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FOODS EATEN BY A HIGH-DENSITY POPULATION OF SOUTHERN FOX SQUIRRELS

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The southern fox squirrel (*Sciurus niger niger*) and other southeastern fox squirrel subspecies have declined in abundance and distribution during recent years (Loeb and Moncrief 1993). Where they exist, their populations rarely exceed 38 squirrels/km² (Hilliard 1979, Edwards et al. 1989, Weigl et al. 1989, Kantola and Humphrey 1990). In contrast, >75 fox squirrels/km² was reported on Spring Island, South Carolina (Lee 1999) where they have been abundant for at least 10 years (B. Lampright, Spring Island Trust, pers. comm.). During this period, managers maintained agricultural plantings (wildlife food plots) directed at Spring Island's fox squirrels. Because food availability might limit southeastern fox squirrel populations (Weigl et al. 1989), we were interested in food use by this high-density population. We suspected that these fox squirrels eat a variety of natural foods, but seasonally supplement their diets by feeding in wildlife food plots. Our objectives were to (1) record observations of feeding by fox squirrels; and (2) identify the most frequently eaten foods during each season.

Spring Island is a 1,200 ha sea island located between Beaufort, South Carolina and Savannah, Georgia. About 1,000 ha of the island are forested with the remainder maintained as fallow fields, wildlife food plots, and a golf course. During the study, there were about 100 residential, administrative, or recreational buildings on the island. The island's forests are a heterogeneous arrangement of mixed hardwoods, pine (*Pinus* spp.), and live oak (*Quercus virginiana*) stands. Loblolly pine (*P. taeda*), hickories (*Carya* spp.), cabbage palm (*Sabal palmetto*), laurel oak (*Q. laurifolia*), live oak, sweetgum (*Liquidambar styraciflua*), southern red oak (*Q. falcata*), water oak (*Q. nigra*), and black gum (*Nyssa sylvatica*) are common trees. Pecan trees (*Carya illinoensis*) are present in a few residential plantings. Common understory plants include wax myrtle (*Myrica cerifera*), oaks, sweetgum, sassafras (*Sassafras albidum*), yaupon holly (*Ilex vomitoria*), American beautyberry (*Callicarpa americana*), saw palmetto (*Serenoa repens*) and greenbriar (*Smilax* spp.).

We trapped fox squirrels in wooden Mosby-style box traps (Day et al. 1980) from August 1998 to June 1999. Captured squirrels were immobilized with 3-5 ml of methoxyflurane (inhalation) or 20-30 mg ketamine hydrochloride (intramuscular injection), weighed with a spring scale, and fitted with a radio-collar (Advanced Telemetry Systems, Isanti, MN or Telemetry Solutions, Walnut Creek, CA). We used the homing method (Mech 1983) to locate 17 to 31 radio-collared squirrels at least 30 times per season at random times between 0.5 h after sunrise and 0.5 h before sunset. Seasons, based on plant phenology, were defined as: fall—1 October 1998 to 15 January 1999; winter—16 January 1999 to 15 March 1999; spring—16 March 1999 to 1 June 1999; early summer—June 1999 and July 1999; and late summer—August 1999 and September 1999 (Weigl et al. 1989). When we located a radio-collared squirrel, if possible, we watched it through 10 × 50-mm binoculars until it fed, and recorded foods eaten. When unidentified squirrels (i.e., those without radio-collars) were seen feeding, we also recorded foods eaten. Because observations of unidentified squirrels contributed to our account of foods eaten (Table 1), the number of squirrels that we observed is unknown. Each season, to

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Table 1. Observations of foods eaten by fox squirrels on Spring Island, South Carolina, August 1998-September 1999.

Food	Season ^a				
	Fall	Winter	Spring	Early Summer	Late Summer
<i>Quercus</i> spp. acorns	41.4 (12)	42.4 (14)	33.3 (15)	63.6 (7)	
<i>Pinus</i> spp. seeds	27.6 (8)	39.4 (13)	8.9 (4)		54.6 (6)
<i>Carya illinoensis</i> nuts	24.1 (6)	6.1 (2)	6.7 (3)	9.1 (1)	
<i>Carya</i> spp. nuts	3.5 (1)	6.1 (2)	2.2 (1)		
Mushrooms				27.3 (3)	45.5 (5)
<i>Triticum aestivum</i> seeds			13.3 (6)		
<i>Acer rubrum</i> seeds		6.1 (2)	8.9 (4)		
Other ^b	3.5 (1)		26.6 (12)		

^aPercent frequency of observations by season (number of observations by season).

^bIncludes tree buds, oak catkins, *Liquidambar styraciflua* seeds, *Cornus florida* fruit and *Rubus* spp. fruit.

help us better understand the availability of fox squirrel foods on Spring Island we recorded a list of apparent foods based on previous reports (Korschgen 1981, Koprowski 1994) and our perceptions. We did not measure availability of these foods or the proportion of each food in the diet.

Of foods that we saw fox squirrels eat throughout the year (Table 1), pine seeds and acorns were most frequently eaten. Hard mast (pine seeds, acorns, pecan nuts, and hickory nuts) was available year-round, although no fox squirrels were seen eating acorns during late summer or hickory nuts during early summer. Mushrooms were most available during early and late summer, when we frequently observed fox squirrels eating several species of them, including *Boletus bicolor*. Red maple seeds (samaras) were available during late winter and spring, but few squirrels were seen eating them. Other available foods that we did not see fox squirrels eat were the fruits of black gum, muscadine (*Vitis rotundifolia*), cabbage palmetto, and American beautyberry. Buds and catkins of trees, especially oaks, were eaten during spring, however we did not see squirrels eating them during winter. Flowering dogwood (*Cornus florida*) fruits and sweetgum seeds were little-used, although they were available during fall and winter. Blackberry (*Rubus* spp.) fruits were available during spring and early summer, but only one fox squirrel was seen eating them.

During May and June, it was common to see fox squirrels in wildlife food plots where on six occasions they were seen eating wheat (*Triticum aestivum*) seed heads that were in the milk stage. Our radio-collared squirrels ate wheat in wildlife food plots, but early succession fields (a habitat category that included food plots) was not a preferred habitat during any season (Lee 1999). In previous years, particularly years following a poor acorn crop, use of wheat seeds was more apparent than during our study with 4-10 fox squirrels frequently seen in each 1 ha wildlife food plot (Lampright, Spring Island Trust, pers. comm.).

Based on our observations, fox squirrel foods were not scarce during any season. Although Weigl et al. (1989) reported that fox squirrels were in poor condition during early summer in North Carolina because of a scarcity of foods, it was common to see squirrels eating hard mast and mushrooms during this season on Spring Island. Weights of fox squirrels captured on Spring Island during early and late summer did not suggest an inadequate food supply (Lee 1999). Although successive seasons of high or

low availability of important foods like acorns and pine seeds can result in drastic changes in squirrel abundance (Weigl et al. 1989), we believe that such population fluctuations are rare on Spring Island. Spring Island has a variety of pines (i.e., loblolly; longleaf, *P. palustris*; spruce, *P. glabra*; pond, *P. serotina*; and slash, *P. elliotii*), oaks (live; southern red; water; laurel; and post, *Q. stellata*), and other food plants to buffer the effects of poor mast production by some trees.

In summary, fox squirrels on Spring Island ate a variety of natural foods and seasonally ate foods associated with wildlife food plots. They ate acorns more than other foods in each season except during late summer when pine seeds and mushrooms were the most frequently eaten foods. Extensive use of acorns during spring and early summer might be the most apparent difference in diets of squirrels in our study and those reported for squirrels in lower-density populations (Moore 1957, Weigl et al. 1989). We believe that acorns were available to squirrels during all seasons, whereas acorn supplies typically were exhausted by late spring or early summer in the sandhill habitats studied by Moore (1957, 38 squirrels/km²) and Weigl et al. (1989, 0-28 squirrels/km²). Fox squirrels on Spring Island ate pecans during all seasons except late summer suggesting that they benefited from these residential plantings. During spring, they supplemented hard mast consumption by eating wheat and newly formed samaras, buds, and flowers of trees. Where fox squirrel conservation is a priority, a diversity of seed trees should be maintained and managers should consider the potential value of wildlife food plots. Plantings that include wheat or similar grains might supplement diets of fox squirrels during periods when natural foods are limited (e.g., following a hard mast failure). Further research should compare the value of a variety of plantings to fox squirrels based on their timing and intensity of use. Ideally, these studies will be conducted during years following hard mast failures. Optimal distribution, size, and shape of wildlife food plots must be determined before they are routinely prescribed for management of southeastern fox squirrels.

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