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AMERICAN WOODCOCKS' (*SCOLOPAX MINOR*) USE OF PINE PLANTATION HABITAT DURING SPRING IN CENTRAL ARKANSAS

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ABSTRACT.—We evaluated sites on an industrial forest in central Arkansas that American Woodcocks (*Scolopax minor*) used for courtship during their spring migration. Our main objective was to determine the vegetation characteristics used by male woodcocks on their courtship sites within early successional pine stands. We quantified use within three stages of early successional pine stand; pine seedling (1 year old), young-pine sapling (2–3 years old), and old-pine sapling (4–5 years old). We used crespuscular surveys as an index to the number of woodcock using each stand. We completed surveys in January–March 2010 and 2011 on eight stands of each stage ($n = 24$) during 7–10 day sampling periods across spring migration. We quantified the vegetation structure of each stand including the percent of bare ground, standing herbaceous, flattened herbaceous, shrub, coarse woody debris, and canopy cover and horizontal density. We found that woodcocks used stands with greater shrub, standing herbaceous, and flattened herbaceous cover. This is different from other studies in the southern United States that have shown woodcocks to use areas with sparse vegetation and increased bare ground. We suggest this disparity occurred because previous studies assumed constant detection between stands with different vegetative structure, whereas we completed detection tests to determine how vegetative structure may influence detection between stand types and incorporated these differences in detection into our analyses. *Received 21 September 2012. Accepted 31 December 2012.*

Key words: American Woodcock, central region, habitat use, industrial forests, loblolly pine, *Scolopax minor*, spring migration.

Many migratory bird species require a diversity of habitat types, including early successional forests (Brawn et al. 2001). Within the United States, the amount of early successional habitat has been declining in the northeastern states (Trani et al. 2001), whereas the decline in southeastern states has been slower because of the dominance of industrial plantations (Trani et al. 2001). Early successional forests provided by industrial plantations may be important to the persistence of migratory birds that rely on this stage of vegetation for obtaining resources or breeding (Trani et al. 2001). Thus, understanding habitat use by birds within industrial forests is critical to the formulation and implementation of conservation strategies for these species.

American Woodcocks (*Scolopax minor*) are migratory shorebirds found in the eastern United States and southern portions of eastern Canada whose populations are experiencing declines across their range (Cooper and Parker 2009). Population declines have been linked to a decrease in early successional forests (Dessecker and McAuley 2001, Trani et al. 2001, Kelley et al. 2008) which provide breeding habitat (Keppie and Whiting 1994). Moreover, woodcocks use early successional vegetation at night during the winter and migratory periods for feeding and courtship rituals, which they initiate during spring migration (Keppie and Whiting 1994).

Although several studies have characterized habitats selected by woodcocks on their northern breeding range, less has been done to understand habitat utilization on their wintering grounds and migratory stopover sites (Roberts 1993, Kelley et al. 2008). Gathering information on winter and migratory habitat has been indicated as a research priority within the American Woodcock Conservation Plan (Kelley et al. 2008) and Priority Information Needs for American Woodcock (Case and Associates 2010). Specifically, less research has been completed in the Central Region, comprised of Ontario, the Great Lakes states, and states bordering the Mississippi River (Pace 2000, Cooper and Parker 2009).

Many industrial forests occur within the southern portion of the Central Region (Trani et al. 2001). Specifically, Arkansas, a southern state within the Central Region dominated by plantations of loblolly pine (*Pinus taeda*), has been indicated as a conservation priority for

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American Woodcocks (Myatt and Krementz 2007). Thus, opportunities exist to address the lack of information on American Woodcocks' winter and migratory habitat use in the Central Region, because Arkansas is used both as a wintering ground and migratory stopover site (Myatt and Krementz 2007). Prior research on habitat use in industrial forests has shown that woodcocks select 1–3 year-old clearcuts (Berdeen and Krementz 1998) and seedling and sapling pine (*Pinus* spp.) stands (Tappe and Whiting 1989, Roberts 1993, Krementz et al. 1995). However, these studies did not incorporate differences in detection caused by vegetation structure into their analyses. It has been shown that vegetative structure can influence the detection of woodcocks (Bergh 2011). Thus, assuming that detection is constant in studies comparing woodcock use or selection across different cover types could lead to spurious results. Similarly, past studies used a wide range of ages to classify pine stands. Although this does not detract from the utility of their results, pine stands grow rapidly (e.g., loblolly pines can grow 0.9–1.2 m/year) and thus tend to have a vegetative structure that shifts over small periods of time. We can narrow the age range of stands studied to possibly provide a clearer understanding of woodcock use of vegetation within early successional stands.

Previous studies that have focused on woodcock use of early successional pine stands defined only by age may be misleading as vegetation composition and structure can vary within stands of the same age based on other features such as site quality and soil type. Thus, the main goal of our research was to increase our understanding of the basic ecology of American Woodcocks in the Central Region by evaluating their use of specific vegetative features within early successional forests on an industrial plantation during spring in Arkansas. Specifically, our objectives were to determine the vegetation characteristics used by male woodcocks on their courtship sites within 1–5 year old pine stands and to account for differences in detection because of vegetative structure.

METHODS

Study Area.—We completed our study in Cleveland and Bradley Counties in Warren, Arkansas, USA. Our study site was located within the West Gulf Coastal Plain on an industrial forest bordered by the Saline River. Previous research indicates woodcocks use this portion of Arkansas during their fall migration, and it is within a high-priority management area for American Woodcocks (Myatt and Krementz 2007). Approximately 25% of the site was comprised of a plantation of loblolly pine, 36% of bottomland hardwoods that provide important diurnal cover (Hamel et al. 1982), and 39% of pines and mixed hardwood-pine stands.

Data Collection.—We sampled for American Woodcocks in three general stand ages which varied in their vegetative structure in 2010 and 2011. Pine-seedling stands were ≤ 1 year old with trees < 0.5 m, young-pine sapling stands were 2–3 years old with trees 1–1.5 m tall, and old-pine sapling stands were stands 4–5 years old with trees 1.5–3 m tall. Stands were located < 1 km from bottomland hardwoods and were > 5.5 ha, because woodcocks generally do not travel > 1 km from their diurnal grounds; bottomland hardwoods are their preferred diurnal sites; and, woodcocks use fields smaller than 5.5 ha less frequently than fields greater than 5.5 ha (Berdeen and Krementz 1998). We randomly selected stands from those meeting the above criteria using ArcGIS 9.3 (Environmental Systems Research Institute 2008). We sampled three replicates of each stand type in 2010 ($n = 9$) and five replicates in 2011 ($n = 15$). We sampled the same individual stands within 7–10 day sampling periods across the spring migration. In 2010, we sampled each stand six times, and in 2011 we sampled each stand 10 times. No stands surveyed in 2010 were resurveyed in 2011, thus each replicate represents a unique stand. Stands ranged from 29.4–57.1 ha in 2010 and 7.81–73.2 ha in 2011.

To determine habitat use, we used crepuscular surveys as an index to the number of woodcocks that used each stand (Glasgow 1958, Berdeen and Krementz 1998, Welch et al. 2001). Prior to completing surveys, we calculated the expected range of our detection of woodcocks in the three stand types. Previous studies assumed that the area in which the woodcocks' ''peent'' was audible during crepuscular surveys was five ha, regardless of vegetative structure (Berdeen and Krementz 1998). However, vegetative structure has been shown to impact detection of woodcocks (Bergh 2011). Emlen and DeJong (1981) suggest that detection threshold distances (DTDs; the distance in a natural setting where a bird song becomes inaudible) can be used to calculate detection areas (DAs). These detection areas can then be used to adjust counts of birds based on aural surveys. Although other methods to measure DAs have been suggested (Wolf et al. 1995, Bergh 2011), we chose to use the method detailed by Emlen and DeJong (1981) because of time and resource restraints. However, we feel that these measures provide a suitable indication of our ability to detect woodcocks within the three stand types we surveyed.

Prior to determining the DTDs for each stand, we wanted to examine if there was a difference in detection between the stand types. We completed our detection surveys of American Woodcocks in one randomly selected stand of each stand type. We used an Edge™ Mighty Predator Caller 3 (Explorer Expedite) to broadcast a recording of woodcocks ''peenting'' at 50 m, 67 m, 133 m, and 178 m from the stand edge. For each stand type, one observer was situated at the edge of the stand being surveyed while the second person stood at each distance playing the audio. We used a two-way radio to communicate with the observer when listening should begin, and the second person waited 3 sec before playing the recording. We repeated the survey in each stand stage 20 times at each distance. As the observer was told when to begin listening for the recording during each play, we wanted to assure that this did not bias the observer's results (e.g., indicating they heard the recording when they did not). Thus, to minimize observer bias associated with knowing the recording was to be played, we randomly played the recording during 10 of the 20 instances. Following these tests, we determined the DTDs in each stand type for woodcocks by having one person increase their distance from the observer and broadcast the recording of a woodcock ''peenting'' until it could no longer be heard. The audio was played two times with a series of four ''peents'' to account for distractions (e.g., wind). When the recording was inaudible, the person playing the audio walked towards the observer in five m increments until the recording was audible. We marked this location and measured the distance (m) from the point of inaudibility to the observer which provided the DTDs for each stand type. To minimize bias associated with various weather factors, we completed all detection surveys on the same day for each stand type within a 3-hr period prior to sunset and held the recording volume constant for all surveys.

We completed crepuscular surveys by situating one observer at the edge of a stand at least 20 min before sunset in the same, marked location each sampling period to allow for comparison among sampling periods. We randomly selected the standing location at each stand in ArcGIS 9.3 (Environmental Systems Research Institute 2008). We counted individual woodcocks seen flying into the stand or heard ''peenting'' from 20 min pre-sunset to 20 min post-sunset. However, most observations were aural as few woodcocks were seen entering the stands. We began surveys in mid-January in 2010 and in early-January in 2011.

We measured vegetation characteristics within each individual stand at six locations in 2010 and 10 locations in 2011 using a 1×1 m quadrat. We randomly selected locations within stands using ArcGIS 9.3 (Environmental Systems Research Institute 2008). We measured percent bare soil, standing herbaceous cover (herbaceous vegetation, including grass, with intact stems standing upright or mostly upright), flattened herbaceous cover (herbaceous vegetation, including grass, with broken stems lying parallel to the ground (Berdeen and Krementz 1998); and canopy cover within a 1×1 m quadrat. These variables have been shown to correlate with a woodcock's use of an area (Cade 1985). We used a density board to quantify horizontal density by placing the board at the edge of each plot and taking a picture from five m away at ground level. Using the photo, we calculated percent visual obstruction. We repeated this procedure on the opposite side and averaged the two values for each plot. We measured percent shrub cover and coarse woody debris using the line–intercept method along a 25 m tape extended from the corner of each quadrat perpendicular to the main road on the study site (Higgins et al. 1996). We classified the percent cover of all vegetative features into 10 equal classes from 0–100% (Higgins et al. 1996).

Analyses.—We used a χ^2 goodness of fit test to determine differences in the proportion of ''peent'' broadcasts heard, calculated as the number of broadcasts heard divided by 10 (the total number of broadcasts), at 50 m, 67 m, 133 m, and 178 m in pine seedling, young-pine sapling, and old-pine sapling stands. We completed statistical analyses in Program R (R Development Core Team 2005). We used the DTDs to calculate the DAs for each stand type as the area of a half circle around the observer.

We used the number of woodcocks within each stand sampled ($n = 24$) during the period of peak numbers of woodcocks (the sampling period with the highest number of woodcocks counted across all stands) in 2010 and 2011 as a measure of use for analyses. We did not include four stands in analyses, because they were not sampled during the peak period. We developed and evaluated 35 models including 33 *a priori* models, a null model with only the y-intercept, and a global model with all vegetative measures. We considered horizontal density (HORIZ_DEN), standing herbaceous (STAND), flattened herbaceous (FLAT), bare ground (BARE), shrub cover (SHRUB), coarse woody debris (CWD), and canopy cover (CANOPY) independent variables in the models. Because of limited vegetative measures, we did not evaluate models with interaction terms. We ran a generalized linear mixed regression in Program R with year as a random variable. We included the calculated DAs based on detection tests as an offset in the model. The offset adjusted the counts of woodcocks to the number of woodcocks/ha which allowed us to account for differences in detectability between stand types.

We used Akaike's Information Criteria (Akaike 1973) corrected for a small sample size (AIC*c*) to assess models and considered models with a ΔAIC*c* $\leq$ 2 to be competing models (Burnham and Anderson 2002). We used the model weights (w_i; Probability of a model being the best given the candidate models and data set) of each competing model to average model parameters and 95% confidence intervals (Burnham and Anderson 2002). We developed a prediction model by holding each variable constant at its mean while allowing one variable to vary to determine each variable's relative influence on woodcock use (Guthery and Bingham 2007).

RESULTS

We had no observer misidentification (e.g., hearing a ''peent'' during the 10 times out of 20 it was not played), thus observer bias associated with our sampling method for determining differences in detection relative to stand type was minimal. We detected 80% of the calls from woodcocks in pine seedling stands at 178 m, compared to 20% in young-pine saplings, and 0% in old-pine saplings (χ^2 = 16.8, $P < 0.001$). No differences were detected at 50 m, 67 m, or 133 m. Our measured DTD's for each stand type were 194 m, 178 m, and 136 m for pine seedling, young-pine sapling, and old-pine sapling stands respectively. Based on the DTDs, the calculated DA was approximately twice as large on pine seedling stands (5.91 ha) than old-pine sapling stands (2.91 ha), and young-pine sapling stands had a DA of 4.97 ha.

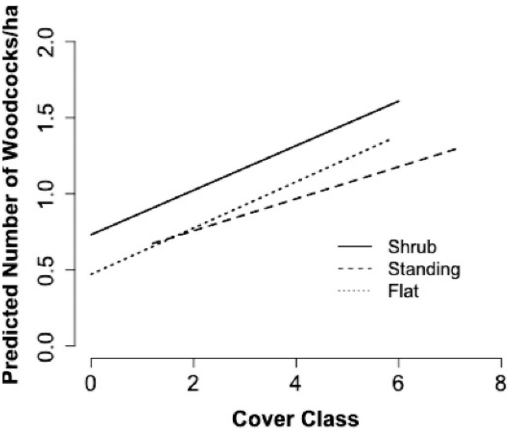

FIG. 1. The predicted number of American Woodcocks (*Scolopax minor*) per hectare as a function of Shrub, Standing herbaceous, and Flattened herbaceous cover class[a] from the logistic regression predictive model based on crepuscular surveys conducted in Warren, Arkansas, USA.

[a] Vegetative features were divided into 10 equal cover classes (0–9) based on percent cover from 0–100%.

Periods of peak woodcock use occurred from 17–27 January 2010 and 3–9 February 2011. Based on AIC*c* and model weight (w_i), our top model included the variable SHRUB (Table 1). Our w_i for this model was 0.22, indicating a 22% probability that this model provided us with the best explanation of woodcock use within industrial pine stands. We found one competing model which included the variables FLAT and STAND (Table 1). However, the w_i of this model indicated that it was approximately two times less likely to be our top model than the model containing only the variable SHRUB (Table 1).

No variables in our average model had a 95% confidence interval overlapping 0 and woodcock use was positively associated with SHRUB (β = 0.1462, 95% CI = 0.0425–0.2499), STAND (β = 0.1049, 95% CI = 0.0070–0.2029), and FLAT (β = 0.1519, 95% CI = 0.0304–0.2734).

The prediction model indicated a greater predicted number of woodcocks/ha with increasing SHRUB than STAND and FLAT (Fig. 1). Moreover, STAND appeared to be the least important variable of the three (Fig. 1).

DISCUSSION

We found that woodcock use of courting sites in Arkansas was positively associated with shrub,

TABLE 1. *A priori* models and the associated number of parameters (K), Akaike's Information Criteria corrected for small sample size (AIC*c*), delta AIC*c* (ΔAIC*c*), and model weights (w_i) of habitat use by American Woodcocks (*Scolopax minor*) relative to shrub cover (SHRUB), standing herbaceous (STAND), flattened herbaceous (FLAT), canopy cover (CANOPY), bare ground (BARE), coarse woody debris (CWD), and horizontal density on plantations of loblolly pine based on crepuscular surveys conducted in Warren, Arkansas, USA.

Model	K	AIC*c*	ΔAIC*c*	w_i
SHRUB	3	45.89	0.00	0.22
FLAT + STAND	4	47.48	1.60	0.10
CANOPY	3	48.19	2.31	0.07
CANOPY + FLAT	4	48.58	2.70	0.06
SHRUB + STAND	4	48.66	2.78	0.05
FLAT	3	48.87	2.99	0.05
BARE + SHRUB	4	48.98	3.10	0.05
SHRUB + CANOPY	4	49.03	3.14	0.05
HORIZ_DEN + SHRUB	4	49.03	3.15	0.05
BARE + STAND + FLAT	5	49.36	3.48	0.04
Null	2	49.93	4.04	0.03
STAND	3	50.08	4.19	0.03
BARE + FLAT	4	50.59	4.70	0.02
HORIZ_DEN + FLAT	4	50.60	4.72	0.02
BARE	3	50.88	4.99	0.02
BARE + STAND + FLAT + CANOPY	6	51.04	5.16	0.02
BARE + CANOPY	4	51.08	5.20	0.02
HORIZ_DEN + CANOPY	4	51.16	5.27	0.02
CANOPY + CWD	4	51.33	5.45	0.01
HORIZ_DEN	3	51.37	5.49	0.01
HORIZ_DEN + FLAT + STAND	4	51.48	5.60	0.01
FLAT + HORIZ_DEN + CANOPY	5	51.90	6.01	0.01
SHRUB + STAND + CWD	5	52.28	6.39	0.01
CWD	3	52.30	6.41	0.01
BARE + SHRUB + CANOPY	5	52.56	6.67	0.01
BARE + SHRUB + CWD	5	52.58	6.69	0.01
HORIZ_DEN + SHRUB + CANOPY	5	52.62	6.73	0.01
HORIZ_DEN + STAND	5	52.85	6.96	0.01
BARE + STAND	4	53.24	7.35	0.01
BARE + CWD	4	53.65	7.76	0.00
BARE + HORIZ_DEN	4	54.04	8.16	0.00
HORIZ_DEN + CWD	4	54.36	8.48	0.00
BARE + STAND + HORIZ_DEN	5	54.77	8.88	0.00
STAND + FLAT + CANOPY + SHRUB + CWD	7	58.46	12.57	0.00
Global	9	60.49	14.61	0.00

standing herbaceous, and flattened herbaceous cover. These vegetative features were characteristic of old-pine sapling and young pine-sapling stands. Our findings differed from previous studies in Louisiana, eastern Texas, and Georgia in which woodcocks were found in areas with light ground cover and increased bare soil (Glasgow 1958, Boggus and Whiting 1982, Berdeen and Krementz 1998). Specifically, our predictive model indicates that woodcock use within the stands is greatest when standing herbaceous cover is between 70–80%, and flattened grass and shrub cover is between 50–60% (Fig. 1). Krementz (2000) suggested that patchiness is an important factor in determining whether or not woodcocks select an area for courtship activity. Thus, it is likely that woodcocks require a combination of flattened herbaceous cover to provide openings for courtship and standing herbaceous and shrub cover to provide refuge from predators (e.g., owls, bobcats, and coyotes). Moreover, bare ground may not be as important as previously thought. We suggest that flattened herbaceous cover may provide the same benefits (e.g., flat areas for landing during courtship flights) as bare ground and that the benefits of increased shrub and standing herbaceous cover for refuge from predators may outweigh the benefits of increased bare ground.

Because increased shrub cover and standing herbaceous vegetation was typical of old-pine and young-pine sapling stands, our study also differed from research on courtship site use in Texas indicating that woodcocks have a greater association with pine seedling stands than pine sapling stands (Tappe and Whiting 1989). These differences are likely because Tappe and Whiting (1989) did not adjust their counts of woodcocks based on detectability. We suggest future studies that use crepuscular surveys to monitor woodcocks within areas of different structure incorporate detectability into their final counts to gain an accurate depiction of woodcock use.

These results have increased our understanding of the basic ecology of American Woodcocks and have implications for management of industrial forest stands for woodcocks to meet the requirements of programs such as the Sustainable Forestry Initiative. Prior to this research, pine seedling stands were considered to be of greater importance to woodcock use than pine sapling stands. However, our study has elucidated the importance of 2–5 year old stands to woodcocks. We suggest managers of large or small scale industrial pine plantations may want to alter their rotation to assure sufficient stands exist in the 2–5 year old age class. However, we did not quantify the number of stands in the 2–5 year old age class that would achieve maximum woodcock use in an area or the optimal configuration of stands for woodcock use in this study. We recommend future research focus on better understanding these relationships.

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