

Spatial Fidelity of Wild Turkeys Between the Seasons in Central Mississippi

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Abstract: Understanding space use patterns of wildlife may be useful to spatially plan habitat management options and understand how species use resources on a landscape. Spatial fidelity can be defined as the tendency of an animal to maintain similar space use patterns among periods of interest and can be described in terms of differences in dispersion of points and shift in central tendency. However, little information is available concerning spatial fidelity in wild turkeys (*Meleagris gallopavo*). Therefore, we investigated seasonal spatial fidelity of male and female eastern wild turkeys (*M. g. silvestris*) on the Tallahala Wildlife Management Area (TWMA) in central Mississippi during 1984–1996. We estimated dispersion between seasons as the mean distance between each location and the bivariate median. We estimated shifts in space use patterns as the distance between bivariate median centers for consecutive seasons. We also used habitat data to determine if habitat needs influenced observed fidelity patterns of males. Both sexes displayed spatial shift, dispersional differences, both shift and dispersion, or neither between consecutive seasons. Spatial shift may have been related to habitat preferences. Males had similar dispersion across seasons indicating consistent space use patterns. Decreased dispersion of locations during preincubation by females may have been related to concentrated searches for nest sites. Spatial shift between spring and summer for males may have been related to movements associated with spring breeding. Spatial shifts observed in a turkey population may be indicative of individuals seeking preferred habitat and may identify absent habitat type(s) or habitat association(s) in a given area.

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Spatial fidelity can be defined as the tendency of an animal to maintain similar space use patterns among periods of interest. This fidelity can be measured in terms of dispersion of location and shifts in central tendency (White and Garrott 1990). An understanding of spatial use dynamics provides information on movement response of a species to a particular landscape and may suggest how habitat management activities or habitat changes may affect a species.

A plethora of information is available documenting home ranges for wild turkeys (e.g., Brown 1980, Godwin et al. 1996, Miller et al. 1997). However, few previous studies have investigated spatial fidelity in wild turkeys. Badyaev and Faust (1996) determined that 69% of females on a study area in Arkansas displayed site fidelity during sequential breeding seasons. Palmer and Hurst (1996) determined female wild turkeys in Mississippi had high fidelity to specific drainages and suggested using these creek drainages as minimum habitat management units. On an area under intensive management for loblolly pine (*Pinus taeda*) production in Mississippi, female wild turkeys traveled from upland pine stands to a bottomland hardwood complex during fall and returned to pine plantations in spring for breeding and brood-rearing (Burk et al. 1990, Smith et al. 1990). Understanding such spatial dynamics may indicate how wild turkey are using resources within a management area and provide information to optimize habitat management options.

We compared spatial fidelity patterns, via measures of dispersion and shifts in central tendency, between seasons for wild turkeys on TWMA during 1984–1996 for females and 1986–1990 for males. We also used habitat data to determine if habitat choices were related to observed fidelity patterns in male turkeys.

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Methods

Study Area

We conducted our study on the 14,410-ha Tallahala Wildlife Management Area (TWMA) located within the Bienville National Forest in Jasper, Newton, Scott, and Smith counties in central Mississippi. Our area was located within the Lower Coastal Plain Province and the Blackland Prairie Resource Area (Pettry 1977). Most (95%) of TWMA was forested with 30% in mature bottomland hardwood forests, 37% in mature pine (*Pinus* spp.) forests, 17% in mature mixed pine-hardwood (hereinafter referred to as “mixed”) forests (30%–70% pine), and 11% in 1- to 14-year-old loblolly pine (*P. taeda*) plantations. The remaining area (5%) was comprised of open

areas and human habitations. Prescribed burning of pine stands (>14 years old) occurred at a mean rotation length of 6.25 years. Mean patch size ranged from a maximum of 121 ha for pine sawtimber (>30 year old) stands burned within 3 years to a minimum of 9 ha for mixed regeneration (< 16 year old) stands (Miller 1997). Most pine stands on TWMA were predominantly even-aged. Bottomland hardwood stands (most > 80 years old) were under custodial management (i.e., little to no timber harvest or other management activities) with clearcutting prohibited. Harvest of mature pine stands was conducted by clearcutting with regeneration by planting or seed tree methods.

Capture and Telemetry

We captured wild turkey females (1984–1992) and males (1986–1989) by cannon net (Bailey 1976) or with alphachloralose (Williams et al. 1966) from 7 January to 4 March and 1 July to 25 August. For both capture procedures, we used cracked corn for bait. We removed turkeys from the net and placed them into cardboard boxes sized for wild turkeys (76.2 × 35.6 × 61 cm). We classified turkeys as adults or juveniles (Williams and Austin 1988) and marked them with 2 patagial wing tags (Knowlton et al. 1964) and 2 metal triple-lock leg bands. We used backpack harnesses to attach 108-g, motion-sensitive radiotransmitters (Wildl. Materials, Carbondale, Ill.). We released cannon-netted turkeys within 10–45 minutes of capture. We transported tranquilized turkeys to TWMA headquarters for marking and recovery and released them the next day. We released all turkeys at the site of capture. We operated under Mississippi State University Animal Care and Use Committee Protocol 93-030.

We recorded turkey locations using triangulation (Cochran and Lord 1963) from 2 fixed telemetry stations if azimuths were ≤ 12 minutes apart and angles were between 60° and 120° . We used a hand-held, 3-element, directional Yagi antenna and either a Telonics (Mesa, Ariz.) or Wildlife Materials (Carbondale, Ill.) receiver for triangulation. We placed transmitters in forested areas at a height and angle similar to that of females to determine telemetry accuracy and precision. Average telemetry system error was 7.2° ($SD = 6.3^\circ$) with a mean distance between test locations and actual locations of 100 m ($N = 43$; Palmer 1990). We located all females at least once daily during 14 March to approximately 1 June of each year. During the remainder, we located females ≥ 3 times/week; brood-rearing females were located as often as 6 times/day, 3 times/week. We located males twice daily every other day from January to August and ≥ 1 time weekly during fall and early winter. For all analyses of fidelity, we selected randomly 1 radio location per day for turkeys located greater than once daily.

Calculation of Fidelity Metrics

We used seasons to divide the annual cycle into biologically meaningful intervals associated with shifts in habitat use patterns (Table 1; Miller et al. 1999a). To maintain sample sizes, we combined age classes and years for all analyses (White and Garrott 1990).

Table 1. Male and female seasons used to analyze changes in spatial fidelity, Tallahala Wildlife Management Area, Mississippi, 1984–1996.

Season	Begin date	End date
Males		
Spring	1 Mar	13 May
Summer	14 May	1 Oct
Fall–winter	2 Oct	28/29 Feb
Females		
Preincubation	1 Mar	Begin incubation
Brood-rearing	15 days post-incubation	1 Oct
Nonreproductive	End incubation/preincubation	1 Oct
Fall–winter	2 Oct	28/29 Feb

We used a Fortran program to compare dispersion of locations and shifts in central tendency between consecutive seasons. For males, we compared fall-winter and spring seasons, spring and summer seasons, and summer and fall-winter seasons (Table 1). Likewise for females, we compared fall-winter and preincubation seasons, preincubation and brood-rearing seasons, preincubation and nonreproductive seasons, and nonreproductive and fall-winter seasons (Table 1). For females, brood-rearing and nonreproductive seasons occurred concurrently, with females placed in one of the 2 seasons according to reproductive status, to examine the possible influence of reproductive status on site fidelity. To ensure that sample size did not influence dispersion calculations, we used simple linear progression to test the hypothesis that number of locations for each turkey within each season was not related linearly to dispersion.

For every turkey within each pairwise comparison, we first used a multiple response permutation procedure (MRPP; Biondini et al. 1985, Zimmerman et al. 1985) to determine if dispersion points differed between seasons of interest. The MRPP statistic was developed using 5,000 randomizations of the locational data. Although the MRPP statistic indicated if a distributional difference in locations occurred, it was unable to differentiate whether the difference occurred due to a shift in central tendency, a change in dispersion of points, or both. If the overall MRPP statistic was significant, then we further examined the comparison to determine where the difference(s) occurred. This methodology is analogous to using an overall *F*-value to test for main effects and then examining pairwise comparison to determine where differences exist.

We calculated dispersion of points within each season by estimating distance (m) of each point from the bivariate median (Berry et al. 1984). We then used Van Valen's test (Van Valen 1978) to test the hypothesis that dispersion of animal locations about the median did not differ between seasons. This test can be thought of as a multivariate form of Levene's test (Brian S. Cade, U.S. Geol. Surv. – Biol. Resour. Div., pers. commun.) and is performed by: (1) calculating the bivariate median

(sensu Berry et al. 1984) for each group of interest; (2) within each group, calculate the distance between each location and the bivariate median, and (3) use a *t*-test, with appropriate adjustment for unequal variances if needed, to evaluate whether intra-group distances differ. A significant test indicates that dispersions differ between groups (i.e., periods).

There is not a straight forward method to test for a shift because it requires an arbitrary definition of how far apart central tendencies must be to have a shift occur. We first calculated median center of animal locations within each season and used the difference between median centers to estimate distance (m) that this center shifted between seasons. We then calculated a weighted mean of dispersion using equation 1:

$$\text{Weightedmean} = ((DISP_1)(n_1) + (DISP_2)(n_2))/(n_1 + n_2) \quad \text{Equation 1}$$

where $DISP_1$ is dispersion of points during season 1, n_1 is number of locations during season 1, $DISP_2$ is dispersion of points during season 2, and n_2 is number of locations during season 2. This measure represents the mean distance turkey locations were from their respective bivariate medians across seasons. To evaluate if a turkey shifted central tendencies between seasons, we assumed that a shift occurred if the distance between the bivariate median centers exceeded this weighted mean. In essence, if a turkey shifted its center of activity greater than the mean dispersion of points about the bivariate medians, then a shift occurred.

We computed the above statistics for each turkey tracked in at least 2 consecutive seasons and provided data on if individuals displayed site fidelity. However, we also wanted to examine site fidelity between seasons at the population level. To examine differences in dispersion at the population level, we tested the hypothesis that the difference in mean dispersion between seasons was zero. For this test, we used each turkey as the experimental unit and conducted a paired *t*-test, with each season as the treatment. We tested this hypothesis for each seasonal comparison. Likewise to determine if a shift in central tendency occurred at the population level, we tested the hypothesis that the difference between the weighted mean dispersion and the distance between seasonal bivariate medians was less than or equal to zero. We also used a paired *t*-test, with the turkey as the experimental unit, to test this hypothesis for each seasonal comparison.

Fidelity Patterns and Habitat Use of Male Turkeys

We had sufficient habitat and movement data to examine possible relations among habitat use patterns and spatial fidelity for male turkeys for spring to summer and summer to fall-winter comparisons. Previously, Miller et al. (1999a) used compositional analysis to estimate habitat preferences of male turkeys on TWMA. Based on this, we categorized habitat types into 3 classes, based on preference rankings: (1) mature (≥ 41 -year-old) bottomland hardwood forest, (2) pine regeneration (0–7 years old) and pine sawtimber (≥ 30 years old), and (3) other. We used these classes because males consistently preferred pine regeneration and pine sawtimber, displayed a strong secondary preference (after the above pine habitat types) for mature bottom-

land hardwood forest, and used the remainder of habitat types ($N = 8$) at different preference levels, but always less preferred than the first 2 classes (Miller et al. 1999a).

We tested 3 hypotheses for each of the 2 comparisons. The first set of hypotheses was that for those turkeys that had a shift or different dispersions between seasons: (1) habitat availability did not differ between seasons, (2) habitat use did not differ between seasons, and (3) habitat preference did not differ between seasons. Available habitats were those located within a turkey's home range (Miller et al. 1999a). We estimated used habitat based on proportion of radiolocations within each habitat type (Miller et al. 1999a). We estimated habitat preference using multiple analysis of variance (MANOVA) by comparing habitat use versus habitat availability as per compositional analysis (Aebischer et al. 1993). Home ranges were estimated using 95% convex minimum polygons and were the same home ranges reported by Miller et al. (1997). For habitat preference analyses and home range determination, we used all turkey locations, not the subset we used (1 location per day for turkeys located ≥ 1 time per day) to calculate fidelity metrics (see Miller et al. 1997 and Miller et al. 1999a).

We used a second set of hypotheses to examine differences in habitat availability, habitat use, and habitat preference, as described above, between males that did display shifts or dispersional differences versus those that did not. For these comparisons, we subtracted the log-ratio for each habitat use to availability ratio in season 1 and used this difference as the response variable in the MANOVA (Conner et al. 1999). We tested all hypotheses at $\alpha = 0.10$.

Results

Site Fidelity of Female Wild Turkeys

For females, we had 12 sampling units (11 different females; 1 female followed for 2 fall-winter to preincubation seasons) for the fall-winter to preincubation comparison, 5 sampling units (5 different females) for the preincubation to brood-rearing comparison, 25 sampling units (23 different females) for the preincubation to nonreproductive comparison, and 5 sampling units (5 different females) for the nonreproductive to fall-winter comparison. None of the regressions of sample size on dispersion were significant ($R^2 < 0.28$, $P > 0.11$). For the overall MRPP test, we observed significant differences in spatial fidelity for 11 of the fall-winter to preincubation comparisons ($P \leq 0.08$), all of the preincubation to brood-rearing comparisons ($P \leq 0.001$), 23 of the preincubation to nonreproductive comparisons ($P \leq 0.018$), and all of the nonreproductive to fall-winter comparisons ($P \leq 0.061$).

During fall-winter to preincubation, 6 comparisons were significant ($t_{>28} \geq 2.18$, $P < 0.03$) with respect to dispersion of points and 6 turkeys displayed a spatial shift (i.e., weighted mean of dispersion was less than median center shift). Of those females whose dispersions differed, 5 (83%) had greater dispersion during preincubation than fall-winter. Four females had dispersional differences and shifted central

Table 2. Mean standard error (SE), sample size (N), and P -value (paired t -test, $\alpha = 0.10$) for seasonal comparisons of locational dispersion [mean distance (m) from every point to bivariate median center] for female wild turkeys, Tallahala Wildlife Management Area, Mississippi, 1984–1996.

Seasonal comparison	Season 1		Season 2		N	P
	\bar{x} (m)	SE	\bar{x}	SE		
Fall-winter ^a (season 1) to preincubation ^b (season 2)	1,087.25	132.31	793.19	103.69	12	0.086
Preincubation (season 1) to brood-rearing ^c (season 2)	906.56	66.95	998.46	215.34	5	0.721
Preincubation (season 1) to nonreproduction ^d (season 2)	736.96	51.64	901.55	78.71	25	0.062
Nonreproduction (season 1) to fall-winter (season 2)	1,313.93	300.59	1,008.28	173.82	5	0.274

a. 2 Oct – 28/29 Feb.

b. 1 Mar – begin incubation.

c. 15 days post-incubation to 1 Oct.

d. End incubation/preincubation – 1 Oct.

Table 3. Mean, standard error (SE), sample size (N), and P -value (paired t -test, $\alpha = 0.10$) to test for seasonal spatial shift [if distance (m) between seasonal bivariate median centers was greater than weighted mean of dispersion (m) of points, then shift occurred] between consecutive seasons for female wild turkeys, Tallahala Wildlife Management Area, Mississippi, 1984–1996.

Seasonal comparison	Seasonal spatial shaft (m)		Weighted mean of dispersion (m)		N	P
	\bar{x} (m)	SE	\bar{x}	SE		
Fall-winter ^a to preincubation ^b	1,283.42	310.85	948.04	96.38	12	0.257
Preincubation to brood-rearing ^c	1,289.43	324.92	961.99	145.01	5	0.363
Preincubation to nonreproduction ^d	1,115.39	182.97	801.02	45.21	25	0.079
Nonreproduction to fall-winter	1,543.39	415.66	1,226.76	219.55	5	0.461

a. 2 Oct–28/29 Feb.

b. 1 Mar–begin incubation.

c. 15 days post-incubation to 1 Oct.

d. End incubation/preincubation–1 Oct.

tendencies. Overall, females exhibited less ($t_{11} = 1.89$, $P = 0.086$) dispersion during preincubation than fall-winter (Table 2) but did not display spatial shift ($t_{11} = 1.19$, $P = 0.257$; Table 3).

During preincubation to brood-rearing, 2 females significantly changed dispersion ($t_{\geq 38} \geq 2.96$, $P < 0.004$); 1 female had greater dispersion during brood-rearing and 1 had greater dispersion during preincubation. Four of 5 females had a spatial shift from preincubation to brood-rearing. Two females had dispersional differences and shifted central tendencies. Overall, no differences in dispersion ($t_4 = 0.38$, $P = 0.721$; Table 2) nor spatial shift ($t_4 = 1.02$, $P = 0.362$; Table 3) were detected for females during preincubation to brood-rearing.

During preincubation to nonreproduction, 12 females changed dispersion ($t_{\geq 19}$

≥ 1.72 , $P < 0.02$) and 13 females (52.0%) displayed spatial shift. Of the 12 females that differed with respect to dispersion, 8 increased dispersion during nonreproduction compared to preincubation and 4 decreased their dispersion. Overall, females had greater dispersion ($t_{24} = 1.96$, $P = 0.062$; Table 2) of locations during nonreproduction and shifted ($t_{24} = 1.83$, $P = 0.079$; Table 3) their median locational center.

During nonreproduction to fall-winter, 4 females (80.0%) changed dispersion of locations ($t_{\geq 66} \geq 2.49$, $P = 0.092$), with 3 of the females having less dispersion during fall-winter. Two females (40.0%) displayed spatial shifts between nonreproduction and fall-winter. Two females had dispersional differences and shifted central tendencies. Overall, females did not differ with respect to dispersion of points ($t_4 = 1.27$, $P = 0.274$; Table 2) nor shift in central tendency ($t_4 = 0.82$, $P = 0.46$; Table 3).

Site Fidelity of Male Wild Turkeys

For males, we had 39 sampling units (36 different males) for the spring to summer comparison, 17 sampling units (17 different males) for the summer to fall-winter comparison, and 5 sampling units (5 different males) for the fall-winter to spring comparison. None of the regressions of sample size on dispersion were significant ($R_2 < 0.32$, $P > 0.11$). For the overall MRPP test, we detected a significant difference in spatial fidelity for 38 of the spring to summer comparisons ($P \leq 0.006$), all of the summer to fall-winter comparisons ($P \leq 0.002$), and 4 of the fall-winter to spring comparisons ($P \leq 0.001$).

During spring to summer, 26 (66.7%) males differed ($t_{>25} \geq 1.81$, $P < 0.005$) with respect to dispersion of locations. Of these, 15 had less dispersion of locations during summer than spring and 11 displayed the reverse. Twenty-six males (66.7%) displayed spatial shifts between spring and summer. Eighteen males had dispersional differences and shifted central tendencies. Overall, males did not differ ($t_{38} = 1.45$, $P < 0.156$) with respect to dispersion of points between spring and summer (Table 4) but did display spatial shift ($t_{38} = 3.31$, $P = 0.002$; Table 5).

For the summer to fall-winter comparison, 11 males (64.7%) differed ($t_{\geq 34} \geq 1.91$, $P < 0.006$) with respect to dispersion of locations. Of these 7 had greater dispersion during fall-winter than summer and 4 displayed the reverse. Twelve (70.6%) males displayed spatial shifts between summer and fall-winter. Nine males had dispersional differences and shifted central tendencies. Overall, males did not differ ($t_{16} = 0.173$, $P < 0.865$) with respect to dispersion of points between summer and fall-winter (Table 4) but did display spatial shift ($t_{16} = 2.09$, $P = 0.052$; Table 5).

For the fall-winter to spring comparison, 2 males (80.0%) differed ($t_{\geq 76} \geq 1.75$, $P < 0.008$) with respect to dispersion of locations. Both males had greater locational dispersion during spring than during fall-winter. Three (60.0%) males displayed spatial shifts between fall-winter and spring. Two males had dispersional differences and shifted central tendencies. Overall, males did not differ ($t_4 = 1.53$, $P \geq 0.2$) with respect to dispersion of points between fall-winter and spring (Table 4) nor displayed significant ($t_4 = 1.02$, $P = 0.364$) spatial shift (Table 5).

Table 4. Mean, standard error (SE), sample size (*N*), and *P*-value paired (*t*-test, $\alpha = 0.10$) for seasonal comparisons of locational dispersion [mean distance (m) from every point to bivariate median center] for male wild turkeys, Tallahala Wildlife Management Area, Mississippi, 1984–1990.

Seasonal comparison	Season 1		Season 2		<i>N</i>	<i>P</i>
	\bar{x} (m)	SE	\bar{x}	SE		
Spring ^a (season 1) to summer ^b (season 2)	1,165.84	65.75	1,046.14	54.49	39	0.156
Summer (season 1) to fall–winter ^c (season 2)	1,034.65	101.91	1,051.51	109.32	17	0.865
Fall–winter (season 1) to spring (season 2)	1,178.42	220.39	1,426.04	258.03	5	0.201

a. 1 Mar – 13 May.
 b. 14 May – 1 Oct.
 c. 2 Oct – 28/29 Feb.

Table 5. Mean, standard error (SE), sample size (*N*), and *P*-value (paired *t*-test, $\alpha = 0.10$) to test for seasonal spatial shift [if distance (m) between seasonal bivariate median centers was greater than weighted mean of dispersion (m) of points, then shift occurred] between consecutive seasons for male wild turkeys, Tallahala Wildlife Management Area, Mississippi, 1986–1990.

Seasonal comparison	Seasonal spatial shift (m)		Weighted mean of dispersion (m)		<i>N</i>	<i>P</i>
	\bar{x} (m)	SE	\bar{x}	SE		
Spring ^a to summer ^b	1,552.51	133.75	1,090.82	45.36	39	0.002
Summer to fall–winter ^c	1,481.53	263.86	1,030.45	93.44	17	0.052
Fall–winter to spring	1,958.65	543.72	1,372.23	234.88	5	0.364

a. 1 Mar – 13 May.
 b. 14 May – 1 Oct.
 c. 2 Oct – 28/29 Feb.

Fidelity Patterns and Habitat Use of Male Turkey

The analyses to examine habitat differences between males that maintained spatial fidelity versus those that did not, revealed no differences in habitat availability ($F_{\geq 2,4} \leq 2.51, P \geq 0.117$), habitat use ($F_{\geq 2,4} \leq 1.50, P \geq 0.327$), nor habitat preference ($F_{\geq 2,9} \leq 1.29, P \geq 0.370$) for the spring to summer nor the summer to fall–winter comparisons.

Mixed results were obtained for the hypotheses examining differences in habitat use between seasons for males that did display different dispersions or shifted locations. Habitat preference did not differ ($F_{\leq 2,4} \leq 1.29, P \geq 0.370$) for any of the comparisons. For the spring to summer comparison of shift, we detected a significant difference in habitat availability between seasons ($F_{2,8} = 10.29, P = 0.006$) but not in habitat use ($F_{2,8} = 2.82, P = 0.118$). For the spring to summer comparison of dispersion, a significant difference was detected in habitat availability ($F_{2,11} = 3.10, P = 0.085$) and habitat use ($F_{2,11} = 8.98, P = 0.005$) between seasons. For the summer to

fall-winter comparisons, habitat use differed between seasons for shift ($F_{2,3} = 15.40$, $P = 0.026$) and dispersion ($F_{2,3} = 15.79$, $P = 0.026$). However, there were no differences in habitat availability between seasons for either shift ($F_{2,3} = 1.82$, $P = 0.304$) or dispersion ($F_{2,4} = 1.84$, $P = 0.301$).

Discussion

Individual turkeys varied widely in their patterns of spatial fidelity. For all comparisons, there was a mixture of individuals that either had different seasonal dispersions, displayed spatial shift, had both different dispersions and shifted, or had neither. The lack of consistent patterns among individuals indicates that some factor, operating on an individual level, influenced fidelity decisions of turkeys on our area. The most likely cause was a habitat response.

TWMA is a very heterogeneous landscape (Chamberlain et al. 1996, Miller et al. 1999a), potentially providing turkeys with needed resources without necessitating changes in spatial fidelity. Miller et al (1999a) determined few scale-dependent habitat choices were made by turkeys on TWMA, attributed in part due to their generalistic nature and also due to the great degree of landscape heterogeneity on TWMA. However, our mixed results indicated that although some turkeys were able to meet habitat requirements while maintaining spatial fidelity, other turkeys may have had to change space use patterns to meet habitat requirements. This suggests that there are habitat features that turkeys on TWMA are responding to and that they may change spatial patterns, when needed, to incorporate these features into their home range.

The hypothesis that turkeys on TWMA are responding to habitat features is explicitly addressed by, and supported by, our examination of male habitat choices in relation to spatial fidelity. None of the comparisons for shift or dispersion between males that shifted/dispersed versus those that did not were significant. This indicates that males had similar habitat use patterns regardless of their spatial fidelity. Additionally, although some seasonal differences in habitat use and habitat availability were detected for males that displayed different dispersions or shifted, habitat preferences (use versus availability) did not differ for any comparisons. Males possibly were choosing similar habitat associations, but some males may have had to change spatial patterns to exploit preferred habitat types. Our results indicate that certain habitat associations on TWMA may be important for male turkeys and that they may change spatial patterns to use these associations. The same may be true for female turkeys, especially given they may be more habitat-specific than males (Wigley et al. 1985, Miller et al. 1999a, Miller et al. 2000).

Males on TWMA did not have different dispersional patterns between any seasons. Therefore, it appears that males used their home ranges uniformly, with respect to dispersion, across seasons. This is somewhat surprising given that habitat use patterns of males on TWMA significantly differed across seasons (Miller et al. 1999a) and that breeding activity during spring would be expected to alter a male's movement patterns during spring. Perhaps our sampling intensity was not sufficient to detect differences from breeding behavior. Nevertheless, our results suggest that

males move about their home range similarly among seasons. On TWMA, this may be a reflection of the generalistic habitat use of male turkeys, the great degree of habitat heterogeneity present, and ability of male turkeys to exploit a wide diversity of habitat types and food items (Godwin et al. 1992, Miller et al. 1999a). These factors would lessen the need for males on TWMA to change foraging/movement patterns as seasonal habitat changes occur.

Overall, males displayed spatial shift between spring and summer and summer and fall-winter. On TWMA, males may move to bottomland hardwood stands to associate with females during spring for breeding purposes (Godwin et al. 1992, Miller et al. 1999a). The shift observed between spring and summer may reflect males moving into summer ranges and out of spring breeding ranges. However, males on TWMA had similar habitat preferences during summer and fall-winter (Miller et al. 1999a); it is unclear why males displayed spatial shift between these 2 seasons. Perhaps males were responding to changes in foraging opportunities between summer and fall-winter (e.g., hard mast availability).

Females on TWMA nest almost exclusively in upland pine habitats (Seiss et al. 1990, Miller et al. 1999b). Increased search time for potential nest sites may increase probability that a female turkey will nest successfully (Badyaev et al. 1996, Miller et al. 1999a). In Arkansas, female turkeys that used a larger area were more successful nesters (Badyaev et al. 1996). On TWMA, successfully nesting females associated more with potential nesting habitat than unsuccessfully nesting females, but did not use more area (Miller et al. 1997, 1999a). In the current study, females during preincubation had overall significantly less dispersion of points than during either fall-winter or non-reproduction. This may indicate that females during preincubation were concentrating their movements in potential nesting habitat to optimally sample these habitat types. Lack of statistical significance regarding dispersion between preincubation and brood-rearing may have been from low power ($N=5$) and/or because females with young poults also have restrictive movements, thus negating any dispersal differences due to nest searching.

Different habitat preferences for females between preincubation and summer (brood-rearing or nonreproductive) also may have caused spatial shifts. Although not significant when averaged over all females, 4 of 5 females displayed spatial shift between preincubation and brood-rearing seasons. Additionally, females overall shifted between preincubation and nonreproductive seasons. These differences may be a reflection of females moving from upland nesting sites to bottomland hardwood stands, the preferred habitat type (Miller et al. 1999a) at the end of the nesting period. In addition, females with broods on TWMA preferred bottomland hardwood stands (Phalen et al. 1986), consistent with the observed pattern. The lack of significant spatial shift or different dispersions between nonreproductive season and fall-winter may reflect similar habitat preferences by female turkeys on TWMA during these 2 seasons (Miller et al. 1999a).

Conclusions

Based on our data, it appears that male turkeys on TWMA may opportunistically shift use areas to take advantage of preferred habitat conditions or habitat associations and/or to obtain reproductive opportunities. Observed spatial shifts by turkeys in other areas may be indicative of movements associated with changing habitat needs. As cited in the Introduction, some turkey populations may display spatial shifts to exploit different habitats that are important seasonally (Burk et al. 1990, Smith et al. 1990). Therefore, if managers observe significant spatial shifts, there may be a habitat type or habitat association not readily available so that turkeys must adjust movements to be able to use it. On TWMA, we observed some spatial shifting even given the great degree of habitat heterogeneity. In areas with less heterogeneity, spatial shifting could be conceivably drastic enough to effect turkey survival or to force turkeys to move out of management area boundaries. Investigation of turkey space use patterns in conjunction with habitat preference studies may provide additional insights into habitat use patterns and habitat requirements.

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