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Avian Response to Forest Management and Military Training Activities at Fort Benning, Georgia

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AVIAN RESPONSE TO FOREST MANAGEMENT AND MILITARY TRAINING ACTIVITIES AT FORT BENNING, GEORGIA

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ABSTRACT

Evaluating intensity and effects of land use disturbance is difficult, especially in sites with multiple land use. We conducted point counts to determine if abundance of bird species could be used to assess military training and forestry management practices at Fort Benning, Georgia. We evaluated heavy and light use sites in the 1st growing season after prescribed fire and in the 3rd growing season post-fire. Results focus on species common to early successional habitats and pine-grasslands and on forest species and habitat generalists. In the 3rd growing season post-fire, Indigo buntings (*Passerina cyanea*) and northern bobwhites (*Colinus virginianus*) were more abundant in recently burned heavy use sites than in light use sites. Conversely, red-eyed vireos (*Vireo olivaceus*) were more abundant in light use sites in the 3rd growing season post-fire than in recently burned, heavy use sites. Further study could help determine if these species are indicators of disturbance.

INTRODUCTION

Land management on military installations must provide adequate provision for support of the military training mission. In addition, on many installations in the southeast, land management is driven by a mandate to protect and improve habitat for the endangered red-cockaded woodpecker (*Picoides borealis*; RCW). Management prescriptions under the recovery plan for RCW include prescribed burning on a short burn rotation, uneven age timber management, and understory hardwood reductions (1). The combined effects of military training and forestry practices create a complicated disturbance regime on the landscape. Military installations and other public lands with multiple land use need reliable measures of land-use disturbance effects on ecosystem composition, structure, and dynamics to responsibly implement and monitor their complex management plans.

Response to disturbance, or to the habitat patches and edge effects created by that disturbance, has been documented for many bird species. Early successional species such as brown-headed cowbirds (*Molothrus ater*) and yellow-breasted chats (*Icteria virens*) might be expected to occur more frequently in areas heavily disturbed by military training or by forestry practices that create forest openings and increase edge (2, 3). Several species, including Bachman's sparrow (*Aimophila aestivalis*), northern bobwhite, eastern wood-pewee (*Contopus virens*), and indigo bunting respond favorably to RCW management practices such as prescribed

burning and hardwood understory reduction (4, 5, 6, 7, 8). Alternatively, frequent prescribed burning, timber harvest, and hardwood reduction may negatively impact some species, including tufted titmouse (*Baeolophus bicolor*) (9), ovenbird (*Seiurus aurocapillus*), red-eyed vireo (10), and black-and-white warbler (*Mniotilta varia*; 5). Canterbury et al. (11) examined the effects of forest disturbance in the southeastern U.S. on four functional groups based on habitat assemblages (shrubland, forest-edge, habitat generalist, and mature forest) and found that shrubland (e.g., yellow-breasted chat, common yellowthroat [*Geothlypis trichas*], eastern towhee [*Pipilo erythrophthalmus*], and indigo bunting) and mature-forest (e.g., pine warbler [*Dendroica pinus*], red-eyed vireo, wood thrush [*Hylocichla mustelina*], and hooded warbler [*Wilsonia citrina*]) assemblages were most commonly correlated with disturbance measures (canopy cover and tree basal area). All four commonly occurring species in the shrubland assemblage decreased with increasing canopy cover and all four in the mature-forest assemblage increased with increasing canopy cover.

The research reported here was conducted in upland mixed pine-hardwood forest stands. These stands are part of a larger study at Fort Benning, Georgia of the ecological effects of disturbances imposed by land use and management practices on upland forests. All sites were assigned *a priori* to a 'heavier' or 'lighter' military training use category based on known history of military training in that area. Site disturbance was further evaluated using a survey of vegetation and disturbance features. Our objective was to conduct short-term point counts in stands with known disturbance and vegetation patterns to determine if abundance of selected bird species might, in turn, be an indicator of disturbance. We focused on two groups of birds based on habitat preferences. One group includes associates of early successional and pine-grassland habitats. The other group includes habitat generalists and species associated with forests. This approach may provide land managers with useful measures of land-use disturbance and information on the implications of forestry management and military training on bird populations, including neotropical migrant species, which are a particular concern.

MATERIALS AND METHODS

Fort Benning is a 73,533 ha U.S. Army installation located on the Coastal Plain-Piedmont Fall Line in west-central Georgia and eastern Alabama. In association with management prescriptions for the red-cockaded woodpecker, upland managed forests at Fort Benning are thinned on a nine-year cycle and prescribe-burned, typically on a three-year cycle.

We selected 16 of the 32 upland forest stands being studied by our research team at Fort Benning. All were burned in 2000 and half were burned again prior to the 2002 growing season, when our research was conducted. The eight stands burned only in 2000 were in their third post-burn growing season. Half of these stands are located in 'heavier' (H) military use compartments open to mechanized training (tracked vehicles) and half are in 'lighter' (L) use compartments supporting only dismounted infantry training (foot traffic) off the roads and trails. The combinations of military training (H, L) and prescribed fire (sites burned in

2002 = 1st growing season post-fire, sites burned only in 2000 = 3rd growing season post-fire) produced four land-management categories: 1st growing season post-fire, heavy use (1H); 1st growing season post-fire, light use (1L); 3rd growing season post-fire, heavy use (3H); and 3rd growing season post-fire, light use (3L).

In 2000, 25 vegetation sampling points were established in a 100 m x 100 m plot in each stand. Tree density (dbh > 10 cm) was measured in 2000 and groundlayer vegetation (< 1.4 m height) was measured in 2002 as described by Dilustro et al. (12). Sapling density was surveyed in 2000 by recording each shrub or tree sapling (> 1.4 m height, dbh 1 to 10 cm) that intercepted a 10 m transect at each sampling point. In 2001, hemispherical canopy photographs were taken at each of the vegetation sampling points in each plot using a Nikon Coolpix 950 with a FC-E8 fisheye lens converter. Gap Light Analyzer (GLA) imaging software was used with these photographs to estimate canopy cover (13).

To confirm the heavier vs. lighter military use categories correctly reflected level of disturbance, and to evaluate disturbance features that might influence avian species, we conducted a survey of disturbance features along two 300 m transects that bisected each 100 m x 100 m plot. Features associated with forestry, military use, and natural disturbance, including roads, tank trails, gullies, and canopy openings, were assessed by line-intercept along each transect (12).

The vegetation and disturbance survey results include 6 additional stands (2 additional stands in 3H and 3L land use categories and 1 additional stand in 1H and 1L categories). These stands were included because point counts had to be relocated (see next paragraph) or because at least one count from the selected stand fell within another nearby stand.

Point counts were conducted at the center of each 100 m x 100 m plot and 50 m from both ends of each disturbance survey transect (5 points/plot; 20 points/land use category). Because of windy conditions, only three point counts could be conducted in one 3H stand (18 points total/3H). Locations were modified if the land use category was not met (e.g., the area had not burned) or if the area did not meet the study criteria (e.g., was a hardwood slope forest). Three points were moved to the center of 100 m x 100 m plots in other nearby stands that had the same land use (included in the vegetation and disturbance survey results). Points were located at least 200 m apart and most were ≥ 250 m. We surveyed each point for 10 minutes, typically between sunrise and 10:00 h, during May 2002. Occurrence of each individual seen or heard was recorded by species in concentric distance bands of < 25 m, 25-50 m, and > 50 m (14). Because birds were detected most often beyond the 50 m band and sample size was small (20 points/land use category) we did not limit our analysis to birds detected only within a fixed-radius of 50 m. An effort was made to not record individuals believed to have been recorded in other counts; however, some of the species can be heard from greater than the 250 m that typically separated our counts (e.g., northern bobwhite and indigo bunting), likely causing some repeated counts of individuals (15). Ideally, sample size would have been larger; however,

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which could likely mimic management constraints, to look at results from this level of effort.

Results focus on seven resident or neotropical migratory species associated with open pine-grasslands or early successional habitats and on seven resident or neotropical migratory forest and habitat generalist species common to Fort Benning (Table I). We compared abundance among land use categories for 1) individual species, 2) combined species abundance or early successional and pine-grassland species (brown-headed cowbird abundance was not used in this analysis because of its very low occurrence in our study), and 3) combined species abundance of forest species and habitat generalists. Analysis of variance was used to test differences among the four land use categories for species abundance and habitat variables. Tukey's standardized range test was used to compare means among land use categories. A one-way ANOVA was used to test differences in disturbance (m of line "disturbed" per 600 m transect sampled) between heavy and light use categories.

Table I. Mean (SE) abundance (mean detections/point/land use category) of selected avian species in recently burned heavy use (1H) and light use (1L) and 3rd growing season post-fire heavy use (3H) and light use (3L) land use categories at Fort Benning, Georgia, May 2002.

	Land Use Category			
	1H	1L	3H	3L
Early successional or pine-grassland species				
Bachman's Sparrow (*Aimophila aestivalis*)	0.50 (0.15)	0.50 (0.19)	0.33 (0.14)	0.35 (0.20)
Brown-headed Cowbird (*Molothrus ater*)	0.20 (0.12	0	0	0.15 (0.08)
Eastern Towhee (*Pipilo erythrophthalmus*)	0.50 (0.14)	0.45 (0.14)	0.61 (0.16)	0.55 (0.14)
Indigo Bunting (*Paserina cyanea*)	1.50^a (0.27)	0.95^{ab} (0.21)	1.11^{ab} (0.24)	0.65^b (0.18)
Northern Bobwhite (*Colinus virginianus*)	0.35^a (0.35)	0.85^{ab} (0.25)	0.78^{ab} (0.21)	0.25^b (0.10)
Prairie Warbler (*Dendroica discolor*)	1.05 (0.29)	0.95 (0.23)	0.94 (0.21)	1.10 (0.22)
Yellow-breasted Chat (*Icteria virens*)	0.25 (0.12)	0.50 (0.15)	0.33 (0.14)	0.60 (0.13)
Species combined*	5.15 (0.50)	4.20 (0.75)	4.11 (0.62)	3.50 (0.52)

Forest species or habitat generalists

Carolina Wren	0.70[ab] (0.16)	0.80[ab] (0.19)	0.44[b] (0.12)	1.25[a] (0.20)
(*Thryothorus ludovicianus*)				
Great-crested Flycatcher	0.65 (0.13)	0.55 (0.11	0.78 (0.15)	0.55 (0.14)
(*Myiarchus crinitus*)				
Northern Cardinal	1.30 (0.28)	0.80 (0.20)	1.33 (0.21)	1.15 (0.23)
(*Cardinalis cardinalis*)				
Pine Warbler	0.75 (0.23)	0.75 (0.18)	0.78 (0.19)	0.65 (0.15)
(*Dendroica pinus*)				
Red-eyed Vireo	0.35[b] (0.13)	0.45[ab] (0.15)	0.33[b] (0.11)	0.90[a] (0.18)
(*Vireo olivaceus*)				
Summer Tanager	0.55 (0.14)	0.35 (0.11)	0.44 (0.12)	0.45 (0.11)
(*Piranga rubra*)				
Tufted Titmouse	0.45 (0.15)	0.35 (0.11)	0.83 (0.15)	0.80 (0.20)
(*Baeolophus bicolor*)				
Species combined	4.75[ab] (0.44)	4.05[b] (0.48)	4.94[ab] (0.37)	5.75[a] (0.39)

Abundance means with the same letter and without a letter do not differ significantly ($P > 0.10$).

*Does not include brown-headed cowbird abundance.

RESULTS

Groundlayer vegetation differed among the land use categories. Percent ground cover (all species combined) was greater in 1H and lower in 1L than in other categories (Table II). Relative cover of forbs, legumes, and grasses was greatest in recently burned sites with heavier military training (1H; Table II). Shrubs and trees had higher relative abundance in sites with lighter military training and last burned in 2000 (3L; Table II). Although canopy level vegetation (tree density and canopy closure) did not differ significantly among the land use categories; within-site variation was high in all land use categories.

Table II. Mean (SE) habitat measurements in recently burned heavy use (1H) and light use (1L) and 3rd growing season post-fire heavy use (3H) and light use (3L) land use categories at Fort Benning, Georgia.

Parameter	1H	1L	3H	3L
Tree density (no./ha)	262 (41)	360 (75)	310 (38)	467 (93)
Pine density (no./ha)	188 (34)	181 (17)	207 (45)	292 (60)
Hardwood density (no./ha)	74 (45)	179 (87)	102 (31)	175 (40)
% Canopy closure	64 (1.5)	69 (4.1)	68 (0.84)	70 (1.5)
% Relative sapling density	46 (16)	127 (57)	138 (22)	112 (41)
% Ground cover	78^a (3.1)	55^c (3.2)	69^b (3.1)	67^b (2.9)
% Forb	21^a (1.3)	15^b (1.6)	13^b (1.1)	8^c (0.7)
% Legume	8^a (0.8)	6^b (0.6)	2^c (0.3)	2^c (0.3)
% Grass	21^a (1.8)	19^{ab} (1.7)	14^b (1.6)	6^c (0.6)
% Shrub	9^{bc} (1.1)	5^c (0.8)	10^b (1.4)	17^a (1.4)
% Tree species	12^b (1.3)	5^c (0.6)	16^b (1.6)	23^a (1.5)
% Vine	6^b (0.9)	4^b (0.7)	12^a (1.5)	10^a (1.4)
% Dead or woody debris	2 (0.3)	2 (0.4)	1 (0.2)	1 (0.3)

Abundance means within a row with the same letter and without a letter do not differ significantly (P > 0.05).

Clearcuts, remnant roads, remnant trails, skidder trails, and gullies were the most common disturbance features observed in the disturbance survey of these sites (Table III). Sites designated as heavy land use (1H and 3H) did have significantly greater disturbance than those designated light land use (P = 0.0011). Remnant roads, remnant trails, and gullies were common in light use sites and remnant roads, skidder trails, tank trails, and gullies were common in heavy use sites. Clearcuts were present in all land use categories but relative abundance of clearcuts was highest in 1H sites.

Table III. Mean disturbance (m of line "disturbed" per 600 m sampled; SE), % clearcut disturbance (m clearcut/total m disturbed x 100), and other common disturbance features in recently burned heavy use (1H) and light use (1L) and 3rd growing season post-fire heavy use (3H) and light use (3L) land use categories at Fort Benning, Georgia.

Category	Disturbance (m)	% Clearcut	Other Common Features
1H	199.53 (28.83)	33	Skidder trails, remnant roads, gullies
1L	96.76 (28.89)	21	Remnant roads, gullies, remnant trails
3H	191.21 (32.92)	20	Remnant roads, tank trails, gullies
3L	94.68 (17.69)	18	Gullies, remnant roads, remnant trails

Abundance of two bird species in the early successional and pine-grassland group and of two birds in the forest species and habitat generalists group differed among the land-use categories (Table I). Both indigo bunting and northern bobwhite abundance differed only between land use extremes; and both were more abundant in recently burned, heavy use sites (1H) than in light use sites burned in 2000 (3L; Table I). Carolina wrens were more abundant in 3L sites than in heavy use sites burned in 2000 (3H), but there were no differences among other land use categories. Red-eyed vireos were more abundant in 3L sites than in heavy use sites (3H and 1H: Table I). When we combined species abundances based on similar habitat preference (early successional and pine-grassland species or forest and habitat generalist species), we found that each group occurred most often at opposite land use extremes. Early successional and pine-grassland species were most abundant in 1H, while forest species and habitat generalists were most abundant in 3L. However, differences in early successional and pine-grassland species abundance were not significant, and forest species and habitat generalists were only significantly more abundant in 3L than in 1L (Table I).

DISCUSSION

Some combination of past or present military training, forestry practices, or agricultural practices impacts all the upland forest stands considered in this study. Our disturbance survey revealed a gradient of disturbance among sites within and among each land use category studied. Vegetation parameters, including tree, shrub, and ground cover density, reflect these disturbance patterns. Canopy cover was lowest and ground cover was highest in recently burned sites with heavier military training (1H sites). As previously stated, our objective was to determine whether abundances of early successional and pine-grassland birds or forest species and habitat generalists would reflect these disturbance gradients and vegetation patterns.

Abundances of individual species differed most often between land use category extremes. Early successional indigo buntings and northern bobwhites were more abundant in 1H than in 3L stands. These species have been shown to benefit from ground cover response to open tree canopies (4, 5). Cram et al. (8) found that northern bobwhites occurred most frequently in unburned, thinned pine-grassland stands and in thinned stands in the third growing season following fire. Wilson et al. (5) found that indigo bunting densities also peak three years after fire. In our study, abundances of both species were higher in recently burned stands (1H) than in stands in the third post-fire growing season (3L). Stands in the 1H category had lower tree densities and more ground cover than 3L stands.

In contrast to the early succession and pine grassland species, forest-dwelling red-eyed vireos were more abundant in 3L than in 1H. Red-eyed vireos typically are associated with hardwood forests, but will utilize older pine stands (16). This species can be negatively affected by timber harvesting but may still commonly occur in thinned or clearcut stands (10, 17). In our study, red-eyed vireo abundance was greater in stands with highest tree density (3L) than in those with lowest tree density (1H). Carolina wrens were less common in 3H sites but abundance only differed significantly from 3L. Red-eyed vireos showed a similar response in sites in their third growing season post-fire.

Our study revealed other notable patterns of species abundances among the land use categories. Brown-headed cowbirds were not common in any category possibly because they may prefer areas disturbed by agricultural practices or residential and recreational human activities as opposed to disturbed patches created from logging (or, in this case logging and military) practices within forested areas (18). Tufted titmice occurred less often in recently burned sites (1H and 1L) than at sites in the third season post-fire (3H and 3L). These birds have been suggested as potential indicators of fire exclusion (9).

Although disturbance likely influences occurrence of birds over the Fort Benning landscape, abundance of the focal species in our study may not be the most suitable indicator of current land use. These species may not discriminate finely over a landscape and region that reflects a long history of natural disturbances and intensive land use. However, our limited study did reveal some individual species responses to land use disturbance. Further, examining the abundance of groups of species that use similar habitats (such as early successional and pine-grassland species) may be useful in defining disturbed habitats. Our results suggest a more intensive study of avian abundance across Fort Benning, that better defined distribution and population patterns, would reveal that early successional and pine-grassland species are positively affected by management practices; conversely, forest species and habitat generalists may utilize less disturbed areas.

ACKNOWLEDGMENTS

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