WOODCOCK SINGING GROUNDS AND DIURNAL HABITAT IN NORTH CENTRAL OKLAHOMA

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ABSTRACT

The use of tall grass prairie singing sites and associated diurnal habitat by American woodcock was analyzed on the Oklahoma State University Ecology Preserve near Stillwater, Payne County, Oklahoma. The effect on woodcock use of breeding display habitat via artificially creating singing sites by mowing was observed in conjunction with an extensive study of display behavior. Woodcock preferred sparsely vegetated singing sites, regardless of their floral composition, aspect, shape, size, area, perimeter, soil texture, and pH. Preferred singing sites were well drained, had moderate slopes and were close to water or diurnal cover. Distances between singing grounds ranged from 150 to 300m. The mowing of plots proved successful in setting back succession and creating new display sites. The essential components of diurnal habitat were moderately dense overstory and understory, adequate ground cover, and moist loamy soil. Overgrazing appeared to be incompatible with good diurnal woodcock cover.

INTRODUCTION

The American woodcock, *Philohela minor* (Gmelin), has traditionally been considered a rare transient in Oklahoma by authorities such as Nice (1931), Force (1929), and Fletcher and Temple (1942), Baumgartner and Howell (1948) and Sutton (1968). On 27 February 1970, Barclay discovered a small population of woodcock displaying on eroded tallgrass prairie sites 14.5km west of Stillwater, Oklahoma, on the Oklahoma State University Ecology Preserve. Woodcock display behavior had not been recorded in Oklahoma prior to the present study. The presence of the local population, far from traditional breeding and wintering grounds (Sheldon 1967), thus led to investigation of breeding behavior and habitat use each spring through 1975. This paper documents only that portion of the study which evaluated woodcock habitat on the Ecology Preserve.

Displays on the study area were observed as early as 26 December in 1971, under unseasonably warm temperatures. However, subsequent displays were not encountered again that winter until 12 February, 1972. Other than the above exception, display initiation dates ranged from 26 January (1971) to 12 February (1972). The earliest date of termination of courtship activity was 11 March (1974) and the latest was 8 April (1970). Display season length ranged from 38 days (1974) to 59 days (1973). On 7 April, 1973, a woodcock hen with a 10 day old chick was observed on the area. The chick was captured and banded as the only confirmed nesting record for the Preserve.

Mendall and Aldous (1943) had remarked that no woodcock breeding records were available for Oklahoma in the 25 years prior to 1943. However, as Leopold (1933) noted, valuable insights relative to biological tolerance and habitat requirements of a species can be obtained on the periphery of its range. Thus, the presence of breeding woodcock on the western fringe of its range afforded a unique research opportunity in terms of woodcock population ecology and management.

The objectives of that portion of the study reported here were to: (1) analyze the characteristics of woodcock singing grounds and diurnal habitat on the Oklahoma State University Ecology Preserve; and (2) observe the response of a small woodcock breeding population to manipulation of habitat by artificially creating singing sites by mowing.

The project was funded by the Rob and Bessie Welder Wildlife Foundation of Sinton, Texas. We wish to thank James Lewis, Acting Leader, Oklahoma Cooperative Wildlife Research Unit, for reviewing the manuscript; James McPherson, Associate Professor, School of Biological Sciences, Oklahoma State University, for helping mow plots on the study area and for assisting in the vegetative analyses; and the Oklahoma Cooperative Wildlife Research Unit for the use of vehicles and other equipment.

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STUDY AREA

The study area was the 62.3 ha Oklahoma State University Ecology Preserve, located 14.5km west of Stillwater near Highway 51 in a region of gently rolling tallgrass prairie interspersed with broken tracts of brush and scrub oak forest (savannah). Bottomland hardwoods occurred close to the larger drainages. Lands adjacent to the Preserve were quite similar in respect to topography, soils, and vegetation but, unlike the Preserve, were severely overgrazed for the duration of the study. Bottomland hardwoods on the study area consisted mostly of chinkapin oak (see Appendix A for scientific names), American elm, red mulberry and eastern redbud. The dominant upland hardwoods included post oak, blackjack oak, American elm and hackberry. The brushlands were dominated by greenbriar, roughleaf dogwood, blackjack oak, red cedar and native grasses. The grasslands, which in 1968 were removed from all but incidental grazing, consisted primarily of Indian grass, big bluestem, little bluestem, split-beard bluestem and silver bluestem. Harrington Creek, a small seasonal stream, drained northeasterly across the Preserve. A one ha pond was located in the northeast corner of the Preserve. The mean annual temperature and precipitation for the study area are 60° F and 81cm., respectively. The average annual frost-free growing period is 210 days. Weather extremes are common and exert a limiting effect on many species of plants and animals in the region.

METHODS

Circular to oval plots 18m in diameter were mowed with a brushog in the brushland and grassland areas of the Preserve in 1974 and 1975 in order to test the response of displaying woodcock to habitat manipulation. The plots were observed periodically throughout each breeding season and, if used by woodcock, subjected to the analyses described below.

Natural and artificial (mowed) singing sites used by woodcock on the study area were analyzed and compared to controls, i.e., arbitrarily selected "unused" sites in identical habitat adjacent to used sites. Habitat parameters analyzed were vegetative (general composition, aerial density at three different height intervals and vegetative density at ground level), spatial (distance between singing grounds, distances from singing grounds to water or diurnal cover and ecotone), physical (size, perimeter, area, slope, aspect and elevation) and soil (pH, moisture, texture).

The five different terms selected to describe the existing categories of potential singing sites on the upland prairie habitat of the study area included: used eroded, unused eroded, used mowed, unused mowed and unused native prairie. Eroded sites were once either highly overgrazed or used as salting areas for cattle, and consequently were characterized by weedy plants and bare soil. Mowed sites were located on upland grass or brush areas. Unused "native prairie" sites were healthy grassland areas which had either never been eroded or had recuperated from such erosion. All grassland areas except one near the creek had been cultivated prior to 1938 when they were allowed to revert to natural vegetation and used for pasture.

The vegetative composition of singing sites was determined with a point sampling frame. The frame was placed at 15 randomly selected points at each singing site, the first vegetative part of a plant touched by each point on the frame being recorded as an individual of that species.

A density board was used to measure aerial (vertical) density of vegetation on each site at six 10cm height intervals (only the first three intervals provided sufficient data for analysis). There were 40 squares (each 1cm by 1cm) at each of the six height intervals. The density board was placed randomly at 30 different locations on each site. The number of squares obscured by vegetation at each interval as observed from approximately 1m away were recorded.

A point sample frame was also used to determine vegetative density at ground level and percent exposed soil and litter at each site. Vegetative density at ground level was defined as the percent of a site occupied by vegetative stems. whereas aerial density dealt with the obscuring effect of vegetation at a site.

Distances between singing sites; distances from singing sites to water, to edge and to diurnal cover; and area and perimeter of singing sites were determined by pacing or by measuring aerial photos or maps. Slope and aspect were measured with a protractor and compass. Elevation was estimated from a topographic map. Soil pH at each site was measured with a Beckman pH meter. Other soil characteristics (texture, moisture, friability) were subjectively evaluated.

Periodic searches of bottomland and upland hardwood habitat on the study area were made each year but intensified in 1974 and 1975 to determine characteristics of the diurnal cover used by woodcock. When woodcock or sign of woodcock were found, major habitat features were recorded.

RESULTS

Singing Ground Analyses. Analyses of variance revealed that unused native grass sites had significantly greater ($P \leq 0.05$) ground and aerial vegetative density values at all three height intervals than did the eroded and mowed sites used by woodcock. The average site density values are summarized in Table 1. There were no significant differences ($P \leq 0.05$) between used mowed and used eroded sites, nor were there significant aerial density differences ($P \leq 0.05$) between used mowed sites and unused mowed sites because of the similar mowing procedure on each type. The spacing influence of territorial behavior by woodcock and other physical site characteristics discussed below appear to have been responsible for the preferred use of certain mowed sites as opposed to unused mowed sites. Since we deliberately mowed more sites than were likely to be used the social aspect was probably more influential. Eroded sites used by woodcock were slightly more ($P \leq 0.10$) densely vegetated at the first level (0-10cm) than were eroded unused sites, suggesting a preference by woodcock for subtle specific density conditions near ground level.

Table 1. Average aerial vegetative density results (percent) for sites analyzed on the Oklahoma State University Ecology Preserve.

	Percentages of Squares Obscured by Vegetation		
Type and Number of Sites ( )	*First Level (0-10cm) interval*	*Second Level (10-20cm) interval*	*Third Level (20-30cm) interval*
Eroded Sites			
Used (6)			
range	30-57	1-15	0.5-7
average	44.3	2.5	0.6
Unused (6)			
range	19-52	1-14	0-2.6
average	32.7	8.0	1.3
Mowed Plots			
Used (5)			
range	35-51	0-12	0-7
average	44.0	4.6	1.6
Unused (5)			
range	23-53	1.9-4.7	0-1.3
average	43.4	3.7	0.6
Control Plots			
Unused Native Prairie (4)			
range	60-82	6-39	2-14
average	73.0	26.5	9.8

The vegetative density at ground level on used singing sites was much less than on unused sites (Table 2). Unused native grass sites had significantly less ($P \leq 0.05$) vegetative litter and bare soil (Table 3) than did eroded or mowed sites used by woodcock. Virtually no difference in litter and bare soil existed between eroded used and eroded unused sites. Mowed used sites had more ($P \leq 0.10$) bare soil and litter than mowed unused sites. Used mowed sites also had more litter and exposed soil ($P \leq 0.10$) than did the used eroded sites. Although significant to only 0.10, the above two relationships suggest that more exposed soil and litter is necessary to attract woodcock on used mowed plots than on used eroded and unused mowed sites.

The vegetative composition of sites (Table 4) did not suggest any statistically significant preference by woodcock for any particular plant species. This was in accord with the findings on singing grounds in Maine (Mendall and Aldous, 1943). However, three species which were not generally associated with eroded sites were Scribner panicum, Indian grass and big bluestem. The latter two are very tall grasses and would obsure a woodcock's vision while on a site. Areas containing these tall grasses were used readily when mowed. Thus, it was probably not the species of vegetation which made the singing site attractive to woodcock but the aerial and ground level vegetative density at the site.

Table 2. Vegetative density analysis results for sites on the Oklahoma State University Ecology Preserve.

Site and Year	*Possible Hits*	*Hits on Vegetation*	*Percent Vegetation*	*Hits on Soil and Litter*	*Percent Soil and Litter*
Used Mowed (n = 3)					
Total	457	212	139	245	162
Average	152	71	46	82	54
Used Eroded (n = 4)					
Total	597	400	268	197	132
Average	149	100	67	49	33
Unused Native (n = 4)					
Total	596	564	379	32	21
Average	149	133	95	8	5
Unused Mowed (n = 3)					
Total	450	260	173	190	127
Average	150	87	58	63	42
Unused Eroded (n = 4)					
Total	599	399	259	210	141
Average	150	44	65	52	35

Elevation and slope appeared to be the only physical aspects of singing grounds which were influential in a woodcock's selection of a site (Table 5). Elevation ranged from 297 to 305m (average 301 to 302m) on all used sites, while all unused sites ranged from 299 to 312m (average 306 to 308m). Unused mowed sites, however, were at very significantly ($P \leq 0.005$) higher elevations than were used eroded sites. This use difference may have been due to the proximity of water or higher soil moistures at the lower elevations (see spatial characteristics below). Eroded used sites were on significantly ($P \leq 0.025$) greater slopes than were the eroded sites unused by woodcock (Table 7), probably because the latter sites often accumulated standing water which was avoided.

No significant differences ($P \leq 0.05$) were observed between physical characteristics on sites where the perimeter and area were well defined (Table 5). Sizes of singing sites on our study area did not differ from sizes of those in other states. In Oklahoma, singing site diameters ranged from 20 to 25m. In Minnesota, Dangler and Marshall (1950) found singing sites of 21 to 40m in diameter. Ritcher (1948) found the average diameter of singing grounds in Pennsylvania to be 22 to 34m. Mendall and Aldous (1943) and Blankenship (see Sheldon, 1967) found sizes of singing grounds to be "endless." As Sheldon suggested, there does seem to be a requirement of a "getaway" route for the bird's aerial flight. Several sites mowed in the midst of tall trees and thick brush on our study area were not used very intensively. This may have been due to the absence of suitable getaway routes.

Spatial characteristics of singing grounds (Table 6) suggested that distances from singing grounds to water and distances between singing grounds may have been critical to a woodcock's selection of a singing site. Mowed used sites were very significantly ($P \leq 0.005$, Table 7) closer to the nearest surface drainage or diurnal cover than were mowed unused sites. This may indicate that woodcock singing grounds in northcentral Oklahoma need to be close to water or moist soils. This is further evidenced by the fact that used eroded sites, though further away from the creek (average = 125m) than used mowed sites (average = 56m), were almost always at the source of a seasonally wet draw which drained from the eroded site to Harrington Creek.

Distances between used singing sites varied, depending on existing conditions. Used singing sites not separated by a creek or draw averaged 280 to 300m apart. However, two used singing sites separated by a small drainage and associated wooded belt were only 150m apart. Apparently, the wooded draw reduced visual contact and muffled the acoustical activities of the two adjacent males. The territorial conflict which did exist may not have been intensive enough to rule out use of the sites by separate birds.

No significant differences in soil characteristics were determined between used and unused display sites. The results of testing soil pH levels between any two categories of singing sites were not significantly different ($P \leq 0.05$). Soil textures on all sites were generally the same (Table 8).

Table 3. Analyses of variance results for aerial and vegetative density between important singing site categories on the Oklahoma State University Ecology Preserve.

Sampling Level	*Used Eroded vs. Unused Native*	*F Value and (Significance Level)*			*Used Mowed vs. Used Eroded*
		Used Eroded vs. Unused Eroded	*Used Mowed vs. Unused Native*	*Used Mowed vs. Unused Mowed*	
Aerial Density					
First (0-10cm)	21.16	3.78	25.08	0.009	0.004
	(0.005)	(0.100)	(0.005)	*[1]	*
Second (10-20cm)	8.90	0.08	9.64	0.15	0.84
	(0.025)	*	(0.025)	*	*
Third (20-30cm)	8.31	1.00	8.29	0.48	0.29
	(0.025)	*	(0.025)	*	*
Vegetative Density					
Ground	13.24	0.03	831.52	4.63	5.29
	(0.025)	*	(0.005)	(0.10)	(0.10)

[1] * = F value not significant.

Table 4. Vegetative composition analysis of used eroded, unused eroded and native grass sites on the Oklahoma State University Ecology Preserve.

Plant Species	*Percentage of Sites Occupied by the Species*		
	Used Eroded	*Unused Native Grass (controls)*	*Unused Eroded (controls)*
Little and Split-beard bluestems	32.5	35.9	35.2
Tall dropseed	8.9	0.1	
Goldenrod	3.2	0.1	5.0
Silver bluestem	2.2		
Heath aster	1.7	0.3	
Johnson grass	1.4		
Yellow broomweed	0.5		
Fescue	0.4		
Western ragweed	0.4	1.2	
Prairie acacia	0.4	0.1	1.0
Sedge	0.3		
Flax	0.3		0.4
Scribner panicum	0.5	4.6	0.4
Prairie three-awn	1.7		
Indian grass	0.2	19.3	1.6
Japanese brome	0.2	0.5	
Croton	0.2		
Hawkweed	0.2	0.1	
Slender lespedeza	0.2		
Big bluestem		6.1	3.0
Purple top		1.2	
Dallis grass		0.1	
Torrey nightshade		0.4	
Thistle		0.1	
Smooth sumac		0.5	
Rough-leaf dogwood		0.7	
Greenbriar		0.1	
Buckbrush		1.3	
Switchgrass		0.1	
Dogbane		0.1	
Prairie clover		0.1	0.8
Mint		0.1	
Hairy grama			
Strophostyles			1.0
Acalypha			0.4
Dotted gayfeather			1.1
Unknown		0.4	1.0
Bare Soil	12.0	0.1	9.0
Ground Litter	7.4	4.6	4.6
Litter	24.7	20.8	29.4

Table 5. Physical aspects of singing sites on Oklahoma State University Ecology Preserve.

Category and Site	*Perimeter (m)*	*Area (m^2)*	*Slope (%)*	*Aspect*	*Elevation (m)*	*Shape*
Used Eroded						
$5D_0$	——	——	5.0	SE	302	Irregular
$4C_0$	——	——	3.0	SSE	302	Irregular
$6E_0$	——	——	5.0	SSE	302	Irregular
$7E_0$	——	——	6.0	SSE	302	Irregular
$6E_1$	——	——	6.0	E	302	Irregular
Total			25.0		1510	
Average			5.0		302	
Unused Eroded						
1E	——	——	0.0	N	312	Irregular
$3B_1$	——	——	5.0	ENE	305	Irregular
$4C_0$	——	——	3.0	SSE	302	Irregular
$3C_1$	——	——	2.0	E	302	Irregular
$2F_0$	——	——	1.0	NW	312	Irregular
Total			11.0		1533	
Average			2.2		307	
Unused Native Prairie						
$2B_0$	——	——	9.0	ESE	308	Irregular
$1G_0$	——	——	3.0	NE	311	Irregular
$7E_1$	——	——	4.0	SSE	305	Irregular
$6E_2$	——	——	6.0	E	299	Irregular
Total			22.0		1223	
Average			5.5		306	
Used Mowed Plots						
$3C_0$	141	1422	9.0	E	302	Oval
$5C_0$	137	1372	8.0	SSE	305	Circular
$4D_1$	150	1661	9.0	E	300	Circular
5F	128	1134	0.0	E	297	Circular
Total	556	5589	26.0		1204	
Average	139	1397	6.5		301	
Unused Mowed Plots						
$6D_0$	123	1280	8.0	E	308	Oval
3G	141	1515	0.0	NE	308	Oval
2B	149	1488	9.0	E	308	Circular
$6D_1$	138	1461	5.0	SE	308	Circular
8E	139	1515	3.0	SE	308	Circular
Total	690	7259	25.0		1540	
Average	138	1452	5.0		308	

Table 6. Spatial characteristics of singing sites on the Oklahoma State University Ecology Preserve.

Category and Site	*Distance to Nearest Used Singing Site (m)*	*Distance to Water (m)*	*Distance to Ecotone (m)*
Used Eroded			
$5D_0$	300 (to $3C_0$)	110	45
$4C_0$	105 (to $3C_0$)	45	20
$6E_0$	250 (to $5C_0$)	150	45
$7E_0$	280 (to $5C_0$)	165	20
$6E_1$	270 (to $5C_0$)	155	30
Total	1205	625	160
Average	241	125	32
Unused Eroded			
1E	225 (to 2D)	110	45
$4C_0$	105 (to $3C_0$)	45	20
$3C_1$	55 (to $3C_0$)	45	15
$2F_0$	225 (to 2D)	190	135
Total	610	390	215
Average	152	98	54
Unused Native Prairie			
$2B_0$	135 (to $3C_0$)	120	60
$1G_0$	450 (to $4C_0$)	200	135
$7E_1$	50 (to $6E_0$)	200	45
$6E_2$	45 (to $6D_1$)	100	25
Total	680	620	265
Average	170	155	66
Used Mowed			
$2B_0$	65 (to $3C_0$)	65	0
$3C_0$	105 (to $4C_0$)	55	15
$5C_0$	250 (to $6E_0$)	90	30
$4D_1$	270 (to $6E_1$)	45	22
5F	200 (to $6E_1$)	25	10
Total	890	280	77
Average	178	56	15
Unused Mowed			
$6D_0$	90 (to $6D_1$)	225	0
3G	270 (to 5F)	225	25
2B	155 (to $3C_1$)	50	20
$6D_1$	45 (to $6E_1$)	160	15
8E	135 (to $7E_1$)	225	80
Total	695	885	140
Average	139	177	28

Table 7. Analyses of variance results for physical aspects and spatial characteristics between important categories of singing sites on the Oklahoma State University Ecology Preserve.

Categories	*F Value and (Significance Level)*				
	Used Eroded vs. Unused Mowed	*Used Eroded vs. Unused Eroded*	*Used Mowed vs. Unused Eroded*	*Used Mowed vs. Unused Mowed*	*Used Mowed vs. Used Eroded*
Physical Aspects					
Slope	0.00	7.61	3.86	0.29	0.48
	——[1]	(0.025)	(0.10)	——	——
Elevation	16.67	3.09	2.65	2.53	0.30
	(0.005)	——	——	——	——
Spatial Characteristics					
Distance	1.41	0.38	1.62	29.85	7.89
to water	——	——	——	(0.005)	(0.025)
Distance to	6.52	2.01	0.19	0.49	0.54
Nearest Site	(0.05)	——	——	——	——
Distance to	——	0.57	2.37	1.33	5.01
Ecotone	——	——	——	——	(0.01)

[1] —— = F value not significant.

Table 8. Soil characteristics of singing sites on the Oklahoma State University Ecology Preserve.

Category and Site	*pH*	*Texture*	*Category and Site*	*pH*	*Texture*
Used Eroded			*Unused Eroded*		
$5D_0$	7.7	Red silty clay	1E	7.4	Red sandy clay
$4C_0$	6.3	Red clay	$3B_1$	6.4	Red sandy silt
$6E_0$	6.2	Red clay	$4C_0$	6.3	Red clay
$7E_0$	6.3	Red sandy clay	$3C_1$	6.0	Red sandy clay
$6E_1$	6.1	Red sandy clay	$3B_1$	6.4	Red sandy silt
			$2F_0$	6.2	Red sandy loam
Total	32.6			38.7	
Average	6.5			6.5	
Used Mowed			*Unused Mowed*		
$3C_0$	6.5	Dark sandy loam	3G	6.7	Red sandy loam
$5C_0$	6.8	Dark sandy loam	2B	6.4	Dark sandy loam
$4D_1$	6.3	Dark sandy loam	$6D_1$	6.8	Red sandy loam
5F	6.3	Dark sandy loam	8E	6.2	Dark sandy loam
Total	25.9			26.1	
Average	6.5			6.5	
Unused Native Prairie					
$2B_0$	6.4	Dark sandy loam			
$1G_0$	6.4	Dark sandy loam			
$7E_1$	6.0	Dark sandy loam			
$6E_2$	6.3	Dark sandy loam			
Total	25.1				
Average	6.3				

Habitat Manipulation. Many of the characteristics of mowed sites have been discussed above. The actual response by woodcock to habitat manipulation (mowed sites) was excellent. Of the 19 plots mowed in 1974, five were subsequently used as singing sites; four of these were in formerly brushy areas, and one was in native grassland with some scattered sumac. Nine of the 20 plots mowed in 1975 were used: three were in brushy areas and six were in native grass or slightly brushy areas. The territorial behavior of male woodcock and, possibly, the proximity of mowed sites to water or diurnal cover may have limited the use of these sites, since we deliberately mowed more sites than would normally be used on a given display ground. The mowing provided openings in otherwise too dense cover and is believed to have been primarily responsible for the three to four fold increase in numbers of displaying birds observed in 1975.

Diurnal Habitat. Woodcock or their sign have been observed inconsistently on the study area over the last five years from December through July. However, in 1974, in spite of frequent searches, no woodcock or woodcock signs were found in diurnal cover. This was probably due to the small population of displaying woodcock present (2 at any one time) in 1974 as well as to the difficulty of locating woodcock in diurnal cover. In 1975, efforts were more productive. Eight of the 13 diurnal observation sites (Table 9) had American elm or hackberry present, and the other five had post oak as the dominant tree. Eleven of the 13 observations made were in a brushy draw draining from a nearby field into Harrington Creek. Probe holes indicated that the birds had been feeding on subsurface invertebrates.

Eastern redbud, a legume, was present in the understory on 10 of the 13 locations where woodcock or their sign were found. Redbud may be important to woodcock in that the nitrogen-fixing bacteria associated with the root nodules could contribute to rich soil and, as a consequence, good earthworm habitat. In the ground cover, greenbriar was present at 12 of the 13 sites, broadleaf uniola at eight of the 13, and leafy elephant foot at five of the 13. There was a close association between greenbriar and the presence of woodcock. Greenbriar offered excellent escape cover while presenting a formidable barrier to livestock, large predators, and human intruders. The presence of broad-leaf uniola and

Table 9. Habitat characteristics where woodcock or their feeding sign were observed on the Oklahoma State University Ecology Preserve.

Dominant		*Ground Vegetation*	*% Ground Covered by Vegetation*	*Soil Type*	*Moisture Rating*	*Proximity to Creek (m)*
Overstory[1]	*Understory*					
100% Po 10-12m	None	U, G, Gra	25-50	Dark, alluvial loam	Wet	10-25
20% Rb 6m, 80% Hn 10m	100% Rb 3m	U, L, Gra	50-75	Dark, alluvial loam	Wet	1-10
50% Em 13-15m and Hk 13-15m, 50% Rb 5m	75% Rb 3m, 25% Dg 3m	G	0-25	Red, alluvial silt deposits	Wet	10-25
100% Po and Bo 10-12m	None	Leaves and dead limbs	0-25	Dark loam	Wet	10-25
100% Em 6-10m	100% Rb 2-3m	U, L, G	0-25	Dark loam	Moist to Wet	10-25
100% Po and Bo 13-15m	None	L, G, Wr	0-25	Red silty loam	Moist	10-25
80% Em and 20% Co 13-15m	100% Rb 3-4m	U, Bb, G	25-50	Dark red silt loam	Moist	1-10
100% Po 13-15m	100% Rb 3-5m	Gra, Dg, G	0-25	Darl alluvial loam	Moist	1-10
100% Po 13-15m	100% Rb 3-4m	U, L, G	0-25	Dark alluvial loam	Wet	1-10
50% Co 12-15m, 50% Hk and Em 10m	50% Rb 5m, 30% Dg 4m, 20% Gra	U, L, G	25-50	Red sandy loam	Wet	1-10
100% Co 20-25m	100% Dg 3-5m	G, Bb	25-50	Dark alluvial loam	Wet	1-10
25% Co 30m, 50% Em 15m, 20% Hk 5m, 5% A 15m	80% Rb 2-3m, 10% Hk 5m, 10% Rc 2m	G, Gra, U, Bb	25-50	Reddish sandy loam	Wet	1-10

[1] A = Green ash, Bb = Buckbrush, Co = Chinkapin oak, Dg = Rough leaf dogwood, Em = American elm, Gr = Greenbriar, Gra = Wild grape, Hk = Hackberry, Hnl = Honeylocust, L = Leafy elephant foot, Po = Post oak, Rb = Eastern redbud, U = Broad leaf uniola.

leafy elephant foot also appeared to be highly indicative of good habitat. These two species afforded the bird necessary ground cover. They did not occur on other areas where grazing was practiced. Most of the land in Payne County, Oklahoma, is very heavily grazed, and this practice appears to be incompatible with woodcock habitat requirements where moisture and shade afforded by ground vegetation are crucial to the birds' well-being. Constant trampling and grazing of bottomland habitat by cattle eliminate almost all ground cover. The amount of the ground occupied by vegetation in woodcock diurnal cover was about 25 percent in all cases. The diurnal habitat soils were mostly loamy, often very dark and rich in organic matter, and generally very moist to wet.

DISCUSSION

The findings relating to aerial density and vegetative density at ground level on used versus unused woodcock singing sites suggested a preference by male woodcock for relatively sparse cover at the singing site. The work of previous researchers supports these findings. Sparsely vegetated sites maximized display flight take-off and landing requirements, freedom of movement during mating and/or feeding on the singing site, and general visibility by the calling male of predators, females and other singing males. Vegetative composition affected the choice of a singing site only when the plant species present were very tall and thus eliminated the advantages of sparsely vegetated sites; unused native prairie sites were readily used after mowing when other habitat requirements were met.

The authors observed that heavily used singing sites were closely associated with water. Mowed sites and/or eroded sites which were not close to water were not used, even though they were an adequate distance apart from each other. The only exception to this was the temporary use of drier sites during the peak of migration by presumed migrant or surplus birds. Thus, the success of artificially created singing sites seems to be limited by distance from water. Territorial behavior limited the use of mowed sites not spaced adequately apart from each other. Physical, spatial and soil characteristics of singing grounds affected the woodcocks' choices of singing sites only insofar as the two other habitat conditions were met: (1) adequate moisture and associated diurnal cover near the singing site and (2) adequate spacing between used singing sites.

The authors conclude that moisture and land use are the major limiting factors to breeding woodcock in northcentral Oklahoma. This is no surprise, as Sutton (1968) has said that a necessary requirement for woodcock in Oklahoma is the presence of soft mud to allow the birds to probe for earthworms. The characteristics of the diurnal cover on the study area support our and Sutton's *(op. cit.)* hypotheses concerning moisture and woodcock habitat. The Ecology Preserve has not been grazed since 1968 and consequently the prairie grasses, the bottomland vegetation and corresponding soils have not been removed or trampled by cattle. Thus, the ungrazed habitat is better able to conserve moisture, support more lush vegetation and assure better woodcock cover than is the surrounding overgrazed habitat.

Admittedly, the woodcock population we studied was small and essentially restricted by land use practices to a limited area. These same factors, however, plus ease of access to the study area, enabled us to monitor the population closely. We were also able to analyze habitat components more intensively than is often the case in studies of this type. As a consequence of these efforts we have summarized our conclusions as follows:

1) All available evidence, historical and contemporary, indicates that we have witnessed habitat colonization and/or range expansion by the American woodcock on the western periphery of its range. Opportunities to document such biological events are not common but was made possible in this case by the species' conspicuous breeding display and the localized presence of favorable habitat.
2) At the present time we are confident that favorable land use practices coupled with adequate soil moistures are responsible for the presence of this and other woodcock populations we are encountering in Oklahoma. Light to moderate seasonal livestock grazing may be beneficial to woodcock in some instances, especially for retarding succession. However, overgrazing, as has been commonly practiced in the study region in recent years, appears to be detrimental to the presence of all but incidental migrant woodcock.
3) The creation of artificial singing sites in favorable prairie habitats on an experimental management basis is strongly recommended. Woodcock habitat manipulation studies could be conducted on areas in the eastern half of Oklahoma where we have observed breeding displays. These and other studies already underway should provide much of the information necessary for undertaking realistic prairie woodcock management programs.

APPENDIX A

The common and scientific names of plants mentioned in the text after Fernald and Robinson (1908) and Waterfall (1966).

Common name	*Scientific name*
American elm	*Ulmus americana*
big bluestem	*Andropogon gerardi*
blackjack oak	*Quercus marilandica*
broad leaf uniola	*Uniola latifolia*
buckbrush	*Symphoricarpus orbiculatus*
goldenrod	*Solidago* spp.
Canada wildrye	*Elymus canadensis*
chinkapin oak	*Quercus muehlenbergi*
croton	*Croton capitatus*
dallisgrass	*Paspalum dilatatum*
dogbane	*Apocynum* sp.
dotted gayfeather	*Liatris punctata*
eastern redbud	*Cercis canadensis*
eastern red cedar	*Juniperus virginiana*
fescue	*Festuca* sp.
flax	*Linum medium*
green ash	*Fraxinus pennsylvanica*
greenbriar	*Smilax bona-nox*
hackberry	*Celtis* sp.
hawkweed	*Hieracium aurantacium*
heath aster	*Aster ericoides*
honeylocust	*Gymnocladus dioica*
Indian grass	*Sorghastrum nutans*
Japanese bromegrass	*Bromus japonicus*
leafy elephant foot	*Elephantopus carolinianus*
little bluestem	*Andropogon scoparius*
mint	*Caryophyllaceae*
post oak	*Quercus stellata*
prairie acacia	*Acacia angustissima*
prairie three awn	*Aristida purpurea*
purple prairie clover	*Dalea purpurea*
purple top	*Tridens flavus*
red mulberry	*Morus rubra*
Scribner panicum	*Panicum oliganthes*
sedge	*Cyperus* sp.
silver bluestem	*Andropogon sacharoides*
smooth sumac	*Rhus glabra*
split-beard bluestem	*Andropogon ternarius*
switchgrass	*Panicum virgatum*
tall dropseed	*Sporobolus asper*
thistle	*Cirsium* sp.
Torrey nightshade	*Solanum Torreyi*
western ragweed	*Ambrosia psylostachia*
wild grape	*Vitis* sp.
yellow broomweed	*Gutierrezia dracunculoides*

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OBSERVATIONS ON WINTERING WOODCOCK IN NORTHEAST GEORGIA[1, 2]

by

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ABSTRACT

During 5 consecutive hunting seasons (1969-1974), 57 hunters made 136 woodcock hunts at 27 sites in northeast Georgia. In 728 man-hours of hunting, 1,132 woodcock flushes occurred. Hunters fired 1,171 shots and bagged 308 woodcock. Forty-three birds were shot down but lost and 20 were feathered but kept flying. Overall, 1.56 woodcock were flushed per man-hour of hunting, and hunters bagged approximately one bird of every four flushed. Crippling loss (in relation to total kill) was computed to be 17 percent. Although hunting opportunity and hunter success compared closely with results of previous hunter surveys undertaken in northern areas, crippling loss was much higher than previously indicated.

Using flushing rates, river or creek floodplains were preferred diurnal sites as opposed to beaver pond, upland, and mixed habitat locales. Swamp privet appeared to be favorite cover.

Climatic conditions were the probable cause of decline in woodcock abundance in most sites during the 1971-72 season. Additional observations were given on seasonal variations in woodcock abundance, arrival and departure dates, and other information regarding woodcock wintering in the area.

INTRODUCTION

Recent studies suggest that the south Atlantic region serves as the major wintering ground for most woodcock hatched east of the Appalachian Mountains (Clark 1972, Krohn 1973, Martin et al. 1970, Sheldon 1967). Little information is available, however, on abundance, distribution, habitat preferences, and other factors affecting woodcock wintering in the region.

In conjunction with collections for parasite and disease studies on woodcock, Pursglove and Doster (1971) found 13 wintering populations in the Southeast, including surprisingly dense concentrations in several south Atlantic states. Diurnal habitat utilized by these birds was characterized, and suggestions were given to aid woodcock hunters in the region.

The occurrence of numerous woodcock at two sites in Greene and Oglethorpe Counties, Georgia (Pursglove and Doster 1971), led to the discovery of additional locales in these and nearby counties.

[1] This study was supported by the Federal Aid in Wildlife Restoration Act (50 Stat. 917) and Contract No. 14-16-0008-676, Fish and Wildlife Service, U. S. Department of the Interior.

[2] Results of this study were presented previously at the 5th American Woodcock Workshop, Georgia Center for Continuing Education, Athens, Georgia, December 2-5, 1974.