5-29-2024

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Recommended Citation

Bakner, N., Ulrey, E., Wightman, P., Gulotta, N., Collier, B., & Chamberlain, M. (2024). Spatial roost networks and resource selection of female wild turkeys. *Royal Society Open Science, 11* (5) https://doi.org/10.1098/rsos.231938

ROYAL SOCIETY OPEN SCIENCE

royalsocietypublishing.org/journal/rsos

Research

Cite this article: Bakner NW, Ulrey EE, Wightman PH, Gulotta NA, Collier BA, Chamberlain MJ. 2024 Spatial roost networks and resource selection of female wild turkeys. *R. Soc. Open Sci.* **11**: 231938.
https://doi.org/10.1098/rsos.231938

Received: 13 December 2023
Accepted: 11 April 2024

Subject Category:
Ecology, conservation, and global change biology

Subject Areas:
ecology, behaviour, environmental science

Keywords:
avian, behaviour, resource selection, roost, spatial network, wild turkey

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Spatial roost networks and resource selection of female wild turkeys

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Wildlife demography is influenced by behavioural decisions, with sleep being a crucial avian behaviour. Avian species use roost sites to minimize thermoregulation costs, predation risk and enhance foraging efficiency. Sleep locations are often reused, forming networks within the home range. Our study, focusing on female eastern wild turkeys (*Meleagris gallopavo silvestris*) during the reproductive season, used social network analysis to quantify both roost site selection and network structure. We identified roost networks which were composed of a small percentage of hub roost sites connecting satellite roosts. Hub roosts were characterized by greater values of betweenness (β = 0.62, s.e. = 0.02), closeness (β = 0.59, s.e. = 0.03) and eigenvalue centrality (β = 1.15, s.e. = 0.05), indicating their importance as connectors and proximity to the network's functional centre. The probability of a roost being a hub increased significantly with greater eigenvalue centrality. Female wild turkeys consistently chose roost sites at lower elevations and with greater topographical ruggedness. Hub roost probability was higher near secondary roads and further from water. Our research highlights well-organized roost site networks around hub roosts, emphasizing the importance of further investigations into how these networks influence conspecific interactions, reproduction and resource utilization in wild turkeys.

1. Introduction

Sleep behaviour is a prominent and vulnerable behavioural state that all wildlife species engage in [1–4]. Despite sleep

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behaviour being the most prominent behavioural state, little attention has been dedicated towards understanding aspects of sleep behaviours, such as where an individual chooses to sleep [3,5]. Behavioural decisions made while choosing a location to sleep are probably influenced by a host of abiotic and biotic factors as species are most vulnerable during sleep [3,6]. The dangers of sleep owing to increased vulnerability to predation are apparent; however, certain strategies can be considered safer than others and are more conducive to diurnal activities [6–8]. Thus, where an animal chooses to sleep plays a fundamental role in a species' ecological processes [3].

Animals engage in spatial behaviours, moving among preferred habitat types or foraging sites, which develop into patterns like the route taken across the landscape with consequences in both spatial and social domains [9]. For diurnal species, sleeping sites can have critical consequences for individual fitness, as individuals must select sites that provide access to resources while providing protection from predators or natural elements [7,10]. Contemporary literature has noted that behavioural decisions such as sleep site switching [11,12] or reuse of sites may reduce predation risks and presumably influence individual fitness [13,14]. Understanding sleep behavioural decisions is important to fully comprehend their impact on ecological dynamics, including resource acquisition [15], mating [16] and mechanisms reducing predation risk [17]. Moreover, integrating social network analysis (SNA), which elucidates the spatial structure and implications for behaviour [18,19], allows for a more comprehensive evaluation of the consequences of spatial behaviours on social dynamics and network connectivity [20–22].

For avian species, roost sites are important as they reduce the cost of thermoregulation [23,24], decrease predation risk [25,26] and increase foraging efficiency [27–29]. Drivers of roost site selection are fundamental as an individual must position itself on the landscape in ways that are beneficial for resource acquisition, survival and reproduction [8]. Roost sites are ideally concentrated in core use areas, which may provide individuals with increased access to resources and reduced competition from conspecifics [30]. Hence, identifying the distribution of roosts within home ranges and how they are positioned relative to other roosts can allow an understanding of important ecological processes [31].

Roosting is an important aspect of wild turkey (*Meleagris gallopavo* spp.) ecology that can influence demography and spatial distribution [32]. The primary benefits of roosting are reduced predation risk and protection from adverse weather conditions [33,34]. Previous research on wild turkey roosting ecology has focused on roost tree descriptions and associated habitat conditions [35–37], and aspects of roost site selection at microhabitat or landscape scales [38–42]. Furthermore, site fidelity for male eastern wild turkeys (*M. gallopavo silvestris*; hereafter, wild turkeys) is low, suggesting that trees which provide suitable roost sites are abundant [43]. However, microhabitat and landscape characteristics at roosts vary across temporal and spatial scales, suggesting roost site selection may underlie access to receptive mates, foraging habitats and preferred vegetation cover used during nesting or brooding [32,38,43–47].

Reproduction drives wild turkey population trajectories, and female behavioural decisions have been shown to have a considerable influence on fitness outcomes [48–51]. During reproductive activities, female wild turkeys face strict spatial constraints, including access to males for breeding opportunities [52,53] and the need to stay near their nesting locations [48,50]. During the reproductive period, females transition from pre-laying areas to unfamiliar locations to initiate egg-laying [54]. Prospecting of unfamiliar areas is used to identify profitable locations during the egg-laying process to ensure there are adequate resources for incubation [55,56]. Thus, spatially quantifying roost selection and roost relationships for females throughout the reproductive period could offer insight into how they allocate themselves during sleep periods within these critical phenological periods.

Here, we used an SNA to evaluate roost site selection and structure of roost site networks for female eastern wild turkeys during the reproductive season. Specifically, we estimated site fidelity and identified hub and satellite roosts during different reproductive phases (i.e. pre-laying, laying, finished nesting and non-nesting), and we identified relevant landscape features selected at roost sites. We hypothesized that females would select roost sites to optimize their access to resources. Thus, we predicted females would have centralized hub roost sites (higher site fidelity) that exhibit higher degrees of fidelity in closer proximity to areas offering resources important during the reproductive season.

2. Methods

We used rocket nets to capture wild turkeys from January to March of 2014–2021 (for details on study sites refer to the electronic supplementary material, S1). We aged captured individuals based on the presence of barring on the ninth and tenth primary feathers and sexed them by the coloration of the breast feathers [57]. We banded each bird with an aluminium rivet leg band (National Band and Tag Company, Newport, Kentucky; female size = 8, male size = 9) and radio-tagged each individual with a backpack-style GPS-VHF transmitter [58] produced by Biotrack Ltd (Wareham, Dorset, UK). We programmed transmitters to record one GPS location nightly (23.58) and hourly GPS locations from 5.00 to 20.00 (Standard Time and according to the appropriate time zones) for the duration of the study [59]. Each transmitter had a mortality switch programmed to activate after more than 23 h of no movement. We released wild turkeys immediately at the capture location after processing. All wild turkey capture, handling and marking procedures were approved by the Institutional Animal Care and Use Committee at the University of Georgia (protocol nos. A2019 01-025-R2 and A2020 06-018-R1) and the Louisiana State University Agricultural Center (protocol nos. A2014-013, A2015-07 and A2018-13).

We performed data processing and analysis in program R (v. 4.1.0) [60]. We processed and cleaned the raw GPS data by removing locations that had dilution of precision values of greater than 7 [61]. To determine the dates of nest initiation (i.e. initiation of laying) and the onset of incubation, we mapped our spatial–temporal data using ArcGIS 10.8 (Environment Systems Research Institute, Redlands, CA, USA). We identified the onset of incubation as the first time an individual remained on the nest overnight [48,50], and then evaluated hourly locations for the previous 20 days to determine when a female initially visited the nest site (defined as location being <20 m from the known nest site [54,56,62]). We considered the date of the first visit as the date of nest initiation and used it as the beginning of the laying period, as wild turkeys rarely visit nest sites before laying the first egg [54,63]. We removed incubation locations from analyses because female wild turkeys remained on the ground at the nest location during this period. From the information described above, we were able to categorize reproductive phases for each female throughout the reproductive season, which we later used as a covariate in models to describe the temporal aspect of female roost selection ([64]; table 1).

Wild turkeys may use specific roosting areas repeatedly but select different trees from one night to the next [32]. Therefore, we defined a roost site by running a sensitivity analysis of the distance between consecutive roost sites to provide an appropriate cluster radius (250 m) and considered any roost locations that fell within the cluster radius as a single roost site. We used the R package dbscan [65] to conduct the cluster analysis. We then estimated roost site fidelity (RF) as 1 minus the number of unique roost sites used divided by the number of nights within the period (RF = 1 − (unique roosts/total nights)) [43]. An RF value of 1 would indicate that an individual roosted in the same location every night, whereas values approaching 0 indicated that individuals roosted in a unique location every night. We calculated inter-roost distance between consecutive roosts for each female to identify phenological transitions in roosting behaviours across all birds [43,66]. For each roost site, we quantified elevation, slope, aspect and topographical ruggedness (degree of irregularity or roughness in the surface of a geographical area) using digital elevation models from the United States Geological Survey National Elevation Dataset (https://www.usgs.gov/the-national-map-data-delivery/gis-data-download, accessed 10 April 2023; [46,47,63]). We obtained road data for wildlife management areas (WMAs) from the Georgia Department of Natural Resources, Louisiana Department of Wildlife and Fisheries, South Carolina Department of Natural Resources and the United States Department of Agriculture: Forest Service and used United States Geological Survey Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line data for roads outside the WMAs. We categorized roads as primary if they were paved/gravelled and vehicle access was not limited, whereas secondary roads were unpaved gravel and/or logging roads where vehicle use was reduced [67]. We obtained year-specific, 30 m resolution spatial data on landcover from the Cropland Data Layer (Cropscape) provided by the National Agricultural Statistics Service. We recoded and combined landcover in program R to create two unique landcover types (open treeless areas, water). We decided to exclude forested habitats in our analyses because wild turkeys will ultimately be in these areas because they roost in trees. Hence, we chose to use open treeless areas and water because these are resources that wild turkeys use for foraging opportunities [43,68]. We then calculated the nearest distance to primary and secondary roads and landcover types using the Euclidean distance tool in ArcGIS 10.8 (Environmental System Research Institute, Inc., Redlands, CA, USA) keeping all raster layers at a 30 m resolution.

Table 1. Descriptions of reproductive phases relative to roost site selection for female eastern wild turkeys (*M. gallopavo silvestris*).

reproductive phase	description
pre-laying	movements from 1 March until laying
laying	when a female initially visited the nest site and until incubation
finished nesting	when reproductive activity ceased
non-nester	females that did not make a nesting attempt

2.1. Network analysis

Networks are composed of nodes connected by edges, which are used to understand network function and structure [19,69]. In our spatial network, we defined nodes as roost sites and assigned corresponding edges based on visits to different roost locations (roost-to-roost movement). Specifically, we used our RF values to define roost sites as it is more informative to use rates rather than raw counts [70]. We calculated a suite of metrics describing the nodes and edges for each individual female's network (table 2). The distribution of the node degree can be used to determine the structure of a network, with the node degree being the number of edges one node has to other nodes [72]. In the context of roosting behaviour, degree is how connected a specific roost site is to the other roost sites within the network. Therefore, we calculated the degree distribution by summing the nodes that had edges and dividing by the total number of nodes.

We then characterized our nodes with few edges as satellite roost sites (lower degree) and those that have many edges as hub roost sites (high degree). We calculated betweenness, closeness, eigenvalue centrality and clustering coefficients for each unique roost cluster using the R package igraph ([73]; table 2). Betweenness, as defined by [74], suggests that a node (in this case, roost sites) plays a crucial role in connecting two other nodes within a network. In the context of roost sites, this implies that specific roosting locations have a significant influence on enhancing overall connectivity among different roosting sites. Closeness is a metric used to describe centrality which evaluates the shortest path length between a roost site and all other roost sites within the network [75]. Eigenvalue centrality describes the influence of a roost site by assessing the relative score of connected roosts with high-scoring roosts providing more importance than connections to low-scoring roosts [76]. Eigenvalue centrality is bounded from 0 and 1. The clustering coefficient evaluates cliques within a network, which means it identifies if there are localized communities (group) of roosts within the network. Using the 90th percentile values from the degree calculation, we determined whether roost sites were considered hubs or satellites [18,69]. Using the network metrics as covariates, we determined whether there were differences between hub and satellite roost sites. We tested for collinearity between each of our covariates and excluded covariates using Pearson's correlation with an $r > 0.60$ [77]. We used a generalized linear model with a binomial response distribution and logit link to evaluate spatial network data for female wild turkeys. Our response was binary (0 = satellite, 1 = hub) to model network parameters at hub and satellite roosts. We used the R package glmmTMB to conduct our analysis [78].

2.2. Resource selection model

From the beginning of pre-laying until post-reproduction, we calculated 95% home ranges by fitting dynamic Brownian bridge movement models to the time-specific location data [59] using R package move [79]. We used an error estimate of 20 m, a moving window size of seven locations and a margin setting of three locations [59,80].

We used resource selection functions to examine relationships between distance to landcover types, distance to secondary roads and terrain features to wild turkey roost sites within individual home ranges (third-order selection) following a design III approach suggested by Manly *et al*. [81]. We tested for collinearity between each of our covariates and excluded covariates using Pearson's correlation with an $r > 0.60$ [77]. After testing for collinearity, we removed the slope and primary roads from our models. We chose to retain topographical roughness, which is the standard deviation of the slope, instead of slope to characterize the relief of the terrain. We chose to keep secondary roads as they provide connectivity between areas selected by wild turkeys on our study sites as well as providing

Table 2. Descriptions of parameters used to describe spatial networks and the biological context of what information parameters provided for roost sites used by female eastern wild turkeys (*M. gallopavo silvestris*) [71].

parameters	description	biological context	biological relevance
betweenness	a count of the number of shortest paths that flow through the node	the number of times a roost forms a connection between other roost sites based on the shortest distance (Euclidian distance) from the roost site	this captures if an individual has a tendency to switch roost sites
closeness	the mean shortest path between a node and all other nodes	the shortest distance (Euclidian distance) between a roost and all other roosts within the network	identifies the spatial network positioning that can influence social dynamics, communication pathways, resource utilization and overall community resilience
clustering coefficient	a measure of cliquishness of the network, which is the fraction of a node's immediate neighbours that are themselves neighbours	a measure of how close a roost is to other neighbouring roosts. This describes if there are communities of roosts that are not connected to the entire network	indicates the extent to which roosts are a community that can provide insight into social behaviour, resource utilization and overall fitness
degree	the number of edges that are connected to a node	the number of edges (connections) to a roost	this measure captures the association between other roost sites
edge	the interaction between two nodes	a female wild turkey moving between two roosts	the connectivity between roost sites
eigenvalue centrality	relative score assigned to nodes to assess their importance based on the connections to other nodes	assessment of the importance of a roost site in the network based on connections to other roost sites	this metric captures the potential importance of a roost site (hub) for propagation of information
node	an individual entity	the roost site	the roost site is used to understand the characteristics and attributes of a spatial network

Table 3. Model structure for global, resource, feature and null models for female eastern wild turkey (*M. gallopavo silvestris*) roost sites during 2014–2021 across the southeastern United States. (Each covariate within the model had an interaction with reproductive phase (pre-laying, laying, finished nesting and non-nester). The resource covariates were calculated as a distance (m) to metric.)

model	parameter
global	secondary roads + open treeless area + water + elevation + ruggedness
resource	secondary roads + open treeless area + water
feature	elevation + ruggedness
null	(.)

Table 4. Total and unique number of roost sites, mean site fidelity with associated standard deviations (s.d.) and mean inter-roost distance in meters with associated s.d. by reproductive phase for female eastern wild turkeys (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021.

reproductive phase	total roost sites	unique roost sites	mean site fidelity (s.d.)	mean inter-roost distance (s.d.)
pre-laying	26 455	12 752	0.48 (0.19)	478.07 (505.95)
laying	7430	4242	0.41 (0.20)	554.46 (515.04)
finished nesting	21 114	9456	0.50 (0.21)	501.35 (478.68)
non-nester	11 365	5383	0.54 (0.19)	547.16 (545.86)

foraging opportunities [68]. We did not include interactions of aspect and reproductive phase as models failed to converge owing to quasi-complete separation. We compared each used point (roost site) to 50 available points sampled within each range [82]. We created four models which included a global model (i.e. including all covariates), a resource model, a feature model and a null model (table 3). Each model included an interaction of the reproductive phase for each female [64]. We used a generalized linear mixed model with a binomial response distribution (logistic regression) and logit link to the used-available data [81,83]. We used the glmmTMB R package [78] with a binary (0 = available, 1 = used) response variable to model resource selection [84]. To account for variability among individuals within our models, we included a random effect for each unique individual [84]. To improve performance and ease of interpretation, we rescaled all fixed effects by subtracting their mean and dividing by two standard deviations prior to modelling [85]. Similar to the methodology above, to determine if resource selection differed between hub and satellite roosts, we used a generalized linear mixed model with a binomial response distribution and logit link to evaluate spatial network data for female wild turkeys. Our response was binary (0 = satellite, 1 = hub) to model resources at hub and satellite roosts.

We used second-order Akaike's information criteria (AIC*c*) to assess the amount of support for the different candidate models [86,87]. We calculated ΔAIC*c* values between the AIC*c* value for candidate model *i* and the lowest-ranked AIC value. We also calculated Akaike's weights (w_i) for each model. We then calculated parameter estimates and their standard errors for all covariates in models within two ΔAIC*c* units of the lowest-ranked AIC value.

3. Results

We monitored 663 (560 adults, 102 juveniles, one unknown) female wild turkeys during 2014–2021. We monitored 689 nesting attempts (initial attempts = 491, renesting attempts = 198) made by 499 females. We identified 66 364 roost locations after removing locations that occurred during incubation and brooding (table 4).

Our degree rate described individual female networks as having few (13.6% total roost sites) hub roost sites within their network (figure 1; table 5). Hub roosts had greater values of betweenness (β = 0.62, s.e. = 0.02), closeness (β = 0.59, s.e. = 0.03) and eigenvalue centrality (β = 1.15, s.e. = 0.05) but lower values of cluster coefficient (β = −0.36, s.e. = 0.02) than satellite sites (figure 2). Mean betweenness for hub roosts was 416 (s.d. = 334; table 5), suggesting that hub roosts served as connections or bridges within the network. Hub roosts were associated with higher closeness values suggesting that hub

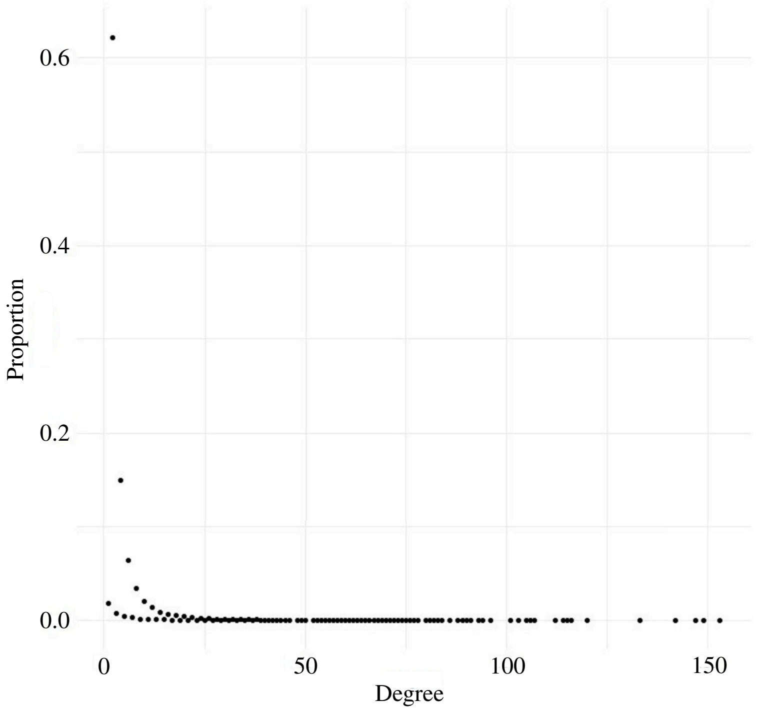

Figure 1. Degree distribution characterizing a spatial network for roost sites of female eastern wild turkeys (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021.

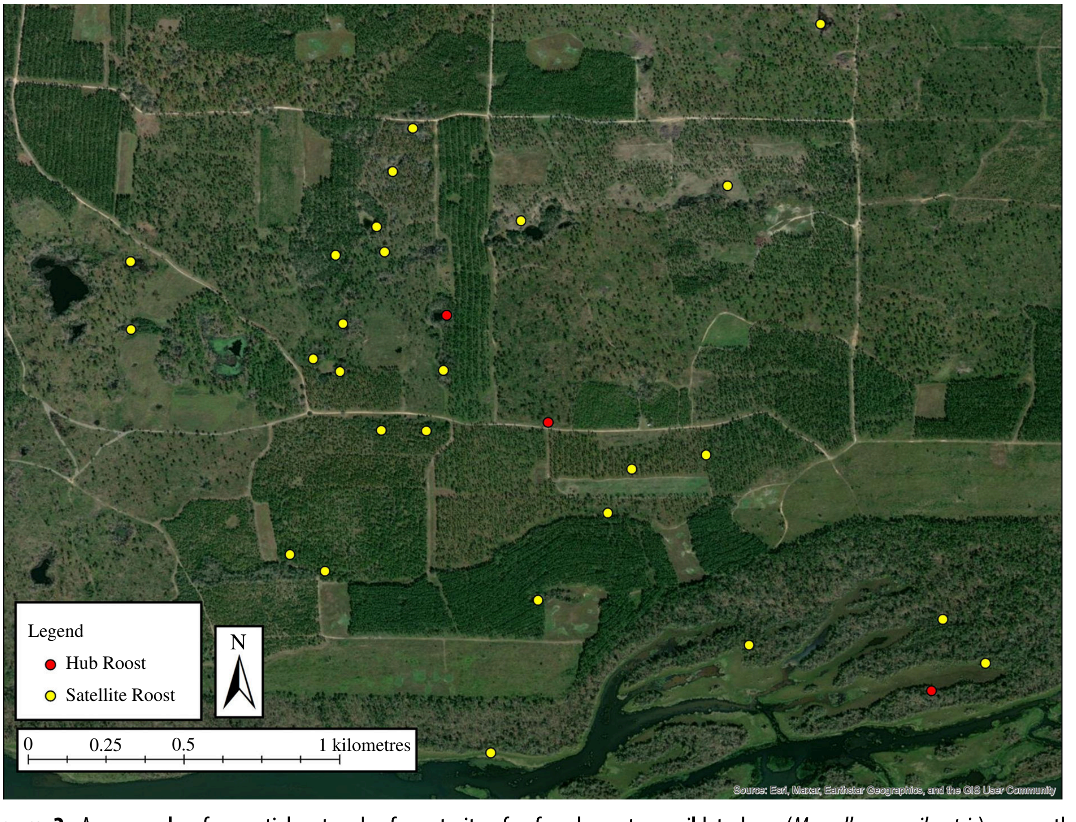

Figure 2. An example of a spatial network of roost sites for female eastern wild turkeys (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021.

roosts were positioned near the functional centre of the network (figure 3). The probability of the roost site being a hub roost increased by 12.25% for every 0.1 increase in eigenvalue centrality, suggesting hub roosts played an important role in structuring the network (figure 2). Our clustering coefficient was lower for hub roosts suggesting one network rather than multiple communities.

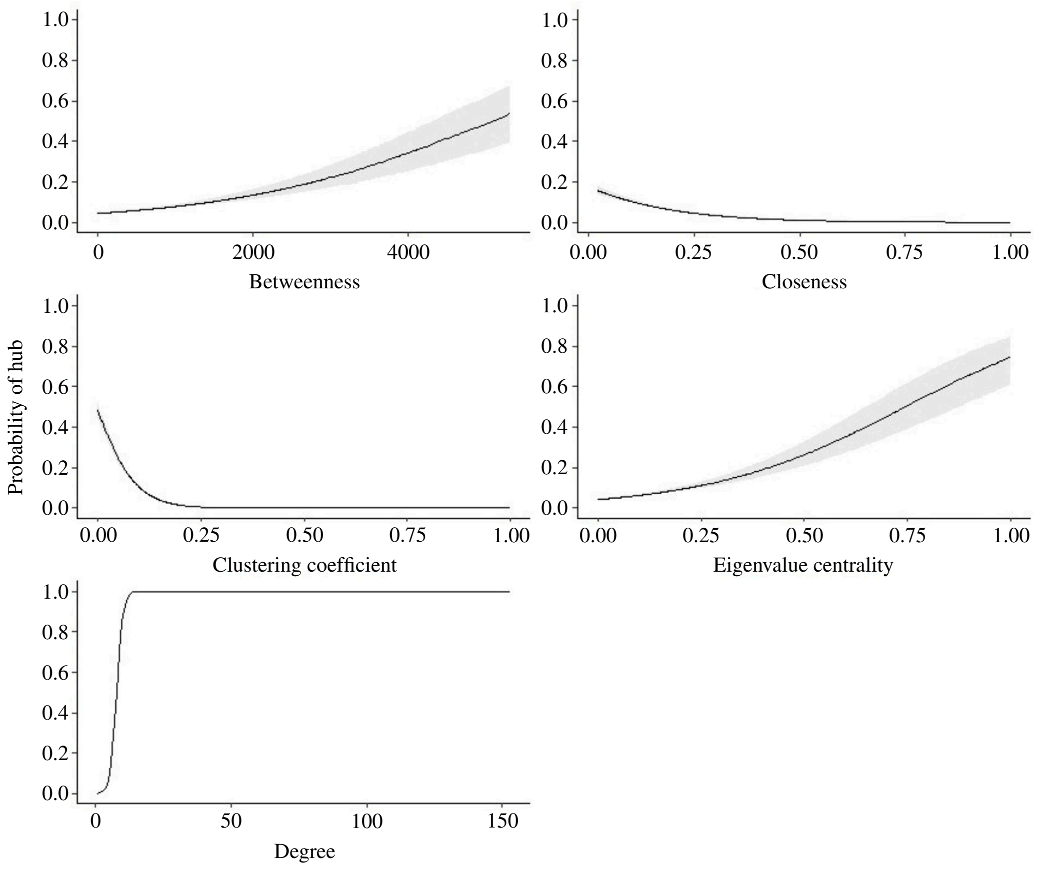

Figure 3. Predicted probability of hub roosts relative to betweenness, clustering coefficient, degree and eigenvalue centrality (solid line) with 95% confidence intervals (dotted line) from the best approximating model for female eastern wild turkeysy (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021.

Table 5. Descriptive statistics including median, mean, standard deviation and range for parameters included in a spatial network analysis of roost selection by female eastern wild turkeys (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021.

parameter	median	mean	s.d.	range
betweenness	30.40	156.53	391.70	0.00–5323.65
closeness	0.23	0.24	0.11	0.02–1.00
clustering coefficient	0.13	0.14	0.07	0.00–1.00
degree	2.00	4.61	7.54	1.00–153.00
eigenvalue centrality	0.00	0.04	0.16	0.00–1.00

The global model (w_i = 1.00; table 6) best fitted our data for predicting roost site selection. Females selected for roost sites were at lower elevations and with greater ruggedness (figure 4). During the pre-laying, females selected roost sites closer to water, whereas during laying they selected roosts further from secondary roads (figure 4). When females ceased reproductive activities, they selected roost sites closer to open treeless areas and water but further from secondary roads (figure 4).

The global model (w_i = 1.00; table 6) best fitted our data for predicting selection of hub versus satellite roosts. During all phases, females selected hub roosts that were closer to secondary roads and further from water (figure 5). Additionally, during pre-laying, laying and when the reproductive season ceased, females selected for hub roosts that were at lower elevations. Non-nesting females selected for hub roosts with greater ruggedness (figure 5).

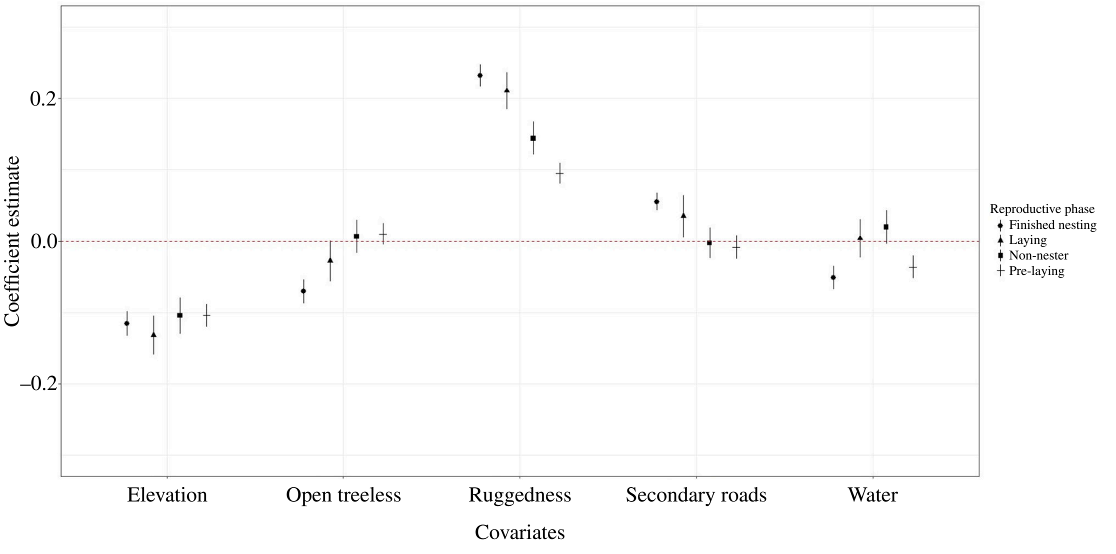

Figure 4. Coefficient plot depicting roost site selection during reproductive phases of female eastern wild turkey (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021. The whiskers depict 95% confidence intervals around mean estimates.

Table 6. Akaike's iinformation criterion with small sample bias adjustment (AICc), number of parameters (*K*), ΔAICc, adjusted Akaike weight of evidence (w_i) in support of model and log-likelihood (LL) for each model examining roost site selection and selection of hub versus satellite roosts of female eastern wild turkeys (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021.

model	*K*	AICc	ΔAICc	w_i	LL
roost site selection					
global	22	353 563.9	0.00	1.00	−176 760.0
resource	14	354 977.0	1413.1	0.00	−177 474.5
feature	10	357 507.3	3943.4	0.00	−178 743.7
(.)	2	358 816.5	5252.6	0.00	−179 406.3
hub versus satellite roosts					
global	22	52 304.3	0.00	1.00	−26 130.1
resource	14	53 324.4	20.4	0.00	−26 148.4
feature	10	52 944.0	639.7	0.00	−26 462.0
(.)	2	52 960.4	656.1	0.00	−26 478.2

4. Discussion

We observed high site fidelity and lower distances between consecutive roost sites for female wild turkeys during the reproductive season, observations that differ markedly from roost behaviours exhibited by males (table 4; [32,43]). This has also been observed in capercaillie (*Tetrao urogallus*), an upland bird that relies on similar reproductive and resource acquisition strategies [88]. With capercaillie and probably with female turkeys, remaining at the same roost sites during the breeding season could be a tactic used to increase exposure and predictability to males while also increasing resource acquisition, which is crucial for egg laying and incubation [89].

We found that the roost site network evaluated for individual female wild turkeys had few highly centralized hub roosts (approx. 13%) that had many connections, promoting connectivity to other roosts in the network. Maintaining networks with centralized hub sites allows an individual to learn about the location and exploit high-quality resources [90,91]. Hence, networks exhibiting these characteristics are often associated with resource-rich areas [21,22] , interactions with conspecifics for information [92–94] or mate acquisition [88,95]. The level of experience an individual has with the landscape has been attributed to reduced predation risk by identifying refuges and escape routes

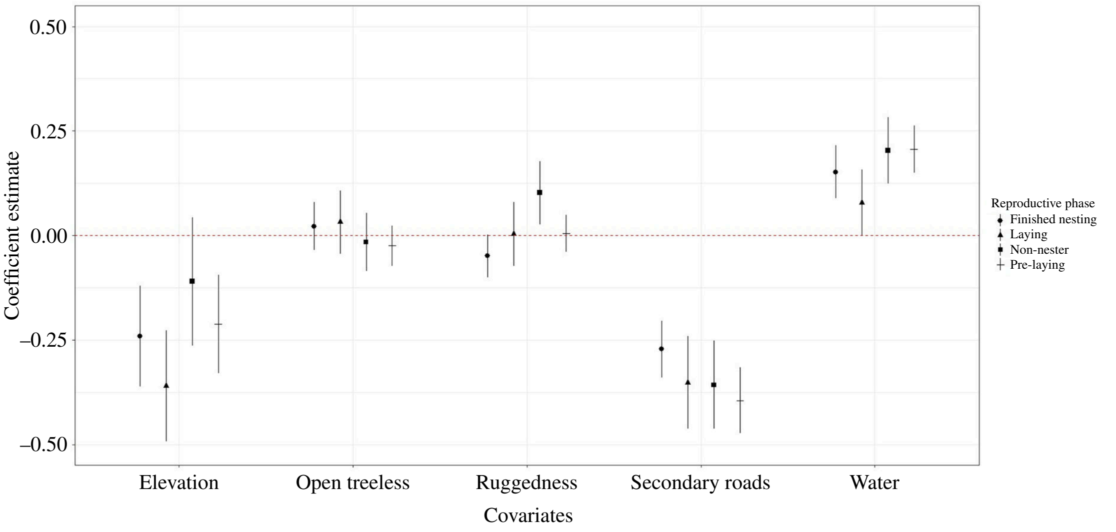

Figure 5. Coefficient plot depicting hub versus satellite site during the reproductive phase of female eastern wild turkey (*M. gallopavo silvestris*) across the southeastern United States during 2014–2021. The whiskers depict 95% confidence intervals around mean estimates.

[96,97]. For example, pheasants (*Phasianus colchicus*) killed by predators were more on the periphery of their home range than towards the centre [98]. Hence, female wild turkeys maintaining hub roosts centrally located within their reproductive range may facilitate increased vigilance and efficient resource acquisition that positively influences fitness.

Environmental variation across landscapes has the potential to influence how species interact with terrain [99,100]. For wild turkeys that occur within forested landscapes, potential roost sites are often ubiquitous within individual home ranges [32]. By contrast, for subspecies residing in more arid environments (such as Gould's (*M. gallopavo Mexicana*), Merriam's (*M. gallopavo merriami*) and Rio Grande wild turkeys (*M. gallopavo intermedia*)), roost sites are often confined to riparian corridors [101–104]. We found that roosts selected by female wild turkeys were at lower elevations with greater ruggedness regardless of reproductive phase. This is consistent not only with eastern wild turkeys but Gould's, Merriam's and Rio Grande wild turkeys that select roosts at lower elevations often associated with riparian corridors [43,101,102,104]. Increased ruggedness is often associated with the irregularity on the outer edges of riparian corridors where the landscape begins to become steep [99]. Selecting roosts in areas with greater ruggedness enables avian species to perch at elevated positions, enhancing their ability to better observe their surroundings and increase the efficiency of flights [105,106]. Wild turkeys depend on their vision to detect predators before flying down from their roosts in the morning [57], thus, choosing roost sites in areas with increased ruggedness may diminish the risk of predation.

Resource acquisition is necessary for the survival of avian species upon completion of the reproductive period [107]. We found that upon the completion of reproduction, female wild turkeys selected to roost closer to open treeless areas and water. Open treeless areas are selected by wild turkeys throughout portions of their annual cycle [46,47,49], and provide the opportunity to increase foraging efficiency while also increasing the detectability of predators, which has similarly been shown in various Galliformes [108,109]. Furthermore, open treeless areas provide forb and grass communities that provide relatively high densities of invertebrates necessary for poult development [49,110–112]. Additionally, selecting roost sites closer to water could buffer thermal extremes common throughout the southeastern United States during the summer after reproductive activities cease [68,113,114].

Locations of hub nodes within a network are often affiliated with greater connectivity to other nodes within the network [19]. Within our network, hub roosts were situated closer to secondary roads, which may provide quality foraging opportunities and opportunities to escape predation threats [68,113] and enhance mobility for females [110]. Furthermore, the low-intensity maintenance of trails and secondary roads promotes early successional vegetative communities, which were spatially limited on our study sites [68]. Research on hazel grouse (*Tetrastes bonasia*) has shown that in areas with minimal trail maintenance, individuals may select trails to exploit early successional plant species [115].

Few ecological studies have explored the impact of environmental characteristics and resources on spatial networks of wildlife [22]. Our findings indicate that wild turkeys develop and maintain a spatial network of roosts within their reproductive range, with centralized hub roosts that are ecologically important. The roost site networks used by wild turkeys require further study into how conspecific interactions may occur, as extant literature demonstrates the critical role of networks in breeding [116], resource access [21,117] and disease or parasite transmission [118–120] among various gregarious species.

Ethics. All turkey capture, handling, and marking procedures were approved by the Institutional Animal Care and Use Committee at the University of Georgia (protocol nos. A2019 01-025-R2 and A2020 06 018-R1) and the Louisiana State University Agricultural Center (protocol nos. A2014-013, A2015-07, and A2018-13).

Data accessibility. Data and relevant code and data for this research work are stored in Dyrad [121].

Declaration of AI use. We have not used AI-assisted technologies in creating this article.

Authors' contributions. N.W.B.: conceptualization, data curation, formal analysis, methodology, visualization, writing—original draft, writing—review and editing; E.E.U.: conceptualization, data curation, methodology, writing—review and editing; P.H.W.: conceptualization, data curation, writing—review and editing; N.A.G.: conceptualization, data curation, writing—review and editing; B.A.C: conceptualization, funding acquisition, resources, writing—review and editing; M.J.C.: conceptualization, funding acquisition, investigation, project administration, writing—review and editing.

All authors gave final approval for publication and agreed to be held accountable for the work performed therein.

Conflict of interest declaration. We declare we have no competing interests.

Funding. We appreciate funding and logistical support provided by the Georgia Department of Natural Resources—Wildlife Resources Division, the Louisiana Department of Wildlife and Fisheries, the School of Renewable Natural Resources and Louisiana State University Agricultural Center, the South Carolina Department of Natural Resources, and the Warnell School of Forestry and Natural Resources at the University of Georgia. This material is partially based on work supported by the National Institute of Food and Agriculture and United States Department of Agriculture under McIntire Stennis project (7001494).

Acknowledgements. We thank A. P. Roth, A. K. Lohr, C. M. Argabright, A. Byers, N. A. Yeldell, L. Schofield, C. J. Wakefield, S. D. Nelson, S. Watkins, P. Goodman and J. W. Wood for their efforts collecting field data.

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