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Notes

Songbird Breeding Season Use of Pine Plantations Treated Chemically for Herbaceous Vegetation Control

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Abstract

Pine plantations, a common early successional habitat in the southeastern United States, have been subject in recent years to increased use of herbicides to control herbaceous vegetation immediately postestablishment. Such treatments may affect songbird use during the breeding season, but studies documenting bird response are limited. Furthermore, songbirds that breed in early successional habitats have experienced sustained population declines in recent decades. Therefore, we examined the influence of herbaceous vegetation control on songbird use during the breeding season within pine plantations on the Piedmont Plateau in Virginia. We evaluated 35 plantations characterized by one of five treatments: herbaceous vegetation control applied during the establishment year and that were 1, 2, or 3 y old when sampled, and those that had not received herbaceous vegetation control at establishment and that were 1 or 2 y old when sampled. There was no difference ($P > 0.05$) in detections of birds between plantations with and without herbicide treatment. However, 1-y-old plantations (both treated and untreated) had fewer detections ($P < 0.05$) than 2-y-old plantations for 3 individual species and for all 16 species combined.

Keywords: breeding birds; early successional habitat; forest management; herbicide; pine management; Piedmont Plateau

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Introduction

Forest managers have been concerned for many years about forest-breeding songbirds that have exhibited population declines (Crawford et al. 1981; Robinson et al. 1995; Thompson et al. 1995). In recent years, however, there has been increased attention focused on species associated with early successional habitats (Askins 2001; Rich et al. 2004) because they are experiencing more serious declines than species that require late-successional nesting habitat (Sauer et al. 2004). Early successional habitats are becoming increasingly rare in many parts of the southeastern United States (Trani-Griep 1999) and there are concerns about the quality of remaining habitats. Pine (*Pinus* spp.) plantations in the southeastern United States are common (12.18 million ha as of 2007; Smith et al. 2009) and provide habitat for early successional bird species during the first few years postestablishment (Childers et al. 1986; Lanham and Guynn 1998). However, Askins (2001) raised concerns

about the ability of intensively managed pine plantations in the southeastern United States to provide suitable habitat for breeding birds.

The Southern Forest Resource Assessment (Wear and Greis 2002) projected an 83% increase in the area of pine plantations in the southeastern United States by 2040, a gain of 10.2 million ha. Management regimes for these plantations increasingly include use of herbicides that control herbaceous vegetation during establishment (Wagner et al. 2004) because such treatments decrease rotation age (Lauer et al. 1993) and improve returns to forest landowners (Busby 1992). Shepard et al. (2004) reported more than 971,000 ha were treated with herbicides for some forest management objective in the southeastern United States alone in 2002. Further, they reported that herbaceous vegetation control accounted for 43% of the area treated with all herbicides, nearly 50% more area than reported for site preparation (i.e., the elimination of hardwood or other competing vegetation prior to planting pine seedlings) or hardwood release (i.e., the control of competing hardwood vegetation subsequent to establishment of pine seedlings).

Impacts of herbaceous vegetation control treatments on wildlife habitat have not been studied extensively. Keyser et al. (2003) reported on impacts of herbaceous competition control on various measures of habitat quality and found significant impacts for total herbaceous cover and herbaceous species richness, but not herbaceous species diversity in year of treatment. They also reported that differences between treatment and control areas diminished the following year and were largely gone by year three. Similarly, an examination of six herbaceous competition control tank mixes (i.e., more than one herbicide applied in combination during a given application) found that by the second year posttreatment virtually no differences in vegetation remained between an unsprayed control and the treatments (Keyser and Ford 2006). Zutter et al. (1987) reported that areas treated with herbicide had reduced herbaceous cover and biomass versus a control during the year of application, but that these measures were not different 2 and 3 y postapplication.

Studies documenting response of songbirds during the breeding season to herbaceous control treatments (and not simply measures of habitat alone) are limited. To our knowledge, they have been conducted only in the Coastal Plain, an area characterized by sandy soils, elevations below 60 m above mean sea level extending from southeastern New Jersey southward to Florida and then westward to Texas, encompassing more than 40 million ha. Jones et al. (2009) evaluated impacts of intensively established pine plantations in Mississippi and reported that herbaceous-weed control effects were largely limited to the year of application. In their case, however, all such weed control followed either chemical or mechanical site preparation. Working on the same Mississippi study sites, Hanberry (2007) examined breeding bird responses to increasing intensity (i.e., the number of individual establishment practices intended to limit competition for pine seedlings that are applied to a given site and the degree to which they eliminate such competing vegetation) of plantation establishment. Mihalco (2004) examined breeding bird response to an intensity gradient for plantation establishment. Finally, Miller and Miller (2004) reviewed several studies that compared chemical and mechanical site-preparation treatments on avian communities and concluded that there were few detectable differences in avian richness, diversity, and abundance in these studies.

By comparison to the Coastal Plain, relationships between breeding songbirds and pine plantation management are understudied in the Piedmont Plateau, an area that lies between the Appalachian Mountains to the west and the Coastal Plain to the east, extending from Maryland to Alabama with elevations ranging between 70 and 300 m above mean sea level, encompasses approximately 20 million ha, and is an important pine production area. Our objective was to provide an assessment of use during the breeding season by songbirds of pine plantations in the Piedmont Plateau that had been operationally treated with herbicides to control herbaceous vegetation following low-intensity site preparation. Furthermore, we sought to strengthen the understanding of bird response to pine management in the Piedmont Plateau.

Methods

Study area

We selected 35 loblolly pine *P. taeda* plantations on the Piedmont Plateau in Virginia (Albemarle, Amherst, Buckingham, Louisa, and Nelson Counties). Plantation size ranged from 5.7 to 42.1 ha with a mean of 23.9 (SE = 1.98) ha. We constrained selection of sites to keep them as close as possible to one another for logistic reasons. In addition, we selected sites with a common landscape-classification designation based largely on soil properties and that had been developed by the landowner, MeadWestvaco Corporation. Soils were formed over quartzose schist, metagraywacke, and mica schist; they were thicker than 127 cm, with an average pH of 5.86. The Natural Resources Conservation Service classified these soils as Cecil, Appling, Airmont, Chester, or Gunstock (NRCS 1993).

Treatments

The 35 plantations provided a chrono-sequence that featured five treatment × age combinations, each replicated seven times: plantations age 1 (HC1), 2 (HC2), and 3 y (HC3), all with herbaceous control applied during the year of establishment; and plantations age 1 (NH1), and 2 y (NH2), without any herbaceous control treatment. Age 3 untreated sites were not available. All sites had been operationally harvested the year preceding planting. Site preparation consisted of broadcast prescribed burning during summer (June–September) the year of harvest. Because these sites were second- or third-generation plantations, there were few snags or residual trees. Pine seedlings had been planted on HC1 and NH1 sites during February 2002, HC2 and NH2 sites during February 2001, and HC3 sites during February

Table 1. Bird species observed during point counts located in 35 loblolly pine plantations in the Piedmont Plateau, Virginia, United States, during May–June 2002.

Common name	Scientific name	Conservation concern level[a]	Total detections
Indigo bunting	*Passerina cyanea*	LP&R[b], SS[c]	47
Eastern towhee	*Pipilo erythrophthalmus*	Mgmt[d], SS	46
Prairie warbler	*Dendroica discolor*	Mgmt, WL[e]	46
Field sparrow	*Spizella pusilla*	na	39
Yellow-breasted chat	*Icteria virens*	na	21
Brown thrasher	*Toxostoma rufum*	Mgmt, SS	11
Northern bobwhite	*Colinus virginianus*	na	9
Eastern bluebird	*Sialia sialis*	na	6
Carolina wren	*Thryothorus ludovicianus*	LP&R, SS	3
Common yellowthroat	*Geothlypis trichas*	na	2
Chipping sparrow	*Spizella passerina*	na	2
American goldfinch	*Carduelis tristis*	na	2
Blue jay	*Cyanocitta cristata*	na	1
Wild turkey	*Meleagris gallopavo*	na	1
Grasshopper sparrow	*Ammodramus savannarum*	Mgmt, SS	1
Song sparrow	*Melospiza melodia*	na	1

[a] Based on Partners in Flight (http://www.partnersinflight.org/cont_plan/).
[b] Long-term Planning & Responsibility Action Category.
[c] Stewardship Species.
[d] Management Action Category.
[e] Watch Listed species.

2000. All herbaceous control treatments were operationally broadcast applied (aerially) during April in the year of planting. Herbicides were applied at a rate of 291 mL/ha of Arsenal AC® (imazapyr; BASF, Florham Park, NJ) and 73 mL/ha of Oust® (sulfometuron methyl; Dupont, Newark, DE).

Field methods

We assessed songbird use during the breeding season by establishing one point-count station in each of the 35 plantations following Lanham and Guynn (1998). Points were 393–668 (mean = 485) m apart. A single observer that was familiar with birds in the region and able to identify them aurally and visually collected data at all 35 points. We located each station systematically within the plantation, typically near the center and away from log decks, to maximize the ability of the observer to cover the site and minimize influences from adjacent plantations. We surveyed each site once between 0600 and 1000 hours during the period 24 May through 26 June 2002 on mornings when there was little or no wind and no precipitation. We recorded all birds either heard or seen within the plantation during a 7-min observation period on each site.

Analysis

Because of nonnormality, we rank-transformed our data and used analysis of variance (PROC GLM; SAS 1996) on the ranked data to test for treatment effects where the five treatment × age combinations (HC1, HC2, HC3, NH1, and NH2) were main effects. Number of birds detected at point-count stations was the response variable. Where sample size permitted, we conducted tests for individual species in addition to those for miscellaneous species and all species combined. For means separation of ranked data, we relied on least-square means and a Bonferroni technique ($\alpha = 0.05$) to account for experiment-wise error (Neter et al. 1996). Data are provided in Table S1 (*Supplemental Material*, http://dx.doi.org/10.3996/092010-JFWM-035.S1).

We evaluated relationships between size of plantations (ha) and number of birds detected with Pearson correlations using PROC CORR (SAS 1996) and between plantation size using three area categories (<12, 12–26, and >26 ha) and presence–absence of a species using a chi-square test PROC FREQ (SAS 1996) to assure that there was no area-related bias in our data. We conducted these analyses for the four most common species in our sample and for all species combined.

Results

We detected 238 birds of 16 species using the 35 plantations, including 6 species of high conservation concern (i.e., Management or Planning & Responsibility Action Categories; and either Watch List or Stewardship Species) as determined by Partners in Flight in their North American Landbird Conservation Plan for the Eastern Avifaunal Biome (Rich et al. 2004; Table 1). Five species, *Passerina cyanea* (indigo bunting), *Pipilo erythrophthalmus* (eastern towhee), *Dendroica discolor* (prairie warbler), *Spizella pusilla* (field sparrow), and *Icteria virens* (yellow-breasted chat), accounted for 84% of the total detections. The remaining 11 species were placed into the miscellaneous category. Treatment means and standard errors (Table 2) suggested that there was a large amount of site-to-site variability.

Table 2. Mean (SE) detections for bird species observed in 35 loblolly pine plantations in the Piedmont Plateau, Virginia, United States, during May–June 2002. Treatments were as follows: age 1 (HC1), 2 (HC2), and 3 y (HC3) with herbaceous control applied during the year of establishment; and age 1 (NH1) and 2 y (NH2) without herbaceous control.

	Species[a]						
Treatment	**INBU**	**EATO**	**PRWA**	**FISP**	**YBCH**	**MISC**	**All**
HC1	1.00 (0.488)	1.14 (0.340)	1.00 (0.436)	0.29 (0.184)	0	0.43 (0.297)	3.86 (0.670)
HC2	1.86 (0.340)	1.14 (0.340)	2.29 (0.474)	1.43 (0.429)	1.00 (0.309)	0.71 (0.360)	8.40 (0.972)
HC3	1.29 (0.360)	2.00 (0.488)	1.00 (0.218)	1.71 (0.421)	1.00 (0.309)	2.14 (0.634)	9.14 (0.634)
NH1	0.71 (0.474)	0.86 (0.261)	0.29 (0.286)	0.43 (0.297)	0	1.00 (0.378)	3.29 (0.747)
NH2	1.86 (0.459)	1.43 (0.612)	2.00 (0.436)	1.71 (0.421)	1.00 (0.309)	1.29 (0.360)	9.29 (1.304)

[a] INBU = indigo bunting *Passerina cyanea*, EATO = eastern towhee *Pipilo erythrophthalmus*, PRWA = prairie warbler *Dendroica discolor*, FISP = field sparrow *Spizella pusilla*, YBCH = yellow-breasted chat *Icteria virens*; Misc includes brown thrasher *Toxostoma rufum*, northern bobwhite *Colinus virginianus*, eastern bluebird *Sialia sialis*, Carolina wren *Thryothorus ludovicianus*, common yellowthroat *Geothlypis trichas*, chipping sparrow *Spizella passerina*, American goldfinch *Carduelis tristis*, blue jay *Cyanocitta cristata*, wild turkey *Meleagris gallopavo*, grasshopper sparrow *Ammodramus savannarum*, and song sparrow *Melospiza melodia*.

We detected significant ($P < 0.05$) differences among treatments for detections of prairie warbler, field sparrow, yellow-breasted chat, and for all species combined (Table 3). In most cases, we detected fewer birds on the two 1-y-old treatments (HC1 and NH1) than on the three older treatments (HC2, HC3, and NH2; Table 4). We did not find any differences in detections for any species or for all birds combined between the two first-year treatments or between the two second-year treatments (Table 4).

We observed no significant relationship between size of the plantation and the number of detections for indigo bunting ($r = -0.02$, $P = 0.91$), eastern towhee ($r = 0.23$, $P = 0.18$), prairie warbler ($r = -0.04$, $P = 0.82$), field sparrow ($r = 0.18$, $P = 0.30$), or for all species combined ($r = 0.19$, $P = 0.26$). Similarly, we were unable to detect any significant relationship for these same species for plantation size based on simple presence or absence (indigo bunting, $\chi^2_{24} = 26.88$, $P = 0.31$; eastern towhee, $\chi^2_{24} = 28.89$, $P = 0.22$; prairie warbler, = 24, $\chi^2_{24} = 30.56$, $P = 0.17$; field sparrow, $\chi^2_{24} = 23.54$, $P = 0.49$; total for all species combined, $\chi^2_{288} = 305.16$, $P = 0.23$). Yellow-breasted chat was not represented on enough sites to permit an individual comparison.

Table 3. Results from analysis of variance on ranked data (F = F-statistic; P = probability of rejection of null hypothesis) for breeding bird detection in 35 loblolly pine plantations in the Piedmont Plateau, Virginia, United States, May–June 2002. Models compare five treatments: age 1 (HC1), 2 (HC2), and 3 y (HC3) with herbaceous control applied during the year of establishment; and age 1 (NH1) and 2 y (NH2) without herbaceous control.

Species[a]	$F_{4,30}$	P
INBU	1.63	0.1920
EATO	0.87	0.4921
PRWA	4.49	0.0058
FISP	3.88	0.0117
YBCH	6.50	0.0007
MISC	2.06	0.1114
Total	11.11	0.0001

[a] INBU = indigo bunting *Passerina cyanea*, EATO = eastern towhee *Pipilo erythrophthalmus*, PRWA = prairie warbler *Dendroica discolor*, FISP = field sparrow *Spizella pusilla*, YBCH = yellow-breasted chat *Icteria virens*; MISC includes brown thrasher *Toxostoma rufum*, northern bobwhite *Colinus virginianus*, eastern bluebird *Sialia sialis*, Carolina wren *Thryothorus ludovicianus*, common yellowthroat *Geothlypis trichas*, chipping sparrow *Spizella passerina*, American goldfinch *Carduelis tristis*, blue jay *Cyanocitta cristata*, wild turkey *Meleagris gallopavo*, grasshopper sparrow *Ammodramus savannarum*, and song sparrow *Melospiza melodia*.

Discussion

Jones et al. (2009) reported decreasing vegetative cover as intensity of pine plantation establishment practices increased. Working on the same study area, Hanberry (2007) evaluated breeding bird use of pine plantations and documented the same early successional species (i.e., eastern towhee, field sparrow, indigo bunting, prairie warbler, and yellow-breasted chat) using his sites that we observed on ours. Although these species were absent during year 1 for some treatments, typically the more intensive ones, they occurred on all sites by year 2 and thereafter (Hanberry 2007). This pattern reinforces the one we observed; namely, increasing use of the sites by songbirds with years posttreatment. However, their results reflected not only broadcast herbaceous-weed control, but impacts from either mechanical or chemical site preparation that preceded that treatment. Their chemical treatments used a rate of the chemical imazapyr more than eight times higher than we used and was applied the year preceding herbaceous-weed control. Because of the soil activity of this chemical, it would still have been influencing the vegetation during the year of application of herbaceous control chemicals. Furthermore, their herbaceous control tank mix included hexazinone, a chemical we did not use. Their results also may not be directly comparable to ours due to differences in plant communities of the Coastal Plain and the Piedmont Plateau. Nevertheless, they found that bird use generally decreased with increasing intensity of establishment practices for the five species in common with our study.

Another Coastal Plain study evaluated several pine plantation establishment treatments in poorly drained soils in North Carolina (Mihalco 2004). She examined an

Table 4. Ranked mean detections by treatments for 3 bird species with significant analysis of variance results (see Table 3) and all 16 species in our study (35 loblolly pine plantations in the Piedmont Plateau, Virginia, United States, May–June 2002) combined. Means separations are based on least-square means and a Bonferroni technique. Means within a row with different letters are different. Treatments were as follows: age 1 (HC1), 2 (HC2), and 3 y (HC3) with herbaceous control applied during the year of establishment; and age 1 (NH1) and 2 y (NH2) without herbaceous control.

	Ranked mean (SE)				
Species[a]	HC1	HC2	HC3	NH1	NH2
PRWA	15.5 (3.148) BC	25.4 (3.148) AB	16.2 (3.148) BC	9.1 (3.148) C	23.8 (3.148) AB
FISP	10.6 (3.193) B	20.9 (3.193) AB	23.4 (3.193) A	11.8 (3.193) B	23.4 (3.193) A
YBCH	10.5 (2.686) B	23.0 (2.686) A	23.0 (2.686) A	10.5 (2.686) B	23.0 (2.686) A
Total[b]	9.1 (2.596) B	23.0 (2.596) A	25.1 (2.596) A	8.1 (2.596) B	24.8 (2.596) A

[a] PRWA = prairie warbler *Dendroica discolor*, FISP = field sparrow *Spizella pusilla*, YBCH = yellow-breasted chat *Icteria virens*.
[b] Total includes indigo bunting *Passerina cyanea*, eastern towhee *Pipilo erythrophthalmus*, prairie warbler *Dendroica discolor*, field sparrow *Spizella pusilla*, yellow-breasted chat *Icteria virens*, brown thrasher *Toxostoma rufum*, northern bobwhite *Colinus virginianus*, eastern bluebird *Sialia sialis*, Carolina wren *Thryothorus ludovicianus*, common yellow-throat *Geothlypis trichas*, chipping sparrow *Spizella passerina*, American goldfinch *Carduelis tristis*, blue jay *Cyanocitta cristata*, wild turkey *Meleagris gallopavo*, grasshopper sparrow *Ammodramus savannarum*, and song sparrow *Melospiza melodia*.

herbaceous-weed control treatment that was virtually identical to ours, but following either mechanical or chemical site preparation rather than the burning-only on our sites. Nevertheless, the results of Hanberry (2007) and Mihalco (2004) were similar to ours in key respects. Eastern towhee, indigo bunting, prairie warbler, and yellow-breasted chat all used their sites, but were more abundant the second year after establishment. Furthermore, abundances decreased with intensity of site preparation, a factor attributed to reduced structural complexity of vegetation.

Our results suggested that age and associated succession may have had a greater impact on habitat use by breeding birds than the application of herbicides in year 1. We found as many birds, including three of high conservation concern (i.e., prairie warbler, indigo bunting, and eastern towhee) in plantations that were sprayed as in those that were untreated. Although we did not sample untreated third-year plantations, we did not detect a difference in bird abundances between treated third-year plantations and those in the second year.

We recorded low relative abundances of songbirds during the breeding season on all sites during year 1. We surmise that this may have been due to the lack of vertical structure in this early successional phase (O'Connell and Miller 1994). In year 2 in the treated sites, when many of the effects of spraying were beginning to disappear and vegetation began to recover, bird abundance increased. Thus, chemical herbaceous control at establishment may have occurred at a time when bird use of the sites was already limited by a lack of suitable structure. It was noteworthy that high conservation-priority species like the prairie warbler occurred in abundances that were comparable to, or even exceeded that of nontreated sites (i.e., HC2 $>$ NH1). We suggest that succession on newly regenerating pine plantations may have exerted more influence on bird use than the short-duration effects of spraying herbicides in the early stages of stand development, a contention supported by the work of Lautenschlager and Sullivan (2004) and Miller and Miller (2004). We found no evidence that the range of plantation sizes that we evaluated influenced songbird occupancy of the sites, a finding in contrast to that of Lanham and Guynn (1998).

While using multiple point counts for a given location can be desirable where density estimates, detection probabilities, or occupancy models are to be developed, our objective was to characterize bird species composition and proportional (relative) abundances as a function of the ''effect'' (e.g., herbicide treatment level). Therefore, we relied on single point counts per location. Single point-count visits have been considered appropriate to develop indices of impact relative to ''treatment'' level or other gradient (see Bryce et al. 2002; Bryce 2006; Larsen et al. 2010). This type of indexing has been deemed a useful tool for baseline environmental-impact assessment of phenomena such as riparian condition, which exist along a gradient (Bryce et al. 2002). We also were not concerned about species with low relative abundance or those that occurred sporadically on the study area; indeed, our species list was representative of bird species composition in regenerating pine plantations (Lanham and Guynn 1998; Mihalco 2004; Hanberry 2007).

Declining populations of early successional songbirds associated with forested habitats are an increasing concern for forest managers. Changes in management strategies, including use of herbicides to control herbaceous vegetation early in the development of pine plantations, need to be evaluated to understand the implications for the conservation of biodiversity, especially avifauna. Our assessment suggests that chemical herbaceous vegetation control, when conducted during the year of plantation establishment, may have limited impact on relative abundance of songbirds during the breeding season in the context of low-intensity establishment on Piedmont Plateau sites. Normal successional development may be a more substantial influence.

Supplemental Material

Please note: The *Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author for the article.

Table S1. Breeding bird detections on 35 pine plantations treated and not treated for herbaceous-weed control in the Piedmont Plateau in Virginia, United States, May–June, 2002.

Found at DOI: http://dx.doi.org/10.3996/092010-JFWM-035.S1 (39 KB XLS).

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