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HABITAT ASSOCIATIONS OF BIRDS IN THE GEORGIA PIEDMONT DURING WINTER

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Abstract.—During 3 winter seasons (1991–1994), we studied the distribution and abundance of birds in 3 habitat types of the Georgia Piedmont. Bird densities were calculated using data from 2160 variable circular-plot counts, 720 each in the interiors of the 3 habitats. Habitat variables were measured in 135 0.04-ha circles, 45 in each of the 3 habitats. The objective was to compare bird densities during winter in the Piedmont's fragmented mature pine forests and mature upland hardwood forests with those in planted pine plantations, a major replacement type. A total of 49 species was detected: 44 in mature pines, 42 in mature upland hardwoods, and 32 in 20–30-yr old pine plantations. Twenty-nine species occurred across all habitats. Overall, density estimates were low and variability among counts was high; consequently, significant ($P < 0.05$) habitat preferences were found for only about 25% of the species. Species richness (S) and diversity (H′) were greatest ($P < 0.05$) in mature pines and lowest ($P < 0.05$) in planted pine plantations. Also, species evenness (E) was higher ($P < 0.05$) in mature pines and upland hardwoods than in planted pine plantations.

ASOCIACIONES DE PÁJAROS EN HABITATS AL PIE DE LAS MONTAÑAS DE GEORGIA DURANTE EL INVIERNO

Sinopsis.—Durante tres inviernos (1991–1994) se estudió la distribución y abundancia de aves en tres tipos de habitats en Georgia. La densidad de pájaros se calculó utilizando datos obtenidos de 720 censos circulares en el interior de cada uno de los diferentes tipos de hábitat. Las variables en los habitats fueron medidas estableciendo 45 círculos de 0.04 ha en cada uno de los habitats. El objetivo fue comparar la densidad de aves durante el invierno en bosques de pino maduro fragmentado, bosques de maderas duras de altura, con plantaciones de pino, las cuales son el principal tipo de vegetación de reemplazo en la localidad. Se encontraron 49 especies de pájaros. A saber: 44 en bosques de pinos maduros, 42 en bosques de maderas duras y 32 en plantaciones de pino de 20-30 anos de edad. En los tres tipos de habitats se encontró en común 25 especies de pájaros. A grandes rasgos los estimados de densidad resultaron bajos y la variabilidad de los censos alta. Como consecuencia solo hubo diferencia significativa para preferencia de hábitat ($P < 0.05$) en el 25% de las especies. La riqueza de especies (S) y diversidad (H′) fue mayor ($P < 0.05$) en los pinos maduros y menor ($P < 0.05$) en las plantaciones. Además la uniformidad de especies (E) fue mayor ($P < 0.05$) en hábitats de pinos maduros y maderas duras que en las plantaciones.

Urbanization and the conversion of land for agricultural and silvicultural purposes have claimed much of the mature deciduous and pine forests in the Georgia Piedmont. Only small remnant tracts remain (Sheffield and Johnson 1993) and many of these tracts are on public lands. Although the impact of habitat disruption on breeding birds in the United States has been well documented (Crawford et al. 1981, Galli et al. 1976, Robbins et al. 1989, Yahner 1986), little is known of its effects on wintering birds (Yahner 1985), especially in the southeastern states. This group of birds, comprised of residents and short-stop migrants, includes woodpeckers, nuthatches, creepers, wrens, thrushes, kinglets, warblers and sparrows, among others. Because of the paucity of information on this group of birds during winter, we compared their distribution and abundance in mature forest habitats with that in planted pine plantations, a major replacement type.

STUDY AREA AND METHODS

With the assistance of the U.S. Forest Service, The University of Georgia, and private landowners, we selected 5 tracts each of mature upland hardwoods (60+ yr), mature pines (60+ yr), and 20–30-yr old pine plantations (nearing the harvest age of 25–30 yr) within 160 km of Athens, Georgia, on the Piedmont physiographic region. Locations of the sites by county are: 34°14′N, 82°52′W; 34°09′N, 83°03′W; 33°59′N, 82°44′W in Elbert Co.; 34°04′N, 83°14′W; 34°01′N, 83°14′W in Madison Co.; 34°02′N, 83°08′W in Oglethorpe Co.; 33°45′N, 83°22′W in Clarke Co.; 33°41′N, 83°17′W in Greene Co.; 33°25′N, 83°26′W; 33°23′N, 83°30′W; 33°21′N, 83°27′W in Putnam Co.; 33°16′N, 83°45′W; 33°15′N, 83°48′W; 33°10′N, 83°46′W in Jasper Co.; and 33°02′N, 83°44′W in Jones Co. This area of the Piedmont is characterized by gentle rolling hills (250 m average elevation) with hardwood, pine, or mixed pine-hardwood forests, but extensive acreage has been cleared for agricultural and silvicultural purposes. We wanted tracts of mature forests as large as possible for study, but were limited to those of about 30–50 ha; larger tracts could not be located, an indication of the severity of fragmentation. The criteria we used in the selection process included size and shape of the tract, homogeneity of tree types, age class of dominant species, and history of management practices. The landowners agreed to refrain from any habitat alterations during our study.

In order to sample forest avifauna, we used the variable circular-plot method developed by Reynolds et al. (1980). With this technique, density estimates are obtained using standard fixed maximum distances to calculate coefficients of detectability. We established 9 count stations within the interior of each study tract; stations were located at least 100 m from forest edges where feasible. Usually, stations were arranged in a 3 × 3 grid, with the direction of the grid being determined randomly. In 4 irregularly shaped tracts, the stations were established along a zig-zag transect, which minimized departure from the 3 × 3 grid. Successive stations

(circular-plot centers) within the grid or transect were 122 m apart, thus each circular-plot radius was half that, or 61 m.z

Two morning counts (Rollfinke and Yahner 1990) were conducted (0700–1100 hours) at each study site each month during December, January and February, beginning January 1992 and ending February 1994. Rainy or windy days were excluded. All birds seen or heard during a 10-min period at each of the 9 count stations per site were recorded. In addition, the horizontal distance to each bird's location within the 61-m limits of each circular plot was estimated; birds estimated to be outside this radius were not counted nor were birds flying overhead. We randomly rotated assignments among study sites and switched starting points between subsequent counts to reduce observer and station bias.

We measured vegetational characteristics of habitat types in 0.04-ha circular plots (James and Shugart 1970) within each variable circular-plot where bird count stations were centered. Measurements were taken once in January–February 1993. In each 0.04-ha plot, we determined tree species composition and density by size class, tree basal area, shrub stem density, dead tree density and basal area, log density and volume, canopy height, percent canopy closure, percent ground cover, slope, and aspect.

We calculated bird densities using a modification of the program DISTANCE (Buckland et al. 1993). We grouped distance observations into the following intervals: 0, 6.1, 12.2, 18.3, 24.4, 30.5, 38.1, 45.7, 53.3, and 61.0 m. We tested differences in habitat variables, bird densities, species richness (S), species diversity (H′), and species evenness (E) (Magurran 1988) among habitats using analysis of variance (ANOVA) with Tukey's HSD multiple comparison procedure. Null hypotheses were rejected at $P \leq 0.05$.

RESULTS

Habitat descriptions.—Mature upland hardwood tracts (Table 1) were characterized by moderately dense stands of large hardwoods, dominated by oaks (*Quercus*) and hickories (*Carya*) with scattered pines (*Pinus*). Canopy closure was 81%, resulting in extensive deciduous leaf litter on the forest floor during winter. Shrub density was lowest ($P < 0.05$) in upland hardwoods and herbaceous cover (%) here was lower ($P < 0.05$) than in mature pines.

Mature pine forests were dominated by large loblolly pines (*Pinus taeda*) with some scattered hardwood species. Although tree density was lowest ($P < 0.05$) here (Table 1), mean tree basal area was greatest ($P < 0.05$) because of the large size of the dominant pines. Canopy closure was lowest ($P < 0.05$) in mature pines, and because of this relative openness, shrub density and herbaceous cover were highest ($P < 0.05$). Prior to our study, mature pines were burned periodically (4–5 yr cycle), thus burning also may have contributed to a dense understory, as well as low snag density and high log density ($P < 0.05$) in these stands.

Pine plantations were dominated by planted loblolly pines in the 20–30-yr age class. Tree density and canopy closure were greatest ($P < 0.05$)

TABLE 1. Measurements ($\bar{x} \pm SE$) of untransformed habitat variables in 135 0.04-ha circles in 3 habitat types (5 tracts each) of the Georgia Piedmont during winter, 1992–1993.

Variable	Habitat type		
	Mature upland hardwoods	Mature pines	20–30-yr old planted pines
Hardwood trees >7.5 cm dbh (no./ha)	549A[a] ± 22	269B ± 32.1	167C ± 30.2
Coniferous trees >7.5 cm dbh (no./ha)	42C ± 12.8	139B ± 13.9	782A ± 39.0
Total trees >7.5 cm dbh (no./ha)	591B ± 24	408C ± 29	949A ± 36
Basal area of total trees >7.5 cm dbh (m^2/ha)	46.7B ± 5.0	91.1A ± 7.5	32.1B ± 7.6
Canopy height (m)	17.6A ± 0.4	16.9A ± 2.3	17.6A ± 1.4
Snags >7.5 cm dbh (no./ha)	56B ± 7.5	43B ± 5.8	116A ± 15.8
Basal area of snags >7.5 cm dbh (m^2/ha)	29.4A ± 5.8	27.3A ± 5.4	13.8B ± 1.4
Snag height (m)	7.6A ± 1.2	7.3A ± 0.8	8.7A ± 1.3
% canopy closure	81B ± 1.4	59C ± 2.6	88A ± 1.4
Logs >7.5 cm dbh (no./ha)	218B ± 21.7	401A ± 52.1	228B ± 35.4
Log volume (m^3/ha)	11.7B ± 2.2	21.0A ± 2.9	12.1B ± 2.3
Shrub (non-herbaceous plants <7.5 cm dbh) density (no./ha)	3086B ± 380	5555A ± 673	4935A ± 566
% herb cover	17.8B ± 2.3	59.2A ± 5.3	24.9B ± 4.1
% leaf litter	61.3A ± 6.4	10.5C ± 2.3	41.1B ± 5.9
Aspect (°)	161A ± 18.9	166A ± 14.6	171A ± 15.7
Slope (°)	9.8A ± 0.74	5.9B ± 0.56	4.3B ± 0.35

[a] Means within a row that share a common letter are not different ($P > 0.05$, ANOVA with Tukey's HSD test).

in these sites, but basal area was lowest because of the small mean diameter of most trees. Some hardwoods persisted in pine plantations, occurring mainly along streams and drains. Snag density was greatest ($P < 0.05$) in pine plantations but snag basal area was lowest. There was no significant difference in canopy height or snag height among the 3 habitat types.

Bird densities.—We conducted 2160 variable circular-plot counts, 720 in each of 3 habitat types, over 3 winters. Density estimates (no./50 ha) were low for most species, so we pooled data across years for comparisons among habitat types (Rice et al. 1984). During the 3 winter seasons, we detected a total of 49 species (common and scientific names are listed in Table 2): 44 in mature pines, 42 in upland hardwoods, and 32 in planted pines. Four species (Sharp-shinned Hawk, Barred Owl, Cedar Waxwing, and House Finch) were found only in upland hardwoods and 5 species (Red-cockaded Woodpecker, Common Yellowthroat, Field Sparrow, Red-winged Blackbird, and Evening Grosbeak) occurred only in mature pines; no species were detected only in pine plantations. Twenty-nine species occurred across all 3 habitat types (Table 2). Species richness (S) and diversity (H′) were greatest ($P < 0.05$) in mature pine forests and lowest ($P < 0.05$) in pine plantations; also, species evenness (E) was higher ($P < 0.05$) in mature pines and upland hardwoods than in pine plantations

(Table 3). The 5 species detected most often across habitats in order of decreasing abundance were Golden-crowned Kinglet, Ruby-crowned Kinglet, Pine Warbler, Carolina Chickadee, and Tufted Titmouse (Table 2).

Of the 49 species observed during winter, we were only able to detect significant habitat preferences in about 25% of them, probably because of variability extant in the data set (Table 2). Five of the 8 woodpecker species censused showed a preference ($P < 0.05$) for upland hardwoods and mature pines over pine plantations, and a sixth, the endangered Red-cockaded Woodpecker, was found only in mature pine forests. Brown-headed Nuthatches also preferred ($P < 0.05$) mature pines, were rarely found in pine plantations, and were never found in upland hardwoods. The Carolina and Winter Wrens, Hermit Thrush, Pine Warbler, and Northern Cardinal were most often found ($P < 0.05$) in mature pine forests. Three of the 5 most abundant species, the Golden-crowned and Ruby-crowned Kinglets, and Carolina Chickadee showed no significant habitat preferences.

DISCUSSION

To our knowledge, this is the first reported multi-year census of wintering birds in selected forests of the southeastern Piedmont physiographic region. Bird density estimates were low overall, but this is common in many habitat types during winter, especially in northern latitudes (Yahner 1986). Because many species form interspecific flocks and range over a wide area during winter, the chances of intercepting a feeding flock are reduced during winter counts (Yahner 1985), and this also increases variability in the data.

Of the habitats we studied, mature (60+ yr) pine and upland hardwood forests were more attractive to wintering birds than 20–30-yr old pine plantations. These mature forests are rapidly disappearing; of the 9.8 million ha of timberland in Georgia, less than 0.2 million ha of each remained in 1989 (Sheffield and Johnson 1993). Large tracts of these forests are difficult to find; in our area, we were only able to locate tracts of about 30–50 ha. All of the mature pine tracts were on federal or state lands and were managed (burned) for the endangered Red-cockaded Woodpecker. Between 1982 and 1989, lands diverted to pine plantations increased by 40% in Georgia, and by the year 2020, another 37% increase is projected (Sheffield and Johnson 1993). In contrast, old stand pine forests are projected to decrease 39%, while upland hardwoods will remain relatively stable.

Our objective was to compare bird densities during winter in Georgia's fragmented mature forests with those in pine plantations nearing harvest age (25–30 yr). Although the 3-yr study was too short for a population trends analysis, these data should be useful as a baseline for future work. Of particular interest would be the comparison of our results with the species composition found in pine plantations post-harvest and in the 1–10 yr age classes.

TABLE 2. Mean (± SE) bird densities in 3 habitat types (5 tracts each) of the Georgia Piedmont during winters 1991–1992, 1992–1993, and 1993–1994.

Variable	Habitat type		
	Mature upland hardwoods	Mature pines	20–30-yr old planted pines
Species density (no./50 ha)			
Sharp-shinned Hawk (*Accipiter striatus*)	0.03 ± 0.02	0	0
Cooper's Hawk (*Accipiter cooperii*)	0.03 ± 0.03	0.05 ± 0.05	0
Red-shouldered Hawk (*Buteo lineatus*)	0.03 ± 0.02	0.04 ± 0.01	0.02 ± 0.008
Red-tailed Hawk (*Buteo jamaicensis*)	0.007 ± 0.006	0.02 ± 0.01	0
Wild Turkey (*Meleagris gallopavo*)	0.09 ± 0.04	0.22 ± 0.15	0.09 ± 0.08
Northern Bobwhite (*Colinus virginianus*)	0	3.13 ± 1.74	1.29 ± 1.29
Mourning Dove (*Zenaida macroura*)	0.007B[a] ± 0.007	0.28A ± 0.09	0.028B ± 0.028
Great Horned Owl (*Bubo virginianus*)	0.02 ± 0.02	0	0.01 ± 0.008
Barred Owl (*Strix varia*)	0.014 ± 0.014	0	0
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	0.006 ± 0.006	0.014 ± 0.014	0
Red-bellied Woodpecker (*Melanerpes carolinus*)	1.95A ± 0.55	1.05AB ± 0.13	0.36B ± 0.16
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	1.46A ± 0.43	0.77AB ± 0.21	0.10B ± 0.09
Downy Woodpecker (*Picoides pubescens*)	1.31 ± 0.29	0.92 ± 0.19	0.57 ± 0.24
Hairy Woodpecker (*Picoides villosus*)	0.49A ± 0.06	0.22B ± 0.04	0.14B ± 0.02
Red-cockaded Woodpecker (*Picoides borealis*)	0	0.45 ± 0.34	0
Northern Flicker (*Colaptes auratus*)	0.33A ± 0.09	0.28AB ± 0.06	0.03B ± 0.02
Pileated Woodpecker (*Dryocopus pileatus*)	0.15AB ± 0.03	0.19A ± 0.04	0.05B ± 0.02
Eastern Phoebe (*Sayornis phoebe*)	0.75 ± 0.18	0.52 ± 0.14	0.49 ± 0.19
Blue Jay (*Cyanocitta cristata*)	0.37 ± 0.14	0.50 ± 0.20	0.17 ± 0.04
American Crow (*Corvus brachyrhynchos*)	0.10 ± 0.07	0.13 ± 0.08	0.31 ± 0.19
Carolina Chickadee (*Parus carolinensis*)	5.63 ± 0.77	6.39 ± 1.33	2.77 ± 0.90
Tufted Titmouse (*Parus bicolor*)	5.42A ± 0.91	5.70A ± 1.69	1.08B ± 0.34
Brown-headed Nuthatch (*Sitta pusilla*)	0	11.3A ± 2.28	0.007B ± 0.007
Brown Creeper (*Certhia americana*)	1.29 ± 0.71	0.44 ± 0.24	0.11 ± 0.08

TABLE 2. Continued.

Variable	Habitat type		
	Mature upland hardwoods	Mature pines	20–30-yr old planted pines
Carolina Wren (*Thryothorus ludovicianus*)	1.65AB ± 0.33	3.26A ± 0.87	0.90B ± 0.18
Winter Wren (*Troglodytes troglodytes*)	0.24AB ± 0.06	0.47A ± 0.14	0.08B ± 0.03
Golden-crowned Kinglet (*Regulus satrapa*)	12.3 ± 1.93	9.73 ± 2.33	22.3 ± 5.79
Ruby-crowned Kinglet (*Regulus calendula*)	5.66 ± 1.90	6.53 ± 1.56	7.03 ± 1.28
Eastern Bluebird (*Sialia sialis*)	1.32 ± 0.63	0.66 ± 0.32	0.06 ± 0.03
Hermit Thrush (*Catharus guttatus*)	0.41B ± 0.26	2.80A ± 0.78	1.16AB ± 0.27
American Robin (*Turdus migratorius*)	2.87 ± 1.53	2.74 ± 0.94	0.44 ± 0.13
Brown Thrasher (*Toxostoma rufum*)	0.007 ± 0.006	0.013 ± 0.008	0
Cedar Waxwing (*Bombycilla cedrorum*)	0.38 ± 0.34	0	0
Solitary Vireo (*Vireo solitarius*)	0.51 ± 0.19	0.25 ± 0.07	0.27 ± 0.18
Yellow-rumped Warbler (*Dendroica coronata*)	3.22 ± 0.75	1.49 ± 0.65	2.03 ± 1.61
Pine Warbler (*Dendroica pinus*)	2.50B ± 1.06	7.37A ± 1.21	5.26AB ± 0.48
Common Yellowthroat (*Geothlypis trichas*)	0	0.02 ± 0.02	0
Northern Cardinal (*Cardinalis cardinalis*)	0.43B ± 0.16	2.33A ± 0.58	0.53B ± 0.26
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	0.01 ± 0.01	2.71 ± 1.27	0.007 ± 0.006
Field Sparrow (*Spizella pusilla*)	0	0.05 ± 0.04	0
Fox Sparrow (*Passerella iliaca*)	0.70 ± 0.70	0.99 ± 0.56	0
Song Sparrow (*Melospiza melodia*)	0.03 ± 0.02	0.09 ± 0.09	0
Dark-eyed Junco (*Junco hyemalis*)	0.07 ± 0.07	0.14 ± 0.08	0
Red-winged Blackbird (*Agelaius phoeniceus*)	0	0.41 ± 0.36	0
Common Grackle (*Quiscalus quiscula*)	0.14 ± 0.008	0.03 ± 0.01	0
Purple Finch (*Carpodacus purpureus*)	1.69 ± 1.32	3.20 ± 2.78	0.01 ± 0.01
House Finch (*Carpodacus mexicanus*)	0.01 ± 0.01	0	0
American Goldfinch (*Carduelis tristis*)	1.28 ± 0.75	0.24 ± 0.07	0.10 ± 0.05
Evening Grosbeak (*Coccothraustes vespertinus*)	0	0.03 ± 0.01	0

[a] Means within a row that share a common letter are not different ($P < 0.05$, ANOVA); means within a row without letters are not different.

TABLE 3. Bird species richness, diversity, and evenness in 3 habitat types (5 tracts each) of the Georgia Piedmont during winters 1991–1992, 1992–1993, and 1993–1994.

Variable	Habitat type		
	Mature upland hardwoods	Mature pines	20–30-yr old planted pines
Species richness (S)	2.81B[a]	3.83A	1.48C
Species diversity (H′)	0.75B	1.04A	0.36C
Species evenness (E)	0.58A	0.74A	0.34B

[a] Means within a row that share a common letter are not different ($P > 0.05$, ANOVA).

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