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Author(s): Indrani Sasmal, Eric L. Kilburg, Christopher S. DePerno, M. Colter Chitwood, Marcus A. Lashley, Bret A. Collier and Christopher E. Moorman

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Eastern Wild Turkey Roost-site Selection in a Fire-maintained Longleaf Pine Ecosystem

Indrani Sasmal[1,*], Eric L. Kilburg[1], Christopher S. DePerno[1], M. Colter Chitwood[2], Marcus A. Lashley[3], Bret A. Collier[4], and Christopher E. Moorman[1]

Abstract - Night-time roosting in *Meleagris gallopavo* (Wild Turkey) is a quotidian activity that minimizes vulnerability to predators and weather. Roost-site selection in managed *Pinus palustris* (Longleaf Pine) communities is poorly documented. We assessed roost-site selection by comparing use and availability of vegetation types at the individual female Wild Turkey home-range level. We monitored 14 Wild Turkeys from February 2011 to June 2012. The Wild Turkeys did not use vegetation types within the estimated home ranges for roosting in proportion to availability ($\chi^2 = 601.696$, $P < 0.001$). Female Wild Turkeys roosted in the upland Longleaf Pine in proportion to availability, selected for lowland hardwood, and avoided upland hardwood patches. We documented that roost-site availability is not likely a limiting factor in managed Longleaf Pine forests.

Introduction

Roosting locations for *Meleagris gallopavo silvestris* Vieillot (Eastern Wild Turkey; hereafter, Wild Turkey) limit vulnerability to predation and can provide refugia from poor weather conditions (Byrne et al. 2016, Kilpatrick et al. 1988, Ludwig 2012, Porter 1978). Hence, roosting sites are a critical habitat component for Wild Turkeys (Bailey and Rinell 1967, Chamberlain et al. 2000). The structure and composition of Wild Turkey roosting locations are similar across the species' range (Kimmel and Zwank 1985, Still and Baumann 1989, Zwank et al. 1988). In the southeastern US, Wild Turkey roost sites often are in lowland hardwood stands adjacent to permanent water or in *Pinus* (pine)–hardwood stands (Chamberlain et al. 2000, Kimmel and Zwank 1985, Miller et al. 1999, Zwank et al. 1988).

Although Wild Turkey roost-site selection has been documented in a variety of community types (Chamberlain et al. 2000, Kilpatrick et al. 1988, Tzilkowski 1971), information on roost-site selection in frequently burned *Pinus palustris* Mill. (Longleaf Pine) communities is lacking. Longleaf Pine communities represent one of the most diverse ecosystems in the temperate zone and commonly are restored and maintained with frequent, low-intensity prescribed fire (Drew et al. 1998, Fill et al. 2012, Lashley et al. 2015). However, homogeneous application of burning

[1]Fisheries, Wildlife, and Conservation Biology Program, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695. [2]Wildlife Biology Program, Department of Ecosystem and Conservation Sciences, University of Montana, Missoula, MT 59812. [3]Department of Wildlife, Fisheries, and Aquaculture, Mississippi State University, Mississippi State, MS 39762. [4]School of Renewable Natural Resources, Louisiana State University, Baton Rouge, LA 70803. [*]Corresponding author - bulirchithi@gmail.com.

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techniques, return interval, and season of burn can decrease compositional and structural heterogeneity of plant communities in frequently burned Longleaf Pine communities by differentially promoting the prevailing vegetation type (Longleaf Pine woodland) and suppressing less-prominent hardwood inclusions (Lashley et al. 2014). Thus, if mature upland hardwoods provide the best roosting cover, current prescribed fire regimes may be problematic for Wild Turkeys.

Historically, much of the southeastern US burned frequently, and experimentation with prescribed fire has produced vegetation conditions that benefit Wild Turkeys by providing more diverse or more abundant food and higher-quality nesting cover (Cox and Widener 2008, Kilburg et al. 2015, Knapp et al. 2009, Lashley et al. 2015). Yet, little is known about Wild Turkey roost-site selection in frequently burned Longleaf Pine forests—a landscape where lowland hardwood availability often is limited. Therefore, our objective was to assess roost-site selection by female Wild Turkeys in frequently burned Longleaf Pine woodlands in central North Carolina.

Field-Site Description

We evaluated female Wild Turkey roost-site selection at Fort Bragg Military Installation (hereafter, Fort Bragg) in the Sandhills physiographic region of North Carolina. The Sandhills region is characterized by variably deep, well-drained, and sandy soils, with xeric uplands and hillside seeps that feed numerous blackwater streams (Sorrie et al. 2006). Frequent fire and variable soil moisture produced several vegetation types at Fort Bragg (Sorrie et al. 2006), including lowland hardwood (10% of the land area), upland hardwood (4%), upland pine (69%), and non-forested (17%) (Lashley et al. 2014).

Lowland hardwoods contained *Acer rubrum* L. (Red Maple), *Liquidambar styraciflua* L. (Sweetgum), *Liriodendron tulipifera* L. (Tulip-poplar), and *Nyssa sylvatica* Marsh. (Blackgum), forming generally closed canopy stands along permanently flowing streams. Dense thickets of *Ilex* spp. (gallberries), *Lyonia* spp. (Fetterbush), and *Smilax* spp. (greenbriers) comprised the understory. Xeric hardwood species (primarily *Quercus* spp. [oaks]) dominated upland hardwood areas. A Longleaf Pine overstory, with an understory of *Aristida stricta* Michx. (Wiregrass), *Gaylussacia dumosa* (Andrews) Torr. & A. Gray (Dwarf Huckleberry), *Q. laevis* Walter (Turkey Oak), and *Q. marilandica* Münchh. (Blackjack Oak), dominated the uplands. Upland pine stands were burned every 3 years during the growing-season (i.e., April–August) to control woody-stem encroachment to the forest midstory in accordance with management objectives for the endangered *Leuconotopicus borealis* (Vieillot) (Red-cockaded Woodpecker). Non-forested vegetation occurred primarily in areas with military activity (hereafter, military-activity zones), including artillery-firing points, aerial-drop zones, and artillery-impact areas. Military-activity zones were all sparsely vegetated and dominated by grasses and forbs, including non-native *Eragrostis curvula* (Schrad.) Nees (Weeping Lovegrass) and *Lespedeza cuneata* (Dum. Cours.) G. Don (Sericea Lespedeza). Drop zones were burned and mowed annually or biennially to reduce woody vegetation for the safety of paratroopers; these areas provided no roosting cover for Wild Turkeys.

Methods

We captured Wild Turkeys by rocket net during February–April 2011 and January–March 2012. In 2011, we fitted each captured female Wild Turkey with an 85-g micro GPS-data logger (Model G1H271; Sirtrack LTD, Havelock North, New Zealand) programmed to obtain 4 locations daily (every 6 h, beginning at 00:00:00). We set the fix rate to optimize relocation frequency with data-logger battery life to ensure the devices could collect data for >1 year. Data loggers were equipped with radio transmitters and programmed to store relocation coordinates onboard (Guthrie et al. 2011). All capture and handling protocols were approved by North Carolina State University Institutional Animal Care and Use Committee (#10-149-A).

Kernel methods may perform poorly with large data sets when using common methods of determining the smoothing parameter (h) (Getz and Wilmers 2004, Hemson et al. 2005). Hence, we used dynamic Brownian-bridge movement models (Kranstauber et al. 2012) to estimate year-round utilization distributions (UDs) for female Wild Turkeys. We based UDs on the movement tracks of each individual (February 2011–June 2012) using R package move (Kranstauber and Smolla 2016) in Program R version 3.4.2 (R Core Team 2016). The dynamic Brownian-bridge movement model incorporates the behavioral heterogeneity of the movement process (Horne et al. 2007, Kranstauber et al. 2012) and quantifies individual-space use using individual behavioral information. We used a GPS-error estimate of 20 (Byrne et al. 2014, Guthrie et al. 2011), a raster value of 100, and time-step value of 60 (equivalent to 1 hour) with a moving-window size of 29 relocations (equivalent to 7 d) with a margin of 9 relocations over full tracks of each Wild Turkey.

We assessed roost-site selection within female Wild Turkey ranges using resource-selection Design III (Manly et al. 2002). We included only 1 nocturnal relocation per female to ensure that we quantified only a single roost-location per night. Using ArcGIS 10.3.1 (ESRI, Redlands, CA) and Fort Bragg's vegetation-type layer (Fig. 1), we determined percentages of each forested vegetation type (lowland hardwood, upland pine, and upland hardwood) within the estimated home-range of each individual Wild Turkey. We assessed roost-site selection by comparing use and availability of vegetation types within each estimated home-range (Manly et al. 2002). We defined use as the number of roost locations in a particular vegetation type, and availability as the percentage of that vegetation type available within the individual range. We calculated selection ratios and chi-square values to estimate the overall deviation from random use using program R version 3.2.4 (R Core Team 2016) and the 'adehabitat' package (Calenge 2006). Selection ratios ($\hat{w}$) indicated selection if estimates differed from 1, and we computed ratios for each vegetation type and individual as the ratio of used proportion to available proportion (Calenge and Dufour 2006). Selection for vegetation types was indicated if the lower limit of the 90% confidence interval (CI) of $\hat{w}$ was >1, whereas selection against vegetation types was indicated if the upper limit of the 90% CI of $\hat{w}$ was <1. Use in proportion to availability (neutral selection) was indicated if the 90% CI of $\hat{w}$ contained the value 1 (Manly et al. 2002).

We generated a minimum convex polygon (MCP) area of all roost locations using Home Range Tool version 2 in ArcGIS. We generated equal numbers of random locations within the buffered MCP area of all roost locations, which we used to delineate the boundaries for vegetation-type analysis. We measured distances from roosts and random locations to firebreaks/roads, streams, and military-activity zones using the proximity tool in ArcGIS 10.3.1. We used paired *t*-tests to assess whether distance from firebreaks/roads, streams, and military-activity zones differed between Wild Turkey roost sites and random locations at the 90% level of significance ($\alpha = 0.1$).

Results

We recovered data from 14 GPS tagged Wild Turkeys (13 in 2011 and 1 in 2012), which recorded 11,655 relocations (mean = 833) between February 2011 and June 2012. Average annual home-range size was 8.54 km^2 (SE = 62; Table 1). We recorded 2610 roost locations; not all vegetation types within the 95% home-range estimates were used in proportion to availability ($\chi^2 = 601.696$, $P < 0.001$; Table 2). Wild Turkeys used the upland pine (90% CI = 0.68–1.03) in proportion to availability, whereas

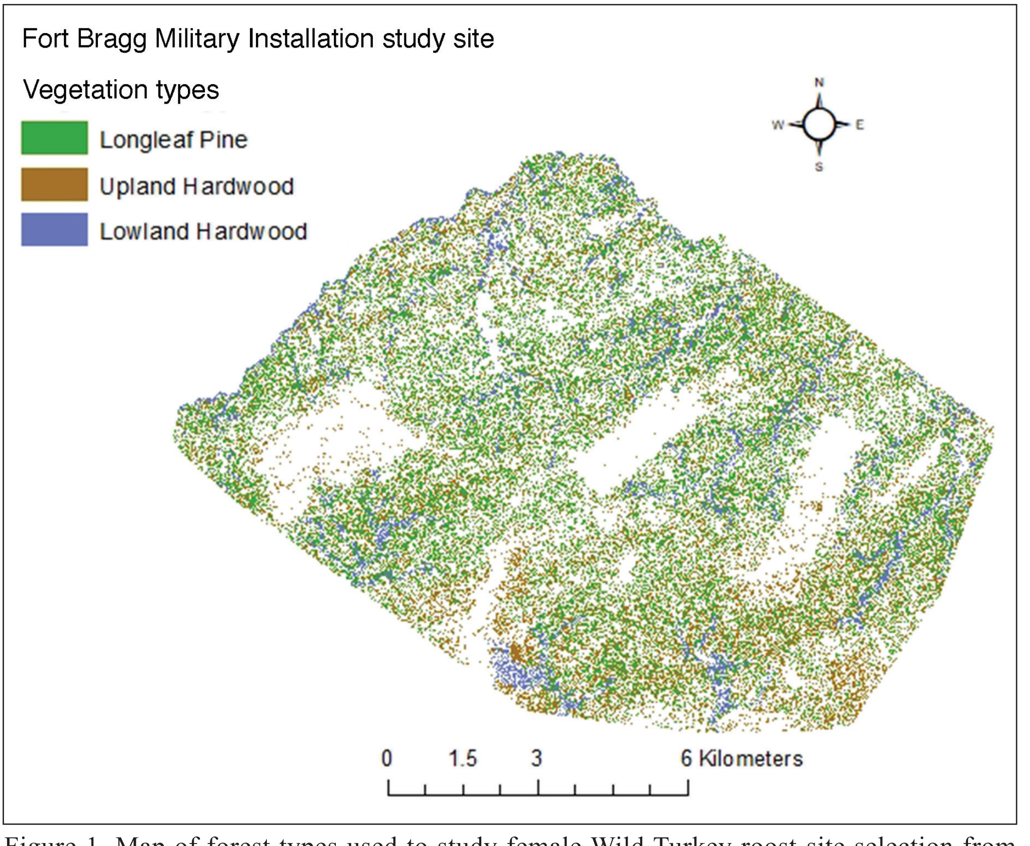

Figure 1. Map of forest types used to study female Wild Turkey roost-site selection from February 2011 to June 2012 at Fort Bragg Military Installation, NC. The white areas within the forest-type map represent non-forested areas.

they avoided upland hardwoods (90% CI = 0.44–0.72) and selected for lowland hardwoods (90% CI = 2.45–4.3) (Table 3). Random locations were an average of 245.75 m (SE = 3.78) from a stream, 96.24 m (SE = 2.64) from a firebreak/road, and 357.29 m (SE = 8.33) from a military-activity zone. Female Wild Turkey roost locations were an average of 238.21 m (SE = 3.76) from a stream, 112.9 m (SE = 3.75) from a firebreak/road, and 490.32 m (SE = 10.95) from a military-activity zone. Compared to random locations, female Wild Turkeys selected roost sites farther from firebreaks/roads ($P < 0.001$) and military-activity zones ($P < 0.001$). Distance to streams was similar ($P = 0.16$) between roost sites and random locations.

Table 1. Female Wild Turkey ($n = 14$) home-range (95%) size estimated using a dynamic Brownian-bridge movement model, Fort Bragg Military Installation, NC, February 2011–June 2012.

Turkey ID	95% home-range (km^2)
851	11.644
800	11.629
701	8.267
650	12.152
551	5.911
450	6.295
371	5.351
350	6.452
311	9.213
251	6.407
171	8.498
123	7.851
91	10.787
21	9.149

Table 2. Available (%) and used (%) forested vegetation types for roosting female Wild Turkeys ($n = 14$) at Fort Bragg Military Installation, NC, February 2011–June 2012.

Vegetation type*	Available (%)	Used (%)
Upland pine	21.69	25.14
Upland hardwood	13.36	9.68
Lowland hardwood	3.12	16.21

*Remainder was not forested (i.e., military-drop zones, firing zones, water bodies, and roads)

Table 3. Roost-site selection, including selection ratios ($\hat{w}$), standard errors (SE), and 90% confidence intervals (CI), by vegetation type for female Wild Turkeys ($n = 14$) at Fort Bragg Military Installation, NC, February 2011–June 2012. Selection for roosting in a vegetation type is indicated by a CI above 1, selection against by a CI below 1, and use in proportion to availability (i.e., neutral selection) by a CI overlapping 1.

Vegetation type	$\hat{w}$	SE	Lower CI	Upper CI
Upland pine	0.85	0.08	0.68	1.03
Upland hardwood	0.58	0.07	0.44	0.72
Lowland hardwood	3.37	0.43	2.45	4.30

Discussion

Female Wild Turkeys frequently roosted in upland Longleaf Pine, but the confidence interval for the selection ratio only slightly overlapped zero, indicating some avoidance of the vegetation type. Animals adjust their space use according to resource availability to optimally exploit the resources (Fauchald 1999, Turchin 1991), and it has been demonstrated that roosting sites are selected according to availability of potential sites on the landscape (Byrne et al. 2015). Thus, the sheer abundance of Longleaf Pine woodland available on the Fort Bragg landscape could explain its value as potential roosting cover for Wild Turkeys. Finer-scale location and vegetation data are needed to help determine the degree of selection for roosts within upland pine stands. For example, Chamberlain et al. (2000) noted 2 possible scenarios for roost-site selection that could be relevant for explaining Wild Turkey roosting behavior in upland Longleaf Pine stands at Fort Bragg: (1) females foraging in upland pine stands may simply fly up to roost in the nearest roosting cover at the end of the day, or (2) females may be using their daily movements through the upland pine stands to arrive at predetermined roosting sites by evening. Regardless of these 2 scenarios, Wild Turkeys likely use upland pine for roosting because of sparse understory (Palmer et al. 1996) and the potential protection provided by conifers against harsh weather (Bailey and Rinell 1967, Kilpatrick et al. 1988).

Similar to elsewhere in the species' range, female Wild Turkeys in our study selectively roosted in lowland hardwood habitat, but individuals avoided upland hardwood patches. Lowland hardwood covered ~10% of the land area on Fort Bragg but offered critically important roosting cover. Although we did not examine roost-site selection at the level of individually selected trees, Wild Turkey use of lowland hardwoods for roosting likely suggests selection for taller hardwood trees. Lowland hardwood areas generally contained tall non-oak hardwoods (e.g., Blackgum, Tulip-poplar) and interspersed *P. taeda* L. (Loblolly Pine) (Prince et al. 2016). At Fort Bragg, mature hardwoods were removed mechanically in some upland stands, potentially restricting the tallest hardwoods to riparian areas that did not burn or along firebreaks that provided a fire shadow (Lashley et al. 2014). Indeed, most of the largest-diameter hardwoods and pines were located in riparian areas at Fort Bragg, and those areas generally contained low densities of reproductively mature oak trees (Lashley et al. 2014). Given the potential importance of large hardwoods for Wild Turkey roosting coupled with the known importance of hard mast to the Wild Turkey diet (Dickson 2001), management actions in Longleaf Pine communities (i.e., frequent fires, chemical or mechanical treatments) that limit the abundance and distribution of mature hardwoods could negatively affect Wild Turkey roost availability, especially if the fire regime is applied in a way that limits fire shadows that promote succession of hardwoods to maturity in this ecosystem (Lashley et al. 2014).

Roosting Wild Turkeys avoided the military-activity zones and firebreaks/roads, but demonstrated no selection for or avoidance of water sources. The birds likely avoided military-activity zones because they generally lacked trees suitable for roosting, except along the edges of the openings. However, it is also probable that frequent anthropogenic disturbance in the military-activity zones and along firebreaks/roads may have deterred roosting Wild Turkeys. Although some studies have suggested that Wild Turkeys roost near water sources (Boeker and Scott 1969, Chamberlain et al. 2000, Kilpatrick et al. 1988), we did not detect selection or avoidance for roosting near or over water. Selection of roost sites in proximity to water in other studies might be an artifact of the improved foraging resources nearby (Crockett 1973), which might explain why we did not detect a similar effect. Moreover, data limitations precluded our ability to test for seasonal trends in roost-site selection, which could have reduced our ability to identify seasonal importance of water sources.

Movements and behavior of Wild Turkeys can be influenced by roost sites (Gross et al. 2015), so maintenance of roost-site availability in Longleaf Pine communities is warranted. At Fort Bragg, limited availability of tall hardwoods coupled with anthropogenic disturbance appeared to have the combined effect of limiting the areas that Wild Turkeys selected for viable roost sites. Although frequent fire has numerous ecological benefits for Wild Turkeys and other taxa in the Longleaf Pine ecosystem, managers will need to consider the compounding effects of additional management actions (e.g., mechanical removal of hardwoods) that could further reduce the hardwood component on the landscape. For example, Streich et al. (2015) determined that frequent fire (≤2-y return-interval) was compatible with conservation of Wild Turkey nest-site and brood ground-roost cover but that managers should carefully consider removal of hardwoods, particularly in riparian areas, due to their importance to hens and broods. Also, frequent fire can eliminate species that produce fleshy fruits, which are an important food resource for Wild Turkeys (Lashley et al. 2015, 2017). Moreover, removal of relic mature oaks within forest stands may be particularly problematic without adjusting concurrent fire regimes to allow oak succession in fire shadows (Lashley et al. 2014). Thus, managers of the Longleaf Pine ecosystem should promote heterogeneous landscape conditions including fire-maintained uplands as well as lowland hardwoods that are less frequently burned to provide roosting and nesting cover for Wild Turkeys, while simultaneously allowing the restoration and maintenance of habitat conditions for other wildlife species associated with the ecosystem (Kilburg et al. 2014, 2015; Prince et al. 2016, Sasmal et al. 2017). To conserve Wild Turkey roosting cover in the Longleaf Pine ecosystem, resource managers should strive to protect lowland hardwoods and create a mosaic of upland hardwoods that include both recently burned as well as less recently burned sections, allowing for the regeneration and maturation of oaks and other hardwoods in areas of low topography and mesic areas near streams (i.e., in fire shadows; Prince et al. 2016).

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Literature Cited

Bailey, R.W., and K.T. Rinell. 1967. Management of the Eastern Turkey in the northern hardwoods. Pp. 261–302, *In* O.H. Hewitt (Ed.). The Wild Turkey and its Management. Wildlife Society, Washington, DC. 589 pp.

Boeker, E.L., and V.E. Scott. 1969. Roost-tree characteristics for Merriam's Turkey. Journal of Wildlife Management 33:121–124.

Byrne, M.E, J.C. McCoy, J.W. Hinton, M.J. Chamberlain, and B.A. Collier. 2014. Using dynamic Brownian-bridge movement modeling to measure temporal patterns of habitat selection. Journal of Animal Ecology 83:1234–1243. DOI:10.1111/1365-2656.12205.

Byrne, M.E., B.A. Collier, and M.J. Chamberlain. 2016. Roosting behavior of male Eastern and Rio Grande Wild Turkeys. Pp. 175–185, *In* D.A. Miller (Ed.). Proceedings of the Eleventh National Wild Turkey Symposium, 5–7 January 2016, Tuscon, AZ. 410 pp.

Calenge, C. 2006. The package 'adehabitat' for the R software: A tool for the analysis of space and habitat use by animals. Ecological Modeling 197:516–519.

Calenge, C., and A.B. Dufour. 2006. Eigenanalysis of selection ratios from animal radio-tracking data. Ecology 87:2349–2355.

Chamberlain, M.J., B.D. Leopold, and L.W. Burger. 2000. Characteristics of roost sites of adult Wild Turkey females. The Journal of Wildlife Management 64:1025–1032.

Cox, J., and B. Widener. 2008. Lightning-season burning: Friend or foe of breeding birds. Tall Timbers Research Station Miscellaneous Publication, 17. Tall Timbers Research Station and Land Conservancy, Tallahassee, FL. 16 pp.

Crockett, B.C. 1973. Quantitative evaluation of winter-roost sites of the Rio Grande Turkey in north-central Oklahoma. Pp. 211–218, *In* G.C. Sanderson and H.C. Schultz (Eds.). Wild Turkey Management: Current Problems and Programs. University of Missouri Press, Columbia, MO. 379 pp.

Dickson, J.G. 2001. Wild Turkey. Pp. 108–121, *In* J.G. Dickson (Ed). Wildlife of Southern Forests: Habitat and Management. Hancock House Publishers, Surrey, BC, Canada. 480 pp.

Drew, M.B., L.K. Kirkman, and A.K. Gholson Jr. 1998. The vascular flora of Ichauway, Baker County, Georgia: A remnant Longleaf Pine/Wiregrass ecosystem. Castanea 63(1):1–24.

Fauchald, P. 1999. Foraging in a hierarchical patch system. The American Naturalist 153:603–613.

Fill, J.M., S.M. Welch, J.L. Waldron, and T.A. Moussea. 2012. The reproductive success of an endemic bunchgrass indicates historical timing of keystone process. Echosphere 3(7):1–12.

Getz, W.M., and C.C. Wilmers. 2004. A local nearest-neighbor convex-hull construction of home ranges and utilization distributions. Ecography 27:489–505.

Gross, J.T., A.R. Little, B.A. Collier, and M.J. Chamberlain. 2015. Space use, daily movements, and roosting behavior of male Wild Turkeys during spring in Louisiana and Texas. Journal of the Southeastern Association of Fish and Wildlife Agencies 2:229–234.

Guthrie, J.D., M.E. Byrne, J.B. Hardin, C.O. Kochanny, K.L. Skow, R.T. Snelgrove, M.J. Butler, M.J. Peterson, M.J. Chamberlain, and B.A. Collier. 2011. Evaluation of a global positioning system backpack transmitter for Wild Turkey research. Journal of Wildlife Management 75:539–547.

Hemson, G., P. Johnson, A. South, R. Kenward, R. Ripley, and D. MacDonald. 2005. Are kernels the mustard? Data from global positioning system (GPS) collars suggests problems for kernel home-range analyses with least-squares cross-validation. Journal of Animal Ecology 74:455–463.

Horne, J.S., E.O. Garton, S.M. Krone, and J.S Lewis. 2007. Analyzing animal movements using Brownian bridges. Ecology 89:2354–2363.

Kilburg, E., C.E. Moorman, C.S. DePerno, D. Cobb, and C.A. Harper. 2014. Wild Turkey nest survival and nest-site selection in the presence of growing-season prescribed fire. Journal of Wildlife Management 78:1033–1039.

Kilburg, E., C.E. Moorman, C.S. DePerno, D. Cobb, and C.A. Harper. 2015. Wild Turkey pre-nesting resource-selection in a landscape managed with frequent prescribed burns. Southeastern Naturalist 14:137–146.

Kilpatrick, H.J., T.P. Husband, and C.A. Pringle. 1988. Winter-roost site characteristics of Eastern Wild Turkeys. The Journal of Wildlife Management 52:461–463.

Kimmel, F.G., and P.J. Zwank. 1985. Habitat selection and nesting responses to spring flooding by Eastern Wild Turkey hens in Louisiana. Proceedings of the National Wild Turkey Symposium 5:155–171.

Knapp, E.E., B.L. Estes, and C.N. Skinner. 2009. Ecological effects of prescribed-fire season: A literature review and synthesis for managers. General Technical Report PSW-GTR-224. US Department of Agriculture Forest Service, Pacific Southwest Research Station, Albany, CA. 80 pp.

Kranstauber, B., and M. Smolla. 2016. move: Visualizing and analyzing animal-track data. R package version 1.6.541. Available online at https://CRAN.R-project.org/package=move. Accessed 18 July 2018.

Kranstauber, B., R. Kays, S.D. LaPoint, M. Wikelski, and K. Safi. 2012. A dynamic Brownian-bridge movement model to estimate utilization distributions for heterogeneous animal movement. Journal of Animal Ecology 81(4):738–746.

Lashley, M.A., M.C. Chitwood, A. Prince, M.B. Elfelt, E.L. Kilburg, C.S. DePerno, and C.E. Moorman. 2014. Subtle effects of a managed-fire regime: A case study in the Longleaf Pine ecosystem. Ecological Indicators 38:212–217.

Lashley, M.A., M.C. Chitwood, C.A. Harper, C.S. DePerno, and C.E. Moorman. 2015. Variability in fire prescriptions to promote wildlife foods in the Longleaf Pine ecosystem. Fire Ecology 11(3):62–79.

Lashley, M.A., M.C. Chitwood, C.S. DePerno, and C.E. Moorman. 2017. Frequent fires eliminate fleshy fruit production. Forest Ecology and Management 405:9–12.

Ludwig, E. 2012. Reproductive ecology of Eastern Wild Turkey hens in Sussex County, Delaware. Ph.D. Dissertation. University of Delaware, Newark, DE.

Manly, B.F., L.L. McDonald, and D.L. Thomas. 2002. Resource Selection by Animals: Statistical Design and Analysis for Field Studies. Revised Edition. Kluwer Academic, Boston, MA. 222 pp.

Miller, D.A., G.A. Hurst, and B.D. Leopold. 1999. Habitat use of Eastern Wild Turkeys in central Mississippi. The Journal of Wildlife Management 63:210–222.

Palmer, W.E., G.A. Hurst, and B.D. Leopold. 1996. Pre-incubation habitat use by Wild Turkey hens in central Mississippi. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies 50: 417–427.

Porter, W.F. 1978. The ecology and behavior of the Wild Turkey (*Meleagris gallopavo*) in south-eastern Minnesota. Ph.D. Dissertation. University of Minnesota, Minneaplois, MN.

Prince, A., M.C. Chitwood, M.A. Lashley, C.S. DePerno, and C.E. Moorman. 2016. Resource selection by southeastern Fox Squirrels in a fire-maintained forest system. Journal of Mammalogy 97:631–638.

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available online at www.r-project.org. Accessed 18 July 2018.

Sasmal, I., C.S. DePerno, M.B. Swingen, and C.E. Moorman. 2017. Influence of vegetation type and prescribed fire on *Peromyscus* abundance in a Longleaf Pine ecosystem. Wildlife Society Bulletin 41:49–54. DOI:10.1002/wsb.740.

Sorrie, B.A., J.B. Gray, and P.J. Crutchfield. 2006. The vascular flora of the Longleaf Pine ecosystem of Fort Bragg and Weymouth Woods, North Carolina. Castanea 71(2):129–161.

Still, H.R., Jr., and D.P. Baumann Jr. 1989. Wild Turkey activities in relation to timber types on the Francis Marion National Forest. Pp 137–141, *In* T.A. Waldrop (Ed). Pine–Hardwood Mixtures: Management and Ecology of the Type. US Forest Service General Technical Report SE-58. Southeast Forest Exprriment Station, Asheville, NC. 271 pp.

Streich, M.M., A.R. Little, M.J. Chamberlain, L.M. Conner, and R.J. Warren. 2015. Habitat characteristics of Eastern Wild Turkey nest- and ground-roost sites in 2 Longleaf Pine forests. Journal of the Southeastern Association of Fish and Wildlife Agencies 2:164–170.

Turchin, P. 1991. Translating foraging movements in heterogeneous environments into the spatial distribution of foragers. Ecology 72:1253–1266.

Tzilkowski, W.M. 1971. Winter roost sites of Wild Turkeys in southwest Pennsylvania. Transactions of the Northeast Fish and Wildlife Conference 28:167–178.

Zwank, P.J., T.H. White Jr., and F.G. Kimmel. 1988. Female turkey habitat-use in Mississippi river batture. Journal of Wildlife Management 52:253–260.