

# Pocosin breeding bird fauna

**Widely recognized for their unique botanical nature, little study has been done on pocosin avifauna.**

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**T**HE WORD POCOSIN ORIGINATED from an Algonquin Indian term "poquosin" and is one of the few Algonquin words used by European settlers. Pocosin habitats are defined with difficulty since considerable confusion persists in the use of the term. Nevertheless, it is obviously critical to define these habits accurately if meaningful habitat comparisons are to be made. Tooker (1899) provided detailed discussion on the origin, meaning, and usage of the word, and some recent authors have credited him as translating pocosin as "swamp on a hill." While this is an interesting interpretation of the word, it was never defined as such by Tooker. In tracing out the early usage of the term, both by Native Americans and early settlers, Tooker found that "pocosin" referred to a wide variety of low wet areas extending from New England through the Carolinas. It was locally used interchangeably with "dismals" and "galls" by European settlers to describe swampy thickets.

Geologists, hydrologists, botanists, ecologists, and other investigators have likewise used the word to describe a variety of low, wooded wetland habitats, and in many instances the terms bay, bayhead, stream head forest, shrub bog,

or evergreen shrub bog have been used to describe pocosin vegetation types. The term "bay" is particularly confusing because it refers to a number of moderately advanced successional stages of Southeastern wetlands that support several species of bay trees (Sweetbay, Redbay, and Loblolly-bay), whereas the term Carolina bay, partly named for the presence of bay trees, refers to elliptical depressions that may support pocosin vegetation. Carolina bays, which are permanent geological features, are often specifically named sites (*i.e.*, Wolf Bay in Bladen County), but bay forests are successional stages of wetlands. Likewise, there are many areas on maps named pocosin (*i.e.* Light Ground Pocosin in Pamlico County), but visits to these sites reveal that many outgrew, long ago, the pocosin vegetation stage. Definition is further hampered by the fact that many pocosins are situated within extensive palustrine

systems and/or adjacent to estuarine systems. Such mixed areas often provide a rich mosaic of wetland habitats involving broad zones of transition and complex successional patterns. Extensive areas called pocosins by naturalists and environmentalists are, in fact, often composed of swamp forest, hardwood forest, and marshes. Although there seems to be no comprehensive botanical definition of pocosin most researchers agree that pocosins are characterized by Pond Pine and dense evergreen shrub vegetation growing on deep peat or sandy peat soils with protracted hydroperiods.

Although pocosins are currently communities of major interest to environmentalists and are widely recognized for their unique botanical nature, few have been intensively studied floristically. Wells (1946) provided a general botanical analysis of Holly Shelter's pocosins (Pender County, North Carolina) and Kologiski (1977) investigated the vegetative communities of the Green Swamp (Brunswick County, North Carolina), including several types of pocosin, savanna and related successional communities. Buell and Cain (1943) described the successional role and ecological requirements of Atlantic



Figure 1. Pocosin areas in North Carolina (modified from Richardson 1981).

White-cedar forests in southeastern North Carolina. White-cedar forests and savannas are both closely allied with pocosins. Additionally Wells, (1932), Woodwell (1956), and Sharitz and Gibbons (1983) provided good overviews of pocosin vegetation; and Wells and Whitford (1976) presented an outline of the serial development and successional fate of stream head swamp forests, pocosins, and savanna communities.

Carolina bays must also be mentioned in that they often support po-

cosin communities. Although this study does not cover Carolina bays *per se*, several specific types of vegetative communities that I studied were growing in these bays. Carolina bays vary in size from only a few acres to many hundreds of acres. An exposed sand rim of varying width normally occurs around the perimeter. These depressions are naturally wetter at all seasons than most surrounding areas, contrasting markedly with the dry sand rims which support xeric plant communities. While many Carolina bays host pocosin communi-

ties in various seral stages, some also contain sizable lakes, ponds, marshes, bogs, and swamps. In a large number of bays, natural fire has been suppressed for so long that the plant communities in them are now mature bay forests

Little field work has been conducted to survey birds within or adjacent to pocosin habitats. In fact, the only notable studies in pocosin areas have been by Brooke Meanley on the Dismal Swamp fauna of northeastern North Carolina and southeastern Virginia (Meanley 1968, 1969, 1976, 1979), but none of these was in typical pocosin habitats. Authors have commented on the lack of information on vertebrates associated with pocosins and successional related southeastern Coastal Plain habitats (*e.g.*, Wilbur 1981, Sharitz and Gibbons 1983). However, several reports on the bird life of successional stages of pocosin-associated communities have recently appeared Lynch (1981) reported on a six-hour survey of birds he conducted in a young bay forest in North Carolina and Terwilliger and Rose (1984) compared breeding birds associated with Atlantic White Cedar and maple-gum forest in the Dismal Swamp. The only actual published study on the birds of a true pocosin community is that of Clark and Potter (1982). This profile of various plant communities on the North Carolina Biological Survey study site at McCain, Hoke County, North Carolina, provides a partially annotated list of breeding birds of the six major plant communities occurring on the property. One of these is a five-acre Carolina Bay that is dominated by high shrub pocosin, from which 21 species of nesting birds is reported. With these exceptions, published information on the avian fauna of pocosin systems and associated successional stages is unavailable.

Pocosin habitats are widespread geographically and can be found from southeast Virginia to northern Florida and are estimated to have originally occupied over 20% (2.25 million acres) of the Coastal Plain of North Carolina alone (Fig. 1). Wells (1946) noted that there were over 300 square miles of pocosin in just three southeastern North Carolina counties. Since that time a high percentage of these areas has been drained, or partially drained, and cleared for agricultural or silvicultural purposes; some have been dammed for mill ponds. Other areas have been pro-

tected from fire for so long that the plant communities, through natural succession, have outgrown pocosin community serial stages.

There is some uncertainty about the extent of the loss of these habitats and the need for concern. Reports by Heath (1975) and Richardson *et al.* (1981) provide a general and gloomy summary of the projected future of these Coastal Plain wetlands. Most other studies have drawn on these sources as the basis for major concern for vanishing pocosin habitats. Richardson (1983) stated that only 31% of North Carolina pocosins remain in a natural state. McMullan (1984) has suggested that the reasons for concern may be less serious than previously stated, owing to faulty data sources and incomplete or nonexistent inventories. McMullan (1984) also demonstrated, in an analysis of a 300-year historical study of land use on the Albemarle-Pamlico Peninsula of North Carolina, that pocosin communities have persisted in spite of a long history of clearing and draining, and that many present day pocosins have developed (or redeveloped) on abandoned farm lands. Assuming that the answer is somewhere between the extremes expressed in these reports, it appears that the original estimates of habitat loss are too high, but that concern for loss of pocosin habitats is justified, although perhaps overstated. Likewise, since little information on the vertebrate fauna associated with pocosins is available, definitive statements made by previous authors concerning wildlife values of pocosins were premature. For example, Lee and Potter (1984) and Clark *et al.* (1985) demonstrate that the bird and mammal associates are mostly ubiquitous forms and that for mammals, density is generally low.

An overview of the breeding bird fauna of these communities is overdue. Currently, discussions about the unique biological value of pocosins and consideration for their use in agribusiness, silviculture, peat mining, and waste disposal are commonplace; but in most cases detailed information on which to base management decisions is lacking. For the last four years I have been surveying the birds of pocosins and their associated plant communities in the North Carolina Coastal Plain.

With exception of the previously mentioned studies, pocosins and their successional associated communities

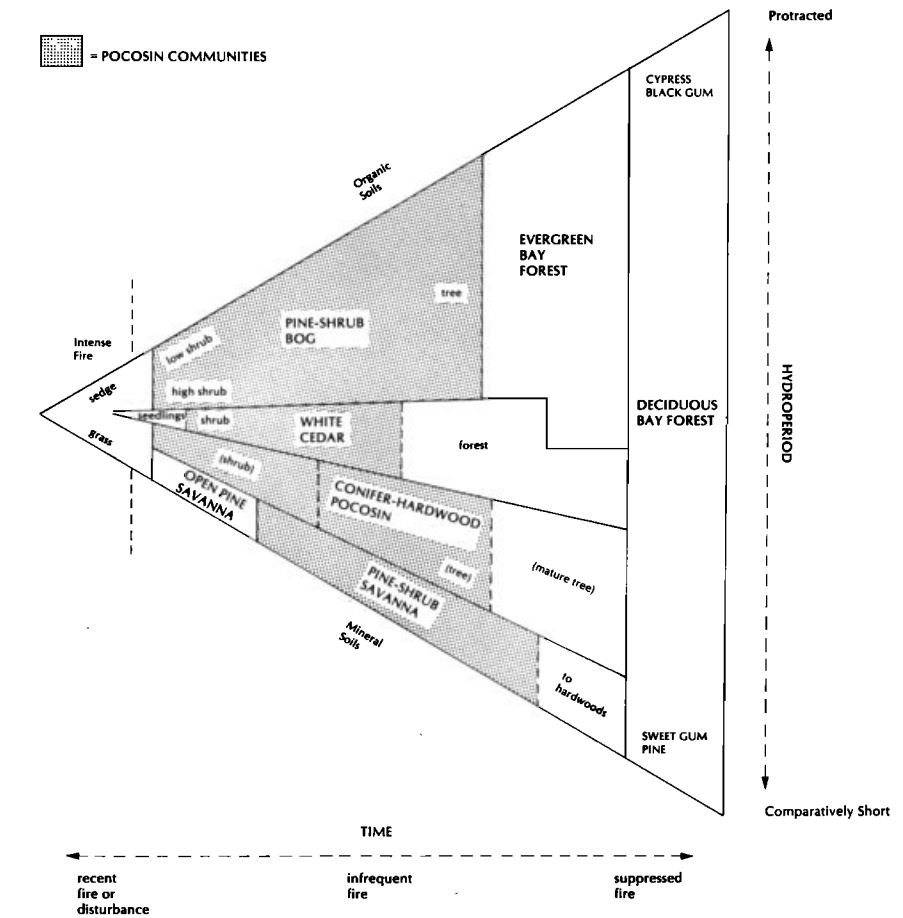
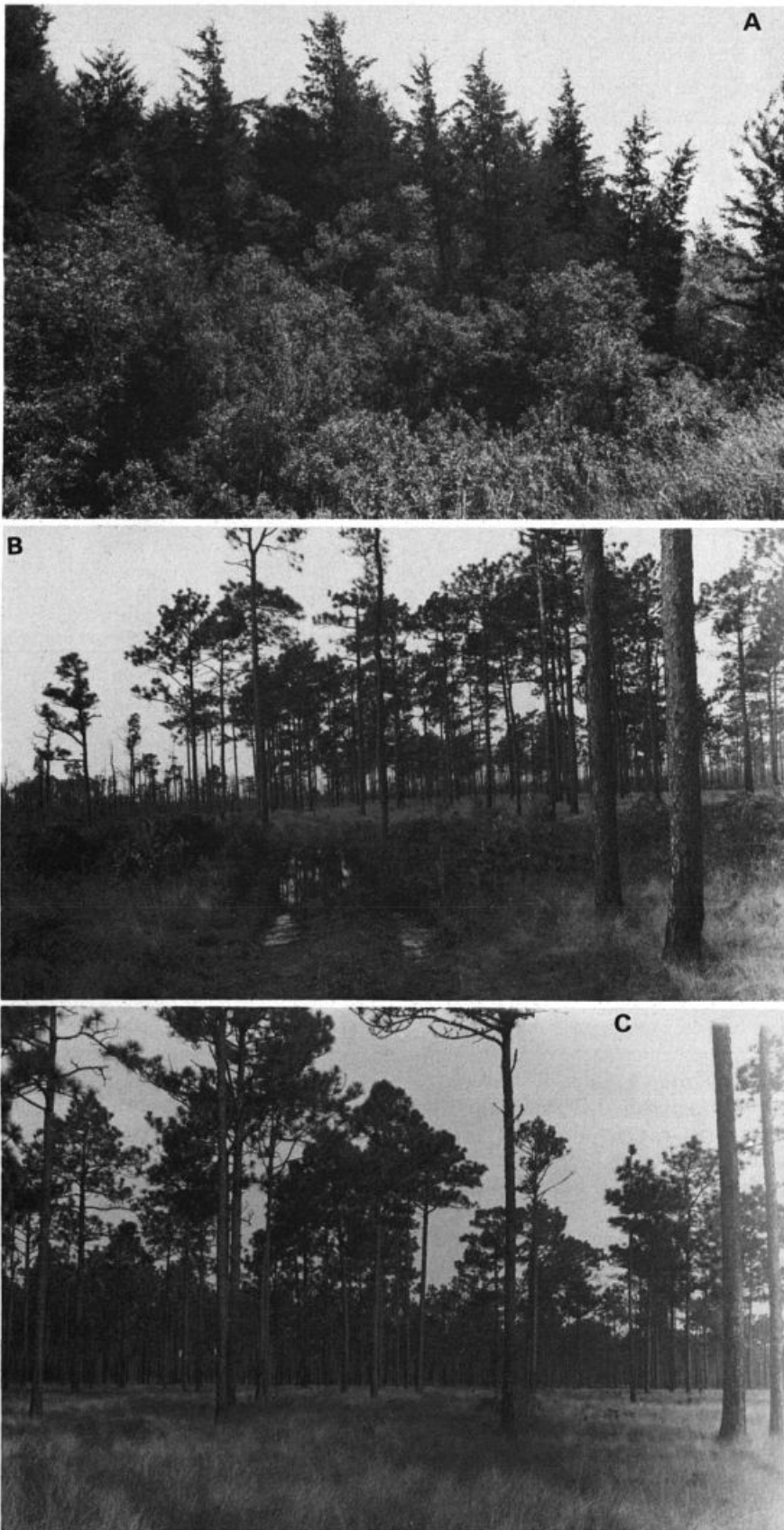


Figure 2. Proposed vegetation development of pocosins and associated plant communities as related to disturbance, time, and hydroperiod.

have not been investigated in terms of their bird fauna anywhere. Although the information presented here pertains only to North Carolina, I suspect that these findings would generally apply to other areas in the Southeast. My efforts to date have been focused on species inventories of a large number of different shrub dominated communities throughout the North Carolina Coastal Plain. While I consider the findings more than preliminary, problems associated with sampling the wide array of pocosin communities and the influence of geographical distributions on portions of the fauna at any particular site make it impractical to provide elaborate comparisons of relative abundance and density of species in specific habitat types at different localities. Furthermore, the impenetrable nature of the plant communities makes it difficult to census habitats by established standard spot mapping or transect techniques.

#### Community development and structure

Various environmental factors dictate the type of pocosin community that develops on a site. The most conspicuous factors are surface and sub-surface soil types, hydroperiod, and fire. The importance of the regularity and intensity of fire as it relates to season, hydroperiod, wind, and the accumulation of combustible vegetation cannot be overstated. Natural fire and fires set by Native Americans for game exploitation and later by Europeans for livestock range management were all important for long-term maintenance of various serial stages of pocosins. Fire prevention policies were detrimental to certain communities (particularly savannas), but recent understanding of the importance of consistent controlled burning in certain southeastern vegetation types for game and habitat enhancement and wildfire control has, in part, alleviated this problem.



**Figure 3.** Pocosin related communities (all photos/David S. Lee): a) Shortleaf Pine shrub bog. b) Longleaf Pine savanna with shrub bog developing in low wet area. c) Longleaf Pine/Wire Grass savanna. d) Young American White-cedar stand growing from a burned out shrub pocosin. e) Mature American White-cedar forest showing winter wind and ice storm damage. f) Carolina bays with exposed sand rims.

The characteristic and conspicuous plants of pocosins and successional related communities are comparatively few. In most instances each species occurs in a majority of the vegetative community types and only their relative abundance or growth forms change. These variations in relative composition, however, may be dramatic, both visually and ecologically, and are obviously important influences on the species composition of the breeding bird fauna. It is generally understood that birds are recruited by growth form, not plant species, as far as territorial needs are concerned. This is perhaps demonstrated more dramatically in pocosins and their later serial stages than anywhere else because the major plant communities vary more in growth form than in species composition. The major plant associates (alphabetically by genus, see Appendix 1) are Red Maple, Wire Grass, Atlantic White-cedar, Titi, Loblolly-bay, Sweet Gallberry, Inkberry, Fetterbush, Sweet-bay, Blackgum, Redbay, Pond Pine, "Bamboo" or Laurel-leaved Greenbrier, Pond Cypress, and Honey-Cup. Species less uniformly distributed include, Giant Cane, sedges, rushes, Sheep-Laurel, Longleaf Pine, Loblolly Pine, and blueberries. These latter species are, however, occasionally the dominant vegetation on certain sites.

Major pocosin community types include shrub bogs with scattered Pond Pine overstory, mixed conifer-hardwood pocosins, and shrub-pine savannas. Early successional stages of all of these types appear to be grass-sedge communities and later ones mature pine-hardwood and evergreen bay forests. With long-term absence of fire, all eventually become deciduous bay forests. In these later stages cypress and Blackgum emerge on the sites with protracted hydroperiods and Sweet Gum and pines on dryer ones. Thus, pocosins can be viewed as intermediate successional communities, often maintained in a subclimax stage by fire and hydroperiod, with the mature vegetative stages being suppressed for long periods on the wettest sites, but developing relatively quickly on dryer ones. Figure 2 depicts a general successional model for pocosin communities discussed. Figure 3 shows various examples of communities discussed.

The development of Atlantic White-cedar forests is unusual as this species needs fire or other disturbance to re-

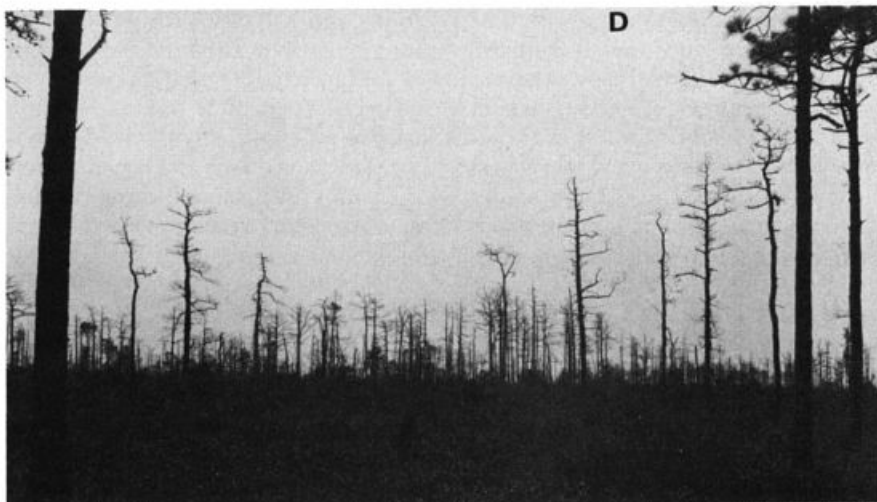
move competitive vegetation so that the seedlings can develop. However, extremely hot fires destroy the peat soil and cedar forests do not appear. Low-intensity, fast-moving fires on the other hand, do not destroy enough of the root stocks of competitive shrubs for this cedar to become well established. Even when established, Atlantic White-cedar is extremely fire susceptible, and forests persist only in the total absence of fire. Young cedar forests are usually pure stands of nearly even-age trees and the density of such forests often inhibits the establishment of other tree species for about 40 years. After that time the trees begin to thin out and the nature of their crowns changes, permitting light to penetrate to the forest floor. Terwilliger and Rose (1984) commented on the management problems of maintaining advanced-age cedar forest. At this stage bay forests develop rapidly, although individual cedars in these forests may persist for long periods. The open savanna community, on the other hand, requires continual policing by fire. If fire is suppressed for several consecutive years, many characteristic savanna plants vanish. The preceding analysis is summarized from Wells (1946), Buell and Cain (1943), Kologiski (1977), Wells and Whitford (1976), and personal observations.

### Methods

The avifauna of pocosins and associated communities was studied and inventoried in portions of Bladen, Brunswick, Dare, Hoke, and Pender counties of North Carolina between April 1980 and June 1984.

Inventories (species list and species dominance) were compiled for all sites and habitats surveyed. Density of the plant cover made it impractical to survey many of the breeding bird communities by traditional spot mapping or transect methods, and a more expedient comparative method was necessary. In some areas roads or other avenues of access allowed transects through monotypic habitats. The major survey problem was obtaining comparative data while excluding edge effects.

Counts of singing males were made for each habitat studied from walked transects (not always straight) 0.5 to 2



miles in length, ones driven with 0.25 mile, 5-minute stops (up to 8 miles), and from scattered specific stations within pure stands of certain habitat types. Additionally, at a few sites ecotonal areas were so narrow that it was possible to census two habitats simultaneously by recording singing males from each habitat while walking transects or from listing stations straddling two habitat types. Each major community was studied at several different sites (usually areas separated geographically by distances of 50–150 miles) and were revisited at different times during the nesting season (late April to late June). To be sure that the total diversity and relative composition of each major community type was recorded, I arbitrarily determined that 1000 encounters with singing males were necessary before the survey of any particular community was completed. In fact, after about 200–300 encounters the species composition of the fauna was well established, and the number of additional species discovered was extremely low. Species added after 200–300 encounters were birds that represented one-half of one percent of the total avifauna or less. Therefore, in some of the less typical pocosin-associated communities, I did not live up to my ambitious attempt to tally 1000 individuals. Non-vocal encounters with some birds (*e.g.*, Turkey Vulture, hawks, woodpeckers) were also included. For crude comparisons of density in different communities, the number of birds encountered/minute during prime survey hours (0600–0800) and seasons (May through the first week of June) were averaged.

## Results

For the most part, the characteristic avifauna of pocosins and related communities are wide-ranging, common species (Table 1). Within the North Carolina Coastal Plain only a few species are geographically restricted to the extent that they would not be expected wherever pocosin habitats exist, and none of these is a major component of the fauna. Most of the true pocosin birds discussed here are opportunistic species that exploit early and intermediate successional stages of many plant communities and are certainly not limited

to pocosin habitats. Because most are ubiquitous in distribution, no segment of the fauna can be used successfully to characterize pocosins. Some species appear to exist normally in low densities within true pocosins and become common only in disturbed areas or ones with temporary vegetative shifts caused by fires or storms. Birds characteristically found in one or more community types are listed in Table 1.

Natural ecotones, edges caused by land-use practices, and openings were far more diverse than interiors of bay or cedar forests, and many birds included some edge as part of their territories. This can be attributed to generally good cover in ecotonal areas, to a richer diversity of insect food, and perhaps to slight changes in topography that provide temporary refuge from seasonal flooding for ground-nesting species.

In many areas the plant communities are located on hard subsoils that form natural basins retaining surface water in the organic topsoils. Root systems of many of the bay forest trees do not usually penetrate the subsoils and the limited support offered by the shallow peat soils makes larger trees extremely vulnerable to strong winds and ice storms. This is magnified by the fact that many such trees are also “crown heavy” as a result of early competition with the normally dense understory vegetation. A visit to Carolina bays in Bladen County and to Atlantic White-cedar forests in Brunswick County during the spring of 1983 revealed extensive uprooting and limb breakage (particularly Red Maples, Redbay and cedars) caused by late March snow and ice storms. Hurricanes and tornados would certainly cause even greater damage. Buell and Cain (1943) observed areas where the weight of *Smilax* climbing into the canopies of cedar forests caused trees to uproot. Thus, natural openings in advanced successional stages are commonplace and these openings provide numerous sites for shade intolerant plants and early successional and ecotonal faunas. Around such openings an increased avian diversity is apparent.

Degree and duration of flooding of pocosin communities is extremely variable. Generally, areas with organic soils have protracted hydroperiods whereas those with mineral soils have comparatively short hydroperiods. Local topography, the nature of soil types of ad-

jacent communities, and land drainage operations also affect the amount of standing water.

Although the effect of fire in pocosins is logically an important factor in governing the breeding bird fauna, its overall influence is certainly more positive than negative. Plants associated with pocosins respond quickly to burning; thus the abundant new growth of herbaceous species and the temporary opening of the shrub layers generally produce an increase in birds.

The order of successional patterns of the plant/breeding bird community relationships have been interpreted as follows (birds listed in approximate order of abundance). It should be emphasized that these categories do not represent total faunal lists, but are the species most regularly encountered in each major community type. The relative abundance of each species is expressed as its percent of the total fauna of that community.

**Early Stages**—sedge/grass/rush (often scattered pines, but canopy and shrubs removed by fire or man) and open pine savanna:

**Characteristic** (>50%): Pine Warbler (14%), Great Crested Flycatcher (9%), Brown-headed Nuthatch (7%), Eastern Meadowlark (7%), Common Yellowthroat (6%), Eastern Wood-Pewee (5%), Northern Bobwhite (5%)

**Regular** (2–5%): Red-headed Woodpecker, American Crow, Tufted Titmouse, Prairie Warbler, Rufous-sided Towhee.

**Remarks:** A total of 38 species of birds was encountered, 14 of which were seen no more than three times (*i.e.*, each less than 1% of population).

Sedge Wrens were found in altered open areas as well as in natural early successional stages, exhibiting a noteworthy distributional pattern. Most survey work was done in savannas, and birds of early sedge/grass communities are not included in the percentages shown here or in Table 1. Figures and relative densities are based on a savanna study site in the Green Swamp in Brunswick County (Table 1).

**Intermediate Stages**—shrub bog and other pocosin types:

**Characteristic** (>50%): Common Yellowthroat (16–27%), Rufous-sided Towhee (12–19%), Prairie Warbler (15–16%), Northern Bobwhite (5%), White-eyed Vireo (4–7%).

**Table 1. Relative abundance index for birds regularly encountered in pocosins and associated habitats. Numbers represent abundance (percent to thousandth) for each of six specific communities surveyed. Abundance exceeding 5% and most conspicuous components of fauna in boldfaced type.**

	<i>Pocosin</i>					
	<i>Open grass and savanna</i>	<i>Shrub savannah</i>	<i>Low shrub pocosin</i>	<i>High shrub pocosin</i>	<i>White-cedar forest</i>	<i>Evergreen bay forest</i>
No. of encounters	355	175	1190	1095	354	1057
Approx. number hours surveyed	6.75	3.5	7.5	8.5	3	20.5
Individuals per minute	1.15	.53	3.39	2.89	2.75	1.34
Species						
<b>Northern Bobwhite</b>	<b>.051</b>	<b>.093</b>	.049	.029	.011	.015
<b>Mourning Dove</b>	.012		.021	<b>.051</b>	.017	.023
Red-headed Woodpecker	.022			.006		
Red-bellied Woodpecker				.004	.022	.006
Downy Woodpecker	.003		.002	.009	.003	.013
Hairy Woodpecker			.001	.001	.003	
Northern Flicker	.019	.018	.016	.013	.006	.004
<b>Eastern Wood-Pewee</b>	<b>.054</b>	.009	.015			
Acadian Flycatcher					.006	.018
<b>Great Crested Flycatcher</b>	<b>.090</b>	<b>.056</b>	.021	.009	.028	.029
Eastern Kingbird	.009		.014	.023		
Blue Jay			.003	.010	.003	.006
American Crow	.045	.009	.002	.011	.014	.024
Fish Crow	.016	.009	.001	.006	.006	.009
<b>Carolina Chickadee</b>	.003		.013	.012	<b>.050</b>	.040
<b>Tufted Titmouse</b>	.022	<b>.093</b>	.013	.014	<b>.079</b>	.048
<b>Brown-headed Nuthatch</b>	<b>.070</b>	.009	.013	.003		.011
Blue-gray Gnatcatcher			.003	.003	.006	.007
Carolina Wren	.016	.046	.027	.036		.038
Gray Catbird			.047	.044	.006	.021
Brown Thrasher			.003	.006		.001
<b>White-eyed Vireo</b>	.003	.037	.036	<b>.073</b>	.037	<b>.072</b>
<b>Northern Parula</b>			.001		.022	<b>.105</b>
<b>Black-throated Green Warbler</b>			.001	.001	<b>.147</b>	.018
Yellow-throated Warbler	.006			.006	.003	.023
<b>Pine Warbler</b>	<b>.141</b>		.012	.001	.011	<b>.055</b>
Prairie Warbler	.041	<b>.205</b>	<b>.147</b>	<b>.163</b>	<b>.113</b>	.032
Kentucky Warbler		.037	.005	.015	.017	.010
<b>Prothonotary Warbler</b>				.004	<b>.093</b>	<b>.084</b>
Worm-eating Warbler			.002	.003	.003	.040
Swainson's Warbler			.002		.022	.010
<b>Common Yellowthroat</b>	<b>.058</b>	<b>.242</b>	<b>.270</b>	.160	.037	.016
Hooded Warbler			.014	.004	.028	<b>.070</b>
Yellow-breasted Chat			.006	.010		.011
Northern Cardinal	.009	.046	.013	.024	.056	.030
<b>Rufous-sided Towhee</b>	.022	<b>.074</b>	<b>.190</b>	<b>.123</b>	.042	<b>.050</b>
<b>Eastern Meadowlark</b>	<b>.070</b>			.002		
Brown-headed Cowbird	.009		.004	.004	.039	
Total all other birds	<b>.167</b>	.009	.029	<b>.102</b>	<b>.093</b>	.041
Total species	38	16	40	51	40	44

**Regular (2-5%):** Gray Catbird, Mourning Dove, Great Crested Flycatcher, Carolina Wren, Northern Flicker, Eastern Kingbird, Eastern Wood Pewee, Carolina Chickadee, Tufted Titmouse, Brown-headed Nuthatch, Hooded Warbler, Northern Cardinal.

**Remarks:** The five characteristic species make up slightly more than 70% of the breeding fauna. Of 40 breeding species encountered, over one-half made up less than 1% of the fauna. Information from study sites in Holly Shelter, Pender County and Dare County, including both short and high shrub pocosins. House Wrens (1.1%) were found at both these sites and habitat types as well as in similar habitats in Brunswick County. These birds are south and east of their documented range and appear to be confined to this habitat in eastern North Carolina.

**Advanced Stages**—Atlantic White-cedar forest (mature dense forest)

**Characteristic (>50%):** Black-throated Green Warbler (15%), Prairie Warbler (11%), Prothonotary Warbler (9%), Tufted Titmouse (8%), Northern Cardinal (6%), Carolina Chickadee (5%).

**Regular (2-5%):** Red-bellied Woodpecker, Great Crested Flycatcher, White-eyed Vireo, Swainson's Warbler, Northern Parula, Common Yellowthroat, Hooded Warbler, Brown-headed Cowbird, Rufous-sided Towhee.

**Remarks:** Forty species of birds were encountered, 14 of which each made up less than 1% of the fauna. White-breasted Nuthatches (up to 2.5% at one site) replaced Brown-headed Nuthatches in this habitat. Individuals of many species were restricted to areas of the forest where part of their territory contained forest edges. Wood warblers made up 50% of the total fauna density and were represented by 11 species. Atlantic White-cedar forests were surveyed in Bladen, Brunswick, and Dare counties.

—Evergreen bay forest:

**Characteristic (>50%):** Northern Parula (10%), Prothonotary Warbler (8%), White-eyed Vireo (7%), Hooded Warbler (7%), Pine Warbler (5%).

**Regular (2-5%):** Mourning Dove, Great Crested Flycatcher, American

Crow, Carolina Chickadee, Tufted Titmouse, Carolina Wren, Gray Catbird, Worm-eating Warbler, Yellow-throated Warbler, Prairie Warbler, Northern Cardinal, Rufous-sided Towhee.

**Remarks:** Bay forest supports the most interesting and diverse assemblage of birds with most of the 44 species encountered being regular components of the community. Several peripheral as well as semi-disjunct bird populations seem locally dependent on these communities. Bay forests contain a remarkable diversity of breeding *Parulidae*, with no fewer than 13 species representing over 57% of faunal density, and several others were noted in transitional communities. Bay forests were surveyed at four sites in Bladen County. Only 16 of the 44 species recorded each made up less than 1% of the total population. Most birds included portions of edges or openings in their territories.

Other breeding birds encountered but considered transient, atypical or rare components of the fauna (followed by percent relative dominance combined for all habitats): Green-backed Heron (0.05%), Wood Duck (0.05%), Black Vulture (0.21%), Turkey Vulture (0.88%), Red-shouldered Hawk (0.24%), American Kestrel (0.03%), Yellow-billed Cuckoo (0.62%), Barred Owl (0.03%), Chuck-will's widow (0.03%), Chimney Swift (0.27%), Ruby-throated Hummingbird (0.03%), Belted Kingfisher (0.05%), Red-cockaded Woodpecker (0.08%), Pileated Woodpecker (0.38%), Purple Martin (0.03%), Northern Rough-winged Swallow (0.24%), Barn Swallow (0.05%), White-breasted Nuthatch (0.24%), House Wren (0.38%), Sedge Wren (0.11%), Eastern Bluebird (0.43%), Wood Thrush (0.03%), European Starling (0.13%), Yellow-throated Vireo (0.13%), Red-eyed Vireo (0.13%), Ovenbird (0.21%), Summer Tanager (0.08%), Indigo Bunting (0.32%), Bachman's Sparrow (0.16%), Red-winged Blackbird (0.05%), Common Grackle (1.61%) and Orchard Oriole (0.34%). The total of all miscellaneous birds in all habitats was 7.66% of faunal density.

*Notes on select species*

**Red-cockaded Woodpecker:** Low shrub pocosins supported small numbers of

this woodpecker. Single clans were encountered on study sites in Dare and Pender counties. The birds were also found in savannas, typical habitat for the species, in Brunswick County and on sand ridges adjoining Carolina Bays in Bladen County. Combined the species made up less than 0.10% of the total fauna of communities censused. This was the only Endangered Species found during the study, and pocosins provide only sub-marginal habitat for this woodpecker.

**Northern Rough-winged Swallow:** This swallow has expanded its range into pocosin areas by using banks of drainage ditches as nest sites. At present it is uncommon and restricted to specific sites in southeastern North Carolina.

**House Wren:** Prior to these studies, the House Wren was not recognized as occurring in the nesting season on the North Carolina coastal plain. Nevertheless, it is likely that these habitats have been used for some years and been simply overlooked. In July 1934, Burleigh (1937) found wrens near Stumpy Point in Dare County, and at Beaufort, Carteret County, but these records have been neglected. Both towns are in pocosin areas, and it appears that pocosins form the only sites in eastern North Carolina in which this wren lives. Birds presently inhabit a few short shrub pocosins in Dare (Potter *pers. comm.*) and Brunswick counties.

**Sedge Wren:** Although no positive evidence of nesting was found, Eloise Potter (*pers. comm.*) found Sedge Wrens on territory from April 4 to June 2 in early grass-sedge successional pocosin development in Dare County. This represents a slight southward range extension from the scattered records of coastal Maryland and Virginia.

**Wood warblers:** As a group and as individual species these comprised the dominant component of all habitats surveyed. For example, 69 singing male Common Yellowthroats were tallied in a census strip one-half mile long and 40 yards wide in a low shrub pocosin in Brunswick County. Additionally, several species that were either unknown from the Coastal Plain, or at least considered very rare, were found as regular components of tall shrub pocosins as well as bay and white-cedar forest. No fewer than 15 of the 16 species known to breed on the Coastal Plain of North



Carolina were found during this study, but several were not actually recorded during census periods; they were limited to peripheral communities, or atypical sites not censused. Black-and-white Warbler, Louisiana Waterthrush, and American Redstart all seemed to be limited to advanced forest stages that cannot be considered as pocosin associated communities.

**Worm-eating Warbler and Ovenbird:** Both warblers were regularly, though not abundantly, encountered in advanced stage successional communities. These birds seemed to persist south and east of their documented breeding range in bay and cedar forests, but are absent, or nearly so, from other Coastal Plain areas. Kentucky Warblers exhibited a similar distributional pattern, but they were also common in high shrub pocosins throughout the North Carolina Coastal Plain.

**Swainson's Warbler:** Generally regarded a warbler of southern swamps and cane breaks, Swainson's were found as regular, though not common inhabitants of cedar and bay forest communities. They were found in every bay forest visited in Bladen County.

**Prairie Warbler:** Although it was predicted that the Prairie Warbler would be an important component of shrub communities, the abundance of this species in Atlantic White-cedar communities and near absence in bay forest is difficult to explain. Nolan (1978) and Terwilliger and Rose (1984) noted that Dismal Swamp cedar stands were among the few places where this warbler has been reported in closed habitats. Terwilliger and Rose (1984) provide an explanation for this occurrence that involves Pleistocene evolutionary behavioral history of the species. In view of the relatively rapid growth of Atlantic White Cedar from shrub level to tree height, it seems just as likely that succeeding generations continue to return to these cedar forests to nest because they are site imprinted. Because cedar forests are the result of clearing and rapidly colonizing cedar seedlings, this process becomes all the more feasible. Orians (1971) proposed that site imprinting with successional change is one way in which a species can exploit new habitats and expand distributions.

**Yellow-breasted Chat:** Densities of chats varied considerably in pocosins. Tall shrub pocosin and recently burned

pocosins with dense shrubs had the most birds but some, seemingly identical, sites were unoccupied.

**Black-throated Green Warbler:** These warblers were abundant in Atlantic White-cedar forests, but in all other mature forest communities they were sporadically distributed. However, Potter (*pers. comm.*) found them common in tall Pond Pine pocosins in Dare County.

Pocosins probably were important as precolonial habitat refugia. The subclimatic communities and complex zonation of pocosins provided habitats for early and intermediate successional bird species then that would not otherwise have occurred regularly in most Coastal Plain habitats. It appears that they may have provided a reserve stock of birds that populated short-lived natural openings in other southeastern plant communities. Today pocosins and related communities are not critical to most mid-successional stage bird species because grazing, mowing, lumbering, and other development produce and maintain a wide array of early and intermediate successional stages over extensive areas of the Coastal Plain. Thus, for bird species already associated with pocosins and thereby widely distributed across the Coastal Plain, local expansion into suitable disturbed habitats is not surprising. In other words, species that may have been common only in pocosins in the past owing to ecological restrictions, are now able to exploit a wide array of disturbed community types. Except for maritime shrub thickets on barrier islands, there were few precolonial natural communities other than pocosins that could have supported species currently regarded as ubiquitous on the Coastal Plain.

The true pocosin fauna generally consists of species with wide ecological tolerance with the ability to exploit small plots of early successional stages and areas disrupted by human activities. The more advanced serial stages, notably bay forest and Atlantic White-cedar forests, however, support an interesting assemblage of breeding species including several birds that, prior to this study, were considered locally rare or were mostly unknown in the southeastern Coastal Plain. While interesting, these communities are not really pocosins, although it could be argued that it is normal to pass through a pocosin stage before a bay forest evolves.

## Summary and discussion

Pocosins and associated plant communities occupy an extensive portion of the southeastern Coastal Plain. Recent concern over development or potential exploitation of these areas has raised questions concerning the importance of their preservation. This study, the first attempt to systematically evaluate the avifauna of pocosins, indicates that while the avifauna composition is interesting, there may be insufficient justification for protection of these habitats on ornithological grounds alone. Index species are lacking and most associates are ubiquitous. Except for marginal populations of Red-cockaded Woodpeckers, they do not include species of national concern. This does not imply that these communities should not be preserved and managed for their own sake, or for the refuge they may provide to unique flora.

The habitat diversity found in the stages of pocosin succession maintained by storms, flooding, and fire, collectively allows considerable faunal diversity over broad areas. At specific sites, however, diversity is seldom high. In most cases, the uniform intermediate pocosin stages of community development support a low diversity but a high density of breeding birds. Advanced stages of community development, which are more structurally diverse, may support a higher diversity, but a modest density. Fire, flooding, and limited seasonal food resources singly and collectively dictate diversity and density of birds in ways that to date have not been measured.

In the past, pocosin communities may have been more important to the Coastal Plain avifauna than they are today. Since historical times land management practices have opened up vast areas for early successional species that in the past were probably ecologically confined to pocosins and other naturally suppressed serial community stages.

From a zoogeographic perspective, a number of Atlantic Coastal Plain species presently reach either northern, southern, or eastern limits of distribution in pocosin rich areas. The ecological nature of pocosin habitats, and perhaps the ability of these areas to buffer temperature extremes, is certainly a factor in the geographic distribution of some southeastern species.

In general, the practice of lumping a

variety of communities, ranging from open grass savannas to mature hardwood swamp forest, as pocosins has allowed a wide array of species to be considered as pocosin inhabitants. Such a system allows Eastern Meadowlarks and Bachman's Sparrows to be inhabitants of the same community in which one finds Prothonotary and Worm-eating warblers. When only the shrub bog stage of succession is regarded as pocosin, the fauna is characterized by a small assemblage of early to intermediate successional, shrub stage species.

Misconceptions and continued misquotations in newspaper accounts, environmental impact statements, and scholarly publications make it difficult to separate emotional concerns from the emerging facts regarding pocosins. Definition and interpretation have caused problems with inventory of habitat and projection of habitat loss. The general classification of pocosins as a type of wetland, although correct, has led some environmentalists to assume high wildlife values associated with pocosins despite the previous lack of systematic inventories. Statements about pocosin wildlife values are further hampered by the lack of comparable information for other wetland habitats and historical comparisons of the avifauna in the Southeast in general and the North Carolina Coastal Plain in particular. In this study I have provided the first attempt to document the breeding bird fauna associated with pocosin communities, and I hope to have started a process that will allow future researchers to define and separate the fauna of pocosins from that of their closely associated but very different communities.

#### ACKNOWLEDGMENTS

The United States Fish & Wildlife Service provided partial support for studies in Dare County under contract number 14-16-0004-81-056. Bryan Taylor, North Carolina State Parks, provided permission and encourage-

#### Appendix 1. Vegetative species arranged in alphabetical order by genus.

Red Maple	<i>Acer rubrum</i>
Wire Grass	<i>Aristida stricta</i>
Giant Cane	<i>Arundinaria gigantea</i>
sedges	<i>Carex</i> , sp.
Atlantic White-cedar	<i>Chamaecyparis thyoides</i>
Titi	<i>Cyrilla racemiflora</i>
Loblolly-bay	<i>Gordonia lasianthus</i>
Sweet Gallberry	<i>Ilex coriacea</i>
Inkberry	<i>Ilex glabra</i>
rushes	<i>Juncus</i> , sp.
Sheep-Laurel	<i>Kalmia caroliniana</i>
Sweet Gum	<i>Liquidambar styraciflua</i>
Fetterbush	<i>Lyonia lucida</i>
Sweet Bay	<i>Magnolia virginiana</i>
Blackgum	<i>Nyssa sylvatica</i>
Redbay	<i>Persea borbonia</i>
Shortleaf Pine	<i>Pinus echinata</i>
Longleaf Pine	<i>Pinus palustris</i>
Pond Pine	<i>Pinus serotina</i>
Loblolly Pine	<i>Pinus taeda</i>
Laurel-leaved Greenbrier	<i>Smilax laurifolia</i>
Pond Cypress	<i>Taxodium (distichum) ascendans</i>
blueberries	<i>Vaccinium</i> , sp.
Honey-Cup	<i>Zenobia pulverulenta</i>

ment to study certain areas in the state parks system. Eloise Potter, Mary Kay Clark, John B. Funderburg, Jr., and Gilbert Grant (all North Carolina State Museum) assisted in portions of the inventory effort. David K. Clark, Elizabethtown, provided assistance in aerial surveys and lodging during the Bladen County phase of this study. Potter conducted extensive surveys of Dare County and her findings were most helpful in preparing this manuscript and her comments greatly improved it.

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Appendix 2. Bird species arranged in taxonomic order.

Green-backed Heron	<i>Butorides virescens</i>
Wood Duck	<i>Aix sponsa</i>
Black Vulture	<i>Coragyps atratus</i>
Turkey Vulture	<i>Cathartes aura</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
American Kestrel	<i>Falco sparverius</i>
Northern Bobwhite	<i>Colinus virginianus</i>
Mourning Dove	<i>Zenaida macroura</i>
Yellow-billed Cuckoo	<i>Coccyzus minor</i>
Barred Owl	<i>Strix varia</i>
Chuck-will's-widow	<i>Caprimulgus carolinensis</i>
Chimney Swift	<i>Chaetura pelagica</i>
Ruby-throated Hummingbird	<i>Archilochus colubris</i>
Belted Kingfisher	<i>Ceryle alcyon</i>
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Hairy Woodpecker	<i>Picoides villosus</i>
Red-cockaded Woodpecker	<i>Picoides borealis</i>
Northern Flicker	<i>Colaptes auratus</i>
Pileated Woodpecker	<i>Dryocopus pileatus</i>
Eastern Wood-Pewee	<i>Contopus virens</i>
Acadian Flycatcher	<i>Empidonax virescens</i>
Great Crested Flycatcher	<i>Myiarchus cineritus</i>
Eastern Kingbird	<i>Tyrannus tyrannus</i>
Purple Martin	<i>Progne subis</i>
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>
Barn Swallow	<i>Hirundo rustica</i>
Blue Jay	<i>Cyanocitta cristata</i>
American Crow	<i>Corvus brachyrhynchos</i>
Fish Crow	<i>Corvus ossifragus</i>
Carolina Chickadee	<i>Parus carolinensis</i>
Tufted Titmouse	<i>Parus bicolor</i>
White-breasted Nuthatch	<i>Sitta carolinensis</i>
Brown-headed Nuthatch	<i>Sitta pusilla</i>
Carolina Wren	<i>Thryothorus ludovicianus</i>
House Wren	<i>Troglodytes aedon</i>
Sedge Wren	<i>Cistothorus platensis</i>
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>
Eastern Bluebird	<i>Sialia sialis</i>
Wood Thrush	<i>Hylocichla mustelina</i>
Gray Catbird	<i>Dumatella carolinensis</i>
Brown Thrasher	<i>Toxostoma rufum</i>
European Starling	<i>Sturnus vulgaris</i>
White-eyed Vireo	<i>Vireo griseus</i>
Yellow-throated Vireo	<i>Vireo flavifrons</i>
Red-eyed Vireo	<i>Vireo olivaceus</i>
Northern Parula	<i>Parula americana</i>
Black-throated Green Warbler	<i>Dendroica virens</i>
Yellow-throated Warbler	<i>Dendroica dominica</i>
Pine Warbler	<i>Dendroica pinus</i>
Prairie Warbler	<i>Dendroica discolor</i>
Black-and-white Warbler	<i>Mniotilta varia</i>
American Redstart	<i>Setophaga ruticilla</i>
Prothonotary Warbler	<i>Protonotaria citrea</i>
Worm-eating Warbler	<i>Helmitheros vermivora</i>
Swainson's Warbler	<i>Limnithlypis swainsonii</i>
Ovenbird	<i>Seiurus aurocapillus</i>
Louisiana Waterthrush	<i>Seiurus motacilla</i>
Kentucky Warbler	<i>Oporornis formosus</i>
Common Yellowthroat	<i>Geothlypis trichas</i>
Hooded Warbler	<i>Wilsonia citrina</i>
Yellow-breasted Chat	<i>Icteria virens</i>
Summer Tanager	<i>Piranga rubra</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
Indigo Bunting	<i>Passerina cyanea</i>
Rufous-sided Towhee	<i>Pipilo erythrophthalmus</i>
Bachman's Sparrow	<i>Aimophila aestivalis</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Eastern Meadowlark	<i>Sturnella magna</i>
Common Grackle	<i>Quiscalus quiscula</i>
Brown-headed Cowbird	<i>Molothrus ater</i>
Orchard Oriole	<i>Icterus spurius</i>

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