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Bird community responses to a gradient of site preparation intensities in pine plantations in the Coastal Plain of North Carolina

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ABSTRACT

Although intensively managed pine forests are common in the southeastern US, few studies describe how combinations of mechanical (MSP) and chemical site preparation (CSP) and herbaceous weed control (HWC) techniques affect bird communities that use early successional habitats within young pine forests. Therefore, we examined effects of six treatments of increasing management intensity via combinations of MSP (strip-shear and wide spacing or roller chop and narrow spacing) and CSP (application or no application) treatments with banded or broadcast HWC on bird communities in six loblolly pine (*Pinus taeda*) plantations in the Coastal Plain of North Carolina, USA, for 8 years following site preparation. Wide pine spacing and strip-shear MSP increased bird abundance and species richness over narrow spacing and chopped MSP for 6 years after planting. Chemical SP reduced bird abundance in year 2, increased bird abundance in year 6, had no effect on abundance after year 7, and did not affect species richness in any year. Total bird abundance and species richness were similar between banded and broadcast HWC. Site preparation and HWC had no effect on bird diversity and bird communities were most similar in treatments of similar intensity. Site preparation and HWC had few or no effects on birds based upon migratory status, habitat association, or conservation value. The addition of chemical site preparation or HWC had little effect on birds beyond pine spacing, and bird abundance was not proportional to management intensity. Although we observed treatment effects, all treatments provided habitat used by a variety of bird species, and pine plantations may play an increasingly important role in bird conservation as forests become fragmented and converted to other land uses and as natural processes that create early successional habitat, such as fire, are suppressed.

1. Introduction

Intensively managed pine forests are common in the southeastern US and are known to support many bird species (Childers et al., 1986; Wilson and Watts, 2000; NCSSF, 2005). Wildlife conservation within managed forests is of great interest and importance to foresters and biologists, in part because industry-owned forests consist of large, contiguous blocks of land that are increasingly uncommon in the southeastern US (Wigley et al., 2001). Conservation opportunities exist due to the diverse array of habitats present on privately owned and managed forest landscapes, and conservation efforts that consider such landscapes may be more effective than those that focus solely on public land (Wigley et al., 2000).

In recently established pine plantations, habitat changes and succession can be directed using a variety of mechanical and chemical applications that allow managers to selectively control vegetation to enhance pine productivity and wildlife habitat (Miller et al., 2009). Mechanical site preparation affects the amount and distribution of coarse woody debris and snags used by many bird species, particularly woodpeckers, flycatchers, and cavity-nesting birds (Hartley, 2002; Lohr et al., 2002; Jones et al., 2009a). Chemical site preparation and chemical releases such as herbaceous weed control (HWC) can affect bird communities through changes in plant community richness, diversity, structure, and succession due to herbicide specificity (Boyd et al., 1995; Miller and Miller, 2004). Increased management intensity through combinations of mechanical and chemical treatments can substantially increase

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pine growth and yields (Borders and Bailey, 2001; Wagner et al., 2004), but understanding potential tradeoffs between pine growth and bird habitat is important to conserving bird species in managed forests.

Many bird species that use early successional grassland and scrub–shrub vegetation associations are in nationwide decline due in part to changing land-use practices that often do not incorporate frequent disturbances needed to maintain early successional plant communities (Brennan and Kuvlesky, 2005). In the southeastern US, industrial forest lands create early successional plant associations through clearcutting, site preparation, and thinning (Krementz and Christie, 2000). Because mechanical and chemical site preparation techniques applied after clearcutting can alter plant communities, the interaction of various site preparation techniques and HWC may reduce or lengthen duration of early successional avian communities within pine plantations (Atkeson and Johnson, 1979; Miller et al., 1995; Zutter and Miller, 1998).

Although other studies have examined bird communities across multiple pine stands of varying ages (Wilson and Watts, 2000), few studies have assessed long-term effects of site preparation techniques on bird communities within the same stands over time. In addition, few studies have examined the effects of increasing pine management intensity on bird communities through combinations of site preparation and HWC techniques, which are becoming increasingly popular to control vegetation competing with pines (Shepard et al., 2004). Determining how site preparation and HWC combinations affect bird communities is essential because intensively managed pine forests can provide early successional vegetation communities known to be used by a variety of declining bird species. Therefore, we examined effects of six treatments of increasing management intensity on bird abundance, species richness, and diversity in loblolly pine (*Pinus taeda*) plantations within the Coastal Plain of North Carolina, USA for 8 years following site preparation.

2. Methods

2.1. Study area

We conducted our study on six stands managed for loblolly pine (*P. taeda*) in the Lower Coastal Plain of North Carolina, USA. Two stands in Craven County were managed by Weyerhaeuser Company and four stands in Brunswick County were managed by International Paper, The Nature Conservancy, Resource Management Service, LLC, or North Carolina Wildlife Resources Commission during our study. The Craven county stands were dominated by Leaf and Bayboro soils, and the Brunswick county stands were dominated by Croatan, Hobcaw, and Ogeechee soils. All types are loamy, poorly drained soils. All sites were previously planted in loblolly pine, and were clear-cut harvested between late 2000 and early 2001. Two Brunswick County stands were eliminated in 2005 and one treatment (narrow spacing, no chemical site preparation, banded herbaceous weed control) was eliminated at one Brunswick County site in 2008 because mortality due to flooding lowered tree densities below standard forestry practices. Operationally these stands would be cut and replaced. Stands averaged 60.7 ha and were divided into six treatment plots of 4.5–12.2 ha each (Mihalco, 2004).

2.2. Treatment descriptions

We chemically (imazapyr in the form of Chopper™, BASF Corp., Research Triangle Park, North Carolina, USA, at 3.51 L ha^{-1} mixed with 11.58 L ha^{-1} of methylated seed oil) or mechanically (roller-chop or strip shear) prepared plots for planting in late summer 2001–winter 2002, with loblolly pine hand planted in beds within either narrow (3.0×2.4 m) or wide (6.1×1.5 m) spacing during February 2002. Chemical site preparation was broadcast with a ground skidder and applied in August 2001. The strip-shear mechanical site preparation was accomplished in February 2002 with a v-blade followed by a ripper or bedding plow, leaving a 3.4 m cleared swath with a strip of piled debris between planting beds. We fertilized all plots with diammonium phosphate applied into beds at 0.08 kg m^{-1} prior to planting. In March 2002, we applied herbaceous weed control (HWC) with 0.30 L/ha of Arsenal™ (active ingredient imazapyr, BASF Corp., Research Triangle Park, North Carolina, USA) and 0.15 L ha^{-1} of Oust™ (active ingredient sulfometuron methyl, E.I. du Pont de Nemours and Company, Inc., Wilmington, Delaware) as either backpack-sprayed 1.5 m bands centered on the beds or broadcast ground skidder applications. We used a randomized complete block design and treatment plots received 1 of 6 treatment combinations that varied in intensity of vegetation control (Table 1). Treatment plots were adjacent to one another and separated by drainage ditches that rapidly grew vegetation and provided a visual barrier between plots. Treatment components included mechanical site preparation (strip shear coupled with wide spacing [SSW] or roller-chop coupled with narrow spacing [RCN]), use or lack of chemical site preparation (N = no application, H = application), and banded or broadcast HWC during the first year after planting (Ba = banded, Br = broadcast).

2.3. Bird surveys

We surveyed birds from 2002 to 2005 and 2007 to 2009 using a spot mapping technique derived from protocol established by Robbins (1970) and Wunderle (1994). Six surveys were completed for each treatment plot at all stands during the breeding season (May–June), and all treatments within a stand were surveyed during the same morning. We surveyed birds between sunrise and 1000 h on days with winds $\leqslant$32 km/h and no precipitation. We placed multiple transects 100 m apart and in each treatment plot noted all birds singing or seen within 50 m of each transect. Transects were arranged so we could survey all area within a treatment plot during each visit, and observers noted bird location, movements, and behavior (such as counter-singing, aggressive encounters, and chasing) within a plot to aid with territory mapping and avoid double counting. We rotated observers between treatments among stands to minimize observer bias, although the same treatment within a stand was assigned to a single observer because dense vegetation made navigation difficult in some years and plot familiarity was a necessity. Observers reversed their walking direction every survey to avoid timing effects.

2.4. Analysis

We used mean number of territorial singing males as our response variable because dense vegetation made it difficult to reliably detect birds by sight in some years and to account for territories only partially located within plot boundaries. We tested for differences in bird abundance (males/10 ha), bird species richness (species/10 ha), and Shannon H′ diversity (Shannon and Weaver, 1949) among treatments. Bird migratory status (resident, neotropical migrant, or short-distance migrant determined from Poole, 2010), general habitat preferences (forest interior, forest edge, and pine-grassland adapted from Wilson et al. (1995)), and ranked conservation values (CV) were also compared among treatments.

Conservation values by year, stand, and treatment were calculated using Partners in Flight (PIF) conservation ranks developed in Beissinger et al. (2000) and modified by Nuttle et al. (2003).