

Southern Fox Squirrel

Sciurus niger niger

Contributors: David Guynn, John Edwards, Susan Guynn and Judy Barnes

DESCRIPTION

Taxonomy and Basic Description

Fox squirrels (*Sciurus niger*) were first described by Linnaeus (1758); ten recognized subspecies exist throughout the United States. These arboreal mammals range in length from 450 to 698 mm (17 to 27.5 inches) and weigh 0.5 to 1.2 kg (17.6 to 42.3 ounces). Coloration varies greatly, both locally and regionally; this variation has resulted in subdivision into numerous subspecies (Hall 1981). Fox squirrel subspecies can be divided into two distinctive but intergrading coloration groups (Weigl et al. 1989). Six subspecies (*S. n. vulpinus*, *S. n. cinereus*, *S. n. niger*, *S. n. shermani*, *S. n. avicennia* and *S. n. bachmani*) have silver, gray, agouti (grizzled) and/or melanistic (black)

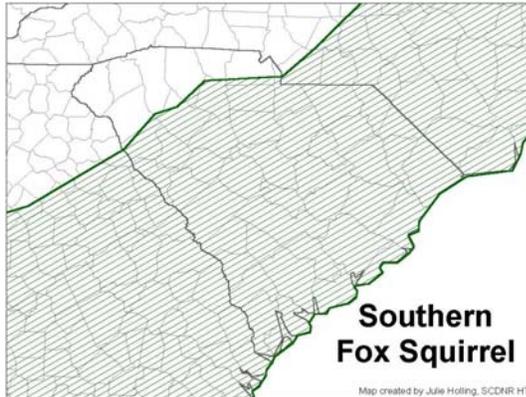
pelage with tan, gold or reddish undersides. In this coloration group, animals have black head markings, white or gray noses, and white ears and feet. The other coloration group contains four subspecies (*S. n. vulpinus*, *S. n. subauratus*, *S. n. ludovicianus*, and *S. n. limitis*) that are characterized by a distinctly reddish, orange, or tan agouti (grizzled) pelage, a grizzled or black nose, and no white markings on the head or feet. Melanism is common in the southern portions of the range (Lowery 1974; Kiltie 1989; Roe 1994). However, Turner and Laerm (1993) concluded that pelage characteristics are too varied and subjective to permit consistent determination or subspecies in the southeastern portions of the range. The fox squirrel is readily distinguished from the smaller gray squirrel (*S. carolinensis*) by its larger size and presence of only a single pair of premolars in the upper and lower jaws.



Status

The eastern fox squirrel has state rank of S4, apparently secure, in South Carolina and a global rank of G5, secure (NatureServe 2004). However, it is listed as vulnerable in North Carolina, as vulnerable/apparently secure in Alabama, as apparently secure in Arkansas, South Carolina, and Virginia, and as secure in Florida, Georgia, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas. The Delmarva Peninsula fox squirrel (*S. n. cinereus*) is federally listed as endangered (US Department of Interior 2003). The fox squirrel is considered a game animal and its harvest seasons are regulated in all states in the southeast (Edwards et al. 2003). Concerns for the conservation status of the southern fox squirrel are due to the lack of information on the distribution, abundance and ecology of the species.

POPULATION DISTRIBUTION AND SIZE



The southern fox squirrel (*Sciurus niger niger*) is the only fox squirrel native to South Carolina (Edwards et al. 2003). Populations are scattered across the South Carolina Coastal Plain, occur less often in the piedmont (Wood and Davis 1981; Harrigal 1993) and are rare to absent in the Blue Ridge (Harrigal 1993). In Georgia the species is most common in the coastal plain and piedmont and rare to absent in the Blue Ridge (Hilliard 1979; Turner 1988; Turner and Laerm 1993). Fox squirrels in North Carolina are restricted to the southeastern coastal plain south of the Pamlico River (Weigl 1987); although historical records indicate its former occurrence in the piedmont and Blue Ridge (Lee et al. 1982), the fox squirrel is now rare to absent (Weigl 1987).

Fox squirrel populations east of the Appalachians and along the eastern Gulf Coast have been declining dramatically over the past 100 years (Doutt et al. 1977; Webster et al. 1985; Loeb and Lennartz 1989; Weigl et al. 1989; Humphrey and Jodice 1992, Loeb and Moncrief 1993; Conner et al. 1999). Density estimates in the southeast range from 0.1 to 75 per square km (0.2 to 185 per square acre) (Moore 1957; Hilliard 1979; Humphrey et al. 1985; Weigl et al. 1989; Tappe 1991; Tappe et al. 1993; Lee 1999).

HABITAT AND NATURAL COMMUNITY REQUIREMENTS

Southeastern fox squirrels select more pine-dominated habitats compared to the deciduous habitats selected by the midwestern subspecies (Weigl et al. 1989). In southern Florida, they occur in cypress swamps, tropical hardwood forests, live oak (*Q. virginiana*) forests and mangrove forests (Humphrey and Jodice 1992). Throughout the lower coastal plain, fox squirrels occur in fire-maintained longleaf pine (*P. palustris*) turkey oak (*Q. laevis*) sand hills, pine flatwoods and associated bottomland habitat (Moore 1957; Williams and Humphrey 1979; Kantola 1992; Wooding 1997; Conner et al. 1999). The preferred habitat of fox squirrels in the sandhills and piedmont of the Carolinas, Georgia and elsewhere is mixed stands of longleaf, loblolly (*P. taeda*) and shortleaf pine (*P. echinata*), hardwoods and bottomlands (Taylor 1973; Hilliard 1979; Dueser et al. 1988; Edwards et al. 1989; Loeb and Lennartz 1989; Weigl et al. 1989; Loeb and Moncrief 1993). Throughout its range, parks, golf courses and residential areas may support substantial fox squirrel populations (Jodice and Humphrey 1992).

Fox squirrels use tree cavities and leaf nests both as refugia and for rearing young. Leaf nests occur in a variety of tree species including both hardwoods and pines. Fox squirrels use cavities in a variety of tree species. Cavity use is greatest during winter and spring (Nixon and Hansen 1987; Edwards et al. 1989; Edwards and Guynn 1995). Hilliard (1979) and Weigl et al. (1989) suggested that the absence of suitable cavity trees might be a critical factor in litter survival and subsequent recruitment of fox squirrels in Georgia and North Carolina. However, others have found no evidence that an absence of cavities was limiting fox squirrels in Florida or Georgia (Kantola 1986; Edwards and Guynn 1995).

Throughout their range, fox squirrels produce two litters per year; breeding is concentrated in late winter/early spring and, to a lesser extent, in summer (Moore 1957; Hoffman and Kirkpatrick 1959; Harnishfeger et al. 1978; Weigl et al. 1989; Larson 1990). Reproductive success is highly variable and dependent on demographic and environmental factors such as availability and timing of food sources, availability of cavities and weather (Nixon and McClain 1969).

The diet of the fox squirrel is diverse and varies seasonally and by region (Flyger and Gates 1982). Nuts, seeds, buds and flowers of pines (*Pinus* spp.), oaks (*Quercus* spp.), hickories (*Carya* spp.), beech (*Fagus grandifolia*), walnut (*Juglans* spp.) and other available hardwood species like dogwood (*Cornus* spp.) and maple (*Acer* spp.) are major components of the squirrel's diet. Soft mast, such as grape (*Vitis* spp.), persimmon (*Diospyros virginiana*) and cherry (*Prunus* spp.), various fruits, fungi, and insects are also eaten.

CHALLENGES

The widespread loss of preferred habitat, including mature, open pine-oak forests and associated bottomland and swamps is detrimental to fox squirrels throughout the southeast. Practices that have contributed to habitat loss include large-scale monocultural replacement of longleaf pine by loblolly pine, shortened stand rotation, loss of hardwoods and fire suppression (Weigl 1987; Loeb and Lennartz 1989; Weigl et al. 1989; Dueser and Handley 1991; Humphrey and Jodice 1992; Kantola 1992).

Habitat improvement practices for fox squirrels generally target forest structure and tree species composition. Changes in forest structure affect overstory and understory densities and tree cavity availability. Tree species composition markedly affects mast production. Specific management practices vary among regions. The primary factor in maintaining fox squirrel populations in forest stands after harvest is sustaining adequate levels of winter-storable tree seeds (Nixon et al. 1975). Chamberlain et al. (1999) and Yarrow and Yarrow (1999) provide management guidelines specific to Mississippi and Alabama, respectively. Streamside management zones offer an option for providing high-quality habitat and travel corridors for fox squirrels in areas affected by even-aged forest management. Studies in the southeast suggest that forest management practices that reduce dense understory vegetation and promote retention of mature mast-producing hardwood will benefit fox squirrels. Such practices include use of prescribed fire, mowing and retention of hardwood stringers in pine-dominated habitats (Kantola 1986; Edwards et al. 1989; Lee 1999; Chamberlain et al. 1999; Conner et al. 1999).

Fox squirrels also benefit from promotion and retention of cavity trees. Although cavity trees benefit both fox and gray squirrels, cavities are a more important habitat component for gray squirrels (Sanderson et al. 1980; Flyger and Gates 1982; Edwards and Guynn 1995).

The fox squirrel is a popular small game animal. Hunting mortality is considered compensatory to some extent, and is generally not thought of as a major factor controlling squirrel populations (Conner 2001). However, intensively hunted populations may be particularly vulnerable to overharvest depending on their level of isolation and potential for recolonization from nearby

refuges or other lightly hunted areas (Allen 1943; Nixon et al. 1974; Herkert et al. 1992). In South Carolina, no distinction is made between hunting regulations for fox and gray squirrels on private lands, which contain the bulk of suitable fox squirrel habitats. Tappe and Guynn (1998) suggested that it might be more appropriate to manage southern fox squirrels differently than the gray squirrel because the former requires large home ranges and has a low reproductive rate. Hunting fox squirrels is prohibited on many wildlife management areas in South Carolina.

CONSERVATION ACCOMPLISHMENTS

Fox squirrels have been protected from hunting mortality on 22 of 36 (61 percent) Wildlife Management Areas within South Carolina. Additionally, a sighting survey to determine fox squirrel distribution in South Carolina was performed in 1989 and became a biennial event beginning in 1994. County distribution of fox squirrels appears to be stable. The data are not appropriate for estimating abundance as the number of personnel and sighting effort vary greatly between survey periods. A restoration project on St. Phillips and Hall Islands, South Carolina suggests translocation of fox squirrels may be a useful tool in restoring and augmenting fox squirrel populations throughout the southeast (Senecal 2001). Fifty-two fox squirrels were released on the islands in 1999 and 2000. Annual survival of translocated fox squirrels was similar to reported rates in native populations and reproduction was documented.

CONSERVATION RECOMMENDATIONS

- Consider southern fox squirrel habitat requirements when managing for red-cockaded woodpeckers (*Picoides borealis*) as these two species often occur sympatrically.
- Consider southern fox squirrel habitat when restoring longleaf pine/wiregrass ecosystems.
- Encourage landowners and developers to consider southern fox squirrels when planning and constructing developed areas such as golf courses, parks and residential communities.
- Encourage maintenance of mature (greater than 50 years) loblolly and longleaf pine stands that have open canopies and sparse midstories. When possible, encourage landowners to create mature stands on their properties.
- Use prescribed burning to maintain sparse midstories in pine and mixed pine/hardwood stands on SCDNR properties. Encourage other landowners to also use prescribed burning to provide habitat for southern fox squirrels.
- Consider establishing separate hunting regulations for gray and fox squirrels, especially regarding bag limits on SCDNR owned wildlife management areas (WMAs).
- Develop a restoration program to enhance fox squirrel populations in the piedmont.
- Document the distribution and population status of southern fox squirrels in South Carolina, particularly in the piedmont.
- Conduct studies of dispersal patterns, feeding habits, translocation success, hunting mortality and population dynamics for southern fox squirrels.
- Conduct landscape-scale research studies to determine the effects of anthropogenic-induced habitat fragmentation and loss.
- Establish a survey protocol to periodically monitor southern fox squirrel population trends on WMAs and large SCDNR land holdings.

- Estimate harvest of fox squirrels on game harvest surveys.
- Continue the biennial fox squirrel sighting survey.

MEASUREMENTS OF SUCCESS

The ongoing biennial survey has shown population fluctuations from year to year. At this point, there are not enough data to determine if this is a cyclical pattern of a stable population. Over time, biologists hope that the population in South Carolina can be stabilized or increased. As research and management needs are identified, projects will be initiated to address those needs.

LITERATURE CITED

- Allen, D.L. 1943. Michigan fox squirrel management. Michigan Department of Conservation, Game Division Publication 100. Lansing, Michigan. 404 pp.
- Chamberlain, M.J., J.M. Ross and B.D. Leopold. 1999. Influence of forest management and microhabitat conditions on abundance of southern fox and gray squirrels. *Proceedings Annual Conference Southeastern Association Fish and Wildlife Agencies*. 53:402-414.
- Conner, L.M., J.L. Landers and W.K. Michener. 1999. Fox squirrel and gray squirrel associations within minimally disturbed longleaf pine forests. *Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies*. 53:364-374.
- Conner, L.M. 2001. Survival and cause-specific mortality of adult fox squirrels in southwestern Georgia. *Journal of Wildlife Management*. 65:200-204.
- Doutt, J.K., C.A. Heppenstall and J.E. Guilday. 1977. Mammals of Pennsylvania. Pennsylvania Game Commission. Harrisburg, Pennsylvania. 281 pp.
- Dueser, R.D., J.L. Dooley, Jr. and G.J. Taylor. 1988. Habitat structure, forest composition and landscape dimensions as components of habitat suitability for the Delmarva fox squirrel. Pp. 414-421. *In: Management of amphibians, reptiles, and small mammals in North America*, R.C. Szaro, K.E. Severson, and D.R. Patton, editors. Rocky Mountain Forest and Range Experiment Station. USDA Forest Service General Technical Report RM-166. 539 pp.
- Dueser, R.D. and C.O. Handley, Jr. 1991. Fox Squirrel *Sciurus niger cinereus* Linnaeus. Pp. 587-589. *In: Virginia's endangered species*, K. Terwilliger, editor. McDonald and Woodland. Blacksburg, Virginia. 672 pp.
- Edwards, J.W., D.C. Gynn, Jr. and M.R. Lennartz. 1989. Habitat use by southern fox squirrel in coastal South Carolina. *Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies*. 43:337-345.
- Edwards, J.W. and D.C. Gynn, Jr. 1995. Nest characteristics of sympatric populations of fox and gray squirrels. *Journal of Wildlife Management*. 59:103-110.

- Edwards, J.W., W.M. Ford and D.C. Guynn, Jr. 2003. Fox and gray squirrels. Pp. 248-267. *In*: Wild Mammals of North America, G. Feldhamer, B. Thompson and J. Chapman, editors. Second edition. Johns Hopkins University Press. Baltimore, Maryland. 1216 pp.
- Flyger, V. and J.E. Gates. 1982. Fox and Gray squirrel. Pages 209-119. *In*: Wild mammals of North America: biology, management, and economics, J.A. Chapman and G.A. Feldhamer, editors. Johns Hopkins University Press, Baltimore, Maryland. 1147 pp.
- Hall, E.R. 1981. The Mammals of North America. Second edition. John Wiley & Sons. New York, New York. 690 pp.
- Harnishfeger, R.L., J.L. Roseberry and W.D. Klimstra. 1978. Reproductive levels in unexploited woodlot fox squirrels. Transactions of the Illinois State Academy of Science. 71:342-355.
- Harrigal, D. 1993. Fox squirrel (*Sciurus niger*) distribution and habitat preference in South Carolina. P. 51. *In*: Proceedings of the second symposium on southeastern fox squirrels, *Sciurus niger*, N.D. Moncrief, J.W. Edwards and P.A. Tappe, editors. Virginia Museum of Natural Special Publication 1, 1993. Martinsville, Virginia. 84 pp.
- Herkert, J.R., C.M. Nixon and L.P. Hansen. 1992. Dynamics of exploited and unexploited fox squirrel (*Sciurus niger*) populations in the Midwestern United States. Pp. 864-874. *In*: Wildlife 2001: populations, D.R. McCullough and P.H. Barrett, editors. Elsevier Applied Science. New York, New York. 1037 pp.
- Hilliard, T.H. 1979. Radio-telemetry of fox squirrel in the Georgia Coastal Plain. MS Thesis, University of Georgia. Athens, Georgia. 112 pp.
- Hoffman, R.A. and C.M. Kirkpatrick. 1959. Current knowledge of tree squirrel reproductive cycles and development. Proceedings of the Annual Conference of the Southeastern Association of Fish and Game Commissioners. 13:363-367.
- Humphrey, S.R., J.F. Eisenburg and R. Franz. 1985. Possibilities for restoring wildlife of a longleaf pine savanna in an abandoned citrus grove. Wildlife Society Bulletin. 13:487-496.
- Humphrey, S.R. and G.R. Jodice. 1992. Big Cypress fox squirrel *Sciurus niger avicennia*. Pp. 224-233. *In*: Rare and endangered biota of Florida, Volume 1. Mammals, S.R. Humphrey, editor. University Press of Florida. Gainesville, Florida. 392 pp.
- Jodice, P.G. and S.R. Humphrey. 1992. Activity and diet of an urban population of Big Cypress fox squirrels. Journal of Wildlife Management. 56:685-692.
- Kantola, A.T. 1986. Fox squirrel home range and mast crops in Florida. M.S. Thesis, University of Florida. Gainesville, Florida. 68 pp.

- Kantola, A.T. 1992. Sherman's fox squirrel *Sciurus niger shermani*. Pp. 234-240. *In*: Rare and endangered biota of Florida, Volume 1. Mammals, S.R. Humphrey, editor. University Press of Florida. Gainesville, Florida. 392 pp.
- Kiltie, R.A. 1989. Wildfire and the evolution of dorsal melanism in fox squirrels, *Sciurus niger*. *Journal of Mammalogy*. 70:726-739.
- Larson, B.J. 1990. Habitat utilization, population dynamics and long-term viability in an insular population of Delmarva fox squirrel (*Sciurus niger cinereus*). M.S. Thesis, University of Virginia. Charlottesville, Virginia. 87 pp.
- Lee, J.C. 1999. Ecology of the southern fox squirrel on Spring Island, South Carolina. M. S. Thesis, University of Georgia. Athens, Georgia. 64 pp.
- Lee, S.D., J.B. Funderburg, Jr. and M.K. Clark. 1982. A distributional survey of North Carolina Mammals. Occasional Papers of the North Carolina Biological Survey. Raleigh, North Carolina. 70 pp.
- Linnaeus, C. 1758. *Systema naturae*. Tenth edition. Laurentii Salvii, Stockholm. 1:1-824.
- Loeb, S.C. and M.R. Lennartz. 1989. The fox squirrel (*Sciurus niger*) in southeastern pine-hardwood forests. Pp. 142-147. *In*: Proceedings of pine-hardwood mixtures: a symposium on management and ecology of the type, T.A. Waldrop, editor. United States Department of Agriculture, Forest Service, General Technical Report, SE- 58, Asheville, North Carolina. 271 pp.
- Loeb, S.C. and N.D. Moncrief. 1993. The biology of fox squirrels (*Sciurus niger*) in the southeast: a review. Pages 1-19. *In*: Proceedings of the second symposium on southeastern fox squirrels, *Sciurus niger*, N.D. Moncrief, J.W. Edwards and P.A. Tappe, editors. Virginia Museum of Natural History Special Publication 1. Martinsville, Virginia. 84 pp.
- Lowery, G.H., Jr. 1974. The mammals of Louisiana and its adjacent waters. Louisiana State University Press. Baton Rouge, Louisiana. 565 pp.
- Moore, J.C. 1957. The natural History of the fox squirrel, *Sciurus niger shermani*. *Bulletin of the American Museum of Natural History*. 113:1-71.
- NatureServe. 2004. An online encyclopedia of life [Database]. Version 1.6. Association for Biodiversity Information. <http://www.natureserve.org/>.
- Nixon, C.M., and M. W. McClain. 1969. Squirrel population decline following a late spring frost. *Journal of Wildlife Management*. 33:353-357.
- Nixon, C.M., R. W. Donohoe and T. Nash. 1974. Overharvest of fox squirrels from two woodlots in western Ohio. *Journal of Wildlife Management*. 38:67-80.

- Nixon, C.M., M.W. McClain and R.W. Donohue. 1975. Effects of hunting and mast crops on a squirrel population. *Journal of Wildlife Management*. 39:1-25.
- Nixon, C.M. and L.P. Hansen. 1987. Managing forests to maintain populations of gray and fox squirrels. *Illinois Department of Conservation Technical Bulletin*. 5:1-35.
- Roe, K.J. 1994. Morphological variation in the fox squirrel (*Sciurus niger*). MS Thesis, University of Georgia. Athens, Georgia. 97 pp.
- Sanderson, H.R., C.M. Nixon, R.W. Donohue and L.P. Hansen. 1980. Grapevines – an important component of gray and fox squirrel habitat. *Wildlife Society Bulletin*. 8:307-310.
- Senecal, J.R. 2001. Survival, movements, and habitat use of translocated fox squirrels on St. Phillips and Hall Islands, South Carolina. M.S. Thesis. University of Georgia, Athens, Georgia. 83 pp.
- Tappe, P.A. 1991. Capture-recapture methods for estimating fox squirrel abundance. Ph.D. Dissertation, Clemson University. Clemson, South Carolina. 92 pp.
- Tappe, P.A., J.W. Edwards and D.C. Guynn, Jr. 1993. Capture methodology and density estimates of southeastern fox squirrels (*Sciurus niger*). Pp. 71-77. *In: Proceedings of the second symposium on southeastern fox squirrels, Sciurus niger*, N.D. Moncrief, J.W. Edwards and P.A. Tappe, editors. Virginia Museum of Natural History Special Publication 1. Martinsville, Virginia. 84 pp.
- Tappe, P.A. and D.C. Guynn, Jr. 1998. Southeastern fox squirrels: R- or K-selected? Implications for management. Pages 239-247. *In: Ecology and Evolutionary Biology of Tree Squirrels*, M.A. Steele, J.F. Merritt and D.A. Zegers editors. Special Publication 6. Virginia Museum of Natural History. Martinsville, Virginia. 84 pp.
- Taylor, G.J. 1973. Present status and habitat survey of the Delmarva fox squirrel (*Sciurus niger cinereus*) with a discussion of reasons for its decline. *Proceedings of the Southeastern Association of Game and Fish Commissioners*. 27:278-289.
- Turner, D.A. 1988. Systematic status and distribution of the fox squirrel (*Sciurus niger*) in Georgia. MS thesis, University of Georgia. Athens, Georgia. 65 pp.
- Turner, D.A. and J. Laerm. 1993. Systematic relationship of populations of the fox squirrel (*Sciurus niger*) in the southeastern United States, Pp. 21-36. *In: Proceedings of the second symposium on southeastern fox squirrels, Sciurus niger*, N.D. Moncrief, J.W. Edwards and P.A. Tappe, editors. Virginia Museum of Natural History Special Publication 1. Martinsville, Virginia. 84 pp.
- U. S. Department of the Interior, Fish and Wildlife Service. 2003. Southeast Region 4. <http://endangered.fws.gov/wildlife.html> (Accessed May 2003).

- Webster, W.D., J.F. Parnell and W.C. Biggs. 1985. Mammals of the Carolinas, Virginia and Maryland. University of North Carolina Press. Chapel Hill, North Carolina. 272 pp.
- Weigl, P.D. 1987. *Sciurus niger niger* Linnaeus. Pages 25-28. *In*: Endangered, threatened and rare fauna of North Carolina. Part 1. A reevaluation of the mammals, M.K. Clark, editor. Occasional Papers of the North Carolina Biological Survey. Raleigh, North Carolina. 52 pp.
- Weigl, P.D., M.A. Steele, L.J. Sherman, J.C. Ha and T.S. Sharpe. 1989. The ecology of the fox squirrel (*Sciurus niger*) in North Carolina: implications for survival in the Southeast. Bulletin of the Tall Timbers Research Station. 24:1-93.
- Williams, K.S. and S.R. Humphrey. 1979. Distribution and status of the endangered Big Cypress fox squirrel (*Sciurus niger avicennia*) in Florida. Florida Scientist. 42:201-205.
- Wood, G.W. and J.R. Davis. 1981. A survey of perceptions of fox squirrel populations in South Carolina. Forestry Bulletin No. 29. Department of Forestry, Clemson University. Clemson, South Carolina. 6 pp.
- Wooding, J.B. 1997. Distribution and population ecology of the fox squirrel in Florida. Ph.D. Dissertation, University of Florida. Gainesville, Florida. 139 pp.
- Yarrow, G.K. and D.T. Yarrow. 1999. Managing wildlife: on private lands in Alabama and the Southeast. Sweetwater Press. Birmingham, Alabama. 588 pp.