Microhabitat Characteristics of Nocturnal Roost Sites of American Woodcock in East Texas

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Abstract: Long-term declines in American woodcock *(Scolopax minor)* populations may be partially the result of low survival rates on wintering grounds especially in nocturnal habitats. We compared microhabitat characteristics of woodcock nocturnal roost sites to random sites in eastern Texas. We located woodcock roost points by nightlighting in winters of 2000–01 (45 points) and 2001–02 (74 points). Percentage bare soil, sapling-size tree canopy cover above 0.5 m, and sapling density were greater at roost than random sites. Conversely, shrub ground cover (i.e., below 0.5 m) was lower at roost than random sites. Woodcock roosted in mowed areas, unmowed bunchgrass, under saplings treated with herbicides the previous summer, and in areas where carpetgrass had been burned the previous winter. They did not roost in unburned carpetgrass. In eastern Texas, woodcock nocturnal roost sites can be created in abandoned fields and pastures by mowing or the judicious use of herbicides and/or prescribed fire.

Key words: American woodcock, nocturnal roost sites, old fields, prescribed fire

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The American woodcock *(Scolopax minor)* is a popular game bird in the eastern and northeastern United States. For management purposes, the range of the woodcock is divided into the Eastern and Central regions. In both regions, annual singing-ground surveys have suggested long-term (1968–2000) population declines (Kelley 2000). Although these declines are in part due to range-wide habitat loss (Kelley 2000), low survival rates on the wintering grounds (Krementz et al. 1994, Pace 2000) may also be a factor. If so, winter survival may play a crucial role in recruitment potential of the species (Krementz et al. 1994). Regardless, better understanding of woodcock habitat use on the wintering grounds is essential to properly manage this species.

On the wintering range, woodcock typically use different habitats for diurnal and nocturnal cover. Diurnal habitat typically consists of dense forested thickets with sparse ground cover (Boggus and Whiting 1982). Nocturnal areas generally consist

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of open-field habitats such as clearcuts and old fields (Horton and Causey 1979, Krementz et al. 1995, Berdeen and Krementz 1998). Approximately 43% of woodcock in an area move between diurnal habitat and nocturnal habitat each day (Horton and Causey 1979, Krementz et al. 1995). During winter, nocturnal sites are used primarily for feeding (Connors and Doerr 1982, Stribling and Doerr 1985, Krementz and Jackson 1999), roosting (Connors and Doerr 1982), and conducting courtship displays (Tappe et al. 1989).

Woodcock use certain open-field habitat types more frequently than others for nocturnal activities (Horton and Causey 1979, Krementz et al. 1995, Berdeen and Krementz 1998). However, the specific reasons woodcock choose such fields are not well understood. Furthermore, there is scarce information pertaining to the specific habitat components at preferred nocturnal sites. Additional information concerning the characteristics of nocturnal sites is needed to better manage this species on a local scale. We hypothesized that microhabitat characteristics of nocturnal roost sites used by American woodcock differed from those at random sites in the Pineywoods Region of eastern Texas.

Methods

This study was conducted on the Alazan Bayou Wildlife Management Area (ABWMA) in Nacogdoches County, Texas. Alazan Bayou, an 835-ha area managed by the Texas Parks and Wildlife Department (TPWD), is in the Pineywoods Vegetation Region (Gould 1962). The climate in this area is humid and subtropical with approximately 114 cm of annual precipitation. The average ambient temperature ranges between 18 and 19 C (Larkin and Bomar 1983). Most soils on ABWMA are in the Attoyac, Bernaldo-Besner, and Woden series. These soils are very deep, well drained, fine sandy loams. The surface layers are slightly-to-moderately acidic and natural soil fertility is moderate (Dolezel and Fuchs 1980). At the time of this study, approximately 243 ha of the ABWMA was in old-field habitat; the remainder was comprised of bottomland hardwood forests in the Angelina River floodplain. The upland portion of the old-field habitat was classified as a mesic abandoned pasture; plants common on the area included southern dewberry *(Rubus trivialis)*, yellow woodsorrel *(Oxalis dillenii)*, perennial ryegrass *(Lolium perrene)*, and common bermudagrass *(Cyodon dactylon)* (Quine 2000).

Searches were conducted 3–4 nights per week during 1 December 2000–15 March 2001 and 13 November 2001–15 March 2002. Woodcock were captured by nightlighting, banded, aged, sexed, and weighed, then each bird was released at the capture site. Roost points (capture and non-capture locations) were marked for subsequent habitat measurements.

Microhabitat variables were measured around each roost point (i.e., roost site) and around an associated random point (i.e., random site). The direction between the points was randomly selected, but in an attempt to keep both points in the same macrohabitat, the distance between them was set at 30 m. Variables measured included ground cover, canopy cover, and woody plant density. We gathered data to evaluate ground cover in the stratum below 0.5 m using the point quadrat technique (Hays et al. 1981). We used a 10-point pin frame with 10 cm between points at nine locations associated with each roost or random point. One location was directly over the point and the remaining locations were at 1 and 2 m from the respective point in each cardinal direction; the pin frame was positioned perpendicular to a tape stretched in the cardinal direction. Each pin was lowered from a height of 0.5 m. We recorded every piece of vegetation touched by the pin, thus multiple touches could be recorded for each pin. We categorized vegetation as grass, herbaceous plant, woody plant, or vine. We recorded the last item that the pin encountered as litter, soil, or by vegetation category if the pin touched the base of a plant. We converted all ground cover data to percentages for analyses.

We estimated canopy cover above 0.5 m using the line-intercept method. We extended a tape 5 m in each cardinal direction from the roost or random point and recorded species and intercept length (cm) of each plant >0.5 m tall and directly above the tape. We placed plants into one of the aforementioned general vegetation categories except that woody plants with a multiple stem growth form were categorized as shrubs and those with a single stem as trees (Hardin et al. 2001). Finally, we centered a 0.04-ha circular plot on the roost or random point and recorded number of woody stems ≥2 cm diameter at breast height (dbh).

Soil parameters evaluated at each site included soil type, texture, moisture content (%), organic matter content (%), pH, and macronutrient concentration (parts per million) (Ponge et al. 1999). We used a 186-cm^3 impact sampler to collect a soil sample at each roost and random point on the same night as the roost point was located. We determined soil type and texture for general areas around roost and random points from Nacogdoches County Soil Survey maps (Dolezel and Fuchs 1980). In the lab, we weighed soil samples and oven-dried them at 105 C to a constant weight. We calculated moisture content by dividing the oven-dried weight by the wet weight of the sample. Soil samples were further analyzed by the Stephen F. Austin State University Agriculture Lab to determine the pH, percentage organic matter, and macronutrient concentration.

We used multivariate analysis of variance (MANOVA) tests to examine for differences in vegetation and soil parameter means between roost and random sites. Multiple MANOVA tests were conducted to test for differences by year, age, and sex (SAS 1999). As we used MANOVA, we did not test the data for normality because nonnormality does not affect the test criteria (Olson 1976). Likewise, as roost and random points had equal replications, we did not test for homogeneity of dispersal matrices (Ito 1969). Except for ground cover, we arc-sine transformed all percentage data. As ground cover values could exceed 100%, transformation was not necessary (D.W. Coble, College of Forestry, Stephen F. Austin State University, pers. commun.). The rejection level was set at 0.05 for all tests.

Results

In early winter 2000–01, we searched privately-owned fields for roosting woodcock without success. In late December we began searching ABWMA and recorded the first roost point on 1 January 2001; the last of 45 points (28 capture, 17 non-capture) was recorded on 15 February. Nine captured birds were subadult females, 10 were adult females, 2 were subadult males, and 6 were adult males; an adult male was captured twice. Although all old-field habitat on the ABWMA was searched, all roost points were on a stream terrace along Murvall Creek which bisects the management area. Six points were in a mowed area, 10 points were in an unmowed wet area dominated by bunchgrasses, primarily broomsedge *(Andropogon virginicus)* and several species of rushes (*Juncus* spp.) and sedges (*Carex* spp.), and the remaining 29 points were under dead sapling-size Chinese tallowtrees *(Triadica sebifera)* which had been treated with herbicide the previous summer. The herbicide created a small area void of vegetation under each tree except for a carpet of sprouting perennial ryegrass.

In 2001–02, all searches were conducted on ABWMA. The first of 71 woodcock was captured on 13 November 2001 and the last on 4 February; only 3 non-capture points were recorded. There were 17, 21, 19, and 14 subadult females, adult females, subadult males, and adult males captured, respectively. During summer 2001, TPWD burned 36 ha of old-field habitat on an upland site. Although the burn was spotty, it created numerous patches of bare soil and sparse ground vegetation; sapling-size trees were scattered throughout the burned area. Thirty-seven roost points were in the burned area. The remaining points were in the mowed area (20) and under tallowtrees (17) on the stream terrace. No birds were recorded in the bunchgrass area, which was drier than in 2000–01.

Vegetation and soil parameters at woodcock roost sites differed between years (Wilks $\lambda = 0.405$, $F_{27, 216} = 11.77$, $P < 0.001$). Therefore, we examined the data separately by year. Woodcock did not select sites differentially based on sex (2000–01: Wilk's $\lambda = 0.749$, $F_{16,37} = 0.77$, $P = 0.704$; 2001–02: Wilk's $\lambda = 0.883$, $F_{17,130} = 1.02$, $P = 0.446$) or age (2000–01: Wilk's $\lambda = 0.688$, $F_{16,37} = 1.05$, $P = 0.436$; 2001–02: Wilk's $\lambda = 0.865$, $F_{17,130} = 1.19$, $P = 0.282$). Therefore, we pooled vegetation and soil data to include all woodcock roost sites each year.

In 2000–01, habitat characteristics at woodcock roost sites were not different from those at random sites (Wilk's $\lambda = 0.608$, $F_{26, 63} = 1.56$, $P = 0.077$). However, as our sample size was relatively small and the *P*-value approached the preset alpha value (0.05), individual univariate ANOVAs below that level are reported, but must be viewed with caution. Percent bare soil (Table 1), intercept lengths of grass and tree canopy covers above 0.5 m, number of woody stems ≥2 cm dbh per 0.04-ha plot (Table 2), and percentage soil moisture (Table 3) were greater at roost sites than at random sites. Percentage shrub cover in the stratum below 0.5 m (Table 1) and potassium ion concentration (Table 3) were greater at random than roost sites.

In 2001–02, there were differences between roost sites and random sites (Wilk's $\lambda = 0.717$, $F_{26, 129} = 1.96$, $P = 0.007$). Percentages of bare soil and herbaceous covers in the stratum below 0.5 m (Table 1), length of tree canopy cover, number of woody stems ≥2 cm dbh per 0.04-ha plot (Table 2), and sulfur ion concentration (Table 3) were greater at woodcock roost sites than at random sites. Conversely, percentages of litter and shrub covers in the stratum below 0.5 m were lower at roost than random sites (Table 1).

Table 1. Mean percentage (± SE) ground cover (i.e., the stratum 0.00–0.50 m above ground level) by category at American woodcock nocturnal roost sites and random sites on Alazan Bayou Wildlife Management Area, Nacogdoches County, Texas, winters 2000–01 and 2001–02. Data were gathered using the point quadrant technique and analyzed using MANOVA.

Variable	Roost	Random	*P*-value
2000–01 (*N* = 45)			
Litter	82.07 (2.92)	89.31 (2.52)	0.064
Bare soil	13.58 (2.42)	5.83 (1.60)	0.009
Grass	27.80 (3.35)	28.12 (2.77)	0.941
Herbs	9.23 (1.44)	11.14 (1.58)	0.376
Shrub	9.33 (1.55)	16.09 (2.28)	0.016
Vine	0.22 (0.13)	1.85 (1.04)	0.123
Total plant	46.88 (4.51)	53.70 (4.04)	0.263
2001–02 (*N* = 74)			
Litter	75.80 (2.75)	83.55 (2.54)	0.040
Bare soil	23.35 (2.75)	15.00 (2.27)	0.020
Grass	18.46 (1.80)	21.94 (3.20)	0.345
Herbs	9.44 (0.88)	6.60 (0.77)	0.016
Shrub	3.93 (0.76)	11.00 (2.37)	0.005
Vine	0.48 (0.18)	0.85 (0.34)	0.337
Total plant	32.82 (2.18)	40.67 (3.86)	0.078

Table 2. Mean (± SE) intercept length (cm) by vegetation category at American woodcock nocturnal roost sites and random sites on Alazan Bayou Wildlife Management Area, Nacogdoches County, Texas, winters 2000–01 and 2001–02. Number of woody stems ≥2 cm dbh per 0.04-ha plot and average dbh of those stems are also shown. Data were gathered using the line intercept method and analyzed using MANOVA.

Variable	Roost	Random	*P*-value
2000–01 (*N* = 45)			
Grass	25.29 (9.55)	4.80 (2.07)	0.039
Herbaceous	24.09 (6.36)	42.76 (8.00)	0.071
Shrub	49.58 (17.45)	73.96 (34.85)	0.533
Tree	418.76 (63.09)	186.22 (49.23)	0.005
Vine	5.38 (2.46)	37.78 (16.31)	0.053
N woody stems	27.11 (2.25)	17.33 (2.42)	0.004
DBH (cm)	6.16 (0.40)	5.61 (0.39)	0.321
2001–02 (*N* = 74)			
Grass	6.64 (3.27)	23.76 (9.78)	0.099
Herbaceous	81.74 (15.80)	144.05 (31.80)	0.081
Shrub	70.78 (14.91)	69.92 (20.61)	0.973
Tree	287.50 (49.59)	147.40 (42.81)	0.034
Vine	33.79 (9.47)	62.39 (24.95)	0.285
N woody stems	13.96 (2.10)	7.72 (1.25)	0.012
DBH (cm)	4.30 (0.38)	3.97 (0.40)	0.549

Table 3. Soil characteristics (± SE) at American woodcock nocturnal roost points and random points on the Alazan Bayou Wildlife Management Area, Nacogdoches County, Texas, winters 2000–01 and 2001–02. Data were analyzed using MANOVA.

Variable	Roost	Random	*P*-value
2000–01 ($N = 45$)			
Calcium (ppm)	1043.62 (103.90)	958.88 (96.64)	0.552
Magnesium (ppm)	165.88 (9.43)	159.61 (9.26)	0.636
Phosphorus (ppm)	48.14 (3.47)	39.44 (3.19)	0.068
Potassium (ppm)	89.73 (8.77)	113.62 (7.56)	0.042
Sodium (ppm)	320.39 (5.95)	307.40 (4.35)	0.082
Sulfur (ppm)	81.51 (4.22)	68.88 (5.10)	0.060
pH	5.22 (0.08)	5.39 (0.08)	0.140
Organic matter (%)	2.88 (0.09)	2.66 (0.12)	0.103
Soil moisture (%)	24.15 (0.48)	21.11 (0.69)	< 0.001
2001–02 ($N = 74$)			
Calcium (ppm)	1071.01 (146.09)	1023.19 (66.71)	0.766
Magnesium (ppm)	150.15 (10.27)	162.69 (11.92)	0.426
Phosphorus (ppm)	97.74 (17.00)	85.82 (12.73)	0.576
Potassium (ppm)	123.59 (9.52)	135.31 (9.44)	0.383
Sodium (ppm)	296.77 (7.92)	290.83 (6.58)	0.565
Sulfur (ppm)	61.44 (1.83)	56.37 (1.39)	0.029
pH	5.25 (0.06)	5.36 (0.06)	0.191
Organic matter (%)	3.25 (0.16)	3.44 (0.17)	0.399
Soil moisture (%)	18.51 (0.84)	17.18 (0.72)	0.328

Discussion

Our data indicate that most woodcock which roosted on ABWMA used sites with bare soil and canopy cover as provided by bunchgrasses or sapling-size trees. Similarly, woodcock in the Georgia Piedmont commonly used fields with bare soil and high foliar volume in the 0.8–2.0 m stratum (Berdeen and Krementz 1998). Those authors suggested that the volume of vegetation in that height range was more crucial for woodcock selection of nocturnal fields than the amount of bare soil. In eastern Texas, woodcock foraging increased proportionally with both the amount of bare soil and foliage density in the 0.26–0.75 m level (Boggus and Whiting 1982). Such habitat characteristics likely provide protection from avian predators while allowing woodcock to forage.

Our results suggest that type of ground cover and structure of canopy cover are critical to use by woodcock. In each year, percentages of grass in the ground cover (i.e., below 0.5 m) at roost and random sites were similar. However, in 2000–01, when some roost points were in bunchgrass, intercept length of grass canopy cover (i.e., above 0.5 m) was higher at roost sites than random sites. Conversely, although the values did not differ in 2001–02 when no points were in bunchgrass, grass canopy cover was much lower at roost sites than random sites. Structure of bunchgrasses allowed woodcock to forage between the clumps and the canopy provided protection from aerial predators. The bunchgrasses also were an excellent source of low acidity litter for earthworms (Curry 1998). No roost points were recorded in unburned bermudagrass either winter. Apparently the growth form of the carpet-forming bermudagrass inhibited use by woodcock.

Ground cover of shrubs was lower at roost than random points, and the opposite relationship existed for canopy cover of trees. These results also were related to type of ground cover and the structure of the canopy cover. Low-growing shrubs would impede movement by woodcock whereas canopy cover by sapling-size trees would offer overhead protection. Although trees on the burned upland site were widely scattered, woodcock often selected roost points near a tree.

There is a point where too much bare soil coupled with lack of overhead cover deters use by woodcock. Disked strips on ABWMA near where woodcock were recorded each year were searched regularly, but no birds were observed. In Virginia, woodcock did not use croplands that had been tilled and the residual vegetation removed; however, the birds did use croplands that had residual vegetation and furrows (Krementz et al. 1995). The removal of all vegetation/crop residue from an area by disking or other agricultural activities likely leaves woodcock overly exposed to predation. Additionally, tilling the soil may affect earthworm abundance near the soil surface. Disking may move the food resources of earthworms down into the soil profile (Curry 1998) thus beyond the reach of a woodcock's bill. The lack of woodcock in the disked strips on ABWMA may have been due to the lack of cover and food.

Woodcock selected roost sites with higher soil moisture than random sites in 2000–01 but not in 2001–02. Although percent soil moisture was lower at both roost and random sites in 2001–02 than in 2000–01, moisture levels were within the levels reported to be optimum (15%–80%) for earthworms (Reynolds et al. 1977). The lower moisture values and the lack of difference between roost and random sites in the latter winter was probably due to the addition of the upland area. This area was well drained, and the clay content of the soil was lower than that of the streamside terrace (Dolezel and Fuchs 1980). Changes in soil and vegetative properties resulting from the fire were probably more important than soil moisture in attracting woodcock to the upland site.

Kroll and Whiting (1977) found potassium to be an important predictor of woodcock diurnal habitats. Soils in good habitat had 56.4 ± 3.8 ppm potassium, whereas poor habitat had 84.7 ± 14.1 ppm. In our study, both roost and random sites had higher potassium levels than Kroll and Whiting (1977) found in poor woodcock habitat. These findings suggest that soils on ABWMA were not optimal for use by woodcock. The birds probably roosted on ABWMA because there was no other suitable nocturnal habitat within at least 1000 m (Glenn 2003).

The sulfur ion content was higher at roost sites than at random sites in 2001–02. The reason for this is unknown. However, the prescribed fire on the upland site may have released a large amount of sulfur stored in the vegetation. Nutrients not volatized by a fire translocate downward into the soil, resulting in a net gain in nutrient content (Wright and Bailey 1982). Woodcock roost points on the upland site were usually in areas that had been burned to the mineral soil or that had minimal amounts of litter remaining. These areas may have been higher in sulfur than random sites, some of which were in unburned areas. Regardless, sulfur is not considered an important chemical factor that influences earthworm abundance (Curry 1998).

Neither calcium, magnesium, phosphorus, and sodium ion concentration nor pH and percent organic matter differed between roost and random sites either year. Soils of the entire old-field habitat on the ABWMA were derived from the same parent material, thus differences in soil texture and horizon depth were relatively minor (Dolezel and Fuchs 1980). Additionally, Kroll and Whiting (1977) reported that neither calcium nor magnesium was significant in determining good woodcock habitat, and the pH levels we recorded were in the optimal range (5.0–7.4) for most temperate earthworm species (Curry 1998).

Management Implications

This study demonstrated the importance of proper vegetative structure to use of nocturnal roost sites by American woodcock. Ground cover must be somewhat open, thus allowing the birds to move. Overhead cover should offer some protection but not be so thick as to impede flight. Mowing, herbicides, and fire can be used to create such conditions.

Woodcock will roost in old-field habitats dominated by unmowed bunchgrasses. However, mowing may be necessary in old fields dominated by other types of vegetation. Also, herbiciding undesirable sapling-size trees will create roost sites under such trees if ground cover is not too dense. Prescribed fire is a useful tool for creating nocturnal roost sites for woodcock, especially if sapling-size trees are present in the burned area. In this study, the elimination of carpetgrass and litter by fire provided roost sites for half the birds recorded in 2001–02. No birds were recorded in that area during the winter prior to the fire. In Georgia, Welch et al. (2001) recorded more roosting woodcock in a burned strip than in any other strip sampled.

We did not investigate the impact of mowing or burning bunchgrass or mowing carpetgrass on roost site selection by woodcock. However, either activity would probably improve roosting habitat. Conversely, herbiciding densely vegetated old fields would probably result in thick layers of dead vegetation and thus not improve roosting habitat. However, prescribed fire would eliminate the dead vegetation and if soil conditions and overhead cover were adequate, woodcock likely would roost in such areas.

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