which were completely empty (e.g. without occupants or nesting material) in all seasons strongly suggests that the availability of suitable nest sites was not a limiting factor in controlling the Delmarva fox squirrel populations. This is because any empty nest cavity was available to any tree squirrel, regardless of the proximity of the nesting site to those sites already occupied by squirrels.

## A CASE STUDY: DELMARVA FOX SQUIRRELS ON THE LECOMPTE WILDLIFE REFUGE

An analysis of the relative abundance of fox squirrels and gray squirrels was conducted on the populations present at the LeCompte Wildlife Refuge, south of Vienna, Maryland. In the spring of 1964, 150 squirrel nest boxes were hung in the woods at this refuge. This number of boxes was maintained by periodic additions to replace those which had deteriorated or been destroyed. Tree squirrels prefer nest boxes to natural dens because of the increased protection from predators and adverse weather conditions (Barkalow and Shorten 1973). Thus, conjectures can be made about the relative abundance of squirrels on the basis of the numbers of adults and litters found from year to year in the nest boxes.

The LeCompte site is a 485 acre (196 hectare) area which was purchased by the state of Maryland in 1945 as a refuge for the specific benefit of the Delmarva fox squirrel. Included in the site are approximately 400 acres (162 hectares) of woodland. The forested portion which harbors the Delmarva fox squirrel is composed of mature loblolly pine (*Pinus taeda*), red gum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), white oak (*Quercus alba*), and willow oak (*Quercus phellos*). A substantial number of the trees are large, including a number of loblolly pine which are over 20" (50cm) d.b.h. The overstory is 70% occluded. The understory is moderate to dense and covers 60% of the forest floor. The percentage understory on the site is among the greatest of those sites surveyed by Taylor (1973) which contain Delmarva fox squirrels (mean of 17 sites =

Table 1. Squirrel Nest Box Utilization.

	Feb.-Mar.-Apr.		May-June-July		Aug.-Sept.-Oct.		Nov.-Dec.-Jan.	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Squirrel nest in nest box actively being used with squirrels present	332	18.9%	51	4.3%	127	7.7%	119	16.8%
Squirrel nest found in nest box but no squirrels present	572	32.6%	434	36.5%	713	43.1%	163	23.0%
Empty (without occupants or nesting material)	738	42.1%	571	48.0%	714	43.2%	412	58.1%
Bees, wasps, or vertebrate organisms other than fox or gray squirrels present in nest box	112	6.4%	134	11.3%	100	6.0%	15	2.1%
<b>Total</b>	<b>1754</b>	<b>100%</b>	<b>1190</b>	<b>100%</b>	<b>1654</b>	<b>100%</b>	<b>709</b>	<b>100%</b>

Table 2. Litter Sizes in Delmarva Fox Squirrels by Reproductive Season.

Reproductive Season	Sample Size	Average Litter Size	Standard Deviation	Range
Spring	8	2.38	0.92	1-4
Fall	4	2.00	0.82	1-3
Total	12	2.25	0.87	1-4

30%). The percentage understory at the LeCompte Refuge is, however, still lower than at the sites surveyed (Taylor 1973) which contain only gray squirrels (mean of 13 sites = 72%). The understory at the LeCompte site is composed predominantly of deciduous saplings, greenbrier (*Smilax* spp.), highbush blueberries (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), and American holly (*Ilex opaca*). Much of the ground is covered with standing water up to 18" (46cm) deep during the winter. This is also the case throughout the year following rainstorms. When this condition is present, the only dry areas in the woods are the small islands which surround the base of the largest trees. The effects of this standing water on the Delmarva fox squirrel are unknown.

The numbers of squirrels found in the LeCompte nest boxes since 1964 are presented in Figures 2 and 3. The abundance of adults and litters of both Delmarva fox squirrels and gray squirrels on the refuge apparently fluctuates markedly from year to year. However, it is most important to note that the last fox squirrel litter was found in 1972 and the last fox squirrel adult was found in 1973.

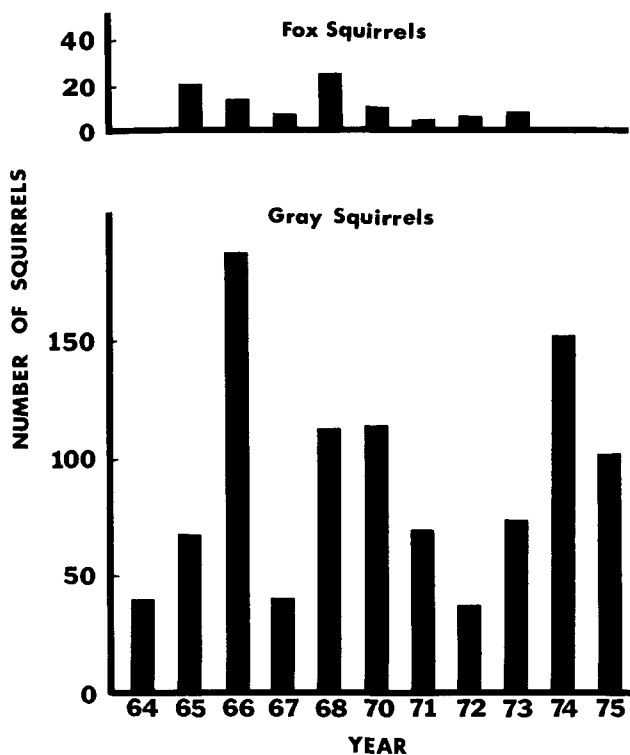


Figure 2. Number of squirrels, excluding nursing young, found per 1000 nest boxes examined during the nesting seasons of eleven years at the LeCompte Wildlife Refuge.

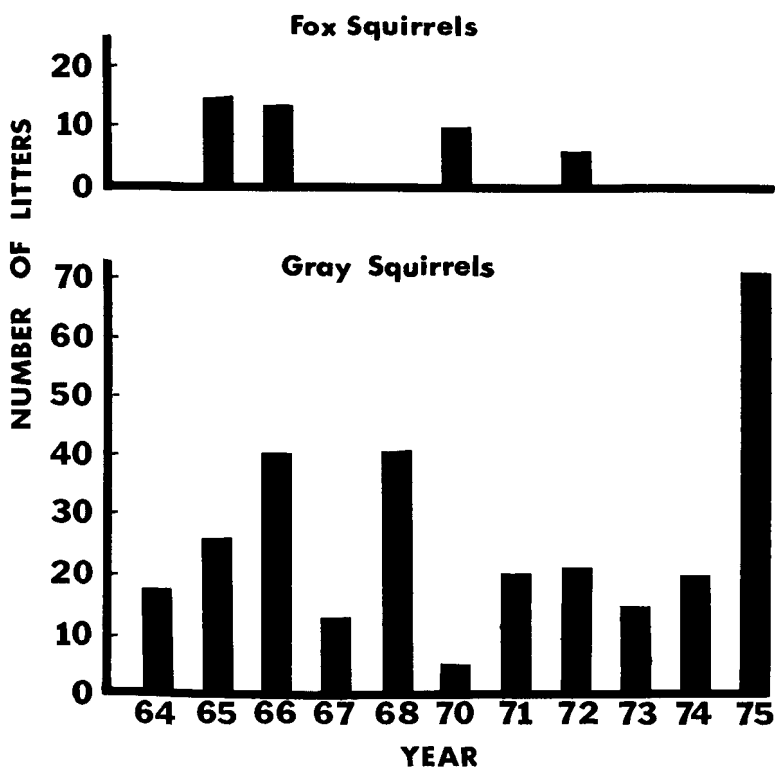


Figure 3. Number of squirrel litters found per 1000 nest boxes examined during the nesting seasons of eleven years at the LeCompte Wildlife Refuge.

Since 1971, the authors have selectively removed all the gray squirrels captured, both adults (51 individuals removed) and young (56 individuals removed) from the nest boxes in an attempt to decrease the competitive interactions between the two species. This was, however, an average of only 21 squirrels removed per year, an amount considered to be insignificant. The 400 acres (162 hectares) of wooded land at the LeCompte site is excellent gray squirrel habitat. If it is assumed that the average density of gray squirrels is one or two squirrels per acre, this means that from a total population of at least 300 gray squirrels, an average of only 1/14 were removed annually. This population reduction is easily compensated for by immigration, reproduction, and other factors. In order to reduce gray squirrels to a level where competition with fox squirrels is lowered enough to benefit the latter, it is likely that an annual removal of  $\frac{1}{3}$  to  $\frac{1}{2}$  of the total gray squirrel population would be necessary (Shorten 1954).

Food and den requirements seem to be the same for fox and gray squirrels. An acorn consumed by a gray squirrel is unavailable to a fox squirrel and a den occupied by one species cannot be used by the other. Therefore, competition between the two species does exist but the extent of such competition is not known. An indication that such competition is important is demonstrated by the status of Delmarva fox squirrels on The Eastern Neck Wildlife Refuge, an island where no gray squirrels are present. At this site, the fox squirrels are known to be utilizing every available squirrel niche (Taylor 1973) and have reached the highest density of any location within the range. Brown and Yeager (1948) state that in Illinois towns either gray or fox squirrels may be present but not both. If competition were not a factor the two species could occupy these communities together.

The absence of Delmarva fox squirrels in the nest boxes at the LeCompte Refuge since 1973 may also reflect a further shrinking of the overall range of the Delmarva fox squirrel (Figure 1). The

LeCompte site is located approximately 3 miles (5km) from the Southeastern edge of the limits of its present distribution (Taylor and Flyger 1974). In the 1940's, the range of the Delmarva fox squirrel included all of Maryland's Eastern Shore counties to the south and east of the LeCompte site (Dozier and Hall 1944). Therefore, at that time the refuge was situated near the middle of the range. Since then, however, the range has steadily shrunk. Immigration by Delmarva fox squirrels onto the refuge would presently be at a minimum level due to the refuge's position on the edge of the range. On the other hand, immigration to the refuge by gray squirrels, when combined with their reproductive potential, would tend to keep their population numbers at the highest levels attainable.

### CONCLUSION

Based upon the relatively few Delmarva fox squirrels found in the nesting boxes over the past 11 years, and their complete absence in the past two years, it is concluded that the status of this animal is insecure, even upon the LeCompte Wildlife Refuge. The fluctuations in numbers of both the Delmarva fox squirrel and the gray squirrel on this refuge put the former squirrel at a disadvantage. Based on nest box utilization, the gray squirrels already outnumber Delmarva fox squirrels by a ratio of 23:1. Thus, Delmarva fox squirrels could be reduced to such a low level during a fluctuation that the population might not be able to recover. With this in mind, increased efforts should be made to encourage the Delmarva fox squirrel in any way possible. However, reduction of gray squirrel populations to depress interspecific competition does not seem practical. On the basis of a five year program, the authors were able to remove only a small fraction of the magnitude necessary. Similarly, Shorten (1959) demonstrated the futility of intensive gray squirrel reduction measures in Great Britain. Reduction of gray squirrels by selective hunting is also not practical because of the difficulty in distinguishing between the two species in the tree canopy.

Delmarva fox squirrel management is presently at a pioneer stage because it is based on aspects of the animal's life history which are inadequately understood. There is a definite need for research involving experimental management techniques. The most promising fox squirrel management strategy appears to be habitat manipulation. This would involve reduction of the underbrush in areas inhabited by Delmarva fox squirrels. This could be accomplished by either repeated light burning or by allowing cattle to graze in fenced woodlots during the spring and early summer. The authors believe that any other method of underbrush reduction would be prohibitively expensive. With regard to the technique employing cattle, Baumgartner (1938) demonstrated that lightly grazed Ohio woodlots had higher densities of fox squirrels than did non-grazed woodlots. Livestock, however, can become competitors by consuming much of the mast crop which falls to the ground, and therefore, they should be permitted in the woodlots only in the spring and early summer. Repeated controlled burning is probably the most effective method for underbrush control, but it may be possible to use these two methods in conjunction with each other.

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