Microhabitat Characteristics of Wild Turkey Prenest and Nest Site Selection in Central Mississippi

Michael J. Chamberlain, *Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS 39762*

Bruce D. Leopold, *Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS 39762*

Abstract: We radio-monitored 35 wild turkey (*Meleagris gallopavo*) hens during prenesting and nesting periods in central Mississippi, 1996–1997. Comparing microhabitat variables associated with prenesting areas (N = 35) and nest sites (N = 22) with random sites indicated that groundstory conditions, including grass and woody growth, were related to hen selection of both prenesting and nesting sites. Distance to nearest road, vertical vegetative cover, and basal area were not related to nest site location ($P >$ 0.05). We recommend managers maintain habitats with abundant grasses within landscapes managed for wild turkeys. Research addressing depredation of hens during reproductive periods should incorporate and quantify microhabitat conditions.

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Although macrohabitat selection for wild turkey hens has been documented (e.g., Everett et al. 1985, Wigley et al. 1985, Palmer 1990, Hurst and Dickson 1992, Miller 1997), effects of microhabitat conditions on selection processes prior to and during incubation have not been quantified. In Mississippi during prenesting periods, hens select areas with herbaceous understories and predominately nest within prenesting home ranges (Palmer et al. 1996). Vegetative characteristics of nest sites have been linked to understory conditions dominated by grasses in Mississippi (Seiss 1989, Palmer 1990). However, little research has focused on examining habitat selection during both prenesting and nesting periods and subsequently comparing habitat variables important in habitat selection by hens during the reproductive period.

Habitat selection of wild turkey hens during prenesting and nesting periods may influence reproductive success (Seiss et al. 1990, Badyaev et al. 1996, Miller 1997). Quantification of microhabitat conditions associated with wild turkey reproduction in forested landscapes is needed. Recent declines in the wild turkey population in Mississippi and on the Tallahala Wildlife Management Area (TWMA; Miller 1997), and concerns over low reproductive success on TWMA (Miller et al. 1998), mandate research examining habitat selection by hens during prenesting and nesting periods. Our objectives were to 1) examine and quantify habitat variables of prenesting use areas and nest sites and 2) compare habitat variables at prenesting and nesting sites to random locations for a wild turkey population in central Mississippi during 1996–1997.

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Methods

Study Area

We conducted our research on the 14,410-ha TWMA and an adjacent 2,400-ha area owned by Georgia-Pacific Corporation (GP). Topography on TWMA and GP was flat to moderately rolling with a mean annual temperature of 18 C and annual precipitation averaging 152 cm. TWMA was mostly (95%) forested with 30% bottomland hardwood forests, 37% mature pine (*Pinus* spp.) forests, 17% mixed pine-hardwood forests, with the remainder comprised of 1- to 14-year-old loblolly pine (*P. taeda*) plantations. In November 1992, a tornado altered 5% of TWMA, destroying mature pine and hardwood stands. This area was replanted to loblolly pine in 1993. GP was managed for wood fiber with 90% of the area composed of 1- to 35-year-old loblolly pine plantations.

Turkey Capture and Radio Telemetry

We captured wild turkey hens via cannon net on bait sites established on TWMA and GP during January–March 1996–1997 and July–August 1996. Captured adult hens were tagged patagially (Knowlton et al. 1964) and fitted with 85–100 g mortality-sensitive radio-transmitters (Advanced Telemetry Systems, Isanti, Minn.) attached backpack-style. Hens were then released at the capture site.

We determined hen locations using triangulation (Cochran and Lord 1963) from fixed telemetry stations ($N = 480$) using a 3-element Yagi antenna and a Wildlife Materials (Carbondale, Ill.) receiver. Locations were obtained using sequential telemetry (focal runs) beginning March 1. During focal runs, hens were monitored for 4 consecutive hours with triangulated locations recorded hourly. All hens were monitored for a 4-hour period three times weekly. Thus, a minimum of 12 locations were recorded weekly for each hen.

Hens found in the same location for 2 consecutive days were considered incubating, particularly when roosting did not occur. Incubating hens were located a minimum of once daily, but focal runs were conducted to monitor hen movements during departures from the nest site. After 5 days of incubation, nests were approached to within 50 m and azimuths were taken toward the nest from several points encircling the nest. After cessation of nesting activity, nests were located to determine nest fate and for microhabitat sampling.

Plot Delineation and Vegetation Sampling

We used telemetry to determine hen use areas during the prenesting period (March). During prenesting, we triangulated all telemetry locations for each hen and x,y coordinates derived in program TELEBASE (Wynn et al. 1990). Locations were then entered into program CALHOME (Kie et al. 1994) and hen use areas determined using the adaptive kernel method (Worton 1989). We used the center of activity within each hen's core use area to determine plot location if the designated center of activity overlapped known locations for each hen. In instances where the center of activity was designated in an area devoid of known locations for that hen, a known x,y coordinate (telemetry location) was randomly selected and sampled. To sample nest sites, the nest was designated as plot center, with sampling occurring in the 4 cardinal directions. To determine random plot location, a random x,y coordinate was generated within the boundary of the study area. A random plot was sampled for each prenesting ($N = 35$) and nesting plot ($N = 22$). Random plots were sampled the same day as prenesting and nest plots.

Within each plot, canopy closure was measured with a spherical densiometer (Lemmon 1956), tree density was determined using the Point-Center-Quarter method (Cottam and Curtis 1956), and understory density was determined using a Nudds Density Board (Nudds 1977; Table 1). Ground cover diversity was estimated using a Daubenmire frame (Daubenmire 1959; Table 1). Variables collected at each cardinal direction and at plot center were averaged to determine microhabitat conditions within each plot, and those variables were entered into model selection procedures.

We used logistic regression to build a predictive model for prenesting and nesting habitat selection within PROC LOGISTIC (SAS Inst. 1992). Random locations were coded as 0 while prenesting and nesting sites were coded as 1. An equal number of random and use sites ensured a prior probability of group membership of 0.5. Significant ($\alpha = 0.05$) variables were selected using stepwise selection. Default significance levels of entry and retention (0.05) in SAS (SAS Inst. 1992) were used to build models. Predicted classification into pre-nesting, nesting or random were compared with actual classification to examine model performance. Classification of observations followed equation 1

$$P(1/x) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \ldots \beta_i x_i)}}$$

where P was the posterior probability of classification, β_0 was a constant (intercept), β_i were regression coefficients and X_i were regressor values (Brennan et al. 1986).

Table 1. Methods used to measure microhabitat conditions of prenesting and nesting areas for wild turkey hens and random plots on Tallahala Wildlife Management Area and Georgia-Pacific lands, Mississippi, 1996–1997.

Variable	Explanation
Canopy closure	Percentage of the canopy above plot center and a point in each cardinal direction 10 m from plot center that covered a spherical densiometer (Lemmon 1956).
Percentage of grass, forbs, woody, debris, vine and bare ground	Daubenmire frame (1959) at plot center and 10 m from plot center in each cardinal direction
Understory vegetative height	Average understory vegetation height in cm measured 10 m from plot center in each cardinal direction.
Percentage vegetative cover and understory density	Vegetative composition between 0–0.3, 0.3–0.6, 0.6–0.9, 0.9–1.2, 1.2–1.5, and 1.5–1.8 m measured using a Nudds Density Board (Nudds 1977) 10 m from plot center in each cardinal direction.
Species of hardwoods and pines and DBH of those species	One hardwood and 1 pine measured in each quadrant of the Point-Center-Quarter method (Cottam and Curtis 1956) and the diameter of those trees.
Distance to hardwoods and pines and height of hardwoods and pines	Distance (m) to nearest hardwood and pine in each quadrant of the Point-Center-Quarter method and the height of those trees using a clinometer.
Hardwood and pine basal area	The sum of hardwood and pine basal area taken with a 10-factor prism at plot center.
Distance to edge	Meters to the nearest change in habitat type or feature (i.e., roads, regeneration areas.)
Distance to water	Meters to the nearest water source (stream, creek, pond, etc.) whether ephemeral or permanent.

We tested hypotheses that microhabitat variables quantified did not differ between random sites and prenesting sites, nor between random and nesting sites. Variables included in prenesting and nesting models were subsequently compared to examine differences in habitat selection between seasons.

Results

Thirty-five hens (35 prenesting, 22 nesting) were located using telemetry 3,661 times during the 1996–1997 pre-nesting and nesting periods. During the 4-week prenesting period, 1,061 locations were used for these 35 hens to determine use areas and subsequent plot locations. Although 2,600 locations were taken on 22 incubating hens, essentially each nest site represented 1 location.

We used 70 observations (35 prenesting, 35 random) to develop the predictive model for prenesting sites. Three variables were retained in the model: an intercept term ($\beta = -5.99$, $P < 0.001$), AVGRASS ($\beta = 12.96$, $P < 0.001$), and AVWOODY ($\beta = 5.11$, $P = 0.0267$; Table 2). Prenesting sites were positively related to AVGRASS and AVWOODY indicating that prenesting sites had consistently more grass and woody vegetation than random sites. Model prediction was high, with 83% of prenesting sites points classified correctly and 86% of random plots classified correctly.

Table 2. Mean values and associated standard errors for variables used to determine wild turkey prenesting, nesting, and random locations on Tallahala Wildlife Management Area and Georgia-Pacific Corporation lands, Mississippi, 1996–1997.

	Time of year			
	Prenesting and Random		Nesting and Random	
Variable[a]	$\bar{x}$	SE	$\bar{x}$	SE
DIST	123 m	78.21 m	71.1 m	13.0 m
	94 m	13.6 m	86.9 m	12.7 m
AVEPER1	0.41	0.04	0.52	0.05
	0.39	0.05	0.47	0.08
AVEPER2	0.46	0.04	0.61	0.04
	0.42	0.05	0.48	0.08
AVEPER3	0.51	0.04	0.78	0.05
	0.44	0.05	0.58	0.08
AVEPER4	0.55	0.04	0.98	0.02
	0.48	0.06	0.70	0.09
AVEPER5	0.70	0.05	1.00	0.00
	0.54	0.06	0.89	0.09
AVEPER6	0.90	0.06	1.00	0.00
	0.88	0.06	1.00	0.00
AVGRASS	0.44	0.02	0.56	0.02
	0.28	0.02	0.41	0.05
AVFORB	0.16	0.02	0.17	0.02
	0.15	0.02	0.12	0.03
AVWOODY	0.31	0.03	0.42	0.03
	0.22	0.02	0.26	0.02
AVVINE	0.34	0.04	0.46	0.03
	0.29	0.04	0.38	0.04
AVDEBRY	0.80	0.04	0.56	0.04
	0.96	0.04	0.74	0.06
AVBGRND	0.02	0.01	0.03	0.01
	0.08	0.02	0.19	0.06
AVEVERT	108.6 cm	4.29 cm	128.1 cm	3.9 cm
	88.2 cm	8.79 cm	98.4 cm	10.74 cm
AVECAN	0.71	0.12	0.98	0.02
	0.69	0.08	0.94	0.12
AVPBASL	90.3 m^2/ha	9.63 m^2/ha	70.0 m^2/ha	4.47 m^2/ha
	92.1 m^2/ha	11.9 m^2/ha	55.2 m^2/ha	20.7 m^2/ha
AVHBASL	42.2 m^2/ha	7.09 m^2/ha	11.9 m^2/ha	3.49 m^2/ha
	25.5 m^2/ha	6.72 m^2/ha	33.5 m^2/ha	7.58 m^2/ha
DISTPINE	6.3 m	1.34 m	6.1 m	0.71 m
	6.4 m	1.14 m	8.4m	1.8 m
DISTHARD	6.8 m	3.1 m	8.1 m	0.66 m
	8.8 m	1.9 m	6.5 m	1.65 ma.

DIST = Distance to near edge.

AVEPER 1–6 = Percentage of Nudds' (1977) board in 0.3 m increments obstructed by vegetation.

AVGRASS = Average percentage of grass in groundstory.

AVFORB=Average percentage of forb in groundstory.

AVWOODY = Average percentage of woody in groundstory.

AVVINE = Average percentage of vine in groundstory.

AVDEBRY = Average percentage of debris in groundstory.

AVBGRND = Average percentage of bare ground in ground story.

AVEVERT = Average height of vertical vegetation.

AVECAN = Average canopy closure.

AVPBASL = Average pine basal area.

AVHBASL = Average hardwood basal area.

DISTPINE = Average distance to nearest pine.

DISTHARD = Average distance to nearest hardwood.

We used 44 observations (22 used, 22 random) to develop the predictive model for nesting sites. Four variables were retained in the model: an intercept term ($\beta = -23.99$, $P = 0.004$), AVGRASS ($\beta = 18.26$, $P = 0.009$), AVWOODY ($\beta = 16.86$, $P = 0.016$), and AVECAN ($\beta = 7.88$, $P = 0.025$). Nesting sites were positively related to AVGRASS, AVWOODY, and AVECAN indicating that nest sites had higher proportions of grass and woody vegetation in the understory and greater canopy closure than did random sites. Model prediction was higher for the nesting model than for the pre-nesting model with 95% of nest sites classified correctly and 91% of random sites classified correctly.

Discussion

Although model performance in our study was high, classification rates could be incorrect due to a lack of model validation. We realize model validation is important to better assess model performance (Hosmer and Lemeshow 1989), but a relatively low number of hens in our study prevented development of a validation data set. Although capture success during our study was good, development of a validation data set would require higher sample sizes than those in this study. Thus, interpretation of our results should be predicated on the fact that models were not validated.

Although the nesting habitat model performed best, both models provided classification rates adequate to formulate conclusions regarding habitat variables involved in selection of prenesting and nesting sites. Percentage of grass and woody stems were consistently less at random sites relative to prenesting and nesting sites. A non-significant relation between prenesting and random sites regarding AVECAN likely resulted from similar canopy conditions across stand types during prenesting periods, which occurred prior to full spring greenup. Lack of early canopy closure allowed vigorous herbaceous growth during prenesting periods, particularly in pine dominated stands. Subsequently, AVGRASS was important in prenesting and nesting habitat selection. Seiss (1989) and Palmer (1990) also reported that understory grasses were important variables in nest site selection on TWMA.

Palmer et al. (1996) reported that prenesting areas on TWMA were dominated by groundstories of grasses and forbs, and that hens often nested within prenesting home ranges. We found similar patterns in habitat selection as stands with abundant grasses were selected by hens during prenesting. Palmer et al. (1996) also determined that hardwood bottomland forests and upland forests along creeks were preferred habitats for prenesting hens on TWMA. Only 1 of 35 prenesting use areas occurred in bottomland stands during this study and distance to water was not significant in determining prenesting habitat selection. Palmer et al. (1996) used 1984–1989 data from TWMA; however, considerable changes in forest management [i.e., management for red-cockaded woodpecker (*Picoides borealis*)] have occurred on TWMA since 1994. We also included hens captured on GP and coupled with changes in forest management strategies, likely resulted in differences between our study and results reported by Palmer et al. (1996).

On GP, bottomland stands were available, but limited. High-grading along boundaries of these bottomland stands created closed canopy conditions resulting in reduced herbaceous understory growth. Based on point locations of hens during prenesting, hens were seldom located in bottomland stands, except for roosting. Instead, hens were often located in >20-year-old pine stands characterized by high herbaceous understory growth. Further, a lack of burning on TWMA and GP had allowed presence of woody growth within these older pine stands. AVWOODY was a significant determinant of prenesting and nesting habitat selection. We suggest that woody cover was likely selected by prenesting and nesting hens. Visual structure, whether woody or herbaceous, is an important determinant of nesting locations (Hurst and Dickson 1992). Nest sites on TWMA and GP were often situated within dense woody cover, particularly eastern baccharis (*Baccharis halimifolia*). Badyaev et al. (1996) found that nest sites survived longer with increasing visual obstruction at the nest site. Woody cover on TWMA and GP increased visual obstruction, but whether hens in this study selected nest sites with high woody cover to increase visual obstruction is unclear. Dense stands of baccharis often created nearly closed canopy conditions at 0.7 m. Thus, dense woody cover may serve as protective cover from aerial predators or serve to improve hen comfort during extreme heat, often present during nesting.

Similarities among variables selected in the prenesting and nesting models suggest that hens may display varying intensity of habitat sampling between the 2 seasons. Badyaev et al. (1996) and Miller (1997) reported that increased habitat sampling by hens during prenesting resulted in greater nest success and increased fitness. Our data suggests that hens select prenesting areas based mostly on grasses and woody cover. However, hens appeared to increase intensity of habitat selection after establishment of prenesting ranges to eventually choose sites with preferred densities of grass and woody cover, as well as desirable canopy conditions. Thus, hens may select prenesting areas based on more general cues, then subsequently use intense habitat sampling to determine nesting locations with prenesting ranges.

On TWMA, most nest attempts occur in pine dominated stands (Miller 1997) with highest nest success and lowest nest predation occurring in mature pine stands versus pine regeneration stands (Seiss et al. 1990, Miller 1997). Understories in older pine stands on both areas were mostly grasses with the influence of woody cover dependent on previous burning history. Badyaev (1995) reported that nest predation strongly affected nest habitat selection in Arkansas. Nest success in this study was low (2 of 22 nests successful), regardless of nest location, thus we were unable to correlate nest success with vegetative characteristics. However, hens on TWMA and GP may choose nest sites based on past experience with nest predation and use vegetation characteristics as visual cues.

Although distance to nearest roads or openings (edge) has often been correlated with location of nest sites (Speake et al. 1975, Exum et al. 1987), we did not observe relationships between nest sites and distance to roads. On TWMA, preferred brooding habitat is within mature bottomland stands (Phalen et al. 1986, Palmer 1990). Few bottomland hardwood stands were near roads, thus hens selecting nests in pine stands adjacent to brooding areas tended to be situated away from roads. Further, vegetative conditions along road systems on TWMA and GP were not conducive for brooding or hen foraging during nesting.

Microhabitat conditions could and likely do change from nest site selection by the hen and time when vegetation sampling occurred. These changes in microhabitat could result in differences between microhabitat conditions when hens selected nest sites and time when sampling occurred. However, unfortunately most nest loss occurred within 14 days of nest initiation. Thus in most instances sampling occurred within 4 weeks of nest initiation (i.e., approximately 2 weeks laying, 2 weeks incubating until nest loss). We believe that this time lag between nest site selection and sampling was unavoidable and although changes occurred in microhabitat conditions, it is unlikely that these changes were pronounced enough to strongly influence our results.

Management Implications

In forested landscapes, habitat selection during prenesting and nesting periods is a function of many factors, including vegetational characteristics within stands. Management of constantly changing landscapes to benefit wild turkey populations requires knowledge of habitat selection processes during reproductive periods. Research addressing depredation of nests during reproductive periods should incorporate and quantify microhabitat conditions prior to drawing conclusions concerning nesting success. Similar to previous studies, we found that understory herbaceous cover was used by hens in selecting nesting sites, although nest success in this study was poor. However, grasses also were important habitat components during prenesting periods, when hens must acquire resources prior to the physiological demanding process of laying and incubation. Thus, we suggest managers maintain habitats with abundant grasses within landscapes managed for wild turkeys, either through burning regimes of 3–5 years (Hurst 1981, Palmer et al. 1996) or perhaps other stand manipulations (e.g., thinning).

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