NEST SITE FIDELITY IN FEMALE WILD TURKEY: POTENTIAL CAUSES AND REPRODUCTIVE CONSEQUENCES[1]

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Abstract. We studied nest site fidelity of female Wild Turkeys in the Arkansas Ozarks during 1992–94. Sixty-nine percent of surviving females returned to breed on their previous breeding areas. Older females had higher return rate compared to younger females. Females did not appear to base their return decision on the previous year nest success. Females that returned to their previous nesting areas laid larger clutches than females that did not return and nests of returned females survived longer than those of females that moved to new areas. Nest site fidelity did not associate with future reproductive success; nest success of females that returned and those that switched breeding areas was similar. Spring dispersal distance and size of prenesting ranges were similar between females that returned and females that moved to new areas between years. Females that nested in habitats that appeared to provide reduced protection from predation relocated in the following year independently of whether their previous nests actually were depredated. Increased social status and experience may account for correlation between habitat quality and breeding site fidelity.

Key words: breeding dispersal; Meleagris gallopavo; *nest site fidelity; reproductive performance, Wild Turkey.*

INTRODUCTION

Intraspecific differences in fidelity to a previous breeding site may reflect individual variation in balance between the costs of dispersal and the benefits of finding a better quality site (Parker 1983, Real 1990, Switzer 1993, Pärt 1995). Familiarity with local conditions is beneficial, because prior knowledge of foraging resources, nesting sites and local predators could enhance reproductive performance and survival (Hinde 1956, Greenwood 1980, Gavin and Bollinger 1988, Schieck and Hannon 1989, Koivula et al. 1993). In addition, greater dispersal is often costly because of increased predation risk and energetic constraints of extensive movements (Johnson and Gaines 1990). However, relocation between breeding attempts could be advantageous for individuals with poor quality breeding territories (Harvey et al. 1984, Beletsky and Orians 1987) and, if high quality sites are limited, subordinate individuals are expected to increase their reproductive performance by breeding outside of the areas occupied by dominant conspecifics (Johnson and Gaines 1990, Badyaev et al. 1996a).

In this paper we examine potential causes and reproductive consequences of breeding site fidelity in radiomarked female Wild Turkeys (*Meleagris gallopavo*). Previous studies of Wild Turkey populations in the Arkansas Ozarks suggest that the cost of extensive habitat searching in spring is high: (1) most annual mortality is associated with prenesting movements, (2) decreasing probability of nest success as the season progresses favors early nest initiation, and (3) high quality nesting habitats are limited (Badyaev 1995, Badyaev et al. 1996a, 1996b). Thus, prior familiarity with the nesting area should be especially beneficial for birds in our study population. We specifically predict that prenesting movements should be smaller in females that breed within their previous breeding area under the assumption that the extent of prenesting movement associates with habitat sampling (Badyaev et al. 1996a). Alternatively, distribution of suitable habitats could vary between years and females can attempt to improve the quality of their previous habitat by searching for better quality habitats at the beginning of each breeding season (Switzer 1993).

Nest predation strongly affected nest habitat selection in the study populations (Badyaev 1995). Wild Turkeys were also shown to modify selection of habitats for renesting attempts based on previous experience with predation within a season (Badyaev et al. 1996a). Thus, there is some

evidence that experience with predation affects reproductive performance in this species. Under the assumption that past reproductive success is a reliable indicator of future success, we predict that females that were successful in the previous year will return to their previous breeding area, while unsuccessful females will relocate. We also examine reproductive consequences of both fidelity and infidelity to the previous year breeding area. Social dominance and thus, ability to successfully defend a breeding area against younger birds increases with age in Wild Turkeys (Healy 1992). That and increase in benefits of local familiarity with age (Hinde 1956, Greenwood 1980, Pärt 1995, Badyaev et al. 1996a, 1996c) should contribute to higher site fidelity in older birds.

METHODS

This study was conducted on two study sites in the Ozark Mountains, Arkansas. Both study sites—White Rock and Piney Creeks Wildlife Management Areas—are flat-topped mountains (elevation up to 746 m) with numerous narrow valleys. White oak *(Quercus alba)*-red oak (*Q. rubra*)-hickory (*Carya* spp.), and shortleaf pine (*Pinus echinata*)-oak-hickory forest types cover most of both study areas. For a detailed description of the study sites, see Badyaev (1995).

We captured 105 female Wild Turkeys in both study sites during winters 1992–1993 and 1993–1994. All birds were weighed and outfitted with 120 g motion-sensitive backpack-style radio transmitters. Hens were located in different periods of the day every two days during spring dispersal and the nesting season (March–June). See Badyaev et al. (1996b) for details of telemetry protocol. Range overlap, the 95% probability convex estimate of spring home ranges, interlocation distances and associated statistics were computed and analyzed using RANGES IV (Kenward 1990) and the SAS software (SAS Institute 1989). Spring dispersal was the distance between the arithmetic mean of a female's winter range and her first nest. Prenesting range was the 95% convex polygon of the area a female occupied after her initial dispersal move until the start of incubation of her first nest. Initial dispersal movement (associated with winter flock breakup) was defined as a movement greater than the mean of a female's three previous inter-location distances (Badyaev et al. 1996a).

Nest area fidelity was estimated in two ways. First, we calculated overlap between prenesting range in X year (previous year) and prenesting range in X+1 year (following year). Females were considered returned if the overlap was greater than zero and not returned if the overlap was zero. Secondly, we calculated the distance between female first nest in Xth year and her first nest in X+1th year as a continuous measure of nest site fidelity. For females that renested following unsuccessful first nesting attempt, we also measured the distance between renest attempt site of Xth year and the first nest site of X+1 year.

Nest sites were marked by flagging vegetation at 40–50 m from incubating hens. We calculated nest initiation date for most of the nests either by analyzing movement data or telemetry signal pattern (i.e., motionless vs active signal), or by subtracting the days of the egg-laying period (based on clutch size) from the first date of incubation (Schmutz and Braun 1989). Only a small percentage of all nests were successful. Thus, we used the number of days the nest survived (from initiation to predation or other fate) as the relative measure of nest survival. To examine whether previous year' nesting habitat influenced the return decision, we sampled vegetation structure and composition on nest-centered plots that were 20 m in diameter and on adjacent to the nest plots located 40 m from the nest. For site fidelity analyses we pooled these measurements to obtain habitat characteristics of nest area (Badyaev 1995). We measured understory height and overstory density at the center of each plot and at four perimeter points. Litter depth and number of shrub and tree stems were measured along two perpendicular diameters within each plot. Number of stems was counted in the following categories: small tree (<25 cm in diameter at breast height), medium tree (25–45 cm DBH), large tree (>45 cm), small shrub (<3 cm in diameter at 0.1 m height), and large shrub (>3 cm). We used a vegetation profile board (Nudds 1977) to evaluate percentage of visual obstruction at 0–1.0 m height. The profile board was placed at the center of the plot and read from four points at the plot perimeter. It was then placed at four intermediate points 5 m from the center of the plot and read from corresponding points on the plot perimeter at 10 m distance (Badyaev 1995).

TABLE 1. Body mass and reproductive performance [mean ± SD (n)] of female Wild Turkeys that returned to the previous nesting area and those that did not return. P-values are for comparisons of means between females that returned and did not return to their previous breeding area. See text for significance of changes in reproductive performance between year X and X + 1 within each fidelity class.

Variable		Returned	Did not return	P
		Year X		
Body mass, kg		4.4 ± 0.6 (22)	4.2 ± 0.5 (10)	0.2
Nest initiation, date	First nest	14 April ± 12.4 d (22)	17 April ± 10.4 d (10)	0.2
	Renest	14 May ± 19.8 d (7)	11 June (1)	—
Duration of breeding attempt before depredation,[a] d	First nest	25.3 ± 8.1 (12)	24.4 ± 14.2 (5)	0.6
	Renest	26.7 ± 5.6 (6)	25.0 (1)	—
Clutch size		11.0 ± 2.4 (10)	10.0 ± 1.3 (6)	0.09
Nest success, rate[b]		0.30 ± 0.1 (6)	0.25 ± 0.1 (2)	0.8
		Year X + 1		
Nest initiation, date	First nest	19 April ± 9.9 d (20)	15 April ± 11.1 d (10)	0.4
	Renest	15 May ± 3.5 d (4)	17 May ± 17.0 d (2)	—
Duration of breeding attempt before depredation, d	First nest	27.0 ± 10.5 (11)	32.0 ± 8.8 (5)	0.3
	Renest	19.0 ± 2.8 (2)	22.0 (1)	—
Clutch size		9.5 ± 2.8 (12)	11.2 ± 1.3 (7)	0.1
Nest success, rate		0.22 ± 0.09	0.29 ± 0.18	0.7

[a] Egg-laying plus incubation.
[b] Standard deviation estimated with equations for binomial distributions.

RESULTS

SITE FIDELITY, AGE, AND NEST PREDATION

Twenty two of 32 females (69%) returned to their previous nesting areas. Return rates did not differ between two study sites (59% vs. 75% in White Rock and Piney Creeks correspondingly; $G = 0.95$, $P = 0.3$). More females returned to their previous nesting areas in 1993 than in 1994 ($G = 4.43$, $P = 0.03$), but the difference was confounded by age of returning females; return rate was similar between years when age of females was controlled. Thus, data were pooled across years and study areas. Three-year-old (TY) females had much lower probability of returning to their previous nesting area than after-third-year (ATY) females (25% vs. 83%; $G = 9.13$, $P < 0.01$). Return rate of females that were successful in Xth year did not differ from that of unsuccessful females (75% vs. 70%, $G = 0.07$, $P = 0.8$). Site fidelity did not contribute to nest success in X+1 year; nest predation rate in X+1 year was similar between returning and not returning females (67.0% vs. 74%; $G = 0.11$, $P = 0.74$; Table 1). However, nests of returned females survived longer before depredation in X+1 year as compared to X year than the nests of females that did not return ($F_{1,20} = 3.74$, $P = 0.06$).

In returning females, the percent of overlap between X and X+1 breeding areas positively correlated with female age ($F_{2,28} = 7.17$, $P = 0.01$; Table 2) and previous nesting success ($F_{2,28} = 4.05$, $P = 0.05$). Distance between first nest in X year and first nest in X+1 year significantly negatively covaried with female age ($F_{2,27} = 14.69$, $P < 0.001$, Table 2), but not with previous nesting success ($F_{2,27} = 0.01$, $P = 0.9$). Distance between renest site in X year and first nest in X+1 year also significantly negatively covaried with female age ($F_{2,7} = 6.87$, $P = 0.04$), but not with Xth year nesting success ($F_{2,7} = 0.27$, $P = 0.62$).

SITE FIDELITY AND REPRODUCTIVE PERFORMANCE

Returning females initiated their nests later in X+1 year than in Xth year ($t = 2.27$, $P = 0.03$; Table 1). There were no other changes in their reproductive performance between X and X+1 years (all t's < 2.0, P's > 0.2). There were no changes in any measured reproductive performance parameters between X and X+1 years in females that did not return (all t's < 1.11, P's > 0.3). Returning females tended to initiate nests later in the X+1 year ($F_{1,30} = 2.86$, $P = 0.08$), and had larger clutch sizes in Xth year than females that did not return ($F_{1,8} = 5.28$, $P = 0.05$).

TABLE 2.   Measures of breeding site fidelity [mean ± SD (n)] for TY (third year) and ATY (after third year) female Wild Turkeys. P-values are for mean comparisons between TY and ATY females.

Variable	TY females	ATY females	P
Distance between nests, m			
First (X) to First (X + 1)	5,694.8 ± 3,403.4 (8)	1,775.9 ± 1,258.7 (22)	0.0001
Renest (X) to First (X + 1)	4,619.0 (1)	2,045.9 ± 615.3 (7)	—
Overlap between nest areas, %			
First (X) by First (X + 1)	0.9 ± 2.5 (8)	26.0 ± 27.2 (24)	0.003
Renest (X) by First (X + 1)	0.0 ± 0.0 (2)	6.6 ± 10.7 (7)	—

SITE FIDELITY AND SPRING DISPERSAL

To examine whether high nest site fidelity was associated with reduced movements in spring (i.e., whether returning birds simply winter in their breeding areas), we compared spring dispersal distances and prenesting ranges of returning females and females that did not return in X+1 year (Table 3). Females that returned traveled the same distance in spring ($F_{1,30} = 0.2$, $P = 0.7$) and covered similar prenesting ranges ($F_{1,30} = 0.03$, $P = 0.9$) as females that did not return. In returning females there were no changes in spring dispersal distance or prenesting ranges between X and X+1 years (Table 3).

SITE FIDELITY AND PREVIOUS NESTING HABITAT

Returning females and females that did not return in X+1 year nested in different habitats in Xth year (Table 4). Vegetation parameters that differed between nests of returning and not returning females included understory height, number of shrubs, litter depth, distance to road, and overall visual obstruction (Table 4). These parameters strongly affected nest predation probability (Badyaev 1995).

DISCUSSION

Female Wild Turkeys showed strong age-biased site fidelity; as predicted, older females were more likely to use their previous nesting areas than younger females. Age-biased breeding dispersal could be promoted by gains in local familiarity with age and social interactions between subdominant young and dominant older birds (Hinde 1956, Greenwood 1980, Waser 1985, Johnson and Gaines 1990, Badyaev et al. 1996c). If local familiarity contributes to increased reproductive performance and local experience increases with age, then selection should favor increased site fidelity by older birds (Greenwood 1980, Pärt 1995). In our study sites, a seasonal increase in nest predation and limitation of suitable nest habitats restricted time available for nest habitat sampling prior to nesting. However, returning females neither initiated their nests earlier than in the previous year, nor earlier than not returning females. Returning females had potentially higher reproductive performance than females that did not return because the former laid larger clutches than in the previous year and their new nests survived longer than those of not returning females. However, nests of females that returned to their previous nesting area were not less likely

TABLE 3.   Measures of spring dispersal [mean ± SD] of returned female Wild Turkeys and those that did not return to their previous breeding area. P-values are for significance of changes between year X and year X + 1 within each fidelity class. See text for significance of changes between returned and not returned females.

Variable	Year X	Year X + 1	P
	Returned ($n = 22$)		
Spring dispersal distance, m	3,825.4 ± 2,770.4	2,528.8 ± 2,086.6	0.14
Prenesting range, ha	471.7 ± 319.6	484.3 ± 546.8	0.70
	Did not return ($n = 10$)		
Spring dispersal distance, m	3,221.5 ± 2,586.2	2,417.0 ± 2,413.4	0.31
Prenesting range, ha	506.8 ± 428.1	407.0 ± 628.2	0.37

TABLE 4. Means (range) of habitat variables at nest areas of 15 female Wild Turkeys that returned to the previous nesting area and eight that did not return. See Badyaev (1995) for details of measurements. Untransformed values are shown here, normalized data were used for statistical tests.

Variable	Returned	Did not return
Understory height (center) (cm)	205.0 (51.1)	185.0 (60.3)*
Understory height (medium) (cm)	175.0 (58.5)	66.3 (57.9)
Overstory density (%)	49.8 (85.0)	69.8 (86.7)
Small shrubs (no)	205.0 (72.6)	84.0 (49.3)*
Large shrubs (no)	120.0 (47.6)	69.0 (40.0)*
Small trees (no)	155.0 (61.4)	141.0 (73.8)
Large trees (no)	31.0 (14.6)	27.0 (11.5)
Litter depth (cm)	5.3 (3.7)	1.9 (4.36)*
Slope (%)	61.0 (28.1)	55.0 (42.5)
Distance to road (m)	290.0 (50.0)	68.0 (24.7)*
Distance to edge (m)	83.7 (72.5)	76.2 (70.9)
Distance to large tree (m)	10.0 (1.2)	20.0 (4.4)*
Visual obstruction, category	3.2 (4.3)	2.3 (4.2)*

* $P < 0.05$, Kruskal-Wallis test—nests of returned vs. not returned females.

to be depredated compared with nests of females that nested in new areas. Females did not appear to make return decisions based on their previous year nest success because return rates were similar between successful and unsuccessful females. This does not indicate that experience with predation is not important for return decisions; ultimately successful females could "witness" high density of predators in their nesting area and thus abandon it in the following year. In birds that returned to their previous nesting areas, those that were successful in the previous year searched for their new nest sites mostly within the area they selected the previous year (Table 3), thus indicating the importance of local familiarity with juxtaposition of available nesting areas.

Returning to the previous year's nesting area was not associated with reduced movements between wintering and breeding area because both returning and not returning birds winter in common flocks (Badyaev et al. 1996b). Wild Turkey hens search for suitable nesting habitat after spring dispersal and size of prenesting range indicates the intensity of habitat sampling (Badyaev et al. 1996a). If prior experience with predation and

local familiarity enhance habitat sampling efficiency (Parker 1983, Real 1990, Pärt 1995), then renesting ranges of returning females should be smaller than both their previous years' ranges and those of not returning females. Contrary to this prediction, there were no changes in prenesting ranges between years in returning females and no differences in renesting ranges between returning and not returning females.

Alternatively, females may attempt to improve their previous habitat search by examining unoccupied habitats of higher quality every spring (Parker 1983, Real 1990). Indeed, return decisions were associated with characteristics of previous year nest areas. Birds that occupied areas that appeared to provide greater protection from nest predation tended to nest within this area in the next year, while birds that occupied nesting habitat that provided less protection against nest predation moved to a different area (Table 4; Badyaev 1995). This correlation between characteristics of previous nest-sites which were closely linked to predation avoidance and breeding site fidelity might be associated with an increase in age and thus, greater competitive abilities; social dominance of older birds over younger may account for age-biased site fidelity (Waser 1985). In Wild Turkeys, older males and females commonly move shorter distances between wintering and breeding grounds compared to younger birds (Badyaev et al. 1996b, 1996c). Longer spring dispersal of subdominants could be driven by improved chances of their successful breeding outside of areas already occupied by dominant individuals and by reduced risk of inbreeding (Johnson and Gaines 1990). Territorial behavior of older females could reduce population density when good quality habitats are limited, as has been documented for grouse species (Jenkins et al. 1963, Boag et al. 1979). There is some anecdotal evidence of aggressive territorial interactions between dominant and subdominant females Wild Turkeys (AVB, pers. observ.). However, the influence of female-female interactions on dispersal patterns has yet to be examined in this species.

In sum, nest site fidelity in female Wild Turkeys was mostly affected by age; older females had higher return rates to their previous nesting sites than younger females. Unpredictable local patterns of nest predation may account for a lack of relationship between previous and future nest success. Previous year nesting habitat of return-

ing females differed from that of non-returning females in characteristics that were important for nest predation avoidance. Increased social status and individual experience may account for the correlation between habitat quality and breeding site fidelity.

ACKNOWLEDGMENTS

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