

EARLY SUCCESSION BIRD COMMUNITIES OF GROUP-SELECTION OPENINGS AND CLEARCUTS IN THE OUACHITA MOUNTAINS, ARKANSAS AND OKLAHOMA

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Abstract—We compared species presence/absence and density of nongame birds across a range of group-selection opening sizes and clearcuts. Group openings and clearcuts were harvested the summer of 1993. Birds were surveyed during 1995, 1996, and 1998 in 12 group openings ranging in size from 0.54 to 2.62 ac and within 4 clearcuts of approximately 35-40 ac each. Several species occurred throughout a variety of available opening sizes and many had their highest densities recorded in group openings. Bird densities were only related with opening size during 1995. No correlations with opening size were apparent for densities of individual species. Results indicate that group-selection cuts in late-rotation, shortleaf pine-dominated stands may help enhance relative breeding bird abundance. However, our data reflect bird responses to the initial transition of an uneven-aged forest structure, and may not adequately represent responses in the latter part of this transition. Additionally, data are needed on reproductive success of birds utilizing these openings under a variety of successional stages.

INTRODUCTION

Recent changes in management of national forests has increased interest in silvicultural alternatives to clearcutting and planting for the regeneration of pines in the southeastern United States. One alternative silvicultural method receiving increased use in southern national forests is group-selection management. Group-selection management consists of periodic harvesting of small groups of trees to create and maintain an uneven-aged stand structure with at least three distinct age/size classes. Cutting intervals on southern national forests generally range from 5 to 10 years for pine, with opening sizes from 0.5 to 2.0 ac (Kerpez 1994). If the stand surrounding these openings (termed the matrix) contains sufficient timber volume, the matrix is typically thinned at the same time these openings are created. Group-selection management is normally used to regenerate shade intolerant tree species. Little information exists on the effects of group selection harvesting on wildlife in southern pine and pine-hardwood forests.

Structural and floristic habitat alterations that result from group-selection harvesting may affect ecologically important faunal groups such as nongame birds. Nongame birds help facilitate seed and fungi dispersal, help control insect numbers, play essential roles in food web dynamics, and can create habitat for other wildlife species through excavation of cavities. In addition to their ecological values, nongame birds are important as a recreational resource to millions of people that watch and feed birds (U.S. Department of the Interior 1992). Neotropical migratory birds are of particular research interest due to recent evidence of long-term population declines in many species (Finch 1991).

Forest edges, such as those created by openings in forest canopies, are generally considered to be detrimental to

many avian species because of possible increases in nest predation and parasitism by the brown-headed cowbird (*Molothrus ater*) (Brittingham and Temple 1983, Gates and Gysel 1978, Temple and Cary 1988, Wilcove 1985, Yahner and Scott 1988). Indices of habitat fragmentation, such as interior/edge ratios, fragment/matrix ratios, habitat patch heterogeneity, and the absolute amount of edge, are proportional to opening sizes (Rolstad 1991). Forest interior and area sensitive bird species may be adversely affected by management practices that increase forest fragmentation.

Few studies have assessed the effects of different opening sizes on nongame birds within forested landscapes. Lanham and Guynn (1998) found that species richness and relative abundance of neotropical migrants were positively related to increasing clearcut size, ranging from 1.24 to 32.12 ac, at piedmont sites in South Carolina. Using mist nets in bottomland hardwood forest gaps of 0.08, 0.31, and 1.24 ac, Kilgo and others (1999) captured more fall migrants in larger than smaller openings. However, the suitability of group-selection openings for breeding birds that utilize early succession habitats is unknown. Here, we compared presence/absence and densities of nongame birds among a range of group-selection opening sizes with those found in 35-40 ac clearcuts.

METHODS

Study Areas

We selected a subset of the 52 forest stands included in the Phase II (stand-level) Ecosystem Management Study described by Baker (1994). This subset consisted of eight stands located in Arkansas and Oklahoma on the Ouachita National Forest and the southern-most district of the Ozark/St. Francis National Forest. All stands were late-rotation (60-70 years old), 35-40 ac shortleaf pine- (*Pinus echinata*

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Mill.) dominated stands with mostly south, southeastern, or southwestern aspects. Prior to harvest, coniferous basal area of the 52 Phase II stands averaged 95.3 ft²/ac; hardwood basal area averaged 34.3 ft²/ac (Guldin and others 1994). Pretreatment stand and habitat conditions are described by Guldin and others (1994) and Thill and others (1994).

Treatments

Although the overall Phase II study included 13 treatments, this paper contrasts bird communities within group openings of different size in the pine/hardwood group-selection treatment and the clearcut treatment. All harvesting was completed between June 1 and September 30, 1993, and site preparation was completed between October 1, 1993 and April 30, 1994.

Group-selection stands—Approximately 10 percent of each of the four stands receiving the pine/hardwood group-selection treatment was harvested, creating a total of twelve group openings with the following sizes: 0.54, 0.59, 0.60, 0.72, 0.75, 0.92, 0.95, 0.98, 1.12, 1.23, 1.48, and 2.62 ac. All pines, except a few smaller trees totaling an average of only 1.3 ft²/ac basal area, were removed from the openings. Hardwoods < 5.9 in. d.b.h. were felled and left on site. A residual overstory hardwood component averaging 17.0 ft²/ac basal area was retained in the openings to improve aesthetics, forest diversity, and hard mast availability for wildlife. Pines in the matrix surrounding group openings were thinned to 70 to 80 ft²/ac; no other management occurred within the matrices.

Clearcuts—All four stands receiving the clearcut treatment contained ephemeral drainages that typically flow only for brief periods during high rainfall events. Unharvested linear strips (“greenbelts”) were retained along these drainages for watershed protection. Averaging about 11 percent per stand, greenbelts were comprised of woody vegetation that was similar in composition and structure to pretreatment stand conditions. Except for these greenbelts and a few overstory hardwoods (averaging 2-5 ft²/ac basal area), all merchantable pines and hardwoods were harvested from the four clearcut stands. All remaining trees were injected with herbicide (Baker 1994). Although clearcuts were scheduled to be ripped prior to planting, contractors could not be found to rip two of the stands. All stands were planted with genetically improved pines on an 8- by 10-ft spacing between December 1994 and March 1995. One stand was replanted in February 1996 due to inadequate stocking.

Bird Surveys

Relative bird abundance was quantified within a 131-ft-radius (40 m) circular plot centered in each of the 12 group openings. Additionally, one plot per clearcut stand was randomly selected from the five plots used for the Phase II Ecosystem Management bird surveys (Thill and others, in press). Plots were surveyed six times, once by six different observers, for 10 minutes. All plots were surveyed within 3.5 hours of sunrise. Surveys were conducted during May and June of 1995, 1996, and 1998. Birds were recorded as either in or outside of the 131-ft-radius plots. Birds within the plots were recorded by species, sex (if known), and

singing status; birds outside the plots were recorded as present only. Since a 131-ft-radius plot encompasses an area of 1.24 ac, larger than most group openings studied, many group-opening plots included both opening and matrix habitat. Thus, birds were also recorded as either in the opening or in the surrounding thinned matrix.

Analyses

Because sampling plots within group-selection stands often contained both opening and matrix habitat, bird data for the openings only were converted to numbers of birds per ac; i.e., density values. The mean number of birds encountered by all observers on each group-opening plot was computed using birds recorded within the actual opening only, and for each clearcut plot. Clearcut plots did not include any greenbelt inclusions, thus the area sampled was 1.24 ac per clearcut.

Densities were computed for each opening size for three sets of birds: (1) all birds combined (males and females), (2) migrants, and (3) residents. Pearson's correlation coefficients were computed to test ($\alpha \leq 0.05$) for linear relationships between group-opening size (including the four clearcuts) and mean total density for all birds combined, migrants, and residents. Correlation coefficients were also used to test ($\alpha \leq 0.05$) for relationships between group-opening size and densities of individual species.

RESULTS

A total of 1,383 breeding birds representing 53 species were recorded over all years (tables 1 and 6). Presence/absence and density information by opening size are summarized in tabular form (tables 1, 2, 3, and 4). Four species comprised almost 50 percent of the individuals recorded: indigo bunting, Carolina wren, prairie warbler, and yellow-breasted chat. Seventeen percent of species were recorded only in clearcuts, 20.7 percent were recorded only in group-selection openings, and 62.3 percent were recorded in both clearcuts and group openings (table 1). The indigo bunting was the only species to occur in all group-opening sizes and the clearcuts. Over all years, the Carolina wren occurred in all but the 0.60 ac opening, the summer tanager occurred in all but the 0.60 and 0.72 ac openings, and the black-and-white warbler occurred in all but the 0.60 and 0.75 ac openings. All other species were absent in ≥ 3 openings. However, species presence or absence by opening size varied by year (tables 2, 3, and 4). Over all years, 37 species (69.8 percent) had highest average densities recorded in a group opening; 13 species (24.5 percent) had their highest densities in the clearcut treatment (table 1). Of the 33 species found in both group openings and clearcuts, only 4 had their highest average densities in clearcuts: the prairie warbler, brown-headed cowbird, common yellowthroat, and eastern bluebird. However, density by opening size also varied by year (tables 2, 3, and 4).

A significant, positive linear relationship between opening size and mean total bird density was found during 1995 ($r = 0.68$, $P = 0.004$). However, no linear relationships were evident during 1996 or 1998 (table 5 and fig. 1). Furthermore, no densities of individual species were correlated with opening size ($P > 0.05$).

Table 1—Densities of birds (birds per ac), averaged across birders and years (1995, 1996, and 1998), during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June in the Ouachita Mountains of Arkansas and Oklahoma

Species	Density no.	Total percent	Opening size acres												Clearcuts	
			0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40	
Indigo bunting*	408	29.5	1.5	2.1	2.5	1.7	1.9	1.6	1.7	1.1	1.0	1.3	0.8	1.0	1.5	
Carolina wren	101	7.3	1.2	0.5	—	0.3	0.4	0.4	0.2	0.3	0.3	0.4	0.2	0.5	0.3	
Prairie warbler*	91	6.6	—	0.2	—	—	0.2	0.5	—	0.2	0.1	0.1	0.1	—	0.8	
Yellow-breasted chat*	90	6.5	—	—	0.3	—	—	0.2	—	—	0.3	0.5	—	0.2	0.6	
Brown-headed cowbird	66	4.8	0.1	0.2	—	—	0.2	0.1	0.1	0.1	0.1	0.2	—	0.2	0.5	
Summer tanager*	64	4.6	0.2	0.3	—	—	0.5	0.5	0.1	0.1	0.3	0.5	0.1	0.1	0.2	
Mourning dove	38	2.7	—	—	—	—	—	—	—	—	—	—	—	—	0.4	
American goldfinch	32	2.3	—	—	0.3	—	—	—	0.4	—	—	—	—	0.1	0.2	
Carolina chickadee	30	2.2	0.2	0.1	0.4	—	0.3	—	0.1	—	0.2	0.1	0.2	0.2	<0.1	
Pine warbler	30	2.2	—	0.4	0.2	0.2	0.2	0.2	—	0.2	0.2	—	0.5	—	<0.1	
Blue-gray gnatcatcher*	29	2.1	0.2	—	—	—	0.7	0.1	0.1	—	0.2	0.2	—	0.1	0.1	
Great-crested flycatcher*	28	2.0	—	—	—	—	0.2	—	0.1	0.1	—	0.1	—	0.1	0.2	
Eastern wood pewee*	27	2.0	0.4	—	—	—	0.2	—	0.4	—	0.1	0.1	—	0.2	0.1	
Common yellowthroat*	24	1.7	—	—	0.1	—	—	—	—	—	—	0.1	—	0.1	0.2	
Black & white warbler*	24	1.7	0.2	0.1	—	0.1	—	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	
Red-headed woodpecker	24	1.7	—	—	—	—	—	—	—	—	—	—	—	—	0.3	
Ruby-throated hummingbird*	21	1.5	0.3	—	—	0.2	0.3	—	0.2	—	0.1	0.2	—	0.1	<0.1	
White-eyed vireo*	19	1.4	0.1	—	—	—	0.4	—	—	—	0.3	0.1	—	<0.1	0.1	
Red-eyed vireo*	19	1.4	—	0.1	—	—	0.3	—	—	0.1	0.1	0.1	0.1	0.1	<0.1	
Tufted-titmouse	19	1.4	0.1	—	—	—	0.2	0.1	—	—	—	0.1	—	0.5	<0.1	
Eastern bluebird	18	1.3	—	—	0.1	—	—	—	—	—	—	—	—	—	0.2	
White-breasted nuthatch	17	1.2	0.4	—	—	—	—	—	0.1	—	0.1	0.1	—	0.1	0.1	
Field sparrow	16	1.2	—	—	—	0.2	—	0.1	—	—	—	—	—	—	0.1	
Northern cardinal	15	1.1	—	—	—	—	—	—	—	—	0.3	0.4	—	—	<0.1	
Bachman's sparrow*	14	1.0	—	—	—	—	—	0.1	—	0.1	—	—	—	—	0.1	
Eastern kingbird*	12	0.9	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Bluejay	10	0.7	—	—	—	—	—	—	—	—	—	0.1	—	—	0.1	
Common flicker	7	0.5	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Lark sparrow*	7	0.5	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Hooded warbler*	6	0.4	—	—	—	—	—	—	—	—	—	0.1	—	0.1	<0.1	
Downy woodpecker	5	0.4	—	—	—	—	0.1	—	—	—	—	—	—	0.1	<0.1	
Hairy woodpecker	5	0.4	0.1	—	0.1	—	—	—	0.1	—	—	0.1	<0.1	—	—	
Scarlet tanager*	5	0.4	—	—	0.1	—	—	—	—	—	—	0.1	—	—	<0.1	
Pileated woodpecker	4	0.3	—	—	0.1	—	—	0.1	—	—	—	0.1	—	<0.1	—	
Red-bellied woodpecker	4	0.3	0.1	—	—	—	—	—	—	0.1	0.1	0.1	—	—	—	
Yellow-throated vireo*	4	0.3	—	—	—	—	—	0.1	—	—	—	—	—	<0.1	<0.1	
Baltimore oriole*	4	0.3	—	—	—	—	0.1	—	—	—	—	—	—	<0.1	<0.1	

(continued)

Table 1—Densities of birds (birds per ac), averaged across birders and years (1995, 1996, and 1998), during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June in the Ouachita Mountains of Arkansas and Oklahoma (continued)

Species	Density	Opening size												Clearcuts			
		Total	0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40		
	<i>no.</i>	<i>percent</i>	<i>acres</i>														
American kestrel	4	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Chipping sparrow	3	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Broad-winged hawk*	3	0.2	0.1	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1	< 0.1
Orchard oriole*	3	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Eastern phoebe	3	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Yellow-billed cuckoo*	2	0.1	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Brown-headed nuthatch	2	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Yellow-throated warbler*	2	0.1	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	< 0.1
N. rough-winged swallow*	2	0.1	—	—	—	—	—	—	—	0.2	—	—	—	—	—	—	< 0.1
Worm-eating warbler*	1	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
American crow	1	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Brown thrasher	1	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Gray catbird*	1	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Ovenbird*	1	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Total	1,383	100.0	5.4	4.1	4.2	2.7	7.8	4.4	3.9	2.5	4.0	5.8	2.2	4.0	7.2		

Asterisks after bird names denote migrant species.

Table 2—Densities of birds (birds per ac), averaged across birders, during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June 1995 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Density no.	Total percent	Opening size -----acres-----												Clearcuts	
			0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40	
Indigo bunting*	186	29.6	1.2	1.4	2.5	1.6	2.9	1.8	2.5	1.7	1.3	1.8	1.1	1.6	2.4	
Carolina wren	71	11.3	3.1	0.9	0.9	0.9	0.7	0.7	0.4	0.9	0.7	0.7	0.5	1.2	0.7	
Prairie warbler*	21	3.3	—	0.3	—	—	—	—	—	—	—	—	—	—	0.7	
Yellow-breasted chat*	26	4.1	—	—	—	—	0.2	—	—	—	—	—	—	—	0.8	
Brown-headed cowbird	35	5.5	—	0.6	—	—	—	—	—	—	0.3	0.4	—	—	0.9	
Summer tanager*	32	5.1	—	—	—	—	1.1	—	0.7	0.3	0.7	0.7	0.3	0.3	0.2	
Mourning dove	29	4.6	—	—	—	—	—	—	—	—	—	—	—	—	1.0	
American goldfinch	22	3.5	—	—	0.8	—	—	—	0.2	—	—	—	—	0.3	0.5	
Carolina chickadee	1	0.2	—	0.3	—	—	—	—	—	—	—	—	—	—	—	
Pine warbler	9	1.4	—	0.3	0.6	0.2	—	—	—	—	0.3	—	0.3	—	<0.1	
Blue-gray gnatcatcher*	16	2.5	0.6	—	—	—	1.1	—	0.2	—	—	0.5	—	0.3	<0.1	
Great-crested flycatcher*	14	2.2	—	—	—	—	—	—	0.2	—	—	0.3	—	—	0.4	
Eastern wood pewee*	12	1.9	0.6	—	—	—	0.4	—	—	—	0.2	0.1	—	—	0.1	
Common yellowthroat*	10	1.6	—	—	—	—	—	—	—	—	—	—	—	0.3	0.3	
Black & white warbler*	9	1.4	—	0.3	—	—	—	—	0.2	—	—	0.3	0.1	0.1	0.1	
Red-headed woodpecker	19	3.0	—	—	—	0.2	—	—	—	—	—	—	—	—	0.6	
Ruby-throated hummingbird*	4	0.6	—	—	—	—	0.2	—	—	—	—	0.3	—	—	—	
White-eyed vireo*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Red-eyed vireo*	7	1.1	—	—	—	—	0.4	—	—	—	—	0.1	0.1	0.1	—	
Tufted-titmouse	8	1.3	—	—	—	—	—	—	—	—	—	—	—	0.8	<0.1	
Eastern bluebird	13	2.1	—	—	0.3	—	—	—	—	—	—	—	—	—	0.4	
White-breasted nuthatch	6	1.0	—	—	—	—	—	—	—	—	0.2	—	—	—	0.1	
Field sparrow	9	1.4	—	—	—	—	—	—	—	—	—	—	—	—	0.3	
Northern cardinal	10	1.6	—	—	—	—	—	—	—	—	0.5	0.7	—	—	0.1	
Bachman's sparrow*	14	2.2	—	—	—	—	—	—	—	—	—	—	—	—	0.4	
Eastern kingbird*	2	0.3	—	—	—	0.2	—	—	—	0.2	—	—	—	—	0.1	
Bluejay	8	1.3	—	—	—	—	—	—	—	—	—	0.4	—	—	0.2	
Kentucky warbler*	1	0.2	—	—	—	—	—	—	—	—	—	—	—	0.1	—	
Blue grosbeak*	1	0.2	—	—	0.3	—	—	—	—	—	—	—	—	—	—	
Common flicker	1	0.2	—	—	—	—	—	—	—	—	—	—	—	—	<0.1	
Lark sparrow*	6	1.0	—	—	—	—	—	—	—	—	—	—	—	—	0.2	
Hooded warbler*	2	0.3	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Downy woodpecker	3	0.5	—	—	—	—	0.2	—	—	—	—	—	—	0.1	<0.1	
Hairy woodpecker	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Scarlet tanager*	2	0.3	—	—	—	—	—	—	—	—	—	0.1	—	—	<0.1	
Pileated woodpecker	3	0.5	—	—	—	—	—	—	—	—	—	0.1	—	—	—	
Red-bellied woodpecker	1	0.2	—	—	—	—	—	—	0.2	—	—	—	—	0.1	—	

(continued)

Table 2—Densities of birds (birds per ac), averaged across birders, during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June 1995 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Density	Opening size												Clearcuts			
		Total	0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40		
	<i>no.</i>	<i>percent</i>	<i>acres</i>														
Yellow-throated vireo*	2	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	< 0.1
Baltimore oriole*	1	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
American kestrel	2	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1
Chipping sparrow	1	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Broad-winged hawk*	1	0.2	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—
Orchard oriole*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eastern phoebe	3	0.3	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	0.1
Yellow-billed cuckoo*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brown-headed nuthatch	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Yellow-throated warbler*	2	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
N. rough-winged swallow*	2	0.3	—	—	—	0.4	—	—	—	—	—	—	—	—	—	—	—
Worm-eating warbler*	1	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—
American crow	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brown thrasher	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gray catbird*	1	0.2	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—
Ovenbird*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	629	100.0	5.5	4.1	4.5	3.1	7.6	3.9	4.8	3.1	4.5	6.5	2.5	5.5	11.2		

Asterisks after bird names denote migrant species.

Table 3—Densities of birds (birds per ac), averaged across birders, identified during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June, 1996 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Density	Total	Opening size												Clearcuts	
			0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40	
	<i>no.</i>	<i>percent</i>	<i>acres</i>													
Indigo bunting*	106	29.3	1.5	1.7	3.1	2.1	1.8	1.5	1.2	0.5	0.9	1.5	0.3	1.1	0.7	
Carolina wren	16	4.4	0.6	—	—	—	—	0.7	0.2	—	0.2	0.4	—	0.3	0.1	
Prairie warbler*	30	8.3	—	—	—	—	0.7	0.9	—	—	0.2	0.1	—	—	0.7	
Yellow-breasted chat*	32	8.9	—	—	—	—	0.9	0.5	—	—	0.3	0.8	—	0.5	0.4	
Brown-headed cowbird	17	4.7	—	—	—	—	—	0.2	0.4	0.2	—	0.3	—	0.3	0.3	
Summer tanager*	20	5.5	0.6	0.3	—	—	0.4	0.5	0.2	—	—	0.7	—	—	0.2	
Mourning dove	5	1.4	—	—	—	—	—	—	—	—	—	—	—	—	0.2	
American goldfinch	7	1.9	—	—	—	—	—	—	0.5	—	—	—	—	0.1	0.1	
Carolina chickadee	10	2.7	—	—	0.6	—	—	—	—	—	0.5	—	—	0.5	<0.1	
Pine warbler	9	2.5	—	—	—	—	0.4	0.5	—	0.3	0.2	—	0.1	—	—	
Blue-gray gnatcatcher*	5	1.4	—	—	—	—	0.2	—	—	—	0.3	—	—	—	0.1	
Great-crested flycatcher*	9	2.5	—	—	—	—	0.4	—	—	—	—	—	—	—	0.2	
Eastern wood pewee*	11	3.0	0.6	—	—	—	0.2	—	0.4	—	—	0.1	—	0.4	0.1	
Common yellowthroat*	9	2.5	—	—	—	—	0.2	—	—	—	—	0.4	—	—	0.2	
Black & white warbler*	5	1.4	—	—	—	—	—	—	0.2	0.2	—	—	—	0.1	<0.1	
Red-headed woodpecker	4	1.1	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Ruby-throated hummingbird*	10	2.7	0.9	—	—	0.2	—	—	0.4	—	0.3	0.1	—	—	<0.1	
White-eyed vireo*	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	<0.1	
Red-eyed vireo*	5	1.4	—	—	—	—	0.2	—	—	0.2	—	0.1	0.1	0.1	—	
Tufted-titmouse	4	1.1	—	—	—	—	—	0.2	—	—	—	0.1	—	0.3	—	
Eastern bluebird	3	0.8	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
White-breasted nuthatch	8	2.2	1.2	—	—	—	—	—	—	—	—	0.3	—	—	0.1	
Field sparrow	3	0.8	—	—	—	—	—	—	—	—	—	—	—	—	—	
Northern cardinal	2	0.6	—	—	—	—	—	—	—	—	—	0.3	—	—	—	
Bachman's sparrow*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Eastern kingbird*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Bluejay	2	0.6	—	—	—	—	0.4	—	—	—	—	—	—	—	—	
Kentucky warbler*	1	0.3	—	—	—	—	—	—	—	—	—	0.1	—	—	—	
Blue grosbeak*	4	1.1	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Common flicker	5	1.4	—	—	—	—	—	—	—	—	—	—	—	—	0.2	
Lark sparrow*	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	<0.1	
Hooded warbler*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Downy woodpecker	1	0.3	—	—	—	—	—	—	—	—	—	—	—	0.1	—	
Hairy woodpecker	3	0.8	0.3	—	—	—	—	—	0.2	—	—	—	—	—	—	
Scarlet tanager*	2	0.6	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Pileated woodpecker	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Red-bellied woodpecker	3	0.8	0.3	—	—	—	—	—	—	—	0.2	0.1	—	—	—	

(continued)

Table 3—Densities of birds (birds per ac), averaged across birders, identified during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June, 1996 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Density	Opening size												Clearcuts			
		Total	0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40		
	<i>no.</i>	<i>percent</i>	<i>acres</i>														
Yellow-throated vireo*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Baltimore oriole*	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—
American kestrel	2	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1
Chipping sparrow	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Broad-winged hawk*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Orchard oriole*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eastern phoebe	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Yellow-billed cuckoo*	2	0.6	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brown-headed nuthatch	2	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1
Yellow-throated warbler*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N. rough-winged swallow*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worm-eating warbler*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
American crow	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brown thrasher	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gray catbird*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ovenbird*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	361	100.0	6.6	2.0	3.7	2.3	5.8	5.2	3.7	1.4	3.1	5.5	0.5	3.9	4.5		

Asterisks after bird names denote migrant species.

Table 4—Densities of birds (birds per ac), averaged across birders, during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June, 1998 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Density	Total	Opening size												Clearcuts	
			0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40	
no. percent																
Indigo bunting*	116	29.5	1.8	3.1	1.9	1.4	1.1	1.5	1.4	1.0	0.9	0.5	1.1	0.3	1.3	
Carolina wren	14	3.6	—	0.6	—	—	0.4	0.4	—	—	—	—	—	0.1	0.2	
Prairie warbler*	40	10.1	—	0.3	—	—	—	0.5	—	0.7	—	—	0.4	—	1.0	
Yellow-breasted chat*	32	8.1	—	—	0.8	—	—	—	—	—	0.5	0.7	—	—	0.5	
Brown-headed cowbird	14	3.6	0.3	—	—	—	0.7	—	—	—	—	—	—	0.3	0.3	
Summer tanager*	12	3.1	—	0.6	—	—	—	0.4	—	—	0.2	0.1	0.1	0.1	0.1	
Mourning dove	4	1.0	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
American goldfinch	3	0.8	—	—	—	—	—	—	0.4	—	—	—	—	—	<0.1	
Carolina chickadee	19	4.8	0.6	0.6	—	—	0.9	—	0.4	—	—	0.3	0.7	0.1	<0.1	
Pine warbler	12	3.1	—	0.9	—	0.2	—	—	—	0.2	—	—	0.9	—	<0.1	
Blue-gray gnatcatcher*	8	2.0	—	—	—	—	0.7	—	—	—	0.2	0.1	—	—	—	
Great-crested flycatcher*	5	1.3	—	—	—	—	—	—	—	0.2	—	—	—	0.3	0.1	
Eastern wood pewee*	4	1.0	—	—	—	—	—	—	0.2	—	—	—	—	0.3	<0.1	
Common yellowthroat*	5	1.3	—	—	0.3	—	—	—	—	—	—	—	—	—	0.1	
Black & white warbler*	10	2.5	0.6	—	—	—	—	—	—	—	0.2	0.3	0.3	0.1	0.1	
Red-headed woodpecker	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	<0.1	
Ruby-throated hummingbird*	7	1.8	—	—	—	—	0.7	—	—	—	—	0.1	—	0.3	—	
White-eyed vireo*	18	4.6	0.3	—	—	—	1.3	—	—	—	0.7	0.1	—	0.1	0.1	
Red-eyed vireo*	7	1.8	—	0.3	—	—	0.2	—	—	0.2	—	0.1	0.1	0.1	<0.1	
Tufted-titmouse	7	1.8	0.3	—	—	—	0.4	—	—	—	—	—	—	0.5	—	
Eastern bluebird	2	0.4	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
White-breasted nuthatch	3	0.8	—	—	—	—	—	—	—	—	—	—	—	0.3	<0.1	
Field sparrow	4	1.0	—	—	—	0.5	—	0.2	—	—	—	—	—	—	<0.1	
Northern cardinal	3	0.8	—	—	—	—	—	—	—	—	0.3	0.1	—	—	—	
Bachman's sparrow*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Eastern kingbird*	10	2.5	—	—	—	—	—	—	—	—	—	—	—	—	0.3	
Bluejay	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Kentucky warbler*	7	1.8	—	—	—	—	0.4	—	—	—	0.3	0.4	—	—	—	
Blue grosbeak*	3	0.8	—	0.3	—	—	—	—	—	—	—	0.1	—	—	<0.1	
Common flicker	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	<0.1	
Lark sparrow*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	
Hooded warbler*	4	1.0	—	—	—	—	—	—	—	—	—	0.1	—	0.4	—	
Downy woodpecker	1	0.3	—	—	—	—	—	—	—	—	—	—	0.1	—	<0.1	
Hairy woodpecker	2	0.4	—	—	0.3	—	—	—	—	—	—	—	—	—	—	
Scarlet tanager*	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	<0.1	
Pileated woodpecker	1	0.3	—	—	0.3	—	—	—	—	—	—	—	—	—	—	
Red-bellied woodpecker	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	

(continued)

Table 4—Densities of birds (birds per ac), averaged across birders, during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June, 1998 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Opening size												Clearcuts		
	Density	Total	0.54	0.59	0.60	0.72	0.75	0.92	0.95	0.98	1.12	1.23	1.48	2.62	35-40
	<i>no.</i>	<i>percent</i>	<i>acres</i>												
Yellow-throated vireo*	2	0.4	—	—	—	—	—	0.2	—	—	—	—	—	—	< 0.1
Baltimore oriole*	2	0.4	—	—	—	—	0.2	—	—	—	—	—	—	—	< 0.1
American kestrel	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Chipping sparrow	1	0.3	—	—	—	—	0.2	—	—	—	—	—	—	—	—
Broad-winged hawk*	2	0.4	0.3	—	—	—	—	—	—	—	—	—	—	0.1	—
Orchard oriole*	3	0.8	—	—	—	—	—	—	—	—	—	—	—	—	0.1
Eastern phoebe	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Yellow-billed cuckoo*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Brown-headed nuthatch	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Yellow-throated warbler*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
N. rough-winged swallow*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Worm-eating warbler*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
American crow	1	0.3	—	—	—	—	—	—	0.2	—	—	—	—	—	—
Brown thrasher	1	0.3	—	—	—	—	—	—	—	—	—	—	—	—	< 0.1
Gray catbird*	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Ovenbird*	1	0.3	—	—	—	—	—	—	—	—	0.1	—	—	—	—
Total	393	100.0	4.2	6.7	3.6	2.1	8.5	3.2	2.8	2.3	3.3	3.1	3.7	3.4	5.0

Asterisks after bird names denote migrant species.

Table 5—Correlation coefficients of mean densities (birds per ac) with opening size (0.54-40 ac) during May-June, 1995, 1996 and 1998 in the Ouachita Mountains of Arkansas and Oklahoma

Variable	1995		1996		1998	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Migrants	0.54	0.031	0.06	0.814	0.38	0.144
Residents	0.70	0.003	0.32	0.224	-0.05	0.868
Combined	0.68	0.004	0.22	0.419	0.31	0.242

Table 6—Common and scientific names of birds identified during point counts in 12 group openings (0.54-2.62 ac) and 4 clearcuts (35-40 ac) during May-June, 1995-1996 and 1998 in the Ouachita Mountains of Arkansas and Oklahoma

Species	Scientific name	Species	Scientific name
Indigo bunting*	<i>Passerina cyanea</i>	Bluejay	<i>Cyanocitta cristata</i>
Carolina wren	<i>Thryothorus ludovicianus</i>	Kentucky warbler*	<i>Oporomis formosus</i>
Prairie warbler*	<i>Dendroica discolor</i>	Blue grosbeak*	<i>Guiraca caerulea</i>
Yellow-breasted chat*	<i>Icteria virens</i>	Common flicker	<i>Colaptes auratus</i>
Brown-headed cowbird	<i>Molothrus ater</i>	Lark sparrow*	<i>Chondestes grammacus</i>
Summer tanager*	<i>Piranga rubra</i>	Hooded warbler*	<i>Wilsonia citrina</i>
Mourning dove	<i>Zenaida macroura</i>	Downy woodpecker	<i>Picoides pubescens</i>
American goldfinch	<i>Carduelis tristis</i>	Hairy woodpecker	<i>Picoides villosus</i>
Carolina chickadee	<i>Parus carolinensis</i>	Scarlet tanager*	<i>Piranga olivacea</i>
Pine warbler	<i>Dendroica pinus</i>	Pileated woodpecker	<i>Dryocopus pileatus</i>
Blue-gray gnatcatcher*	<i>Poliophtila caerulea</i>	Red-bellied woodpecker	<i>Melanerpes carolinus</i>
Great-crested flycatcher*	<i>Myiarchus crinitus</i>	Yellow-throated vireo*	<i>Vireo flavifrons</i>
Eastern wood pewee*	<i>Contopus virens</i>	Baltimore oriole*	<i>Icterus galbula</i>
Common yellowthroat*	<i>Geothlypis trichas</i>	American kestrel	<i>Falco sparverius</i>
Black & white warbler*	<i>Mniotilta varia</i>	Chipping sparrow	<i>Spizella passerina</i>
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	Broad-winged hawk*	<i>Buteo platypterus</i>
Ruby-throated hummingbird*	<i>Archilochus colubris</i>	Orchard oriole*	<i>Icterus spurius</i>
White-eyed vireo*	<i>Vireo griseus</i>	Eastern phoebe	<i>Sayornis phoebe</i>
Red-eyed vireo*	<i>Vireo olivaceus</i>	Yellow-billed cuckoo*	<i>Coccyzus americanus</i>
Tufted-titmouse	<i>Parus bicolor</i>	Brown-headed nuthatch	<i>Sitta pusilla</i>
Eastern bluebird	<i>Sialia sialis</i>	Yellow-throated warbler*	<i>Dendroica dominica</i>
White-breasted nuthatch	<i>Sitta carolinensis</i>	N. rough-winged swallow*	<i>Stelgidopteryx serripennis</i>
Field sparrow	<i>Spizella pusilla</i>	Worm-eating warbler*	<i>Helminthos vermivorus</i>
Northern cardinal	<i>Cardinalis cardinalis</i>	American crow	<i>Corvus brachyrhynchos</i>
Bachman's sparrow*	<i>Aimophila aestivalis</i>	Brown thrasher	<i>Toxostoma rufum</i>
Eastern kingbird*	<i>Tyranus tyrannus</i>	Gray catbird*	<i>Dumetella carolinensis</i>
		Ovenbird*	<i>Seiurus aurocapillus</i>

Asterisks after bird names denote migrant species.
Source: Hamel (1992).

Migrants

A total of 928 migrants of 29 species were recorded over all years (table 1). Migrants represented 54.7 percent of species recorded. Four species comprised over 70 percent of the individual migrants recorded: indigo bunting, prairie warbler, yellow-breasted chat, and summer tanager.

A weak but significant, positive linear relationship between opening size and mean total migrant density was found during 1995 ($r = 0.54$, $P = 0.031$). However, no linear relationships were evident during 1996 or 1998 (table 5 and fig. 1).

Residents

A total of 455 residents of 24 species were recorded over all years (table 1). Residents represented 45.3 percent of species recorded. Seven species comprised over 70 percent of the individual residents recorded: Carolina wren, brown-headed cowbird, mourning dove, American goldfinch, Carolina chickadee, pine warbler, and red-headed woodpecker.

A significant, positive linear relationship between opening size and mean total resident density was found during 1995

($r = 0.70$, $P = 0.003$). However, no linear relationships were evident during 1996 or 1998 (table 5 and fig. 1).

CONCLUSIONS

Several species, including species of conservation concern such as the black and white warbler, occurred throughout a variety of opening sizes. Additionally, most species had their highest densities recorded in group openings. Apparently these openings embedded within a more mature habitat matrix are attractive to a variety of species that utilize these early successional habitats. These openings also increase edge and habitat patchiness within a forested stand. However, the length of time a group opening maintains sufficient dissimilarity and edge contrast with the surrounding matrix habitat to sustain these relationships is unknown.

Total bird, migrant, and resident densities were only related with opening size during one of the three years of this study. This was probably due to the high numbers of birds recorded in the four clearcuts in 1995. No relationships between densities of individual species and opening size were apparent. The group-opening sizes in this study ranged from 0.54-2 to 62 ac, with the extremes differing by only 2.08 ac. This distribution of sizes may not be sufficient to reveal potential relationships between opening size and densities of individual species. Additionally, other factors such as opening shape and surrounding habitat matrix characteristics may also influence these relationships (Sisk and others 1997). We suggest additional research on a broader range of opening sizes.

Group-selection stands in our study are in a transition from an even-aged to an uneven-aged structure. Thus, bird community characteristics are expected to change over time as the vegetation composition and structure of these group openings and clearcuts change. Relative bird abundance was significantly higher within these same group-selection stands than for untreated controls in 1994 and 1998 (Thill and others, in press). Thus, our results suggest that during the early part of this transition, relative bird abundance may be enhanced by group-selection cuts in late-rotation, shortleaf pine dominated stands. However, before we can endorse this treatment, data are needed on reproductive success of birds utilizing these openings under a variety of successional stages.

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LITERATURE CITED

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