Potential effects of groundcover restoration on breeding bird communities in longleaf pine stands

Brandon T. Rutledge and L. Mike Conner

Abstract The longleaf pine (*Pinus palustris*) ecosystem is one of the most endangered ecosystems in the United States. Recent incentives have led to increased interest in longleaf pine restoration. These restoration efforts often emphasize reestablishing native groundcovers, yet there have been no studies that address the role of native groundcover on breeding bird communities within longleaf pine forests. Therefore, we studied breeding bird communities in mature longleaf pine stands with either native or disturbed groundcovers to determine the likely effects of groundcover reestablishment associated with longleaf pine reforestation. Avian species richness and diversity did not differ ($P=0.823$, $P=0.571$, respectively), and avian community similarity was high (Morisita's index=0.98) between native and disturbed groundcover. However, pine warblers (*Dendroica pinus*), gray catbirds (*Dumetella carolinensis*), eastern wood-pewees (*Contopus virens*), brown-headed cowbirds (*Molothrus ater*), and Bachman's sparrows (*Aimophila aestivalis*) were more abundant ($P \leq 0.10$) in areas with native groundcover, whereas indigo buntings (*Passerina cyanea*) were more abundant ($P=0.058$) in areas with disturbed groundcover. Although groundcover restoration may benefit some avian populations, overall avian species richness, diversity, and community composition may be unaffected. Restoration of native groundcover may be best justified for aesthetic values and as a tool to facilitate long-term stand management using prescribed fire.

Key words avian community, Conservation Reserve Program, CRP, ecosystem management, Georgia, longleaf pine, native groundcover, *Pinus palustris,* restoration, species diversity

Prior to European settlement, the southeastern United States contained approximately 25 million ha of longleaf pine (*Pinus palustris*)-wiregrass (*Aristida beyrichiana*) forest (Outcalt and Sheffield 1996). Because of fire suppression, conversion of longleaf pine to agriculture or other pine species, introduction of feral hogs (*Sus scrofa*), and utilization of timber for the naval stores industry, <2% of this habitat remains, making the longleaf pine ecosystem one of the most endangered ecosystems in the United States (Myers 1990, Frost 1993, Stout and Marion 1993, Ware et al. 1993, Outcalt and Sheffield 1996, Brockaway and Lewis 1997).

In 1998 the United States Department of Agriculture initiated a longleaf pine conservation priority area within the Conservation Reserve Program (CRP) to provide incentives for landowners to convert agricultural fields into longleaf pine forests (Farm Services Agency 1998). Because the CRP program focuses on reforestation of agricultural fields, native groundcover does not exist within these areas when longleaf pines are planted. However, because native groundcover is considered a critical component of the longleaf pine ecosystem, an emphasis is often placed on reestablishing native groundcovers when longleaf pine restoration is undertaken (Streng et al. 1993, Brockaway and Lewis 1997).

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No research has addressed the influence of native groundcover on avian communities within longleaf pine forests. Consequently, there is little information to predict the likely response of avian communities to groundcover reestablishment associated with longleaf pine reforestation. Therefore, we compared avian species richness, species diversity, and community composition between native and disturbed groundcovers within mature (approximately 70-year-old) longleaf pine stands. We also compared relative abundance of commonly detected avian species to determine whether groundcover type influenced relative abundance of select breeding bird populations.

We predicted that ground-nesting species would be more abundant in native groundcover because of the dense herbaceous layer typically associated with these sites. Further, we predicted that shrub-nesting species would be more abundant in areas with disturbed understories because these areas may not burn as uniformly as areas dominated by native groundcover (Noss 1989, Myers 1990), and this may contribute to increased availability of shrub cover. We also predicted that tree- and cavity-nesters would be unaffected by groundcover type because sampled plots had similar overstory structure. Lastly, we predicted that avian species richness and diversity would be similar within native and disturbed sites, but that community similarity would be low because we anticipated more ground-nesters in native groundcover and more shrub-nesters in disturbed groundcover.

Study area

We conducted our study on Ichauway (31°18′N, 84°28′W), the 11,745-ha former northern bobwhite quail (*Colinus virginiana*) hunting plantation of the late Robert W. Woodruff and current research site of the Joseph W. Jones Ecological Research Center, Georgia. The majority of Ichauway consisted of longleaf pine stands, but slash pine (*P. elliottii*), loblolly pine (*P. taeda*), and various oak species (*Quercus* spp.) were patchily distributed throughout the longleaf forest. The Flint River formed the eastern boundary of Ichauway, and 22 km of Ichawaynochaway Creek coursed through the middle of the property. The remaining area was made up of seasonal wetlands, agricultural fields, and wildlife food plots. Historical agricultural practices resulted in soil disturbance and ultimately created many longleaf pine stands with disturbed groundcovers (i.e., old-field understories dominated by *Andropogon* spp., *Pityopsis* spp.). However, undisturbed sites were also common. These undisturbed sites were dominated by native groundcovers, primarily wiregrass. Prescribed fire had been used on a two-year return interval since 1992 to reduce fine fuels, retard hardwood encroachment, and maintain wildlife habitat. The site had been burned historically on an annual burn rotation, consisting primarily of winter burns, until the early 1990s.

Methods

We used fixed-radius (radius=50 m) point counts (Ralph et al. 1995) to sample bird communities in areas with native and disturbed groundcovers within mature longleaf pine stands. We randomly chose 10 stands in each groundcover type and placed 3 points ≥200 m apart within each stand. At each point, we began counting, following a 3-minute waiting period, and recorded all birds observed within a 5-minute period. All counts occurred within 3 hours after sunrise. We conducted counts from early May through mid-June of 1998 and 1999 and visited each point 4 times each year. We sampled during two consecutive years to ensure that data collection efforts encompassed a complete prescribed-fire cycle (i.e., each stand was sampled with a 1-year rough and just following a prescribed fire, but prior to a complete growing season). To minimize interobserver bias, ≥3 different observers visited each site each year, and 3 of the 4 observers were the same during both years of sampling.

We determined the relative abundance of each species associated with each point by dividing total observations of the species by number of visits to the point. We then treated these numbers as subsamples to estimate relative abundance of each species within each stand. We used number of species detected as an estimate of species richness for each stand. We used the Shannon-Weaver index (H′, Shannon and Weaver 1949) as a measure of diversity for each stand. We compared species richness, species diversity, and relative abundance of common (i.e., occurring in ≥20% of points) species between native and disturbed groundcovers using analysis of variance (ANOVA) on rank-transformed data (Conover and Iman 1981).

We pooled observations into 2 classes based on groundcover type and calculated Morisita's (1959) index of similarity to quantify similarity of avian communities between native and disturbed ground-

Table 1. Shannon-Weaver diversity indices (H′) calculated for point counts conducted from early May through mid-June of 1998 and 1999 in longleaf pine habitat with native and disturbed groundcover at the Joseph W. Jones Ecological Research Center, Newton, Georgia, USA. Each stand was sampled with 3 point-counts.

Native		Disturbed	
Stand number	H′	Stand number	H′
1	2.02	61	1.76
58	1.79	89	1.94
84	1.88	93	1.86
90	1.84	134	1.84
130	1.76	137	1.92
136	1.77	138	1.98
148	1.88	149	1.94
166	1.85	151	2.05
168	2.03	165	1.70
170	1.91	174	1.99

covers. This index accounted for presence and absence as well as abundance of species within communities. The index ranged from 0 (no similarity) to 1 (complete similarity; Krebs 1989). All estimates are presented within 1 standard error (±SE).

Table 2. Twenty species detected in ≥ 20 % of point counts conducted from early May through mid-June of 1998 and 1999 in longleaf pine habitat with either native or disturbed groundcover at the Joseph W. Jones Ecological Research Center, Newton, Georgia, USA.

Common name	Scientific name	% [a]
Bachman's sparrow	*Aimophila aestivalis*	98.3
Brown-headed cowbird	*Molothrus ater*	71.6
Brown-headed nuthatch	*Sitta pusilla*	85.0
Blue grosbeak	*Guiraca caerulea*	83.3
Blue jay	*Cyanocitta cristata*	100.0
Northern bobwhite	*Colinus virginiana*	100.0
Brown thrasher	*Toxostoma rufum*	81.6
Carolina chickadee	*Parus carolinensis*	88.3
Carolina wren	*Thryothorus ludovicianus*	100.0
Eastern wood-pewee	*Contopus virens*	91.6
Eastern tufted titmouse	*Parus bicolor*	98.3
Great-crested flycatcher	*Myiarchus crinitus*	100.0
Gray catbird	*Dumetella carolinensis*	51.7
Indigo bunting	*Passerina cyanea*	93.3
Northern cardinal	*Cardinalis cardinalis*	100.0
Pine warbler	*Dendroica pinus*	93.3
Red-bellied woodpecker	*Melanerpes carolinus*	100.0
Red-headed woodpecker	*Melanerpes erythrocephalus*	95.0
Eastern towhee	*Pipilo erythrophthalmus*	100.0
White-breasted nuthatch	*Sitta carolinensis*	78.3

[a] Percentage of points in which each species was detected.

Results

We detected 48 species during point counts. We observed all of these species in stands with disturbed groundcover, but only 33 were detected in stands with undisturbed groundcover. Species richness did not differ among understory types ($F_{1,18}$= 0.05, P=0.82), with mean values of 22.6±0.89 observed species in disturbed sites and 21.9±0.77 observed species in undisturbed sites. The 15 species that were detected only in sites with disturbed groundcover made up <2% of the total number of observations within these plots, thus contributing little to the overall species richness of disturbed groundcover sites. Similarly, average avian diversity within disturbed (H′ = 1.89) and native (H′=1.87) groundcovers did not differ ($F_{1,18}$ =0.33, P=0.571, Table 1). Twenty species occurred in ≥20% of plots, and these 20 species accounted for 80.5% of all observations (Table 2).

Relative abundance of 6 of 20 species differed between native and disturbed groundcovers. Pine warblers (*Dendroica pinus*, $F_{1,18}$=3.31, P=0.08), gray catbirds (*Dumetella carolinensis*, $F_{1,18}$=2.99, P = 0.10), eastern wood-pewees (*Contopus virens*, $F_{1,18}$ = 5.76, P = 0.03), brown-headed cowbirds (*Molothrus ater*, $F_{1,18}$=3.66, P=0.07), and Bachman's sparrows (*Aimophila aestivalis*, $F_{1,18}$=4.86, P=0.04) were more abundant in native than disturbed sites. Indigo buntings (*Passerina cyanea*) were more abundant ($F_{1,18}$=3.33, P=0.08) in areas with disturbed groundcovers (Figure 1).

We observed 1,250 birds in stands with disturbed groundcover and 1,252 birds in stands with native groundcover. Morisita's index of similarity was 0.98, indicating that avian communities within disturbed and native groundcovers were very similar.

Discussion

Other studies have addressed breeding bird response to management of longleaf pine forests for red-cockaded woodpeckers (*Picoides borealis*, Plentovich et al. 1998, Krementz and Christie 1999) and prescribed-fire regimes (Engstrom et al. 1984, King et al. 1998), but no studies have investigated the relationship of avian species richness, diversity, and relative abundance to understory type in a longleaf pine ecosystem. Restoration of longleaf pine and associated groundcover has only recently received attention from conservationists (Streng et al. 1993, Brockway and Lewis 1997). Therefore, the long-term effects of groundcover restoration efforts

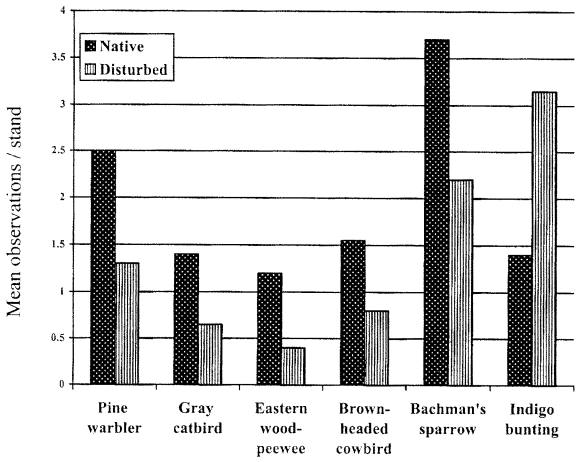

Figure 1. Relative abundance (mean observation/species/stand) of pine warbler (*Dendroica pinus*), gray catbird (*Dumetella carolinensis*), eastern wood-pewee (*Contopus virens*), brown-headed cowbird (*Molothrus ater*), Bachman's sparrow (*Aimophila aestivalis*), and indigo bunting (*Passerina cyanea*) occurring more often ($P < 0.10$) in either native (e.g., wiregrass, *Aristida beyrichiana*) or disturbed (i.e., old-field, *Andropogon* spp., *Pityopsis* spp.) understories within longleaf pine forest of the Joseph W. Jones Ecological Research Center, Newton, Georgia, USA. Data were collected May–mid-June, 1998 and 1999.

on breeding bird communities cannot be measured within restored sites because too few such sites exist. Our study used existing mature longleaf pine stands with either native or disturbed groundcovers as a surrogate for nonexistent restored stands. Our results, therefore, are applicable only insofar as our sampled stands may represent future conditions of restored longleaf pine stands.

Avian species richness and diversity within longleaf pine stands were similar between native and disturbed understories. There were, however, 15 species that were unique to disturbed understories. One of these species, golden-crowned kinglets (*Regulus satrapa*), does not breed in the area. When sampling, we recorded all detected birds regardless of distance from plot center. Therefore, we examined the data to determine whether any of these 14 species occurred within native groundcover but outside the 50-m-radius sampling area. All of the 14 species in question were detected within native groundcover, but the detections occurred outside our 50-m radius. Thus, we believe that the absence of these 14 species within native groundcover was an artifact of detection and not representative of biologically meaningful differences between groundcover types.

Others have studied breeding bird communities in longleaf pine forests, although their goal was not to assess the effects of groundcover type on bird communities. Repenning and Labisky (1985) reported an avian species diversity value of $H' = 2.43$ and species richness of $\bar{x} = 16$ for a mature (>50-year-old) longleaf pine forest in Florida. They also detected greater species diversity in longleaf pine than in slash pine plantations of varying ages. In another study of bird communities within a longleaf pine forest, diversity and richness were $H' = 2.61$ and $\bar{x} = 18.5$, respectively, during the breeding season (Hirth et al. 1991). We found less species diversity but slightly greater species richness than reported in these previous studies, indicating that our species richness values were influenced by seldom-observed species. These seldom-observed species may have been more prevalent on our study area because of the site's landscape configuration (e.g., proximity of sampled stands to other habitats).

If we ignore experiment-wise error rates, relative abundance of several species varied between undisturbed and disturbed groundcover types. Thirteen of the 20 species analyzed in abundance comparisons (Bachman's sparrow, brown-headed cowbird, brown-headed nuthatch [*Sitta pusilla*], blue jay [*Cyanocitta cristata*], northern bobwhite, brown thrasher [*Toxostoma rufum*], Carolina chickadee [*Parus carolinensis*], eastern wood-pewee, gray catbird, indigo bunting, northern cardinal [*Cardinalis cardinalis*], red-headed woodpecker [*Melanerpes erythrocephalus*], eastern towhee [*Pipilo erythrophthalmus*]) showed negative trends in relative abundance according to 1966–2000 breeding bird survey data for the southeastern region (United States Fish and Wildlife Service, Region 4; Sauer et al. 2001). For this reason, we elected not to adjust experiment-wise error rates, preferring to be biologically as opposed to statistically conservative.

Bachman's sparrow and northern bobwhite were the only obligate ground-nesters that commonly occurred in sample plots. In keeping with our predictions, Bachman's sparrows were more abundant in native groundcover sites. Bachman's sparrows are generally most abundant in grasslands with dense groundcover underneath open-canopied pine forests, or in early successional vegetation (Dunning 1993, Wilson et al. 1995, Plentovich et al. 1998). Foraging and nesting ecology of the species influence its need for the dense groundcover associated with these types of habitats (Hamel 1992, Dunning 1993). Because northern bobwhites are

considered an edge species (Stoddard 1931), disturbance of groundcover may have affected them differently than Bachman's sparrows and may explain the similar relative abundance of this species within the 2 groundcover types. Indeed, periodic soil disturbance is often recommended to enhance northern bobwhite habitat (Buckner and Landers 1979, Rosene 1984). However, we did not sample stands with periodic disturbance to properly evaluate this management practice.

We recorded a number of common, predominantly shrub-nesting species. Of these, relative abundance of indigo buntings and gray catbirds differed between groundcover types. Indigo buntings were most abundant in disturbed groundcovers, as predicted. However, gray catbirds were most abundant in native groundcovers, and relative abundance of other shrub-nesters was similar within the 2 groundcover types. Thus, we concluded that groundcover type had little influence on relative abundance of shrub-nesting birds on our study area.

Nine tree- or cavity-nesters commonly occurred in plots. Although we expected abundance of these species to be similar between native and disturbed sites, pine warblers and eastern wood-pewees were more abundant in stands with native groundcovers. Both species tend to prefer open pinelands with sparse midstories and are closely tied to these habitats because of their foraging and nesting behaviors (Hamel 1992, McCarty 1996, Rodewald et al. 1999). However, all of the stands we sampled fell into this broad classification; therefore, this general habitat description offers little explanation for the differences in abundance of these species.

Brown-headed cowbirds were more abundant in areas with native groundcovers. Because cowbirds are thought to watch for movement to identify potential hosts (Robinson et al. 1995), the structure associated with undisturbed groundcover may allow cowbirds better opportunities for detecting hosts.

Although relative abundance of 5 species was higher in stands with native groundcover, avian communities in native and disturbed groundcovers were actually similar in terms of species composition and abundance. Indeed, Morrisita's index of similarity approached its theoretical maximum value, indicating that avian communities were very similar (Krebs 1989) within each of the groundcover types.

Qualitatively, the stands in our study were similar with respect to shrub cover. In contrast to Noss (1989) and Myers (1990), disturbed and native understories on our study area produced equally uniform burns (L. M. Conner, unpublished data). This uniformity was likely a direct result of the skill and experience of the prescribed-fire practitioner, and this may have contributed to the similarities in bird communities among understory types.

Management implications

Overall, breeding bird communities were similar in native and disturbed groundcover types, indicating that breeding birds may be more influenced by presence of an herbaceous understory than by native groundcover restoration. However, many decades have passed since initial soil disturbance, and the effects of this initial disturbance on breeding bird communities are unknown. Two possible conclusions, then, can be drawn from our research. First, avian communities remained similar as stands matured, and loss of native groundcover had no effect on avian communities or, alternatively, loss of native groundcover caused avian communities to differ during early stages of forest establishment, but over time community composition converged. Unfortunately, we lack data to address these competing ideas. However, our data suggest that in the long term, breeding bird communities will be relatively similar regardless of whether native groundcover reestablishment is undertaken as a part of longleaf pine restoration.

Old-field understories may lead to more heterogeneous fires and may cause an increase in midstory development and hardwood encroachment. Because native groundcover enhances the ability to manage longleaf pine forests using fire (Noss 1989, Myers 1990), native groundcover restoration may be warranted when possible and economically feasible. The advantages of native groundcovers may be particularly important when large areas must be burned during a short period of time or with limited manpower. The aesthetic value of native groundcovers should also be considered in developing management and restoration plans.

Future research should compare restored longleaf pine forests to existing longleaf pine forests to determine whether restoration efforts are successful in regaining both breeding and wintering native bird communities. Case studies of avian community succession associated with longleaf pine restoration

efforts, with and without groundcover restoration, are also needed. Such studies would permit evaluation of avian community composition throughout the restoration process and permit more thorough evaluation of the effects of native groundcover restoration on avian communities.

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