Characteristic Mammals and Birds of Longleaf Pine Forests

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ABSTRACT

The structure and plant species composition of natural longleaf pine (Pinus palustris) forests varies in response to disturbance (particularly fire and hurricanes), hydrology and soil quality. Bird and mammal community composition reflects this variation. To define the mammal and bird communities, I considered the entire distribution of longleaf pine, including the forests in eastern Texas and western Louisiana. Considerably more information is available for birds than for mammals. Based primarily on community-wide surveys, 36 mammal and 86 bird species (35 residents, 29 breeders and 22 winter visitors) are characteristic of longleaf pine forest. Three mammal species, bison (Bison bison), red wolf (Canis rufus) and mountain lion (Felis concolor), and one bird species, ivory-billed woodpecker (Campephilus principalis) have been extirpated from the distribution of longleaf since European settlement.

Species that largely are sympatric with longleaf pine and commonly use the habitat type are: southeastern pocket gopher (Geomys pinetis), southeastern fox squirrel (4 subspecies of Sciurus niger), red-cockaded woodpecker (Picoides borealis), brown-headed nuthatch (Sitta pusilla) and Bachman's sparrow (Aimophila aestivalis). Sixty-nine percent of the mammals and 36 percent of the characteristic bird species forage primarily on or near the ground in longleaf forest. This is one measure of the importance of the ground cover to the mammalian and avian communities. Fire is essential for maintaining this important component of the vegetation.

INTRODUCTION

The process of identifying bird and mammal species that are characteristic of longleaf pine forests is as difficult as defining the longleaf pine plant community. The broadest categories of longleaf forest, based primarily on soil and hydrological characteristics, are flatwoods, sandhills, and clayhills (Abrahamson and Hartnett 1990; Myers 1990). These have been subdivided into 12 natural community types east of the Mississippi River (Allard 1990) and seven types in the west Gulf Coastal Plain (Bridges and Orzell 1989). Wahlenberg (1946) described the overstory of undisturbed longleaf forest as a monoculture, but ground cover composition and the structure of longleaf pine community types vary. Savannas with few trees and a ground cover of palmettos, forest with tall trees and prairie-like ground cover, and sparsely vegetated scrub in deep sand are a few of the structural types. Bird and mammal communities of longleaf reflect these variations.

In addition to variation in natural longleaf communities, humans have eliminated large portions of the original habitat and modified much of the remainder. Possibly as little as 500 ha of old-growth longleaf pine forest remains (Davis 1990). Longleaf individuals can be found in suburban settings, dense commercial plantings or regeneration areas, and intermixed with hardwoods following fire exclusion, but natural longleaf forests maintained with frequent fires are increasingly rare (Means and Grow 1985).

Many longleaf communities were eliminated or severely disturbed before systematic community-level studies of vertebrates were undertaken. Also, structural components of old-growth forest, such as old trees, mixed age-class distribution and horizontal patchiness that existed before European settlement, have been lost in the remaining second-growth forests. Therefore, our knowledge of the mammal and bird communities of longleaf is incomplete.

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The purpose of this paper is to identify characteristic bird and mammal species of longleaf pine forests and to examine how some changes in habitat structure and composition have affected longleaf pine forest bird and mammal communities.

MAMMALS OF LONGLEAF

To compose the initial list of mammals, I first compared range maps of individual species (Hall 1981; Schmidly 1983) with the distribution of longleaf pine (Little 1971). This provided a comprehensive list of all potential members of the community. I determined habitat affinities of these species from a literature search and included a species if it was explicitly associated with longleaf. The habitat-specific, systematic surveys of mammals at St. Marks National Wildlife Refuge (United States Fish and Wildlife Service 1980) and along the proposed corridor for the Cross Florida Barge Canal (Florida Game and Fresh Water Fish Commission 1976) were particularly useful. Jennings (1958) provided most of the information about habitat preferences in bats. Thirty-seven species of mammals have ranges that both overlap with the distribution of longleaf pine and are associated with longleaf habitat in the literature (Table 1). Three species, plains pocket gopher, fulvous harvest mouse and northern pygmy mouse, are only sympatric with longleaf in Texas and Louisiana in the west Gulf Coastal Plain.

The mammal community of longleaf has changed over time. Four species, feral swine, northern pygmy mouse, armadillo, and coyote (Table 1) have spread into longleaf forests since European settlement. Swine escaped from Hernando DeSoto's expedition in 1539 and feral populations became established throughout the coastal plain (Hanson and Karstad 1959). Feral and free-ranging domestic swine were detrimental to longleaf reproduction during settlement of the coastal plain (Frost 1993). The northern pygmy mouse probably was restricted to the coastal prairie in eastern Texas before extensive habitat disturbance, but it spread northward into pine-oak forests in the 1970s (Schmidly 1983). First reported in southern Texas along the Rio Grande (Bailey 1905), the armadillo spread into the western Gulf Coastal Plain in the early 1900s and was introduced into Florida during World War I (McBee and Baker 1982). It currently is widespread throughout the Coastal Plain. The coyote, through a combination of range expansion and local introductions, is becoming increasingly common in the Southeast (Bekoff 1977).

In addition to the 36 species currently found in longleaf, three species, red wolf (Canis rufus), mountain lion (Felis concolor) and bison (Bison bison) have been extirpated. Although red wolves are being reintroduced into coastal North Carolina, this large predator has been reduced to such low numbers that it essentially has been eliminated from the distribution of longleaf. Only a small population of mountain lions exists in southern Florida south of the distribution of longleaf, although individuals were seen in central Florida in the mid-1970's (Florida Game and Fresh Water Fish Commission 1976). Bison were distributed widely "although in relatively dispersed and small populations" at the time of European settlement in the sixteenth century (McDonald 1981). The species was eliminated from the southeastern Coastal Plain by the early nineteenth century.

Four additional species, ringtail (Bassariscus astutus), gray wolf (Canis lupus), jaguar (Felis onca), and ocelot (Felis pardalis), which occurred in the western Gulf Coastal Plain in Texas and Louisiana (Bailey 1905), have been extirpated. The degree of use of longleaf habitat by these four species is unknown, but probably was small. The introduced black rat (Rattus rattus), has been recorded in longleaf flatwoods, but only as a transient (Layne 1974). Thirty-two additional mammal species overlap in range with longleaf, but use longleaf forests rarely or accidentally.

Foraging zones provide one indication of the importance of different structural aspects of longleaf forest to the mammal community. Most of the characteristic mammals (25 species, 69%) forage primarily on the ground. Seventeen percent are aerial feeders, 8% are subterranean and 6% feed at least partially in trees. Twenty-seven percent of the species are microtine or cricetine rodents that dwell in ground cover vegetation. These species in particular would be susceptible to alteration of the ground cover.

Of 36 species of mammals that are characteristic of longleaf pine forest, longleaf is used by some species more than others. Most of the species (29) either overlap with longleaf extensively, but have very large distributions of which longleaf is only a small part (eg. raccoon) or have distributions that are mostly peripheral to longleaf (eg. plains pocket gopher).

Seven species, Seminole bat, yellow bat, southeastern fox squirrel, southeastern pocket gopher, marsh rice rat, Florida mouse and oldfield mouse, share at least two-thirds of their distribution with

Table 1. Characteristic mammals of longleaf pine forest and references that describe the species' association with longleaf. Longleaf is not necessarily the primary habitat of the species listed below. Scientific names follow Jones et al. (1979).

Species	Reference
Virginia opossum (Didelphis virginiana)	FGFWFC (1976)[1]
Southeastern shrew (Sorex longirostris)	USFWS (1980)[2]
Southern short-tailed shrew (Blarina carolinensis)	USFWS (1980)
Least shrew (Cryptotis parva)	USFWS (1980)
Eastern mole (Scalopus aquaticus)	Golley (1962)
Eastern pipistrelle (Pipistrellus subflavus)	Jennings (1958)
Southeastern myotis (Myotis austroriparius)	FGFWFC (1976)
Red bat (Lasiurus borealis)	Jennings (1958)
Seminole bat (L. seminolus)	Jennings (1958)
Yellow bat (L. intermedius)	Jennings (1958)
Evening bat (Nycticeius humeralis)	Jennings (1958)
Nine-banded armadillo (Dasypus novemcinctus)	Fitch et al. (1952)
Eastern cottontail (Sylvilagus floridanus)	FGFWFC (1976)
Gray squirrel (Sciurus carolinensis)	FGFWFC (1976)
Fox squirrel (S. niger)[3]	Weigl et al. (1989)
Southern flying squirrel (Glaucomys volans)	FGFWFC (1976)
Southeastern pocket gopher (Geomys pinetis)	FGFWFC (1976)
Plains pocket gopher (G. bursarius)	Schmidly (1983)
Hispid cotton rat (Sigmodon hispidus)	FGFWFC (1976)
Eastern harvest mouse (Reithrodontomys humulis)	USFWS (1980)
Fulvous harvest mouse (R. fulvescens)	Schmidly (1983)
Marsh rice rat (Oryzomys palustris)	USFWS (1980)
Florida mouse (Podomys floridanus)	Stout et al. (1988)
Oldfield mouse (Peromyscus polionotus)	FGFWFC (1976)
Cotton mouse (P. gossypinus)	FGFWFC (1976)
Golden mouse (Ochrotomys nuttalli)	USFWS (1980)
Northern pygmy mouse (Baiomys taylori)	Schmidly (1983)
Pine vole (Microtus pinetorum)	USFWS (1980)
Raccoon (Procyon lotor)	FGFWFC (1976)
Long-tailed weasel (Mustela frenata)	Pournelle (1950)
Striped skunk (Mephitis mephitis)	FGFWFC (1976)
Coyote (Canis latrans)	Pers. obs.
Red fox (Vulpes vulpes)	Sunquist (1989)
Gray fox (Urocyon cinereoargenteus)	Sunquist (1989)
Wild boar (Sus scrofa)[4]	Hanson and Karstad (1959)
White-tailed deer (Odocoileus virginianus)	FGFWFC (1976)

[1] FGFWFC = Florida Game and Fresh Water Fish Commission
[2] USFWS = United States Fish and Wildlife Service.
[3] The southeastern fox squirrel is a combination of 4 subspecies. The entire range of fox squirrel is much larger. (See text).
[4] Introduced.

that of longleaf. Most of these species use a wide range of habitats, but for the fox squirrel and southeastern pocket gopher longleaf could be considered primary habitat.

Historically, the southeastern pocket gopher probably occurred most commonly in sandy soils associated with upland longleaf. Currently, pocket gopher burrows can be found in roadsides and pastures where longleaf has long since disappeared. The southeastern fox squirrel is an amalgamation of four subspecies (cinerea, niger, shermani, and bachmani) and is restricted to the southeastern Coastal Plain. These subspecies are significantly larger and have a more variable pelage than the "western" subspecies (Weigl et al. 1989). The southeastern fox squirrel occurs extensively in longleaf although it was probably rare in large stands of pure longleaf in Texas (Schmidly 1983).

The Florida mouse has a highly restricted distribution in peninsular Florida and is found mostly in sand pine (Pinus clausa) scrub (Stout 1981, Stout et al. 1988), but sandhill longleaf pine-turkey oak (Quercus laevis) woodland is also an important habitat.

BIRDS OF LONGLEAF

I composed the list of birds from 18 Breeding Bird Censuses (BBC) and 11 Winter Bird Population Studies (WBPS) that have been conducted in longleaf forests (Appendix I). All species that visited or held territories on at least one BBC or WBPS were considered characteristic species (Table 2). The foraging zones of the birds of the longleaf community were classified according Ehrlich et al. (1988).

The list of characteristic bird species of longleaf pine forest is subdivided into residents, breeders and winter visitors (Table 2). I did not include transients in this paper. Residents are those species that were found on at least one BBC and one WBPS. Most breeders are long-distance neotropical migrants, but also include species that shift to other habitats in the winter (eg. brown-headed cowbird). Winter visitors migrate from northern breeding grounds and use longleaf for foraging and roosting seasonally.

The standardized bird counts (BBC and WBPS) were made in a variety of structural types of longleaf. The habitats where the bird counts were made include a mature longleaf monoculture in rich clayey uplands (Thomasville, Georgia), sandhills (North Carolina and Gainesville, Florida), mixed hardwood-pine (Mississippi), and flatwoods (Okefenokee National Wildlife Refuge, Georgia).

BBCs have been conducted in longleaf at two sites in Florida, three sites in Georgia, one site in South Carolina, and one site in Mississippi. Fewer WBPSs have been conducted in longleaf, but winter counts have been made at one site in Florida, two sites in Georgia, and two sites in North Carolina (Appendix I). Unfortunately, no BBCs or WBPSs have been conducted in longleaf habitat in the western Gulf Coastal Plain.

All characteristic species were ranked according to abundance and frequency of occurrence (Table 2). Abundance categories for the breeding season were based on the maximum number of territories per 40 ha observed over all BBCs. The abundance categories (number of territories per 40 ha) are: 1 (visitor), 2 (0.5-5), 3 (5.5-10), 4 (10.5-15), and 5 (>15). Frequency of occurrence is the percentage of sites at which a species was observed. All years were pooled for each site. There were 7 BBC sites and 5 WBPS sites. Categories for frequency of occurrence (%) for both the breeding season and winter are the same: 1 (1-20), 2 (21-40), 3 (41-60), 4 (61-80), and 5 (81-100). Abundance categories for winter were based on the maximum number of individuals observed per visit standardized to the number expected on 40 ha. These categories (average number of individuals per 40 ha) are: 1 (<1), 2 (1-5), 3 (6-10), 4 (7-15), and 5 (>15).

Eighty-six species of birds (excluding migrants) occur in longleaf pine forests based on the BBC and WBPS. Thirty-five are residents, 29 are breeders, and 22 are winter visitors (Table 2). Of the breeders, 21 species migrate mostly to the neotropics. Eight species, Wild Turkey, Black Vulture, Barred Owl, Common Ground-dove, Fish Crow, Blue-gray Gnatcatcher, Field Sparrow and the Brown-headed Cowbird, either shift to other habitats or migrate to south Florida in the winter. The wild turkey, for example, uses longleaf seasonally for brood habitat (Sisson 1991).

Although BBC and WBPS sites were not randomly chosen, frequency of occurrence provides a measure of the relative likelihood that a species will be encountered on a longleaf site. Seven species, northern bobwhite, red-headed woodpecker, blue jay, Carolina wren, eastern bluebird, northern cardinal, and great crested flycatcher, were encountered on more than 80 percent of the sites in the breeding season. Brown-headed nuthatch, pine warbler, American robin, and yellow-rumped warbler, were seen on more than 80 percent of the sites in winter.

Table 2. Characteristic birds of longleaf pine forest. All residents were visitors or territorial on at least one BBC and WBPS; all breeders were visitors or territorial on at least one BBC; and all winter visitors were seen on at least one WBPS. Abundance and frequency of occurence of all species were ranked on a scale of one (low) to five (high) for the breeding season and winter. (See text.) Scientific names follow the American Ornithologists' Union (1983).

Residents	Foraging* Technique	Breeding Abun.	Breeding Freq.	Winter Abun.	Winter Freq.
Wood duck (Aix sponsa)	D	2	1	2	1
Turkey vulture (Cathartes aura)	P	1	1	2	2
Red-tailed hawk (Buteo jamaicensis)	P	1	1	1	1
Red-shouldered hawk (B. lineatus)	P	2	1	1	2
American kestrel (Falco sparvarius)	HP	1	1	1	3
Northern bobwhite (Colinus virginianus)	G	4	5	4	2
Mourning dove (Zenaida macroura)	G	4	3	2	3
Great horned owl (Bubo virginianus)	S	2	1	2	2
Red-bellied woodpecker (Melanerpes carolinus)	B	3	4	3	4
Red-headed woodpecker (M. erythrocephalus)	H	4	5	3	1
Downy woodpecker (Picoides pubescens)	B	2	3	2	4
Hairy woodpecker (P. villosus)	B	2	3	2	3
Red-cockaded woodpecker (P. borealis)	B	2	3	4	4
Northern flicker (Colaptes auratus)	G	3	4	3	2
Pileated woodpecker (Dryocopus pileatus)	B	2	1	2	2
Blue jay (Cyanocitta cristata)	G	3	5	3	2
American crow (Corvus brachyrhynchos)	G	3	2	3	3
Carolina chickadee (Parus carolinensis)	F	2	3	3	3
Tufted titmouse (P. bicolor)	F	5	3	4	3
White-breasted nuthatch (Sitta carolinensis)	B	3	2	3	3
Brown-headed nuthatch (S. pusilla)	B	5	4	5	5
Carolina wren (Thryothorus ludovicianus)	G	5	5	3	4
Eastern bluebird (Sialia sialis)	H	2	5	5	3
Gray catbird (Dumetella carolinensis)	G	1	1	2	1
Northern mockingbird (Mimus polyglottos)	G	5	3	1	2
Brown thrasher (Toxostoma rufum)	G	4	3	2	1
Loggerhead shrike (Lanius ludovicianus)	S	2	1	2	1
Pine warbler (Dendroica pinus)	F	5	4	5	5
Common yellowthroat (Geothlypis trichas)	F	5	3	5	2
Northern cardinal (Cardinalis cardinalis)	G	2	5	2	2
Rufous-sided towhee (Pipilo erythrophthalmus)	G	5	4	4	2
Bachman's sparrow (Aimophila aestivalis)	G	5	3	3	2
Eastern meadowlark (Sturnella magna)	G	4	3	5	2
Red-winged blackbird (Agelaius phoeniceus)	G	2	1	5	3
Common grackle (Quiscalus quiscula)	G	2	1	1	1
Breeders					
Black vulture (Coragyps atratus)	P	4	1		
Wild turkey (Melleagris gallopavo)	G	1	1		
Common Ground-dove (Columbina passerina)	G	2	1		
Yellow-billed cuckoo (Coccyzus americanus)	F	3	3		
Barred owl (Strix varia)	P	3	3		

Breeders, Cont'd.	Foraging Technique	Breeding Abun.	Breeding Freq.	Winter Abun.	Winter Freq.
Chimney swift (Chaetura pelagica)	A	1	2		
Common nighthawk (Chordeiles minor)	A	4	3		
Chuck-will's-widow (Caprimulgus carolinensis)	A	2	2		
Eastern wood-pewee (Contopus virens)	H	5	3		
Great crested flycatcher (Myiarchus crinitus)	H	5	5		
Eastern kingbird (Tyrannus tyrannus)	H	4	3		
Purple martin (Progne subis)	A	1	3		
Fish crow (Corvus ossifragus)	G	1	2		
Blue-gray gnatcatcher (Polioptila caerulea)	F	5	3		
Wood thrush (Hylocichla mustelina)	G	4	1		
White-eyed vireo (Vireo griseus)	F	5	1		
Yellow-throated vireo (Vireo flavifrons)	F	4	3		
Red-eyed vireo (Vireo olivaceus)	F	2	1		
Northern parula (Parula americana)	F	2	1		
Prairie warbler (Dendroica discolor)	F	2	2		
Yellow-throated warbler (D. dominica)	F	2	1		
Hooded warbler (Wilsonia citrina)	F	2	1		
Yellow-breasted chat (Icteria virens)	F	3	1		
Summer tanager (Piranga rubra)	F	5	4		
Blue grosbeak (Guiraca caerulea)	G	5	3		
Indigo bunting (Passerina cyanea)	F	5	3		
Field sparrow (Spizella pusilla)	G	3	1		
Brown-headed cowbird (Molothrus ater)	G	3	3		
Orchard oriole (Icterus spurius)	F	2	1		
Winter visitors					
Yellow-bellied sapsucker (Sphyrapicus varius)	B			3	4
Eastern phoebe (Sayornis phoebe)	H			2	3
Tree swallow (Tachycineta bicolor)	A			1	1
Brown creeper (Certhia americana)	B			1	1
Red-breasted nuthatch (Sitta canadensis)	B			1	1
House wren (Troglodytes aedon)	G			5	3
Golden-crowned kinglet (Regulus satrapa)	F			1	3
Ruby-crowned kinglet (R. calendula)	F			3	3
Hermit thrush (Catharus guttatus)	G			2	2
American robin (Turdus migratorius)	G			5	5
Cedar waxwing (Bombycilla cedrorum)	F			1	1
Solitary vireo (Vireo solitarius)	F			3	3
Orange-crowned warbler (Vermivora celata)	F			1	1
Yellow-rumped warbler (Dendroica coronata)	F			5	5
Palm warbler (D. palmarum)	G			3	3
Chipping sparrow (Spizella passerina)	G			1	2
Song sparrow (Melospiza melodia)	G			2	1
Swamp sparrow (M. georgiana)	G			5	2
Dark-eyed junco (Junco hyemalis)	G			1	1
White-throated sparrow (Zonotrichia albicollis)	G			2	1
Pine siskin (Carduelis pinus)	F			2	1
American goldfinch (C. tristis)	F			5	4

*Foraging techniques (based on Ehrlich et al. 1988): A=aerial forage, B=bark glean, D=dabble, F=foliage glean, G=ground glean, H=hawk, HP=hover and pounce, P=patrol, and S=swoop.

For most species ranks of abundance and frequency of occurrence were similar (ranks equal or less than one rank apart). Twenty-two species were locally abundant (abundance two or more ranks higher than frequency of occurrence) in either the winter or the breeding season (eg. common yellowthroat). Several residents show seasonal changes in use of longleaf or at least changes in detectability. For example, mourning dove, Carolina wren, northern mockingbird, brown thrasher, and Bachman's sparrow were more abundant or more detectable in the breeding season than in the winter. Eastern bluebird and red-winged blackbird were more abundant in the winter than in the breeding season. Although these data are crude, they are useful for an initial examination of patterns of abundance and distribution. A model that includes vegetation structure would be valuable.

Some relatively rare birds that use longleaf do not appear on the lists composed from BBC and WBPS data. The bald eagle (Haliaeetus leucocephalus) frequently uses tall living pines for its nest trees (Wood et al. 1989). The Florida sandhill crane (Grus canadensis pratensis) is sometimes found in open, wet flatwoods, but it prefers wet savannas and pastures (Williams 1978).

Two bird species, the ivory-billed woodpecker and the passenger pigeon (Ectopistes migratorius) have been extirpated from longleaf. The ivory-billed woodpecker was found in mature hardwood swamps and floodplain forests throughout most of its range. Evidence that the ivory-billed woodpecker used pine forests came from A. A. Allen and P. P. Kellogg, who found that this woodpecker nested in swamps and fed on fire-killed trees in the pinelands in Florida (pg.16, Tanner 1942). Tanner (1942) speculated that use of upland pine forests by the woodpecker explained why it was relatively more abundant in Florida than in other parts of its range.

The extent to which passenger pigeons used longleaf is unclear. Ridgway (in Mershon 1907) explicitly excludes the pigeon from longleaf. Jackson (1988), however, cites indirect evidence that pigeons ate turkey oak acorns, which is a common associate of longleaf. However, most accounts of pigeon habitat describe hardwood dominance.

Foraging techniques indicate structural aspects of longleaf forests that are important to birds. Nineteen bird species (22% of the characteristic species) forage in the air by aerial-foraging, hawking, patrolling, swooping or hover-pouncing. The number of perches and openness of the habitat are important to these birds. Ten species (12%) are primarily bark gleaners and 25 (29%) are foliage gleaners. Thirty-one species (36%) forage on or close to the ground. The importance of ground cover to the avian community of longleaf is indicated by this large number.

Of all the characteristic bird species, three are most closely associated with longleaf. Red-cockaded woodpecker, brown-headed nuthatch, and Bachman's sparrow use longleaf extensively and are sympatric with longleaf to a significant degree. The dependence of the red-cockaded woodpecker on older age-class pine trees for nesting sites is well-known (Wood 1983). Brown-headed nuthatches forage on the bark and needles of pines and nest in low snags. Bachman's sparrows nest and forage in dense ground cover of open pine forests. Although Bachman's sparrows will breed in clearcuts, they prefer open mature stands of timber with low, thick ground cover (Dunning and Watts 1990).

CHANGES IN FOREST STRUCTURE AND COMPOSITION

Not only has the longleaf pine ecosystem been dramatically reduced in size through conversion to other land uses, but virtually all of the remainder has been altered. Alteration of natural fire frequency and season, forest fragmentation, harvest of old trees, and elimination of native groundcover are some of the major changes. The effects of these changes are not well understood, although forest fragmentation and elimination of old trees (>100 years old) have been implicated in the decline of at least one bird species, the red-cockaded woodpecker (Anonymous 1990, Baker 1981).

Little research has been done on the effects of fire on mammals and birds of longleaf pine forests. However, the effects of fire exclusion on the mammal and bird communities were studied in an oldfield pine forest of loblolly (Pinus taeda) and shortleaf (P. echinata) pine that had a thick diverse ground cover (Engstrom et al. 1984). The gross structural changes following fire exclusion in longleaf pine forest would be similar to those observed in this oldfield forest. Forest structure changed dramatically following fire exclusion. In 15 years a thick midstory of sweetgum (Liquidambar styraciflua) and water oak (Quercus nigra) shaded out most of the ground cover vegetation and most of the young pines.

The small mammal and bird communities changed radically during the 15 years of fire exclusion on this oldfield forest. Virtually all small ground-dwelling mammals were eliminated from the community after 15 years without fire. The southern flying squirrel was the only species captured in small live-traps in the forest toward the end of the study (W.W. Baker pers. comm.). Bird species that typically nest in vegetation on the ground (Bachman's sparrow) or forage in open habitats (eastern kingbird) also disappeared within a few years of fire exclusion. Species that require more mesic conditions, such as hooded warbler and wood thrush, increased in abundance toward the end of the 15-year study period.

Hirth et al. (1991) described the bird community in an "old-growth" longleaf pine forest in central Florida that had not been burned in many years. Remnants of wiregrass (Aristida stricta) indicated a more abundant ground cover before fire exclusion (pers. obs.). Although no data on the bird community was available before fire exclusion, absence of the closest avian associates of longleaf (red-cockaded woodpecker, brown-headed nuthatch, and Bachman's sparrow) could have been caused by changes in forest structure.

The effects of fire exclusion on mammal and bird communities in southeastern upland pine forests are dramatic. But in longleaf forests that are burned, the effects of season of fire, especially growing season fires, are poorly understood. As interest increases in using growing season fire to enhance flowering of certain plant species or to control hardwoods, the direct and indirect effects of growing season fire on mammals and birds need to be documented. Maintenance of a schedule of frequent prescribed fire is essential for the long-term persistence of the characteristic mammals and birds of longleaf.

CONCLUSIONS

Although any list of mammals and birds for an entire forest type is incomplete and somewhat arbitrary, certain limited generalizations can be made from the lists provided. Significant portions of the mammal and bird communities forage on the ground. This indicates that the quality and composition of the ground cover should be important considerations for longleaf pine forest management. Fire is most important factor for ground cover management.

The mammal and bird species that have been extirpated from longleaf pine forest could not be called longleaf specialists. In fact most of them probably only used longleaf occasionally. Of the species that are most closely associated with longleaf only the red-cockaded woodpecker is federally endangered, although the Bachman's sparrow is under consideration for listing. Implementing ecologically sensitive land and timber management techniques will improve the long-term prospects for retaining the mammal and bird communities of the longleaf pine forest.

Appendix I.

Breeding Bird Censuses and Winter Bird Population Studies that have been conducted in longleaf pine forest.

State	County	Citation
FL	Alachua	Allen, T. T., D. E. Birkenholz, and D. A. Jenni. 1960. BBC 18. Longleaf pine-turkey oak association. Audubon Field Notes 14:497-498.
GA	Thomas	Baker, W.W. 1989a. WBPS 11. Mature longleaf pine forest. Journal Field Ornithology 60:12.
GA	Thomas	_____1989b. BBC 84. Mature longleaf pine forest. Journal of Field Ornithology 60:70.
GA	Thomas	Engstrom, R.T. 1980a. Mature longleaf pine forest. WBPS No.15. American Birds 34:29-30.
GA	Thomas	_____1980b. Mature longleaf pine forest. BBC No.4. American Birds 34:61.
GA	Thomas	_____1981. Mature longleaf pine forest. BBC No.80. American Birds. 35:69.
GA	Thomas	_____1982a. Mature longleaf pine forest. WBPS No.8. American Birds. 36:31.
GA	Thomas	_____1982b. Mature longleaf pine forest. BBC No.86. American Birds. 36:74.
GA	Thomas	_____1983. Mature longleaf pine forest. WBPS No.13. American Birds. 37:34.
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