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Evaluation of reproductive phenology, space use, and ecology of the eastern wild turkey (Meleagris gallopavo silvestris) in west-central Louisiana

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EVALUATION OF REPRODUCTIVE PHENOLOGY, SPACE USE, AND ECOLOGY OF THE EASTERN WILD TURKEY (*MELAGRIS GALLOPAVO SILVESTRIS*) IN WEST-CENTRAL LOUISIANA

A Thesis

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Dedication

I would like to dedicate this to the family that has continued to support me through this incredibly trying time in my life, including my father Dave, his wife Lisa, and my sister Amanda, my aunt Jill, my uncle Marc, and my cousins Courtney and Will. I'd also like to thank my girlfriend Erin for sticking with me in what we agree was probably the worst point in our lives that we could have met.

I could not have made it through this period without meeting so many great graduate students throughout my time at Louisiana State University. I was incredibly lucky to come to a program that has had so many great people come through, not only that so many will go on to be great contributors in our field, but that they are just wonderful human beings to be around and spend time with. I will always cherish the time I got to spend with my friends here.

Finally, I'd like to thank the doctors and nurses who literally saved my life in 2021, specifically Drs. Mark Posner and Christopher McCanless. When I was diagnosed with cancer in June of 2021, I was immensely frightened for what it meant for my future. The doctors did an incredibly job of giving me a steady guiding hand through every step of the process, giving me a clear path to when I would finally be safe again. They say I'm likely in remission since cancer was last detected in December of 2021, but as anyone with a disease like this can tell you, it's hard to know when you can ever trust your body again. It has been a long journey back in the time since my initial diagnosis (and special thanks to my advisor Dr. Bret Collier for his patience in that time), but I cannot help but feel optimistic about my life and my ability to work in the field that I love so dearly that I've already given nearly a decade and a half to. Without the help of those doctors and nurses, I would literally not be here to write this, but I also would not have the confidence to know that this is all worth fighting for.

Acknowledgments

I would like to thank my major professor, Dr. Bret Collier and thesis committee members, Dr. Michael Chamberlain and Dr. Michael Kaller for their mentoring, support, and patience during the pursuit of my M.S. Degree.

I would also like to thank the collaborators on this project for their financial support: the Louisiana Department of Wildlife and Fisheries and Louisiana State University's School of Renewable Natural Resources. This project also could not have occurred without a long list of Louisiana Department of Wildlife and Fisheries and United States Forest Service employees including L. Bennett, C. Boles, C. Cedotal, M. Pardue, B. Parker, C. Sonnier, K. Legleu, B. Bennett, and J. Nolde. I also want to thank all the graduate students and postdocs who have helped me along the way including N. Bakner, D. Bakner, E. Thayer, A. Byers, E. Ulrey, D. Moscicki, B. Buckley, N. Raginski, M. Gamble, L. Schofield, J. Kunberger, and J. Bushaw. The undergraduates and field technicians who worked with me were also crucial to the completion of this project and made my experience in the field much more enjoyable: L. McFarland, O. Roy, M. Stafford, E. Patterson, K. Fryar, S. Beck, J. Fuess, and G. Link.

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Abstract

Nest site selection is a driving demographic force behind eastern wild turkey (*Meleagris gallopavo silvestris*) populations. However, previous research was likely not focused on the actual time of nest site selection, considering that nest site selection is likely only able to occur on the day of the first egg being laid. My objective was to determine if selection for any vegetation characteristics was occurring on the first day of laying. I estimated the path taken from the roost to the nest on the first day of egg laying (i.e., laying path) using GPS data collected from 164 unique female wild turkey first nest attempts in west-central Louisiana from 2014 to 2021. I compared the vegetative characteristics of those laying paths to other available habitat. I found that female wild turkeys had no clear selection of any vegetation characteristics on their laying path. My results suggest that nest site selection is not based on available habitat, thus nest site selection is either driven by other factors or is stereotypic.

Wild turkey research often focuses on the movement of single individuals without considering group effects, despite wild turkeys being mostly gregarious. My objective was to determine how often female wild turkeys share space during the breeding season over multiple years. I used GPS data collected from 231 female wild turkeys that each produced ≥ one nest to estimate each individuals' ranges during two periods of the breeding season (pre-laying and laying). I then determined how often those ranges overlapped, while also comparing ranges for individuals who had multiple nests for individual site fidelity. I found that the probability of sharing space depended on where individuals were caught, but that breeding female wild turkeys had a high probability of sharing space during the pre-laying period with any breeding female captured within 7.5 km. The probability of sharing space was lower during the laying period. Individual site fidelity was high throughout the breeding season. My results suggest that female

wild turkeys are using similar areas during the breeding season over time, with persistent leks being the anchor for female wild turkeys and their offspring.

CHAPTER 1. INTRODUCTION

The wild turkey (*Meleagris gallopavo spp.*) is a large galliform that is widely distributed across North America. In the 20th century, due to overharvest and unsustainable habitat conservation practices, the wild turkey was nearly extirpated from the United States (Dickson 1992). Extensive restoration efforts at the state and federal level (with help from non-government organizations) were able to restore wild turkey populations to sustainable levels, making their restoration one of the success stories of North American wildlife conservation (Dickson 1992). The wild turkey is also a popular game species, with nearly 650,000 wild turkeys harvested in the United States in 2018-2019 (Chamberlain et al. 2022), so their environmental needs influence habitat management for most species that occur in North America. Thus, maintaining sustainable wild turkey populations is both ecologically and economically important. In recent years across the United States wild turkey populations have generally been declining (Chamberlain et al. 2022), therefore many interested parties have been trying to identify the drivers of this population decline and find management practices that can reverse this trend to maintain wild turkey populations at sustainable levels. Creating sustainable wild turkey populations would provide both economic benefits to regions with wild turkey hunting and hunting suppliers, but also funding for other species research and habitat restoration that benefits entire ecosystems (i.e. wild turkeys as an umbrella species). Specifically in Louisiana the wild turkey is a popular big game species, with ~19,600 hunters harvesting ~5,500 wild turkeys in 2021 (LDWF 2021). Hunters contribute around $120 million to Louisiana’s economy each year, so wild turkey management in the state is crucial to maintaining sustainable populations to retain these economic benefits (LDWF 2008).

The wild turkey is a ground-nesting species where the male only contributes to

reproduction genetically. The reproductive period generally occurs from March to July, with the period being broken into three or four phases: pre-laying, laying, incubation, and (if successful) brooding. After a female selects a male and breeds with him during the pre-laying period, the female will lay 1 egg per day until all eggs in a clutch are laid and incubation can begin. For the eggs to hatch out, a female must incubate her nest from 26–33 days, with nearly 80% of nests failing before that point (Crawford et al. 2021). If incubation fails then females will often repeat the cycle for a second or third (and in rare cases a fourth) nest attempt in the same breeding season. Ground-nesting requires a high energetic cost and creates periods of high risk, as a variety of nest predators will seek out both eggs and the females that are incubating them.

During their life cycle, wild turkey use a variety of habitats, and nest sites occur in a wide variety of vegetative and understory conditions (Holbrook et al. 1987, Porter 1992, Badyaev 1995, Streich et al. 2015, Yeldell et al. 2017). The primary driver of reproductive success (and thus wild turkey populations) is likely nest site selection, which is possibly influenced by vegetative characteristics at the nest site (Badyaev et al. 1996, Miller et al. 1999, Byrne and Chamberlain 2013, Fuller et al. 2013, Conley et al. 2015, Yeldell et al. 2017). Many studies have tried to connect nest site selection to habitat preference and reproductive success using habitat measurements, but recent research on wild turkey nest site selection has shown mostly unclear selection patterns (Yeldell et al. 2017, Wood et al. 2019, Schofield 2019, Crawford et al. 2021).

Most research on wild turkey nest selection is focused on characteristics of specific nest sites (Byrne and Chamberlain 2013, Fuller et al. 2013, Yeldell et al. 2017, Wood et al. 2018) or characteristics of the breeding season habitat overall (Miller et al. 1999, Chamberlain and Leopold 2000, Thogmartin 2001, Miller and Conner 2007) and comparing each of those to what was potentially available to females. However, recent research showed that female wild turkeys

do not visit their nest sites during the breeding season before laying begins (Conley et al. 2016, Collier et al. 2019), so the scales used for previous research are likely not capturing when and where nest site selection is occurring. This pattern only allows for nest site selection within a breeding season to occur on the day a female lays her first egg (laying path). Schofield (2019) measured the microhabitat vegetation characteristics of each laying path and found no clear selection patterns. Previous research found that wild turkeys will select landscapes containing mature, open mixed hardwood-pine forests (Miller et al. 1999, Chamberlain and Leopold 2000, Thogmartin 2001, Miller and Conner 2007), but if their scales were not measuring when selection may occur, then this also warrants further study for landscape level vegetation effects.

Wild turkeys are known to use an exploded lek strategy during the breeding season, but specific behaviors during this period are still poorly understood for turkeys (Conley et al. 2016, Bakner et al. 2019, Chamberlain et al. 2020). Lekking species tend to have four characteristics: 1. Males are not involved in rearing of young, 2. Males aggregate at specific sites for display (i.e. the lek), 3. Leks are primarily used for sexual selection with less of an emphasis on resource selection, and 4. Females drive mate selection (Bradbury 1981). However, there are often deviations from these characteristics, with a notable example being exploded leks. Exploded lekking species will not have individuals aggregate at specific sites for display, but will have multiple males retain space on the landscape and maintain these leks with non-visual cues (*e.g.* gobbling for wild turkeys). These leks are also often maintained over time, with individuals of both sexes often anchoring their movements across their life cycle to these leks (Widemo 1997, Wann et al. 2019). If these ranges are so crucial to wild turkey behavior, movement, and reproduction, then it is imperative for managers to identify and manage for these areas.

With the high resolution data from GPS transmitters and a long term data set in one study

site for wild turkeys, I evaluated how landscape level vegetation characteristics may influence nest site selection on the first day of laying by wild turkey females. I also evaluated spatial overlap between breeding females during the breeding season over time to see how often these females share area in both the same season and between breeding seasons. In this thesis, I present data from 6 study sites located in west-central Louisiana. In Chapter 2, I describe the vegetation characteristics used or avoided on the day a female lays her first egg for her first nest attempt. In Chapter 3, I evaluate the probability and percent shared area of pair-wise overlap between breeding females occurring at 3 different spatial scales along with the difference in within season and between seasons overlap to determine how often and potentially what areas are being shared between breeding females to try to identify areas where breeding is occurring over time (leks). In Chapter 4, I provide overall conclusions of the thesis with management implications and future research suggestions.

CHAPTER 2. FEMALE WILD TURKEY HABITAT SELECTION ON THE FIRST DAY OF EGG LAYING IN WEST-CENTRAL LOUISIANA

2.1. Introduction

Understanding resource selection is critical to assessing avian behavior, as resource availability influences survival and fecundity (Holt 1984, Dunning et al. 1992, Martin 1995). Within the reproductive period, resource selection is thought to underlie nest success (Pulliam et al. 1992, Martin 1995, Johnson 2007, Devers et al. 2007), given that nest site selection affects demographics of avian species (Clark and Shutler 1999, Jones 2001, Fontaine and Martin 2006, Lima 2009). Along with energy considerations, nest site selection is also thought to be driven by predator avoidance (Dunning et al. 1992, Martin 1998, Conway and Martin 2000) and by abiotic factors (e.g., microclimate; Martin 2001).

Eastern wild turkeys (*Meleagris gallopavo silvestris*, hereafter wild turkeys) are a ground-nesting galliform widely distributed throughout North America. Wild turkey populations have declined over the last several decades in the southeastern United States (Byrne et al. 2015, Chamberlain et al. 2022), and long-term declines have been noted in nearly all reproductive indices (e.g., nest success and poults per hen; Byrne et al. 2015, Crawford et al. 2021, Chamberlain et al. 2022, Clawson et al. 2022). Thus, furthering my understanding of resource selection's impact on wild turkey reproduction is likely a major part of informing management to improve wild turkey population trends.

As reproduction influences wild turkey population trajectory, research has focused on resource selection during the breeding season (specifically nest site vegetation selection), which has indicated that female wild turkeys will select for landscapes containing mature, open mixed hardwood-pine forests (Miller et al. 1999, Chamberlain and Leopold 2000, Thogmartin 2001, Miller and Conner 2007). Studies have also shown breeding season and nest site selection for

areas with roads (Wood et al. 2018) and areas that have been burned within the previous two-to-three years (Yeldell et al. 2017), along with an avoidance of flooded or low lying areas (Byrne and Chamberlain 2013). At the patch and microhabitat scale visual obstruction, ground cover, and vegetation density seem to play a role in nest site selection and nest success (Fuller et al. 2013, Yeldell et al. 2017). Selection for various vegetation characteristics was believed to underlie reproductive and survival benefits, thus vegetation has long been identified as the most valuable resources to conserve and manage for wild turkey reproduction. However, there is considerable variation in selection strength and the effect of vegetation selection on nest success (Yeldell et al. 2017, Wood et al. 2019, Crawford et al. 2021) which makes consistent management decisions difficult to render.

Contemporary research indicates nest sites are rarely visited before laying begins (Conley et al. 2016, Collier et al. 2019), so nest site selection is likely not occurring during or prior to the breeding season, as posited by Badyaev et al. (1996). It is likely, however, that nest site selection is occurring on the day of the first egg being laid. Schofield (2019) was the first to focus research on this day by studying the microhabitat conditions on the day of the first egg being laid. He found that selection for vegetation characteristics associated with movements to nest sites on the day the first egg was laid was stereotypic or having no clear direction or purpose (Martin 1993), and that nest site vegetation had little effect on nest success.

My objective was to evaluate resource selection at the landscape scale by focusing on vegetation characteristics used or not used on the laying path that a female wild turkey takes on the day she initiates her nest. I predicted that female wild turkeys would select areas with a higher proportion of roads, recently burned areas (Yeldell et al. 2017, Wood et al. 2018), and upland pine and pine-hardwoods as nesting sites and avoid nesting in wetland areas (Byrne and

Chamberlain 2013). I also examined early diurnal movement patterns of female wild turkeys on the first day of laying and compared this to their typical movement patterns seen in other years.

2.2. Study Area

I conducted research on the Kisatchie National Forest (KNF), Peason Ridge Wildlife Management Area (PRWMA), and Fort Polk WMA (FPWMA) in west-central Louisiana (Figure 2.1). My study area experienced a subtropical climate, with mean daily temperatures at 10^{o}C in January and 28^{o}C in July and mean annual rainfall ~ 151cm. The KNF was managed by the U.S. Forest Service (USFS) and is broken into 5 ranger districts (RD), from which my work was conducted on the Kisatchie RD (41,453 ha), Winn RD (67,408 ha), Catahoula RD (49,169 ha), and the Vernon Unit of the Calcasieu RD (33,994 ha) located in Natchitoches, Winn, Grant, and Vernon Parishes, respectively. The northern portion of the FPWMA was managed by the U.S. Army, and the southern portion was managed by the USFS as part of the Vernon Ranger District. Each of my study areas has similar forest characteristics and land management and are considered one unit for this study. My study area was composed of pine-dominated forests, hardwood riparian zones, and forested wetlands with forest openings, food plots, pipelines, and forest roads throughout. Overstory trees included loblolly pine (*Pinus taeda*), longleaf pine (*P. palustris*), shortleaf pine (*P. echinata*), slash pine (*P. elliottii*), sweetgum (*Liquidambar styraciflua*), oaks (*Quercus* spp.), hickories (*Carya* spp.), and red maple (*Acer rubrum*). Understory species included yaupon (*Ilex vomitoria*), American beautyberry (*Callicarpa americana*), blackberry (*Rubus* spp.), greenbrier (*Smilax* spp), wild grape (*Vitis* spp.), broomsedge (*Andropogon virginicus*), woodoats (*Chasmanthium* spp.), and panic grasses (*Panicum* spp. and *Dichanthelium* spp.). Privately owned land on the borders of the public land is predominately industrial timber production (loblolly pine stands and clearcuts), small homes,

pasture, hardwood-dominated wetlands, and agricultural fields. For additional details of my study area, see Johnson and Dancak (1993), Stambaugh et al. (2011), and Yeldell et al. (2017).

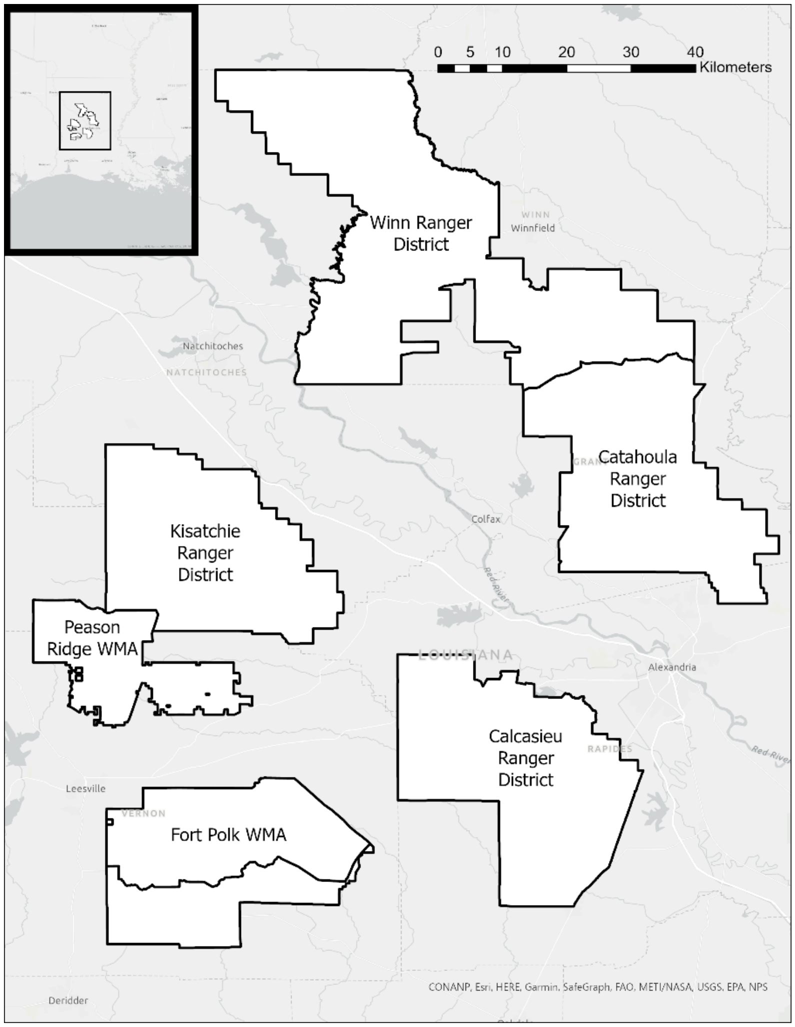

Figure 2.1. Study areas for evaluating reproductive resource selection by eastern wild turkeys including the Fort Polk Wildlife Management Area, four ranger districts of the Kisatchie National Forest (Calcasieu, Catahoula, Kisatchie, and Winn), and Peason Ridge Wildlife Management Area during 2014-2021.

2.3. Methods

I captured female wild turkeys using rocket nets from January-March 2014–2021. Females were classified as juveniles or adults based on barring on the last primary feather (Pelham and Dickson 1992). Each female was fitted with a riveted, uniquely numbered, tarsal aluminum band and a global positioning system (GPS) transmitter equipped with a very high

frequency (VHF) emitter (88 g; Lotek Minitrack Backpack, Lotek PinPoint Backpack; Lotek Wireless, Newmarket, Ontario, Canada). All individuals were released at the capture site after processing. GPS transmitters were programmed to collect a location hourly from 0500 to 2000 each day with 1 roost location at 23:59:58. I used handheld Yagi antennas and a VHF/ultra-high frequency (UHF) PinPoint Commander unit (Lotek Wireless, Newmarket, Ontario, Canada) to downloaded GPS data ≥ 1 per week throughout the study period. Date and time of nest initiation (i.e., beginning of egg laying) and nest incubation were determined following methods from Conley et al. (2015), Bakner et al. (2019), and Lohr et al. (2020). All capture, handling, and marking procedures were approved by the Institutional Animal Care and Use Committee at Louisiana State University AgCenter (protocol A2014-013 and A2015-07 and A2018-13).

After visual confirmation of a nest, I created a behavioral trajectory (hereafter laying path) based on the movement from the roost location the night before the first egg was laid to the nest site. Then, I created a 100 m buffer for each laying path using the rgeos package (Bivand et al. 2021) in R v. 4.2.1 (R Core Team 2022), which I defined as laying path used. For each nest, I replicated each laying path 5 times in random directions originating at the roost location from the night before laying began (using a random number generator in R; Figures 2.2 and 2.3) to create a set of available but unused paths (hereafter random paths). I also created a fixed radius buffer around the night-before roost site to evaluate the laying path relative to the available nesting area. I used the distance from the roost location to the nest site and multiplied that value by 1.5 (Figure 2.4) as the buffered area to provide availability landscape for nesting, which I define as the availability circle. These two methods allowed for evaluation of resource selection both at the direct laying path scale and what was potentially available within a larger radius (Thogmartin 1999, Fuller et al. 2013, Wood et al. 2019, Schofield 2019).

To determine how laying path movement compared to typical female wild turkey movement, I calculated the average distance and speed travelled from roost to nest along with the route using the move package in program R (Kranstaber et al. 2022). I removed likely roost locations (any locations from 19:00 to 06:00) when calculating speed for each female. I used an analysis of variance (ANOVA) test to determine if the distance/speed from the roost to nest and date/times of nest initiations changed from year to year.

I used 30 m resolution National Land Cover Database (NLCD) imagery from both 2016 and 2019 from the United States Geological Survey (USGS) (Homer et al. 2015). I examined 8 landscape metrics [woody wetlands (%), herbaceous, shrub/scrub, mixed forest, evergreen forest, deciduous forest, road (developed open, developed low), and infrastructure (developed medium, developed high)] suggested to be influential during the laying period (Thogmartin 1999, Byrne and Chamberlain 2013, Kilburg et al. 2015, Crawford et al. 2021). I used the 2016 and 2019 NLCD imagery for wild turkeys nesting from 2014 to 2016 and 2017 to 2021, respectively.

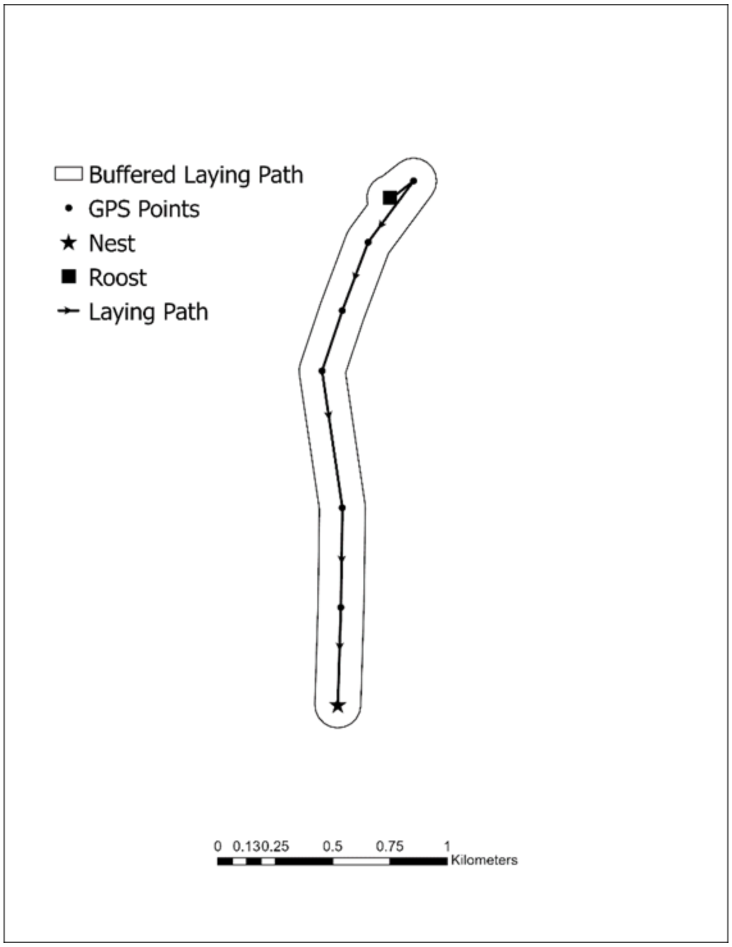

Figure 2.2. Example laying path for a female eastern wild turkey with hourly GPS locations from the roost (square) to the nest (star) monitored during research in west-central Louisiana during 2014-2021.

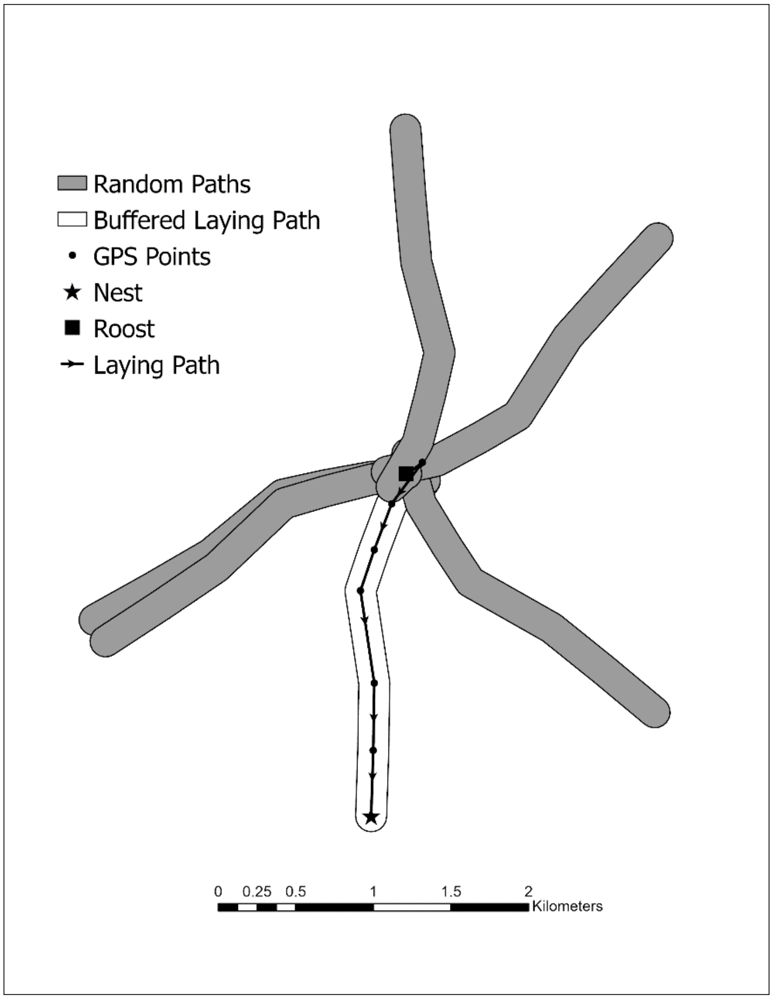

Figure 2.3. Used laying path (clear) and replicant, randomly rotated available/unused paths (gray) for a female eastern wild turkey monitored during research in west-central Louisiana during 2014-2021. The roost (square) and the nest (star) identify the start and ending locations of the use path, respectively.

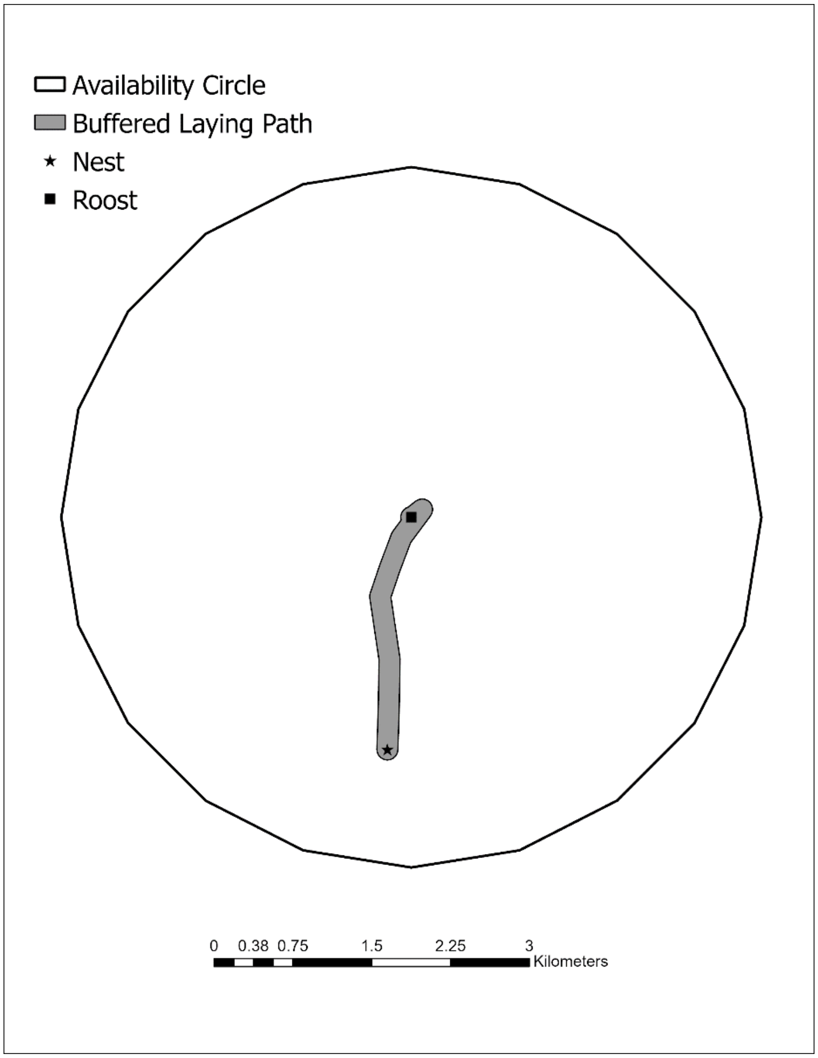

Figure 2.4. Female eastern wild turkey buffered laying path (gray) used during research in west-central Louisiana during 2014-2021.

Next, to determine the effect of green up, I created a normalized difference vegetation index (NDVI) from Sentinel-2 satellite imagery data (10 m resolution) for data from 2016 to 2021 (Pettorelli et al. 2005). For data from 2014 to 2015, I used Landsat-7 satellite imagery data (15 m resolution) from USGS (Irons et al. 2012). I selected imagery with < 10% cloud cover near the median laying date each year (30 April to 1 May). I separated the imagery into two bands and estimated NDVI in ArcMap 10.8 (ESRI, Redlands, CA, USA) to as

$$NDVI = (\text{Near-Infrared} - \text{Red}) / (\text{Near-Infrared} + \text{Red})$$

for my study area (Ulrey et al. 2022). I estimated mean NDVI for each laying path, random path, and the availability circle. To estimate forest density, I used satellite imagery from the United States Department of Agriculture's National Agriculture Imagery Program (NAIP), which has a 1 m resolution per pixel (United States Department of Agriculture 2019), and I used Earth Resources Data Analysis System (ERDAS) Imagine 2020 software (Hexagon AB, Stockholm, Sweden) to recategorized each pixel into 2 general vegetation categories: forested or open area (i.e., forest density). I used spatial data provided by USFS, U.S. Army, and Louisiana Department of Wildlife & Fisheries for my study area to identified if a female's laying path traversed through a prescribed burned or timber harvested/logged (1 = yes, 0 = no) sections within 3 years prior to the laying year (Yeldell et al. 2017, Sullivan et al. 2020).

I evaluated multiple landscape metrics' effects on selection of individual wild turkey laying paths using a logistic regression in program R (R Core Team 2022). I used a Pearson correlation test to remove potentially correlated landscape metrics ($|r| \geq 0.6$) (Dormann et al. 2018). I developed a candidate model set incorporating covariates from vegetation type (listed above), burned or logged, NDVI, and forest density. I created a global model including all the candidate model metrics. I evaluated the interaction between evergreen forest and woody wetlands, evergreen and deciduous forest, mixed and deciduous forest, and forest cover and open (Thogmartin 1999, Byrne and Chamberlain 2013, Kilburg et al. 2014, Sullivan et al. 2020, Crawford et al. 2021). I first compared laying paths (used) to random paths (available) as the response variable then ran a second separate analysis to compare laying paths (used) to the availability circle (available) as the response variable. For both analyses, I used the Akaike Information Criteria (AIC_c) value to determine model support relative to the global and null models (Burnham et al. 2011). Models with an evidence ratio ≤ 5 based on the AIC weight of the

lowest AIC model were considered to be potentially supportive to explaining the variation in laying path versus random path or availability circle (Burnham and Anderson 2002, Dick 2004). I model-averaged parameter estimates to determine biological significance. I used candidate model sets for both logistic regression analyses.

2.3. Results

I captured 304 female wild turkeys from 2014 to 2021 (270 adults, 34 juveniles). 58 individuals died or had transmitter failure before nesting season began (51 adults, 7 juveniles) and 39 females did not attempt to nest during my study (24 adults and 15 juveniles), giving an estimated nesting rate of 89% for adults and 44% for juveniles (84% overall). Of these, I observed a total of 197 first nest attempts and censored 43 due to two or more missed GPS fixes from the roost to the nest. This left me with 164 unique laying paths. Nest initiation dates ranged from 14 March to 26 May ($\bar{x}$ = 13 April, *SE* = 1 day; Figure 2.5). Year influenced females first visited the nest site (F = 8.425; $p < 0.01$), with the date range of nest initiations occurring earlier over time (Figure 2.6). Females initiated nests on average at 11:50 (*SE* = 15 minutes), but I found that first visits to nest sites regularly occurred between 6:00 and 18:00 (Figure 2.7).

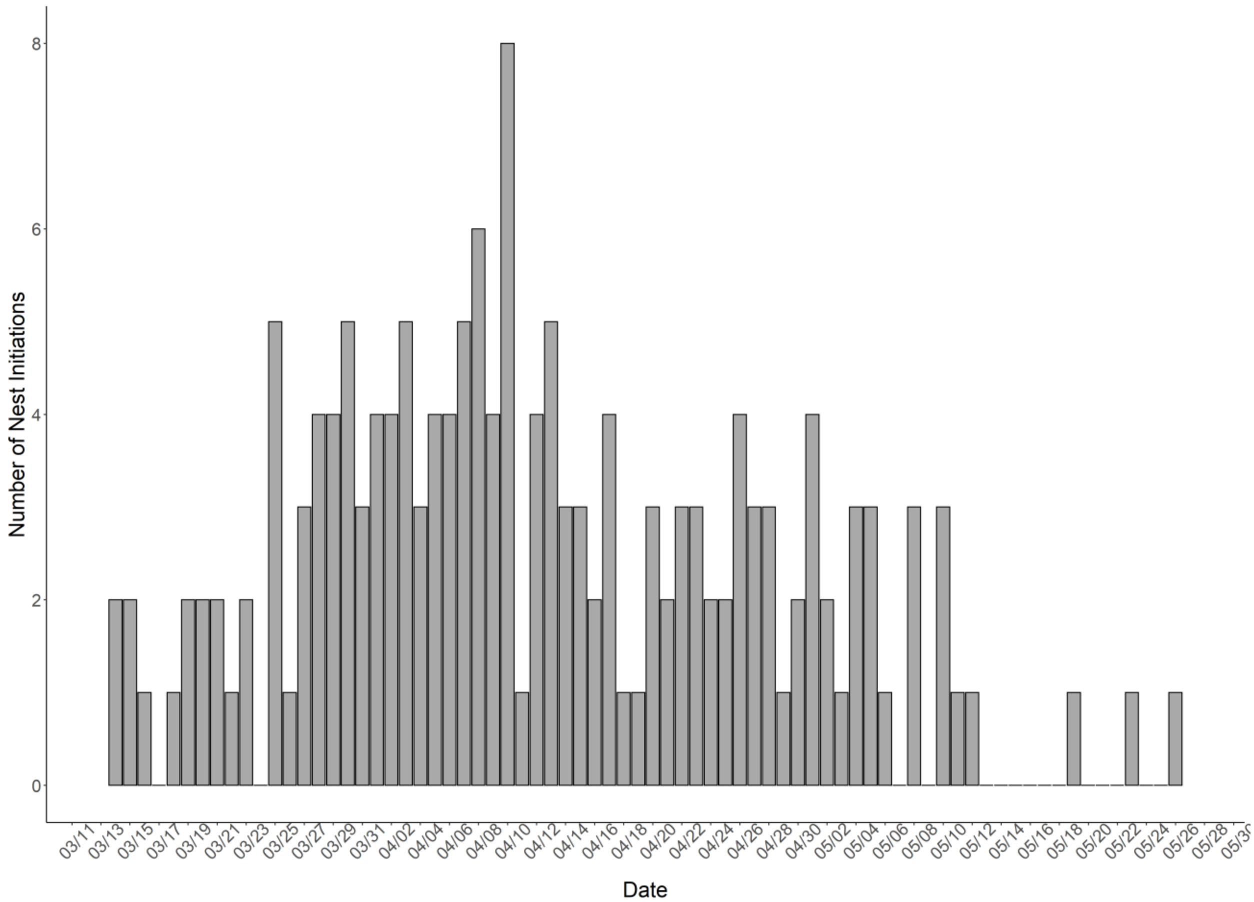

Figure 2.5. Chronology of female eastern wild turkey initial visit to the nest site in west-central Louisiana during 2014-2021.

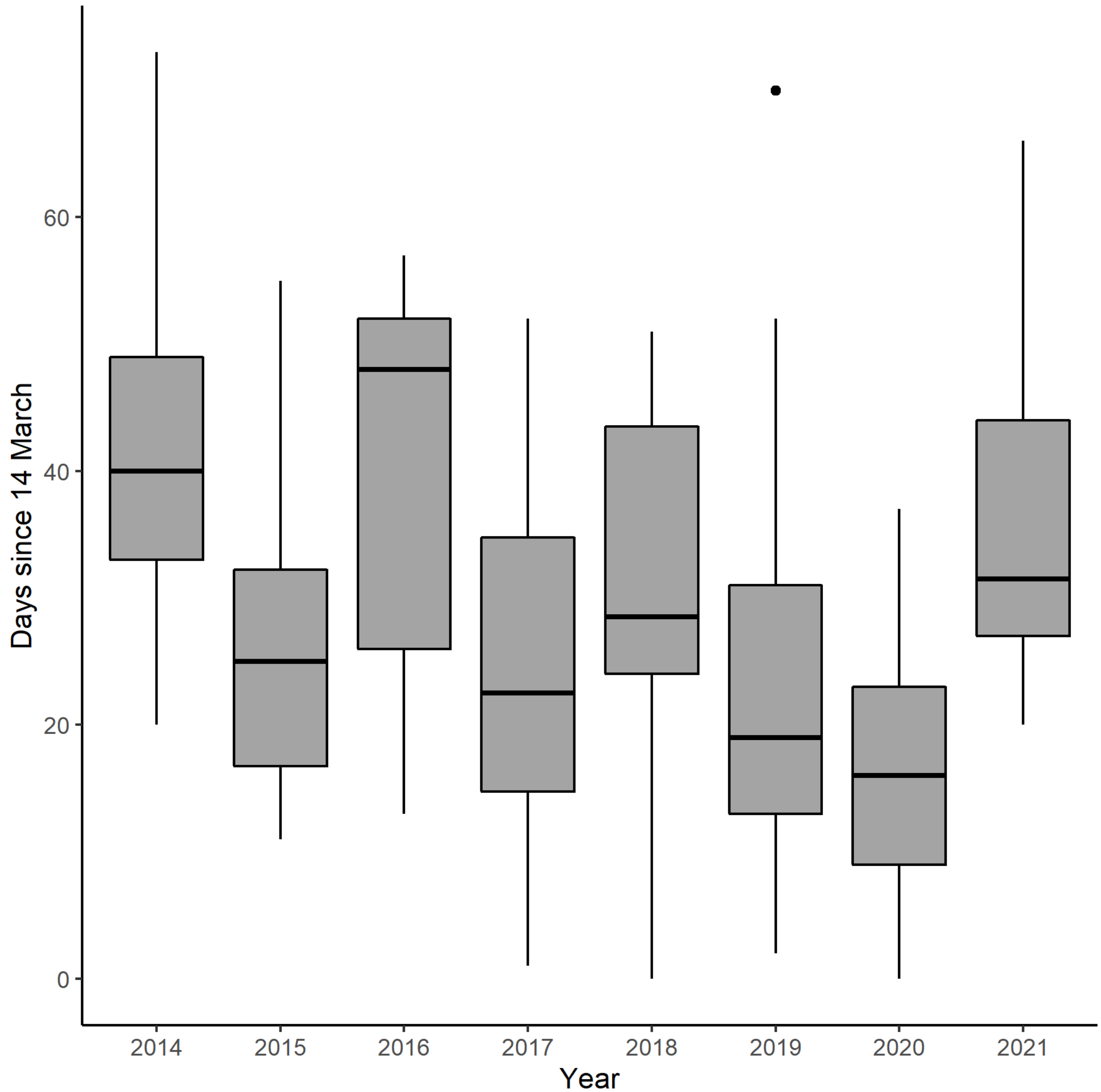

Figure 2.6. Median nest initiation dates of the first nest occurred for female eastern wild turkey in west-central Louisiana during 2014-2021. The 14th of March is represented by Day 0, and each higher number is the number of days since 14 March for all individuals monitored. Any dots represent outlier number of days.

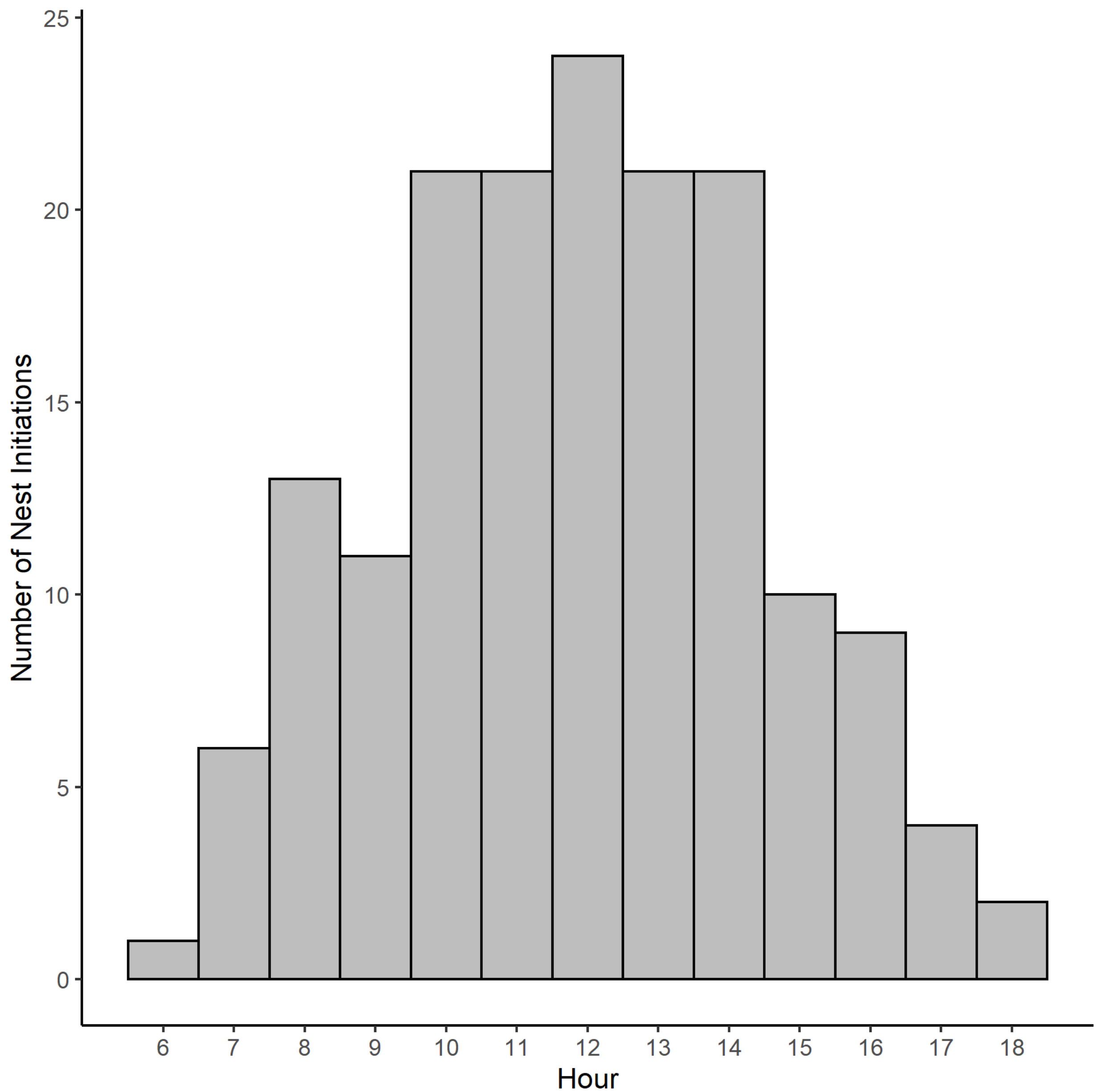

Figure 2.7. Female eastern wild turkey initial nest site visits at the temporal scale (hour) for all monitored turkeys in west-central Louisiana during 2014-2021.

Mean total distance moved for wild turkey laying paths was 1,690 m (*SE* = 85 m; range = 90–7676 m; Figure 2.8). The direct distance between roost sites and nest sites on the first day of laying were on average 956 m (*SE* = 65, range = 24–7,085 m; Figure 2.9). I found that neither of these measurements were significantly different between years. The median speed per step (two consecutive GPS locations) was 198 m (*SE* = 9, range = 4–1,990 m) per hour.

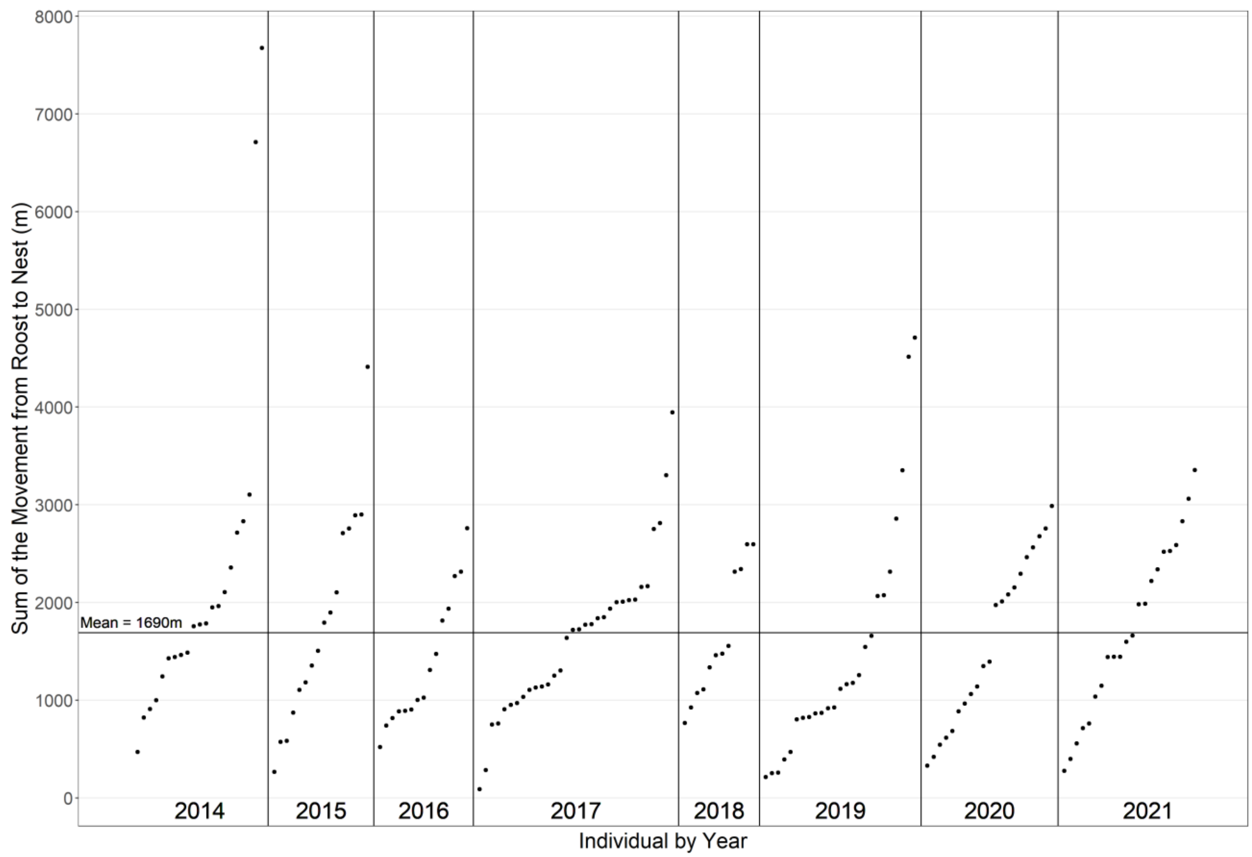

Figure 2.8. Total distance moved from the roost to the nest on the first day of laying for each individual female eastern wild turkey in west-central Louisiana during 2014-2021.

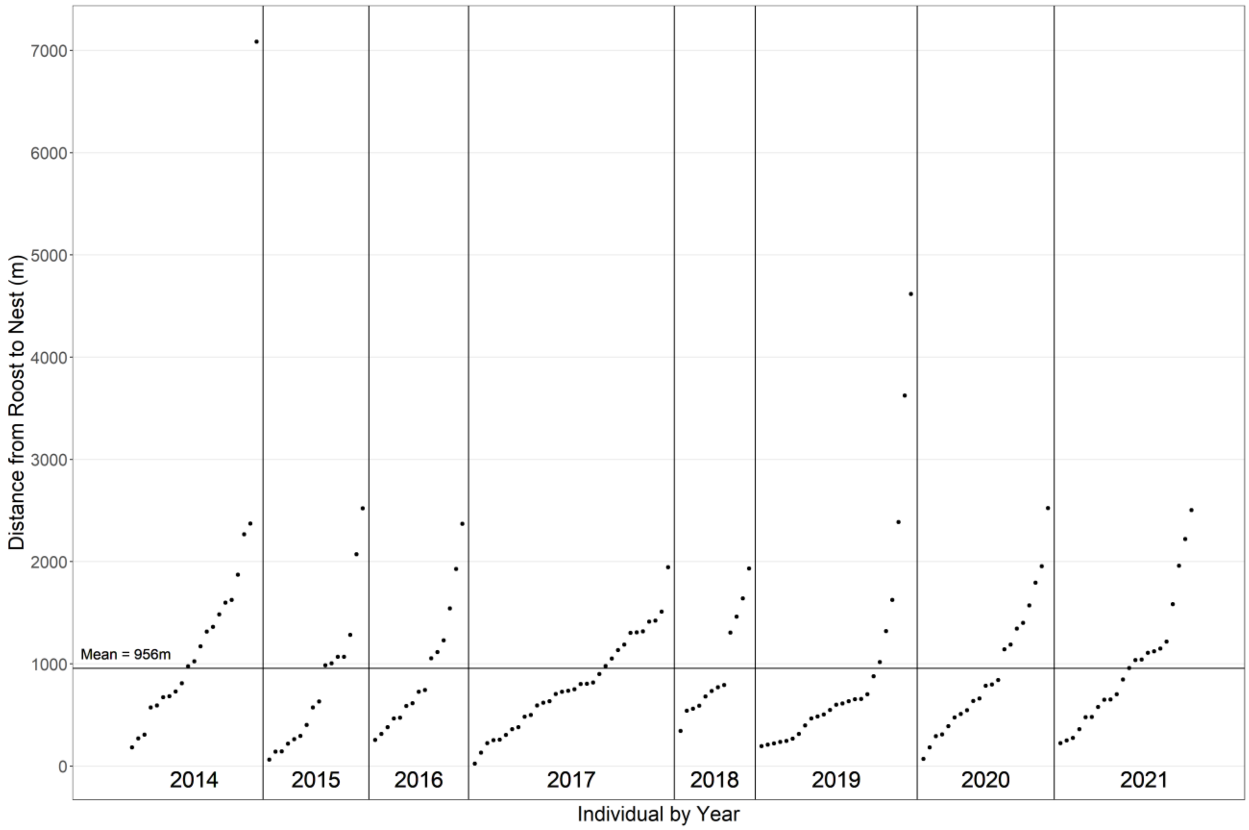

Figure 2.9. The direct distance from the roost to the nest on the first day of laying for each individual female eastern wild turkey in west-central Louisiana during 2014-2021.

I found no correlation between landscape-level metrics (|*r*| < 0.6). I observed no evidence that landscape-level metrics influenced nest site selection, for either laying path selection (Table 2.1) or within the availability circle (Table 2.2). My results did indicate that with a female's used laying path was less likely to contain woody wetlands (β = -1.21; *SE* = 0.57; Table 2.3) and evergreen forest when woody wetlands were present (β = -8.86; *SE* = 2.00; Table 2.3) when compared to random paths. Within the availability circle females avoided areas of evergreen forest when woody wetlands were present (β = -8.86; *SE* = 2.00; Table 2.3) in that for every 10% increase in woody wetlands within a laying path, females were 12% less likely to select that path.

Table 2.1. Logistic regression model selection with matched-pairs case-control sampling, where the used laying path were the cases and 5 random paths were the controls, to show vegetation selection during the path taken to laying the first egg for the first nest based on Louisiana wild turkey data 2014-2021. Model selection was based on Akaike's Information Criterion for each potential model (AIC_c), number of parameters (K), ΔAIC_c, the Akaike weight of evidence (AIC_c W), and the evidence ratio based on the lowest AIC model (ER).

Model	*K*	*AIC_c*	*ΔAIC_c*	*AIC_c W*	*ER*
Woody Wetlands[a]	2	879.77	0.00	0.43	1
Evergreen Forest x Woody Wetlands[a]	4	882.59	2.82	0.11	3.9
Null	1	883.30	3.53	0.07	6.1
Forested[b]	2	884.07	4.30	0.05	8.6
Roads[a]	2	884.10	4.33	0.05	8.6
Deciduous Forest[a]	2	884.14	4.37	0.05	8.6
Evergreen Forest[a]	2	884.26	4.49	0.05	8.6
Mixed Forest[a]	2	884.91	5.14	0.03	14.3
Mean_NDVI	2	884.95	5.18	0.03	14.3
Logging	2	885.13	5.35	0.03	14.3
Open[b]	2	885.18	5.41	0.03	14.3
Burn	2	885.23	5.46	0.03	14.3
Evergreen Forest x Deciduous Forest[a]	4	886.70	6.93	0.01	43.0
Forested x Open[b]	4	886.96	7.19	0.01	43.0
Mixed Forest x Deciduous Forest[a]	4	887.40	7.63	0.01	43.0
Global	14	894.27	14.49	0.00	>43.0

a. Landscape metric estimates based on NLCD imagery
b. Landscape metric estimates based on NAIP imagery

Table 2.2. Logistic regression model selection with matched-pairs case-control sampling, where the used laying path were the cases and an availability circle with the radius being 1.5 times the distance from the roost to the nest was the control, to show vegetation selection during the path taken to laying the first egg for the first nest based on Louisiana wild turkey data 2014-2021. Model selection was based on Akaike's Information Criterion for each potential model (AIC_c), number of parameters (K), ΔAIC_c, the Akaike weight of evidence (AIC_c W), and evidence ratio based on the lowest AIC model (ER).

Model	*K*	*AIC_c*	*ΔAIC_c*	*AIC_c W*	*ER*
Evergreen Forest x Woody Wetlands[a]	4	443.69	0.00	0.95	1
Evergreen Forest[a]	2	451.60	7.91	0.02	47.5
Null	1	453.94	10.26	0.01	95.0
Roads[a]	2	454.54	10.85	0.00	>95.0
Evergreen Forest x Deciduous Forest[a]	4	454.76	11.07	0.00	>95.0
Mixed Forest[a]	2	455.00	11.31	0.00	>95.0
Woody Wetlands[a]	2	455.00	11.31	0.00	>95.0
Mean_NDVI	2	455.81	12.12	0.00	>95.0
Burn	2	455.82	12.13	0.00	>95.0
Forested[b]	2	455.82	12.14	0.00	>95.0
Open[b]	2	455.85	12.17	0.00	>95.0
Deciduous Forest[a]	2	455.91	12.23	0.00	>95.0
Logging	2	455.97	12.28	0.00	>95.0
Forested x Open[b]	4	456.82	13.13	0.00	>95.0
Mixed Forest x Deciduous Forest[a]	4	458.82	15.13	0.00	>95.0
Global	14	459.32	15.64	0.00	>95.0

a. Landscape metric estimates based on NLCD imagery
b. Landscape metric estimates based on NAIP imagery

Table 2.3. Parameter estimates for the 2 models more influential than the null at predicting the vegetation used while selecting for laying the first egg of the first nest of wild turkeys in west-central Louisiana from 2014 to 2021. Negative values indicate avoidance of that vegetation type.

Model	*β^a*	*SE*	*Z*	*P*
Used vs. Random Paths				
Woody Wetlands*	-1.2143	0.5667	-2.143	0.0321
Evergreen Forest:Woody Wetlands	-1.5718	1.9983	-0.787	0.4315
Used vs. Availability				
Evergreen Forest:Woody Wetlands*	-8.8565	2.7832	-3.182	0.0015

* indicates a *p*-value less than 0.05.

2.4. Discussion

My results indicate female wild turkeys' laying path selection on the day of nest initiation was negatively influenced by woody wetlands and that all other measured metrics do not play a biologically significant role in resource selection on this day. My assumption that burned areas or the presence of roads would affect laying path selection was not confirmed, which differs from previous research (Thogmartin 1999, Miller et al. 2007, Martin et al. 2012, Yeldell et al. 2017). My overall nesting season timing and movement patterns were similar to patterns seen in other research (Miller et al. 1998, Conley et al. 2016, Collier et al. 2019, Schofield 2019, Wood et al. 2019, Tyl et al. 2020), which shows that my laying paths are likely representative of breeding season behavior in female wild turkeys. The hour of nest initiations was most often between 10:00 and 14:00, which is most likely a predator avoidance strategy (Kohl et al. 2018). As laying is occurring for wild turkeys, females tend to lay each egg at a similar time every day, so if they initiate their nests at midday they are most likely to avoid predators which are often crepuscular.

Similar to other recent research (Schofield 2019, Ulrey 2021), my results suggest that vegetation characteristics on the day of laying (at the scale that I measured them) likely have little to no impact on female nest site selection. Contemporary research (Crawford et al. 2021, Keever et al. 2022) in the southeastern United States has generally indicated that vegetation is not the primary driver of nest success of wild turkeys. Thus, it is not surprising that geospatial data of vegetation characteristics, a coarser measurement than the microhabitat vegetation characteristics that wild turkeys utilize as they initiate their nest provide little value in selection. Resource selection based on vegetation has been covered exhaustively in wild turkey research and there has yet to be a clear pattern of selection that influences breeding and reproductive

success. Previous research that described wild turkey nest site selection for vegetation characteristics was likely not using an effective scale (Badyaev et al. 1996, Miller et al. 2007, Byrne and Chamberlain 2013, Fuller et al. 2013, Yeldell et al. 2017). Even if there is another scale or vegetation measurement to be found (e.g., increased satellite imagery resolution or more precise microhabitat measurements) future research on this topic is unlikely to find anything that goes against these findings.

Wild turkeys are habitat generalists and can use a variety of available resources during the incubation period (Meanley 1956, Vanguilder and Kurzejeski 1995, Miller and Conner 2007, Bakner et al. 2019). Recent research has shown incubating female wild turkeys spend a significant amount of time (~16%) away from the nest during the incubation period, where they are likely foraging (Bakner et al. 2019). Female wild turkeys likely have enough behavioral plasticity to use a wide variety of resources while nesting, which likely explains why the landscape vegetation variables I examined had little influence on the laying path. One reason my finding of landscape variables' lack of influence on laying path could be due to my study area being a relatively homogenous pine savanna habitat, so female wild turkeys have less habitat variables to potentially chose from or have no realistic options to leave that habitat.

Martin (1993) suggested that avian species chose nest sites based on predator avoidance, which would be logical for wild turkeys as most of their nest attempts fail due to predation (Vangilder et al. 1987, Vander Haegen et al. 1988, Vangilder and Kurzejeski 1995). On my study site, Ulrey et al. (2022) found that wild turkey nest predators were more likely to be detected near nest sites than random sites, that predator detection was not strongly driven by vegetation characteristics, and that predators were detected less at successful nest sites. Neither female wild turkeys nor their nest predators were found to select for or against vegetation characteristics that

I measured based on these previous studies, so I suggest that even though predation plays a large role in wild turkey nesting, it is not influenced by vegetation characteristics outside of some level of visual obstruction.

Social dynamics may play a role in wild turkey nest site selection. Wild turkeys have a dominance hierarchy that can affect the timing of both insemination and incubation (Watts and Stokes 1971, Eaton 1992, Healy 1992, Ulrey 2021). Timing affects nest success as earlier nest attempts are more likely to succeed (Lack 1968, Keever et al. 2022). With females timing their nest attempts based on a dominance hierarchy (Ulrey 2021, Keever et al. 2022), they may also be using that hierarchy to determine spatial arrangement, as female wild turkeys do not often have their nest sites near each other when they overlap temporally (Schaap et al. 2005, Chapter 3). If nest site selection plays a role in nest success, then the females that initiate their nests earlier may be able to use better sites.

I suggest that evaluations of wild turkey nests should transition away from analysis of vegetation to social drivers of nest site selection. The social dynamic of wild turkey nest site selection has only recently regained attention as GPS technology gives a clearer picture of wild turkey movement (and often behavior), with most of the older work on social dynamics being based in direct observations of wild turkey flocks (Watts and Stokes 1971, Healy 1992). This change in focus will give scientists and managers a more accurate portrayal of what behavioral characteristics are likely driving both nest site selection and nest success (Bakner et al. 2019, Lohr et al. 2020, Ulrey 2021, Ulrey et al. 2022), and thus potential paths to improving wild turkey management and creating more stable populations.

CHAPTER 3. BREEDING SEASON SPACE USE OF FEMALE EASTERN WILD TURKEYS IN WEST-CENTRAL LOUISIANA

3.1. Introduction

Animals maintain home ranges over time and identifying the demographic consequences of spatial and temporal variation in range size has a long history in animal ecology (Börger et al. 2008). Space use is known to vary between phenological periods for a variety of species (Bensch 1999, Tucker et al. 2008, Lesmeister et al. 2015). As such, movements of individuals or groups of individuals are regularly used to determine what factors may underlie resource selection and demographic response, especially for species with restricted spatial distributions during specific phenological periods (Storch 1995, Jiguet et al. 2000, Fuhlendorf et al. 2002). For example, conifer stands reduce the use of leks (and thus reproduction) in the endangered greater sage-grouse (*Centrocercus urophasianus*), so as conifers continue to encroach on more sage habitat in western North America, greater sage-grouse populations will be less able to stabilize or grow (Baruch-Mordo et al. 2013).

For species with well-defined phenological space use, conservation actions typically rely on associated resource use and demographic response (Clutton-Brock et al. 1988, Grafe 1997, Alonso et al. 2012). For upland grouse species, research has primarily focused on areas necessary for reproduction (e.g., leks), which has indicated that area used during lekking are often not strictly defined by environmental resources but are defined by social factors that underlie reproductive success (Widemo 1997, DuVal et al. 2018). Widemo (1997) found that when these leks are well defined on the landscape, then inter-annual lek use is common by both new and remaining individuals or individuals between breeding seasons.

Inter-annual site fidelity to leks is common for both sexes during different phenological periods (Alonso et al. 2004, Borchea et al. 2017, O’Neil et al. 2020). Greater sage-grouse have

high natal lek fidelity (Dunn and Braun 1985), and females regularly select nest sites near breeding leks (Holloran and Anderson 2005, Coates et al. 2013). Similar patterns are seen for greater prairie chickens (*Tympanuchus cupido*), lesser prairie chickens (*Tympanuchus pallidicinctus*), and sharp-tailed grouse (*Tympanuchus phasianellus*), which also tend to focus space use year-round on leks regardless of sex (Merrill et al. 1999, Drummer et al. 2011, Schilder et al. 2022). Inter-annual site fidelity, or the selection by females for leks near their natal range, has been shown to have generational effect that anchors the movements of both the female and her offspring on the lek where the female was bred (O'Neil et al. 2020). Inter-generational, inter-annual site fidelity means that species demography is likely driven by resource conditions surrounding leks (O'Neil et al. 2020).

Eastern wild turkeys (*Meleagris gallopavo silvestris*, hereafter wild turkeys) are a ground-nesting galliform distributed throughout North America that uses an exploded lek-based mating system [i.e., males spread out over large distance (~100 m) where females select a mate] with a dominance hierarchy (Emlen and Oring 1977, Healy 1992, Kotrschal and Taborsky 2010). Males and females are gregarious in male only, or female and offspring flocks during fall and winter. Female wild turkey behavior during the reproductive period shows a consistent order of events (Conley et al. 2016, Bakner et al. 2019, Chamberlain et al. 2020), but individual behavioral decisions have clear demographic impacts on both survival (Hubbard et al. 1999, Collier et al. 2009, Pollentier et al. 2014) and recruitment (Bakner et al. 2019, Lohr et al. 2020, Keever et al. 2022). For example, wild turkeys adhere to a dominance hierarchy (Watts and Stokes 1971, Eaton 1992, Healy 1992), which plays a role in space use and reproductive timing (Watts and Stokes 1971, Keever et al. 2022).

Within the exploded lek system used by wild turkeys, reproductive aggregations are less

strictly defined (as opposed to prairie grouse; Jiguet et al. 2000, Hingrat et al. 2007), and often formed based on non-visual cues (e.g., gobbling), as opposed to a specific spatial location (Bradbury 1981). Thus, exploded leks used by wild turkeys encompass more area than grouse leks and individual ranges may overlap multiple, or be encompassed within a singular exploded lek (Ligon 1999), which may provide benefits that mitigate the typical costs related to lekking (e.g., predation risk; Alonso et al. 2001). Female wild turkeys generally show inter-annual site fidelity between breeding seasons (Locke et al. 2013, Byrne et al. 2022), which suggest that breeding location may underlie female space use and hence resource availability and selection during nesting (Moscicki et al. 2022). However, the relationship between spatial and temporal overlap in wild turkey breeding phenology is unknown.

My objective is to evaluate spatial overlap and inter-annual site fidelity for wild turkey females within an exploded lek system to better support land management decision planning. I predict that female spatial overlap will be limited within some radius and that females will have a high probability of sharing space with other females during the breeding season, with more overlap earlier in the breeding season. I predict that there will be a quantifiable radius of breeding habitat based on a distance that most females will not move outside of to place their nests. Within that available radius, there will also be high variability in probability of sharing space depending on the group a female is captured with, but when females are trapped closer together they will be more likely to share space. I predict that the probability of sharing breeding season space between females will mostly not be affected whether those females are occurring in the same or different years and that females will re-use their previous ranges both within the same breeding season and between seasons with high frequency.

3.2. Study Area

I conducted research on the Kisatchie National Forest (KNF), Peason Ridge Wildlife Management Area (PRWMA), Fort Polk WMA (FPWMA), and adjacent private lands in west-central Louisiana. My study area experienced a subtropical climate, with mean daily temperatures at 10^{o}C in January and 28^{o}C in July and mean annual rainfall ~ 151cm. The United States Department of Agriculture–Forest Service (USFS) managed the KNF from which my study area used 4 Ranger Districts (RD): Kisatchie RD (41,453 ha), Winn RD (67,408 ha), Catahoula RD (49,169 ha), and the Vernon Unit of the Calcasieu RD (33,994 ha) located in Natchitoches, Winn, Grant, and Vernon Parishes, respectively. The FPWMA is jointly managed by the Louisiana Department of Wildlife and Fisheries (LDWF), USFS, and the Department of Defense, U.S. Army. Each of my study areas had similar forest characteristics with land management techniques applied throughout (Yeldell et al. 2017), and I considered them as one unit for my study. The study area was mostly composed of pine-dominated forests, with a mixture of forested wetlands, hardwood riparian zones, forest openings, pipelines, food plots and forest roads. Privately owned land on the borders of the public land, which was also considered part of the study area, is predominately used for timber production (loblolly pine and clearcuts), pasture, small homes, and agriculture, with some hardwood-dominated wetlands as well. For additional details of my study area, see Yeldell et al. (2017) and Schofield (2019).

3.3. Methods

I captured female wild turkeys using rocket nets (3–4 rockets, 1,200–2,400 ft^2 net) during January-March from 2014–2022. Captured individuals were classified as juveniles or adults based on barring on the last primary feather (Pelham and Dickson 1992). Wild turkeys were fitted with a riveted, uniquely numbered, tarsal aluminum band and all females I tagged with a global positioning system (GPS) transmitter with a very high frequency (VHF) backpack (88 g;

Lotek Minitrack Backpack, Lotek PinPoint Backpack; Lotek Wireless, Newmarket, Ontario, Canada). All individuals were released at the capture site after processing. Each GPS transmitter was programmed to collect points hourly from 0500 to 2000 each day with 1 roost location at 23:59:58. Females were identified as recaptures based on the presence of an aluminum tarsal band and confirmed by matching the number on the band with a previously captured female wild turkey. All capture, handling, and marking procedures were approved by the Institutional Animal Care and Use Committee at Louisiana State University AgCenter (protocol A2014-013 and A2015-07 and A2018-13). I used handheld Yagi antennas and a VHF/ultra high frequency (UHF) PinPoint Commander unit (Lotek Wireless, Newmarket, Ontario, Canada) to downloaded GPS data ≥ 1 per week throughout the study period. Date and time of nest initiation (i.e., beginning of egg laying) and nest incubation were determined following methods from Conley et al. (2016), Bakner et al. (2019), and Lohr et al. (2020).

I compared the phenology-specific ranges of females that were reproductively active (i.e. breeding females) to create a more direct comparison in behavior. For each breeding female, I developed phenology-specific ranges sizes for the pre-laying and laying periods (Moscicki et al. 2022). I followed methods set forth by Schofield (2019) and Moscicki et al. (2022) who used male wild turkey gobbling chronology data (Chamberlain et al. 2018, Wightman et al. 2019, Wakefield et al. 2020) to define the pre-laying period for female's first nest attempt as beginning on 15 March and ending on the day before nest initiation. I excluded any female's pre-laying range who initiated her nest earlier than 20 March or had a period that lasted longer than 45 days to avoid comparing ranges with large differences in period length, thus preventing the comparison between females who had vast differences in time to use their potential range. I defined the laying period as beginning on the day of nest initiation and ending on the day before

nest incubation began. For second or third nest attempts, I defined the pre-laying period as beginning on the day following the prior nest attempt's date of failure, but again limited these ranges to less than 45 days (Schofield 2019, Moscicki et al. 2022). For females who failed their first nest attempt but also survived at least 5 days afterwards, I defined a post-failure period, which started the day after their first nest attempt failed and ended 30 days later, or when they died or had transmitter failure if either occurred before 30 days. Similar to pre-nesting, I excluded all post-failure ranges with less than 5 days of GPS data.

After defining the above phenological periods for each female nest attempt, I estimated range size for each period using a dynamic Brownian Bridge movement model (dBBMM) to build utilization distributions (UD) at 99% (Byrne et al. 2014, Cohen et al. 2018). I calculated the UDs in program R version 4.2.1 (R Core Team 2022) using package move (Kranstauber et al. 2022) following methods used by Cohen et al. (2018). I quantified range overlap by intersecting each of these ranges in program R using package rgeos (Bivand et al. 2021). To quantify the amount of overlap that occurred, for each pair of overlapping females I calculated the percent of shared area that overlapped between each pair of ranges with the following equation:

$$Percent\ shared\ area = \frac{Intersect\ area}{(Range\ 1\ area - Intersect\ area) + (Range\ 2\ area - Intersect\ area) + Intersect\ area}$$

Defining pairs and spatial scales

Female wild turkeys are regularly captured in mixed sex groups which tend to disband in March and April as breeding and nest laying occurs (Schofield 2019, Ulrey 2021), contrary to some older research which suggested they would disband from their winter flocks before breeding began (Badyaev et al. 1996). As such, I assumed that females caught at the same location in the same year were a part of a social group (i.e. trap cohorts) (Ulrey 2021) that had

access to the same resources, including potential mates (Figure 3.1). I paired each female's first nest attempt range with other individual from her trap cohort's ranges in both the pre-laying (FNPL) and laying (FNL) periods to evaluate pair-wise overlap (Figure 3.2).

Figure 3.1. First nest attempt pre-laying ranges from four different breeding female wild turkeys (A, B, C, and D) that were captured at the same trapsite (star) in the same year. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

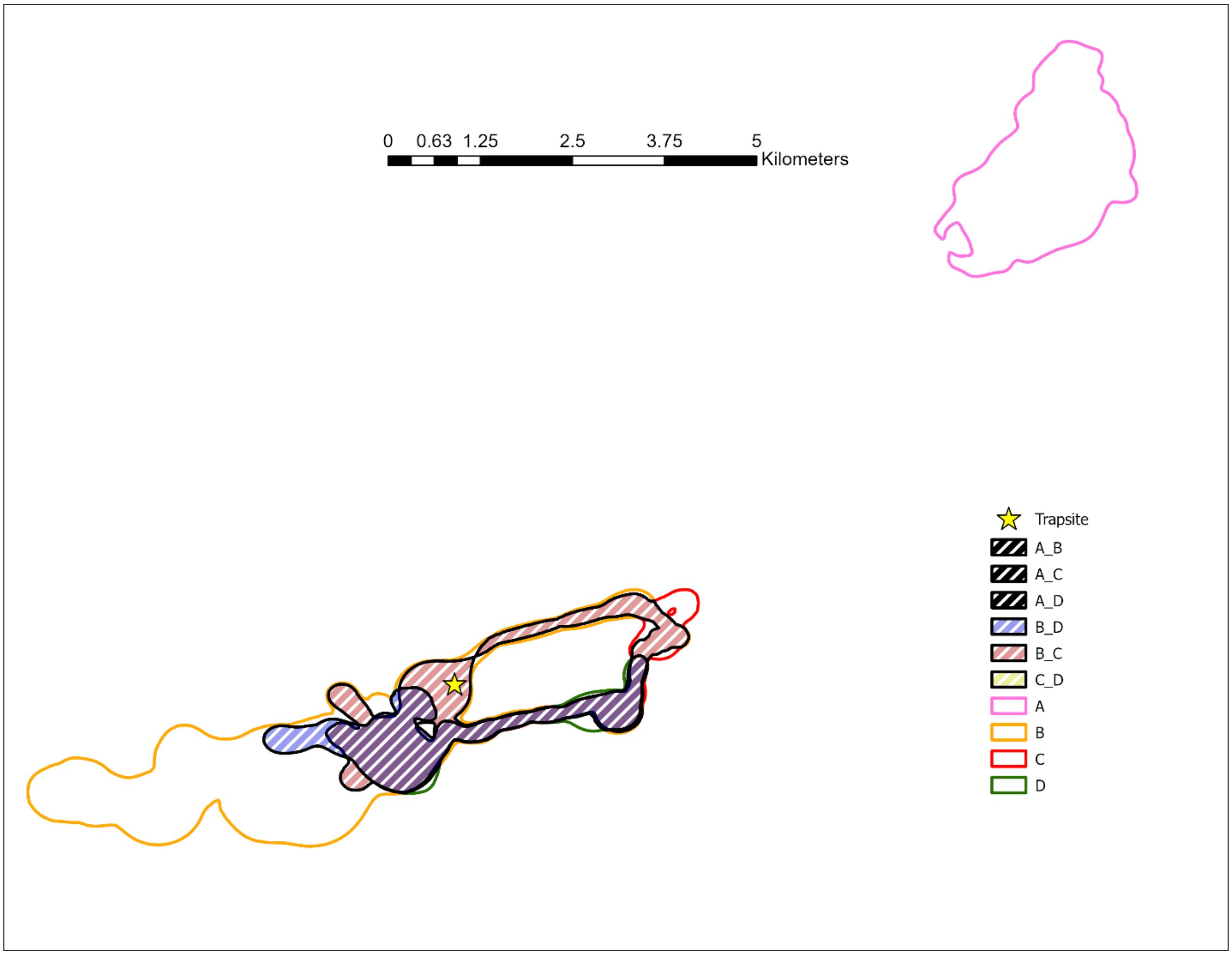

Figure 3.2. First nest attempt pre-laying ranges from four different breeding female wild turkeys (A, B, C, and D) that were captured at the same trapsite (star) in the same year with any pair-wise overlap that occurred between females. Females without overlap are listed in black in the figure legend. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

Female wild turkeys often cover large areas during the breeding season, with mean range sizes in my study area being ~600 ha during the pre-laying period (the largest of any phenological period for wild turkeys; Moscicki et al. 2022) and ~250 ha during the laying period (Schofield 2019). To understand shared space at this scale, I paired breeding females within an available radius (i.e., available cohorts), as they potentially had access to the same resources and mates as the trap cohorts. I defined the available radius based the distance between each female's trapsite and nest attempt, with the available radius set at the distance where at least 95% of all

nest attempts occurred within each female's trapsite. I then paired each female's first nest attempt range with each of her available cohorts to determine pair-wise overlap (Figure 3.3)

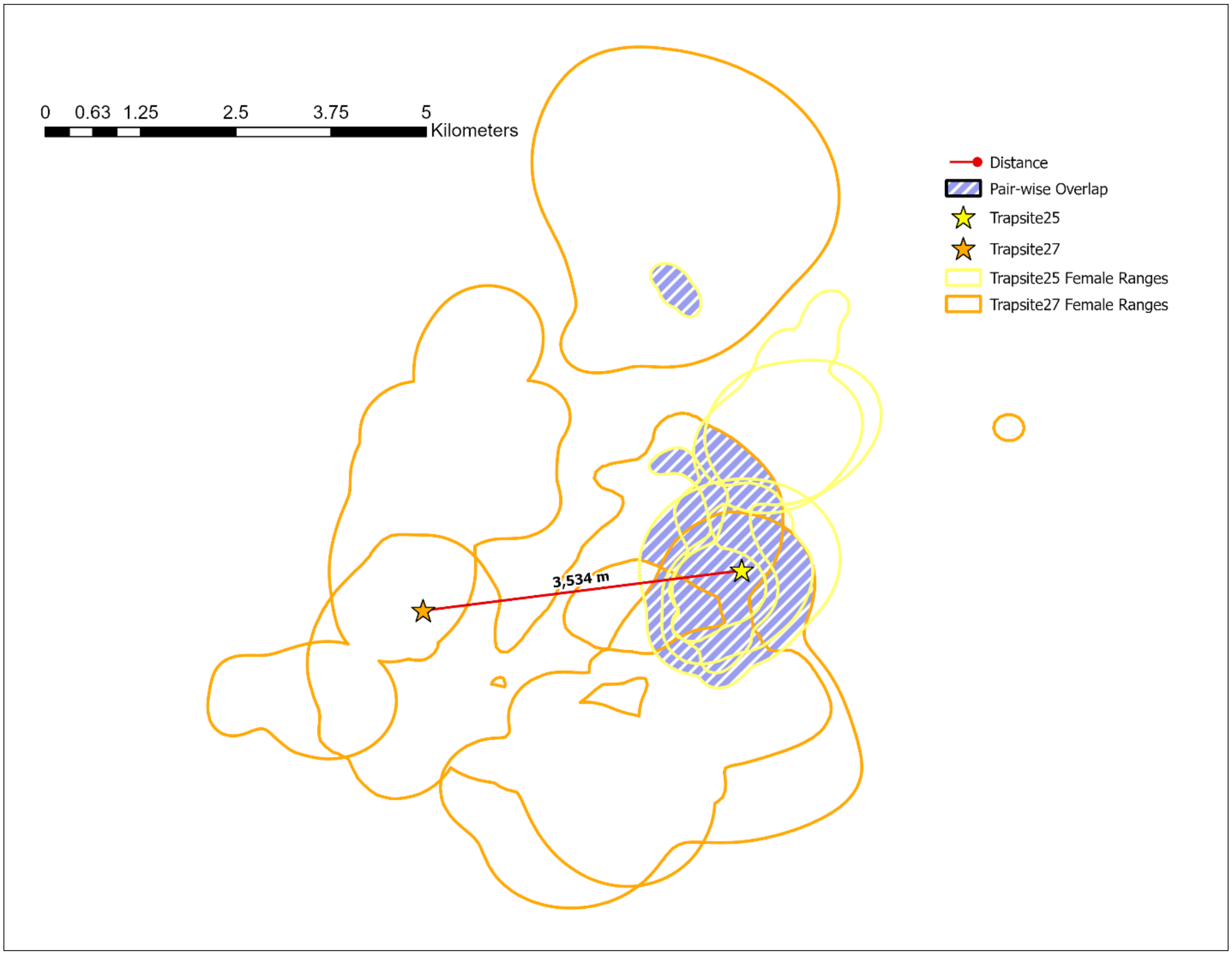

Figure 3.3. First nest attempt pre-laying ranges from two sets of breeding female wild turkeys, each with a separate trapsite that was closer than 7.5 km from the other and the pair-wise range overlap that occurred between the ranges of females of each site. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

To evaluate if nest success differed across trap cohorts or available cohorts, I separated regions of study area based on ≥ 3 trapsites being within an available radius and were used as trapsites for ≥ 3 years (n = 5) and compared nest success. Females rarely leave the available radius defined above (4%), and as such may have had access to resources and mates outside of this available radius (i.e., dispersed cohorts). I paired each female's first nest attempt range with each of her dispersed cohorts' ranges to determine pair-wise overlap (Figure 3.4). For all three

sets of cohort pairs, I also evaluated temporal effects on pair-wise overlap between females in the breeding season.

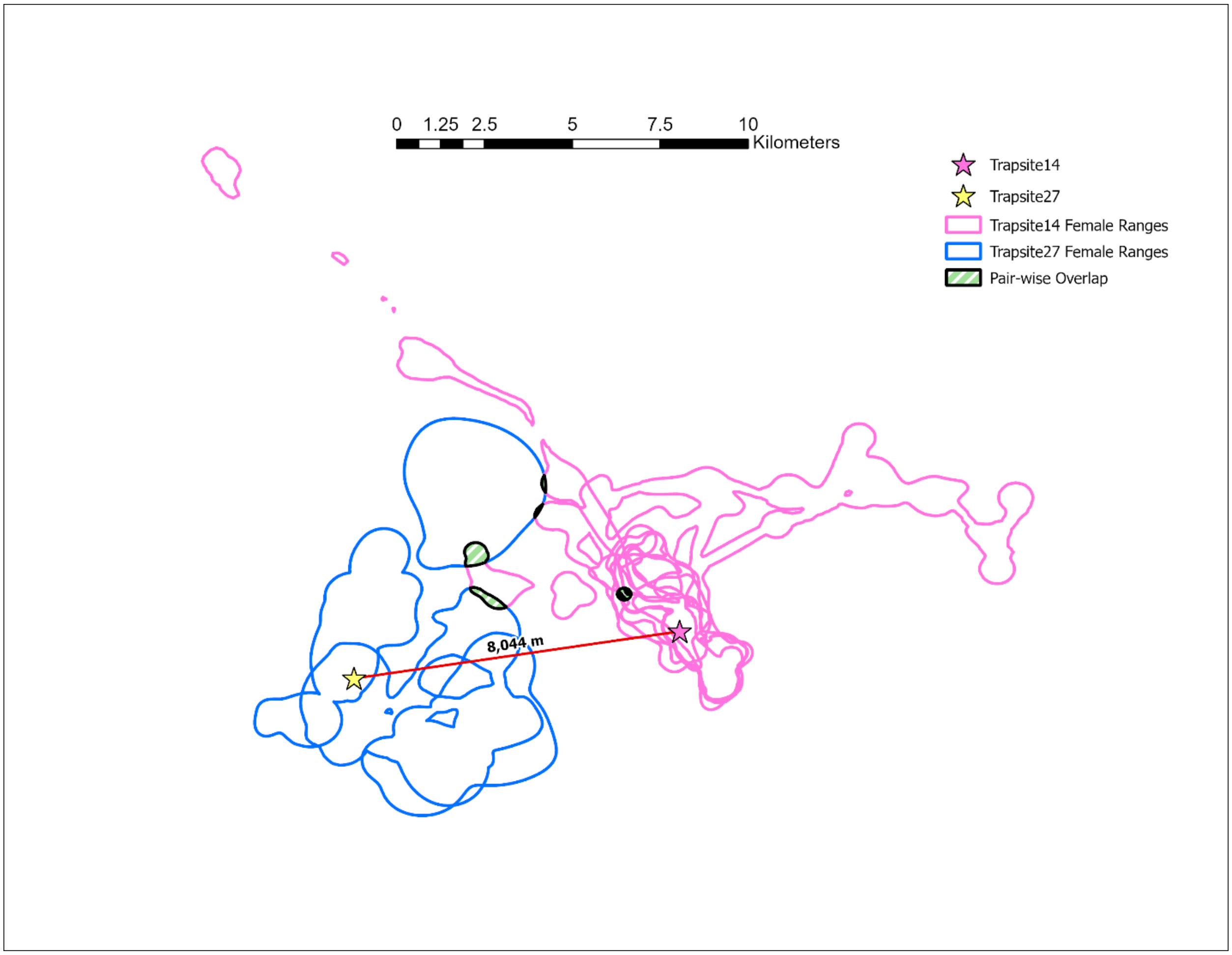

Figure 3.4: First nest attempt pre-laying ranges from two sets of breeding female wild turkeys, each with a separate trapsite that was further than 7.5 km from the other and the pair-wise range overlap that occurred between the ranges of females of each site. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

Individual site fidelity often plays a role in breeding season range selection (Byrne et al. 2022) so I evaluated individual-level pair-wise overlap. If a breeding female wild turkey had a more than one nest attempt in the same year (renesting females), I compared the ranges from that female's first nest attempt (both for the pre-laying and laying periods) to the ranges from her second or third nest attempts to test for pair-wise overlap. I also paired those first nest attempt

ranges with the ranges of each of their trap cohorts. To determine the individual-level effects in different breeding seasons, I used females who were monitored over more than one year and attempted to breed in multiple years (recaptured females). I paired each recaptured female's first nest attempt range to other first nest attempt ranges from both her current trap cohorts and her previous trap cohorts along with that recaptured female's previous first nest attempt range.

I estimated the probability of pair-wise overlap (0 = no overlap, 1 = overlap) using a logistic regression in program R, and percent shared area between overlapping ranges, for which I used a generalized linear model with a Gaussian distribution in R (R Core Team 2022). These models were used for all analyses between cohorts with these response variables (i.e., all first nest attempt ranges at the three scales, renesting females versus trap cohorts, and recaptured females versus current and previous trap cohorts) I developed a candidate set of models for each set of cohort pairs during both pre-laying and laying that included the effects of each trapsite, sum of area between the two paired female's ranges, number of cohorts caught at each trapsite, whether the ranges belong to the same individual (separating recaptured or renesting females as well), distance between trapsites (for the available cohorts and dispersed cohorts), if the females were captured in different years, and the effect of the number of years separating the pair (if the females were captured in different years). For all analyses I used Akaike Information Criteria (AIC_c) to determine model support, with a global and null model also being used for reference (Burnham et al. 2011). Models with an evidence ratio ≤ 5 based on the AIC weight of the lowest AIC model were considered potentially supportive to explaining the variation in probability and percent shared area of pair-wise overlap (Burnham and Anderson 2002, Dick 2004). I model-averaged parameter estimates to determine biological significance. Predicted probabilities and percent shared area of pair-wise range overlap were calculated for each question based on the

best performing model (Table 3.1). To test for nest success by region, I used an analysis of variance (ANOVA) to determine if there was variation in nest success rate by region. To test if there was a difference in distance from trapsite to nest site depending on age class I ran logistic regression with the response variable being distance in kilometers and a binomial predictor variable (adult = 0, juvenile = 1).

Table 3.1. Example of comparing first nest pre-laying period 99% utilization distribution ranges between four individual breeding females captured at the same trapsite in the same year. Table 3.1a is the sum of range size (ha) for the two compared individuals and Table 3.1b is their predicted probabilities of pair-wise spatial overlap calculated from a model based on the probability of overlap at the specific trapsite and the sum of the individual range sizes (ha) for individual female wild turkeys captured and marked between 2014 and 2022 in Louisiana.

3.1a		**Range size sum (ha)**		
Individuals	*A*	*B*	*C*	*D*
A		1215	744	635
B			1139	1030
C				559
D				
3.1b		**Probability of overlap**		
Individuals	*A*	*B*	*C*	*D*
A	1	0.558	0.475	0.455
B		1	0.545	0.525
C			1	0.442
D				1

Table 3.2. Set of acronyms and terms used in Chapter 3.

Term	Meaning
Trapsite	Site where females were captured in the same year
Capture distance	Distance between the trapsites of two breeding females
Range size sum	Sum the area of two breeding females' ranges
Trap cohorts	Group of breeding females captured at the same trapsite in the same year (current) or in a previous year (previous)
Available cohorts	All breeding females not captured at the trapsite but captured at trapsites within 7.5 km
Dispersed cohorts	All breeding females captured at trapsites more > 7.5 km away
Renester	Female who attempts a 2nd or 3rd nest attempt in one year
Non-renester	Female who has 1 nest and has the opportunity but does not produce any further nests in one year
FNPL	Period of pre-laying for each breeding female's first nest attempt. First day is 15 March, last day is first nest initiation
FNL	Period of laying for each breeding female's first nest attempt. First day is nest initiation, last day is first nest incubation
Post-failure period	Period after the failure of a breeding female's first nest that lacks any renesting attempts
Percent shared area	% of shared area over the sum of each female's range (minus the shared area)

3.4 Results

I captured 352 female wild turkeys from 2014 to 2022 (319 adult, 33 juvenile). One hundred and twenty-one females either died (*n* = 26) or had a transmitter failure (*n* = 22) before nesting began or had no known reproductive attempts during my study period (n = 73), thus I evaluated 231 females (210 adult, 21 juvenile) that produced 349 known nests. I censored 15 nest attempts from 8 females who were captured alone or were the only female from their trapsite cohort to have any known nests. For the pre-laying period I censored 10 nests that were initiated either before 20 March for first attempts or for less than five days before laying began for second/third attempts. I censored 39 nest attempts that had a pre-laying period that lasted longer than 45 days. Thus, for analysis, I used 286 nest attempts (178 first, 85 second, and 23 third) with pre-laying ranges and 334 nest attempts (223 first, 88 second, and 23 third) with

laying period ranges. I also had 72 females who had a post-failure period without a second nest attempt.

The mean number of days spent in each pre-laying period was 24 days for first attempts (*SE* = 0.8, range = 5 – 45 days), 15 days for second attempts (*SE* = 0.8, range = 5 – 45 days), and 14 days for third attempts (*SE* = 1.4, range = 5 – 33 days; Figure 3.5). The mean number of days spent in each type of the laying period was 11 days for first attempts (*SE* = 0.2, range = 5 – 18 days), 10 days for second attempts (*SE* = 0.2, range = 5 – 16 days), and 10 days for third attempts (*SE* = 0.3, range = 7 – 13 days, Figure 3.6). The mean size of pre-laying ranges was 765 ha (*SE* = 31, range = 18 – 3,979 ha, Figure 3.7) and for laying ranges it was 378 ha (*SE* = 12, range = 0.5 – 1,666 ha, Figure 3.8). The mean days spent in the post-failure period was 28 days (*SE* = 0.6, range = 8 – 30) and the mean range size during the post-failure period was 661 ha (*SE* = 64, range = 157 – 3,012 ha). When only considering trapsites with at least 3 breeding females captured, each trapsite had 6 females on average (*SE* = 0.4, range = 3 – 12 females).

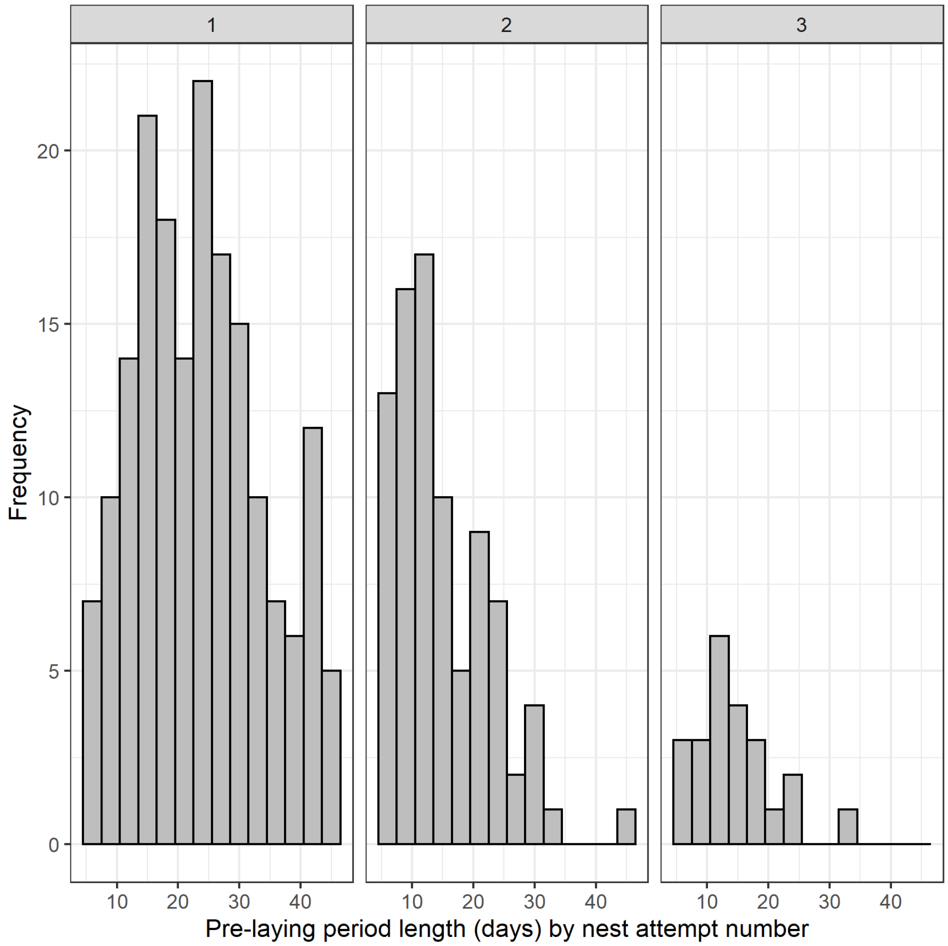

Figure 3.5. Pre-laying period length in days for each nest attempt (separated by attempt number seen at the top of the figure per female per season). Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

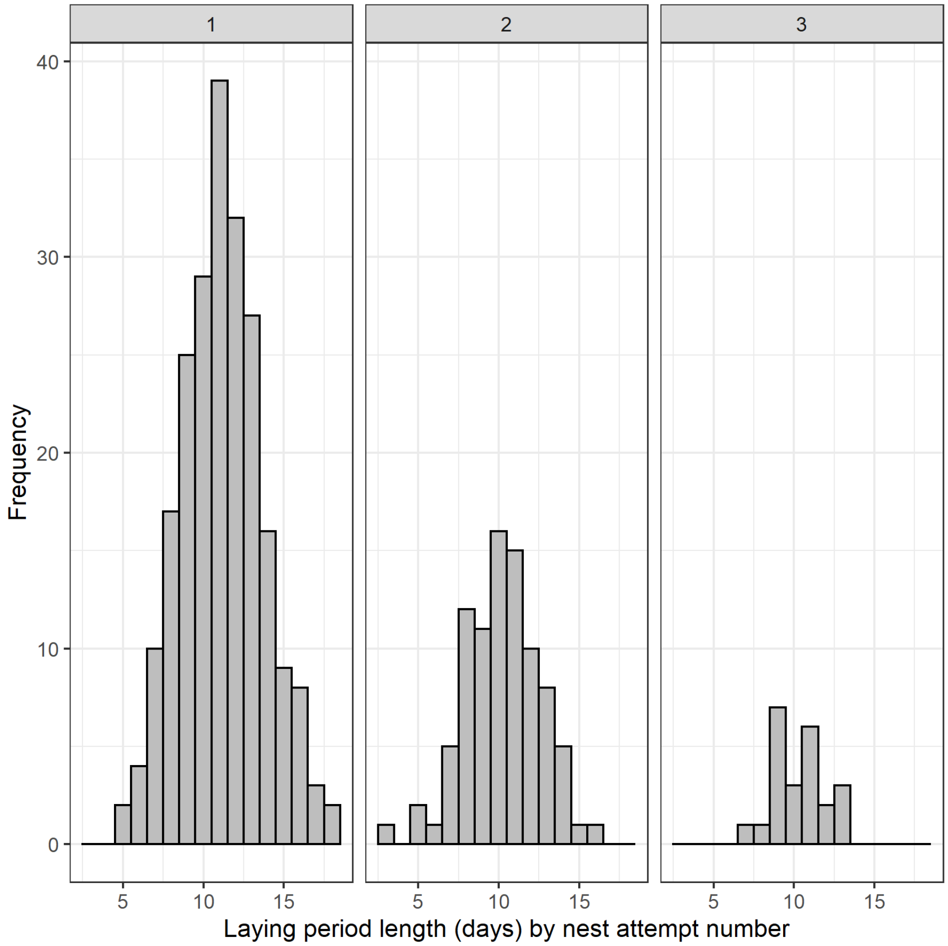

Figure 3.6. Laying period length in days for each nest attempt (separated by attempt number seen at the top of the figure per female per season). Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

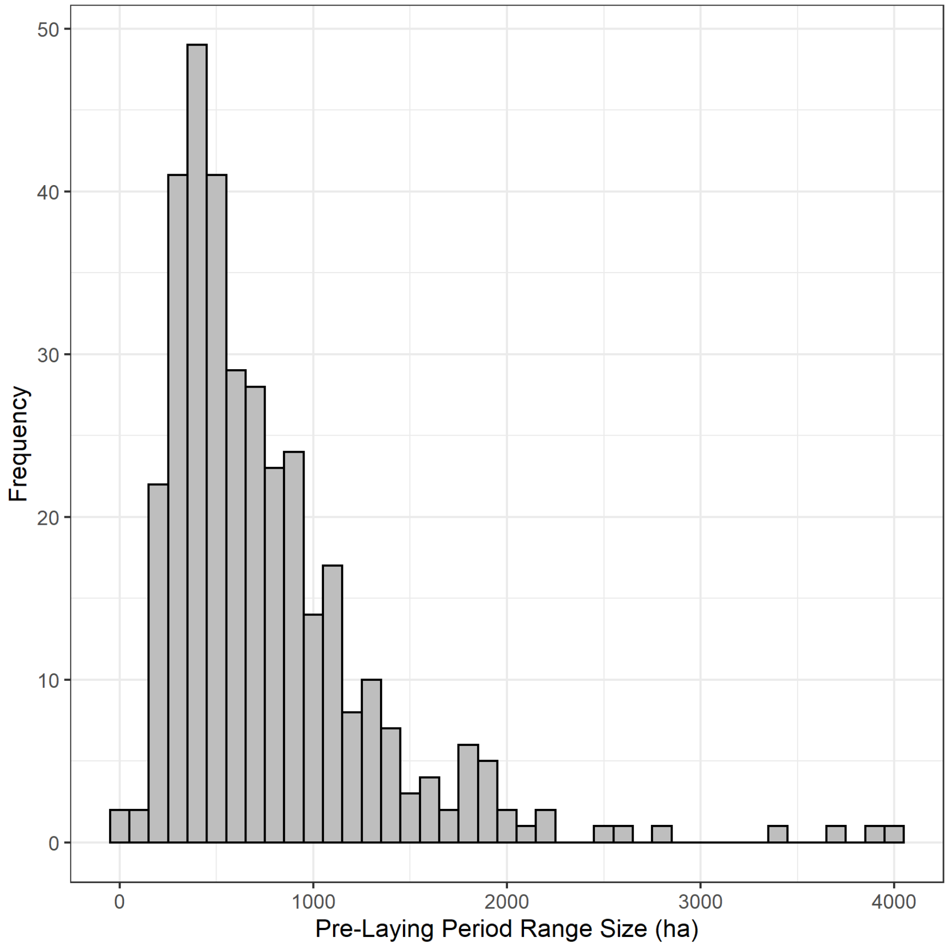

Figure 3.7. Pre-laying period range size in hectares for each nest attempt from female wild turkeys. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

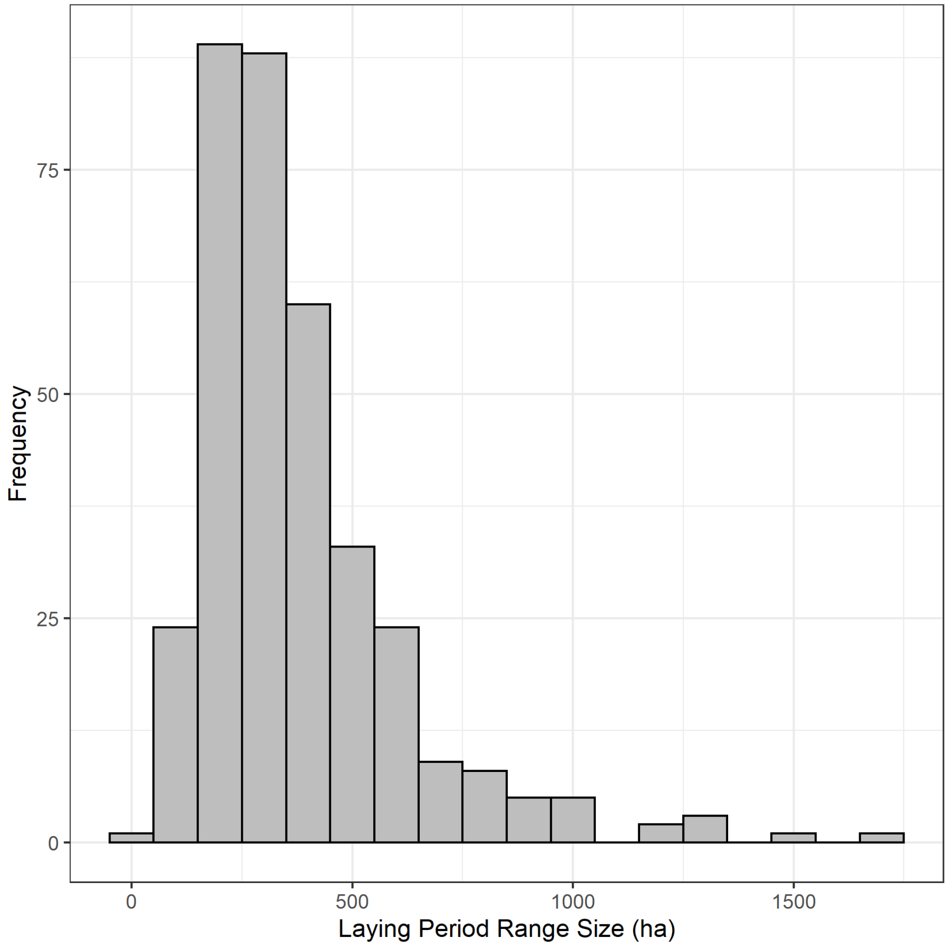

Figure 3.8. Laying period range size in hectares for each nest attempt from female wild turkeys. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

Two reproductively active females caught at the same trapsite in the same year (i.e., trap cohorts) were likely to show pair-wise range overlap during the first nest pre-laying period (FNPL) (*Prob* = 0.788, *SE* = 0.018), with those that overlapped using 23% (*SE* = 1%) shared area. During the first nest laying period (FNL) the pair-wise range overlap probability was lower (*Prob* = 0.407, *SE* = 0.021), with those that overlapped using 20% (*SE* = 2%) shared area. The sum total area of the pair-wise compared ranges was strongly correlated with probability of pair-wise overlap for both FNPL (Figure 3.9) and FNL (Figure 3.10), but variability between trapsites was still high (Table 3.3).

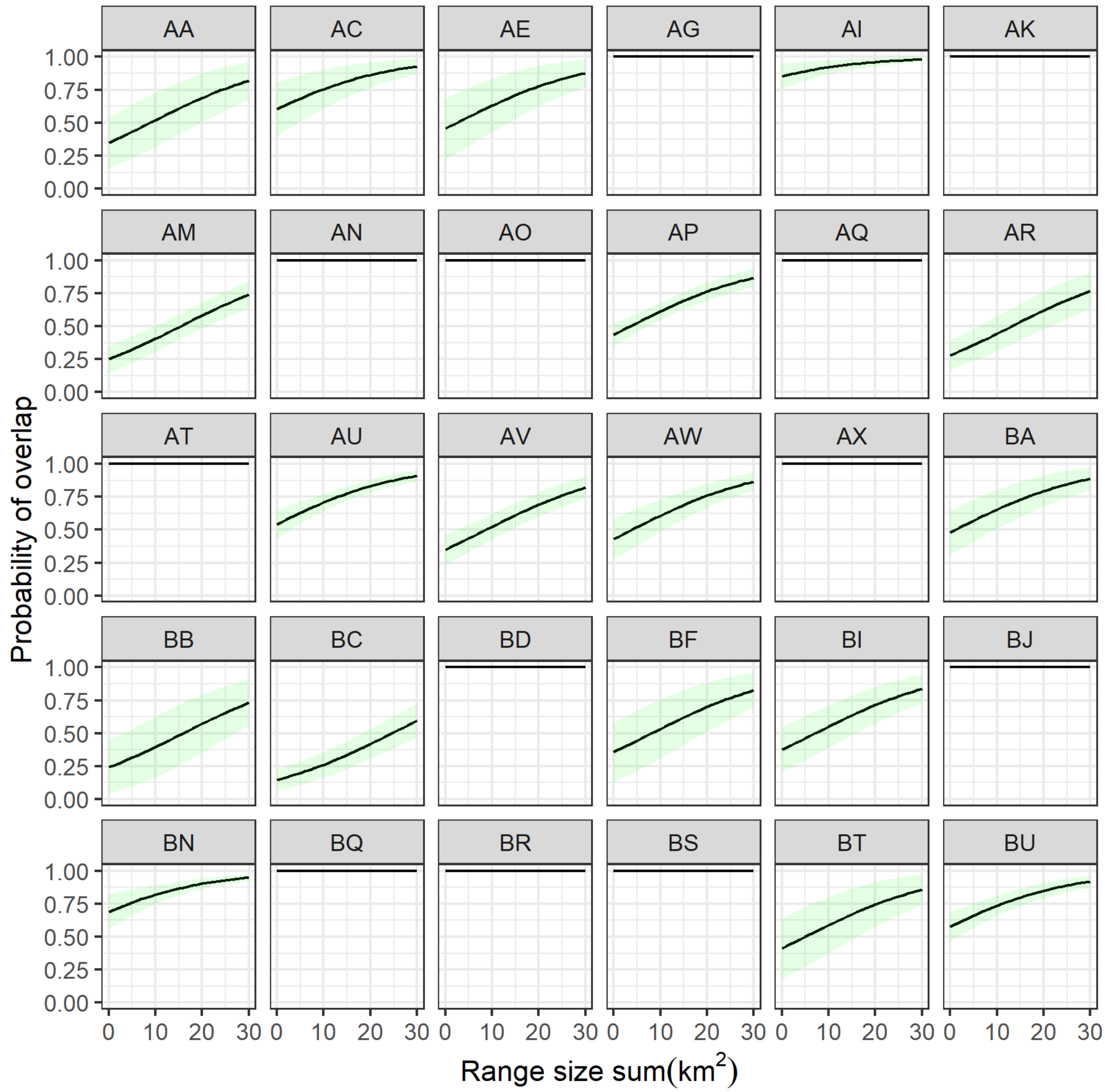

Figure 3.9. Probability of pair-wise first nest attempt pre-laying range overlap between two female wild turkeys captured at the same trapsite in the same year (separated by each trapsite) compared to the sum of the two compared range areas in hectares. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. All of these trapsites had three breeding females captured. Probabilities where the line is horizontal at 1 is where all individuals overlapped each other from that trapsite.

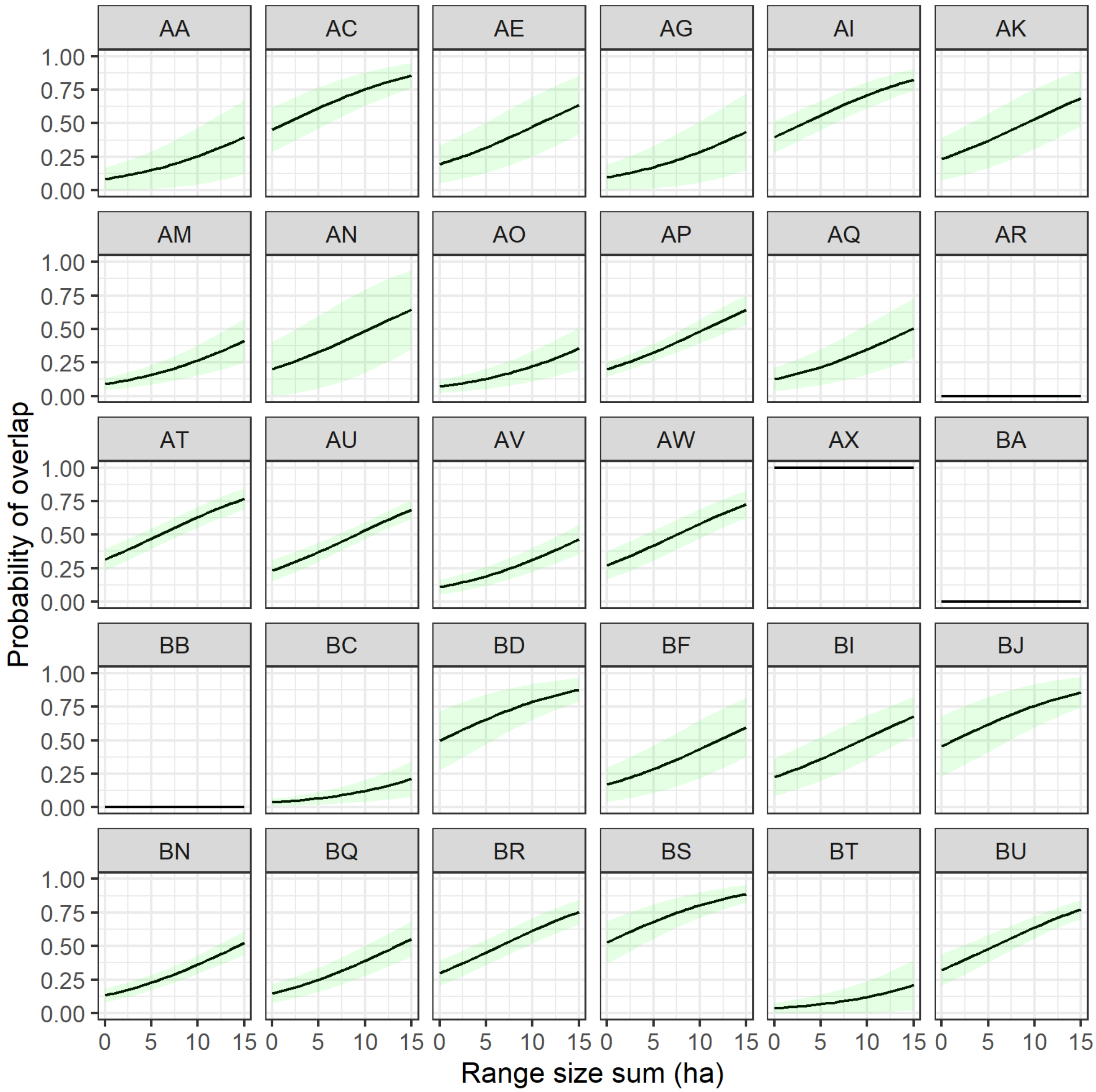

Figure 3.10. Probability of pair-wise first nest attempt laying range overlap between two female wild turkeys captured at the same trapsite in the same year (separated by each trapsite) compared to the sum of the two compared range areas in hectares. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. All of these trapsites had three breeding females captured. Probabilities where the line is horizontal at 1 is where all individuals overlapped each other from that trapsite and where the line is horizontal at 0 no individuals overlapped at that site.

Table 3.3. Logistic regression model selection with matched-pairs case-control sampling, where the probability of pair-wise overlap between 99% utilization distribution ranges were the cases and being caught at the same trapsite in the same year was the control for individual female wild turkeys captured and marked in west-central Louisiana from 2014 to 2022. Table 3.3a is for pairs that occurred during the pre-laying period and Table 3.3b is for pairs that occurred during the laying period. Model selection was based on Akaike's Information Criterion (AIC_c) for each potential model for the probability of pair-wise range overlap, number of parameters (K), ΔAIC_c, the Akaike weight of evidence (AIC_cW), and evidence ratio based on the lowest AIC model (ER).

3.3a		**Pre-Laying Period**			
Model	*K*	AIC_c	ΔAIC_c	AIC_cW	*ER*
Trapsite + Area	30	671.341	0.000	0.997	1
Trapsite	29	683.021	11.680	0.003	332
Area	3	719.052	47.711	0.000	>930
Female/Trapsite	2	741.764	70.423	0.000	>930
Null	0	762.462	91.121	0.000	>930
3.3b		**Laying Period**			
Model	*K*	AIC_c	ΔAIC_c	AIC_cW	
Trapsite + Area	30	476.396	0.000	0.930	1
Trapsite	29	481.579	5.183	0.070	13
Area	3	551.038	74.643	0.000	>930
Female/Trapsite	2	564.406	88.010	0.000	>930
Null	0	752.758	276.362	0.000	>930

Four trapsites were used to capture breeding females over multiple years and there was no significant difference in probability or percent shared area of pair-wise range overlap between females caught in different years and females caught in the same year for both FNPL (β = 0.43, *SE* = 0.29, *p* = 0.141) or FNL (β = 0.19, *SE* = 0.22, *p* = 0.399). Year showed a small but significant effect on percent shared area of pair-wise overlap when comparing females in any year at a trapsite (FNPL: β = -0.07, *SE* = 0.02, *p* = 0.001; FNL: β = -0.05, *SE* = 0.03, *p* = 0.080). The number of females caught at each trapsite did not affect probability of overlap during FNPL (β = -0.02, *SE* = 0.04, *p* = 0.522) and or FNL (β = 0.05, *SE* = 0.03, *p* = 0.095), with minimal effects on percent shared area of pair-wise overlap (FNPL: β = -0.01, *SE* < 0.01, *p* = 0.058; FNL: β > -0.01, *SE* < 0.01, *p* = 0.614).

I found that 96% of nest sites occurred within 7.5 km of each female's trapsite ($\bar{x}$ = 3.1 km, *SE* = 0.2 km; Figure 3.11), so I used a 7.5 km radius around each trapsite as my estimate of available space for each female. Juvenile breeding females tended to move further from their trapsite to have their nests ($\bar{x}$ = 3.8 km, *SE* = 0.5 km) than adult breeding females ($\bar{x}$ = 3.0 km, *SE* = 0.1 km), but the difference was not significant (β = 757 m, *SE* = 519 m, p = 0.146). Outside of the available radius, pair-wise overlap occurred less than 1% of the time between two females during FNPL or FNL, regardless of year, with that likelihood decreasing as distance between trapsites increased (β = -0.22, *SE* = 0.08, p = 0.005). Within the available radius, the probability of pair-wise overlap between females at different trapsites varied for both FNPL (Figure 3.12) and FNL (Figure 3.13), with females occurring in the same year being slightly more likely to overlap. Distance between trapsites had an inverse correlation and range size sum of both females had a positive correlation with the probability of pair-wise overlap during both FNPL and FNL (Table 3.4). Distance between trapsites was inversely correlated with percent shared area of overlap, but female range area did not have an effect during both FNPL and FNL (Table 3.4).

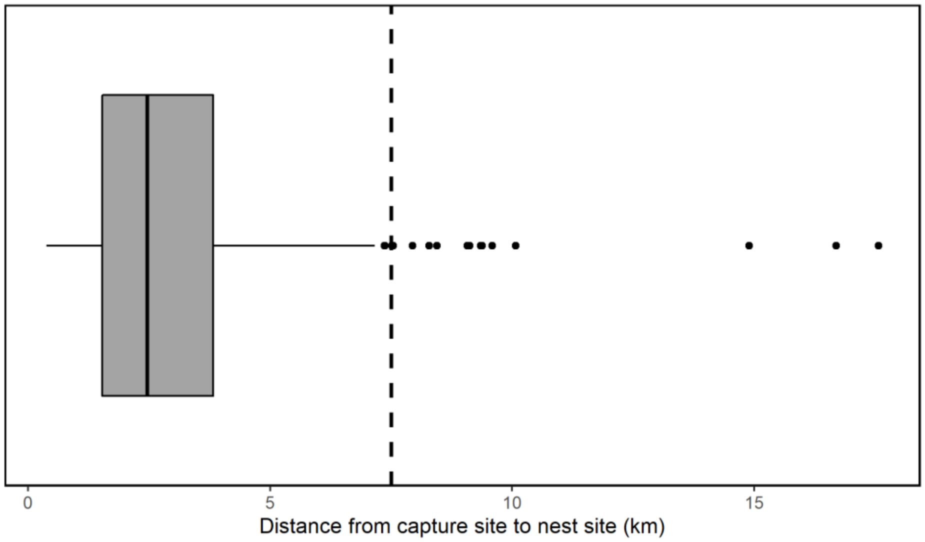

Figure 3.11. Distance from trapsite to nest (km) for each female wild turkey nest attempt, with the chosen threshold of 95% of nest attempts occurring within 7.5 km of each female's trapsite, denoted by the horizontal dotted line. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022.

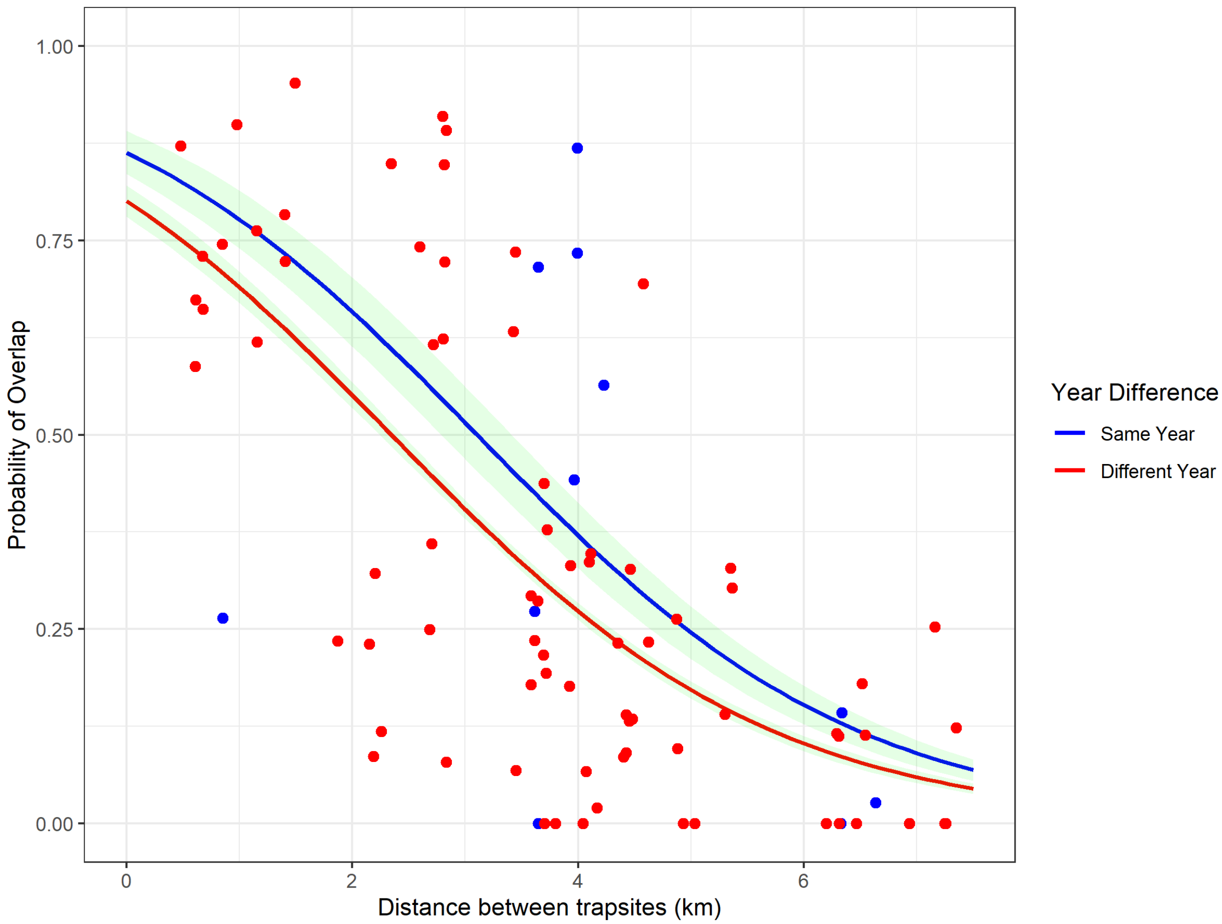

Figure 3.12. Probability of pair-wise first nest attempt pre-laying range overlap between two breeding female wild turkeys captured more than 0.1 km but less than 7.5 km apart (sorted by distance between trapsites). Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. Probability for females in different years is in red, probability for females in the same year is in blue, each with their own 95% confidence intervals. The points represent the probability for each separate interaction between trapsites (set by their respective distance between each other) with blue points representing trapsites in the same year and red points representing trapsites in different years, each with their own 95% confidence intervals.

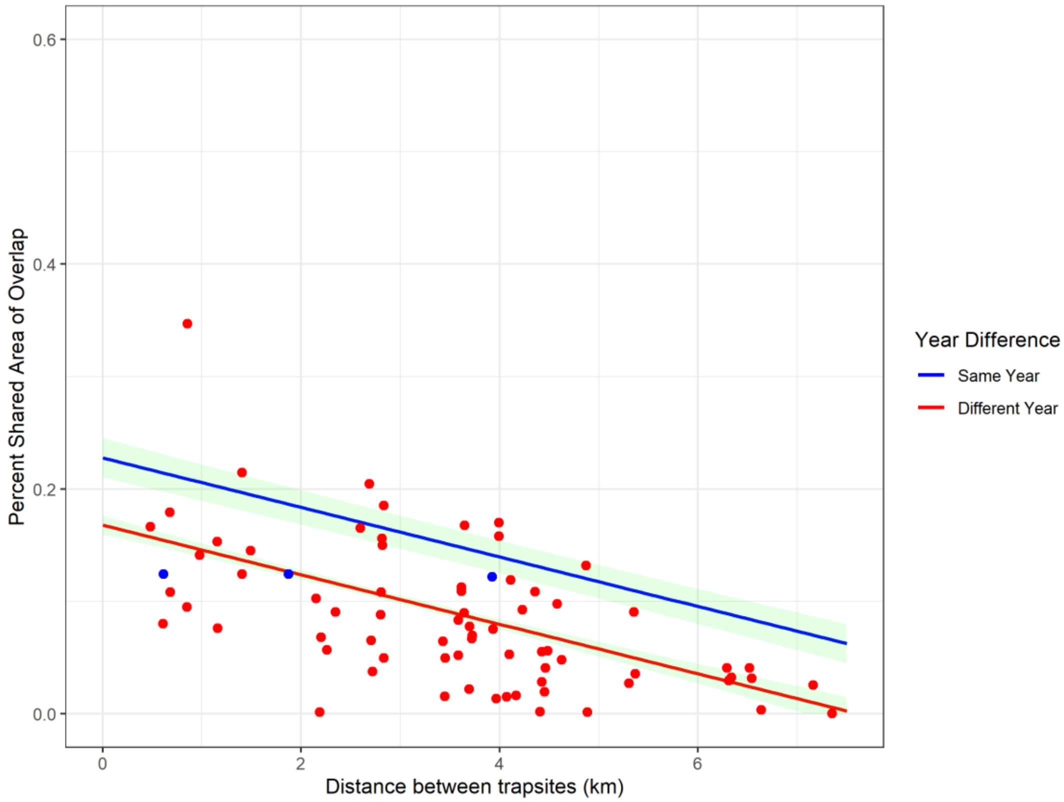

Figure 3.13. Probability of pair-wise first nest attempt laying range overlap between two breeding female wild turkeys captured more than 0.1 km but less than 7.5 km apart (sorted by distance between trapsites). Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. Probability for females in different years is in red, probability for females in the same year is in blue, each with their own 95% confidence intervals. The points represent the probability for each separate interaction between trapsites (set by their respective distance between each other) with blue points representing trapsites in the same year and red points representing trapsites in different years, each with their own 95% confidence intervals.

Table 3.4. Logistic regression model selection with matched-pairs case-control sampling, where the probability and percent shared area of overlap between 99% utilization distribution ranges were the cases and being caught within 7.5 km was the control for female wild turkeys captured and marked in west-central Louisiana from 2014 to 2022. Table 3.4a is for the probability of pair-wise range overlap during the pre-laying period, Table 3.4b is for the probability of pair-wise range overlap during the laying period, Table 3.4c is for the percent shared area of pair-wise range overlap during the pre-laying period, and Table 3.4d is for the percent shared area of pair-wise range overlap during the laying period. Model selection was based on Akaike's Information Criterion (AIC_c) for each potential model for the probability of pair-wise range overlap, number of parameters (K), ΔAIC_c, the Akaike weight of evidence (AIC_cW), and the evidence ratio based on the lowest AIC model (ER).

Probability of Pair-wise Overlap					
3.4a			**Pre-Laying Period**		
Model	*K*	*AIC_c*	*ΔAIC_c*	*AIC_cW*	*ER*
Global	5	2644.812	0.000	0.881	1
Capture Distance + Combined Range Area	4	2648.824	4.011	0.119	7.4
Any Year Difference + Capture Distance	3	2798.832	154.020	0	>881
Capture Distance	2	2802.324	157.512	0	>881
Any Year Difference	2	3144.308	499.496	0	>881
Null	0	3390.876	746.064	0	>881
3.4b			**Laying Period**		
Model	*K*	*AIC_c*	*ΔAIC_c*	*AIC_cW*	*ER*
Capture Distance + Combined Range Area	4	2065.817	0.000	0.623	1
Global	5	2066.818	1.001	0.377	2
Capture Distance	2	2135.859	70.042	0	>623
Any Year Difference + Capture Distance	3	2137.490	71.673	0	>623
Any Year Difference	2	2227.154	161.337	0	>623
Null	0	3424.147	1358.330	0	>623
Percent Shared Area of Pair-Wise Overlap					
3.4c			**Pre-Laying Period**		
Model	*K*	*AIC_c*	*ΔAIC_c*	*AIC_cW*	*ER*
Global	5	-1358.44	0	0.991	1
Any Year Difference + Capture Distance	4	-1348.65	9.795	0.007	142
Capture Distance + Combined Range Area	4	-1345.04	13.402	0.001	991
Capture Distance	3	-1334.96	23.479	0	>991
Any Year Difference	3	-1269.83	88.609	0	>991
Null	1	-735.758	622.683	0	>991
3.4d			**Laying Period**		
Model	*K*	*AIC_c*	*ΔAIC_c*	*AIC_cW*	*ER*
Any Year Difference + Capture Distance	4	-457.642	0	0.41	1
Capture Distance	3	-456.91	0.732	0.284	1
Global	5	-456.007	1.635	0.181	2
Capture Distance + Combined Range Area	4	-455.203	2.439	0.121	3
Any Year Difference	3	-448.507	9.135	0.004	103
Null	1	-168.762	288.88	0	>410

When comparing any breeding female caught within an available radius in any year for either breeding period, capture distance still had an inverse correlation and sum of the range areas still had a positive correlation with probability and percent shared area of pair-wise overlap, but if the female's ranges occurred in different years there was a decrease in the probability and percentage of shared area for both periods (Table 3.4). There was high variability in probability and percent shared area of pair-wise overlap depending on which trapsite each female came from, even beyond just the distance between trapsites. However, distance between trapsites was the most important parameter for predicting probability of overlap (FNPL, Figure 3.12; FNL, Figure 3.13) and percent shared area of overlap (FNPL: Figure 3.14; FNL: Figure 3.15) between two breeding females captured within 7.5 km of each other. For the five regions where breeding females were captured ≥ 3 years and nested successfully, overall probability of nest success for all regions was low (*Prob* = 0.132, *SE* = 0.026, range = 0.070 – 0.200) and there was no significant difference in the probability of nest success by region (*df* = 4, *F-value* = 1.639, *p* = 0.165).

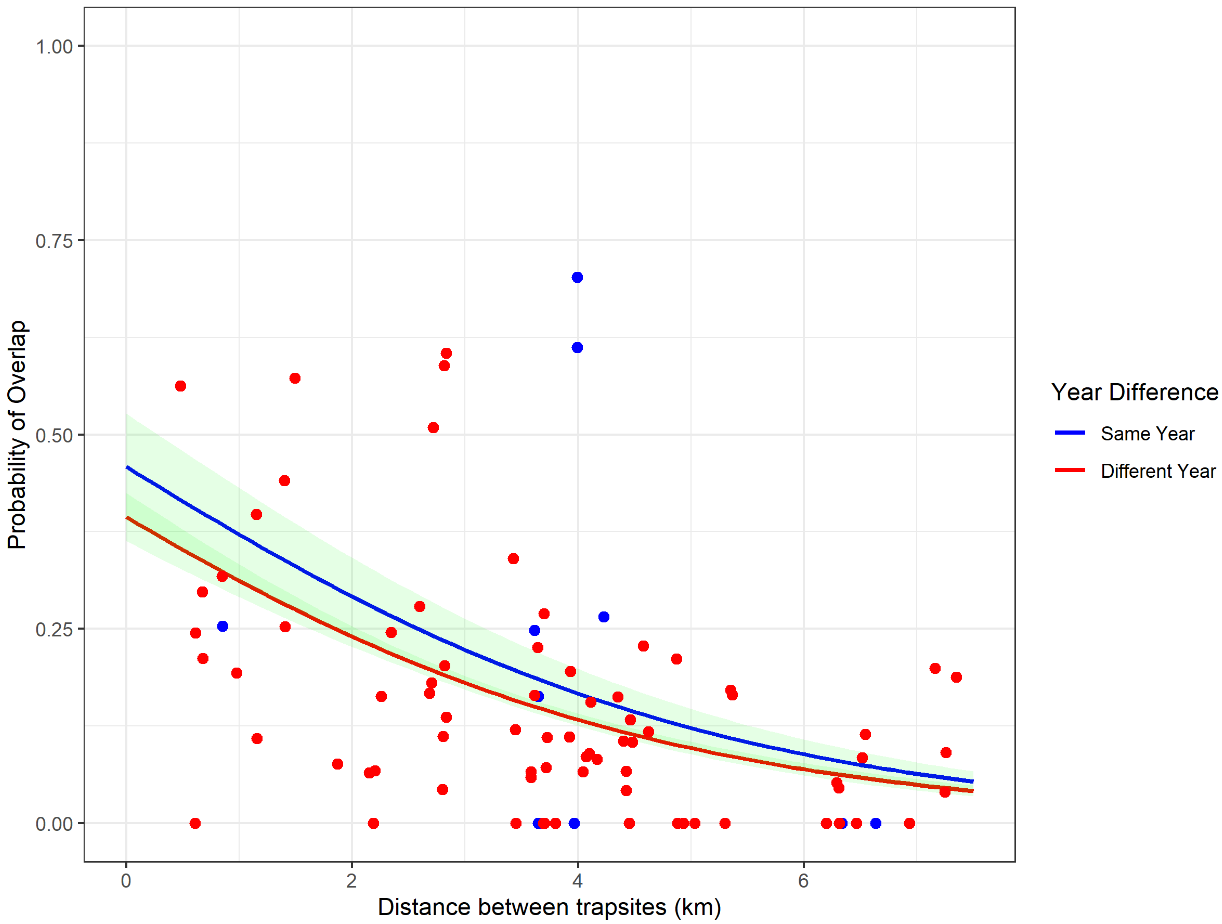

Figure 3.14. Percent shared area of pair-wise first nest attempt pre-laying range overlap between two breeding female wild turkeys captured more than 0.1 km but less than 7.5 km apart (sorted by distance between trapsites). Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. Percent for females in different years is in red, percent for females in the same year is in blue, each with their own 95% confidence intervals. The points represent each separate interaction between trapsites (set by their respective distance between each other) with blue points representing trapsites in the same year and red points representing trapsites in different years, each with their own 95% confidence intervals.

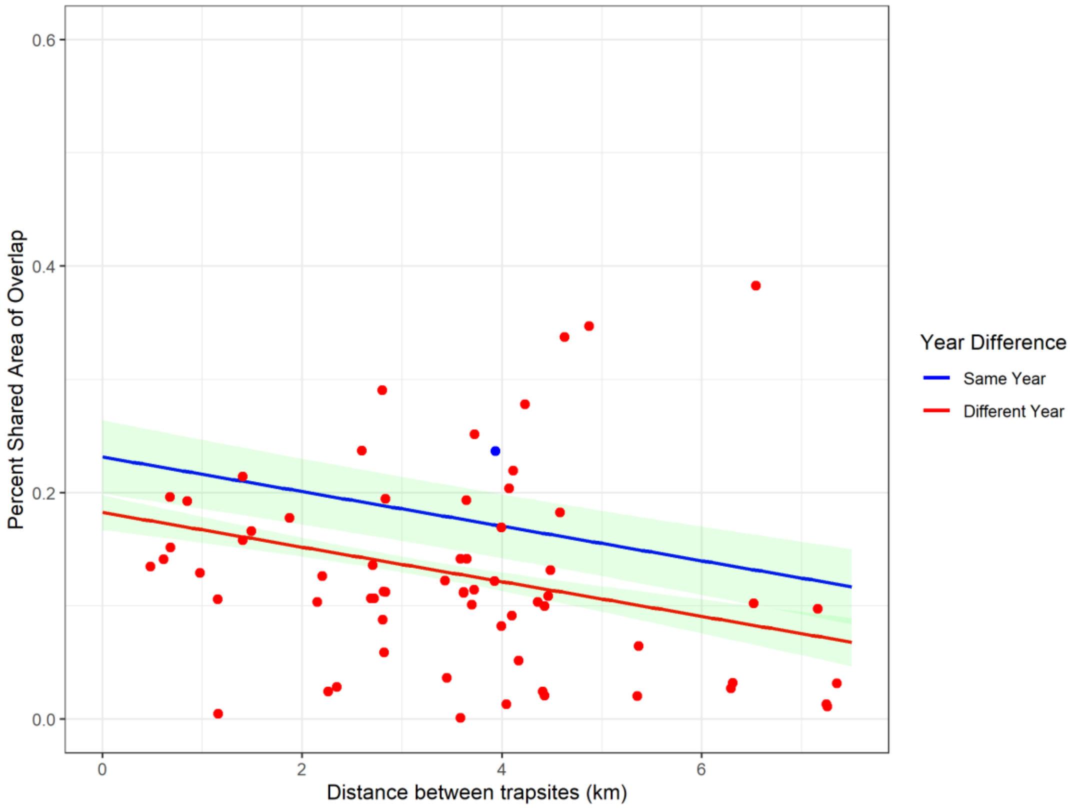

Figure 3.15. Percent shared area of pair-wise first nest attempt laying range overlap between two breeding female wild turkeys captured more than 0.1 km but less than 7.5 km apart (sorted by distance between trapsites). Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. Percent for females in different years is in red, percent for females in the same year is in blue, each with their own 95% confidence intervals. The points represent each separate interaction between trapsites (set by their respective distance between each other) with blue points representing trapsites in the same year and red points representing trapsites in different years, each with their own 95% confidence intervals.

Table 3.5. Comparing three individual-level effects on probability (*Prob*) and percent shared area (*Area*) of pair-wise range overlap during both the pre-laying (*FNPL*) and laying (*FNL*) periods for female wild turkeys captured and marked in west-central Louisiana from 2014 to 2022 with each standard error in parentheses: 3.5a. Comparing the probability and percent shared area of pair-wise overlap between a renesting female (2nd or 3rd nest attempt range) and her own first attempt range (Indv) against all first nest attempt ranges from that renesting female's current trapsite cohorts during each period (CTC) and 3.5b. Comparing the probability and percent shared area of pair-wise overlap of a recaptured female's first nest attempt range with her own first nest attempt range from a different year (Indv) and with all her previous trapsite cohorts' (PTC) and current trapsite cohorts' (CTC) first nest attempt ranges for each period

3.5a	***Renester (2nd or 3rd attempt) vs. trapsite cohort***			
	FNPL Prob*	**FNPL Area***	**FNL Prob***	**FNL Area***
Indv	0.982 (0.013)	18% (1%)	0.732 (0.045)	20% (1%)
CTC	0.739 (0.023)	12% (1%)	0.429 (0.026)	14% (1%)
3.5b	***Recapture vs. previous trapsite cohorts***			
	FNPL Prob	**FNPL Area***	**FNL Prob***	**FNL Area**
Indv	1	27% (6%)	0.875 (0.117)	21% (7%)
PTC	0.760 (0.049)	17% (2%)	0.408 (0.056)	19% (3%)
CTC	0.810 (0.027)	24% (1%)	0.472 (0.034)	22% (2%)

When female's nest attempts failed but the female survived, some would attempt a second or third nest (i.e. renesters) while others would not (i.e. non-renesters), with the overall period being called the post-nest failure period. There was no significant difference in the probability of females returning to any of the FNPL ranges of their trap cohorts during the post-nest failure period, regardless of whether a female was a renester or non-renester (Renesters: *Prob* = 1, Non-renesters: *Prob* = 0.940, *SE* = 0.029; β = 18.8, *SE* = 2968.1, p = 0.995). Renesters had a higher probability of pair-wise overlap with their own FNPL (Renester: *Prob* = 0.982, *SE* = 0.013, Trap cohorts: *Prob* = 0.739, *SE* = 0.023; β = 2.81, *SE* = 0.59, $p < 0.001$; Figure 3.16) and FNL range (Renester: *Prob* = 0.732, *SE* = 0.045, Trap cohorts: *Prob* = 0.429, *SE* = 0.026; β = 1.03, *SE* = 0.20, $p < 0.001$; Figure 3.17) when compared to trap cohorts. When pair-wise

overlap occurred they also shared significantly more area with their own first nest attempt range in both the pre-laying (Renester: 18% *SE* = 1%, Trap cohorts: 12% *SE* = 1%; $\beta = 0.08$, *SE* = 0.01, $p < 0.001$) and laying periods (Renester: 20%, *SE* = 1%, Other: 14%, *SE* = 1%; $\beta = 2.81$, *SE* = 0.59, $p < 0.001$) than their with the first nest ranges of their trap cohorts.

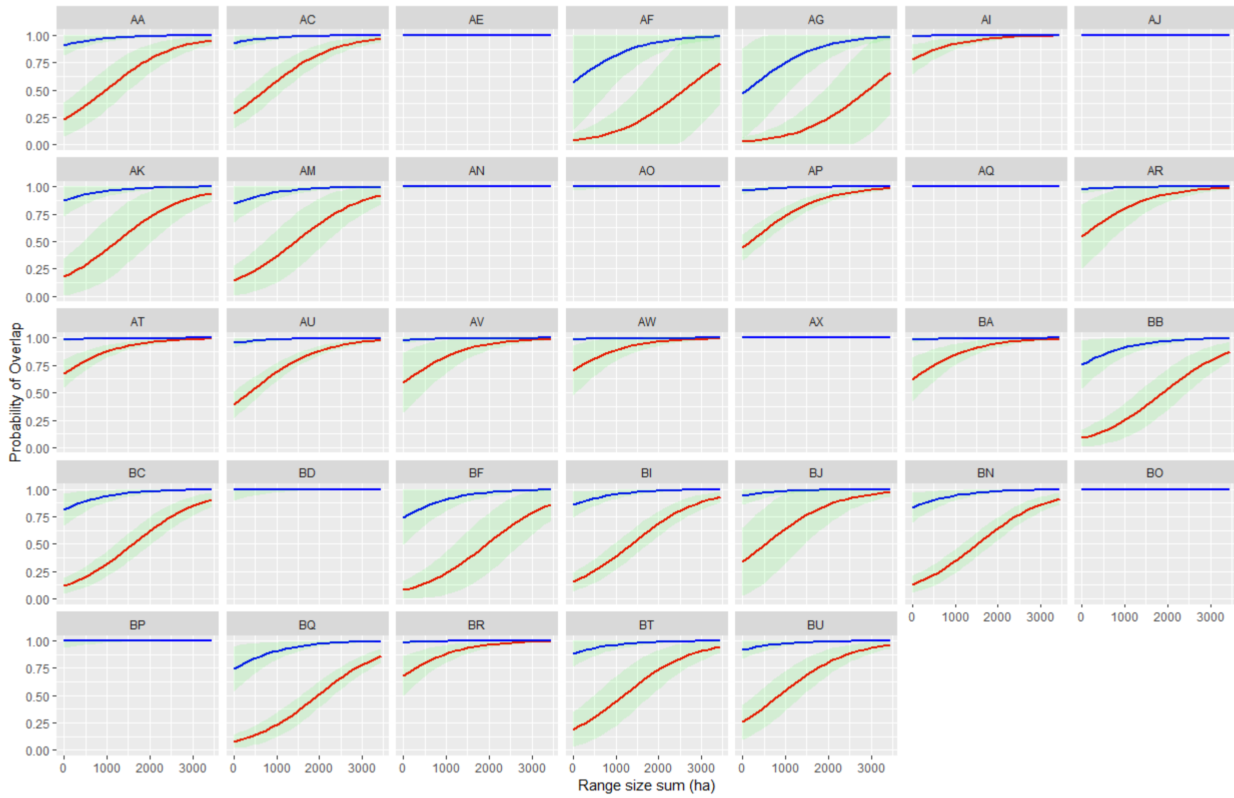

Figure 3.16. Probability of pair-wise first nest attempt pre-laying range overlap between two female wild turkeys captured at the same trapsite in the same year (separated by each trapsite) compared to the sum of the two compared range areas in hectares. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. The blue line is the probability of a renesting female overlapping with her first nest attempt range, the red line represents the probability of a renesting female overlapping with a trap cohort's first nest attempt range (each with their respective 95% confidence interval). All of these trapsites had three breeding females captured. Probabilities where the line is horizontal at 1 is where all individuals overlapped each other from that trapsite.

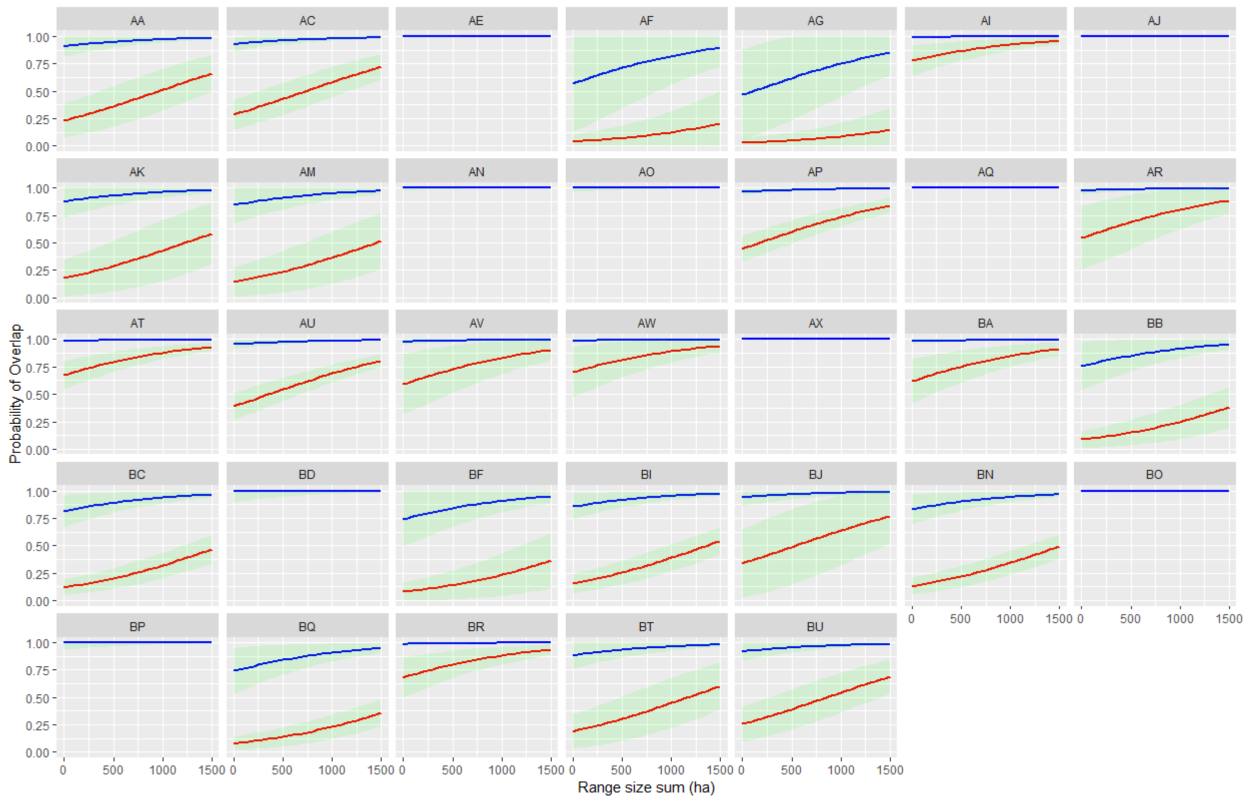

Figure 3.17. Probability of pair-wise first nest attempt laying range overlap between two female wild turkeys captured at the same trapsite in the same year (separated by each trapsite) compared to the sum of the two compared range areas in hectares. Female wild turkeys were captured and marked in west-central Louisiana from 2014 to 2022. The blue line is the probability of a renesting female overlapping with her first nest attempt range, the red line represents the probability of a renesting female overlapping with a trap cohort's first nest attempt range (each with their respective 95% confidence interval). All of these trapsites had three breeding females captured. Probabilities where the line is horizontal at 1 is where all individuals overlapped each other from that trapsite.

Of the 13 recaptured females only 8 had FNPL and FNL ranges that fit my criteria for evaluation. Recaptures were caught on average 2.23 km from their original trapsite (*SE* = 0.53, range = 0.67 – 4.10 km), and all were recaptured either one or two years after their original capture. A recaptured female's probability of pair-wise overlap with the FNPL range of trap cohorts from their previous trapsite was lower (*Prob* = 0.760, *SE* = 0.049) than with their own previous FNPL range (*Prob* = 1; β = 16.4, *SE* = 1398.7, *p* = 0.991), with a similar effect on percent shared area of overlap (Recapture: 27%, *SE* = 5%, Trap cohorts: 17%, *SE* = 2%; β =

0.10, *SE* = 0.05, *p* = 0.077). This effect was also seen during the FNL period as a recaptured female had a lower probability of pair-wise range overlap with trap cohorts from the previous trapsite than their own previous laying range (Recapture: *Prob* = 0.875, *SE* = 0.117, Trap cohorts: *Prob* = 0.408, *SE* = 0.056; β = 2.32, *SE* = 1.09, *p* = 0.034) but no significant difference in percent shared area of overlap (β = 0.03, *SE* = 0.07, *p* = 0.729; Table 3.5).

When comparing the probability and percent shared area of pair-wise range overlap between a recaptured female and her previous range against the pair-wise range overlap with trap cohorts from their current trapsite, during FNPL a recaptured female had a similar probability of overlap with trap cohorts' ranges (*Prob* = 0.810, *SE* = 0.027) than her own previous range (*Prob* = 1; β = 15.1, *SE* = 848.4, *p* = 0.986) with a no difference in percent shared area of overlap (β = 0.02, *SE* = 0.07, *p* = 0.731). During FNL the probability of a female overlapping trap cohorts from her current trapsite was lower than the probability of her overlapping her previous range (Recapture: *Prob* = 0.875, *SE* = 0.117, Trap cohorts: 0.472, *SE* = 0.034; β = 2.06, *SE* = 1.08, *p* = 0.056). Recaptured females would on average have nests between breeding seasons within 1.7 km (*SE* = 0.6 km) of each other, while that same female is generally at least 3 km away from nest sites used by trap cohorts from her current (β = -1.36, *SE* = 0.58, *p* = 0.019) or previous trapsite (β = -1.58, *SE* = 0.62, *p* = 0.013).

3.5. Discussion

Female wild turkeys had a high probability of shared space use both with their trap cohorts and with females captured within a defined available radius during the pre-laying period. The primary motivation behind breeding female wild turkeys sharing space during the pre-laying period is likely the need to access the lekking area containing breeding males, as finding and selecting mates is a primary motivator for female wild turkeys in the breeding period (along with

building up energy to nest; Badyaev et al. 1996, Miller et al. 1999, Chamberlain and Leopold 2000). My research indicates that female wild turkeys utilize similar space over time regardless of what year, which is likely due to the fact that: 1. Habitat in my study area rarely changes dramatically between years and 2. Leks are known to persist on the landscape in most avian lekking species (especially if the lek's habitat is not disturbed; Fedy et al. 2014, Mikolas et al. 2015, Winder et al. 2015). Lek persistence has several potential fitness benefits for both males and females including less search time for mates and more variation in mates that may not just be between the most dominant individuals (Robel and Ballard 1974, Widemo 1997, Wann et al. 2019). Thus, if a female wild turkey's primary motivation during the pre-laying period is to find and select a breeding male, then lek locations that persist over many breeding seasons are the most likely explanation for shared space over time during the pre-laying period by breeding female wild turkeys.

Inter-annual site fidelity seen in recaptured female wild turkeys is not surprising, as wild turkey individuals have shown high site fidelity in previous research (Byrne et al. 2022). The high probability of overlap for recaptured female wild turkeys during the pre-laying period with their own and their trapsite cohorts' ranges indicates selection of breeding areas. Individual inter-annual site fidelity to leks was high, as was fidelity for all females captured within the available radius. When combined with the evidence that recaptured female wild turkeys are rarely captured more than a few kilometers from their original trapsite, my results show that females are likely anchoring year-round movements to leks and allowing for access to the same set of leks (and thus nearby resources) year-over-year. Individual female site fidelity has been seen in other lekking species [e.g. greater sage-grouse (*Centrocercus urophasianus*) and great bustards (*Otis tarda*)] and can be used as a secondary mating tactic when males do not easily make themselves

apparent (i.e. the hotspot hypothesis; Gibson et al. 1991, Gibson 1996, Alonso et al. 2012). Renesting female wild turkeys (and those that failed to renest) also showed a high probability of sharing space with their own and their trap cohorts' ranges during the pre-laying period, indicating high fidelity to these same leks within the season.

The sharp drop in the probability of shared space between the pre-laying and laying periods of the breeding season for my female wild turkeys has been seen in other research (Conley et al. 2016, Bakner et al. 2019, Ulrey 2021). Female wild turkeys separating from each other during the laying period may be a strategy to place their nests more randomly on the landscape to potentially avoid allowing predators to home in on specific areas or habitat types (Schaap et al. 2005, Schofield 2019). Renesting breeding females exhibited intra-annual site fidelity between their second and third nest laying period ranges and their first nest laying period range, which shows a high nest site fidelity regardless of when that nest occurs (Locke et al. 2013). Females continued to avoid other female's first nest laying ranges (Schapp et al. 2005, Schofield 2019), despite those other females often not actively layaing in those ranges at the same time. This effect was also seen for recaptured female wild turkeys between breeding seasons, thus showing females are using the same areas for nesting each year and continuing to avoid their trap cohorts' ranges over time.

I found considerable variability in the probability of sharing space both with trapsite cohorts and with available cohorts (with the probability of pair-wise overlap being negatively correlated to the distance between available cohorts' trapsites). The most likely explanations for the variation in overlap between trapsites comes from behavioral (e.g., social hierarchies) and relatedness between individuals. Dominance hierarchies between individuals affect nest timing, nest success, space use during the breeding season (Schofield 2019, Ulrey et al. 2022, Keever et

al. 2022), but these behaviors are still poorly understood in wild turkeys. Previous research based on direct visual observations showed that dominance hierarchies influence behavior (e.g., flock assemblage, mate choice, breeding timing) and is consistent through the lifespan wild turkeys (Watts and Stoke 1971, Healy 1992). The role of inter-relatedness is only recently coming into focus for wild turkeys, but it is likely of some importance for shared space use and lekking behavior as is seen in other lekking species (Cross et al. 2017, Roy and Gregory 2019, Zimmerman et al. 2022). Watkins (2022) showed that females in my study areas caught at the same trapsite in the same year were generally not closely related, with evidence that closely related females from the same winter flock avoided joining the same social group during the pre-laying period. This could fit with my results, as that would explain why females would not always share space in the pre-laying periods despite likely having access to the same mates.

The high probabilities of overlap between any set of breeding females (within an available radius), suggest that wild turkey movement patterns are anchored at a breeding female's available leks. Female wild turkeys are likely using an "always stay" site fidelity strategy where they are not leaving known resources (Gerber et al. 2019). Juvenile breeding females in my study area did not tend to travel further than adults to nest, which challenges previous research (Ellis and Lewis 1967, Badyaev and Faust 1996, Phillips 2004), but also indicates that dispersal was equally likely for juvenile and adult breeding females. Although juvenile dispersal could be occurring before I captured wild turkeys in January of each year, other lekking species have shown high natal site fidelity (Dunn and Braun 1985, Alonso and Alonso 1992, Borecha et al. 2017). Thus, it is likely that the natal region determines exploded lek use for the lifetime of most female wild turkeys. If true, identifiable lekking areas may provide insights on results availability that impacts local and regional turkey demography and deserves

further research attention.

CHAPTER 4. CONCLUSIONS

My results suggest that most vegetation characteristics at the landscape scale do not affect path selection on the first day of laying (laying path) for female eastern wild turkeys. The only vegetation characteristic that I found to affect laying path selection was woody wetlands, which they likely avoided to prevent flooding of nests. Otherwise, they did not favor or avoid any landscape scale vegetation characteristic when selecting their laying path. My work suggests that wild turkeys do not have strong selection preferences for their nest sites compared to what was available, as the laying path is the only possible day where nest sites can be selected. I also found the nest timing and movement patterns of female wild turkeys in my study area matched patterns in other populations throughout the eastern United States, so my sample should be representative of most eastern wild turkey populations. My findings suggest that habitat is not the primary driver behind nest site selection, and that future research should be focused on other drivers to nest site selection, specifically social effects in wild turkey flocks.

I found that the pre-laying and laying periods for breeding female wild turkeys averaged ~24 and ~11 days for first nest attempts, ~15 and ~10 days for second nest attempts, and ~14 and ~10 days for third attempts respectively. Pre-laying range size averaged ~765 ha and laying ranges averaged ~378 ha. My results indicate female wild turkeys captured at the same trapsite have around a high probability of pair-wise range overlap during the first nest pre-laying period (Prob = 0.788) and lower probability during the first nest laying period (Prob = 0.407). Percent shared area was around 20-23% for each period for those that did overlap. The sum of each female's range size was positively correlated with the probability and percent shared area of pair-wise overlap for both periods. There was high variability between the probabilities of pair-wise overlap at each trapsite. I found that these probabilities and percent shared areas were very

similar whether the females were captured in the same year or different years. I found that 96% of all nests occurred within 7.5 km of the capture site, so that is what I used as the space within a radius of 7.5 km of each female's trapsite to be available to female wild turkeys in a breeding season. Within that available radius, I found both the probability and percent shared area of pair-wise range overlap was strongly predicted by the distance between each female's trapsite as long as those females were captured within 7.5 km (trapsite pair; negative association) and the sum of each of female's range size (positive association), with the variability between different trapsite pairs still being high. Whether or not these ranges occurred in the same year had a small effect in probability and percent shared area of overlap, with ranges occurring in the same year having a slightly higher probability and percent shared area of overlap. By looking at both renesters and recaptured breeding female wild turkeys, I found that individual site fidelity was high for both periods both within and between breeding seasons, respectively. My results suggest that these areas where breeding female wild turkeys are overlapping during the pre-laying period are less likely to be shared energetic resources and more likely to be where breeding is occurring (leks). With such high inter-annual site fidelity during the pre-laying period, it is likely that these leks are persisting on the landscape between seasons. Future research should focus on these leks to see if any habitat characteristics define them and what role female and male occupancy at certain points of the year affects reproduction.

APPENDIX. SUPPLEMENTARY MATERIAL FOR CHAPTER 2

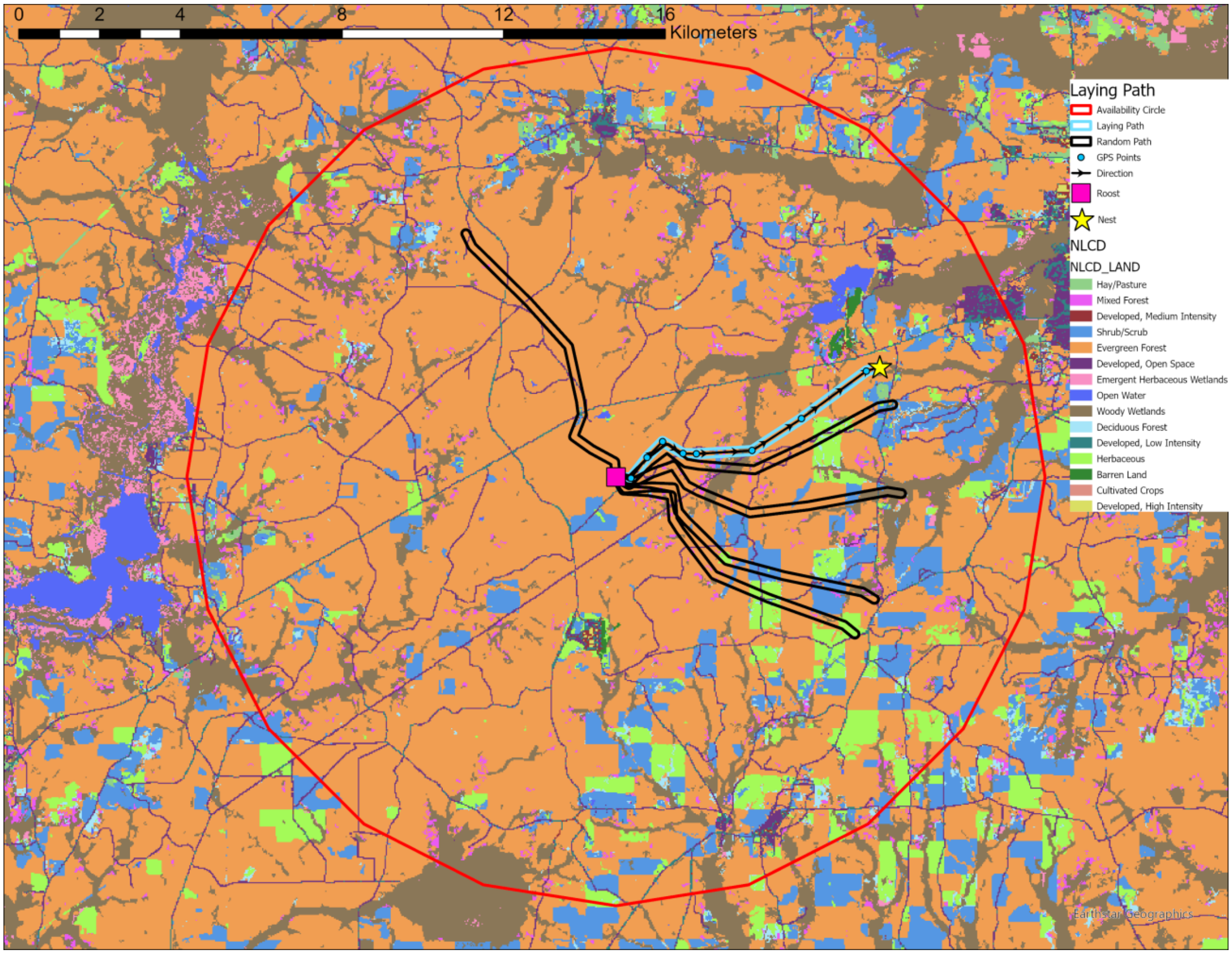

Figure A.1. Laying path of a female wild turkey captured and marked in west-central Louisiana between 2014 and 2021. Laying paths are determined based on the GPS points (blue dots) on the first day of egg laying, starting at the roost (pink square) and ending at the nest (yellow star). The laying path was buffered based on straight lines drawn between GPS points (black line with arrows) out to 50 m and compared to 5 replicated paths in random directions anchored at the roost (black outlines). An availability circle (red circle) was also created centered at the roost and with a radius 1.5x the length of the straight line distance from the roost to the nest. The background is marked with 10m x 10m pixels of different vegetation characteristics (each color representing a separate characteristic) based on the National Land Cover Database.

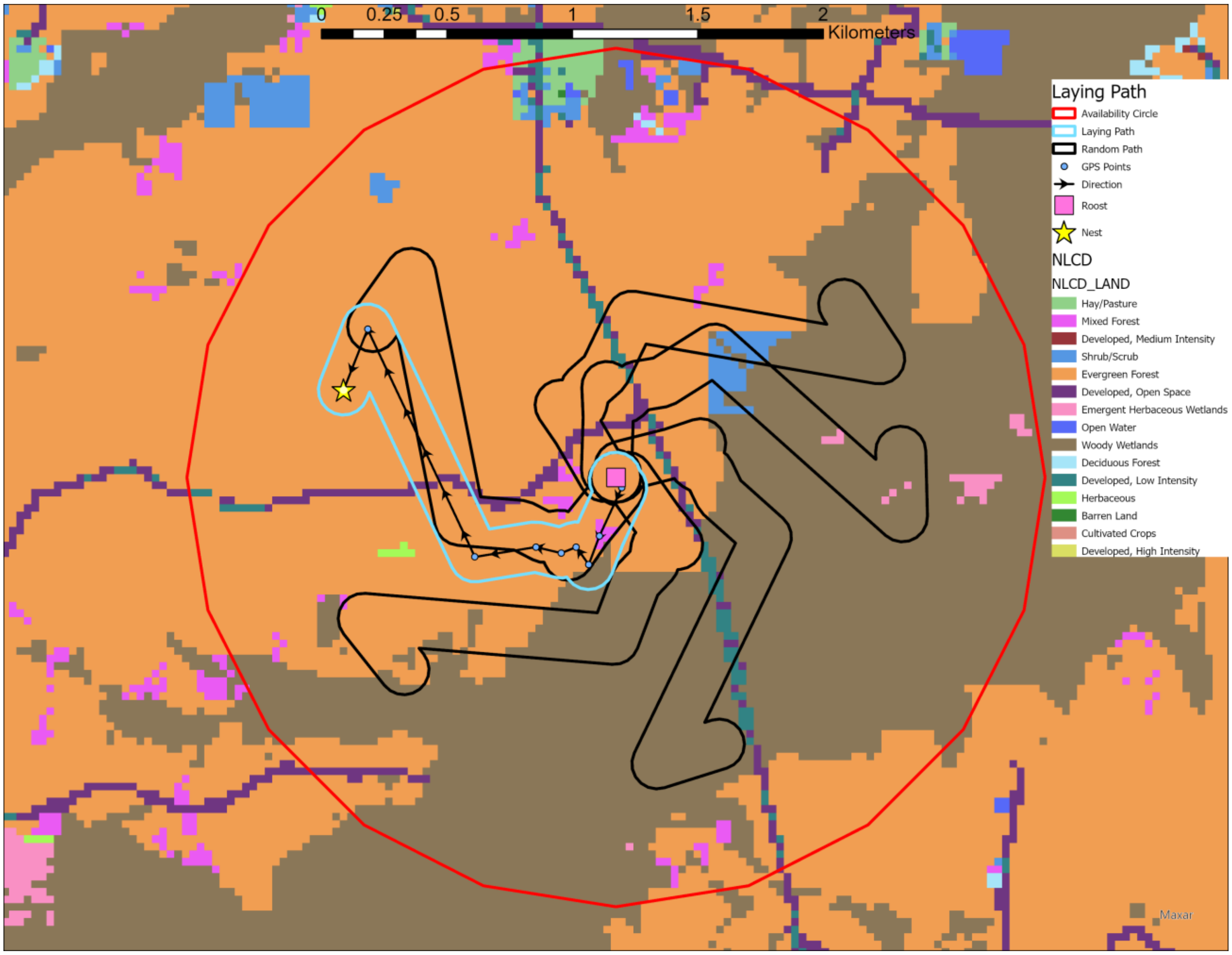

Figure A.2. Laying path of a female wild turkey captured and marked in west-central Louisiana between 2014 and 2021. Laying paths are determined based on the GPS points (blue dots) on the first day of egg laying, starting at the roost (pink square) and ending at the nest (yellow star). The laying path was buffered based on straight lines drawn between GPS points (black line with arrows) out to 50 m and compared to 5 replicated paths in random directions anchored at the roost (black outlines). An availability circle (red circle) was also created centered at the roost and with a radius 1.5x the length of the straight line distance from the roost to the nest. The background is marked with 10m x 10m pixels of different vegetation characteristics (each color representing a separate characteristic) based on the National Land Cover Database.

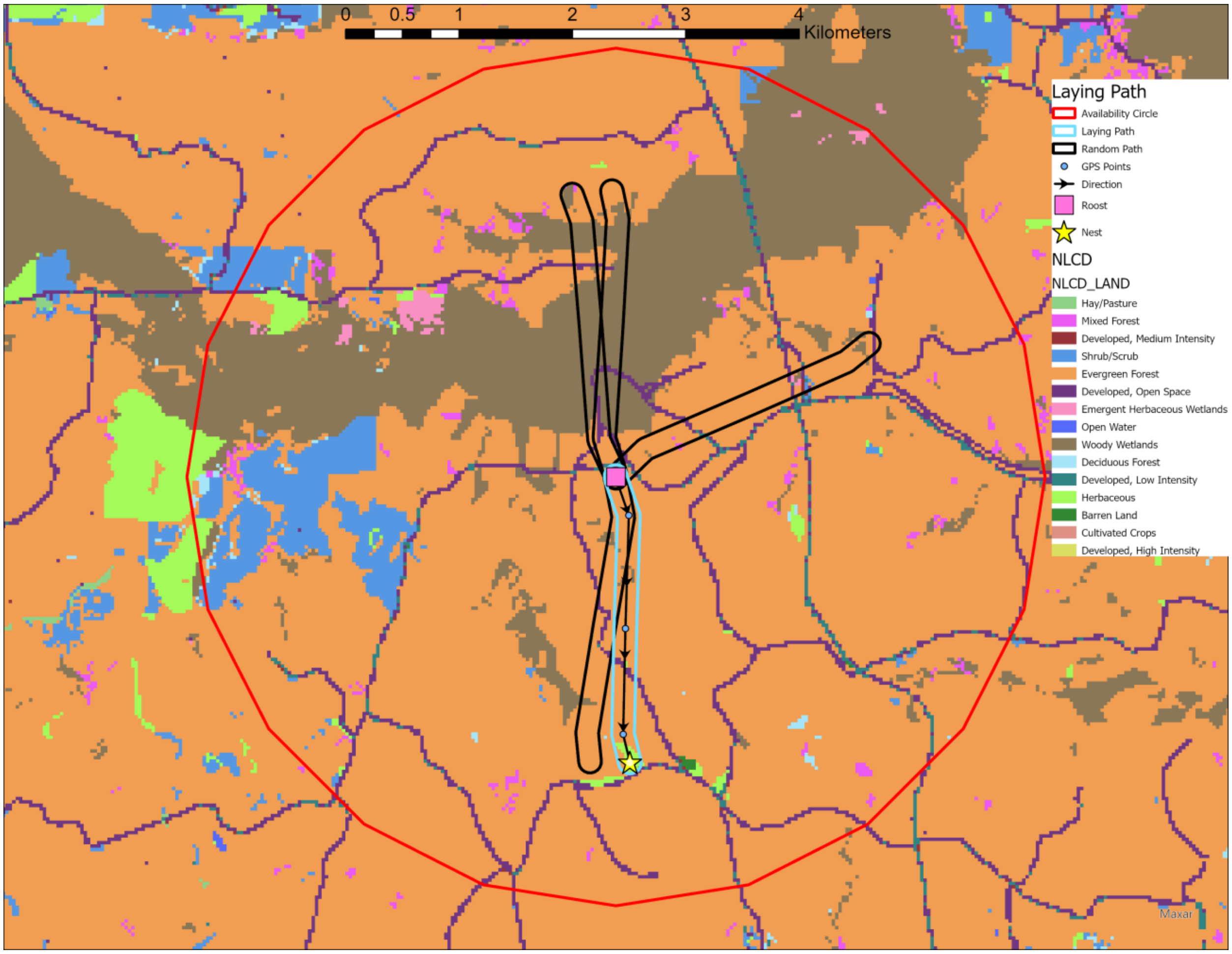

Figure A.3. Laying path of a female wild turkey captured and marked in west-central Louisiana between 2014 and 2021. Laying paths are determined based on the GPS points (blue dots) on the first day of egg laying, starting at the roost (pink square) and ending at the nest (yellow star). The laying path was buffered based on straight lines drawn between GPS points (black line with arrows) out to 50 m and compared to 5 replicated paths in random directions anchored at the roost (black outlines). An availability circle (red circle) was also created centered at the roost and with a radius 1.5x the length of the straight line distance from the roost to the nest. The background is marked with 10m x 10m pixels of different vegetation characteristics (each color representing a separate characteristic) based on the National Land Cover Database.

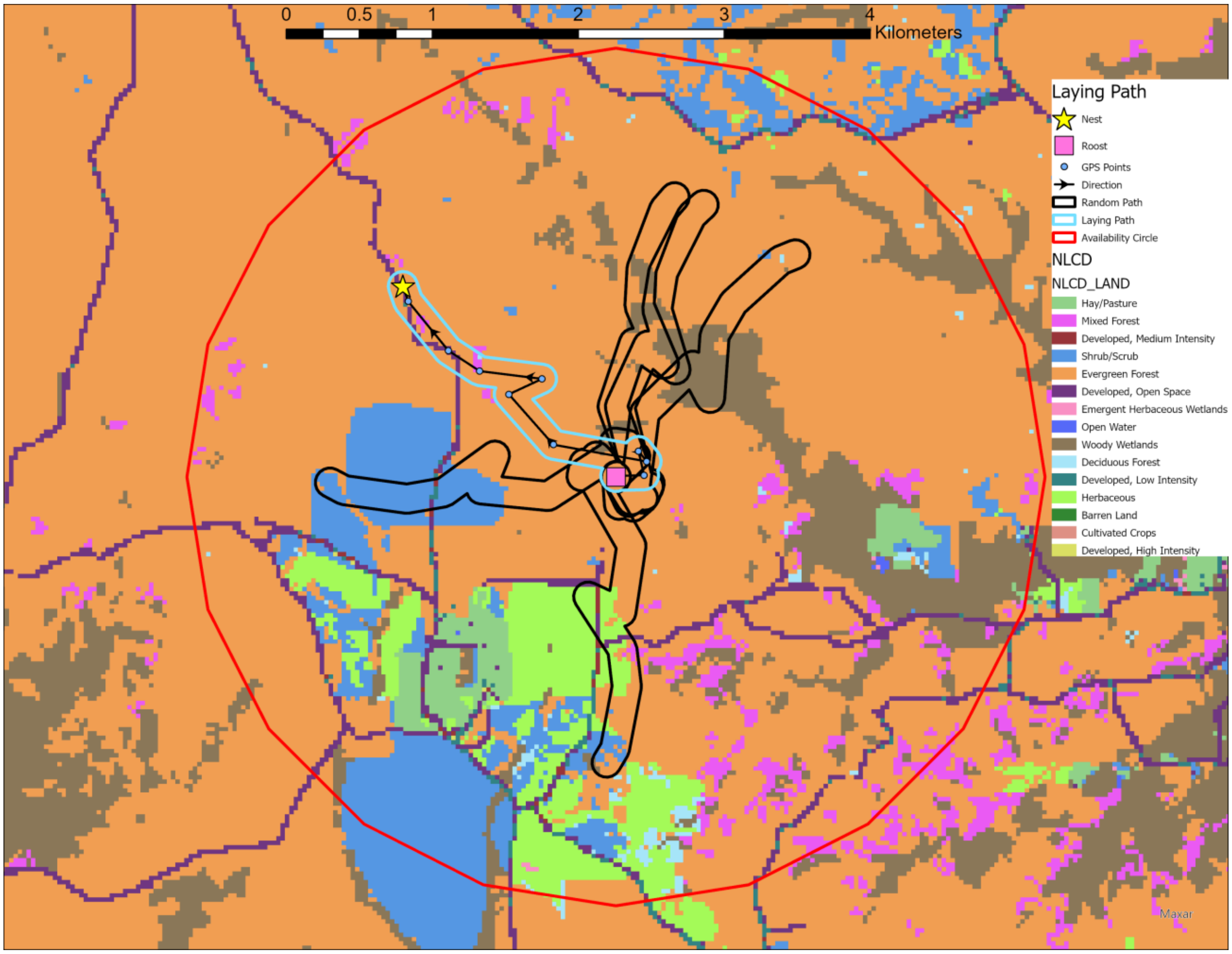

Figure A.4. Laying path of a female wild turkey captured and marked in west-central Louisiana between 2014 and 2021. Laying paths are determined based on the GPS points (blue dots) on the first day of egg laying, starting at the roost (pink square) and ending at the nest (yellow star). The laying path was buffered based on straight lines drawn between GPS points (black line with arrows) out to 50 m and compared to 5 replicated paths in random directions anchored at the roost (black outlines). An availability circle (red circle) was also created centered at the roost and with a radius 1.5x the length of the straight line distance from the roost to the nest. The background is marked with 10m x 10m pixels of different vegetation characteristics (each color representing a separate characteristic) based on the National Land Cover Database.

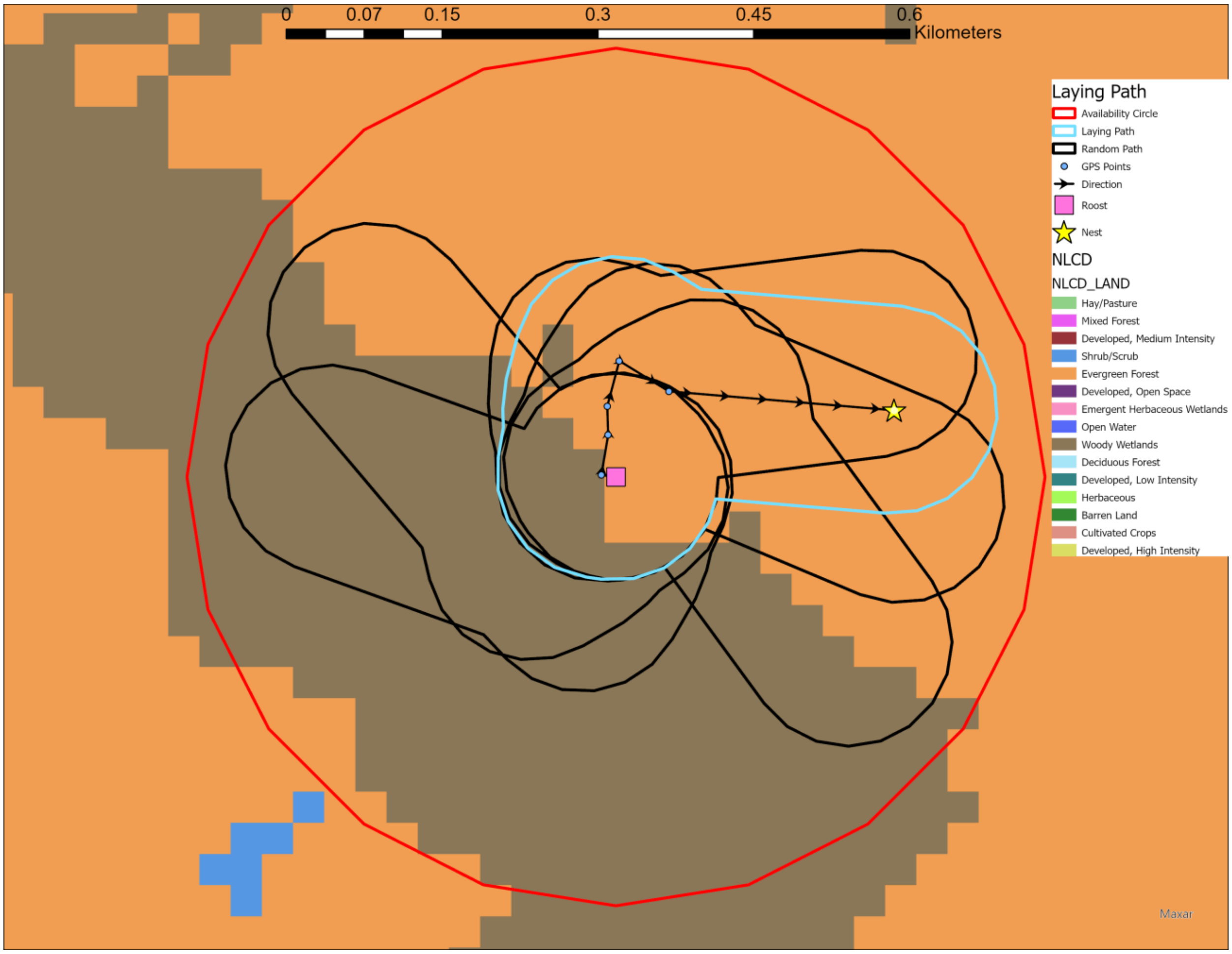

Figure A.5. Laying path of a female wild turkey captured and marked in west-central Louisiana between 2014 and 2021. Laying paths are determined based on the GPS points (blue dots) on the first day of egg laying, starting at the roost (pink square) and ending at the nest (yellow star). The laying path was buffered based on straight lines drawn between GPS points (black line with arrows) out to 50 m and compared to 5 replicated paths in random directions anchored at the roost (black outlines). An availability circle (red circle) was also created centered at the roost and with a radius 1.5x the length of the straight line distance from the roost to the nest. The background is marked with 10m x 10m pixels of different vegetation characteristics (each color representing a separate characteristic) based on the National Land Cover Database.

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