INITIAL BIRD RESPONSES TO ALTERNATIVE PINE REGENERATION METHODS IN ARKANSAS AND OKLAHOMA: PRELIMINARY FINDINGS

Ronald E. Thill, Roger W. Perry, Nancy E. Koerth, Philip A. Tappe, and David G. Peitz[1]

Abstract—We studied spring songbird communities in a predominantly forested landscape in the Ouachita Mountains of west-central Arkansas and eastern Oklahoma. Relative bird abundance, species richness, diversity, and evenness values are presented for the first, third, and fifth years following harvesting in four replications of four regeneration treatments (clearcut/plant, shelterwood, single-tree selection, and group selection), plus mature, untreated "controls." Within clearcut and shelterwood stands, relative abundance, species richness, and diversity of birds increased dramatically from the first to the third year, with smaller increases from the third to the fifth year. Single-tree and group selection stands followed this same pattern for species richness and diversity, but not for relative bird abundance. Within years, differences in response to harvesting generally were not significant, but group selection stands typically had the lowest values for the four harvesting treatments. Of the five treatments, controls typically had the lowest response variable values.

INTRODUCTION

Even-aged silviculture employing clearcutting, site preparation, and planting of pines has dominated forest management practices on forest industry and national forest lands throughout the South for the last 30 years (Baker 1989). Although young pine plantations provide excellent habitat for wildlife species adapted to early seral stages, even-aged pine silviculture, especially under short rotations, can diminish critical habitat for wildlife that require an abundance of snags and cavity trees, hardwoods, hard mast, and large down woody material.

Under recently adopted principles of ecosystem management (Guldin 1996, Overbay 1992), the USDA Forest Service is evaluating the effects of even- and uneven-aged regeneration methods on both an experimental and operational basis (for example, see Baker 1994, Kitchens 1989). One such project was initiated in Arkansas in 1991 on the Ouachita National Forest, the largest national forest (nearly 1.8 million acres) in the southern region. This multiphase project is evaluating partial cutting methods, some of which include long-term retention of a mixed-species overstory, employing natural regeneration as alternatives to clearcutting and planting (Baker 1994).

Phase II of this initiative is a stand-level, replicated study comparing an array of forest outputs and outcomes under 12 silvicultural treatments plus untreated controls (Baker 1994). Two years of pretreatment bird and habitat data were collected in 20 of these stands in 1992 and 1993 (Petit and others 1994). Stands were harvested during summer 1993, site preparation was conducted during the 1993-94 dormant season, and posttreatment bird surveys were initiated during May 1994. This paper reports breeding bird populations 1, 3, and 5 years after treatment and compares them with populations in untreated control stands.

METHODS

Study Areas

The 52 stands that comprise the larger study were randomly selected from a list that included all mixed shortleaf pine (*Pinus echinata* Mill.)-hardwood stands from randomly selected township and range strips in the Ouachita and Ozark National Forests that were candidates for regeneration. The stands also met the following pretreatment criteria: ≥ 60 years old; ≥ 35 acres in size (and blocky in shape to minimize confounding edge influences); predominantly southerly (south, southwest, or southeast) aspect; 60 to 110 square feet per acre pine basal area; and 20 to 50 square feet per acre hardwood basal area (Baker 1994). These 52 stands were blocked into 4 physiographic zones with 13 stands per block. Within each block, treatments were randomly assigned to the stands, yielding a completely randomized block design (Baker 1994). Because of limited resources, we chose to study only 5 of the 13 treatments. Thus, data reported here are from 20 (4 replications of 5 treatments) of the 52 stands (Thill and others 1994).

Eighteen of our study areas were on the Ouachita National Forest and two were on the southernmost district of the Ozark-St. Francis National Forest. Study areas were 35 to 40 acres in size and had slopes ranging from 0 to 15 percent. They generally occupied relatively xeric sites (southerly aspects, usually of mid- or lower slope position) characterized by high canopy coverage, an abundance of mostly small midstory and overstory hardwoods, and limited understory browse and herbage prior to treatment (Thill and others 1994). Pretreatment conifer basal area averaged 76.7 square feet per acre and consisted almost entirely of shortleaf pine and a few eastern redcedars (*Juniperus virginiana* L.); hardwood basal area averaged 36.6 square feet per acre (Thill and others 1994). Common hardwoods included oaks (*Quercus* spp.), hickories (*Carya* spp.), winged elm (*Ulmus*

[1] Supervisory Research Wildlife Biologist, USDA Forest Service, Southern Research Station, Nacogdoches, TX; Wildlife Biologist, USDA Forest Service, Southern Research Station, Hot Springs, AR; Statistician, USDA Forest Service, Southern Research Station, Nacogdoches, TX; Associate Professor and Research Associate, School of Forest Resources and Arkansas Forest Resources Center, University of Arkansas at Monticello, Monticello, AR.

Citation for proceedings: Guldin, James M., tech. comp. 2004. Ouachita and Ozark Mountains symposium: ecosystem management research. Gen. Tech. Rep. SRS–74. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 321 p.

alata Michx.), and black gum (*Nyssa sylvatica* Marsh.) (Guldin and others 1994). Pine site index (base age 50) averaged 62.2 feet over all 52 stands. For information on topography, soils, and climate, see Baker (1994).

All 20 stands contained ephemeral, and occasionally intermittent, drainages that typically flow only during and after heavy rains. Unharvested linear strips ("greenbelts") were established along these drainages in the 16 treated stands for watershed protection. Ephemeral and intermittent greenbelts were typically 65- and 130-feet wide, respectively. Greenbelts comprised 4 to 20 percent of the 16 harvested stands and averaged 10.9 percent. Prior to treatment, there was generally little difference in woody vegetation composition or structure between greenbelts and the surrounding habitat. On the upper slopes of most stands, these drainages tend to be steep and rocky and typically contain water only for brief periods.

Postharvest overstory basal area data were obtained as described by Guldin and others (1994). For additional information on sites, treatments, general stand characteristics, and pretreatment wildlife habitat conditions, see Baker (1994), Guldin and others (1994), and Thill and others (1994), respectively.

Treatments

Although the larger study involves 13 treatments, we chose to evaluate those treatments where an overstory hardwood component was retained to improve wildlife habitat and aesthetics; we also included clearcutting, which had been the principle timber harvesting and regeneration method for decades. Thus, four treatments (clearcut, shelterwood, single-tree, and group selection) plus an untreated control were evaluated. Harvesting was completed between June 1 and September 30, 1993.

Clearcut—All merchantable pines and hardwoods were harvested except for 2 to 5 square feet per acre of hardwood basal area retained for mast production and/or cavity and den sites. All trees that were not harvested or retained were injected with herbicide (Baker 1994). After harvesting, all four sites were scheduled to be ripped on the contour at 10-foot intervals to a depth of 6 to 8 inches and planted with genetically improved shortleaf pine seedlings on an 8-foot spacing within the rips. However, contractors could not be obtained to rip two sites; these sites were treated identically to the other two clearcuts but were not ripped. Genetically improved pines were planted between December 1994 and March 1995. One stand was replanted in February 1996 due to inadequate stocking.

Shelterwood—From 20 to 40 of the largest pines and hardwoods per acre were retained; the combined basal area of trees that were left was 30 to 40 square feet per acre, of which 5 to 15 square feet per acre were hardwoods. All other pines and hardwoods were harvested or felled and left on the ground.

Single-tree selection—Under this treatment, some pines and hardwoods will be harvested approximately every 10 years. As with future thinning treatments, residual basal area after this first cutting cycle ranged from 45 to 65 square feet per acre, with 5 to 20 square feet per acre in hardwoods. Site preparation consisted of removing all hardwoods < 5.9 inches diameter at breast height (d.b.h.).

Group selection—As in the single-tree selection stands, portions of these stands will be harvested approximately every 10 years. During each harvest entry, approximately 10 percent of each stand will be cut in openings that will generally range from 0.5 to 2.0 acres in size. Because 1993 was the first entry, about 10 percent of our stands were in group openings. All pines in these openings were cut, but 5 to 10 square feet per acre of overstory hardwood basal area was retained. Within the matrix surrounding these openings, pines were thinned to 70 to 80 square feet per acre basal area, but no hardwoods were removed. Site preparation in group openings consisted of chain-saw felling all hardwoods < 5.9 inches d.b.h.; no site preparation occurred outside these openings.

Untreated controls—With the exception of protection from severe loss to wildfire or insects, no management was or will be conducted in these mature second-growth, pine-hardwood stands.

Bird Surveys

Before treatment, bird populations were surveyed in five or six (depending on stand size and shape) permanent 131-foot-radius (1.24-acres) point-count plots (Verner 1988) spaced evenly over each of the 20 study areas (Petit and others 1994). Plots were usually ≥ 425 feet apart and all plot edges were ≥ 295 feet from stand boundaries. Beginning in 1994, we randomly deleted one plot from stands where six plots had been established so that all posttreatment comparisons would be based on identical sampling effort.

Because group selection opening locations were not known when permanent sampling plots were established, posttreatment surveys sampled a mix of openings and surrounding (matrix) habitat. Likewise, posttreatment surveys also sampled some greenbelts in most harvested stands. Thus, data presented here characterize operational, stand-level conditions rather than individual, within-stand habitat components such as greenbelts, openings, or matrix habitat.

Plots were surveyed for birds once each by three observers in 1994 and once each by six observers in 1996 and 1998. All surveys were conducted between May 3 and June 12. Surveys at each plot lasted 10 minutes, and all surveys were conducted within 3.5 hours of sunrise. Surveys were not conducted during heavy rain or windy conditions. At each plot, all birds seen or heard within and outside the plot (but within the same stand) were recorded separately.

Analyses

Observers differed to some extent each year and sampling effort was increased the last 2 years; consequently, differences among years were not evaluated statistically but are reported for descriptive purposes. Because our primary interest is in differences among treatments within years, statistical tests are presented only for within-year comparisons. Findings reported here are based only on data collected within 131-foot-radius plots.

Relative bird abundance was calculated as the mean number of birds encountered on each plot across all observers. Relative species richness was calculated as the number of species encountered on each plot, composited across observers. Species diversity (Shannon-Weiner diversity index) and evenness are based on these composited values (Magurran 1988). Differences among treatments for all variables were evaluated using randomized-block analyses of variance (with physiographic zones as blocks and plots as subsamples: n = 100, four blocks X five treatments X five plots/stand). Where sampling error and experimental error were not different (alpha = 0.15), treatment effect was tested with sampling error; otherwise, experimental error was used to test for treatment differences. Mean separation was accomplished using REGWQ multiple range tests (alpha = 0.05) (SAS Institute Inc. 1988).

RESULTS AND DISCUSSION

Posttreatment Stand Characteristics

Prior to harvesting, pine, hardwood, and total basal area averaged 76.7, 36.6, and 113.4 square feet per acre, respectively. Pine and hardwood basal area were similar (P>0.05) among the 20 stands when grouped by future treatment (Thill and others 1994). The most intensive treatments, as indicated by residual basal area, occurred in group selection openings and clearcuts (fig. 1). Average residual hardwood basal area in shelterwood and single-tree selection stands was identical (13.5 square feet per acre), and slightly less than in group openings (17.0 square feet per acre). Residual hardwood basal area in the group selection matrix habitat was comparable (27.0 square feet per acre) to that of controls (28.8 square feet).

Relative Abundance

Within treatments, postharvest bird abundance increased progressively each year in all treatments except controls, which had slightly lower abundance in 1996 than in 1994 or 1998 (fig. 2). The amount of increase in bird abundance between years decreased in clearcuts and shelterwoods from 1996 to 1998 relative to the increase from 1994 to 1996 (fig. 2). This pattern was not apparent in the single-tree and group selection treatments. In fact, the differences in relative abundance for both single-tree and group selection stands between 1996 and 1998 were greater than between 1994 and 1996.

Differences in relative abundance among treatments were statistically significant during 1994 (F = 7.54; 4,80 df; P = 0.0001), 1996 (F = 5.17; 4,12 df; P = 0.0118), and 1998 (F = 27.32; 4,12 df; P = 0.0001). During the first year after treatment, relative abundance was significantly lower in controls than in other treatments; no differences existed among harvested stands (fig. 2). During the third year after treatment, abundance was lower in control stands than in clearcut and shelterwood stands. By the fifth after treatment, relative abundance was comparable in clearcut, shelterwood, and single-tree selection stands, but relative abundance in these three treatments was significantly higher than in group selection and control stands, both of which also differed significantly (fig. 2). When data for the four harvested treatments were averaged within years, relative abundance was 2.1, 3.1, and 2.5 times greater than in controls during 1994, 1996, and 1998, respectively.

Species Richness

In harvested stands, avian species richness increased substantially from the first to the third year for all treatments except controls; only moderate increases occurred in harvested stands between the third and fifth years after treatment (fig. 3). Species richness in control stands also increased each year, but this increase between years was more uniform than in treated stands. While the cause for apparent increases in species richness in control stands is unknown, the amount of between-year variation is only

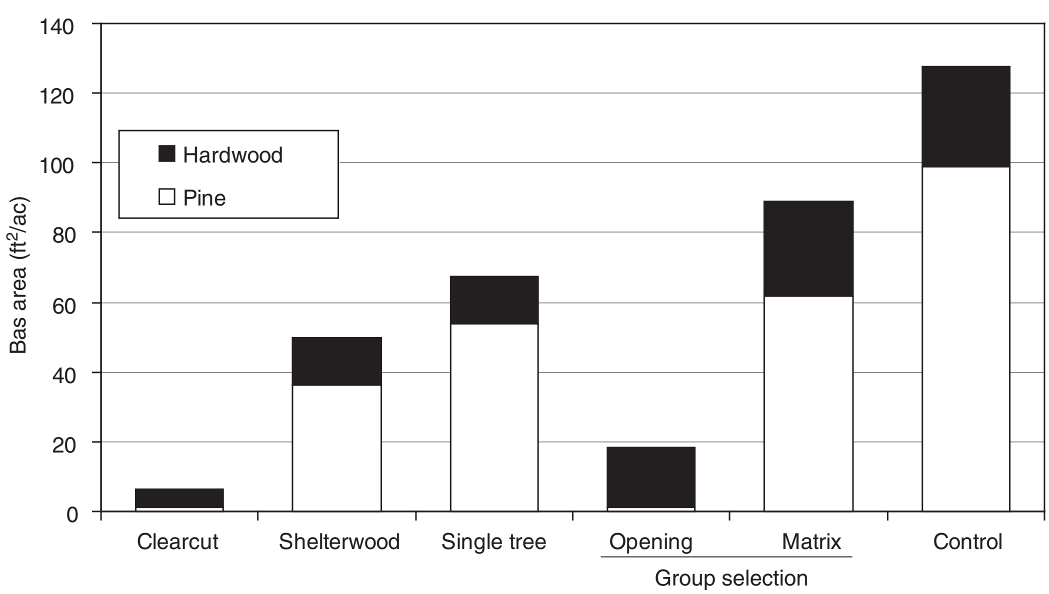

Figure 1—Pine and hardwood basal area in untreated controls and four regeneration treatments immediately after harvest of pine-hardwood stands in the Ouachita Mountains of Arkansas and Oklahoma.

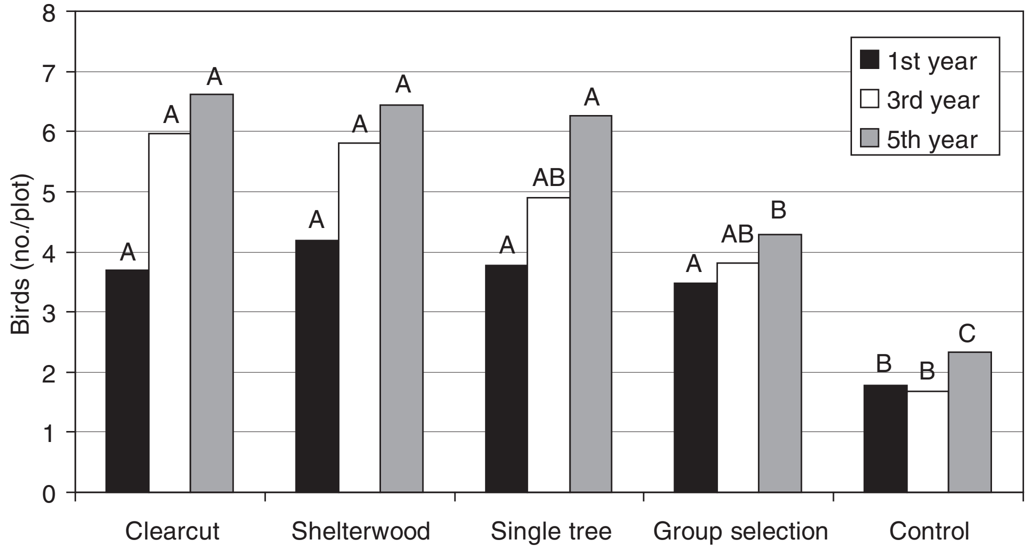

Figure 2—Relative bird abundance by silvicultural treatment during the first (1994), third (1996), and fifth years (1998) after harvesting of pine-hardwood stands in the Ouachita Mountains of Arkansas and Oklahoma. Within years, bars with different letters are significantly different (*P*<0.05).

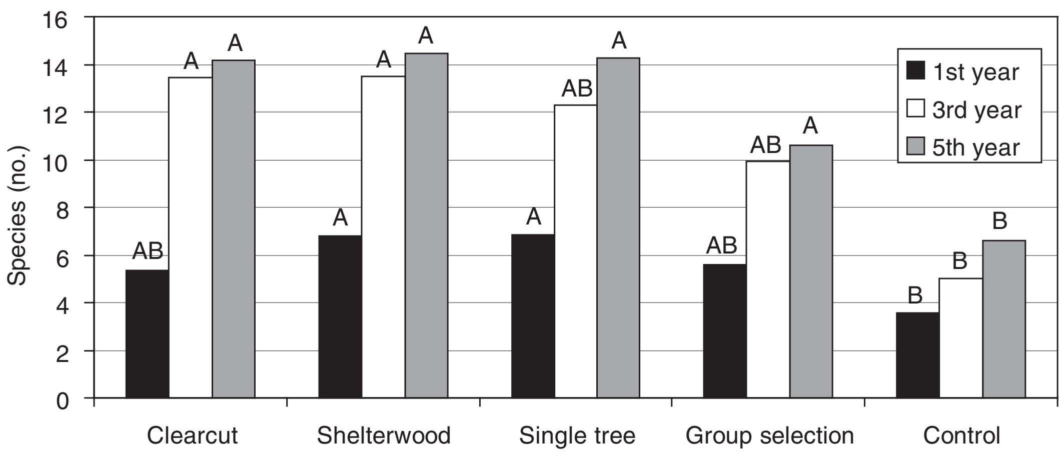

Figure 3—Bird species richness by silvicultural treatment during the first (1994), third (1996), and fifth years (1998) after harvesting of pine-hardwood stands in the Ouachita Mountains of Arkansas and Oklahoma. Within years, bars with different letters are significantly different (*P*<0.05).

slightly higher than observed prior to treatment (Petit and others 1994; fig. 6) and probably reflects inherent temporal variability and/or observer differences.

Within years, differences in species richness among treatments were significant during 1994 ($F = 3.66$; 4,12 df; $P = 0.0360$), 1996 ($F = 3.41$; 4,12 df; $P = 0.0440$), and 1998 ($F = 12.66$; 4,12 df; $P = 0.0003$). Within years, species richness was consistently lowest in untreated controls. Among the four harvested treatments, differences in richness were not significant during any year (fig. 3). However, in all 3 years species richness was significantly higher in shelterwood stands than in controls. Clearcuts and single-tree stands had higher species richness than controls in 2 years (1996 and 1998, and 1994 and 1998, respectively). Species richness in group selection stands was higher than in controls only during the fifth year. When data for the four harvested treatments were averaged within years, species richness was 1.7, 2.5, and 2.0 times greater than in controls during 1994, 1996, and 1998, respectively.

Diversity

Within harvested treatments, diversity increased each year, but the amounts of increase declined over time (fig. 4). Diversity followed a similar pattern to species richness in control stands.

Within years, controls consistently had the lowest avian diversity. Differences in diversity among the five treatments were significant during the first ($F = 4.06$; 4,12 df; $P = 0.0262$) and fifth years ($F = 8.60$; 4,12 df; $P = 0.0016$) and nearly so ($F = 3.15$; 4,12 df; $P = 0.0551$) during the third year after

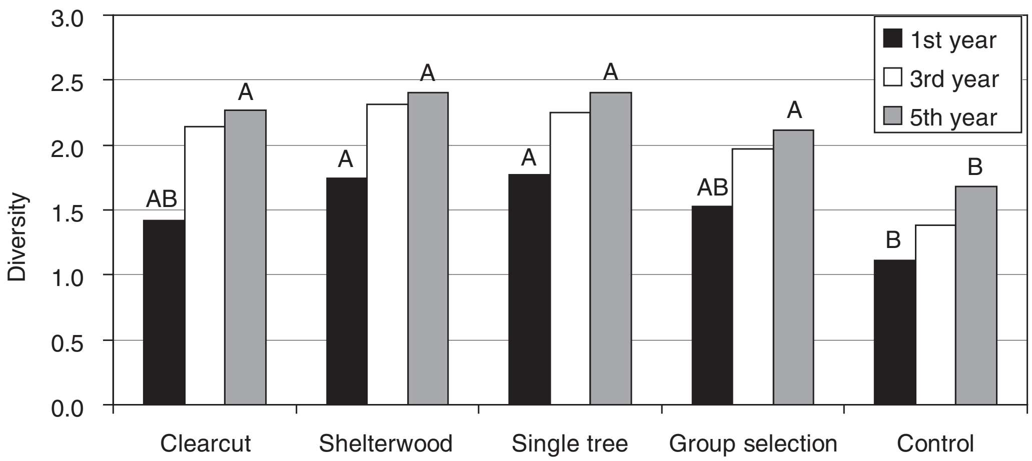

Figure 4—Bird diversity (Shannon-Weiner's index) by silvicultural treatment during the first (1994), third (1996), and fifth years (1998) after harvesting of pine-hardwood stands in the Ouachita Mountains of Arkansas and Oklahoma. Within years, bars with different letters are significantly different ($P<0.05$). No differences existed among treatments in 1996.

treatment. Bird diversity was significantly higher in shelterwood and single-tree stands than in controls the first year. By the fifth year, diversity was significantly higher in all four harvested treatments than in controls. When data for the four harvested treatments were averaged within years, avian diversity was 1.5, 1.6, and 1.4 times greater than in controls during 1994, 1996, and 1998, respectively.

Evenness

In shelterwood, single-tree, and group selection stands, evenness was somewhat higher in 1994 than in the other 2 years, while values for 1996 and 1998 were almost identical (fig. 5). Avian evenness in clearcuts and controls followed different patterns. Consequently, differences among treatments were not significant in 1994 ($F = 1.53$; 4,80 df; $P = 0.2011$), 1996 ($F = 1.06$; 4,12 df; $P = 0.4197$), or 1998 ($F = 1.75$; 4,12 df; $P = 0.2029$).

CONCLUSIONS

Untreated, late-rotation stands occupying southerly aspects of the Ouachita Mountains seem to be characterized by low bird abundance, species richness, and diversity. However, our findings suggest that a variety of regeneration methods can be used to increase bird abundance, richness, and diversity through at least the fifth year after logging. The general pattern of these response variables suggests that they may be close to peak 5 years after treatment, but additional surveys are needed to substantiate this conclusion.

All stands were largely even-aged at study initiation. Consequently, stands that were selected for uneven-aged treatments are in a transition from an even- to an uneven-aged stand structure and will be for at least one or two additional harvest entries. Therefore, it is too early to draw definitive conclusions comparing uneven-aged treatments (single-tree

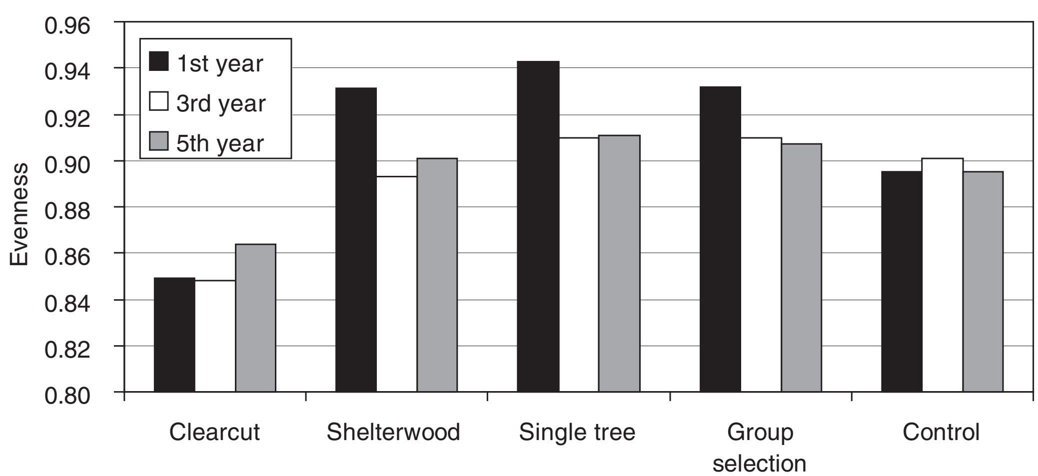

Figure 5—Bird evenness by silvicultural treatment during the first (1994), third (1996), and fifth years (1998) after harvesting of pine-hardwood stands in the Ouachita Mountains of Arkansas and Oklahoma. None of the within-year differences were significant ($P>0.05$).

and group selection) and even-aged (clearcut and shelterwood). Nevertheless, our data suggest that early-transition single-tree and group selection stands should have similar avian abundance, richness, and diversity as clearcut and shelterwood stands. Except for lower abundance in group selection stands during the fifth year, none of the other differences in response variables among these four regeneration methods were significant.

Due to space limitations, data on individual bird species responses to treatments are not presented here. However, it is important to note that the control stands, despite their lower avian abundance and diversity, supported some sensitive species that were uncommon or not encountered in harvested stands. Certain forest interior or disturbance-sensitive species, such as ovenbirds (*Seiurus aurocapillus*) and scarlet tanagers (*Piranga olivacea*), were relatively common in control stands but were absent or rare in harvested stands. Consequently, retention of mature stands is important for the conservation of these species. Furthermore, our preliminary findings suggest that a mix of silvicultural treatments over the landscape should enhance avian species diversity.

Young shelterwood stands may be aesthetically more pleasing than stands that are clearcut and planted (Personal communication. Victor A. Rudis. 2000. Research Forester. USDA Forest Service, Southern Research Station, Forestry Sciences Laboratory, 201 Lincoln Green, Starkville, MS 39759). Retention of seed trees in perpetuity should further increase public acceptance of shelterwood regeneration methods. Our findings indicate that stands regenerated using shelterwood methods on similar sites in the Ouachita Mountains should have comparable levels of avian abundance, richness, and diversity as clearcuts through at least the fifth year after harvest.

ACKNOWLEDGMENTS

We gratefully acknowledge the field assistance provided by L. Anderson, R.A. Buford, R.E. Brown, R.S. Daniel, H. Garner, E.A. Kroese, D.J. Reed, J.F. Taulman, and J.H. Williamson. J.P. Duguay and R.E. Brown provided useful suggestions on an earlier draft of this manuscript. We are also grateful for the technical and logistical assistance provided by J.B. Baker, J.M. Guldin, L.D. Hedrick, T.J. Mersmann, and W.F. Pell.

LITERATURE CITED

Baker, J.B. 1989. Alternative silvicultural systems—South. In: Proceedings of the National Silviculture Workshop: Silvicultural challenges and opportunities in the 1990's; 1989 July 10-13; Petersburg, AK. Washington, DC: U.S. Department of Agriculture, Forest Service, Timber Management: 51-60.

Baker, J.B. 1994. An overview of stand-level ecosystem management research in the Ouachita/Ozark National Forests. In: Baker, J.B., comp. Proceedings of the Symposium on Ecosystem Management Research in the Ouachita Mountains: Pretreatment conditions and preliminary findings; 1993 October 26-27; Hot Springs, AR. Gen. Tech. Rep. SO-112. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 18-28.

Guldin, J.M. 1996. The role of uneven-aged silviculture in the context of ecosystem management. Western Journal of Applied Forestry. 11(1): 4-12.

Guldin, J.M.; Baker, J.B.; Shelton, M.G. 1994. Midstory and overstory plants in mature pine/hardwood stands of the Ouachita/Ozark National Forests. In: Baker, J.B., comp. Proceedings of the Symposium on Ecosystem Management Research in the Ouachita Mountains: Pretreatment conditions and preliminary findings; 1993 October 26-27; Hot Springs, AR. Gen. Tech. Rep. SO-112. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 29-49.

Kitchens, R.N. 1989. Alternative silvicultural systems on southern national forests: a status report. In: Proceedings of the National Silviculture Workshop: Silvicultural challenges and opportunities in the 1990's; 1989 July 10-13; Petersburg, AK. Washington, DC: U.S. Department of Agriculture, Forest Service, Timber Management: 46-50.

Magurran, A.E. 1988. Ecological diversity and its measurement. Princeton, NJ: Princeton University Press. 179 p.

Overbay, J.C. 1992. Ecosystem management. In: Taking an ecological approach to management; 1992 April 27-30; Salt Lake City, UT. Washington, DC: U.S. Department of Agriculture, Forest Service Watershed and Air Management: 3-15.

Petit, D.R.; Petit, L.J.; Martin, T.E. [and others]. 1994. Breeding birds of late-rotation pine-hardwood stands: community characteristics and similarity to other regional pine forests. In: Baker, J.B., comp. Proceedings of the Symposium on Ecosystem Management Research in the Ouachita Mountains: Pretreatment conditions and preliminary findings; 1993 October 26-27; Hot Springs, AR. Gen. Tech. Rep. SO-112. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 103-116.

SAS Institute Inc. 1988. SAS/STAT user's guide. release 6.03 edition. Cary, NC: SAS Institute Inc. 1028 p.

Thill, R.E.; Tappe, P.A.; Koerth, N.E. 1994. Wildlife habitat conditions in mature pine hardwood stands in the Ouachita/Ozark National Forests. In: Baker, J.B., comp. Proceedings of the Symposium on Ecosystem Management Research in the Ouachita Mountains: Pretreatment conditions and preliminary findings; 1993 October 26-27; Hot Springs, AR. Gen. Tech. Rep. SO-112. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 126-143.

Verner, J. 1988. Optimizing the duration of point counts for monitoring trends in bird populations. Res. Note PSW-395. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 4 p.