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Spatial and Temporal Variation in Female Wild Turkey Roost Site Selection

By

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Abstract:

Nocturnal roost sites are a habitat requirement for *Meleagris gallopavo silvestris* (Eastern Wild Turkey), and appropriate roost sites lessen predation risk and provide thermal protection from extreme weather. Most prior research has focused on male roost site selection, typically within a single publicly owned property. We assessed roost site selection of female Wild Turkeys in relation to distance to road, water, and opening on privately owned properties across the three main ecoregions of North Carolina. We captured and monitored 355 individuals and collected 64,924 roost locations from 2020-2022 during the leaf on (March 15 to October 31) and leaf off (November 1 to March 14) seasons, which were based roughly on the phenology of deciduous trees. We used backwards stepwise selection to determine the best fit GLM model that included year, leaf season, region, and distance to water, road, and opening as predictors of roost site selection. Female turkeys roosted closer to water (mean=138.0, SE=0.4047) than random (mean=160.7, SE=0.4872) consistently across leaf seasons and regions. The best fit model included an interaction between leaf season and distance to road and interaction between leaf season and distance to opening. Wild Turkeys selected roost locations closer to roads (mean=507.9, SE=1.562) than random (mean=539.4, SE=1.786) during the leaf on season but not during the leaf off season. Similarly, female Wild Turkeys selected roost locations closer to open land cover (mean=134.2, SE=1.088) than random (mean=167.1, SE=1.151) during the leaf on season but not during the leaf off season. Selection was generally consistent across regions, indicating that efforts to conserve roosting areas can be applied uniformly across broad geographic scales.

Introduction

An important habitat requirement for *Meleagris gallopavo silvestris* Vieillot (Eastern Wild Turkey; hereafter, Wild Turkey) is the availability of nocturnal roost sites, which provide protection from extreme weather and predation. In fact, Wild Turkey distribution may be limited by the absence of appropriate roosting cover (Boeker and Scott 1969). Roost sites may be especially important in the winter, because of high mortality rates during extreme weather (Healy 1992). Wild Turkeys roost communally year-round, except for the duration of the nesting period in females. Although some attributes of roost trees, such as species, height, and diameter, have been examined (Kilpatrick et al. 1988), there has been less research on the larger-scale characteristics of roost sites such as proximity of critical landscape features. Additionally, most prior research has focused on male roost site selection, typically within relatively homogeneous publicly owned properties.

Wild Turkeys may select roost sites in proximity to specific landscape features, including water, roads, or openings. For example, bottomland hardwood forests near permanent water sources commonly serve as roost sites in the southeastern United States, (Kimmel and Swank 1985, Still and Baumann 1989, Zwank et al. 1988) and Wild Turkey roost sites have been associated with proximity to water sources (Chamberlain et al. 2000, Kilpatrick et al. 1988). Additionally, female Wild Turkeys may select roost sites that are farther from roads or non-forested openings because they lack trees for roosting (Sasmal et al. 2018). Merriam Wild Turkeys (*M. gallopavo merriami*) have avoided roosting in areas less than 200m from roads

(Rogers et al. 1999). Additionally, openings, fences, and vehicle presence associated with roads may contribute to Wild Turkey avoidance (McDougal et al. 1990).

In female eastern Wild Turkeys, the influence of landscape features on roost site selection could be related to the time of year, because individuals transition through various behavioral states (Adey 2021). Wild Turkeys may select coniferous trees as roosts during the leaf-off season because of their thermal benefits relative to deciduous trees that drop their leaves during dormancy (Schmitz 1991). The leaf-on period for deciduous trees generally includes the pre-nesting, nesting, and brood-rearing periods for Wild Turkeys. Female Wild Turkeys selected roost sites closer to water during pre-nesting season and farther from roads and edges and in older forest during brood-rearing season (Chamberlain et al. 2000). Female Wild Turkeys may select roosting cover intentionally by moving throughout the day to arrive at a certain roost site, or individuals may simply fly up to roost at the closest available site at the end of the day (Chamberlain et al. 2000). Regardless, the roost sites used inevitably depend on what is available within an individual's home range.

Most studies of Wild Turkey roosting have quantified roost site selection within a single landscape, so concurrent investigation of the variation in roost site characteristics among different regions may be of value. Regional differences in land use and other biotic or abiotic characteristics may affect how female Eastern Wild Turkeys select roost sites. Regional emphasis on specific management practices, such as timber harvest or prescribed burning, could affect roost availability for Wild Turkeys. For example, in frequently burned upland longleaf pine (*Pinus palustris*) communities, roost site selection was concentrated in lowland hardwood areas that represented only a small percentage of the landscape (Sasmal et al. 2018). In another study, brooding females selected roost sites in forest stands not recently burned (3–6 years post-fire) because these areas had dense understory cover and decreased visual obstruction (Wood et al. 2018). Dominant vegetation types and topographic characteristics commonly vary regionally, which in turn could drive regional variation in female Wild Turkey roost selection.

To describe predictors of Wild Turkey roost site selection and to investigate how these relationships may vary regionally and between the leaf on and leaf off seasons, we documented female Wild Turkey roost site selection in each of the three major geographic regions (Coastal Plain, Piedmont, Mountain) of North Carolina. We investigated female roost site selection during the leaf-on and leaf-off seasons over three years (2020-2022). We focused our selection analysis on three spatial covariates – distance to water, openings, and roads. We expected that there would be a regional effect, as well as a seasonal effect. We expected turkeys to roost closer to water bodies in all three regions. Lastly, we expected Wild Turkeys to avoid roosting near roads and openings in all three regions.

Field Site Description

We captured, tagged, and monitored Wild Turkeys across North Carolina's three physiographic regions between 2020 and 2022. The capture area included eight counties across the Coastal Plain (Bladen, Duplin, and Sampson), Piedmont (Moore), and Mountain (Madison, McDowell, Mitchell, and Yancey) regions. All properties where we captured Wild Turkeys were privately

owned, but some bordered public lands. The topography of the Coastal Plain was relatively homogeneous (0-30m elevation), with a climate of mild winters and warm, humid summers, and annual precipitation averaging 160 cm/year. Land use primarily was commercial poultry and swine production embedded in cropland and unmanaged forest. The Piedmont study area had moderate variation in topography (75–180 m elevation), with a climate defined by mild winters and warm, humid summers, and annual precipitation averaging 120 cm/year. Land use on the properties was timber harvest, sometimes paired with prescribed burning, row-crop agriculture, and commercial poultry production. Many of the properties were managed to create and maintain habitat for specific wildlife, including white-tailed deer (*Odocoileus virginianus*) and Wild Turkey. The Mountain study area was comprised of heterogeneous topography (500-1800m elevation). Cool summers and mild winters typified the climate of the region, with annual precipitation of 130–250 cm/year, primarily as rain. The land use primarily was timber harvest, livestock grazing, and hay production. The combined areas of trapping properties were 3041, 3074, and 2843 ha within the Mountains, Piedmont, and Coastal Plain ecoregions, respectively.

Capture and Monitoring Methods

We captured and monitored Wild Turkeys in each of the three eco-regions from 2 January to 31 March during 2020, 2021, and 2022, using rocket nets fired over sites pre-baited with cracked corn (Dill and Thornsberry 1950). All field personnel were required to complete an operation and safety training course before participation in rocket netting. We captured and aged Wild Turkeys as adults or juveniles by the contour of the rectrices and censored mortalities that occurred within 7 days of capture (Pelham and Dickson 1992). We also marked each individual with a uniquely numbered aluminum rivet leg band. Female Wild Turkeys were fitted with a GPS-VHS backpack-style radio transmitter manufactured by Lotek/Biotrack Limited, Wareham, UK. Our goal was to monitor at least 50 female Wild Turkeys in each region each year over a three-year period.

We programmed GPS transmitters to collect locations every 1 hour from 0500 to 2000 and at 23:58:58 (i.e., roost location) daily during the reproductive period (1 March through 1 September) to allow precise detection of nest locations and to document nesting chronology (Conley et al. 2016). Outside of the reproductive period (1 September – 31 August), transmitters collected only a single roost location ats 23:58:58 daily. We limited the percentage of subadult Wild Turkeys (i.e., jennies) in the sample to <25% of all tagged individuals. We remotely downloaded the GPS locations for each individual Wild Turkey ~2 times per week during the reproductive period and approximately twice per month otherwise. All handling and capture operations were authorized under the NCSU Institutional Animal Care and Use Committee (protocol 19-739-O).

Analysis

We censured incubation dates from analysis because females do not roost during incubation. We assigned the leaf on (March 15 to October 31) and leaf off (November 1 to March 14) seasons based roughly on the phenology of deciduous trees (Table 1). We were interested in examining selection of roost sites within each individual's home range. We created

autocorrelated kernel density estimates (AKDE) to calculate each individual's home range following Fleming et al. (2015), using the 'ctmm' (version 4.2.1) package in program R version 4.2.2 (Calabrese et al. 2016, R Core Team 2022). We generated a number of random locations equal to the number of roost locations within each female Wild Turkey's home range. Each random location was selected within the forested areas based on a simplified 2019 National Land Cover Dataset, which we downloaded from the Multi-Resolution Land Characteristics Consortium (Dewitz 2021). We combined land cover into three unique classifications categorized as open (Barren Land, Shrub/Scrub, Grassland/Herbaceous, Sedge/Herbaceous, Pasture/Hay and Cultivated Crops), water (Open Water and Emergent Herbaceous Wetlands), and forest (Deciduous Forest, Evergreen Forest, Mixed Forest and Woody Wetlands). We obtained the location of all state-maintained roads from the North Carolina Department of Transportation website (NCDOT 2023; Table 1). Using the near tool on ArcGIS Pro 2.9.1 (ESRI 2015), we estimated distances to the nearest open land cover, water source, and road (Table 1).

We used a Generalized Linear Model (GLM) to examine selection comparing used versus random sites. Our analysis included six covariates – region (Coastal Plain, Piedmont, Mountain), year, distance to open, distance to water, distance to road, and leaf season (leaf on/off). We included interactions between leaf season and each of the three distance measures, as a means to investigate whether the influence of these covariates on roost site selection changed seasonally. We constructed a global model with all of the covariates and relevant interactions using the glm function in the 'stats' package (R Core Team 2022). We used backwards stepwise selection based on Akaike's Information Criterion (AIC) to identify the best fitting model ('MASS' package, version 7.3-58.2) (Venables 2002).

Results

We captured 371 female Wild Turkeys from 2020-2022 but 16 individuals were censored because of early mortality or GPS tag failure. Therefore, we monitored roost site selection for 355 female Wild Turkeys and collected 64,924 locations, which excludes 5,419 locations collected during incubation. We monitored 132 individuals in the Coastal Plain, 106 in the Piedmont, and 117 in the Mountains, and collected 22,648 roost locations in the Coastal Plain, 20,392 locations in the Piedmont, and 21,884 locations in the Mountains (Table 2). A majority (68%) of roost locations were during the leaf on season.

The best model included distance to opening, distance to road, distance to water, year, region, leaf season, and interactions between leaf season and distance to road and between leaf season and distance to opening (Table 3). Female Wild Turkeys selected roost sites closer to water (mean=138.0, SE=0.4047) than random (mean=160.7, SE=0.4872) regardless of leaf season ($P < 0.001$; Table 3, Table 4). Wild Turkeys selected roost locations closer to roads (mean=507.9, SE=1.562) than random (mean=539.4, SE=1.786) during the leaf on season but not during the leaf off season (Figure 1; Table 4). Female Wild Turkeys selected roost locations closer to open land cover (mean=134.2, SE=1.088) than random (mean=167.1, SE=1.151) during the leaf on season but not during the leaf off season (Figure 2; Table 4). Selection generally was consistent across regions during the leaf on season, with Wild Turkeys selecting roost sites closer to water, openings, and roads in all 3 regions (Table 5). During the leaf off season, Wild Turkeys

roosted closer to water in all 3 regions but relationships with distance to roads and openings were less consistent among regions (Figures 3-5; Table 5).

Discussion

We documented female eastern Wild Turkey roost site selection in relation to specific landscape features, across two seasons and three regions. Proximity to water was the landscape feature that most consistently predicted roost site selection, and Wild Turkeys roosted closer to water bodies regardless of leaf season and region. Distance to openings and roads were less important predictors of roost site selection, especially during the leaf off season. Leaf season was the strongest predictor of roost site selection and had the largest effect size. Region also was a significant predictor of roost site selection, but the slope and direction of the relationships between distance to water, opening, and roads and roost site selection generally were similar among regions.

The importance of road and opening proximity varied among leaf seasons, as food and cover resources likely changed concurrently. Female Wild Turkeys selected roosts closer to openings and roads during the leaf on season more than during leaf off, likely because openings, including cropland, and roadsides contain more lush herbaceous vegetation as food and cover for Wild Turkeys during the growing season (Rumble and Anderson 1996). During the leaf off season, many herbaceous plants enter dormancy and Wild Turkeys shift their diets away from invertebrates to soft and hard mast (Rumble and Anderson 1996). Hard mast, especially acorns, is available in mature forests which would indirectly lead foraging Wild Turkeys further away from openings and roads during the leaf off season (Johnson et al. 1995). Additionally, openings, roadsides, and the more sunlit areas immediately adjacent to these areas have herbaceous and patchy woody understory vegetation that provide nesting and brooding cover for female Wild Turkeys, which have been reported to roost closer to roads and other types of edges (Chamberlain et al. 2000). Female selection for roost sites closer to open land cover during the leaf on season reinforces the importance of herbaceous plant communities as a source food and cover during the pre-nesting, nesting and brooding periods.

Similar to other studies, the female Wild Turkeys in our study consistently roosted near water sources (Boeker and Scott 1969, Kilpatrick et al. 1988, Kimmel and Swank 1985). Wild Turkeys may seek water for drinking after descending from their nocturnal roost locations (Wheeler 1948), and greater forage quality near water bodies could explain the selection for roosting in proximity to water sources (Chamberlain et al. 2000). Additionally, roosting nearby or over water could offer favorable thermal conditions or reduced risk from predation. Forest managers should establish streamside management zones (SMZ) that remain unharvested to conserve roost sites for wild turkeys adjacent to streams and other water bodies. In fact, Wild Turkeys have been documented using SMZs of medium (84-104 m) to wide length (170-179 m) for traveling, roosting and foraging (Burk et al. 1990).

Female Wild Turkeys in our study did not avoid roads as has been reported previously (Rogers et al., 1999). Elevated vehicle presence may contribute to Wild Turkey avoidance of areas near roads (McDougal et al. 1990), but many of the roads in our study areas were

secondary or had low traffic volumes because of the rural landscape context. Consistent with our observation that the importance of road proximity changed seasonally, Adey (2021) reported that winter roosts (i.e., leaf off) were farther from roads than summer or year-round roosts.

Roost sites likely were not a limiting factor on most of the areas where we monitored Wild Turkeys, although many of the Coastal Plain properties were dominated by agricultural land cover, which had fewer trees than in the other 2 regions. Roost site selection by female Wild Turkeys generally was consistent across the 3 regions of our study, indicating that efforts to conserve roosting areas can be applied consistently across broad scales. Managers should consider the importance of landscape elements, such as availability of water sources, when managing landscapes for eastern Wild Turkeys.

Acknowledgments

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Figures and Tables

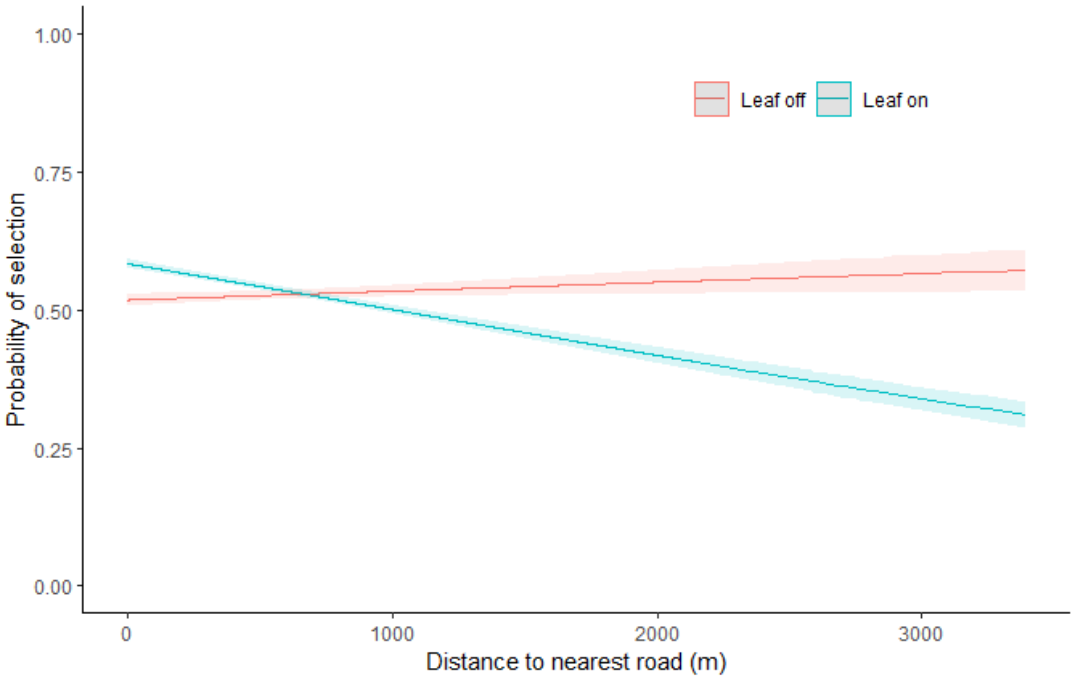

Figure 1. The probability of female Wild Turkey roost site selection in relation to distance to road by leaf season in 2020-2022, North Carolina.

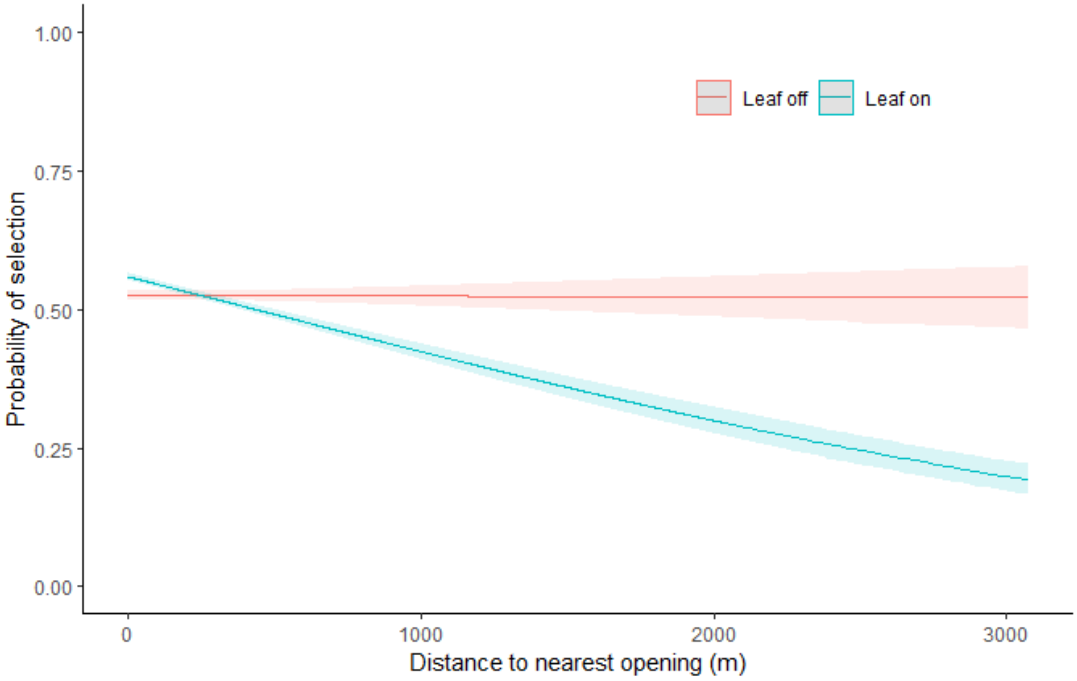

Figure 2. The probability of female Wild Turkey roost site selection in relation to distance to opening by leaf season in 2020-2022, North Carolina.

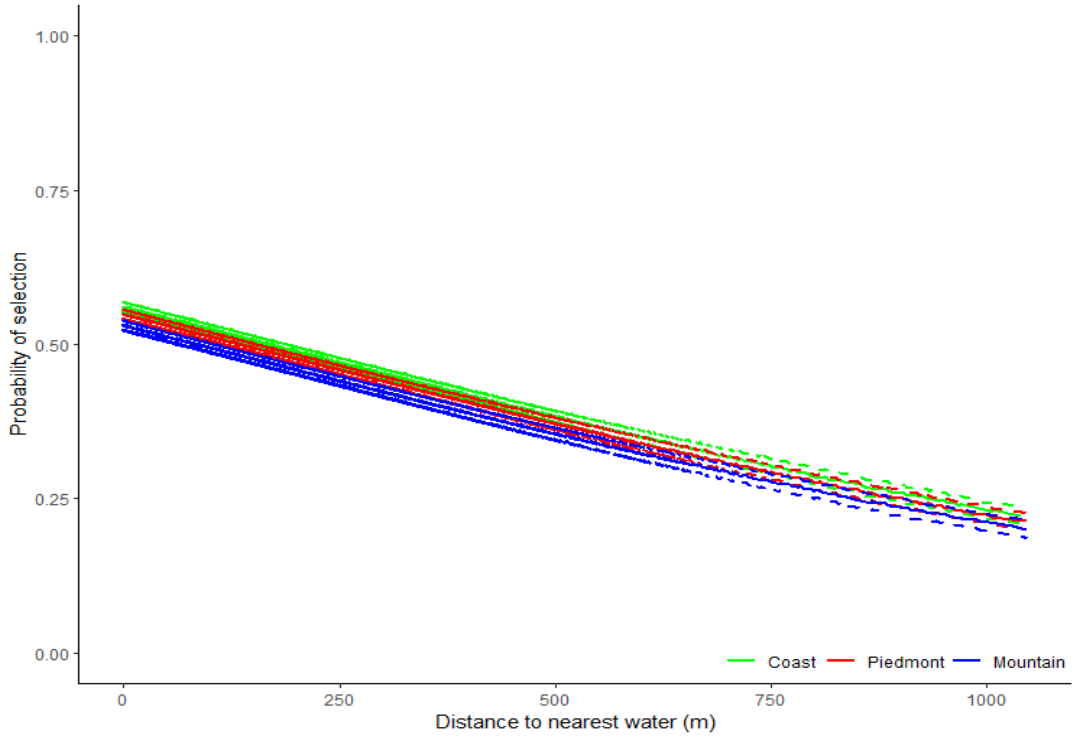

Figure 3. The probability of female Wild Turkey roost site selection in relation to distance to water for each of the 3 regions, 2020-2022, North Carolina.

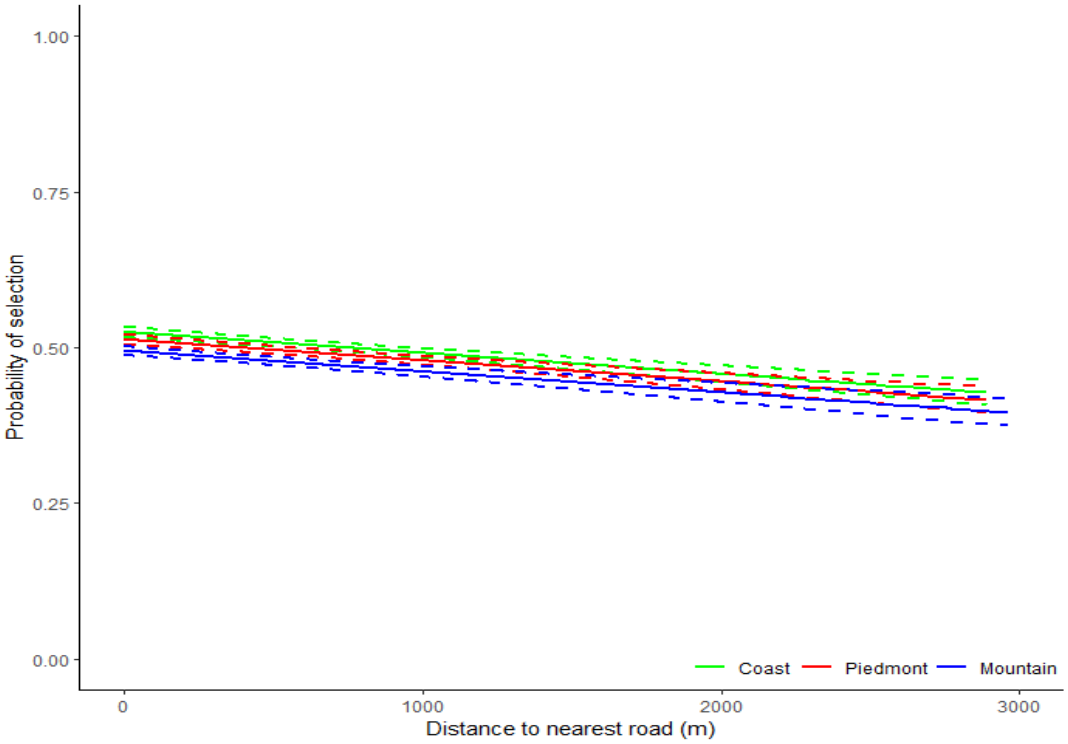

Figure 4. The probability of female Wild Turkey roost site selection in relation to distance to road for each of the 3 regions, 2020-2022, North Carolina.

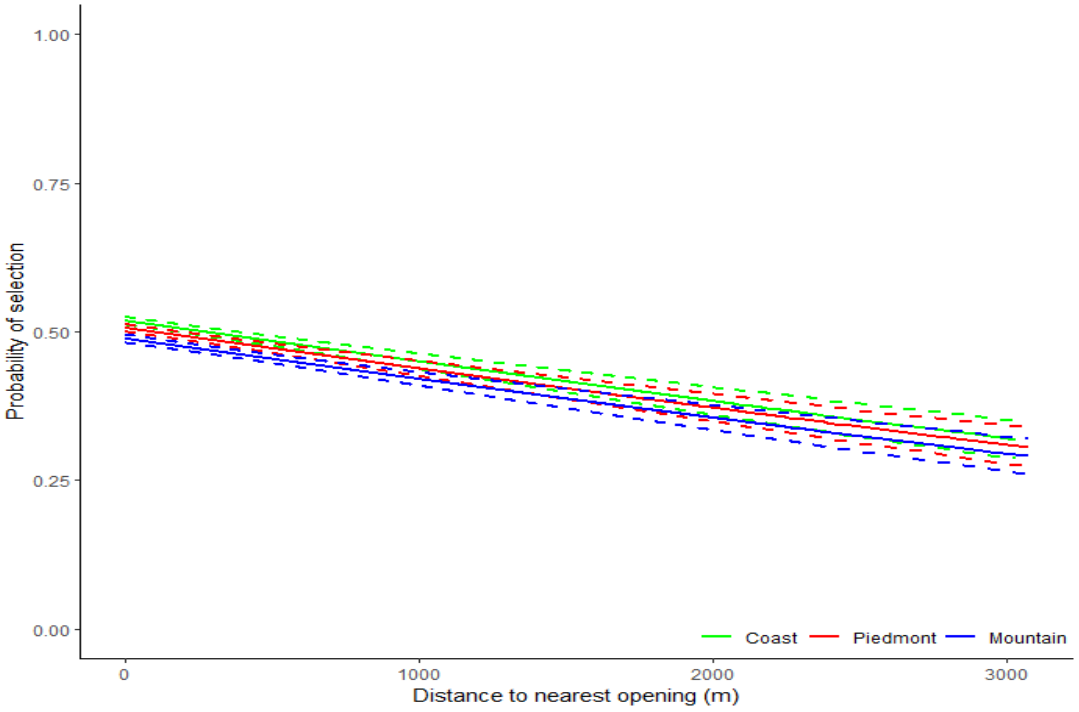

Figure 5. The probability of female Wild Turkey roost site selection in relation to distance to opening for each of the 3 regions, 2020-2022, North Carolina.

Table 1. Description of the covariates used in female eastern Wild Turkey roost site selection analysis in the Coastal Plain, Piedmont, and Mountain regions of North Carolina (2020-2022).

Covariates	Description
Distance to opening	We used a simplified 2019 National Land Cover Dataset (NLCD), and we defined it as: Barren Land, Shrub/Scrub, Grassland/Herbaceous, Sedge/Herbaceous, Pasture/Hay and Cultivated Crops.
Distance to water	We used a simplified 2019 NLCD, and we defined it as: Open Water and Emergent Herbaceous Wetlands.
Distance to road	We used the NCDOT State Maintained Roads from the NCDOT.GOV website.
Leaf season	Leaf on (March 15 to October 31) and leaf off (November 1 to March 14) were loosely based on the phenology of deciduous trees. The two seasons also roughly capture the reproductive period (leaf on) and non-reproductive period (leaf off).

Table 2. Number of female Wild Turkeys (N) monitored for roost site selection in 2020, 2021, and 2022 and in all years combined.

Region	N (2020)	N (2021)	N (2022)	N (all years)
Coastal Plain	50	51	72	132
Piedmont	57	56	32	106
Mountain	66	56	40	117

Table 3. Best fit model predicting female Wild Turkey (N=371) roost site selection, including the Estimate, standard error (SE), standard score (Z) and P value [(Pr(>|z|)] during 2020-2022, North Carolina.

	Estimate	SE	Z	Pr(>|z|)
Intercept	0.225138	0.02444	9.211874	3.20E-20
Distance to Road	6.53E-05	2.80E-05	2.329797	0.01981691
Distance to opening	-4.28E-06	3.96E-05	-0.10809	0.913924
Distance to water	-0.00143	4.29E-05	-33.3793	2.73E-244
2021	-0.02432	0.013237	-1.83747	0.06614093
2022	-0.02549	0.014448	-1.7645	0.07764743
Piedmont	-0.04814	0.014065	-3.42254	0.00062039
Mountain	-0.1203	0.015252	-7.88736	3.09E-15
Leaf season	0.309764	0.022545	13.73999	5.85E-43
Distance to road with leaf season	-0.0004	3.29E-05	-12.1622	4.94E-34
Distance to opening with leaf season	-0.00054	4.82E-05	-11.1911	4.51E-29

Table 4. Means and associated standard error (SE) for covariates at female wild turkey roost sites and random locations by leaf season and for both seasons combined, North Carolina, 2020-2022.

		All regions			
		Roost		Random	
Season	Variable	Mean	SE	Mean	SE
Leaf on	Water (m)	138.1	.596	159.6	.6501
	Open (m)	134.2	1.088	167.1	1.151
	Road (m)	507.9	1.562	539.4	1.786
Leaf off	Water (m)	135.2	.9964	160.0	1.068
	Open (m)	188.1	2.161	179.5	2.028
	Road (m)	544.2	2.958	548.6	2.987
Leaf on and off	Water (m)	138.0	.4047	160.7	.4872
	Open (m)	170.1	.7506	170.4	.9138
	Road (m)	507.8	1.105	542.1	1.362

Table 5. Means and associated standard error (SE) for covariates at female Wild Turkey roost sites and random locations by leaf season and region (Coastal Plain, Piedmont and Mountain), North Carolina, 2020-2022.

		Coastal Plain				Piedmont				Mountain			
		Roost		Random		Roost		Random		Roost		Random	
Season	Variable	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Leaf on	Water (m)	171.0	1.187	194.2	1.336	129.5	1.009	161.7	1.066	106.3	.7529	121.1	.7789
	Open (m)	88.4	1.403	107.4	.8538	116.4	.9301	125.2	.9475	198.5	2.652	267.5	3.015
	Road (m)	592.2	2.416	620.5	3.009	581.7	3.077	600.3	3.254	311.3	2.002	398.9	2.709
Leaf off	Water (m)	161.9	2.201	201.0	2.357	139.5	1.544	168.5	1.705	96.6	1.149	113.1	1.185
	Open (m)	143.6	2.769	108.1	1.419	148.5	1.654	121.7	1.405	267.4	5.485	303.9	5.260
	Road (m)	577.5	4.941	628.6	5.252	692.3	5.164	612.8	5.188	346.1	3.845	410.1	4.589