Pre-incubation Habitat Use by Wild Turkey Hens in Central Mississippi

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Abstract: Habitat use of forested landscapes by wild turkey hens (*Meleagris gallopavo*) during pre-incubation is poorly documented. Information is needed on how vegetative conditions resulting from forest management influence hen movements, habitat use, and reproductive success. We studied habitat relations of wild turkey hens ($N = 111$) during pre-incubation in central Mississippi, 1985–1989. Groundstory composition and structure were different ($P < 0.05$) between areas used and not used by hens. Hens used areas with relatively low ($\bar{x} = 28$ cm) groundstory canopies composed of mostly (79%) grasses and forbs. Mature bottomland hardwood forests and pine forests prescribed-burned the previous February provided suitable groundstories, and these areas were selected by hens ($P < 0.10$). Hen movements were nearer to creeks than expected ($P < 0.001$) unless recently-burned pine forests were available to hens ($P = 0.02$). Hens with pre-incubation ranges composed of mostly bottomland hardwood forests were less successful nesters ($P = 0.01$). A 6-year prescribed burning rotation resulted in unsuitable groundstory vegetation in upland forests and appeared to cause hen movements, home range, and habitat use to be associated with creek drainages. This constraint may have reduced reproductive success.

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Wild turkey hens occur in flocks during the fall-winter season. The breeding period begins in late-winter with males gobbling and seeking hen flocks; courting and mating begin while hens are still in flocks (Williams and Austin 1988). Soon thereafter, hens begin leaving flocks, presumably to locate suitable pre-incubation home ranges in which to nest. Information on habitat selection and movement of hens during the pre-incubation period is needed to better understand how hens use habitat

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mosaics present in managed forest landscapes and how habitat selection during pre-incubation influences reproductive success.

Macro-habitat selection information often fails to explain why selection occurs or how selection affects survival or reproduction, which limits its value to managers (Healy 1990). Although hen macro-habitat selection is dependent on groundstory vegetation (e.g., composition) during brooding (Pack et al. 1980, Healy 1985), less research has centered on the effect of groundstory vegetation on movements and habitat selection of adult hens before brooding behavior begins (Exum et al. 1987, Healy 1990). Objectives of this study were to determine forest type(s) selected by hens during the pre-incubation period, to examine the effect of groundstory vegetation conditions on selection of forest types and hen movements, and to study the effect of pre-incubation home range characteristics upon nesting success.

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Methods

The study area consisted of 14,410 ha of the Tallahala Wildlife Management Area (Strong River District, Bienville National Forest) and associated private lands. The area was 95% forested and was composed of bottomland hardwood (30%), pine (37%), mixed pine-hardwood forests (17%), and pine and hardwood regeneration areas (11%). These forest habitat types were well-distributed across the study area. Age of most pine and hardwood stands exceeded 50 and 70 years, respectively. Pine and hardwood regeneration areas averaged 12.7 ha and 5.2 ha, respectively. Non-forested areas occurred on private lands and were composed of old field (4%), agriculture (1%), and residential (<1%). Pine and some mixed forest stands within U.S. Forest Service planning compartments were prescribed burned, on average, every 6 years (range 3–10).

Macro-Habitat Analyses

Turkey hens were captured by cannon-net during January–February and July–August 1984–1989 following Bailey (1976). Hens were equipped with a 107-g, battery-powered, backpack-style transmitter with a mortality or motion switch (Wild. Materials Inc., Carbondale, Ill.), leg bands, and black patagial wing tags. Hens were released at the capture site.

We determined hen locations by triangulation (Cochran and Lord 1963, Heezen and Tester 1967) from 2 telemetry stations ($N = 275$) using a hand-held, 3-element yagi antenna and a Telonics (Mesa, Ariz.) TR-2 receiver. Absolute value of error of test azimuths ($N = 43$) for transmitters at known locations ($N = 14$) averaged 7.2° (SD = 6.3). Distance from telemetry stations to test transmitters averaged 1.1 km (SD = 0.5) and error was not correlated to distance ($P = 0.21$). Telemetry locations were collected every other day (1985–1988) or daily (1989), beginning by 14 March. Homogeneity of telemetry locations among daily time periods, morning (before 1030 hours), mid-day (1030–1040 hours) and afternoon (after 1430 hours) was tested using G-factor analysis (Sokal and Rohlf 1981).

We used photo interpretation and U.S. Forest Service stand data to delineate habits into 8 types: pine forests (> 70% pine), bottomland hardwood forests (> 70% hardwood), mixed forest (30%–70% pine), regeneration areas (< 4 years post-planting), sapling (5–15 years post-planting), field, pasture, and agriculture. Stands were transferred from color infrared aerial photos to 7.5-minute quadrangles using a vertical sketchmaster and digitized into a personal computer. All stand map analyses were conducted using PC Arc/Info Environ. Systems Res. Inst., Inc. 1989).

We determined habitat availability each year from the proportion of the study area encompassed within the cumulative use polygon of all hens. The hen-use polygon was determined using the minimum convex polygon method (Mohr and Stumpf 1966) from telemetry locations for all hens each year. Habitat selection analyses followed Neu et al. (1974) and were protected for simultaneous inference at $\alpha = 0.10$. In addition to estimating selection for the overall hen population, we examined variation in habitat selection among hens from data collected in 1989. We constructed individual hen-use polygons and compared use and availability for each hen separately following Neu et al. (1974).

We compared hen use to availability of different-aged burn classes (0, 1–2, ≥3 years since-burned) to determine effects of prescribed fire on hen use of pine forests. Percent use and availability of each burn class were compared using simultaneous confidence intervals at $\alpha = 0.10$ (Neu et al. 1974).

In 1989, we investigated the relationship of hen movements to creek drainages and habitat use by comparing distances of hen locations and random points to the nearest creek. We plotted random locations in individual, pre-incubation, hen-use polygons. Differences in distances to creeks from random and actual locations were examined using *t*-tests. Further, an index of an individual hen's "attraction" to creeks was calculated as:

$$\frac{(RD_i - OD_i)}{RD_i}$$

where RD_i was the mean distance from random points, plotted within hens I's use polygon, to nearest creeks; and OD_i was the mean observed distance from telemetry locations for hen I to nearest creeks. Positive values of the index indicated an "attraction" and negative values indicated an "avoidance" of habitats near creeks. Relation of the index to pre-incubation home range characteristics was determined using correlation analyses.

We determined effect of forest types within pre-incubation home ranges on nesting success by comparing percentages of major forest types within pre-incubation home ranges of successful and unsuccessful nesting hens using a Mann-Whitney test

(Steel and Torrie 1980). Based on the relationship between number of telemetry locations and incremental increases in hen home range size, pre-incubation ranges were judged adequately sampled if ≥30 locations were obtained.

Micro-Habitat Analyses

In March 1989, a subsample ($N = 20$) of hens was randomly selected as focal hens. These hens were located 2–3 times/day, with hourly observations taken 1 day/week/hen, to determine movement patterns during the pre-incubation period. However, only hens that incubated first nest attempts were included in micro-habitat analyses. All vegetation measurements were completed within 21 days of delineation of pre-incubation home ranges.

Within each focal hen's home range, vegetation characteristics were determined for regions used and not used by hens based on telemetry data. Vegetation sampling points ($N = 40$) were established equi-distantly along randomly chosen azimuths in used and not used regions. Overstory measurements included basal area by species, height of nearest dominant tree using a clinometer, and canopy closure using a densiometer (Lemmon 1957). We measured ground cover using 6 ground cover boards (GCB) placed systematically about the sampling point and directly above groundstory. Each GCB was composed of 50 5- × 10-cm rectangles. Number of rectangles occupied by vegetation (> 50% obstructed) were counted and assigned to grass/sedge, forb, woody, or vine vegetation classes. Difference in ground cover classes between used and not used regions were analyzed by G-factor contingency table analyses (Sokal and Rohlf 1981). Groundstory structure, defined as degree of obstruction to horizontal vision through vegetation (Gysel and Lyon 1980) was measured indirectly using a sighting board (a 20- × 90-cm board with each 30-cm section alternately painted orange or white) placed at the sampling point. At each of the cardinal directions, an observer moved directly away from the sighting board and, from hen height, recorded the distance when each 20- × 30-cm section became 100% occluded by vegetation.

We used Kolmogorov-Smirnov (K-S) 1-sample tests to test for normality of vegetation variables (Steel and Torrie 1980). Variables which followed the normal distribution were tested for equality of variances using Bartlett's test (Neter et al. 1985). When assumptions of ANOVA were met with raw or log-transformed data, we used ANOVA with equal sub-sampling to determine differences in variables between used and not used regions (Peterson 1985). If following log-transformation the data did not meet ANOVA assumptions, an overall mean from the raw data was determined for each hen and treatment and was compared using either paired t-tests or t-tests for unequal variances (Steel and Torrie 1980). All statistical tests for micro-habitat differences were conducted using SPSS/PC (SPSS, Inc. 1988) at $\alpha = 0.05$.

Results

We monitored 111 hens during the pre-incubation season from 1985 to 1989 (Table 1). The mid-day period (43%) was over-sampled and the afternoon period was

Table 1. Summary of telemetry locations for wild turkey hens monitored during the pre-incubation period on Tallahala Wildlife Management Area, Mississippi, 1985–1989.

Year[a]	*N* hens	*N* locations	Locations per hen (SD)	Range
1989	20	1,267	63.4 (10.8)	33–73
1988	42	1,227	29.2 (3.9)	25–35
1986	20	459	23.4 (5.7)	13–34
1985	29	938	32.3 (6.9)	19–40
Total	111	3,891		

[a] Data from 1987 excluded due to small sample size of hens ($N = 3$).

under-sampled (24%) ($P < 0.001$) except in 1989 when each period was sampled equally ($P > 0.10$). For all years combined, 98.5% of hen locations were in forested habitats and were distributed into bottomland hardwood forest (46.2%), pine forest (28.4%), mixed forest (12.7%), regeneration areas (5.9%), and sapling stands (5.3%). Field and pasture were rarely used (1.5%) and were excluded from habitat use analyses because they were unavailable to >90% of hens monitored.

Hens selected bottomland hardwood forest and avoided pine forest each year. Mixed forest was avoided in 3 of 4 years. Selection varied among years for regeneration areas and sapling stands (Table 2).

Heterogeneity in habitat selection was present among 13 hens monitored in 1989. Six of 13 hens selected, and 1 avoided, bottomland hardwood forest ($P < 0.10$). Four hens avoided and 1 selected pine forest ($P < 0.010$). Seven hens used pine forest extensively (36%–56% of their locations). Most (69%) of this use for 5 of these hens was in pine forest prescribed-burned <2 years prior.

Spring Dispersal and Habitat Use

In 1989, flock ($N = 8$) break-up began 16 March and most radio-equipped hens (76%) had dispersed from their winter range, alone or in small groups, by 31 March. Dispersal from winter range to pre-incubation range (i.e., distance between arithmetic

Table 2. Habitat selection of wild turkey hens during the pre-incubation period on Tallahala Wildlife Management Area, Mississippi, 1985–1989.

Year	Habitat types[a]					Pine forests years since burned		
	BH	PN	MX	RG	SP	0	1–2	3–9
1985	>[b]	<	=	<	=	n/a	n/a	n/a
1986	>	<	<	=	>	=	>	<
1988	>	<	<	>	>	>	<	=
1989	>	<	<	=	<	>	<	<

[a] Bottomland hardwood forest (BH), mature pine forest (PN), mixed forest (MX), regeneration areas (RG), and sapling stands (SP)
[b] Habitat use <, >, or = availability at $P < 0.10$.

mean X/Y coordinates for winter and pre-incubation ranges) averaged 1,785 m (range: 110- 3,524 m). Proportion of locations in bottomland hardwood forest declined from 79% during the first week of March to 44% during the third week of April. This decline was a function of hen dispersal from winter ranges composed mostly of bottomland hardwood forests to upland sites. Dispersal distance was significantly correlated to percentage use of pine forests during pre-incubation ($r = 0.72$, $P = 0.005$).

Prescribed Burning and Pine Habitat Selection

We examined use of different age-burns (i.e., prescribed burned pine forests) by hens during pre-incubation in 1986, 1988, and 1989 (1987 was excluded due to low sample size of hens). Number of locations/year averaged 256 (range: 164–344) and was obtained on an average of 27 (range: 20–42) hens/year.

Pine forests burned the most recent February–March were selected in 2 of 3 years and were used in proportion to availability in 1 year (Table 2). Pine forests burned 1–2 years prior were selected in 1 year and avoided in 2, and pine forests burned ≥3 years prior were avoided in 2 of 3 years. Use of pine forests by hens appeared dependent on juxtaposition of pine forests with bottomland hardwood forests. Pine stands not burned for ≥3 years and used by hens were most likely to be adjacent (48%) to bottomland hardwoods than recently-burned pine forest stands used by hens (25%) ($P = 0.06$).

Hen Movements and Creeks

In 1989, 13 focal hens were monitored ($N = 875$ locations) during pre-incubation to investigate influence of creek drainages on their movements and habitat use. Within all home ranges, locations were closer to creeks than random points ($P < 0.001$). Within pine forests only, distance to creeks from hen locations ($N = 259$) was similar to random ($P = 0.28$). However, hens with > 25% of their pre-incubation home range in pine forests burned within 3 years were located farther from creeks than hens with <25% in pine forests burned within 3 years ($P = 0.014$). Similarly, the creek index was negatively correlated ($r = -0.65$; $P = 0.017$) to availability of pine forests burned within 3 years (i.e., hens used habitats farther from creeks when burned pine was available), but not to availability of pine forest ($r = -0.21$), bottomland hardwood forest ($r = 0.24$), or mixed forest ($r = -0.27$) within pre-incubation home ranges ($P > 0.05$).

Home Range Characteristics and Nesting Success

We used 35 nesting hens that were located ≥ 30 times ($\bar{x} = 50.4$; range: 31–75) during pre-incubation to determine if proportion of different forest types within pre-incubation home ranges was related to nesting success. Pre-incubation home ranges of successful hens ($N = 14$) averaged 34% (SE = 0.06) in bottomland hardwood forest versus 52% (SE = 0.04) for unsuccessful hens ($N = 21$) ($P = 0.011$). All 5 hens with ranges composed of < 18% bottomland hardwood forest were successful and all 5 hens with ranges composed of > 65% bottomland hardwood forests were unsuccessful. Successful hens had a greater proportion of their pre-incubation home range in mixed forest ($\bar{x}$ = 20%; SE = 0.03) than unsuccessful hens ($\bar{x}$ = 11%; SE = 0.02) (P = 0.008). Proportion of home range in pine forest was not different (P = 0.17) for successful ($\bar{x}$ = 33%; SE = 0.05) and unsuccessful ($\bar{x}$ = 25%; SE = 0.03) hens.

Overstory and Groundstory Vegetation Analyses

Vegetation measurements were completed for 11 focal hens nesting in 1989. Hens were monitored ($\bar{x}$ = 101 locations/hen) an average of 44 days (range: 38–53) from 1 March to onset of continuous incubation. Locations were evenly distributed throughout the diurnal periods (P = 0.53).

Height of canopy trees (P = 0.34), canopy closure (P = 0.45), and basal area (P = 0.33) did not differ significantly between used and not used regions. However, canopy closure was more variable on used areas (P = 0.001). Overall, basal area from used regions had more hardwood than not used regions (P = 0.001); however, we found no differences for 2 hens ($P > 0.05$) and the use area of 1 hen had more pine basal area (P = 0.04).

Percentage ground cover was similar (P = 0.32) on used ($\bar{x}$ = 36; SE = 0.75) and not used ($\bar{x}$ = 0.40; SE = 0.91) regions. However, groundstory vegetation in used areas was more likely grass and forbs and less likely woody and vine ($P < 0.001$). Groundstory vegetation was significantly shorter on used ($\bar{x}$ = 28 cm; SE = 0.31) than not used areas ($\bar{x}$ = 58 cm; SE = 0.55) ($P < 0.001$). Sighting board distances were higher ($P \leq 0.001$) on used areas ($\bar{x}$ = 42 m; SE = 0.94) than not used areas ($\bar{x}$ = 24 m; SE = 0.62). Height of the groundstory canopy (r = 0.69), sighting board distances (r = −0.53), and percentage of groundstory in grasses (r = −0.25) and forbs (r = −0.30) were correlated ($P < 0.001$) to percentage woody ground cover.

Discussion

Identifying hen macro-habitat selection hinges on how consistently the habitat characteristics selected by hens correlate with human-defined, macro-habitat categories. If these characteristics are strongly correlated with a subset of available macrohabitats, then, hen macro-habitat use should reflect this by demonstrating selection. On Tallahala, habitat selection by hens during pre-incubation was dependent on characteristics of the groundstory. Hens selected areas with low groundstories composed of mainly grasses and forbs and avoided areas with tall woody and vine ground cover; the latter areas were used to escape disturbance (Wunz 1971, Palmer 1990) and for nest sites (Seisss et al. 1990, Palmer 1990). These micro-habitat conditions were consistently found in bottomland hardwood forests and, to a lesser degree, pine forest burned within 2 years and mixed forest corridors along creeks.

On Tallahala, bottomland hardwood forests were selected each year during preincubation. Groundstory in these forest strands was maintained in a herbaceous state, suitable to hens, by annual spring flooding (Phalen et al. 1986). Analysis of macrohabitat selection by individual hens in 1989 also showed extensive use of this macrohabitat by most hens (11 of 13 hens) and selection of bottomland hardwood forests by nearly 50%. However, the conclusion that micro-habitat conditions, not macro-habitat categories, were determinant of hen habitat use was supported by the variation in selection of habitats among hens. For instance, some hens avoided bottomland hardwood forests and selected upland pine forests. This switch in direction of macro-habitat selection appeared to depend on availability of recently prescribed-burned pine forests. When recently-burned pine forests were available to hens, they moved farther from creeks, increased use of pine forests, and decreased use of bottomland hardwood forests.

A general avoidance of unburned pine forest by hens was likely due to their groundstory condition. During spring, ground cover in unburned pine forests was generally shrubs and vines interspersed with dead grass and forbs. Nearly-complete canopy closure and a 6-year prescribed burning rotation fostered these conditions (W. E. Palmer, unpubl. data). Prescribed burning reduced woody ground cover and promoted a herbaceous groundstory (Stoddard 1963, Hurst 1981, Exum et al. 1987, Palmer unpubl. data), thus improving suitability of pine forests for hens.

That mixed forests appeared to have been avoided may be a misleading result for 2 reasons. First, the mixed forest macro-habitat category included a wide range of conditions, such as upland and lowland sites, variable burning histories, and a wide range in hardwood and pine composition (i.e., 30%–70% pine). Groundstory conditions in mixed forests was likely to vary greatly between mixed forest stands. Often, the groundstory in upland mixed forests was similar to that found in unburned pine forests. However, mixed forest corridors along creeks had suitable ground cover and were used by hens. That these mixed forests may not have been avoided was suggested by the result that hen locations were closer to creeks than random. A second reason that this habitat type may appear to have been avoided was that mixed forest creek corridors were often narrow (< 100 m) and their use by hens was probably underestimated due to misclassification of telemetry locations (White and Garrott, 1986).

Hens form social groups, or flocks, during fall and winter. Following onset of mating, hens become more secretive as they disperse from winter ranges in search of nesting areas (Healy 1992). On Tallahala, hen flocks consistently selected mature, bottomland hardwood forests during winter and avoided pine forests (Palmer 1990). Hens dispersing from their winter home ranges often traveled mixed forest corridors adjacent to creeks into upland areas. Following selection of pre-incubation home ranges, hens continued to use habitats near creeks, presumably due to unsuitable groundstory in unburned, upland forest. This pattern of dispersal, home range selection, and habitat use resulted in hen home ranges associated with creek drainages rather than upland forests. Our data suggests that the probability of a nest being depredated may increase if hens nest in pre-incubation home ranges which border bottomland hardwood forests. Many studies have documented higher densities of common nest predators [e.g., raccoon (*Procyon lotor*) and opossum (*Didelphis virginiana*)] in bottomland hardwood forests than in upland pine forests (Verts 1963, Leberg et al. 1983, Leberg and Kennedy 1987, Sanderson 1987).

Collectively, our data suggest that long prescribed burning rotations maintain upland forests as unsuitable hen habitat during pre-incubation. This negatively impacts turkey populations in 2 main ways: first, by confining hen movements and habitat selection to a smaller area and, second, by reducing nesting success of hens selecting pre-incubation ranges in association with creek drainages.

Management Implications

We conclude that habitat selection by hens during pre-incubation was primarily based on conditions of the groundstory vegetation and that suitable groundstory conditions occurred naturally in bottomland hardwood forests but were a function of prescribed-burning in upland forests. The prescribed burning rotation observed during this study (i.e., 6 years) was for the purpose of hardwood fuel load control and was inadequate for producing suitable hen habitat in upland pine stands most years. We agree with Stoddard (1963) who recommended a 3-year burning rotation for managing upland forests for turkeys. This shorter burning rotation should help to maintain an open, herbaceous-dominated groundstory in upland pine forests that would be suitable for hens.

The current U.S. Forest Service management plan to protect bottomland hardwood forests should benefit the wild turkey by continuing to provide important year-round habitat. However, limiting hen habitat use to bottomland hardwood forests and associated creek drainages during pre-incubation and nesting may reduce nesting success. Mature forest corridors along secondary creek drainages are a critical component of upland turkey habitat and should be protected. Our results affirm the importance of streamside management zone policies. Mature forests should be protected along all drainages to facilitate hen movements and to provide habitat. Streamside management zones should be wide enough to foster groundstory vegetation suitable to turkeys (Burk et al. 1990).

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