CHAPTER 25

# Bird Communities of Southern Forests

**William C. Hunter**
*US Fish and Wildlife Service*
*1875 Century Boulevard, Suite 240, Atlanta, GA*

**James G. Dickson'**
*US Forest Service*
*Southern Research Station, Nacogdoches, TX*

**David N. Pashley**
*American Bird Conservancy*
*4249 Loudoun Avenue*
*P.O. Box 249*
*The Plains, VA*

**Paul B. Hamel**
*US Forest Service*
*Southern Hardwoods Lab*
*P.O. Box 227 Stoneville, MS*

Birds constitute a high-profile group of species that attract a great deal of attention as watchable wildlife. Also, birds are important as indicators of habitat conditions and environmental health. Compared to other groups of animals and plants, birds are relatively conspicuous and can be easily monitored. Available information on bird ecology is substantial, but understanding the management requirements for most nongame bird species **lags** far behind existing knowledge for managing game species.

The moderate climate and diverse forests across the South support abundant and diverse communities of breeding, wintering, and migrating birds. Bird communities in the South have been shaped and influenced by human beings and the vast land use changes that have taken place. Generally, species associated with old-growth forests have declined with the demise of that habitat, and a few species, such as the Carolina parakeet and passenger pigeon, became extinct as the region was cleared of timber and remaining wildlife was hunted for commercial market. Other species are precariously close to extinction and include the ivory-billed woodpecker and Bachman's warbler. Only the warbler's demise cannot be exclusively tied to events in the Southeast U.S., as habitat loss in Cuban wintering areas also likely contributed to declines (Hamel 1986). Some exotics such as European starlings and native species associated with habitats altered by human beings such

'Current Address: School of' Forestry, Louisiana Tech University, Ruston, LA

Above: Dense closed-canopy pine stands with little understory vegetation receive virtually no use by birds *(A. US Fish & Wildlife* Service). Above, right: Stands with some understory hardwoods support species, such as wood thrush and hooded warbler (right) *(B. US Fish & Wildlife Service) (C. B. Duyck, Cornell Lab of Ornithology).*

as cowbirds, grackles, and crows generally have increased over the last 2 centuries and are generally recognized as predators, competitors, and parasites for many other species now in decline. Other species, such as wild turkeys and peregrine falcons, recently have benefitted from direct management, and the decline of others, such as the red-cockaded woodpecker, is being addressed.

In this chapter we present information on birds of southern forests, emphasizing species and habitat conditions in need of special management attention throughout the Southeast. Detailed information on individual species can be found in Hamel (1992a). We do not concentrate on game and endangered bird species because information for these species is detailed in individual chapters. Recommendations for habitat management and for the future are presented.

We present first some general concepts regarding bird communities and forest characteristics in the South and then an explanation of how the Partners in Flight prioritization process can be used to guide both management and research priorities. The body of this chapter reviews the status and trends of priority species associated with each of the following habitats found in the South (see physiographic regions in color section): (1) early-successional and shrub-scrub, (2) southern pine, (3) forested wetlands, (4) hardwood-pine mixed forests, (5) central hardwoods, and (6) Appalachian forests. Under each of these subsections, priority species are described and management recommendations are provided. We end this chapter with a discussion of broad trends in landbird populations in the South and a call for caution in using population trends.

**Birds and Forest Stands**

Bird species distribution and community composition generally are determined by landscape and stand scale habitat conditions. Forest bird communities are associated with foliage layers (MacArthur and MacArthur 196 1), foliage volume (Willson 1974), habitat patchiness (Roth 1976), and stand successional stage (Shugart and James 1973, Dickson and Segelquist 1979). The diversity of forest type and stand structure, including age (characteristics that influence bird species occurrences and abundance) are primary determinants of the presence and relative abundance of bird species (Dickson et al. 1993).

In pine stands the hardwood component is the primary determinant of bird community composition (Johnston and Odum 1956, Dickson and Segelquist

1979). Changes to stand structure, such as from tree harvesting, change stand suitability for bird species and communities (Webb et al. 1977, Thompson et al. 1992). Usually in southern pine and hardwood stands bird density and diversity are high in young brushy stands, decrease in dense pole stands as canopies close and shade out understory, and are highest in older stands with distinct vegetation layers. Thus, changes in stand structure and plant species composition through management results in decreases of some species, increases in others, and has little effect on others. This in turn requires determination of which species should receive the most attention in establishing management priorities for defining future desired conditions and allocation of resources accordingly.

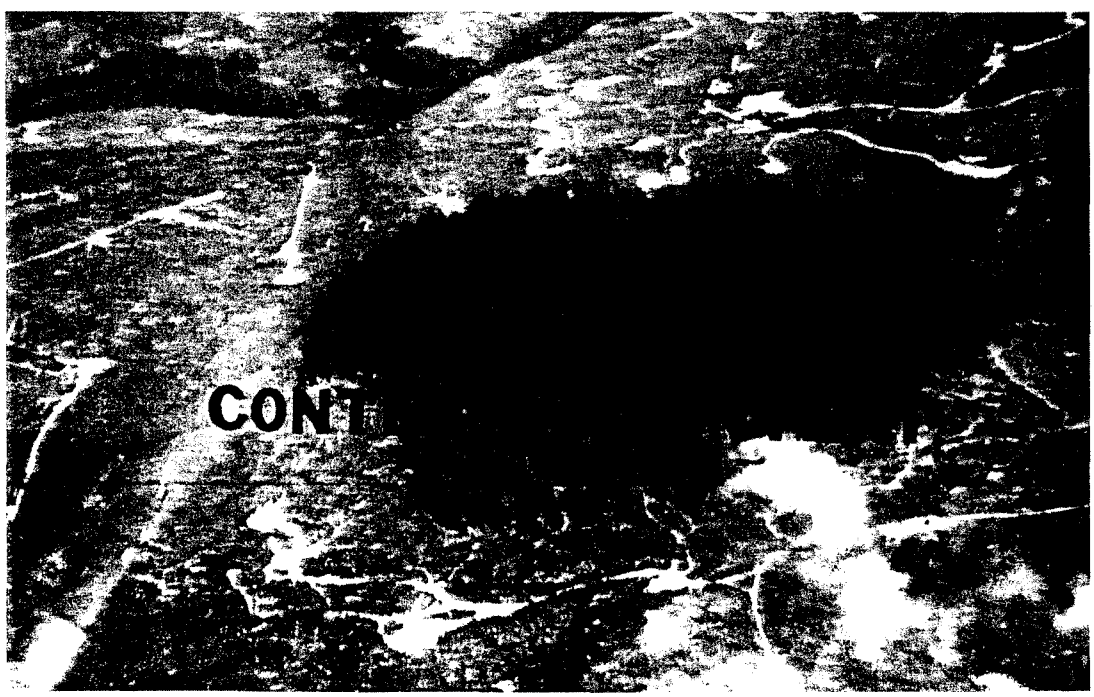
**Concerns for Southern Forest Birds**

The Southeastern landscape has been manipulated by people for millennia (Hamel and Buckner 1998). Since European colonization, impacts of human activities have dominated the landscape. Several physiographic areas formerly dominated by forests (Mississippi Alluvial Plain, much the valley portions of Ridge and Valley, Piedmont, and upper Coastal Plain in South Atlantic and East Gulf states) are now predominantly agricultural. Elsewhere, retirement of agricultural lands has resulted in a widespread recovery of forests (Williams 1989). However, some of these forests may not be suitable for many vulnerable forest bird species. Many of the stands are mid successional, characterized by closed canopies and with little understory and midstory structure. Short-rotation pine monocultures continue to increase in extent. Finally, southern forests generally are increasingly fragmented from recent expansion of residential subdivisions and industrial development accompanying rapid increase in human populations.

From these changes in landscape during the 1900s, 2 overall bird conservation concerns have emerged in recent decades: (1) nearctic-neotropical migratory birds, and (2) grassland birds.

***Nearctic-Neotropical Migratory Birds*** .— Monitoring data indicate recent population declines leading to concern for nearctic-neotropical migratory birds in general (Robbins et al. 1989a,b, 1992). Nearctic-neotropical migrants are those species that breed in temperate areas of North America and winter in the tropics. These reported declines, based on interpretation of Breeding Bird Survey (BBS) data from 1966 to 1987, followed studies showing localized declines of nearctic-neotropical migrants in increasingly urbanized areas and in agriculturally-dominated landscapes, especially in the mid Atlantic and midwest United States (Aldrich and Coffin 1980, Robbins 1980, Blake and Karr 1987, Rappole and McDonald 1994, Robinson et al. 1995, Smith et al. 1996, Latta and Baltz 1997).

These declines were occurring when there was an overall increase in mature forests in eastern North America while tropical forests were being reduced,



Content vs. Context. For bird conservation planning it is important to view the condition of the surrounding landscape as well as the forest stand of interest. There are concerns about bird population viability in heavily fragmented landscapes due to heavy nest predation and parasitism from brown-headed cowbirds (US Fish & Wildlife Service).

Fire historically has been important in maintaining early-successional habitat conditions in older open pine stands.

implying that declines were due to wintering ground effects. However, reasons for the declines of nearctic-neotropical migrants are now understood to be complex and include (1) reduced breeding habitats (perhaps as much in quality as quantity), (2) reduced wintering habitats, (3) increasing threats during migration, (4) predation or competition from other species such as exotics, and (5) possible contaminants (Hagan and Johnston 1992, Finch and Stangel 1993), such as direct exposure to chemicals or indirect effects (global climate change, acid rain, ozone).

Estimated relative densities of representative migratory birds in forest stands of different ages (or stand suitability for bird species) are presented for hardwood forests (Table 1), loblolly-shortleaf pine forests (Table 2), longleaf and slash pine forests (Table 3), and oak-gum-cypress forests (Table 4). These densities may serve as baseline figures for monitoring future population changes.

***Grassland*** Species.-Although this chapter focuses on forest bird species, many species use southern forests that exhibit grassy and shrub-scrub characteristics either through regeneration or disturbances. Many species are particularly associated with fire-maintained forest communities exhibiting grassy or shrub-scrub conditions.

An erroneous. although common, perception has been that declines among nearctic-neotropical migrants involve only forest "area-sensitive" and "forest-interior" species, even though this was never the inference of the authors (Robbins et al. 1989a,b). In fact, many of the nearctic-neotropical migrant species showing the steepest and longest-term declines are grassland and

**Table** 1. Abundance of nearctic-neotropical migratory birds in central hardwood forests.[a]

| Species | Stand age[b] | | | | | |
|---|---|---|---|---|---|---|
| | R | S | P | M | | GT |
| Whip-poor-will | U[c] | U | U | U | **u** | **u** |
| Ruby-throated hummingbird | C | N | N | N | **?** | **N** |
| Acadian flycatcher | N | N | C | A | N | A |
| Eastern wood-pewee | N | N | U | A | N | A |
| Eastern phoebe | N | N | U | U | N | U |
| Great-crested flycatcher | C | C | C | C | c | c |
| Blue jay | C | C | C | C | c | c |
| American crow | U | U | U | U | u | u |
| Carolina wren | C | C | U | N | ? | ? |
| Blue-gray gnatcatcher | A | C | C | C | c | c |
| Eastern bluebird | C | N | N | N | N | N |
| Wood thrush | U | C | C | C | u | c |
| Gray catbird | C | C | N | N | ? | N |
| White-eyed vireo | C | C | N | N | ? | N |
| Yellow-throated vireo | N | N | N | U | N | U |
| Red-eyed vireo | U | U | A | A | U | A |
| Blue-winged warbler | A | C | N | N | ? | N |
| Golden-winged warbler | C | U | N | N | ? | N |
| Northern parula | N | N | U | C | N | C |
| Chestnut-sided warbler | C | C | N | N | ? | N |
| Yellow-throated warbler | N | N | U | U | N | U |
| Pine warbler | N | N | C | C | N | C |
| Prairie warbler | A | C | N | N | ? | N |
| Black-and-white-warbler | C | C | C | C | c | c |
| Worm-eating warbler | U | C | C | C | c | c |
| Ovenbird | U | C | C | C | u | u |
| Louisiana waterthrush | N | U | C | C | c | c |
| Common yellowthroat | A | U | N | N | ? | N |
| Kentucky warbler | A | C | U | U | A | C |
| Hooded warbler | C | C | U | U | c | c |
| Yellow-breasted chat | A | C | N | N | ? | N |
| Orchard oriole | U | N | N | N | N | N |
| Summer tanager | C | C | C | A | c | c |
| Scarlet tanager | U | U | C | A | U | A |
| Indigo bunting | A | C | U | U | A | C |
| Eastern towhee | A | U | N | N | C | N |
| Field sparrow | A | N | N | N | ? | N |
| Brown-headed cowbird | A | C | C | C | c | c |
| American goldfinch | U | N | N | N | N | N |

[a] Data from Dickson et al. (1993)

[b] R = regeneration, S = sapling, P = poletimber, M = mature. G = group selection, T = single tree selection.

[c] A = abundant, C = common or regular, P = present, U = uncommon, N = not present.

Frequent fire promotes grass-forb vegetation important for many species, but some shrub-scrub structure supports associated species, such as prairie warbler and field sparrow (US *fish & Wildlife Service).*

shrub-scrub associated species. Widespread declines also are seen among temperate migrant and resident grassland and shrub-scrub species (Capel et al. 1994), and have been documented for key game species such as ruffed grouse, northern bobwhite, and American woodcock (see individual chapters). In sum, declining and vulnerable species can be found among all types of habitats as well as having differing migration strategies. These complexities should inhibit generalizations for cause and effect relationships based solely on population trend or grouping of species by either habitat preferences or migration status.

**Partners in Flight Prioritization Process**

The Partners in Flight Prioritization Process (PIF Process) was developed to help focus conservation efforts on the species or species assemblages most requiring conservation attention (Millsap et al. 1990, Hunter et al. 1993a,b, Carter et al. 2000). The PIF Process is based on a comparative review of those global and local characteristics that may make each species potentially vulnerable, such as relative global abundance and distribution, broad and local level of threat, population trend, and area importance (a measure of relative density within an area compared with other areas within the species' range).

Population trends and some of the other information used to define priority bird species are based on BBS data from southeastern physiographic areas defined by Partners in Flight. Seventeen of these physiographic areas, similar to Bailey's ecoregions (McNab and Avers 1994), include southern forest habitats important for bird conservation.

Table 2. Abundance Of nearctic-neotropical migratory birds in loblolly-shortleaf pine forests".

| Species | Stand age[b] | | | | |
|---|---|---|---|---|---|
| | R | S | P | M | O |
| Whip-poor-will | N[c] | N | N | N | ? |
| Ruby-throated hummingbird | U | U | U | U | U |
| Acadian flycatcher | N | N | U | C | C |
| Eastern wood-pewee | N | U | P | C | A |
| Eastern phoebe | N | N | N | N | ? |
| Great-crested flycatcher | N | N | U | P | C |
| Blue jay | U | U | C | A | C |
| American crow | U | U | P | C | C |
| Blue-gray gnatcatcher | N | N | U | C | A |
| Eastern bluebird | U | U | N | N | P |
| Wood thrush | N | N | U | C | A |
| American robin | N | U | U | U | U |
| Gray catbird | U | U | N | U | U |
| White-eyed vireo | U | A | P | U | C |
| Yellow-throated vireo | N | N | U | A | C |
| Red-eyed vireo | N | U | C | A | A |
| Blue-winged warbler | N | N | N | N | N |
| Golden-winged warbler | N | N | N | N | N |
| Northern parula | N | N | U | U | C |
| Chestnut-sided warbler | N | N | N | N | N |
| Pine warbler | N | N | C | A | A |
| Prairie warbler | C | A | N | N | U |
| Black-and-white-warbler | N | U | C | C | C |
| Worm-eating warbler | N | N | C | C | C |
| Chuck-will's-widow | U | U | U | U | U |
| Ovenbird | N | N | U | C | C |
| Louisiana waterthrush | N | N | N | P | P |
| Kentucky warbler | N | U | C | P | P |
| Hooded warbler | N | U | C | A | C |
| Yellow-breasted chat | C | A | U | N | P |
| Summer tanager | N | N | U | C | C |
| Scarlet tanager | N | N | U | U | U |
| Indigo bunting | N | A | P | U | P |
| Eastern towhee | N | P | C | C | P |
| Field sparrow | C | U | N | N | N |
| Brown-headed cowbird | P | C | P | P | N |
| American goldfinch | U | U | U | U | U |
| Blue grosbeak | C | U | N | N | N |

[a] Data from Dickson et al. (1993)

[b] R = regeneration, S = sapling, P = poletimber, M = mature, O = oldgrowth.

[c] A = abundant, C = common or regular, P = present, U = uncommon, N = not present.

Table 3. Abundance of nearctic-neotropical migratory birds in longleaf and slash pine forests[a].

| Species | Stand age[b] | | | | |
|---|---|---|---|---|---|
| **Longleaf Pine** | | | | | |
| Common nighthawk | P[c] | P | U | U | U |
| Chuck-will%-widow | | | U | U | U |
| Eastern wood-pewee | | | U | C | C |
| Acadian flycatcher | | | | P | P |
| Great-crested flycatcher | U | P | | | |
| Eastern kingbird | | | P | P | |
| Purple martin | U | | | | |
| Barn swallow | U | | | | |
| Prairie warbler | c | | | | |
| Summer tanager | | U | U | C | C |
| Blue grosbeak | P | P | | | |
| **Slash Pine** | | | | | |
| Yellow-billed cuckoo | | | U | U | U |
| Ruby-throated hummingbird | C | C | | | |
| Eastern wood-pewee | | | C | | |
| Acadian flycatcher | | | C | | |
| Great-crested flycatcher | | P | C | C | |
| Eastern kingbird | P | | | | |
| Bewick's wren | | | C | | |
| Blue-gray gnatcatcher | P | P | | | |
| White-eyed vireo | | C | | | |
| Yellow-throated vireo | | P | | | |
| Yellow-throated warbler | C | | | | |
| Prairie warbler | U | U | U | | |
| Common yellowthroat | | C | P | P | P |
| Yellow-breasted chat | | C | | | |
| Summer tanager | C | | C | C | C |
| Blue grosbeak | P | P | | | |
| Indigo bunting | C | C | P | U | U |
| **Longleaf-Slash Pine** | | | | | |
| Osprey | | | | U | U |
| American swallow-tailed kite | | | U | U | |
| Yellow-billed cuckoo | P | | | | |
| Common nighthawk | P | U | U | U | U |
| Chuck-wili's-widow | | | U | U | U |
| Ruby-throated hummingbird | U | | | | |
| Eastern wood-pewee | | | U | C | C |
| Great crested flycatcher | P | | U | P | P |
| Eastern kingbird | U | U | U | U | U |
| Purple martin | U | | | | |
| Barn swallow | U | | | | |
| White-eyed vireo | | C | C | | |
| Yellow-throated warbler | U | U | U | U | |
| Prairie warbler | U | U | U | U | U |
| Common yellowthroat | U | P | P | C | C |
| Yellow-breasted chat | U | U | | | |
| Summer tanager | | U | U | P | P |
| Blue grosbeak | P | P | | | |
| Indigo bunting | c | C | P | U | U |

a Data from Dickson et al. (1993)
b R = regeneration, S = sapling, P = poletimber, M = mature, 0 = old growth.
c A = abundant, C = common or regular, P = present, U = uncommon

Table 4. Nearctic-neotropical migrant breeding bird species present in southeastern oak-aum-cvoress forests[a].

| | |
|---|---|
| Anhinga | Blue-gray gnatcatcher |
| Green heron | White-eyed vireo |
| Great blue heron | Yellow-throated vireo |
| Little blue heron | Red-eyed vireo |
| Cattle egret[b] | Warbling vireo |
| Great egret | Black-and-white warbler |
| Snowy egret | Prothonotary warbler |
| Tricolored heron | Swainson's warbler |
| Black-crowned night-heron | Worm-eating warbler |
| Yellow-crowned night-heron | Bachman's warbler |
| Wood stork | Northern parula |
| Glossy ibis | Black-throated green warbler |
| White ibis | Yellow-throated warbler |
| Hooded merganser | Cerulean warbler |
| Swallow-tailed kite | Ovenbird |
| Mississippi kite | Louisiana waterthrush |
| Cooper's hawk | Kentucky warbler |
| Bald eagle | Common yellowthroat[c] |
| Osprey | Yellow-breasted chat[c] |
| Purple gallinule | Hooded warbler |
| Common moorhen | American redstart |
| Mourning dove[b] | Eastern meadowlark[b] |
| Yellow-billed cuckoo | Red-winged blackbird |
| Chimney swift[b] | Brown-headed cowbird[b] |
| Ruby-throated hummingbird | Orchard oriole |
| Belted kingfisher | Baltimore oriole |
| Great-crested flycatcher | Summer tanager |
| Eastern phoebe[b] | Scarlet tanager |
| Acadian flycatcher | Blue grosbeak[c] |
| Eastern wood pewee | Indigo bunting" |
| Barn swallow[b] | Painted bunting[c] |
| Purple martin[b] | Eastern towhee[c] |
| Wood thrush | |

a From Hamel et al. 1982 and Dickson et al 1993.
b Associated with human altered non-forest habitat.
c Associated with early successional stands.

Based on the PIF process 64 bird taxa are identified as high regional priority species (Table 5, Hunter et al. in prep.). An additional 20 relatively widespread species are considered of moderate regional priority. These species collectively help guide habitat restoration and management objectives. In order to compare relative management priorities among major habitats (see Table 6), we can compare the proportion of all species showing definite and possible declining trends in each habitat type (Table 5) as discussed below.

**Table** 5. Regional and physiographic area priority levels assigned by the Southeast U.S. Partners in Flight Working Group. E = extremely high priority for physiographic area (total priority score 28-35), H = high priority (total priority score 22-27), M = moderate priority (total priority score 1 g-21, with high scores for relative abundance and unknown or declining population trends), L = low priority for physiographic area. Species included as of High Regional Priority within the Southeast are those meeting criteria listed for at least high priority within at least 3 physiographic areas for widespread species or for narrowly distributed species these same criteria are met for at feast 1 physiographic areas where they occur. Species included as of Moderate Regional Priority within the Southeast are those meeting criteria for at least moderate priority within at feast 4 physiographic areas or high priority in 2-3 physiographic areas. Population trend is one of seven factors leading to overall priority scores,

| Regional priority species | Physiographic area[a] | | | | | | | | | Priority level and population trend[b] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | B5 | C1 | c2 | c3 | c4 | D1 | D2 | D3 | E1 |
| ***High regional priority*** | | | | | | | | | | | | | | | | | |
| Swallow-tailed Kite | | | | | | | | | | | | | | | | | |
| Southeast U.S. subsp. | | | | | E,0 | | | E,0 | E,0 | E,0 | | | | E,-* | E,0 | | E,-* |
| Snail Kite | | | | | | | | | | | | | | | | | |
| Everglades subsp. | | | | | | | | E,- | E,- | | | | | | | | |
| Short-tailed Hawk | | | | | | | | | | | | | | | | | |
| Florida pop. | | | | | | | | E,0 | E,0 | | | | | | | | |
| Crested Caracara | | | | | | | | | | | | | | | | | |
| Florida pop. | | | | | | | | E,- | E,-* | | | | | | | | |
| American Kestrel | | | | | | | | | | | | | | | | | |
| Southeast US. subsp. | | | | | E,- | | | E,- | H,-* | H,- | | | | H,- | | | |
| Greater Prairie-Chicken | | | | | | | | | | | | | | | | | |
| Attwater's subsp. | | | | | | | | | | | | | | | | | E,-* |
| Sandhill Crane | | | | | | | | | | | | | | | | | |
| Mississippi subsp. | | | | | | | | | | E,-* | | | | | | | |
| Florida subsp. | | | | | E,0 | | | H,+* | | E,0 | | | | | | | |
| Upland Sandpiper | | H,-* | H,-* | H,-* | | | | | | | | | | | | | |
| American Woodcock | H,- | H,- | L,O | L,O | H,- | H,- | L,0 | L,- | | H,- | L,0 | L,0 | L,0 | H,- | H,- | L,0 | H,- |
| Yellow-billed Cuckoo | L,+ | L,+ | L,- | M,-* | L,-* | L,0 | L,0 | L,-* | L,0 | H,-* | M,-* | L,+ | H,-* | H,-* | H,-* | L,+ | M,- |
| Burrowing Owl | | | | | | | | | | | | | | | | | |
| Florida subsp. | | | | | | | | E,0 | E,- | | | | | | | | |
| Short-eared Owl | | | | | | | | | | | | | | | | | |
| Temperate subsp. | H,-* | L,-* | L,-* | L,0 | H,-* | L,-* | L,-* | L,-* | L,-* | L,-* | L,-* | L,-* | L,-* | L,-* | H,-* | H,-* | H,-* |
| Northern Saw-whet Owl | | | | | | | | | | | | | | | | | |
| S. Appalachian pop. | | | E,- | | | | E,- | | | | | | | | | | |
| Chuck-will's-widow | L,+ | L,0 | L,0 | L,O | L,+ | L,+ | L,0 | L,+ | L,0 | H,-* | H,- | L,0 | L,- | H,-* | L,0 | L,+ | L,0 |
| Red-headed Woodpecker | L,+* | L,+ | L,0 | L,- | L,+ | L,0 | L,0 | M,-* | | M,-* | L,-* | L,0 | H,-* | H,-• | H,-* | H,-* | M,- |
| Yellow-bellied Sapsucker | | | | | | | | | | | | | | | | | |
| S. Appalachian pop. | | | E,-* | | | | E,-* | | | | | | | | | | |
| Red-cockaded Woodpecker | E,-* | | | | E,- | E,O | E,-* | E,O | E,O | E,- | E , O | E,-* | | E,- | | E,-* | |
| Eastern Wood-Pewee | H,-* | L,+ | H,-* | H,-* | L,+ | M,- | M,-* | L,0 | | M,-* | M,-* | H,-* | H,-* | H,-* | M,-* | M,- | L,0 |
| Acadian Flycatcher | L,0 | L,0 | L,+ | H,+ | L,+* | L,0 | H,-* | L,0 | | L,+* | H,-* | f-f,-* | L,+ | L,+ | L,+ | H,-* | L,0 |
| Scissor-tailed Flycatcher | | | | | | | | | | | | | | H,- | L,0 | L,+ | H,+ |
| Florida Scrub-Jay | | | | | | | | E,-* | E,-* | | | | | | | | |
| Black-capped Chickadee | | | | | | | | | | | | | | | | | |
| S. Appalachian pop. | | | H,+ | L,0 | | | E,-* | | | | | | | | | | |
| Red-breasted Nuthatch | | | | | | | | | | | | | | | | | |
| S. Appalachian pop. | | | E,0 | | | | H,- | | | | | | | | | | |
| Brown-headed Nuthatch | H,0 | H,0 | | | H,-* | H,0 | H,0 | H,0 | H,-* | H,- | H,+ | | | H,+ | | H,0 | |
| Brown Creeper | | | | | | | | | | | | | | | | | |
| S. Appalachian DOD. | | | E,0 | | | | H,- | | | | | | | | | | |

*continued*

**Table 5 continued**

| Regional priority species | Physiographic area[a] | | | | | | | | | Priority level and population trend[b] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | B5 | C1 | C2 | c3 | c4 | D1 | D2 | D3 | E1 |
| ***High regional priority*** | | | | | | | | | | | | | | | | | |
| Bewick's Wren | | | | | | | | | | | | | | | | | |
| Appalachian subsp. | | | E,-* | E,-* | E,-* | E,-* | E,-* | | | | E,-* | E,-* | | | | | |
| Eastern subsp. | | | | | | | | | | E.-• | | | E.-* | E.-• | | E,- | |
| Winter Wren | | | | | | | | | | | | | | | | | |
| S. Appalachian pop. | | | H,+ | | | | H,- | | | | | | | | | | |
| Sedge Wren | H,-* | L,0 | L,0 | H,0 | H,+ | L,+ | | H,+ | H,+ | H,+ | | | | L,+ | H,+ | | H,+ |
| Golden-crowned Kinglet | | | | | | | | | | | | | | | | | |
| S. Appalachian pop. | | | H,0 | | | | H,- | | | | | | | | | | |
| Wood Thrush | H,-* | H,-* | H,-*, | | L,+ | H,-• | H,0 | H,-• | | L,+ | H,-* | H,-* | H,- | L,0 | L,0 | H,- | L,0 |
| Sprague's Pipit | | | | | | | | | | | | | | H,-* | | | H,-* |
| Bell's Vireo | | | | | | | | | | | | | H,0 | H,0 | H,0 | H,- | H,0 |
| Yellow-throated Vireo | H,-* | L,+ | H,-* | L,+ | L,+* | L,+* | H,-* | L,0 | | L,+ | H,-* | H,0 | L,+ | L,+ | L,+ | L,0 | L,0 |
| Blue-winged Warbler | H,-* | L,0 | L,0 | L,+* | | | L,+ | | | L,0 | H,- | H,+* | | H,-* | | | L,+ |
| Golden-winged Warbler | | | E,-* | H,-* | | | E,-* | | | | | E,- | | | | | |
| Northern Parula | L,+ | L,+ | H,-* | L,0 | H,-• | L,+* | L,+ | L,+ | L,0 | L,+* | L,+ | L,+ | L,0 | L,0 | H,-* | L,+ | L,0 |
| Chestnut-sided Warbler | | | L,0 | L,+ | | L,0 | H,-* | | | | L,0 | L,- | L,0 | | | L,0 | |
| Black-throated Blue Warbler | | | H,0 | L,0 | | | H,- | | | | | H,0 | | | | | |
| Black-throated Green Warbler | | | | | | | | | | | | | | | | | |
| Atlantic Coastal DOD. | | | | | E,-* | | | | | | | | | | | | |
| Blackburnian Warbler | | | L,0 | L,0 | | | H,- | | | | | L,0 | | | | | |
| Prairie Warbler | | | | | | | | | | | | | | | | | |
| Northern subsp. | H,-* | H,+ | H,-* | H,-* | H,- | H,-• | H,- | H,-* | H,-* | H,-* | H,-* | H,-* | H,-* | H,-* | L,0 | H,-* | |
| Palm Warbler | | | | | M,-* | | | H,-* | H,-• | M,-* | | | | | | | |
| Cerulean Warbler | H,0 | H,O | E,-* | E,-* | H,0 | H,0 | H,0 | | | H,0 | H,0 | E,-* | E,-* | H,0 | E,-* | H,- | |
| Prothonotary Warbler | H,0 | L,0 | L,0 | L,0 | L,+* | L,0 | L,0 | L,0 | | H,-• | H,0 | L,0 | L,0 | H,-* | H,+ | H,- | H,0 |
| Worm-eating Warbler | H,+ | H,+ | H,+ | H,+ | H,+ | H,0 | H,+ | | | H,0 | H,0 | H,+ | H,0 | H,0 | H,0 | H,0 | |
| Swainson's Warbler | H,0 | | L,0 | H,0 | H,+* | | H,0 | E,- | | E,0 | H,0 | E,+ | L,0 | E,0 | E,0 | H,0 | H,0 |
| Louisiana Waterthrush | H.0 | H.+ | H,+ | H,- | L,+ | H,+ | H,-* | | | L,+* | H,-* | H,-* | H,0 | H,0 | L,0 | H,0 | |
| Kentucky Warbler | H,- | H,- | L,+ | H,+ | L,+* | H,0 | H,-* | | | H,+ | H,-* | H,0 | H,+ | H,-* | H,0 | H,0 | H,0 |
| Hooded Warbler | L,+ | L,+ | L,+ | L,+ | H,- | L,0 | H,+ | L,0 | | L,+* | L,0 | H,+ | L,0 | H,- | L,0 | L,0 | L,0 |
| Canada Warbler | | | L,+ | L,0 | | | H,0 | | | | | L,0 | | | | | |
| Painted Bunting | | | | | | | | | | | | | | | | | |
| Eastern subsp. | | | | | E,-* | | | E,0 | E,-* | | | | | | | | |
| Western subsp. | | | | | | | | | | L,0 | | | | L,+ | H,-* | L,0 | H,- |
| Dickcissel | L,0 | L,0 | L,0 | L,0 | L,0 | L,0 | | | | L,+ | L,0 | L,0 | H,-* | L,+ | L,+ | H,-• | H,0 |
| Bachman's Sparrow | H,0 | L,0 | | | E,-* | H,- | H,0 | E,0 | H,0 | E,-* | H,0 | L,0 | L,0 | H,0 | | H,0 | |
| Field Sparrow | M,-* | H,-* | M,-• | H,-* | M,- | H,-• | M,-* | | | M,-* | M,-* | M,-* | H,-* | L,-* | L,-* | H,-* | L,0 |
| Grasshoooer Sparrow | | | | | | | | | | | | | | | | | |
| Florida subsp. | | | | | | | | E,-* | E,-* | | | | | | | | |
| Henslow's Sparrow | H,0 | H,0 | H,0 | H,+ | E,- | E,-* | | H,- | | E,- | | H,0 | H,0 | E,- | H,- | | H,- |
| LeConte's Sparrow | | | | | H,+ | | | | | H,+ | | | | H,+ | H,+ | H,+ | H,+ |
| Orchard Oriole | L,+* | L,+ | L,0 | L,+ | L,+ | L,+ | L,0 | L,0 | | H,-• | H,-* | L,+ | L,+ | H,-* | H,-• | M,-* | L,+ |
| Red Crossbill | | | | | | | | | | | | | | | | | |
| S. Appalachian pops. | | | E,- | | | | E,- | | | | L,0 | L,0 | | | | | |

*continued*

**Table 5 continued**

| Regional priority species | Physiographic area[a] | | | | | | | | | Priority level and population trend[b] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | B5 | C1 | C2 | C3 | C4 | D1 | D2 | D3 | E1 |
| ***Moderate regional priority*** | | | | | | | | | | | | | | | | | |
| Northern Harrier | M,- | L,- | L,- | L,- | M,- | L,- | L,- | M,- | M,- | M,- | L,- | L,- | L,0 | L,- | M,- | L,0 | M,- |
| Northern Bobwhite | M,-• | M,-* | L,-* | L,-* | M,-* | M,-* | L,-* | M,-* | L,O | M,-* | M,-• | L,-* | M,-• | M,-* | M,-* | M,-* | M,-* |
| Common Ground-Dove | | | | | M,-* | L,0 | | M,-* | M,- | M,-* | | | | L,0 | L,0 | | |
| Barn Owl | M,-* | L,0 | | | M,0 | L,-* | | L,0 | M,0 | L,0 | L,0 | L,0 | L,0 | L,0 | L,0 | L,0 | M,0 |
| Whip-poor-will | L,0 | L,- | H,-* | L,+ | L,+* | L,0 | L,0 | L,0 | L,0 | L,+* | L,0 | L,0 | H,-* | L,0 | L,0 | L,+ | L,0 |
| Chimney Swift[c] | M,- | L,+ | L,+ | L,+ | L,+ | L,+ | L,- | L,0 | | M,-* | L,+ | L,+ | H,-* | L,+ | L,0 | L,+ | L,+* |
| Ruby-throated Hummingbird | L,+ | L,0 | L,0 | L,+* | L,+ | L,+ | M,-* | L,0 | L,0 | L,+* | M,0 | M,0 | L,+ | M,- | M,0 | L,+ | L,0 |
| Eastern Kingbird" | L,-* | L,-* | L,-* | L,- | L,- | L,- | L,- | L,-* | L,0 | M,-* | L,+ | L,+ | L,+ | M,-• | L,-* | L,+ | L,0 |
| Carolina Chickadee | M,-* | L,+ | L,+ | L,+ | M,- | M,- | L,- | L,- | | M,-* | M,-* | L,+ | L,+ | M,- | M,-* | M,- | L,t |
| Blue-gray Gnatcatcher | L,+ | L,+* | L,+ | M,- | L,+ | L,+* | M,-* | L,+ | L,0 | L,+* | L,+ | L,+ | M,- | M,- | M,-* | L,+ | L,0 |
| Gray Catbird | M,-* | L,+ | M,-* | L,+ | L,+ | L,-* | M,-• | M,-* | M,-* | L,-* | L,-* | M,-* | L,-• | L,0 | L,-* | L,-* | L,-• |
| Brown Thrasher | M,-* | M,-* | M,-• | M,-* | L,+ | L,+ | L,- | L,+ | L,0 | L,+ | H,-* | L,0 | L,+ | L,- | L,+ | M,-* | L,0 |
| Loggerhead Shrike[c] | L,-* | L,-* | L,-* | L,-* | L,- | L,-* | L,0 | H,-* | L,0 | M,-* | L,-* | L,0 | L,-* | L,-• | L,0 | L,-* | L,+ |
| White-eyed Vireo | M,-* | L,+* | L,-* | L,+* | L,+ | L,+ | L,- | L,+ | M,0 | L,+* | M,-* | L,+ | M,-* | H,-* | H,-* | L,+ | L,O |
| Yellow-throated Warbler | L,- | L,0 | L,0 | L,+* | H,0 | L,+ | L,0 | L,0 | L,0 | L,+ | H,-* | L,+ | L,+* | L,0 | L,+ | L,0 | L,0 |
| Black-and-white Warbler | L,0 | L,0 | M,-* | L,- | L,+* | L,+ | M,-* | L,0 | L,0 | L,0 | L,-* | M,0 | L,-* | L,- | L,0 | L,- | L,0 |
| Yellow-breasted Chat | L,- | L,+ | M,-* | M,-* | L,+* | L,+ | L,-* | | | L,+* | M,-* | M,-* | M,-* | L,+* | M,-* | L,+ | L,0 |
| Summer Tanager' | L,+ | L,+ | L,0 | L,+ | L,t | M,0 | L,- | L,0 | | L,+ | H,-* | M,-* | L,+ | L,+ | L,+ | L,+ | L,0 |
| Eastern Towhee | M,O | M,-* | M,-* | L,+ | M,-* | L,+ | L,- | M,-* | L,0 | L,+ | M,-* | M,-* | M,-* | L,+* | L,+ | L,-* | L,O |
| Lark Sparrow | | | | L,0 | | | | L,-* | L,-* | L,-* | | L,0 | L,- | M,-* | M , - * | M,-* | M,-* |
| Grasshopper Sparrow | | | | | | | | | | | | | | | | | |
| Eastern subsp. | L,-* | M,0 | M,-* | L,-* | M,-* | L,- | L,0 | M,-* | M,-* | M,-* | L,-* | L,0 | L,-* | M,-* | M,-* | L,+ | M,-* |
| Rusty Blackbird | M,-* | M,-* | L,-* | L,-* | M,-* | M,-* | L.-• | L,-* | L,-* | M,-* | M,-* | M,-* | M,-* | M,-* | M,-* | M,-* | M,-* |

[a]Physiographic areas (PIF Breeding Bird Survey code):
A1 =Mid Atlantic Coastal Plain (44)
A2=Mid Atlantic Piedmont (10)
A3=Mid Atlantic Ridge and Valley (12)
A4=Ohio Hills (22)
B1 =South Atlantic Coastal Plain (03)
B2=Southern Piedmont (11)
B3=Southern Blue Ridge (23)
B4=Peninsular Florida (02)
B5=Subtropical Florida (01)
C1=East Gulf Coastal Plain (04)
C2=Southern Ridge and Valley (13)
C3=Northern Cumberland Plateau (21)
C4=Interior Low Plateaus (14)
D1=West Gulf Coastal Plain (42)
D2=Mississippi Alluvial Plain (05)
D3=Ozark-Ouachita Highlands (19)
E1=Coastal Prairies (06; all U=upper coast)

[b]Population trends are: +*=definitely (significantly) increasing; +=possibly increasing or stable; 0=trend unclear; -=possibly decreasing; -*=definitely (significantly) decreasing. Most trends are based on the Breeding Bird Survey (see Appendix I) within physiographic areas for breeding species and for wintering species continental-wide data from Breeding Bird Survey or Christmas Bird Counts, as appropriate, were used.

Chimney Swift, Eastern Kingbird, Loggerhead Shrike, and Summer Tanager are included here as species of Moderate Regional Concern by meeting criteria in Table heading by combining physiographic area priority levels reported here with "western" physiographic areas, (E2=Oaks and Prairies, E3=Osage Plains, E4=Rolling Red Plains, E5=Staked and Pecos Plains, E6=Edwards Plateau, E7=South Texas Brushlands, E8=Chihuhuan Desert).

# PRIORITY FOREST HABITATS, SPECIES, AND MANAGEMENT RECOMMENDATIONS

## Early-Successional Forest and Shrub-Scrub Habitats

Birds associated with early-successional habitats and frequent disturbance fall into 3 broad groups: (1) grassland, (2) early-successional shrub-scrub, and (3) southern pine. Declines are apparent for 24 priority taxa (5 of these are Federally listed) associated with grasslands within this region (Tables 5,6). The largest number of grassland species occur in Peninsular and Subtropical Florida, the Coastal Plain (South Atlantic, East Gulf, and West Gulf), and Coastal Prairies. Only in very few places do remnants of historical prairie community types persist, with most prairie-dependent species now using a combination of both natural and anthropogenic grassland.

As with grassland species, high numbers of shrub-

Table 6. Primary habitat associations and seasonal status among priority landbird species within forested landscapes of the Southeastern U.S. (see Table 5). Most determinations are following Hamel 1992a. R=resident, B=breeding, W=wintering, B,W= refers to species using similar habitat but in different areas between seasons (i.e., highly migratory), lower case (r,b,w)=refers to habitats where species occurs in very tow densities but may still prove to be important to that species.

| | Major habitat types[a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Regional priority species** | **Grass** | **Shrub-scrub** | | | **Southern pine** | | | **Hardwood-dominated Forests** | | | | |
| | | ES | FE | Sav. | Grass | Shrub | Can. | Forested wetland | Hardwood pine mix | Central hardwoods | Appala. forests[b] | spruce fir |
| *High regional priority* | | | | | | | | | | | | |
| Swallow-tailed Kite | | | | | | | | | | | | |
| Southeast U.S. subsp. | | | | B | | | | B | | | | |
| Snail Kite | | | | | | | | | | | | |
| Everglades subsp. | R | | | | | | | | | | | |
| Short-tailed Hawk | | | | | | | | | | | | |
| Florida DOD. | | | | R | | | | R | | | | |
| Crested Caracara | | | | | | | | | | | | |
| Florida pop. | R | | | | | | | | | | | |
| American Kestrel | | | | | | | | | | | | |
| Southeast U.S. subsp. | R | | | R | R | | R | | | | | |
| Greater Prairie-Chicken | | | | | | | | | | | | |
| Attwater's subsp. | R | | | | | | | | | | | |
| Sandhill Crane | | | | | | | | | | | | |
| Mississippi subsp. | R | | | R | | | | | | | | |
| Florida subsp. | R | | | R | | | | | | | | |
| Upland Sandpiper | B | | | | | | | | | | | |
| American Woodcock | | B,W | | | | | | B,W | B,W | | B | |
| Yellow-billed Cuckoo | | | | | | | | B | B | B | B | |
| Burrowing Owl | | | | | | | | | | | | |
| Florida subsp. | R | | | | | | | | | | | |
| Short-eared Owl | | | | | | | | | | | | |
| Temperate subsp. | W | | | | | | | | | | | |
| Northern Saw-whet Owl | | | | | | | | | | | | |
| S. Appalachian pop. | | | | | | | | | | | b | R |
| Chuck-wills-widow | | | | | | B | | | B | | | |
| Red-headed Woodpecker | | | | R | | | B | B,W | | B,W | | |
| Yellow-bellied Sapsucker | | | | | | | | | | | | |
| S. Appalachian pop. | | | B | | | | | | | | B | |
| Red-cockaded Woodpecker | | | | R | | | R | | | | | |
| Eastern Wood-Pewee | | | | | | | B | B | B | B | B | |
| Acadian Flycatcher | | | | | | | | B | B | B | B | |
| Scissor-tailed Flycatcher | B | | | B | | | | | | | | |
| Florida Scrub-Jay | | R | | | | | | | | | | |
| Black-capped Chickadee | | | | | | | | | | | | |
| S. Appalachian pop. | | | | | | | | | | | b | R |
| Red-breasted Nuthatch | | | | | | | | | | | | |
| S. Appalachian pop. | | | | | | | | | | | b | R |
| Brown-headed Nuthatch | | | | R | | | R | | | | | |
| Brown Creeper | | | | | | | | | | | | |
| S. Appalachian pop. | | | | | | | | | | | b | R |
| Bewick's Wren | | | | | | | | | | | | |
| Appalachian subsp. | | B,W | | | | | | | | | | |

*continued*

**Table 6 continued**

| Regional priority species | Major habitat types[a] | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grass | Shrub-scrub | | Southern pine | | | | Hardwood-dominated | | | Forests | | |
| | | ES | FE | Sav. | Grass | Shrub | Can. | Forested wetland | Hardwood pine mix | Central hardwoods | Appala. forests[b] | Spruce fir | |
| ***High regional priority*** | | | | | | | | | | | | | |
| Eastern subsp. | | B,W | | | | | | | | | | | |
| Winter Wren | | | | | | | | | | | | | |
| S. Appalachian pop. | | | | | | | | | | | b | R | |
| Sedge Wren | W | | | w | w | | | | | | | | |
| Golden-crowned Kinglet | | | | | | | | | | | | | |
| S. Appalachian pop. | | | | | | | | | | | b | R | |
| Wood Thrush | | | | | | | | B | B | B | B | | |
| Soraaue's Pioit | W | | | | | | | | | | | | |
| Bell's Vireo | | B | | | | | | B | | | | | |
| Yellow-throated Vireo | | | | | | | | B | | B | B | | |
| Blue-winged Warbler | | B | | | | | | | | | | | |
| Golden-winged Warbler | | B | | | | | | | | | | | |
| Northern Parula | | | | | | | | B | B | B | B | | |
| Chestnut-sided Warbler | | | B | | | | | | | | | | |
| Black-throated Blue Warbler | | | | | | | | | | | B | | |
| Black-throated Green Warbler | | | | | | | | | | | | | |
| Atlantic Coastal pop. | | | | | | | | B | B | | | | |
| Blackburnian Warbler | | | | | | | | | | | B | B | |
| Prairie Warbler | | | | | | | | | | | | | |
| Northern subsp. | | B | | | | B | | | | | | | |
| Palm Warbler | | W | | | | W | | | | | | | |
| Cerulean Warbler | | | | | | | | B | B | B | B | | |
| Prothonotary Warbler | | | | | | | | B | | | | | |
| Worm-eating Warbler | | | | | | | | B | B | B | B | | |
| Swainson's Warbler | | | | | | | | B | B | | B | | |
| Louisiana Waterthrush | | | | | | | | B | | B | B | | |
| Kentucky Warbler | | | | | | | | B | B | B | B | | |
| Hooded Warbler | | | | | | | | B | B | B | B | | |
| Canada Warbler | | | | | | | | | | | B | B | |
| Painted Bunting | | | | | | | | | | | | | |
| Eastern subsp. | | | B,W | | | | | | | | | | |
| Western subsp. | | | B | | | B | | | | | | | |
| Dickcissel | B | | | | | | | | | | | | |
| Bachman's Sparrow | R | | | R | R | | | | | | | | |
| Field Sparrow | W | R | | ww | | R | | | | | | | |
| Grasshopper Sparrow | | | | | | | | | | | | | |
| Florida subsp. | R | | | | | | | | | | | | |
| Henslow's Sparrow | B,W | | | w | w | | | | | | | | |
| LeConte's Sparrow | W | | | | | | | | | | | | |
| Orchard Oriole | | | B | | | | | | | | | | |
| Red Crossbill | | | | | | | | | | | | | |
| S. Appalachian pops. | | | | | | | R | | | | R | R | |
| ***Moderate regional priority*** | | | | | | | | | | | | | |
| Northern Harrier | W | | | | | | | | | | | | |

**Table 6 continued**

| Regional priority species | Major habitat types[a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grass | Shrub-scrub | | | Southern pine | | | Hardwood-dominated Forests | | | | |
| | | ES | FE | Sav. | Grass | Shrub | Can. | Forested wetland | Hardwood pine mix | Central hardwoods | Appala. forests[b] | Spruce fir |
| ***Moderate regional priority*** | | | | | | | | | | | | |
| Northern Bobwhite | R | R | R | R | R | R | | | | | | |
| Common Ground-Dove | | R | | | | | | | | | | |
| Barn Owl | R | | | R | | | | | | | | |
| Whip-poor-will | | | | | | B | | | B | B | B | |
| Chimney Swift | | | | | | | | B | B | B | B | |
| Ruby-throated Hummingbird | | | | | | | | B | | B | B | B |
| Eastern Kingbird | B | | | B | | | | | | | | |
| Carolina Chickadee | | | | | | | R | R | R | R | R | |
| Blue-gray Gnatcatcher | | | W | | | w | | B | B | B | B | |
| Gray Catbird | | | B,W | | | | | | | | | |
| Brown Thrasher | | | B,W | | | | | | | | | |
| Loggerhead Shrike | R | | | R | | | | | | | | |
| White-eyed Vireo | | | B,W | | | B | | B | B | | | |
| Yellow-throated Warbler | | | | | | | B,W | B | B | B | B | |
| Black-and-white Warbler | | | | | | | | B | B | B | B | |
| Yellow-breasted Chat | | | B | | | B | | | | | | |
| Summer Tanager | | | | | | | B | B | B | B | B | |
| Eastern Towhee | | | B | | | B | | | | | | |
| Lark Sparrow | B,W | | | w | | | | | | | | |
| Grasshopper Sparrow | | | | | | | | | | | | |
| Eastern subsp. | B,W | | | w | w | | | | | | | |
| Rusty Blackbird | | | | | | | | W | | | | |

[a]Grass=Grasslands including prairies, warm-season grasses, regeneration areas and old fields generally I-5 years after disturbance. ES=early successional habitats in large blocks including bogs, glades, barrens, pocosins, regeneration areas and old fields generaly 6-10 years after disturbance. FE=forest edges typically with early successional habitats for species not typically found in high densities throughout a large habitat patch. Sav.=savannas here specifically refer to longleaf and slash pine savannas, but also may refer to any grassland with non-stocked pine of any species: Grass=here refers to grassy-dominated ground cover in a stocked pine stand: Shrub=here refers to a shrubby component to the pine understory; Can.=canopy here refers to species actually dependent upon mature pine, most with no or little hardwood in the midstory (stands with more hardwood midstory results in bird use more similar to hardwood-pine mix).

[b]Appala. Forests=Appalachian forests include here mature to old-growth northern hardwoods, hemlock-white pine-hardwoods. mixed mesophytic (cove) hardwoods, with various gradations into Appalachian oak (Central Hardwoods) types on drier more exposed sites and into spruce-fir at the highest elevations.

scrub species show widespread declines, with 20 priority species warranting management attention (Tables 5, 6). The federally threatened Florida Scrub-Jay is the highest priority species associated with disturbance regimes. Among non-listed taxa, both the Appalachian and eastern subspecies of Bewick's wren populations are temperate migrants that require conservation attention. Painted buntings, Bell's vireos, and golden-winged warblers are nearctic- neotropical migrants for which conservation attention primarily on their breeding grounds is warranted.

***Chestnut-sided and Prairie Warblers.-Some*** priority shrub-scrub species such as chestnut-sided and Prairie warblers are more common today than they were at the turn of the century. However, these species still have relatively small geographic distributions and should receive attention due to the rate at which their shrub-scrub habitat (fire maintained glades, barrens, savannas, etc.) is diminishing. In particular, the prairie warbler appears to have been a species associated primarily with shrub-scrub understories of regularly disturbed longleaf pine, especially in sandhills situations, as well as loblolly-shortleaf pine, and eastern red cedar-pine glades (Nolan 1978). The loss of these habitats through fire suppression appeared to be compensated for by the concurrent increase in old-fields and regeneration of forests through clearcutting. But the overall loss of shrub-scrub habitat in managed land-

scapes, including the suppression of natural fires is undoubtedly contributing to decline not only of the prairie warbler, but also field sparrow and northern bobwhite (Capel et al. 1994). The reduced disturbance and the overall maturing of forests has reduced populations of the chestnut-sided warbler at mid to high elevations in the Southern Appalachians. Roadside edges, however, presently seem to provide extensive and stable habitat.

***Golden-winged Warbler and Bewick's Wren.***— The golden-winged warbler, with its southeastern distribution also restricted to the Southern Appalachians, is much more of a specialist, using early-successional habitat generally at elevations between 2,000 and 5,000 feet. There is some question concerning its status. The Appalachian subspecies of the Bewick's wren has declined drastically. We speculate that the decline may be related to changes in landscape patterns where disturbances have diminished especially above 3,000 feet in elevation (see Southern Appalachian forest section). Previously, declines of Appalachian Bewick's wren were thought to be related to expansion of potentially competing house wrens. A more likely explanation is the reduction in number and acreage of small farms and brushpiles combined, followed by increasing amount of mature forest on public lands, with an increase in clean farming and rural housing developments on private lands (Southern Appalachian Assessment 1996). The fact that all Bewick's wren populations east of the Mississippi River are now undergoing steep declines with similar reductions in disturbance-prone habitats may provide a clue to the almost complete loss of the Appalachian populations.

***Management Recommendations.-Among*** priority early-successional species, the presence or absence of up to half of the priority early successional species may be influenced by patch size. The other half of priority species associated with disturbances tend to use narrow forest edges or small forest openings as well as larger openings and are not likely dependent upon habitat patch size (Table 6). Minimum habitat patch size recommendations based on mostly anecdotal evidence and studies in other regions suggest early successional species occur more consistently and have better nesting success in patches greater than 25-50 acres (Rudnicky and Hunter 1993, Thompson and Dessecker 1997).

A frequent management recommendation is to provide narrow shelterbelts (hedgerows), strips on farmland to reduce soil erosion from wind and to provide wildlife habitat. This practice benefits some game species like rabbits and northern bobwhite and some wintering birds, but may function as an "ecological trap" for many breeding birds.

Most importantly, special attention is needed for endangered early-successional shrub-scrub communities. Among these communities are fire-adapted understory vegetation of mature southern pine forests, pitcher plant bogs, cedar-pine glades, and mountain wetlands and similar high-elevation heath balds. Recovering these communities needs to be accomplished in combination with strategies for supporting species presently depending upon old-fields, abandoned farmland, and clearcuts (Capel et al. 1994).

**Southern Pine Forests and Pine Savannas**

Some of the 18 priority species associated with southern pine forests also show consistent declines among most Southeast physiographic areas (Tables 5,6). In addition to the species included in the discussion of early-successional and shrub species, 2 understory species (Chuck-will's-widow and Whip-poor-will) and 6 species using pines are treated in this section. This discussion here focuses primarily on savannas, sandhills, and flatwoods for species associated with longleaf, shortleaf, slash, and loblolly pines.

The federally endangered Mississippi sandhill crane and red-cockaded woodpecker are the highest priority birds dependent upon southern pine systems. Among the highest regional priority savanna species are Bachman's and Henslow's (winter only) sparrows. Many of the birds for which pine savanna forest is primary habitat also occur in grasslands or shrub-scrub habitat, including the above-mentioned sparrows, northern bobwhite, the southeastern subspecies of American kestrel (requires cavity trees), and loggerhead shrike (requires nest trees). Bachman's and Henslow's sparrows also are associated with longleaf and slash flatwoods where grasses dominate the groundcover.

Extensive patches of shrub-scrub mixed with grasses support prairie warblers, field sparrows, and other moderate regional priority species, especially in longleaf sandhills and loblolly-shortleaf stands. Species dependent on mature open southern pines with few hardwoods include principally the red-cockaded woodpecker, brown-headed nuthatch, and American kestrel (longleaf sandhills). Non-cavity species associated with open pine stands are eastern wood-pewee (high regional priority species), as well as Carolina chickadee and summer tanager (moderate regional priority species).

Many of the highest priority species within the

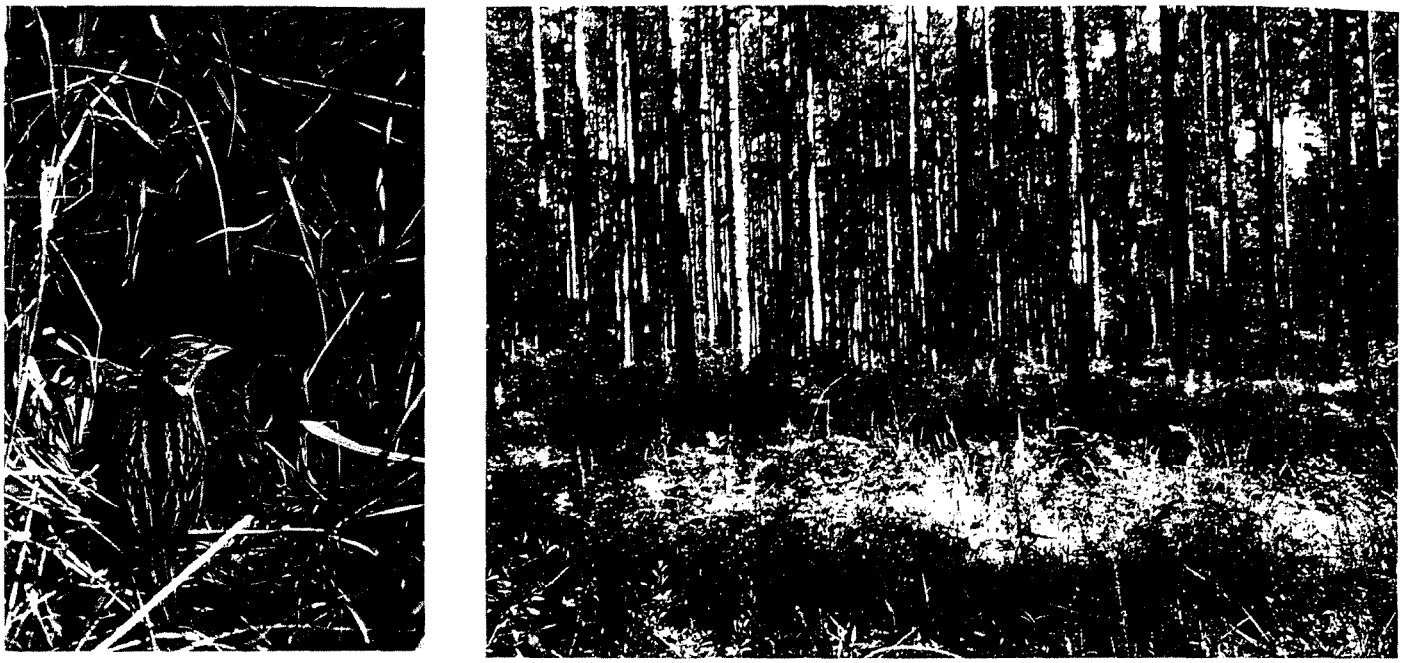
Early successional stands in largely forested landscapes provide habitat for disturbance dependent species as well as mature forest species requiring edge habitat (US *Fish & Wildlife Service).*

Southeast are temperate migrant or resident species in addition to nearctic-neotropical migrants, and the former two groups are especially well represented in southern pine communities. For example, the red-cockaded woodpecker and brown-headed nuthatch are permanent residents and are either completely or mostly dependent on healthy and mature southern pine habitats. Among temperate migrants, Henslow's sparrow breeds farther north and winters in southern pines, but not in the tropics. Also Bachman's and field sparrows, the southeastern American kestrel, and the loggerhead shrike also are all temperate migrants. The Prairie Warbler is the only obvious high priority nearctic-neotropical migrant that benefits from fire-maintained pine ecosystems (Nolan 1978). Most of these high priority pine-associated birds thrive best in longleaf habitat in which management favors ground cover that is grassy and herbaceous over that dominated by shrubby fern, palmetto, or gallberry. These conditions are most easily maintained where growing-season burns are conducted. Also. many early-successional species (Principally Bachman's and field sparrows. prairie warbler, and perhaps Bewick's wren during winter) can be supported in clearcuts in pine. especially when a grassy dominated groundcover (with scattered hardwood shrub patches) remains (Dickson et al. 1993).

Although appropriate longleaf pine stands can Provide the best quality habitats, suitable mature loblolly and shortleaf pines (often mixed with longleaf) provide perhaps the greatest quantity of habitat in the South for brown-headed nuthatch, Bachman's sparrow, field sparrow, prairie warbler, and red-cockaded woodpeckers. The abundance of these birds in these other pine types is dictated by the density of pines and the grass and hardwood component of the stands. These latter factors may be controlled by the season and frequency of burning.

Much of the management of mature southern pines focuses on the red-cockaded woodpecker (covered in separate chapter). However, some management protocols for this species may not satisfy the habitat requirements of other priority pine system species such as the northern bobwhite, brown-headed nuthatch, and Bachman's sparrow (Plentovich et al. 1998b). These species as well as wintering Henslow's sparrows are especially common in longleaf pine habitats with a dense and diverse grassy ground cover (Abrahamson and Hartnett 1990, Myers 1990, Frost 1993). Appropriate management of southern pine forest types can provide optimal habitat for many of these species (Wilson et al. 1995).

***Bachman's Sparrow*** —The range of Bachman's sparrow, also appropriately called the pinewoods spar-



Open pine Savannah with dense ground cover dominated by grasses with some shrubs is excellent habitat for several pine-associated priority species, such as northern bobwhite, Bachman's sparrow, and Henslow's sparrow, shown above left. *(B. Darling, Cornell Lab of Ornithology, US fish & Wildlife Service.)*

row, probably coincided closely with that of the red-cockaded woodpecker in longleaf and secondarily in shortleaf pine at the time of European colonization. With the wholesale cutting of mature forests in the 1900s it extended its range northward (Brooks 1938, Dunning and Watts 1990), but with the recent maturing of these interior forests its range retracted back to its probable earlier distribution. This species has been listed as state endangered or threatened in several parts of this peripheral range. The migratory habits of Bachman's sparrow are poorly understood, but the more northern breeding populations probably move south in winter to join permanent resident populations in the lower Coastal Plain from North Carolina, south into peninsular Florida, and west to Texas.

Habitat requirements of Bachman's Sparrow include a sparse woody midstory and a high density of grasses and forbs (Dunning and Watts 1990, 1991, Plentovich et al. 1998b). Mature stands of longlenf in this condition are optimal habitat for this species. Suitable conditions are also provided in early- successional habitat such as clearcuts and power line rights-of-way.

Some silvicultural practices provide good quality Bachman's sparrow habitat. while others are detrimental. Long harvest rotations. frequent burning, thinning, retention of some mature and late- successional pines, and less drastic site preparation should favor sparrow populations. Pre-planting site preparation, such as drum chopping, in which all hardwoods are removed probably disfavors Bachman's sparrow because little deadwood is left for the birds' use as song perches (Dunning and Watts 1990). Treatments that leave some bare ground may be important as well, if not for this and other nongame species certainly for northern bobwhite. Clearcuts planted in longleaf pine are suitable habitat for Bachman's Sparrow for 7-8 years, while faster growing loblolly or slash pines usually are suitable for no more than 5 years (Dunning and Watts 1990, Landers et al. 1995).

Distribution of habitat at the landscape scale seems important to this species. Evidence suggests that it is a poor disperser that is unlikely to colonize new sites far from occupied habitat without grassy corridors, such as is often maintained in utility rights-of-way or produced by tornadoes (Dunning et al. 1995). Few Bachman's sparrows were observed in otherwise suitable clearcuts that were widely scattered and isolated within a landscape dominated by agricultural fields and unsuitable forests (Dunning et al. 1995). Use of clearcuts appeared to be greatest where other suitable habitat was nearby.

*Henslow's* Sparrow.-One of the highest priority birds in eastern North America, Henslow's sparrows, winter primarily in grass and pine habitat in the Coastal Plain. Wintering habitat requirements are somewhat vague, but they seem to be most common in moist to

wet grassy savannas and flatwoods. Preliminary results from several studies suggest Henslow's sparrows are most numerous on sites burned during the previous growing season, though birds also occur on sites up to 2 years after dormant season burning (Woodrey and Chandler, unpubl. data). Henslow's sparrow populations may be adversely affected where dormant season burns are predominately used. These and other grassland birds are displaced from sites as dormant season burning occurs (McNair 1998), as also occurs with growing season burns. However, the slow recovery of habitat conditions from dormant (as opposed to growing) season bums and the presumed saturation of other already occupied sites likely reduces overall habitat quality across entire landscapes for wintering grassland-dependent species, especially Henslow's sparrows (McNair 1998, Plentovich et al. 1998a).

***Prairie Warbler.***—The highest priority nearctic-neotropical migrant associated with pine habitat is the northern (nominate) subspecies of the prairie warbler, a species that presumably did best in pre- settlement fire-maintained pine systems (Nolan 1978). Currently, it typically breeds in early-successional habitat, such as seedling-sapling pine stands and retarded old-field succession. As a result of proliferation of these conditions, the prairie warbler may be more widespread and common than it was before European colonization. However, this and other early-successional specialists have undergone long-term and steep regional population declines during the last 25 years (Table 5,6) despite the abundance of short-rotation pine plantations (early-successional habitat) (Meyers and Johnson 1978, Hunter et al. 1993b).

As with Bachman's sparrow, early-successional habitats used widely by prairie warblers may not be those in which prairie warbler populations historically achieved stable high densities. Prairie warblers also appear to be absent from much of the South Atlantic coastal plain outside of pocosins. This is not easily explained given a higher abundance for this nearctic-neotropical migrant in both mature pine and early-successional habitat, especially southern pines, within the Piedmont and other Coastal Plain physiographic areas.

***American Kestrel.-The*** cavity-nesting American kestrel has greatly declined throughout the Coastal Plain, with a very few remaining in South Carolina and Georgia (including adjacent Piedmont sites above the Fall line) and a small population persisting along the Mississippi Gulf Coast (Collopy 1996). They are found most frequently in longleaf-turkey oak sandhills, sand Pine scrub. and pastures with standing snags (Bohall-Wood and Collopy 1986). The bird's decline is attributed to the reduced number of longleaf pine snags left standing in agricultural areas and open pine woods, as well as loss of breeding and foraging habitat to agriculture and urban development (Hoffman and Collopy 1988). However, kestrels readily and successfully use nest boxes and some populations appear to have been stabilized or have even expanded in Florida, South Carolina, and Georgia (Cely and Sorrow 1988, Breen 1995).

***Brown-headed Nuthatch.-The*** brown-headed nuthatch is another cavity-nesting species of potential concern in southern pine systems. This species, though still locally common, is restricted in overall distribution and has shown signs of steep and widespread decline, especially where longleaf pine acreage has declined most (South Atlantic Coastal Plain; Table 5). The trend towards shorter rotations in commercial pine forests also may have reduced habitat suitability because this species nests in cavities in older live pines (often with dead limbs) and pine snags. Lengthened pine rotations on most public lands may compensate for declines associated with shorter rotations underway on most industrial and non- industrial private land.

Recommendations to private landowners may include retention of standing but partially rotted snags, or large limbs on live trees, during thinning operations that also should reduce hardwood midstories, at least temporarily (Wilson and Watts 1999). Regardless of factors leading to vulnerability, specific aspects of this species' habitat requirements merit attention, including local population monitoring and the investigation of the potential use of artificial nests by this species.

***Management Recommendations.-Some*** mature pine stands should be maintained in which measures to control hardwoods and promote grass-forb vegetation, such as burning, are conducted regularly. Growing season burns are particularly effective treatments. Although some nests of low-nesting birds likely would be lost during growing season burns, most birds will renest and long-term effects will greatly outweigh these losses. Also, incentive programs to support development and management of longleaf pine ecosystems on private lands should be developed.

**Forested Wetlands and Associated Habitats**

A number of nearctic-neotropical migrants reach their highest abundances in mature forested wetlands (Dickson and Warren 1994). Also, these habitats support high densities of wintering birds (Dickson 1978a, b) and are important as migratory stopover sites to a number of species, such as Swainson's and gray-cheeked thrushes,

Hydrology in bottomland hardwoods influences not only forest composition, but also understory density. The more flooded a site, the less understory will be present. Flooded areas favor prothonotary, but drier sites more likely support Swainson's warblers (US fish & Wildlife Service).

and warblers such as Tennessee. black-throated blue warbler, ovenbird. and northern waterthrush (Hamel, Hunter, pers. observ.).

A total of 26 priority species regularly use forested wetlands (Table 6). Surprisingly low percentages of priority species associated with these habitats were found declining during the period covered by the Breeding Bird Survey (Tables 5.6). Only within the West Gulf Coastal Plain. was the number of declining species approaching 50 percent. Despite these overall trends. Smith et al. ( 1996) speculated that Breeding Bird Survey may he a poor tool to properly characterize population trends for species dependent upon habitats subjected to large scale losses before the survey began. This suggestion mav be especially true for mature forested wetlands in the Southeast (and especially within the Mississippi Alluvial Plain) that dwindled significantly during the first part of the 20th century (McWilliams and Rosson 1990).

Populations of some of these species in fact may be stable or increasing today at least in some areas. such as Swainson's warbler in South Atlantic Coastal Plain, but with an almost 30 percent reduction in overall forested wetland acreage during the 1900s, these species are undoubtedly less common today than they were during the 1800s and early 1900s (Sharitz and Mitsch 1993). Regardless of short-term population trends. the most vulnerable breeding species occurring mostly within forested wetland habitats are the swallow-tailed kite, cerulean warbler. and Swainson's warbler. These and other forested wetland- dependent species are treated in detail below.

*Swallow-tailed Kite*.—The status of the North American breeding subspecies of the swallow-tailed kite in the Southeast is precarious. Total population size for this subspecies is unknown. but estimates are less than 5.000 individuals. or a maximum of I. 150 breeding pairs according to Meyer and Collopy (1990). The breeding range probably has been reduced the most of any still-extant landbird species in eastern North America during the 1900s. The kite probably bred historically in 21 states. but is now known to breed only in

Mature cypress stands which occur on flooded sites support many bird species, a few of which have special affinities for this habitat (US *Fish & Wildlife Service).*

7 states, with concentrations only in peninsular Florida (Meyer 1990, Meyer and Collopy 1990).

Active management to improve habitat conditions for swallow-tailed kites within existing forested wetland systems and restoration of other systems will improve the outlook for this species. It is estimated that about 100,000 acres of largely forested bottomlands are necessary to support a population of 80-100 kite pairs (Cely and Sorrow 1990). Management in floodplains should emphasize retention of scattered patches of mature and tall (70-90 feet) baldcypress and pine interspersed with open areas for foraging. Openings used by foraging kites in largely forested landscapes can be provided by tree harvesting under a variety of silvicultural techniques. Pre-migratory roost sites in the U.S. may be even more important. Some of these sites support hundreds of birds at one time as they stage before migrating to South America (Meyer 1993).

***Cerulean Warbler.***—Another nearctic-neotropical migrant with an uncertain and perhaps precarious status in the Southeast's Upper Coastal Plain is the cerulean warbler. The species persists in some numbers in uplands in the southern Appalachians, Cumberland Mountains. and Ozark and Ouachita mountains (Hamel 2000). Present population levels pale in comparison with historical abundance. such as the reference to this species being among the most abundant breeding birds in the Mississippi Alluvial Valley in the early 1900s (Widmann 1907). Known populations persist in forested wetlands along the Roanoke River in North Carolina and in the northern Gulf Coastal Plain (including Mississippi Alluvial Plain) in Tennessee, Kentucky, and Arkansas. Additional populations may persist in forested wetlands in northern Alabama, Mississippi, and Louisiana, but none are known at this time (Rosenberg and Barker 1998). Landscape characteristics were useful predictors of occurrence of the birds in a set of Mississippi Alluvial Valley tracts studied by Hamel et al. (1998), when birds tended to be associated with sites in landscapes with less cropland and more forest. Breeding habitats of cerulean warblers throughout their range are characterized by deciduous forests dominated by tall. large diameter trees and an uneven forest canopy (Hamel 2000). No particular tree species seem to be favored by the birds.

Hamel (1992b; also see Robbins et al. 1992) recommended I O.OOO-acre tracts of mature forested wetlands to maintain a (potential) source population of cerulean warblers based on his work in western Tennessee. In agriculture-dominated landscapes, such as the Mississippi Alluvial Plain. a more conservative estimate of 20.000 acres may be necessary to support a source population (Mueller et al. 2000). In areas of insufficient habitat. additional habitat patches could be

established through improved habitat management or reforestation.

***Other*** Species.---South Atlantic coastal populations of black-throated green warblers are found from the Dismal Swamp in southeastern Virginia south through the Francis Marion National Forest in South Carolina. This species appears to have declined since Hurricane Hugo in 1989 on the Francis Marion where it was formerly common. Mature and late-successional forested wetlands and associated mature upland forests and remnant large pocosin and Carolina bays constitute optimal habitat for this species. Within these habitats, this species is most commonly associated with baldcypress and Atlantic white-cedar, but also can be found in stands of hardwoods and mixed pine-hardwood areas associated with wetlands (Hamel 1981; Hamel 1992a). This warbler appears to be restricted to largely forested areas, so estimates of area needed to support source populations may be similar to those for cerulean warbler, but verification is needed.

Swainson's and prothonotary warblers are forested wetland-associated species ranked highly in the PIF prioritization process. Both species have specific features with which they are associated. Swainson's warblers occur frequently in conjunction with canebrakes, but also with dense understory vegetation approximately 3-12 feet tall that shades a bare ground surface on which they forage, similar to habitat used by American woodcock within forested wetlands. Prothonotary warblers commonly nest in close association with water. Where suitable nest sites are available, the birds apparently have little regard for the particular forest type.

A healthy population (here defined as of at least 500 pairs) of Swainson's warblers may require at least 6,000 acres (10,000 acres in agriculturally-dominated landscapes; Mueller et al. 2000) of mature forested wetlands, with prothonotary warblers requiring at least 4,000 acres (7,000 acres in agriculturally-dominated landscapes). Smaller populations occur in smaller forest patches, but the status of their viability is uncertain.

Tracts large enough to support large and productive populations of swallow-tailed kites, cerulean warblers, Swainson's warblers, and prothonotary warblers should be adequate to support source populations of less area-sensitive associates in mature forested wetlands. Habitat patches too small even for a large population of prothonotary warblers may still benefit some of these other species (Table 6), as well as provide important stopover habitat for birds during migration.

***Migratory Stopover*** Habitats.---Tropical (in Florida) and maritime woodlands (along Gulf and Atlantic coastlines) as well as forested wetlands are very important habitats for migrating and wintering migratory birds. Almost all eastern and many boreal nearctic-neotropical migrants pass through the Southeast, with their survival probably related to the distribution of maritime and tropical woodlands or other forests near the coast (Moore et al. 1993, Moore and Woodrey 1995).

During autumn migrating landbirds "funnel" southward along the South Atlantic coastline (Watts and Mabey 1993). In maritime woods along the Gulf Coast some species stage for a trans-Gulf flight, while other species orient either toward the Peninsular Florida Gulf coast (and the West Indies) or toward the Texas coast (and Mexico). During spring, northward migrating birds by-pass maritime woodlands on fair-weather days for the more extensive inland forested wetlands and other woods. However, during inclement spring weather, Gulf coast maritime woodlands become critically important. These are the first suitable resting and foraging habitat available to exhausted migrants for recuperation (Moore and Kerlinger 1987, Moore et al. 1990).

Thus, a management strategy for nearctic-neotropical migrants using the Gulf coast should include consideration of the extent and condition of both maritime woodlands and inland forested wetlands, particularly along the Chenier Plain where the hiatus between coastal and inland forests is wide (Gosselink et al. 1979). This area of southwestern Louisiana and southeastern Texas is very important for both southward movements of young migrants as well as a safety net for spring migrants that breed throughout eastern North America. Management strategies should also include residential areas, where preferred fruit-bearing trees, shrubs, vines, and water can be provided to stressed migrants.

***Riparian*** Forest.-Southeastern riparian areas include streamside zones, bottomlands, loess bluff oak-hickory forests, hammocks, and mixed mesic hardwoods. Upland riparian habitats may be as important as bottomland habitats for supporting migratory birds.

Riparian forest types deserving special attention are the loess bluff oak-hickory forests and mixed mesic hardwoods. Loess bluffs support remnant oak-hickory forests adjoining remnant stands of forested wetlands in the Mississippi Alluvial Plain, especially in southwestern Mississippi. Some species occurring regularly in rich loess bluff sites, such as Swainson's warblers, are more characteristic of wetland sites. In contrast, remnant oak-hickory stands along Crowley's Ridge (Arkansas and Missouri) and within the Tennes- see

Plateau (Upper East Gulf Coastal Plain) are unlikely to support many area-sensitive species without extensive reforestation efforts.

In largely forested landscapes, riparian habitat is important for many species, including some of the most sensitive species that do not inhabit or are found in reduced numbers both in upland forested and fragmented landscapes (Smith 1977). Maintaining mature riparian vegetation along streamsides in intensively managed forests and in agricultural areas is a widespread practice for maintaining stream water quality (National Association of Conservation Districts 1994) and wildlife values (Dickson and Warren 1994). However, a number of questions remain about relationships and management of these zones for wildlife communities, as well as the interactions of economic considerations that temper wildlife management options (Wigley and Melchiors 1994).

Streamside zones often are maintained for nearctic-neotropical migratory birds, many of which are associated with mature forests. In eastern Texas, yellow-throated vireos, hooded warblers, and Acadian flycatchers were virtually absent from streamside zones less than 150 feet wide (Dickson et al. 1995a). Maximum numbers of Acadian flycatchers and Louisiana waterthrushes were found in streamside zones 150-300 feet wide, with a somewhat open understory, adjacent to recently regenerated loblolly pine plantations in coastal plain, Piedmont, and Ouachita studies (Dickson et al. 1995a, Tassone 1981, Tappe et al. 1994). Maintaining the width of riparian habitats using the oft-repeated concept that "bigger is better" where feasible perhaps would be an optimum strategy for some precarious species (Dickson and Warren 1994).

The landscape context is a critical issue in consideration of the streamside zone width issue. Riparian zones may be divided into 3 broad categories: (1) streamside zones in managed (usually short- rotation pine) forest stands, (2) riparian forests in agricultural or developed landscapes, and (3) moisture/elevation gradients in largely forested landscapes.

In generally forested landscapes, Acadian flycatchers and Louisiana waterthrushes are more common in narrow riparian zones, becoming rarer with distance from riparian habitats. In similar situations, cerulean and Swainson's warbler are mostly restricted to riparian habitats. Kilgo et al. (1998) found peak densities for most regular species occurred when forest stands were 1/3 mile-wide; and Swainson's warbler, the most area-sensitive species, required I mile or more of forest width The emphasis in this study, was on the ecosystem and not particular streamside zone widths, so timber management could still occur within a mile of the river and Swainson's warbler populations likely would persist as long as the system remains largely forested. In agricultural landscapes, or along major floodplains where much of the surrounding forestland was in short-rotation pine (for example, the Altamaha River in Georgia), maximum numbers of the most area-sensitive species peaked in streamside zones of at least 300 feet in width (Keller et al. 1993, Hodges and Krementz 1996).

It remains unclear whether local implementation of even the wider streamside zones in highly fragmented landscapes would provide suitable or optimal habitat for some vulnerable species. In some areas low reproductive success may be due to high nest parasitism and depredation rates, even in wider patches of high quality riparian habitat. On the other hand, streamside management zones, if widely implemented across a landscape, could be effective in supporting some vulnerable species.

***Management*** Recommendations.-Historical evidence suggests that old-growth southeastern wetland forests were structurally diverse due to break up of stands with age and a variety of disturbance factors influences, such as wind storms and fires. Primarily because of past harvesting, many older riparian stands today tend to be composed of trees of similar diameters, with closed canopies and sparse understories. This habitat condition is not particularly suited to support Swainson's or cerulean warblers. In closed canopy stands, habitat conditions may be enhanced through harvesting operations, such as thinnings, small clearcuts, group selection cuts, and shelterwood cuts. In places such as the Woodbury Tract in South Carolina, it appears Swainson's warblers and other forested wetland species are faring well in the dense understories resulting from recent widespread harvesting, but these conditions likely are short-lived as these stands mature. Swainson's warbler populations also increased in response to natural disturbances to the forest canopy from Hurricane Hugo on the Francis Beidler Forest (Hamel et al. 2000) and in Congaree Swamp National Monument (Hamel 1989), both also in South Carolina.

In addition to promoting dense understories, special efforts are needed to promote and retain large hardwoods with spreading crown and diverse canopy structure within forested wetlands. Some species, such as northern parula, yellow-throated warbler, and especially the cerulean warbler, require mature stands with large trees and complex canopy structure. Cerulean

warblers usually occur in the largest stands of mature or late-successional hardwoods (Hamel 1992b, Robbins et al. 1992), now a very rare condition in southeastern bottomlands. However, cerulean warblers can persist in relatively healthy numbers where forests are managed and harvested, as long as a substantial number of large-diameter trees are left after harvesting (Hamel 1992b). Such management appears to produce habitats that mimic the structure of those created by tree fall gaps.

In summary, (1) management of forests should support important diversity components such as variable understories (from cane thickets to openings), diverse age structure (seedlings to mature), and multiple vegetative layers to provide for high priority species. (2) Restoration of special habitats, such as pocosins, Atlantic white-cedar, and maritime woodlands including cheniers and mottes should be a high priority. (3) Enhancement of backyard habitats, such as establishing native fruit-bearing shrubs, vines, and trees as important food for birds, particularly migrants should be encouraged. And, (4) contingent on landowner objectives and costs, recommendations of optimum streamside zone widths for breeding and other birds include:

(a) narrow streamside zones (less than 150 feet) are probably adequate when adjacent lands within the watershed are dominated by mature or maturing forest stands,

(b) moderate to wide zones (150-300 feet) are probably adequate when adjacent lands within the watershed are dominated by short-rotation plantations,

(c) the widest zones (at least 300 feet) would be necessary when adjacent lands within the watershed are dominated by agricultural or developed lands.

Shrub bogs, most prevalent in southeastern Virginia and the eastern Carolinas. provide habitats for a. wide diversity of bird species (US ***Fish & Wildlife Service).***

**Upland Hardwood Forests**

***Hardwood-Pine*** *Forests.-Much of* the Coastal Plain and Piedmont forests not in pure pine or wetlands are in some transitional stage of upland hardwoods and pine (Dickson et al. 1995, Meyers and Johnston 1978). Virtually none of this forest type persists in the South Atlantic Coastal Plain, but is more prevalent in the Piedmont and Gulf Coastal Plain. Of the 17 priority bird species considered to use mixed hardwood-pine forests in lowland physiographic areas, only within the West Gulf Coastal Plain and Southern Ridge and Valley/Southern Cumberland Plateau are declining priority bird species approaching 50 percent (Tables 5,6).

Overall increasing forest acreage and maturity in the Piedmont would suggest greater security for many vulnerable bird species. Breeding Bird Survey trends indicate that very few vulnerable species overall have undergone declines from 1966- 1996 in either the Mid-Atlantic or Southern Piedmont physiographic areas. However, wood thrushes and red-eyed vireos have shown consistent declines within patches of mature forests within Piedmont suburban settings, such as Atlanta, GA (Robbins 1980, Terborgh 1989). Furthermore, a number of area-sensitive species (northern parulas, black-throated green warblers, Swainson's warblers, and worm-eating warblers) have population centers in the Southern Blue Ridge and in the South Atlantic Coastal Plain but are absent as breeding species over much of the southern Piedmont today (Hamel 1992a).

Retention is the primary consideration for upland pine-hardwood forests. Regardless of successional stage these forests provide breeding, migratory and winter habitat for many species. Loss of forest to other land uses is likely to result in additional bird declines.

In addition, birds in these forests may be affected by changes in forest composition or by other vertebrate species. For example, very abundant deer in the Piedmont and elsewhere may reduce understory vegetation and negatively affect breeding birds such as hooded warblers (DeCalesta 1994, Leimgruber et al. 1994). Also where hogs are abundant they may severely disrupt conditions for ground- nesting species such as Kentucky warblers.

Piedmont forest patches such as Kennesaw Mountain National Battlefield Park are no doubt important for many transient nearctic-neotropical migrants. Fall migrants orienting towards the South Atlantic coast likely depend on at least one forest patch for resting and foraging. Likewise, many spring migrants orienting northeastward from the Gulf of Mexico to the Southern Appalachians also similarly use Piedmont forests.

***Central Hardwood*** Forests.-The 2 southeastern physiographic areas included within the central hardwood region in the Southeast are the Interior Low Plateaus and Ozarks (the Interior Highlands in part), but this forest type also occurs in the West Gulf Coastal Plain and along the edges and on the ridges of the Mississippi Alluvial Plain. Central hardwoods, or western mesophytic forests, are dominated by oaks and hickories in the east and more so by oak to the west. Of the 18 priority birds using these forest types, declining trends were most pronounced in the Interior Low Plateaus and West Gulf Coastal Plain (both approaching 50 percent), while about 25 percent of these species were declining in the Mississippi Alluvial Plain and the Ozark-Ouachita Highlands (Tables 5,6).

Portions of the Interior Low Plateaus in the states of Kentucky, Tennessee, and Alabama may be limited in capability of supporting healthy populations of most of the vulnerable mature forest species due to variably fragmented landscapes and subsequently lower probabilities for nesting success (Robinson 1992). The continued persistence of many forest birds throughout much of the region perhaps is dependent upon immigration from other mostly forested areas such as the Ozark Highlands (Robinson et al. 1995). The Ozark Highlands of Missouri, Arkansas. and Oklahoma today are the most intact hardwood-dominated forested landscape west of the Southern Appalachians. Thus, the Ozarks appear to support among the healthiest "source" populations where average reproduction results in surplus young emigrating to adjacent areas.

Within the Ozarks, current forestry practices do not appear to be negatively affecting bird populations. Available data indicate that even-aged silviculture, with 100-year rotations, in largely forested areas have little effect on relative abundance of most vulnerable mature forest species, while providing for higher numbers of early-successional species (Thompson et al. 1992). Some mature forest species (black-and-white warblers, worm-eating warblers, Kentucky warblers) were found in higher numbers in even-aged regeneration areas than in passively managed areas officially designated as wilderness. Also, the 3 mature forest species found in lower numbers in the even-aged regeneration areas (red-eyed vireo, pine warbler, scarlet tanager) are doing relatively well throughout most of their ranges in the Southeast.

In largely forested landscapes even-aged silviculture with long rotations and relatively large treatment

areas can lead to less forest fragmentation than uneven-aged silviculture with numerous very small patches and frequent stand entry (Thompson et al. 1992). Nevertheless, Thompson (1993) suggests that over the larger Ozark landscape a combination of both uneven-aged and even-aged timber management can provide stability for mature forest species and some early-successional species.

Generally, contiguous and large oak-dominated forest patches are good forest bird habitat when compared to more fragmented landscapes. A recent study by Marquis and Whelan (1995) suggests that healthy bird populations could be important for maintaining healthy oak forests by consumption of herbivorous insects on oak saplings. Therefore, healthy insectivorous bird communities in largely forested landscapes possibly can help to maintain healthier forests.

***Management recommendations for upland hardwoods and hardwood-pine forests.***—( 1) Landscape scale land use patterns should be considered with a goal of maintaining large forest tracts. In large forests, silvicultural options can accommodate timber production and bird communities, including vulnerable mature forest species. (2) Even-aged regeneration with rotations at least 100 years and in relatively large blocks (40-100 acres) can minimize forest fragmentation in largely forested landscapes and support early-successional species. Finally, (3) combining uneven-aged with even-aged regeneration can provide stable habitat for many mature forest breeding species as long as harvest is not excessive.

**Appalachian Forests**

The Southern Appalachians include some of the most heavily forested regions in the Southeast (Southern Blue Ridge, Northern Cumberland Plateau), but also include some of the most heavily fragmented landscapes (Southern Ridge and Valley/Southern Cumberland Plateau). Effective forest bird conservation in the Southern Appalachians therefore will require not only consideration of forest composition and structure. but also attention to landscape context using measures of percent forest cover in heavily forested areas and forest patch size in more fragmented areas.

Appalachian forests are broadly grouped into (1) spruce-fir-northern hardwoods, (2) hemlock- white pine-hardwoods, (3) mixed mesophytic (cove) hardwoods, and (4) Appalachian oaks and mountain yellow pine. Of the 26 priority species included here, declining trends are most pronounced for the Southern Blue Ridge (exceeding 60 percent) and the Southern Ridge and Valley/Southern Cumberland Plateau (about 50 percent; Tables 5,6). The declines reported from the Southern Blue Ridge appear counterintuitive given that this area is 80 percent forested and suggest that factors other than forest cover may be involved as discussed below in interpreting Breeding Bird Survey and land use patterns.

***Spruce-fir-northern hardwoods.-These*** habitats are found mostly above 3500 feet elevation in the Southern Blue Ridge and at lower elevations in the Allegheny Mountains of West Virginia. As with other forest types, spruce-fir-northern hardwood forests were harvested at about the beginning of the 20th century and regenerated stands present today differ from conditions existing prior to harvest. Generally, spruce was replaced by fir from higher elevations and northern hardwoods from below. Today, with the high percentage of the community in public ownership it would appear that protection of healthy high- elevation biotic communities would be achievable. Nevertheless, spruce-fir communities are threatened by exotic pests, possibly compounded by effects from regional air degradation (White et al. 1993, Rabenold et al. 1998, Nicholas et al. 1999). However, some effective restoration probably is possible, at least for spruce.

As many as 7 species closely associated with spruce-fir-northern hardwood forests are effectively isolated from more northerly and western populations (Table 6). These 7 "endemic" high elevation forest birds are all best classified as short-distance temperate migrants. Among these species, the northern saw- whet owl appears to be the most vulnerable to potential habitat loss (Simpson 1992, Milling et al. 1997), followed by the black-capped chickadee and the red crossbill. Although widespread elsewhere, the owl here occurs as isolated populations that need conservation attention. Northern saw-whet owls respond to nest boxes which may partially mitigate the loss of high-elevation conifers. Also, owls may use other habitat, such as older northern hardwoods and hemlock (Milling et al. 1997).

The suite of bird species of interest found in northern hardwoods is similar to that in spruce-fir-northern hardwood mixes, but red crossbills and northern saw-whet owls are more closely associated with old-growth stands in close proximity to spruce, while more disturbed northern hardwood stands (including high-elevation Appalachian oak) are more likely to support black-billed cuckoo, yellow-bellied sapsucker, and golden-winged warbler. The yellow-bellied sapsucker population isolated in the Southern Blue Ridge is a described subspecies with habitat requirements differing from the

other endemic taxa. The sapsucker uses open woodlands (including orchards), forests excessively disturbed by fire, wind damage, and clearcuts where suitable nesting trees are retained.

The importance of early-successional habitats at higher elevations (above 3,000 feet) prior to European colonization remains unclear. However, the likelihood that these habitats were more prevalent prior to European settlement is supported by documented reduction of mountain bogs, balds, savannas, incidence of fire, beaver, and large herbivores in recent times (Delcourt and Delcourt 1997, Buckner and Turrill 1999). Today, only clearcutting and storm damage provide some early successional habitat on a sustainable basis. In addition to high-elevation early-successional habitats supporting the last known Appalachian Bewick's wrens, the decline of both Appalachian yellow-bellied sapsuckers and golden- winged warblers is indicative of that habitat loss in recent decades. Golden-winged warblers in particular are increasingly restricted to elevations between 3,000-5,000 feet with highest densities now apparently in early-successional northern hardwood stands. Large-scale disturbances appear to play an important role in maintaining good habitat conditions (dense grassy-herbaceous layer with scattered saplings) for this species, but opportunities for long-term management may also exist along appropriately maintained powerline rights-of-way, retired agricultural lands, and remaining bogs and bald edges (Confer 1992).

At the other end of the conservation spectrum, the spread of some high-elevation bird species southward appears to correspond with the maturing of some spruce stands, opening of spruce-fir canopies, and understory development. Increases of Swainson's and hermit thrushes as well as magnolia and perhaps yellow-rumped and mourning warblers in recent decades is at least partially attributable to these habitat changes throughout the high-elevation areas within the Southern Appalachians. Black-throated blue, chestnut-sided, and Canada warbler populations are perhaps better stabilized in areas where fir decline is most prevalent but where spruce is still common. At the same time, canopy species such as blackburnian and perhaps black-throated green warblers appear to be in decline, while olive-sided flycatchers now appear to be near extirpation as a breeding species from the Southeast (Simpson 1992, Buckelew and Hall 1994). Unfortunately, most species increasing in the Southern Appalachians are doing relatively well throughout much of their distribution while those species decreasing are generally among the more vulnerable species in the Southeast requiring conservation attention.

***Hemlock-White Pine-Hardwood*** Forests.-Mature hemlock-white pine-hardwood mixes can support local populations of northern parula, black-throated green, blackbumian, and Canada warblers. The first 3 species are obligate canopy species, while the ground nesting Canada warblers are restricted to stands with dense understory (often rhododendron). Blackbumian and Canada warblers are found primarily at the higher elevations. In addition, significant populations of black-throated blue warblers at the higher elevations and Swainson's warblers at the lower elevations (usually below 3,000 feet) also occur in these habitats, and like Canada warblers, both of these species prefer understory thickets.

Groth (1988) provides strong evidence that 2 resident cryptic red crossbill "species" depend upon Southern Appalachian conifers, in particular spruce-fir and hemlock/white pine forests. At least 1 of these types is possibly endemic to the Southern Blue Ridge. Declines in hemlock, white pine, and spruce may be affecting the long-term conservation of at least this crossbill "species."

A few species usually occurring at high-elevations, such as red-breasted nuthatch, winter wren, and golden-crowned kinglet, also occur in pairs or family groups in late successional stands down to elevations of 2,000 feet. Maintenance of existing late-successional hemlock and white pine stands and increasing acreage on public lands may well benefit these as well as more vulnerable birds.

***Mixed Mesophytic (Cove) Hardwood Forests.***— Mixed mesophytic forests are characteristically found on sites sheltered from frequent disturbances and therefore often include very large trees and a high diversity of both plant and animal species. Cerulean warbler reaches its highest abundance within the Southeast in mixed mesophytic hardwood forests within the Northern Cumberland Plateau and adjacent Ohio Hills physiographic areas. Cerulean warblers are found locally in much lower numbers in mature cove hardwood stands of the Southern Blue Ridge and the Mid Atlantic Ridge and Valley between 1,500 and 4,000 feet elevation, but appear to be increasing in areas where storms or forest management have led to a more open canopy, edges, and retention of large trees. Thus, a key habitat feature is an abundance of very tall trees and well-developed and complex canopy often near edges and on steep terrain, but much more information is needed here to definitively promote key habitat requirements.

S wainson's warblers *in* the Southern Appalachians are isolated from other populations and occur in different habitats at higher elevations, but as elsewhere, are associated with very dense understories. Most Southern Appalachian Swainson's warbler populations occur below 3,000 feet elevation along streams in mixed mesophytic hardwoods with dense understories, usually dominated by rhododendron. Some occur in lower-elevation mixed hemlock-hardwood stands. Other vulnerable birds that use mixed mesophytic hardwoods as optimal habitat include Acadian flycatchers, black-throated blue warblers, worm-eating warblers, ovenbirds, hooded warblers, and scarlet tanagers.

The prognosis for future health of mixed mesophytic forests would seem optimistic in the publicly protected coves of the Southern Blue Ridge and Mid Atlantic Ridge and Valley. However, much of the mixed mesophytic forests of the Northern Cumberland Plateau and Ohio Hills are in private ownership and are therefore not necessarily secure into the future. Mixed mesophytic sites are very productive and forests can redevelop rapidly after harvest, but much still needs to be learned about the recovery of healthy populations of certain mature forest birds, particularly cerulean warblers, in forested landscapes.

***Appalachian Oak-Mountain Yellow Pine Forests.-The*** Appalachian oak forest is a widespread forest type in the Southeast (Stephenson et al. 1993, Buckner and Turrill 1999). However, several mountain yellow pine communities are highly vulnerable (Table Mountain Pine in particular) due to fire suppression over the last 50 years (Buckner and Turrill 1999). In fact, due to fire suppression practices the nature and future of Appalachian oak may be in some doubt. Nevertheless, the large amount of public lands supporting Appalachian oak forests (about 5 million acres) in the Southern Blue Ridge would suggest future security for those species dependent upon this forest type.

In contrast to the Southern Blue Ridge, the outlook for bird species in Appalachian oak forests in the Southern Ridge and Valley is not as secure. Fragmentation of mature forest here is the highest of any area in the Southern Appalachians. Oak forests remain along narrow ridges, but the wider valleys have been cleared for agriculture and other development. Continuing downward trends among forest birds in the Southern Ridge and Valley perhaps indicate lessening reproductive success of birds breeding in small forest patches due to the increasing negative effects of nest predators and parasites during the last two decades (S. Pearson unpubl. data). There is too little public land in the area to support viable populations of sensitive species.

The situation in the Mid-Atlantic Ridge and Valley is somewhat similar to that in the Southern Ridge and Valley. The oak-dominated ridges of the Mid-Atlantic Ridge and Valley are wider, but the valleys are mostly devoid of forests. These oak forests are being negatively affected by defoliation from the gypsy moth, which is moving from north to south along the Mid Atlantic ridges. Decline of the oak forests may lead to future problems for forest bird communities. Pesticides used to control gypsy moths may remove not only gypsy moth larvae but also many foliage invertebrates important for birds. Other control methods include cutting affected areas, which would favor early-successional bird species over mature forest species. Recent research indicates an integrated approach may be best for controlling gypsy moth defoliation while avoiding severe habitat loss for mature forest birds (Cooper and Marshall 1997).

***Management recommendations.-(l)*** Realize the importance and maintain healthy forests of both spruce-fir and northern hardwoods as best as possible given the problems posed by ecological pests. (2) Conduct land-use planning on public and cooperating private lands with conservation partners, incorporating efforts targeting the needs of species such as golden-winged and cerulean warblers. (3) Develop management plans for corporate forest lands in cooperation with other private and appropriate public entities, with objectives of maintaining healthy forest bird communities compatible with landowner objectives such as profitable timber management. (4) Increase research and monitoring of ecosystems and threats to them, bird communities, and responses of species to habitat management. (5) Promote appropriate silvicultural operations, such as cuttings of hardwood overstory in hemlock stands to allow full hemlock and as well as understory development on appropriate sites. (6) Minimize effects of pesticide and tree-cutting gypsy moth control on mature forest birds by using an integrated approach.

## DISCUSSION

### Interpreting Bird Population Trends and Land Use Patterns

Current information shows consistent declines in some species (Table 5), sparking concern for their well being. The patterns of bird population change and causes influencing these changes are complex and not easily under-

stood. Our bird survey techniques may be biased, we may not fully understand bird/habitat and landscape scale relationships, there may be historical factors or population phenomena that we do not adequately consider, and we may not yet recognize other factors affecting birds.

The Breeding Bird Survey (BBS) is the standard assessment of occurrence and trends of North American birds, but surveys of breeding birds along roads may not be representative of habitat within landscapes. Trends from BBS data may seem contradictory to the assumption that amount of forest cover is related to population stability among vulnerable species. Some recent interpretations of warbler population trends from BBS data suggest forest birds of the heavily forested Southern Appalachians (especially Southern Blue Ridge) and Ozark-Ouachita Highlands have decreased, while forest species occurring in the highly fragmented Coastal Plain and Mississippi Alluvial Plain physiographic areas are either stable or increasing (James et al. 1992, Smith et al. 1996). But other factors, such as landscape and historical relationships may need to be incorporated in order to properly assess status and trends of bird populations.

*Uplands.*—Regardless of the forest types involved, many of the upland species of interest are most secure in the physiographic areas with more total forest cover such as the Southern Blue Ridge, Northern Cumberland Plateau, and Ohio Hills. These same species would seem less secure in the Mid Atlantic Ridge and Valley/Allegheny Mountains physiographic areas, and least secure in the Southern Cumberland Plateau/Ridge and Valley, based upon the extent of forest in these regions. Other interior physiographic areas, the Ozark-Ouachita Highlands and the Interior Low Plateaus, where large forested patches alternate with equally large or larger unforested areas, would appear to provide intermediate security overall for vulnerable mature forest species.

Potential contradiction to this assumption is the apparent decline of many bird species in the heavily forested Southern Blue Ridge (James et al. 1992, Hunter et al. 1993b). About a third of all regional priority species (both late and early successional species) are declining, along with 18 percent additional species that are possibly declining (Table 5). A hypothesis proposed by James et al. (1996) is that atmospheric pollution becomes increasingly important as elevation increases by affecting tree growth, insectivore food availability, and reduction of important minerals (such as calcium) necessary for successful reproduction. Another possible factor is the recent expansion of new homes and associated development along roads (and BBS routes) of the region. Yet another factor mentioned earlier is the condition (and not only the amount) of forest, in that the structure of regenerating forests in the Southeast during the last 30 years both eliminates habitat for early successional and minimizes optimal conditions for many mature forest species. A fruitful and relevant line of research topics would be focused on field testing each of these hypotheses (and others).

Also, concluding local cause and effects on individual migratory species based on local (or regional) population trends may be based on high speculation. Regardless of local status, or whether the contributing factors are from breeding habitat, non-breeding habitat, or otherwise, problems persist in all areas for at least some species. For example, cerulean warblers reach their greatest relative abundance in the densely forested Ohio Hills and Northern Cumberland Plateau physiographic areas (Buckelew and Hall 1994), where it has declined over the last 3 decades at rates similar to declines in other physiographic areas. Other widespread species using a greater variety of forested habitats that also are declining across the Southeast include yellow-billed cuckoo, eastern wood-pewee, and wood thrush. Known winter habitat loss for cerulean warblers and wood thrushes may be influencing these widespread declines. Both species, however, are also known to be affected by increasing rates of nest predation and parasitism. Thus, management emphasis should include both breeding and wintering grounds.

Lowlands.--In contrast to upland physiographic areas, lowland physiographic areas generally have fewer nearctic-neotropical migrants showing declines (James et al. 1992, Hunter 1993). However, higher percentages of resident and/or temperate migrants are declining in lowland physiographic areas compared with upland physiographic areas. Decline of species such as red-cockaded woodpecker and northern bobwhite is a reflection of degradation of mature longleaf and grassland ecosystems (Hunter et al. 1994).

Population trends among nearctic-neotropical migrants associated with forested wetlands in lowlands show little consistency. The most extensive losses of these habitats occurred before the initiation of the BBS in 1966. At one time floodplain forests probably covered about 45 million acres in the Southeast. Drainage and clearing of floodplain forests that began in the mid-1800s reduced the total to about 37 million acres remaining by 1952. From 1952 until 1995 during years of the Forest Survey, lowland hardwood forests

declined further to about 3 1 million acres (Dickson and Sheffield, Defining the Forest chapter).

**Conclusions**

Southern forests are important breeding and wintering habitat for hundreds of bird species, some faring well and some of apparent precarious status. Although the extent of southern forests has remained relatively stable in recent years, continued threats to bird forest habitat remain from a burgeoning human population.

Substantial information needs exist, such as how to interpret population function and how source populations, where reproductive output exceeds mortality, support sink populations, where reproductive output cannot support populations alone. Research to develop this information is necessary as is regionwide monitoring of bird communities.

Recommendations and conclusions herein are based on best information and interpretation at this time. Modifications will be required as more complete information becomes available. Most recommendations are general, and will need to be adapted for local conditions. Also, application of recommendations specific for some bird species should be considered in conjunction with economic considerations, other land uses, and with traditional game and other species in mind. However, with careful and thoughtful planning, many management options based on this information here can be effective for bird conservation in light of these other considerations.

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**Appendix** 1. Population trend (PT) and population trend data quality (PTDQ) criteria for scoring Breeding Bird Survey data. To determine a PT score, first evaluate PTDQ by checking sample size (n) and statistical significance (P) and choose a trend depending on whether the species is increasing, decreasing, or stable. PDTQ scores are not used in the overall priority score but are important in judging the quality of the trend data.

| PT score | Trend | PTDQ Score | BBS trend quality n | | P |
|---|---|---|---|---|---|
| 5 = Significant decrease | Decreasing at or above an average of 1.0% per year | A1 = | 234 | and | ≤0.10 |
| | | or | | | |
| | | B1 = | 14-33 | and | ≤0.10 |
| 4 = Possible decrease | Decreasing at or above an average of 1.0% per year | C1 = | 6-13 | and | ≤0.10 |
| | | or | | | |
| | | c2 = | ≥14 | and | 0.11-0.35 |
| 3 = Trend unknown | Change at or above an average of 1.0% per year | D = | 214 | and | 20.35 |
| 3 = Insufficient data | Any trend | E1 = | 6-13 | and | >0.10 |
| | | E2= | I-5 | and | any P value |
| 3 = No data | No data | F = | NA | NA | 0 |
| 2 = Stable or no trend | Trend between -1.0% and +1.0% per year | A2 = | ≥34 | and | any P value |
| | | or | + | | |
| | | B2= | 14-33 | and | any P value |
| 2 = Possible increase | Increasing at or above an average of 1.0% per year | C1 = | 6-13 | and | ≤0.10 |
| | | or | + | | |
| | | C2 = | ≥14 | and | 0.11-0.35 |
| 1=Significant increase | Increasing at or above an average of 1.0% per year | A1 = | ≥34 | and | ≤0.10+* |
| | | or | | | |
| | | B1 = | 14-33 | and | ≤0.10 |
| Any score | | x= | Based on information other than BBS | | |