THE EFFECTS OF FIRE SUPPRESSION ON BACHMAN'S SPARROWS IN UPLAND PINE FORESTS OF EASTERN TEXAS

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ABSTRACT.—We studied the effects of 8 years of fire suppression on shrub-level vegetation, Bachman's Sparrows (*Aimophila aestivalis*), and selected forest bird species between 1995 and 2003 in eastern Texas. Woody shrub-level vegetation between ground level and 3 m above the ground, measured using a leaf area index, increased significantly in all sites ($n = 20$) previously managed for Red-cockaded Woodpeckers (*Picoides borealis*) in both longleaf pine (*Pinus palustris*) and loblolly- (*P. taeda*) shortleaf (*P. echinata*) pine habitats. Woody shrub-level vegetation between ground level and 3 m also increased significantly in one-half of control sites ($n = 20$). During the 8 years, Bachman's Sparrow abundance decreased significantly in habitat management areas previously managed for Red-cockaded Woodpeckers. Brown-headed Nuthatches (*Sitta pusilla*), Indigo Buntings (*Passerina cyanea*) and Red-cockaded Woodpeckers also decreased in abundance, but this decrease was not statistically significant. Slight increases or no changes were observed for Northern Cardinals (*Cardinalis cardinalis*), Carolina Wrens (*Thryothorus ludovicianus*), Hooded Warblers (*Wilsonia citrina*), Yellow-breasted Chats (*Icteria virens*), and White-eyed Vireos (*Vireo griseus*). These species generally are considered associates of woody shrub-level vegetation in both woodpecker and control sites.

Fire in the southeastern United States has been associated with upland pine ecosystems for multiple millennia. Fossil pollen records indicate that fire-maintained upland pine ecosystems spread from peninsular Florida approximately 12,000 years ago and arrived at the western extreme of their distribution in Texas about 4,000 years ago (Webb 1987). This expansion followed the retreat of the Wisconsin glaciation (Conner et al. 2001). Bartram (1791) described the original longleaf pine (*Pinus palustris*) forests as nearly unbroken expanses of widely spaced pines within a sea of grass. Fire, which occurred during dry periods throughout the year, was an integral part of the spread and maintenance of this ecosystem (Bonnicksen 2000). The frequent fires burned day and night meandering across the landscape until encountering barriers or sites too wet to burn (Frost 1993, Glitzenstein et al. 1995). The fires killed most hardwoods in the pine ecosystems, virtually eliminating any hardwood midstory and understory, but maintained an herbaceous ground cover consisting primarily of grasses and forbs (Jackson et al. 1986, Glitzenstein et al. 1995). Fallen pine needles and dried grasses served as fine fuel for the frequent ground fires in upland pine ecosystems, which may to have burned every 1 to 3+ years in southern pine forests (Mattoon 1922, Landers 1991, Glitzenstein et al. 1995, Bonnicksen 2000).

Well-burned, open-pine woodland provides habitat for several bird species in the South. Red-cockaded Woodpeckers (*Picoides borealis*), Brown-headed Nuthatches (*Sitta pusilla*), Pine Warblers (*Dendroica pinus*), Southeastern American Kestrels (*Falco sparverius paulus*), Northern Bobwhites (*Colinus virginianus*), and Bachman's Sparrows (*Aimophila aestivalis*) are well known associates of open pine habitat (Brennan et al. 1995, Wilson et al. 1995, Plentovich et al. 1998, Conner et al. 2002). Based on an analysis of information synthesized from the literature, Hunter et al. (1994) speculated that the use of fire in management for Red-cockaded Woodpeckers might have a negative stand-level impact on some Nearctic-Neotropical migrants, but such problems would likely dissolve at a larger landscape scale. Breeding Bird Surveys (BBS) indicated that 86 species of birds (excluding Nearctic-Neotropical migrants) are known to use longleaf pine forests where implemented management using selective harvesting and growing-season fire closely resembles Red-cockaded Woodpecker management (Engstrom 1993). Fire is also an essential component for the management of pitcher plant bogs (Folkerts 1982) and lepidopteran communities in the South (Rudolph and Ely 2000).

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Bachman's Sparrow, a species of management concern, has become rare in many areas throughout the South where previously abundant (Dunning et al. 2000), and in Texas at the western extreme of its distribution, it is listed as a threatened species (Dunning 1993, Campbell 1995). Fire is an essential component of habitat management for Bachman's Sparrows throughout the South (Buckner and Landers 1979, Tucker et al. 1998, Shriver et al. 1999).

Some Neotropical migrants are positively associated with hardwood mid- and understory foliage (Conner and Adkisson 1975; Conner et al. 1979, 1983; Dickson et al. 1993). Thus, fire exclusion may increase the abundance of species that depend on hardwood foliage for nesting and foraging in both mid- and understory layers. Concern over declining populations of many Nearctic-Neotropical migrant birds has recently intensified and programs to determine causes and reverse declines have been sought (Keast and Morton 1980, Hagan and Johnston 1992, Finch and Stangel 1993).

Litigation against the U.S. Forest Service in Texas between 1996 and 1999 resulted in court injunctions that excluded fire and reduction of hardwood midstory from upland pine habitat management until summer 2003 (Conner et al. 2001). Thus, fire was not applied in habitat managed for Red-cockaded Woodpeckers in both longleaf (*Pinus palustris*) and loblolly- (*P. taeda*) shortleaf (*P. echinata*) pine habitats for 8 years (1995 to 2003).

We investigated the effects of 8 years of fire exclusion on upland pine habitat in eastern Texas. We were primarily interested in the effects of fire exclusion on Bachman's Sparrows. We also examined the abundance of other selected bird species associated with open savannah woodlands and selected species associated with shrub-layer foliage.

METHODS

We sampled avian communities using point, time-area counts (Reynolds et al. 1980) during the spring (1 May through 15 June) of 1995 and 2003. Birds were sampled in 20 Red-cockaded Woodpecker cavity tree clusters where management had been implemented recently in 1995 and in 20 control sites within 800 m of woodpecker clusters with no additional management and a hardwood midstory. Control sites were selected randomly by using a hand-held spinner to determine a direction to walk from the center of a woodpecker cluster area. If an appropriate mature forest stand of similar tree height to the cluster was not found within 800 m, a new random direction was selected. Within all 20 cavity tree clusters in 1995, all hardwoods $\leq$ 20 m from cavity trees had been removed, all midstory and understory hardwoods within the entire cluster area had been mulched, and clusters had been thinned (overstory pines) and prescribed burned within the past five years. Further management in cluster areas and control sites was not conducted over the next 8 years (through the 2003 bird breeding season) because of a federal court injunction prohibiting the use of fire and mechanical means to reduce hardwood vegetation. We evaluated habitat and birds during 1995 and 2003 in both longleaf pine and loblolly-shortleaf pine habitats. Longleaf pine study areas for woodpecker clusters and surrounding habitat were located in eastern Texas (31°15'N, 94°15'W) on the southern portion of the Angelina National Forest and loblolly-shortleaf pine study areas were located on the northern portion of that forest.

We established avian census points for time-area counts in the geometric center of woodpecker cluster areas and at randomly determined points in control areas. We selected census points in control areas by walking 100 m into the stand during our walk from cluster areas. We sampled birds weekly at each census point 6 times per season (Reynolds et al. 1980) and calculated a mean abundance value for each species at each point per season per year for subsequent analyses. Two observers sampled all points on each census day with each observer sampling 10 treatment and 10 control points per day. Bird detections were recorded upon entrance into the 50-m radius around the census point to account for birds that may flush and leave the area, and all birds seen or heard within the circular plot were recorded for a total of 5 min (Hutto et al. 1986). Birds flying above the forest canopy were not sampled. Sampling began at sunrise and ended prior to 3 h post sunrise. We did not sample birds during heavy or moderate rain or high wind (>19 kph), but did sample during mist and light drizzle (Conner and Dickson 1980).

We measured shrub-level vegetation foliage density between 0–1, 1–2, and 2–3 m above the ground within cavity tree clusters and control areas using a leaf area index method (MacArthur and MacArthur 1961). We used a *t*-test to compare shrub-level vegetation characteristics and the abundance of selected bird species between 1995 and 2003 (SAS Institute 1988).

RESULTS

Fire exclusion negatively affected Bachman's Sparrow abundance in both longleaf and loblolly-shortleaf pine habitats. During the 8 years that fire and mechanical vegetation control measures were prohibited by court injunction, Bachman's Sparrow abundance decreased significantly (*t*-test, $P < 0.05$) in habitat management areas that had been previously managed for Red-cockaded Woodpeckers (Table 1). Several other bird species generally considered associated with well-burned open pine ecosystems declined in abundance, although not significantly (Table 1), in both pine habitat types. These included Brown-headed Nuthatches (*Sitta pusilla*), Indigo Buntings (*Passerina cyanea*) and Red-cockaded Woodpeckers. The abundances of Northern Cardinals (*Cardinalis cardinalis*), Carolina Wrens (*Thryothorus ludovicianus*), Hooded Warblers (*Wilsonia citrina*), and White-eyed Vireos (*Vireo griseus*), which generally are associated with woody shrub-level vegetation, either increased slightly or remained stable in both woodpecker and control sites (Table 1). Yellow-breasted Chats (*Icteria virens*) decreased in longleaf pine sites but increased in loblolly-shortleaf pine sites; however, these changes were not statistically significant.

Shrub-level foliage of woody plants increased as a result of fire suppression. Foliage from shrub-level vegetation increased significantly at 0–1, 1–2, and 2–3 m over the 8 years fire was absent in Red-cockaded Woodpecker cluster sites in both longleaf and loblolly-shortleaf pine habitats (Table 2). Fire was also excluded at control sites but foliage increased significantly only at the 0–1 m height in longleaf pine habitat and the 1–3 m zones in loblolly-shortleaf pine habitat.

DISCUSSION

Our results indicate that litigation and advocating efforts to prevent the use of fire in the management of upland pine ecosystems of eastern Texas are misguided. The few species that may be negatively affected by fire are very abundant and associated with hardwood tree and shrub species (Conner et al. 2002). Fire does consume grasses used for nesting habitat by Bachman's Sparrows, but this temporary loss does not negatively affect the sparrow (Johnson and Landers 1982). The availability of fire-maintained open pine habitat throughout the South has dwindled dramatically over the past century and, as it declined, so have its associated avian species (Engstrom 1993, Frost 1993, Conner et al. 2001).

Fire is an essential component of upland pine management for Bachman's Sparrows in eastern Texas and throughout the rest of the South (Dunning 1993). Dunning and Watts (1990) noted that prescribed burning was a particularly important management tool to reduce shrubby vegetation and maintain the open habitat with grasses and forbs preferred by Bachman's Sparrows. Our results strongly support observations of previous researchers on the importance of fire as a management tool for Bachman's Sparrows (Buckner and Landers 1979, Dunning et al. 2000).

Bachman's Sparrows were more sensitive to the exclusion of fire from upland pine ecosystems than any of the other bird species we examined. Of the bird species associated with fire-maintained pine ecosystems, Bachman's Sparrow was the only species that declined significantly in abundance during the 8 year study. The decline in abundance of Red-cockaded Woodpeckers and Brown-headed Nuthatches was not of the magnitude observed for Bachman's Sparrows. Because Bachman's Sparrows are closely associated with grasses and forbs of herbaceous layer vegetation, the observed high sensitivity of this species is not surprising. Red-cockaded Woodpeckers and Brown-headed Nuthatches primarily use mature pines within pine savannah habitats maintained by frequent fires, and thus, would not be as sensitive as Bachman's Sparrows to fire exclusion.

In conclusion, we urge environmental groups to carefully consider the full impact of their management recommendations. The results they achieve may be the exact opposite of what they actually intended to accomplish, particularly if litigation is involved. In the current example, the Bachman's Sparrow, a sensitive species, suffered an apparent population decline in the area where fire and other woody vegetation control were excluded by a lengthy temporary restraining order.

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Table 1. Changes in bird abundance (mean number of detections/5 min ± SE) over an 8-year period of fire exclusion in Red-cockaded Woodpecker cavity-tree cluster sites and control sites in loblolly-shortleaf and longleaf pine habitat on the Angelina National Forest in eastern Texas (n = 20/treatment).

	Red-cockaded Woodpecker cluster sites				Control sites			
	Longleaf pine		Loblolly-shortleaf pine		Longleaf pine		Loblolly-shortleaf pine	
Bird species	**1995**	**2003**	**1995**	**2003**	**1995**	**2003**	**1995**	**2003**
Bachman's Sparrow	1.8 (0.55)*	0.4 (0.40)*	0.8 (0.25)*	0.1 (0.10)*	0.0	0.4	0.0	0.0
Brown-headed Nuthatch	3.9 (1.30)	1.4 (0.79)	2.9 (0.57)	1.4 (0.62)	0.0	0.1 (0.10)	0.2 (0.20)	0.0
Carolina Wren	0.8 (0.42)	0.7 (0.40)	1.3 (0.40)	1.0 (0.49)	1.6 (0.37)	0.9 (0.28)	1.6 (0.45)	1.5 (0.34)
Hooded Warbler	0.2 (0.20)	0.5 (0.34)	0.0	1.1 (0.41)	0.6 (0.43)	0.3 (0.21)	0.1 (0.10)	0.5 (0.40)
Indigo Bunting	2.8 (0.85)	0.9 (0.41)	2.8 (0.65)	2.6 (0.52)	0.3 (0.15)	0.0	0.1 (0.10)	1.0 (0.47)
Northern Cardinal	0.4 (0.16)	1.3 (0.47)	2.3 (0.82)	2.1 (0.84)	1.6 (1.18)	0.8 (0.29)	2.5 (0.48)	1.3 (0.21)
Red-cockaded Woodpecker	2.1 (0.81)	1.3 (0.75)	2.8 (0.89)	1.6 (0.93)	0.0	0.0	0.0	0.0
Yellow-breasted Chat	0.7 (0.33)	0.1 (0.10)	1.6 (0.52)	2.2 (0.59)	0.0	0.0	0.0	0.1 (0.10)
White-eyed Vireo	0	0.4 (0.40)	0.4 (0.27)	1.2 (0.42)	0.1 (0.10)	0.0	0.0	0.1 (0.10)

*t-test. $P < 0.05$, significant differences within treatments between 1995 and 2003 detected only for Bachman's Sparrows.

Bachman's Sparrow (*Aimophila aestivalis*) Photo by Cliff Shackelford

Table 2. Changes in shrub-level foliage density (k) (MacArthur and MacArthur 1961) over an 8-year period of fire exclusion in Red-cockaded Woodpecker cluster areas and control sites in loblolly-shortleaf and longleaf pine habitat on the Angelina National Forest, Texas (n = 20).

Habitat condition	Foliage density 0–1 m (k)	Foliage density 1–2 m (k)	Foliage density 2–3 m (k)
Longleaf pine cluster area			
Mean in 1995 (±SE)	0.078 (0.008)	0.017 (0.006)	0.008 (0.001)
Mean in 2003 (±SE)	0.247 (0.053)	0.096 (0.020)	0.062 (0.015)
$t_{(18)}$	3.16	3.84	3.56
P	0.0054	0.0012	0.0023
Loblolly-shortleaf pine cluster area			
Mean in 1995 (±SE)	0.142 (0.012)	0.053 (0.014)	0.026 (0.007)
Mean in 2003 (±SE)	0.277 (0.019)	0.144 (0.023)	0.102 (0.019)
$t_{(18)}$	5.19	3.41	3.73
P	<0.0001	0.0031	0.0031
Longleaf pine control area			
Mean in 1995 (±SE)	0.065 (0.011)	0.041 (0.014)	0.025 (0.008)
Mean in 2003 (±SE)	0.152 (0.018)	0.081 (0.016)	0.045 (0.008)
$t_{(18)}$	4.12	1.87	1.80
P	0.0006	0.0774	0.0895
Loblolly-shortleaf pine control area			
Mean in 1995 (±SE)	0.061 (0.017)	0.022 (0.006)	0.011 (0.003)
Mean in 2003 (±SE)	0.099 (0.016)	0.062 (0.013)	0.034 (0.008)
$t_{(16)}$	1.62	2.96	2.85
P	0.1243	0.0091	0.0205

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