THE IMPORTANCE OF SHORTLEAF PINE FOR WILDLIFE AND DIVERSITY IN MIXED OAK-PINE FORESTS AND IN PINE-GRASSLAND WOODLANDS

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ABSTRACT.—Shortleaf pine, by virtue of its wide distribution and occurrence in many forest types in eastern North America, is an important species that provides high habitat value for many wildlife species. Shortleaf pine functions as a structural habitat element in both mixed oak-pine forests and in pine-grassland woodlands. It also adds diversity throughout all stages of plant succession and stand development. Within the range of shortleaf pine, wildlife species are variously associated with shortleaf based on stand density, the proportion of hardwoods within a structural stage of development, and availability of habitat structure within the specific niche that each wildlife species occupies. Shortleaf also is a key species in ecosystems where it occurs naturally because its occurrence and relative dominance are defined to a large extent by the natural disturbance regime, particularly fire. Fire frequency and season, to some extent, define the understory plant community response and determine shortleaf pine's potential for regeneration, establishment of future codominant and dominant trees, and perpetuate a relative mix of pines with other associated tree species within a stand. This understory community response to fire or lack of fire defines much of the ground-dwelling or ground-foraging wildlife species populations. This paper discusses wildlife species associated with different structural characteristics and fire regime in mixed oak-shortleaf and shortleaf-dominated forests and woodlands.

INTRODUCTION

The oak-pine (*Quercus-Pinus*) forest type is the largest cover type in the eastern United States (Lotan and others 1978). In this area, shortleaf pine (*Pinus echinata* Mill.) is the most prevalent of the southern pines (Lawson and Kitchens 1983) and is associated with a wide array of other pines and hardwoods. It occurs in some 18 different cover types and is dominant in three of these (Eyre 1980). Its wide distribution and occurrence across many forest types make shortleaf pine of great value to associated wildlife species (Wigley 1986). Shortleaf also is a key species in ecosystems because its occurrence and relative dominance are defined by the natural disturbance regime, particularly fire (Masters and others 2003, 2005), which also influences the distribution and abundance of associated wildlife (Masters 1991a).

Shortleaf pine stands develop naturally as even- or uneven-aged stands, depending on the nature of the disturbance regime that initiated the stand and/or the periodic disturbance events that occurred throughout the life of the stand (Turner 1935, Bragg 2002, Masters and others 2005). Stands that initiate following catastrophic disturbance or as small old-field stands typically develop as even-aged stands (Turner 1935, Oosting 1942). If reoccurring fire is part of the disturbance regime, however, the stands will develop an uneven-aged structure (Masters and others 2005). As shortleaf pine ages, it becomes less tolerant of shade and neighboring crowns. By age 50 the crowns of trees develop an irregular shape and the canopy is often punctuated by numerous gaps (Mattoon 1915). Depending on the biophysical site conditions and fire frequency, oaks (*Quercus* spp.) and other hardwoods may vary in abundance based on their fire tolerance and site adaptability.

Stand structure in old-growth shortleaf has been reported as uneven-aged to even-aged and variable in density according to the frequency and nature of the disturbance pulse (Turner 1935, Bragg 2002) and also the scale of consideration. These forests typically had numerous canopy gaps and an open stand structure, depending on site conditions and fire regime (Little 1946, Fryar 1991, Murphy and Nowacki 1997, White and Lloyd 1998, Bragg 2002, Stambaugh and others 2002). However, in old-growth stands where anthropogenic disturbance are excluded, canopy-dominant old-growth pines eventually reach senescence and become prone to attack by various bark beetles, causing them to die and allowing midstory hardwoods to supplant pine in a relatively short period of time (Kreiter 1994, Masters and others 1995, Cain and Shelton 1996). In these senescing stands, shortleaf pine regeneration may occur as even-aged patches under large canopy gaps, or in several distinct size classes of different cohorts, or as individuals (Bragg 2002,

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Stambaugh and others 2002, Cassidy 2004). Given enough time, mixed oak-pine stands will assume an uneven-aged structure with periodic canopy gaps whether initiated in an even-aged or uneven-aged fashion.

The range of structural conditions and successional states found in stands containing shortleaf pine provides a variety of niches for wildlife. A number of review papers have dealt with the influence of southern pine management and wildlife (e.g., Dickson 1982, Buckner 1982, Owen 1984) but only one specifically with shortleaf pine and wildlife (Wigley 1986). For brevity, this paper will focus primarily on habitat relations of small mammals, selected other mammals, and birds in mixed oak-pine and pine-grassland habitats.

FOREST SUCCESSION AND WILDLIFE HABITAT RELATIONSHIPS

Shortleaf pine either in pure stands or mixed oak-pine stands provides habitat for a large number of wildlife species from early seral stages through late seral stages. With progressive stand development and changes in stand structure comes a commensurate succession of wildlife species (Johnson and others 1974). Because some species are habitat specialists, some habitat generalists, and the remainder somewhere in between, structure (vertical and horizontal) and composition of a given stand will determine which species will be found there. Stand configuration, size, and the juxtaposition of stand ages and stand structures within a given landscape matrix also influence the occurrence of some wildlife species. Earlier literature refers to within-stand diversity, between-stand diversity, and landscape diversity (e.g., Wigley 1986). The presence of canopy gaps and the mix of oaks and other hardwoods in the canopy or in the midstory also provide suitable habitat for certain wildlife.

Early Succession

Following a disturbance event that takes a given stand back to an early seral stage, a fairly predictable chronosequence of vegetation replacement occurs (Johnston and Odum 1956, Meyers and Johnson 1978, Masters 1991a,b, Masters and others 2006). On old-field lands or following regeneration clear-cutting, the first stage is represented by herbaceous vegetation with an array of grasses and forbs. If the stand was clearcut and the site prepared for planting, the first stage may have considerable bare ground. Within 2 years of the clearcut, herbaceous vegetation will dominate the site and some woody component will have developed (Masters 1991a,b, Masters and others 2006). Soft mast production, important for many mammals and birds, typically has recovered by the third growing season and is more abundant than in mature mixed pine-hardwood stands (Perry and others 2004). Herbaceous and woody current annual growth will increase until canopy closure, generally within 6-8 years (Fenwood and others 1984, Masters and others 1993, 2006). The forage and browse production will be from 10 to 25 times greater than that in mature oak-pine stands over this short period of time (Masters and others 2006). Within 4 to 6 years woody vegetation begins to assert dominance as a distinct grass-shrub stage (Johnston and Odum 1956, Masters and others 2006). Then after 8 to 10 years a distinct sapling stage occurs. The replacement sequence and relative dominance of woody species can be redirected by subsequent disturbances such as fire (Masters 1991a, Masters and others 2005, 2006).

The chronosequence of mammals and birds that follow the stages of vegetation replacement are also somewhat predictable and fairly well documented except for meso-mammals and herpitofauna. From the first herbaceous-dominated stages, small mammals quickly colonize as cover develops (Atkeson and Johnson 1979, Thill and others 2004), and eastern cotton-tailed rabbit[2], white-tailed deer, and elk begin using the site (Masters 1991a,b, Masters and others 1997) (Fig. 1). Flying squirrel (Taulman and Smith 2004), gray squirrel, and fox squirrel, however, show dramatic declines compared to those in mature stands in these earliest sere stages (Flyger and Gates 1982). Nonetheless, squirrels of all three species have been noted to forage in early seral openings (Flyger and Gates 1982, Taulman and Smith 2004). Mammalian predators also are attracted to these sites (Wigley 1986). These groups of species continue to use these habitats through the shrub stage and into the sapling stage. By the fifth growing season, though, small mammal density (Thill and others 2004) and squirrel use declines dramatically (Flyger and Gates 1982).

Sapling stands provide beneficial escape and bedding cover and browse for white-tailed deer and elk in naturally- or artificially-regenerated stands, but cottontail use declines (Masters 1991a,b, Masters and others 1993, 1997). Deer and elk also preferentially use pine saplings over hardwood saplings as territorial marking sites or antler rubbing sites during the rut. When high stem densities develop, use by either species will decline rapidly with canopy closure where fire is excluded (Masters 1991a,b; Masters and others 1997). As crowns begin to close, herbaceous vegetation declines (Masters and others 1993), as do small mammal richness and density (Atkeson and Johnson 1979). By age 10 and at crown closure, rabbit, elk, and deer dramatically curtail use of either naturally-regenerated or clearcut stands (Masters and others 1997). Use of these stands is extended when prescribed fire is introduced early and at least on a 3-year late-dormant season cycle (Masters and others 1997) (Fig. 2). Prescribed fire reduces the density of small (< 6.5 ft) woody stems (Sparks and others 1999) and maintains herbaceous understory production at high levels (Masters and others 1993, 1996).

[2]Animal species common names and scientific names with authority are found in the Appendix.

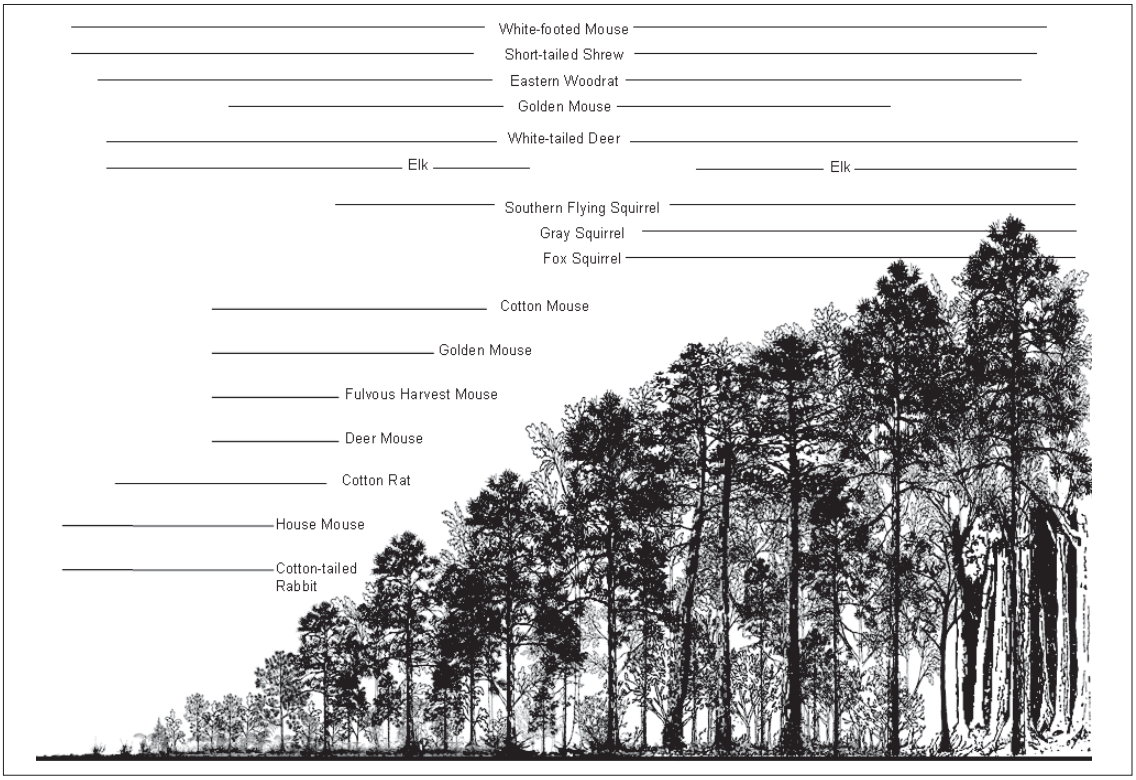

Figure 1.—Plant succession and mammal community succession model of selected common species occurrence associated with different stages of succession in the absence of fire. Horizontal lines indicate only the presence of the named species at a particular successional stage. Based on Atkeson and Johnson (1979), Tappe and others (1994, 2004), Masters and others (1998, 2002).

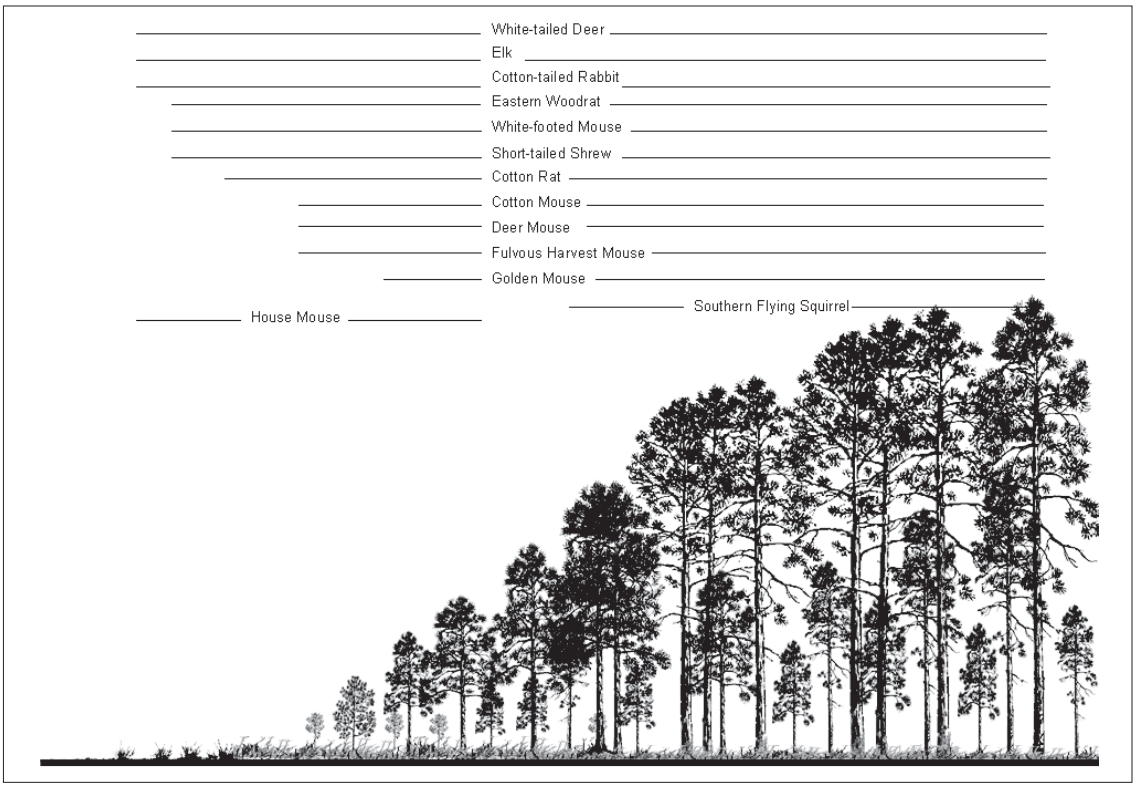

Figure 2.—Plant succession and mammal community succession model of selected common species occurrence associated with different stages of succession with frequent fire of at least 1- to 5-year intervals. Horizontal lines indicate only the presence of the named species at a particular successional stage. Based on Masters and others (1998, 2002).

From the earliest stages of secondary succession (bare ground), mourning dove begin using such sites. When the herbaceous stage is extended, such as in old field situations or in some clearcuts, eastern meadowlark, field sparrow, and grasshopper sparrow have been reported to use this stage (Johnston and Odum 1956, Meyers and Johnson 1978, Dickson and others 1993). Other early-succession bird species such as northern bobwhite, northern cardinal, indigo bunting, blue grosbeak, and, less frequently, Bachman's sparrow make some use of the grass-shrub stage found in regenerated stands as long as adequate ground cover and fairly dense brushy woody plants are present (Fig. 3). Eastern bluebird will use these sites where suitable snags are found. Where ground cover is predominantly needle litter in dense sapling- to post-sized stands, species such as prairie warbler and hooded warbler have been noted (Jennelle 2000). Periodic burning on at least a 3-year rotation in young sapling stands extends the period of use by early-sere wildlife species, such as numerous small mammals, bobwhite, wild turkey, and numerous songbirds, which will continue to use the stands as they develop (Masters 1991a, Stewart 1999, Jennelle 2000, Walsh 2004) (Fig. 4).

Mid-Succession

The mid-succession stage occurs from about 12 to 60 years of age. A common characteristic in stands where fires have been excluded are closed canopies with sparse patches of relatively few herbaceous plants in the understory (Oosting 1942, Meyers and Johnson 1978, Masters and others 2006). Stand density varies throughout this age span, but dense stands generally decline in density over time as competition-induced mortality takes place. Lower density stands will fill in during the early part of this stage, becoming more dense for a short period. But in either case, density will be similar by the later part of this successional stage (Oosting 1942). Once a mixed oak-shortleaf or shortleaf stand enters the post-size class (4-6 inches, diameter at breast height), use by many wildlife species will decline dramatically, as will density, especially in dense stands where fire is excluded. By age 15, stands support low numbers of small mammals (Atkeson and Johnson 1979). By age 18-20 flying squirrels begin using these developing mixed stands (Landers and Crawford 1995). Only during the latter part of this stage will significant numbers of fox or gray squirrels begin using the stand, at which time they may be more abundant than in late seral stages (Flyger and Gates 1982).

At age 12-15, depending on the site index, some songbird species more characteristic of later stages of succession will once again begin using the canopies of shortleaf stands as well as stands of other southern pine species (Engstrom and others 1984, Jennelle 2000). Species such as the red-eyed vireo, hooded warbler, and wood thrush become increasingly common, but ground-dwelling and -nesting species and some shrub-associated species decline (Engstrom and others 1984, Landers and Crawford 1995). The importance of fire in retaining early sere wildlife species was recently shown in a study on the Ouachita National Forest, AR, that examined northern bobwhite use of even-aged stands 12-15 years of age. Following only 3-4 seasons of fire exclusion, the northern bobwhite began avoiding stands that ranged from 600-700 stems/acre and that previously had showed extensive use (Walsh 2004).

In stands from about age 25 to 60, low densities of breeding birds characterize most dense southern pine forests (Johnston and Odum 1956). However, a host of songbirds uses the canopies of pole-sized stands and to a much greater extent the understory where frequent fire is used and lower stand density (<70 ft^2/ac) is maintained (Fig. 4). The songbird species complement in pole stands is similar to mature stands (Wilson and others 1995, Jennelle 2000, Masters and others 2002). In mid-succession stands excluded from fire, both species richness and density of small mammals and songbirds decline markedly as midstory hardwoods develop and as the herbaceous layer declines from litter buildup and shading by hardwoods (Engstrom and others 1984, Landers and Crawford 1995, Masters and others 2002).

Late Succession

Late seral stage mixed oak-pine stands may be characterized by an uneven-aged diameter distribution, sparse herbaceous understory, and considerable horizontal and vertical structure (Meyers and Johnson 1978, Kreiter 1994, Smith and others 1997). Often the canopy may have periodic gaps of different sizes. A snag component is evident.

Small mammal community density, species richness, and diversity are typically lower and composition somewhat different than in early seral stages (Tappe and others 1994, Masters and others 1998, 2002). Southern flying squirrel is considered to be a small mammal representative of mature mixed oak-pine forests (Taulman and Thill 1994), as are fox and gray squirrels, depending on the mix of oaks and other hardwoods (Flyger and Gates 1982).

Ovenbird, scarlet tanager, summer tanager, great-crested flycatcher, Acadian flycatcher, tufted titmouse, Carolina chickadee, Kentucky warbler, pine warbler, worm-eating warbler yellow-billed cuckoo, Northern cardinal, pileated woodpecker, hairy woodpecker, downy woodpecker, chuck-will's widow, whip-poor-will, wood thrush, tufted titmouse, Carolina wren, broad-winged hawk, red-eyed vireo, and possibly yellow-throated vireo are characteristic species of late succession mixed hardwood-pine hardwood stands (Johnston and Odum 1956, Meyers and Johnson 1978, Wilson and others 1995, Masters and others 2002). However, many of these are also characteristic of mature hardwood stands (Meyers and Johnson 1978). There is a paucity of conifer-specialized bird species in the southern forests compared with northern forests (Johnston and Odum 1956).

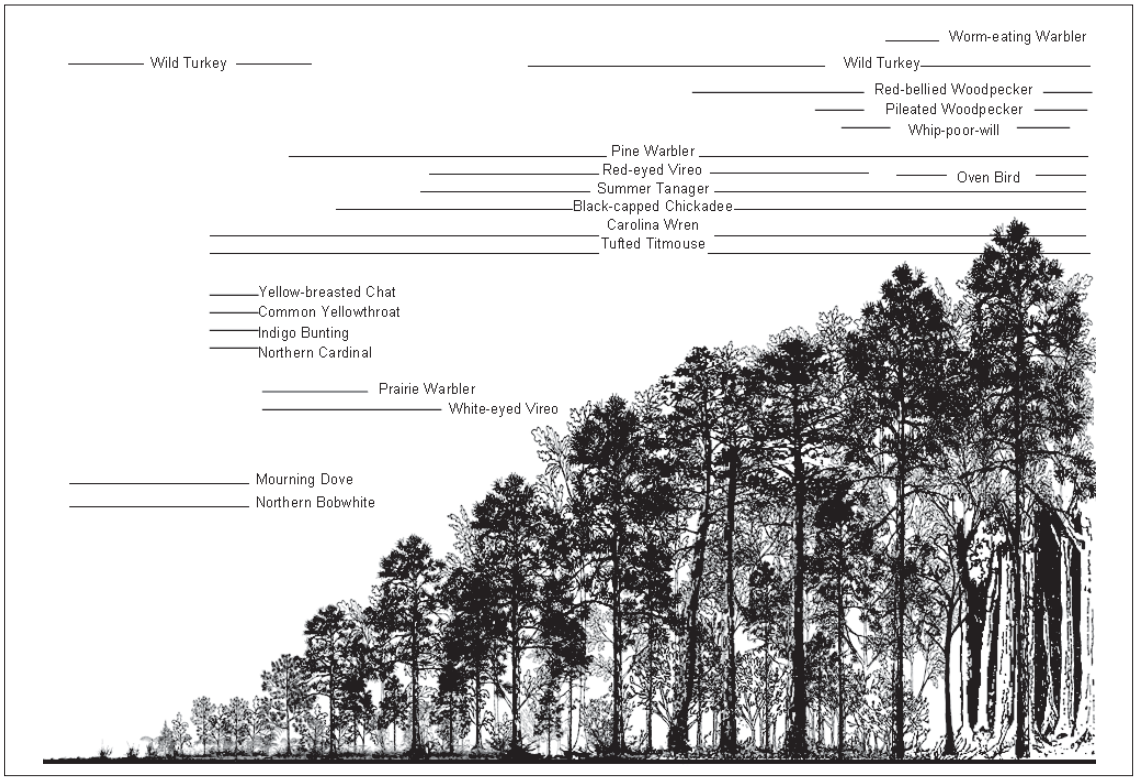

Figure 3.—Plant succession and breeding bird community succession model of selected common species occurrence associated with different stages of succession in the absence of fire. Horizontal lines indicate only the presence of the named species at a particular successional stage. Based on Johnston and Odum (1956), Meyers and Johnson (1978), Wilson and others (1995), Jennelle (2000), and Masters and others (2002).

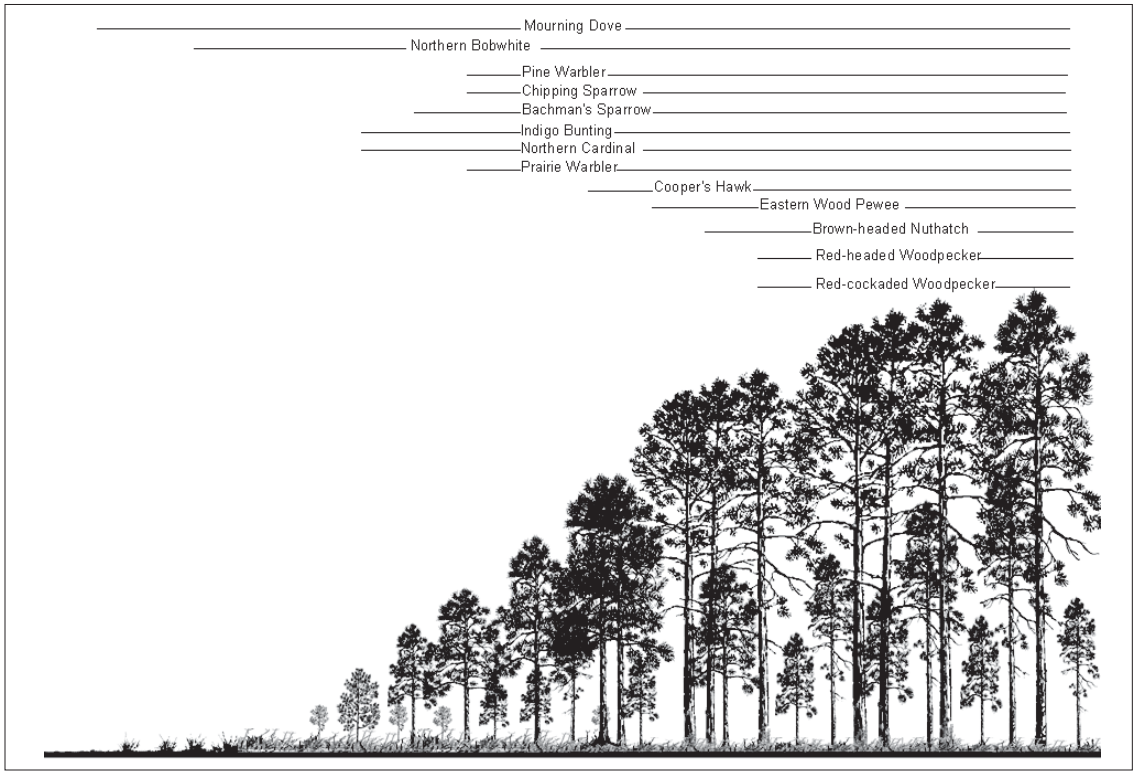

Figure 4.—Plant succession and breeding bird community succession model of selected common species occurrence associated with different stages of succession with frequent fire of at least 1- to 5-year intervals. Most of the bird species from Figure 3 will be found here as well if even 15 ft^2 of hardwood basal area per acre is present in the stand. Horizontal lines indicate only the presence of the named species at a particular successional stage. Based on Wilson and others (1995), Jennelle (2000), and Masters and others (2002).

Pine-bluestem

In ecosystems where natural disturbance processes, particularly frequent fire, are allowed to freely operate, old-growth stands may be characterized by open canopy (basal areas less than 70 ft^2/ac), pure or nearly pure pine stands with limited midstory, and a bluestem-dominated understory (See Vogl 1972, Komarek 1974, Fryar 1991, Masters and others 1995, Sparks and Masters 1996, Batek and others 1999). Oaks and other hardwoods may be present to varying degrees depending on site characteristics (Vogl 1972, Fryar 1991, Kreiter 1994, Masters and others 1995). The understory is rich in grass and forb species with grasses assuming a dominant aspect following repeated cycles of fire (Masters and others 1996, Sparks and others 1998). A distinct woody component will be present but suppressed, depending upon the time since last burned and the intensity of the fire (Sparks and others 1999, 2002). With increasing time since last burned, understory woody stems gradually grow into the lower midstory (Masters and others 2002).

Mature shortleaf pine-bluestem stands with abundant herbaceous ground cover and little to no hardwood midstory, managed with late-dormant season fire at 3-year intervals, show dramatic increases in both richness and density of small mammals and songbirds (Wilson and others 1995, Masters and others 1998, 2001, 2002). Low basal area pine-bluestem stands managed with frequent fire also provide more than adequate high-quality forage for white-tailed deer and elk (Masters 1991a, Masters and others 1993, 1996, 1997) and are used to a greater extent by both species than unburned closed-canopy sites (Masters 1991b, Masters and others 1997). Historically, bison and elk likely occurred throughout much of the range of the shortleaf pine-bluestem type (Smith and Neal 1991). Masters and others (1997) found that elk and white-tailed deer were able to persist together in areas endemic for the meningeal worm (*Parelaphostrongylus tenuis*) when over 21 percent of an area was in early successional openings. The meningeal worm can cause significant mortality in elk. In this system fire may have been particularly important for elk to persist because fire in woodlands causes mortality to woodland snails that may be the intermediate host to the meningeal worm. This hypothesis needs to be tested.

The entire small mammal community is benefited by this system of management. Both small mammal richness and total captures increase in response to thinning and fire, particularly following the first growing season (Masters and others 1998, 2001). In those studies, no part of the small mammal community was disadvantaged by restoration treatments to shortleaf pine-bluestems stands (Masters and others 1998, 2002). Exceptions might be the southern flying squirrel, gray squirrel, and fox squirrel, species which those studies did not examine. The most prevalent species in restored pine-bluestem stands included white-footed mouse and short-tailed shrew. Other species that increased in abundance as well but not significantly included the wood rat and cotton rat. The cotton mouse and deer mouse were found only in restoration treatments (Masters and others 2002). But perhaps the species that benefited the most were specialists such as the fulvous harvest mouse and the golden mouse (Masters and others 1998). In a pine-grassland community, the fire frequency also influences the structure of the understory and thus the small mammal community. If fires are very frequent, the cotton mouse and golden mouse are disadvantaged, but the cotton rat is distinctly benefited by frequent fire (Fig. 5). The golden mouse was more prevalent on 3- to 7-year fire intervals and the cotton mouse tolerated a wide range of frequencies from 2-12 years. The understory woody structure of each of the burn intervals is different, with more frequent fire causing lower height and less percent cover, while less frequent fire intervals allows greater height development and fuller canopies with greater percent cover. Small mammal and breeding bird response is strongly associated with this change (Masters 2002, Masters and others 2002).

At least 10 species of breeding birds are considered pine-grassland obligates and are benefited by pine-bluestem management (Wilson and others 1995, Conner and others 2002, Cram and others 2002, Masters and others 2002). This group of birds has declined more precipitously than any other group of songbirds in eastern North America (Jackson 1988). This group includes red-cockaded woodpecker, red-headed woodpecker, brown headed nuthatch, northern bobwhite, prairie warbler, pine warbler, Bachman's sparrow, chipping sparrow, eastern wood-pewee, and indigo bunting (see Wilson and others 1995, Cram and others 2002, Masters and others 2002). Other

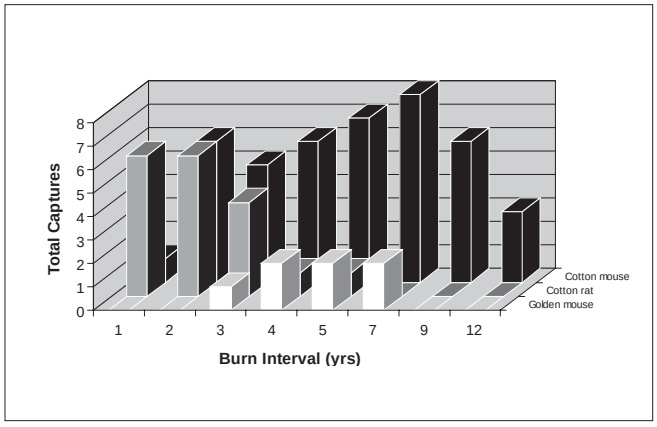

Figure 5.—Response of cotton mouse, cotton rat, and golden mouse to different fire frequencies on the Stoddard fire plots (three replications of 0.5-acre units), Tall Timbers Research Station, Tallahassee, FL. These pine-grassland stands were dominated by mature (>100 years) old-field derived shortleaf and loblolly and in the sub-canopy a mixture of oaks and other hardwoods of varying prevalence depending on fire frequency. From Masters (2002), L. Perkins, Jr., Tall Timbers Research Station (unpublished data).

species that have been noted to increase to some extent with pine-grassland management include the great-crested flycatcher, Acadian flycatcher, brown-headed cowbird, ruby-throated hummingbird, summer tanager, red-eyed vireo, yellow-throated vireo, white-breasted nuthatch, yellow-billed cuckoo, blue-gray gnatcatcher, hairy woodpecker and downy woodpecker (Masters and others 2002). Of note is the fact that these birds have in many cases been considered inhabitants of mixed oak-pine stands and hardwood stands. Their presence is likely related to retention of oaks and other hardwoods within pine-bluestem managed areas and associated hardwoods along ephemeral drainages within stands (Masters and others 2002). Size, composition, and juxtaposition of surrounding stands, as well as size of the stand that has been restored influence the species abundances found within restored stands. These characteristics are important for species that locally are sensitive to habitat condition, as has been found true of the Northern bobwhite quail (Cram and others 2002).

In pine-bluestem stands, there is a rapid successional progression of bird species not considered to be pine-grassland obligates that are associated with increasing height of lower-midstory hardwoods and pine depending on the duration since the last burn (Masters and others 2002). Following three or more growing seasons after burning, species such as the indigo bunting, yellow-breasted chat, common yellow throat, Northern cardinal, and blue grosbeak use the shrubs that develop in the lower midstory. However, other species like the chipping sparrow, Northern bobwhite, prairie warbler, and Eastern wood pewee will decline with increased woody cover in the lower midstory (Wilson and others 1995, Masters and others 2002). The importance of fire in maintaining suitable habitat structure was well illustrated in a recent study by Walsh (2004) in which Northern bobwhite avoided early seral stands and mature stands when they had not been burned for 3 to 5 years. These findings may also apply to the total small mammal community. A salient point is that the understory structure of pine woodlands and forests largely determines the composition of the bird community (Johnston and Odum 1956) and of the small mammal community. Desirable woodland and forest structure can be altered or maintained naturally by periodic fire (Masters and others 2002).

Snag retention has been named as a potential problem in frequently burned woodlands. Snags are essential for primary- and secondary-cavity nesting songbirds (e.g., red-headed woodpecker and eastern bluebird, respectively) (Masters and others 2002) and for southern flying squirrels (Taulman and Smith 2004). Periodic low-intensity fire can be of benefit in creating future snags, but fire under extended dry conditions will consume snags. Burning when snags have high moisture content (>25 percent) (Scott and Burgan 2005) or when the Keetch-Byram Drought Index (KBDI) is low will prevent consumption.

With fire exclusion and the resultant development of a hardwood mid- to upper midstory the pine-grassland obligate species will cease to use the stands (Wilson and others 1995, Masters and others 2002). Species related to a midstory hardwood presence such as the red-eyed vireo, black and white warbler, summer tanager, scarlet tanager, Acadian flycatcher, ovenbird, and worm-eating warbler become more prevalent. Midstory hardwood development has been directly associated with cavity tree abandonment by red-cockaded woodpeckers and subsequent population declines (Masters and others 1989, Jackson and others 1986).

As a food resource, shortleaf pine seed is an important and preferred food source for northern bobwhite (R.E. Masters, Tall Timbers Research Station, unpublished data) and for numerous small mammals (Stephenson and others 1963), including flying squirrels, fox squirrels, and gray squirrels as well as numerous ground-feeding song birds (Martin and others 1951). Shortleaf pine seed production in the southern Ozarks and in the Ouachita Mountains may be characterized as a “boom” or “bust” phenomenon with about one-third of the seed crops considered either good or bumper seed crops (Shelton and Wittwer 1996). Extensive consumption of shortleaf seed by many songbirds and small mammals has been reported as a hindrance to suitable seedling establishment from either natural seed fall or direct seeding of sites (Lawson 1990).

SUMMARY AND CONCLUSIONS

Although no wildlife species specifically requires shortleaf pine as a habitat element, a number of wildlife species do require a pine component to their habitats. Because of its distribution and abundance, shortleaf pine provides this structural and compositional element over a large area. As such, shortleaf pine satisfies habitat requirements for many breeding songbirds and is an important cover component and food resource for many songbird and mammal species. Only the pine warbler, brown-headed nuthatch and red-cockaded woodpecker require a pine species, but not specifically shortleaf. Within the range of shortleaf pine, wildlife species are variously associated with shortleaf pine based on the structural stage of stand development and the specific niche that a given wildlife species occupies. Specifically, stand density and thus understory conditions, and the proportion of hardwoods within a stand strongly influence the distribution and abundance of wildlife species associated with shortleaf at a given seral stage.

Fire frequency and season, to some extent, define the understory plant community response and determine shortleaf pine’s potential for regeneration, establishment, and perpetuation within a given stand and the relative mix with other associated tree species. This understory community response to fire or lack of fire defines the

response of many of the ground-dwelling or ground-foraging wildlife species. However, a number of wildlife species are associated with the fire regime that corresponds to the occurrence of shortleaf pine, especially to the understory structure which varies with frequency of fire. This association is particularly true for pine-grassland obligate songbirds, and numerous small mammals.

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Appendix.—List of common and scientific names of bird and mammal species mentioned in the text and figures.

Common Name	Scientific Name (authority)
Birds	
Acadian Flycatcher	*Empidonax virescens* (Vieillot)
American Crow	*Corvus brachyrhynchos* (Brehm)
American Goldfinch	*Carduelis tristis* (Linnaeus)
American Kestrel	*Falco sparverius* (Linnaeus)
American Redstart	*Setophaga ruticilla* (Linnaeus)
Bachman's Sparrow	*Aimophila aestivalis* (Lichtenstein)
Black and White Warbler	*Mniotilta varia* (Linnaeus)
Blue Grosbeak	*Guiraca caerulea* (Linnaeus)
Blue Jay	*Cyanocitta cristata* (Linnaeus)
Blue-gray Gnatcatcher	*Polioptila caerulea* (Linnaeus)
Broad-winged Hawk	*Buteo platypterus* (Vieillot)
Brown Thrasher	*Toxostoma rufum* (Linnaeus)
Brown-headed Cowbird	*Molothrus ater* (Boddaert)
Brown-headed Nuthatch	*Sitta pusilla* (Latham)
Carolina Chickadee	*Poecile carolinensis* (Audubon)
Carolina Wren	*Thryothorus ludovicianus* (Latham)
Chipping Sparrow	*Spizella passerina* (Bechstein)
Common Flicker	*Colaptes auratus* (Linnaeus)
Common Yellowthroat	*Geothlypis trichas* (Linnaeus)
Cooper's Hawk	*Accipiter cooperii* (Bonaparte)
Downy Woodpecker	*Picoides pubescens* (Linnaeus)
Eastern Bluebird	*Sialia sialis* (Linnaeus)
Eastern Wood Pewee	*Contopus virens* (Linnaeus)
Field Sparrow	*Spizella pusilla* (Wilson)
Great-crested Flycatcher	*Myiarchus crinitus* (Linnaeus)
Great-horned Owl	*Bubo virginianus* (Gmelin)
Hairy Woodpecker	*Picoides villosus* (Linnaeus)
Hooded Warbler	*Wilsonia citrina* (Boddaert)
Indigo Bunting	*Passerina cyanea* (Linnaeus)
Kentucky Warbler	*Oporornis formosus* (Wilson)
Mourning Dove	*Zenaida macroura* (Linnaeus)
Northern Bobwhite	*Colinus virginianus* (Linnaeus)
Northern Cardinal	*Cardinalis cardinalis* (Linnaeus)
Northern Parula	*Parula americana* (Linnaeus)
Ovenbird	*Seiurus aurocapillus* (Linnaeus)
Pileated Woodpecker	*Dryocopus pileatus* (Linnaeus)
Pine Warbler	*Dendroica pinus* (Wilson)
Prairie Warbler	*Dendroica discolor* (Vieillot)
Red-bellied Woodpecker	*Melanerpes carolinus* (Linnaeus)
Red-cockaded Woodpecker	*Picoides borealis* (Vieillot)
Red-eyed Vireo	*Vireo olivaceus* (Linnaeus)
Red-headed Woodpecker	*Melanerpes erythrocephalus* (Linnaeus)
Ruby-throated Hummingbird	*Archilochus colubris* (Linnaeus)
Scarlet Tanager	*Piranga olivacea* (Gmelin)
Summer Tanager	*Piranga rubra* (Linnaeus)
Tufted Titmouse	*Baeolophus bicolor* (Linnaeus)
Whip-poor-will	*Caprimulgus vociferous* (Wilson)
White-breasted Nuthatch	*Sitta carolinensis* (Latham)
White-eyed Vireo	*Vireo griseus* (Boddaert)
Wild Turkey	*Meleagris gallopavo* (Linnaeus)
Wood Thrush	*Hylocichla mustelina* (Gmelin)
Worm-eating Warbler	*Helmitheros vermivorus* (Gmelin)
Yellow-billed Cuckoo	*Coccyzus americanus* (Linnaeus)
Yellow-breasted Chat	*Icteria virens* (Linnaeus)
Yellow-throated Vireo	*Vireo flavifrons* (Vieillot)
Small Mammals	
Cotton Mouse	*Peromyscus gossypinus* (LeConte)
Deer Mouse	*Peromyscus maniculatus* (Wagner)
Eastern Woodrat	*Neotoma floridana* (Ord)
Fulvous Harvest Mouse	*Reithrodontomys fulvescens* (Allen)
Golden Mouse	*Ochrotomys nutalli* (Harlan)
Hispid Cotton Rat	*Sigmodon hispidus* (Say and Ord)
House Mouse	*Mus musculus* (Linnaeus)
Pine Vole	*Microtus pinetorum* (LeConte)
Southern Short-tailed Shrew	*Blarina carolinensis* (Bachman)
White-footed Mouse	*Peromyscus leucopus* (Rafinesque)
Other Mammals	
Bison	*Bison bison* (Linnaeus)
Eastern cotton-tailed rabbit	*Sylvilagus floridanus* (Allen)
Elk	*Cervus elaphus* (Linnaeus)
Fox squirrel	*Sciurus niger* (Linnaeus)
Gray squirrel	*Sciurus carolinensis* (Gmelin)
Southern flying squirrel	*Glaucomys volans* (Linnaeus)
White-Tailed deer	*Odocoileus virginianus* (Zimmermann)