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Relationship of predator relative abundance with wild turkey nest success and relationship of vegetation covariates to resource selection and survival of wild turkey poults

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To the Graduate Council:

I am submitting herewith a thesis written by Casey Swafford entitled "Relationship of predator relative abundance with wild turkey nest success and relationship of vegetation covariates to resource selection and survival of wild turkey poults." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

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ABSTRACT

Wild turkey (*Meleagris gallopavo*) populations in the southeastern United States have experienced declines in productivity, which are reflected in decreasing poult-per-hen ratios and reduced harvest. These declines have been primarily linked to reductions in fecundity that are driven by unsustainable levels of nest predation and poor brood survival. To address these issues, we conducted a study in south-central Tennessee from 2018–2024 to investigate the roles of mammalian predators on nesting. We also studied how vegetation was related to patterns of brood resource selection and poult survival.

We documented the relative abundance of mammalian nest predators and we modeled their relationship to nest fate and daily nest survival across our ten study sites in five counties (Bedford, Giles, Lawrence, Maury, and Wayne). Using radio-tagged females and remote cameras deployed near active nests and on the landscape, we recorded detection rates for common nest and adult turkey predators including raccoon (*Procyon lotor*), nine-banded armadillo (*Dasypus novemcinctus*), coyote (*Canis latrans*), opossum (*Didelphis virginiana*), bobcat (*Lynx rufus*), and striped skunk (*Mephitis mephitis*). The predator indices varied among counties and years and were greatest for raccoons and armadillos. Based on daily nest survival analysis, nest success averaged 31.5%, with 75.4% of failures attributed to predation. Predator detections, particularly those of coyotes and bobcats, were strongly associated with reduced daily nest survival, while our analysis of overall nest fate linked the entirety of the nest predator community with nest failure. Notably, no predators were detected on cameras near successful nests, suggesting that the mere presence of predators near nest sites increased the risk of nest depredation.

We monitored females with broods and radio-tagged poults from 2018–2023 to document patterns of brood resource selection and poult survival. We collected vegetation data at brood-

use and paired random locations to evaluate resource selection and we related vegetation covariates with poult survival during the first 28 days post-hatch. Females with broods selected areas with greater forb cover, greater visual obstruction, and lesser midstory stem density than vegetation structural conditions at available sites. The resource-selection model performance improved when point type (field, forest, edge) was included in the model. Daily poult survival during the 14 two-day intervals (28 days) averaged 0.918 (± 0.021 SE) was different among the three time periods: intervals 1–4 (days 1–8; 0.942 ± 0.023 SE), intervals 5–7 (days 9–14; 0.811 ± 0.064 SE) and intervals 8–14 (days 15–28; 0.967 ± 0.033 SE). Poult survival increased with increasing tree basal area during days 9–14 and 15–28 post-hatch time periods. Additionally, landcover type composition surrounding the nest was related to poult survival during the first 4 days post-hatch. Increasing amounts of mature forest types were negatively related to poult survival, while increasing amounts of pasture/hay were positively related to poult survival. Our data indicated that poor brood survival because of unsustainable levels of predation, in concert with the limited availability of high-quality brood habitat, is likely a significant limiting factor associated with the wild turkey population decline in south-central Tennessee. Provision of quality brood-rearing habitat should be a management priority, and in addition, predator management may be required for landowners to achieve population growth objectives in south-central Tennessee.

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CHAPTER 1: INTRODUCTION

The decline of wild turkey populations has been reported throughout much of their range since 2000, with continued declines in harvest reported as well (Tapley 2011, Ericksen 2015). Turkey populations in Tennessee have declined similarly, based on North American Breeding Bird Survey data, since 2013, with declines in harvest reported in some middle Tennessee counties (Buehler and Harper 2024). Since 1990, there also has been a decline in poult-per-hen ratios in Tennessee (Byrne et al. 2015, Ziolkowski et al. 2023, Shields 2024). Given the important ecological, cultural, and recreational values of wild turkeys in Tennessee, understanding the causal factors associated with the population decline is warranted.

Understanding the role predation is having in limiting reproduction is a critical management need. For ground-nesting birds, nest predation is the most influential factor affecting nest success (Miller and Leopold 1992, Lovell et al. 1997, Rollins and Carroll 2001, Stephens et al. 2005). Successful reproduction is greatly influenced by the intensity of predation and therefore a primary driver of the population (Martin 1992). There is an elevated risk of nest predation in developing urban landscapes, which is occurring in many areas of Tennessee, as these areas have greater predator densities and poor nesting cover (Hoffman and Gottschang 1977, Wilcove 1985, Rosenberg et al. 1999, Thorington and Bowman 2003). In addition, the composition of nest predators has changed and overall predator numbers have increased dramatically in Tennessee since wild turkey restoration began in the 1980s (Ray 2000, Roberts and Crimmins 2010). I investigated the relationship between mammalian nest predators and wild turkey nest success in Chapter 2. My primary objectives were to determine if predator abundance was linked to daily nest survival or nest fate and to determine which mammalian species were most strongly related to nest survival/nest fate.

Poult survival is another critical component of wild turkey population recruitment, and low poult survival likely has contributed to population declines in Tennessee and elsewhere (Londe et al. 2023). Poult survival may be influenced by a number of biotic factors, including vegetation structure (Spears 2005, Hughes et al. 2007, Pollentier et al. 2014, Lehman et al. 2022, Londe et al. 2023), food resource availability (De Filippo 2024), and predator abundance (Hughes et al. 2007). Wild turkey brood resource selection has been evaluated in several studies (Lehman 2010, Johnson 2019, Nelson 2022). It is important to relate the vegetation characteristics of brood-use areas with poult survival to better inform management decisions (Spears 2007). For Chapter 3 of my thesis, we monitored poults and sampled vegetation at brood locations to investigate the contemporary relationship between wild turkey resource selection and brood survival. Our primary objective was to assess brood locations to determine what specific vegetation characteristics were important for brood selection and to test the hypothesis that this selection also was linked with brood survival.

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CHAPTER TWO: RELATIVE ABUNDANCE AND THE RELATIONSHIP OF MAMMALIAN PREDATORS WITH WILD TURKEY NEST SUCCESS IN SOUTH-MIDDLE TENNESSEE

ABSTRACT Wild turkey (*Meleagris gallopavo*) poult-per-hen ratios have declined over the past 35 years in several southeastern U.S. states with associated declines in harvest, leading many state wildlife agencies to alter their hunting season framework and bag limits in response to the decline. Reduced fecundity has been identified as the leading cause of the decline, as predation of nests and incubating females have lowered productivity. There are a number of mammalian predators that may prey on nests and females, but it is unclear which predators are most correlated with nest failure. We conducted a study in 5 counties in south-central Tennessee (Bedford, Giles, Lawrence, Maury, and Wayne) in 2023–2024 to photographically document the relative abundance of turkey and nest predators and assess the relationship of predator abundance to nest failure and daily nest survival. We trapped and radio-tagged females and located and monitored their nesting activity via radio-telemetry. We deployed remote cameras to monitor potential mammalian nest predators near (50–100 m) active nest sites and at other turkey-use areas at each of our ten study sites. We determined nest fate and recorded detections of common nest predators and scavengers, including nine-banded armadillo (*Dasypus novemcinctus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), opossum (*Didelphus virginiana*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*). The global relative index for the predator species per 100 camera nights was raccoon (8.9; 11.73 SE), armadillo (8.7; 11.38 SE), coyote (3.2; 2.58 SE), opossum (1.4; 14.77 SE), bobcat (0.7; 25.52 SE), and skunk (0.3; 47.98 SE). Relative predator indices differed by year (2023 > 2024). There were fewer detections/camera night in the 3 southern counties (Giles, Lawrence, Wayne) than the two northern counties (Bedford, Maury), which correlated with historically lower nest survival in Bedford and Maury counties. Based on daily nest survival analysis, nest success averaged 31.5% for 2023–2024 with 75.4% of nest failures attributed to predation. Daily nest survival was most strongly related to coyote and

bobcat indices. Nest fate (success/failure) was most strongly related to a combination of all predators included in the study. We do not know which mammalian predators were actually responsible for the documented nest depredations. However, we did not detect a single predator near any of the successful nests, which indicates the presence of mammalian nest predators near active nests increases predation risk. Monitoring relative abundance of predators with cameras is an effective way to document mammalian predation risk for nesting wild turkeys. Addressing predation risk through predator management may be needed to reverse declines in wild turkey populations in south-central Tennessee.

INTRODUCTION

Wild turkey populations have decreased recently in Tennessee (Buehler and Harper 2024) and elsewhere in the Southeast (Chamberlain et al. 2022) because of poor recruitment (Byrne et al. 2016). Hypotheses explaining population declines include increases in predator populations, loss of habitat, changing climate, disease issues, and hunter harvest (Dickson 1992, Casalena et al. 2005, Eriksen et al. 2015, Londe et al. 2023). Although disease can affect individuals or local populations (Ryser-Degiorgis 2013), there are no data that indicate any disease has been responsible for any widespread decline in wild turkey populations. Although several states have altered their hunting season framework, there are no data that indicate the timing of the hunting season or the bag limit has impacted turkey populations. In fact, Quehl et al. (2024) reported a 2-week delay in the timing of the hunting season and a concomitant reduction in the bag limit had no effect on fecundity or recruitment in Tennessee.

Wild turkey managers have focused on understanding the causes of nest failure with the goal of addressing associated causal factors through management. Predation is the primary reason for turkey nest failure (Miller and Leopold 1992, Lovell et al. 1997, Yeldell at. al 2017),

and turkey researchers and managers have focused on developing a better understanding of turkey-nest predator relationships. The distribution and abundance of meso-mammalian predators have changed dramatically since wild turkey restoration began in Tennessee in the early 1940s (Lewis 1964) and since large-scale translocation of wild turkeys began in the 1980s.

The removal of large carnivores from North America in the 1800s, followed by meso-mammalian predator release, large-scale land-use change, and the reduction in trapping have led to the increase in meso-mammalian predator abundance for some species (Ray 2000). Coyote distribution, for example, expanded throughout the Southeast since 1970 such that coyotes now have saturated the entire region (Hill et al. 1987, Chitwood et al. 2015). Bobcat populations also have increased across much of North America (Roberts and Crimmins 2010). Raccoons were sufficiently sparse in Tennessee such that the Tennessee Wildlife Resources Agency (TWRA) translocated raccoons across the state in the 1980s to restore/increase populations (Glass 1991). Armadillos have vastly expanded their ranges as well and are near omni-present across our sites in south-middle Tennessee (Taulman and Robbins 2014, DeGregorio and Deshwal 2025). As a result, meso-mammalian predators are increasingly affecting wild turkey nest success and productivity.

A variety of predators can be responsible for the depredation or destruction of turkey nests during laying, incubation, and recess activity, and the spatial overlap between turkey nesting sites and predator distributions may relate to nest fate (Sanders et al. 2020, Ulrey et al. 2022). Although wild turkey nesting has been well-studied, the actual mechanism of predation is poorly understood. Some predators (e.g., coyotes and bobcats) are capable of killing the female, or flushing the female off the nest, thus making the eggs available for depredation by other species. Other species (e.g., opossum or armadillo) may only depredate a nest when the female is

absent. Researchers have been reluctant to place cameras on nests to document actual nest predation events because females may abandon their nests if flushed and because researchers fear the introduction of human scent at nest sites may attract nest predators (Martin et al. 2015). Thus, researchers typically document potential nest predators in the area and associate nest fate with nest predators through statistical modeling but generally lack direct observations of actual depredation events.

We monitored wild turkey nests and used camera-traps near nest sites and in the surrounding landscape in south-central Tennessee, 2023–2024 to better understand the relationship between wild turkey nest success and the predator community. Our primary objectives were to determine if predator abundance was linked to daily nest survival or nest fate and to determine which mammalian species were most strongly related to nest survival/nest fate. We hypothesized predator abundance near nests and in the surrounding landscape would differ, and we predicted greater predator abundance across the landscape than near nests because females would choose areas with fewer predators to nest. We hypothesized that mammalian predator occurrence would differ across the five-county area, and we predicted predator abundance would be greater in counties with lower nest success.

STUDY AREA

We conducted our study in 2023–2024 in five counties in south-central Tennessee: Bedford, Giles, Lawrence, Maury, and Wayne, with two trap sites located in the northern and southern part of each county (Figure 2.1). These counties were selected because they historically had some of the greatest spring turkey harvests of any region in Tennessee and the three southern counties (Giles, Lawrence, and Wayner) also had experienced significant declines in harvest since 2010. We monitored turkeys on more than 400 private properties and two public wildlife management

areas (WMA) totaling more than 30,000 ha. The two WMAs included Yanahli and Tie Camp. Yanahli WMA is owned and managed by TWRA for white-tailed deer (*Odocoileus virginianus*), wild turkey, and northern bobwhite (*Colinus virginianus*) and comprises 5,179 ha in Maury County. Tie Camp WMA is owned and managed by Bascom Southern Timber Company for timber production and comprises 1,325 ha in Wayne County. The landscape across the 5-county region was predominantly composed of mature deciduous, mixed, and coniferous forest interspersed with pasture/hay fields, limited row crop fields (corn and soybean), and human development. Average annual rainfall across the study area was approximately 146 cm and average annual high and low temperatures were 21.22°C and 8°C (U.S Climate Data 2024). The predominant soil types included Bodine cherty silt loam and gravelly silt, Gladeville rock outcrop, Ashwood, Brandon silt loam, Biffle gravelly silt loam, and Frankstone cherty silt loam (United States Department of Agriculture [USDA] 2024).

METHODS

Trapping and Tagging

We baited trap sites with cracked and whole-kernel corn and monitored turkey visitation of trap sites with trail cameras, January–March 2016–2023. We captured turkeys via rocket nets (Delahunt et al. 2011) with a goal of maintaining 10–12 radio-tagged female turkeys in the area surrounding each trap site (n = 100–120 total females with radio-tags each year). We captured additional females, 2017–2023, as needed to maintain 10–12 radio-tagged females per site.

We banded female turkeys with a uniquely numbered aluminum band (National Band and Tag Company: style 1242FR8A, Newport, Kentucky, USA) and attached a VHF (Advanced Telemetry Systems: Series A1500, Isanti, Minnesota, USA) or GPS (Lotek: GPS PinPoint, Wareham, United Kingdom) transmitter via backpack harness (Guthrie 2011). We recorded age

(adult/juvenile), weight (g), tarsus length (cm), beard length (cm, if applicable), and body condition score (Robins 1998). We released all females at the capture site following processing (University of Tennessee IACUC protocol #0561-0720). VHF transmitters weighed 80 grams and had a life expectancy of about 5.7 years. The Lotek GPS transmitters weighed 92 grams and had an expected battery life of approximately 2.5 years. VHF and GPS radio-tags were equipped with a mortality switch that was triggered after eight hours of inactivity. VHF radio-tags also had an activity switch that aided in our documentation of incubation.

VHF and GPS Monitoring

We tracked radio-tagged females 2–3 times weekly with Yagi 3-element antennas prior to the nesting season and then every other day after we detected nesting. We triangulated the location of each turkey with VHF radio-tags from 3 points that generated directional bearings >30° apart within 45 minutes. We entered triangulation data into LOAS software (Ecological Software Solutions, Kevin Sallee, California, USA) to estimate turkey locations. We set GPS radio-tags to collect location data three times daily at 9:00, 15:00, and 23:59 h (roost location); however, during the nesting season, GPS transmitters recorded locations every 2 hours from 7:00 to 18:00 hours in addition to one roost location (23:59 hours) each day. We downloaded data from females with GPS tags biweekly with a LOTEK PinPoint Commander.

Nest Monitoring

Each VHF radio-tag was equipped with an activity sensor that produced a varying signal pulse rate when the female was in motion. We monitored the activity sensor, along with comparing multiple location estimates, to determine when a female began incubating a nest. We documented nesting of GPS-marked females by reviewing downloaded locations on a map each day using ArcGIS Pro (ESRI, Redlands, CA). We assumed a female was incubating when GPS locations

were clustered within a 50-m radius for a 24-hour period and included a roost location. Once we determined a female was incubating (using VHF and GPS hens), we circled the nest within approximately 25 m while monitoring the female with telemetry to document approximate nest location. We monitored nests every other day for the first three weeks of incubation and then monitored them daily until completion or apparent failure. After the nest hatched or failed, we located the nest, counted the number of hatched, unhatched, or destroyed eggs and recorded nest location with a handheld GPS (Garmin Etrex Handheld GPS, Olathe, Kansas).

Motion-sensitive Cameras

Beginning in March 2023, we deployed motion-sensitive cameras (WiseEye, Moultrie, Bushnell, Browning) at turkey trap sites after bait was no longer present to document relative abundance of potential mammalian turkey nest predators and scavengers (armadillo, bobcat, coyote, opossum, raccoon, skunk) at each study site. We added a second camera that was baited with a fatty acid scented predator survey disk in a field >250 m from each trap-site camera to further increase mammalian predator detections (Chamberlain et al. 1999). We set each camera with an unobstructed 5-m view to take one picture when movement was detected with a 30-s delay between photos. We replaced predator scent disks every two weeks.

As monitored hens began incubation, we placed a camera with similar settings as the other cameras 50–100 m from the nest location with a 5-m unobstructed view to document presence of potential turkey nest predators and scavengers near active nests (Ulrey et al. 2022). We chose which nests received cameras based on available access and those that were located early during the incubation process. We left all nest cameras in place for 28 days, regardless of nest fate, and then we removed the cameras and downloaded the camera images.

Land Cover

We quantified land cover composition around each nest by generating a 3,771-m radius buffer (~4,469-ha area) around every nest location using ArcGIS Pro. The buffered area was intended to represent the area of a female's average home range and what she could potentially use during active nesting (laying and incubation stages). We calculated the buffer radius by averaging annual movements from recorded location data points of females from 2018–2021 to determine annual hen home ranges. We then calculated land cover composition within each buffer area by tabulating the area by cover type in ACRGIS Pro Spatial Analyst using U.S. Geological Survey (USGS) National Land Cover Database (NLCD) (U.S. Geological Survey 2024). To ensure spatial accuracy, we explicitly defined the environment settings: we set the snap raster and cell size to match the resolution and alignment of the land cover raster, and we conducted the processing using the WGS 1984 UTM Zone 16N projected coordinate system to maintain consistent projection and units in meters. The output table provided the area (m^2) of each land cover class within each buffer. We calculated the amount of each cover type within the buffer area, represented as a percentage, and graphed this land cover availability with cover types used by hens to nest (Figure 2.2).

DATA ANALYSIS

We recorded all camera events by species, date, and time using a 5-min interval between photos of target predators of the same species. The next event was recorded after the 5-minute interval or if a different target predator species was detected. This method was used to negate double counting individuals while also accounting for the possibility of multiple individuals being present simultaneously. We calculated a species-specific predator index for each nest or landscape camera by tabulating all detections for a given species during the 24-hour (calendar

date) ‘camera-night’ period, summing those detections across camera-nights, and dividing by the total number of camera-nights the camera was deployed. Nest cameras were deployed for a 28-night nest cycle, whereas landscape cameras were deployed for the entire nesting season (April–July; 120 nights). We also calculated a composite predator index by summing detections regardless of species and dividing by the total number of camera nights a given camera was deployed.

We used generalized linear models (GLM) in Program R (Version 4.5.1, R Core Team 2025) to compare predator indices by species, year, county group, and by cover type. The species-specific and composite predator indices were used univariately and in combination to model the relationship with turkey daily nest survival in Program R (Version 4.5.1, R Core Team 2025) with the program RMark nest survival module (Laake 2013). We modeled nest fate with logistic regression in Program R with nest fate as the response variable (failure = 1, success = 0) and predator indices univariately and in combination as predictor variables. For both daily nest survival and nest fate, we used Akaike’s Information Criterion corrected for small sample sizes (AICc) for model selection. Models with ΔAICc score < 2.0 and beta coefficient 85% confidence intervals that did not overlap 0 (Arnold 2010) were considered supported; all other models received no further interpretation.

RESULTS

We monitored 74 camera-trap sites (34 active nest sites, 40 landscape sites) with 4,837 24-h camera-trap periods monitored in 2023–2024. We recorded 1,529 photo events of nest predator or scavenger species; raccoon (n = 429 detections) and nine-banded armadillo (n = 419 detections) were most prevalent. Baited cameras (30.3 detections/100 camera nights) captured more target predator species than un-baited cameras (17.0/100 camera nights).

We used all nest and landscape cameras (n = 74) to produce a global estimate of relative abundance by predator species. The global composite predator index was greater in 2023 than in 2024 (0.34/24-hour period vs 0.11/24-hour period; P = 0.021). The predator index was greater in the two northern counties (Bedford, Maury, Mean = 0.246) than in the southern counties (Giles, Lawrence, Wayne, P = 0.065, M = 0.219 ± 0.06 SE). In general, Giles and Wayne counties had lower predator indices than those in Bedford, Lawrence, and Maury counties (P < 0.05, Table 2.1). Nest cameras had lower detection rates (M = 0.224 ± 0.07 SE) than landscape cameras (M = 0.237 ± 0.06 SE). Average predator indices for all camera types pooled by species were raccoon (0.089 detections/24-hr period), armadillo (0.087/24-hr period), coyote (0.032/24-hr period), opossum (0.014/24-hr period), bobcat (0.007/24-hr period), and skunk (0.003/24-hr period; Table 2.2).

We monitored 71 nests in 2023 (21 successful, 50 failed) and 21 nests in 2024 (6 successful, 15 failed). Crude nest success for the duration of the project was 29.4% (n = 92, SE = 0.047), whereas nest success extrapolated from average daily nest survival was 31.5% (SE = 0.012). Of the nests that failed (n = 65), 75.4% were depredated, 15.4% were abandoned, and 9.2% failed from unknown cause. Of the successful nests, 83.3% were in mature deciduous or coniferous forest, 5.5% were in young forest, and 11.1% in pasture/hayfields (Figure 2.2).

Of the nests with cameras, we detected predators near all of the 28 unsuccessful nests, whereas we detected no predators near all 6 of the successful nests (Figure 2.3). Armadillo detections at nest cameras (PI = 0.121; nest cameras) were greater than all other species across both years and all counties (Table 2.2). Predator indices for the other species did not differ (P > 0.10) in pairwise comparisons (Table 2.2).

The best-supported model relating the predator indices to nest fate (success/fail) contained the "all combined" (β = 1.99, 85% CI: 0.35 to 3.62) covariate with 22% of the model weight (Table 2.3). The beta coefficient for the "all combined" model showed a positive relationship with nest failure (Figure 2.4), and the 85% confidence interval did not overlap 0. Individual species models (bobcat and racoon) did have support (ΔAICc < 2.0), with model beta coefficients positively related to nest failure and 85% confidence intervals that did not overlap 0.

The best-supported model relating daily nest survival to various predator indices contained the coyote covariate with an AICc weight of 0.25 (Table 2.4). An additive model including bobcat and coyote predator indices also had considerable support with an AICc weight of 0.22. Bobcat (AICc weight of 0.11) and skunk (AICc weight of 0.08) single-species models had less support, with beta coefficient confidence intervals not overlapping 0. The coyote covariate was negatively related to daily nest survival (β = -9.67, 85% CI: -17.84 to -1.49), indicating there was greater coyote presence at sites with greater nest failure. Similarly, the bobcat single-species model (β = -17.21, 85% CI: -31.19 to -3.23) and the skunk single-species model (β = -28.80, 85% CI: -53.47 to -4.12) beta coefficients showed a negative relationship with nest survival. The single-species models with raccoon, opossum, and armadillo, and all nest predators combined received no support. In addition, the model which included land cover type did not have any support when compared to models that included individual nest predators, suggesting that the land cover type the nest occurred in (mature forest, young forest, field, or other) was not a good predictor of daily nest survival (Table 2.4).

DISCUSSION

We documented meso-mammalian nest predator relative abundance and related species-specific predator indices to wild turkey nest fate and daily nest survival in five counties in south-

central Tennessee to better inform wild turkey management and address apparent population declines. We identified a diverse and abundant meso-mammalian predator community that was associated with depredated nests and nesting female mortality. Although we identified some species-specific nest-predator relationships with both nest fate and daily nest survival models, our results indicated the entire meso-mammalian predator community is likely contributing to the relatively poor nest success that we documented. The mammalian predator community on our study sites was dominated by a diversity of known wild turkey nest predators, including raccoons, armadillos, coyotes, opossums, bobcats, and skunks. The 'all-combined' nest fate model had the most support, accounting for 22% of the AICc model weight, suggesting that all of the above-listed species were contributing to nest failure, but not necessarily equally. We did not detect a difference between predator detections at nests compared to the surrounding landscape, which did not align with our hypothesis. However, we did not detect any predators near successful nests, indicating successful females were able to locate areas with lower predator abundance, which did align with our prediction.

Coyote detections were less abundant near nests and at the landscape scale than raccoon or armadillo detections, but coyote detections were more strongly related to daily nest survival than any other species or all species combined. Modeling daily nest survival provides a different representation of how predator detections are related to nest success because daily nest survival analyses account for how long a given nest was exposed to potential predation for up to 28 days (Dinsmore et al. 2002). For that reason, our daily nest survival model detected the relationship between coyotes and nest survival, even though coyote relative abundance was relatively low compared to raccoons or armadillos, whereas nest fate analysis did not detect a relationship with coyotes. Coyote populations are far more abundant and expansive than they were 45 years ago

when wild turkey restocking began in Tennessee (Ray 2000, Dodge and Kashian 2013, Hody and Kays 2018). Nielson et al. (2018) suggested coyotes may benefit turkey nest success by suppressing meso-mammalian turkey-nest predators. However, our results support the more direct interpretation: in areas of greater coyote activity, wild turkey nest survival decreases. In addition, coyotes also directly prey on nesting turkeys and may flush females off nests, leading to nest abandonment and failure (Martin et al. 2015). Nest incubation rates, nest success, and recruitment were much lower during our study than 40 years ago (McGuiness and Smith 1990, Johnson et al. 2022).

The disproportionate support of the bobcat nest fate model (19% of model weight), given their relative scarcity on the landscape, suggests bobcats are individually playing an important role in nest fate and in daily nest survival as well. The role of bobcats may be especially important because bobcats can kill the female, flush her off the nest and depredate the eggs, or flush her off the nest and leave eggs vulnerable to depredation by other species. The prominence of raccoons across the landscape, in contrast, was not as strongly associated with nest fate (9% AICc model weight), counter to previous work that identified raccoons as major contributors to nest failure (Schemnitz et al. 1985, Wertz and Flake 1988, Palmer et al. 1993, Hughes et al. 2005, Lehmen et al. 2008). Given the great relative abundance of raccoons on our study sites, we agree with Byrne and Chamberlain (2015) that raccoon depredation of turkey nests likely was incidental. A reduction in raccoon hunting and trapping as well as the immense amount of feed that is placed on the landscape are contributors to burgeoning raccoon populations (Cooper and Ginnett 2000, Campbell et al. 2013).

Armadillo populations have exploded in Tennessee since expanding their range northward in the 1990s (Taulman and Robbins 2014, DeGregorio and Deshwal 2025). Although

armadillos were detected most frequently near nests and were present within 100 m of >50% of failed nests, they were not associated with nest fate or daily nest survival in regression models as were bobcats or coyotes. Armadillos were an important nest predator of northern bobwhite in Florida (Staller et al. 2005), but they likely were only scavenging turkey nests and not actually moving the female off the nest (Martin et al. 2015). Armadillos can be secondary nest predators after the initial depredation by another predator (McInnis et al. 2025). Although not documented, armadillos may be reducing turkey nest success by eating eggs during the laying phase when nests are not attended by the female, given their ubiquitous occurrence across our study sites.

It is important to note that our approach did not directly document which predator was responsible for nest failure at a given nest, but rather we documented which nest predators were detected near (50–100 m) an active nest. Given the tendency of nesting females to abandon when flushed by humans during incubation (Martin et al. 2015), researchers are limited to less intrusive methods, such as the use of cameras as we did in this study. Given the limitations of our approach, we still were able to demonstrate that bobcats and coyotes, as well as the overall predator community, were significantly related to nest fate and daily nest survival. In addition, it was noteworthy that none of the successful nests (n = 6) recorded any nest predator detections for the 28-day period, suggesting that our method of placing cameras near nests was successful at least at a course scale at measuring predation risk. A manipulative experiment involving predator removal with un-trapped controls could provide additional evidence of the cause-and-effect nature of these predator-prey relationships.

We demonstrated that nest survival was more strongly related to predator abundance than the landcover type that a given nest occurred in. Wild turkeys nested in a wide variety of vegetation types. Johnson et al. (2022) reported that turkeys selected early successional

vegetation communities for nesting where available in south-central Tennessee, and the structure of cover at the nest site was related to nest success. However, nest success was relatively low regardless of vegetation type or structure around the nest. We maintain that suitable nesting cover, including early successional plant communities and forests/woodlands with a well-developed understory, should be provided throughout a given property managed for turkeys. However, low fecundity rates and high relative abundance of predators suggest some level of predator management may be necessary to improve wild turkey vital rates where vital rates are relatively low and turkey populations are declining.

MANAGEMENT IMPLICATIONS

Our study highlights the relative abundance of turkey nest predators on the landscape and in proximity of actual wild turkey nest sites in south-central Tennessee. Poor nest success and recruitment, in addition to relatively low adult female survival, are primary reasons for declining turkey populations in portions of the eastern US (Byrne et al. 2016, Londe et al. 2023). Our results indicate bobcats and coyotes are strongly linked to wild turkey nest fate and daily nest survival, but all species combined had the strongest impact on nest fate. Certainly, promoting high-quality nesting and brood-rearing cover is important (Peoples et al. 1995, Johnson et al. 2022, Keever et al. 2023, Buehler and Harper 2024). However, given the increase in predator populations over the past 40 years, it is likely that some level of predator management will be necessary to reverse turkey population declines in some areas. A predator management approach should be predator species and season specific. Management just prior to the nesting season logically would be well-timed to promote increased nest success most effectively. Such an approach has been effective in increasing northern bobwhite nest success (Jackson et al. 2018, Palmer et al. 2019). We encourage public and private landowners and managers to deploy remote

cameras using our methods to generate species-specific predator index estimates (species detections per camera night). Such estimates are valuable for comparison with our results, especially as it relates to predicting nest fate for given levels of specific nest predator indices (Figures 2.4–2.8). Experimental predator removal studies are needed to gauge the effectiveness of such a management approach given a specific level of target predator population reduction.

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APPENDIX

Table 2.1: Overall comparison of wild turkey total nest predator relative abundances by year, county, northern (Bedford and Maury) vs southern (Giles, Lawrence, Wayne) counties, and Camera Type from landscape and nest cameras (n = 74). Pairwise comparisons with different letters (i.e., a, b) differed (P < 0.10).

Comparison	Mean	Lower 90% CI	Upper 90% CI	SE	Pairwise test
Year					
2023	0.3405	0.2460	0.435	0.0567	a
2024	0.0952	-0.0101	0.201	0.0632	b
County					
Giles	0.160	-0.0118	0.332	0.1030	a
Wayne	0.177	-0.0107	0.343	0.0997	a
Bedford	0.209	0.0432	0.376	0.0997	a
Lawrence	0.277	0.1251	0.429	0.0910	a
Maury	0.340	0.1540	0.526	0.1110	a
County groups					
South	0.219	0.119	0.319	0.0599	a
North	0.246	0.135	0.357	0.0667	a
Camera Type					
Nest	0.224	0.114	0.333	0.0658	a
Landscape	0.237	0.136	0.338	0.0606	a

Table 2.2: Mean (+SE) Predator Index (detections per 24-h period) by species and camera location during the wild turkey nesting season (1 April–30 June 2023–2024) in south-central Tennessee. Nest cameras were located 50–100 m from active nests. Unbaited landscape cameras were located on field edges near traditional trap sites and baited (scent tabs) landscape cameras were on field edges >250 m from traditional trap sites.

	Species						
Camera type	Armadillo	Bobcat	Coyote	Opossum	Raccoon	Skunk	Combined
Landscape	0.078 (±0.027)	0.007 (±0.002)	0.035 (±0.007)	0.010 (±0.003)	0.104 (±0.036)	0.003 (±0.001)	0.237 (±0.067)
Nest	0.100 (±0.093)	0.008 (±0.005)	0.019 (±0.006)	0.023 (±0.021)	0.030 (±0.014)	0.002 (±0.002)	0.181 (±0.140)
All cameras	0.081 (±0.023)	0.007 (±0.003)	0.033 (±0.008)	0.012 (±0.004)	0.092 (±0.035)	0.003 (±0.001)	0.227 (0.058)

Table 2.3: AICc general linear model selection results relating wild turkey nest predator indices to turkey nest fate (failure = 1, success = 0; n = 92 nests) in south-central Tennessee 2023–2024. Beta estimates with 85% confidence intervals that do not include 0 are considered significant.

Model	AICc	ΔAICc	AICc weight	Term	Beta estimate	Standard error	Lower 85% CI	Upper 85% CI
All combined	111.36	0.00	0.22	All combined	1.99	1.14	0.35	3.62
Bobcat	111.71	0.34	0.19	Bobcat	37.25	21.13	6.84	67.67
Skunk	113.08	1.71	0.09	Skunk	120.17	90.79	-10.53	250.86
Raccoon	113.08	1.72	0.09	Raccoon	8.00	5.55	0.01	16.00
Adult Predators (Bobcat +Coyote)	113.20	1.83	0.09	Bobcat	32.72	20.93	2.60	62.85
				Coyote	5.40	7.07	-4.77	15.57
Raccoon + Coyote	113.27	1.90	0.09	Raccoon	8.76	6.83	-1.07	18.58
				Coyote	8.69	5.58	0.66	16.73
Null	113.41	2.04	0.08	Null	NA	NA	NA	NA
Coyote	113.98	2.62	0.06	Coyote	8.03	7.13	-2.23	18.29
Armadillo	114.62	3.26	0.04	Armadillo	0.78	0.85	-0.45	2.01
Opossum	115.47	4.10	0.03	Opossum	0.43	2.31	-2.90	3.75
Nest Predators (Armadillo + Opossum + Raccoon + Skunk)	116.75	5.38	0.02	Armadillo	2.56	2.01	-0.34	5.46
				Opossum	-6.98	5.65	-15.11	1.15
				Raccoon	9.86	6.91	-0.08	19.80
				Skunk	8.38	116.43	-159.23	175.99

Table 2.4: AICc model selection results relating wild turkey nest predator indices to daily nest survival (n = 34 nests) in south-central Tennessee 2023–2024. Beta estimates with 85% confidence intervals that do not include 0 are considered significant.

Model	AICc	ΔAICc	AICc Weight	Term	Beta estimate	SE	Lower 85% CI	Upper 85% CI
Coyote	132.10	0.00	0.25	Coyote	-9.67	4.17	-15.67	-3.66
Adult Predators (Bobcat + Coyote)	132.39	0.29	0.22	Bobcat	-13.78	9.88	-28.00	0.45
				Coyote	-8.66	4.32	-14.89	-2.44
Bobcat	133.68	1.58	0.11	Bobcat	-17.21	9.71	-31.19	-3.23
Skunk	134.35	2.25	0.08	Skunk	-28.80	17.13	-53.47	-4.12
Null	134.38	2.28	0.08	Null	2.91	0.20	2.62	3.19
All combined	134.86	2.76	0.06	All combined	-0.63	0.49	-1.34	0.07
Year	135.92	3.82	0.04	Year	0.28	0.41	-0.31	0.86
County	136.40	4.30	0.03	County	0.02	0.39	-0.54	0.58
Raccoon	136.07	3.97	0.03	Raccoon	-1.42	2.40	-4.89	2.04
Opossum	136.20	4.10	0.03	Opossum	-1.03	2.22	-4.23	2.16
Armadillo	136.37	3.27	0.05	Armadillo	-0.75	0.71	-1.77	0.27
Nest Predators (Armadillo + Opossum + Raccoon + Skunk)	139.23	7.13	0.01	Armadillo	-0.88	1.01	-2.85	1.09
				Opossum	0.41	2.78	-5.05	5.87
				Raccoon	0.00	2.96	-5.80	5.80
				Skunk	-30.41	17.24	-64.20	3.37
Cover type	140.02	7.92	0.00	Cover	0.06	0.41	-0.54	0.65

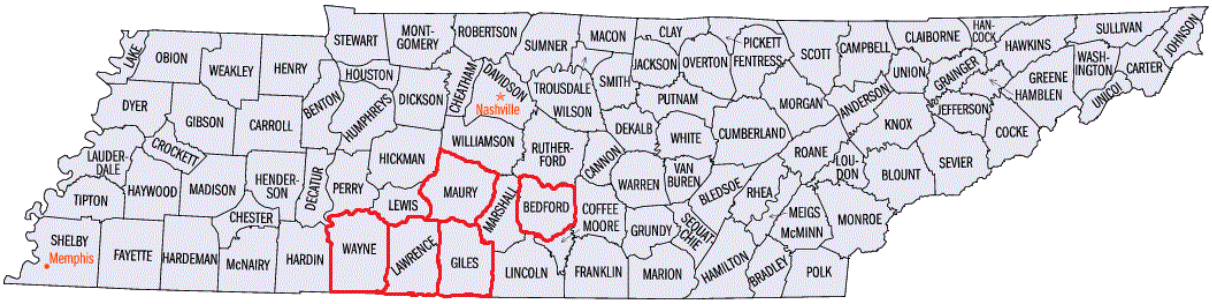

Figure 2.1: Counties in south-central Tennessee (outlined in red) involved in the wild turkey study, 2023–2024.

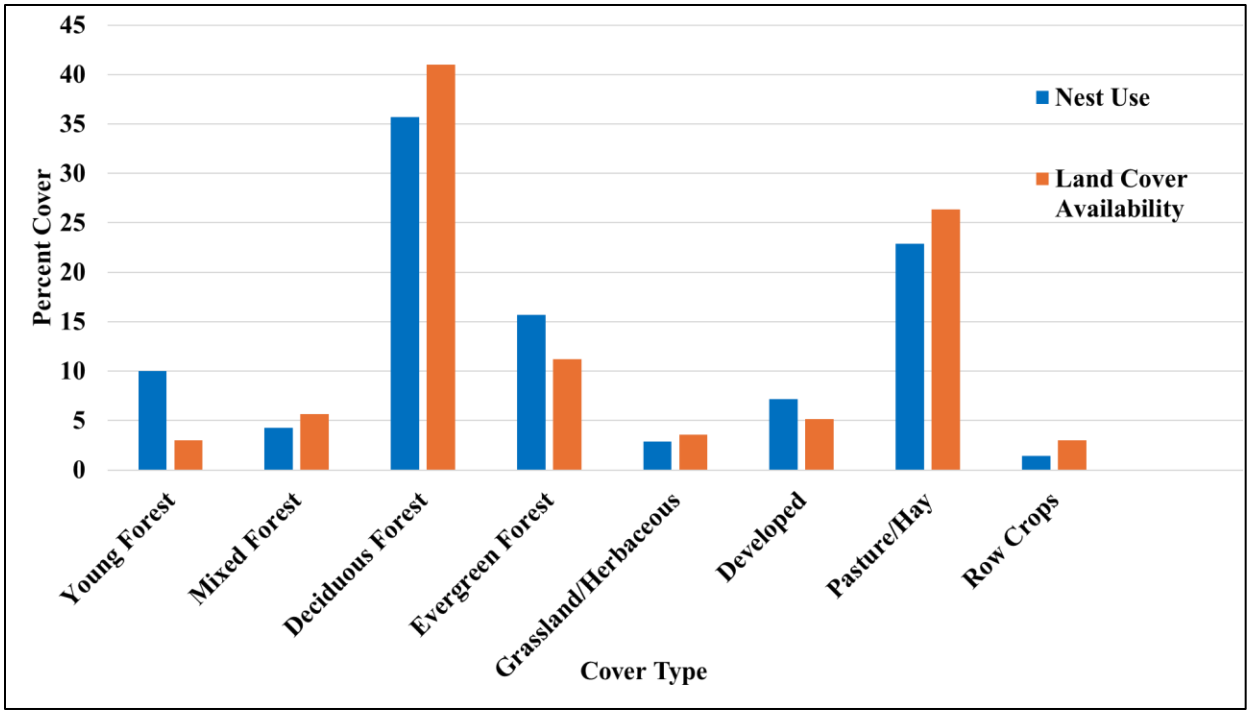

Figure 2.2: Occurrence of wild turkey nests by cover type and percent cover type available in five southern-central Tennessee counties, 2023–2024.

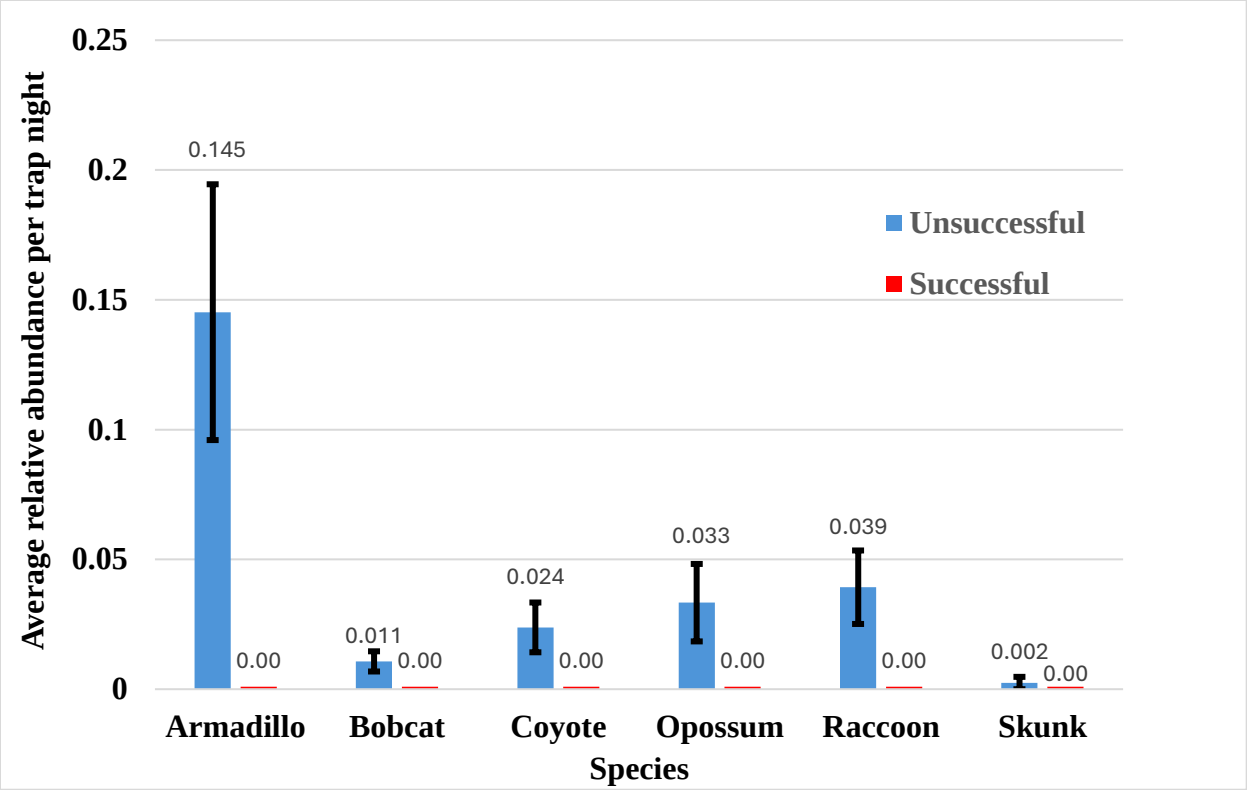

Figure 2.3: Wild turkey nest predator detections by species per camera night at unsuccessful (n = 28; light blue) and successful (n = 6, red) nests (n = 34) in five counties in south-central Tennessee, 2023–2024. Note that no nest predators were detected within 50–100 m of successful nests.

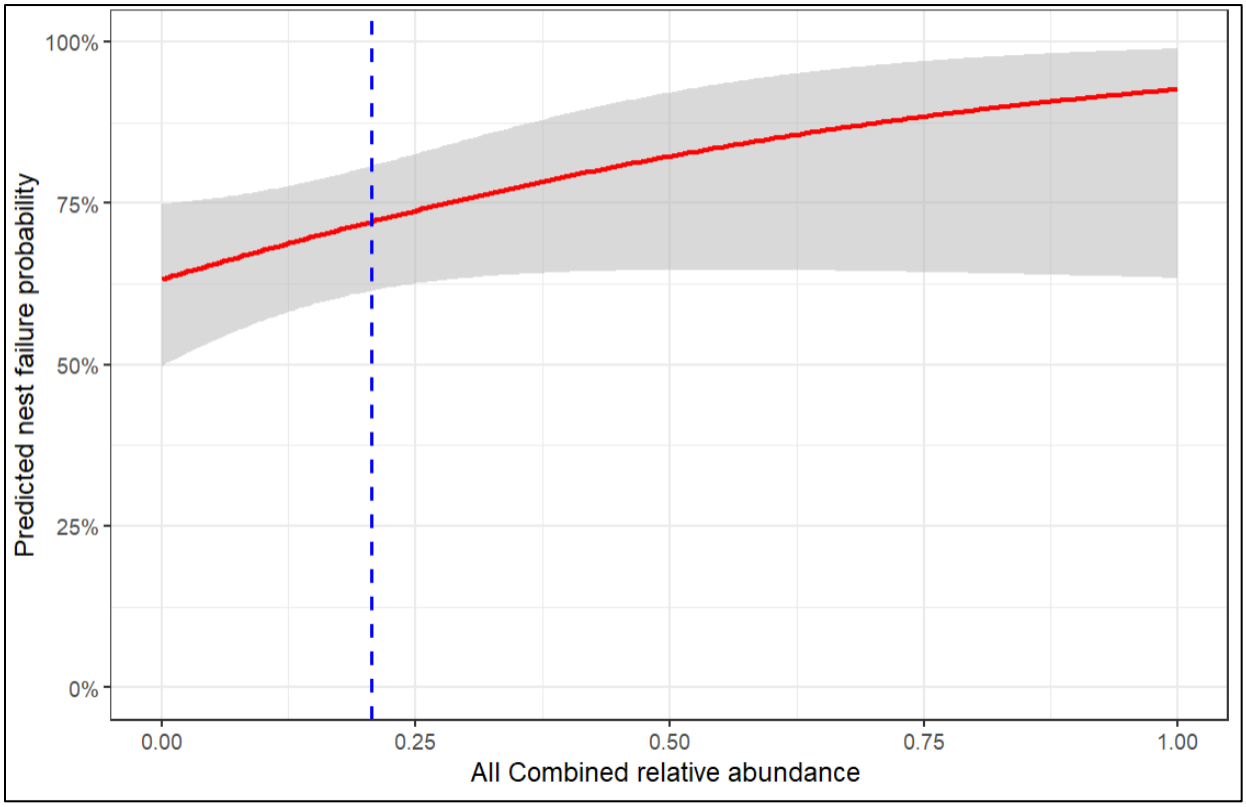

Figure 2.4: All combined relative abundance (detections per camera night) in red with 95% confidence intervals (gray) related to the predicted wild turkey nest failure probability. Mean combo relative abundance from the study sites is displayed (blue) to show average all combined relative abundance from camera data.

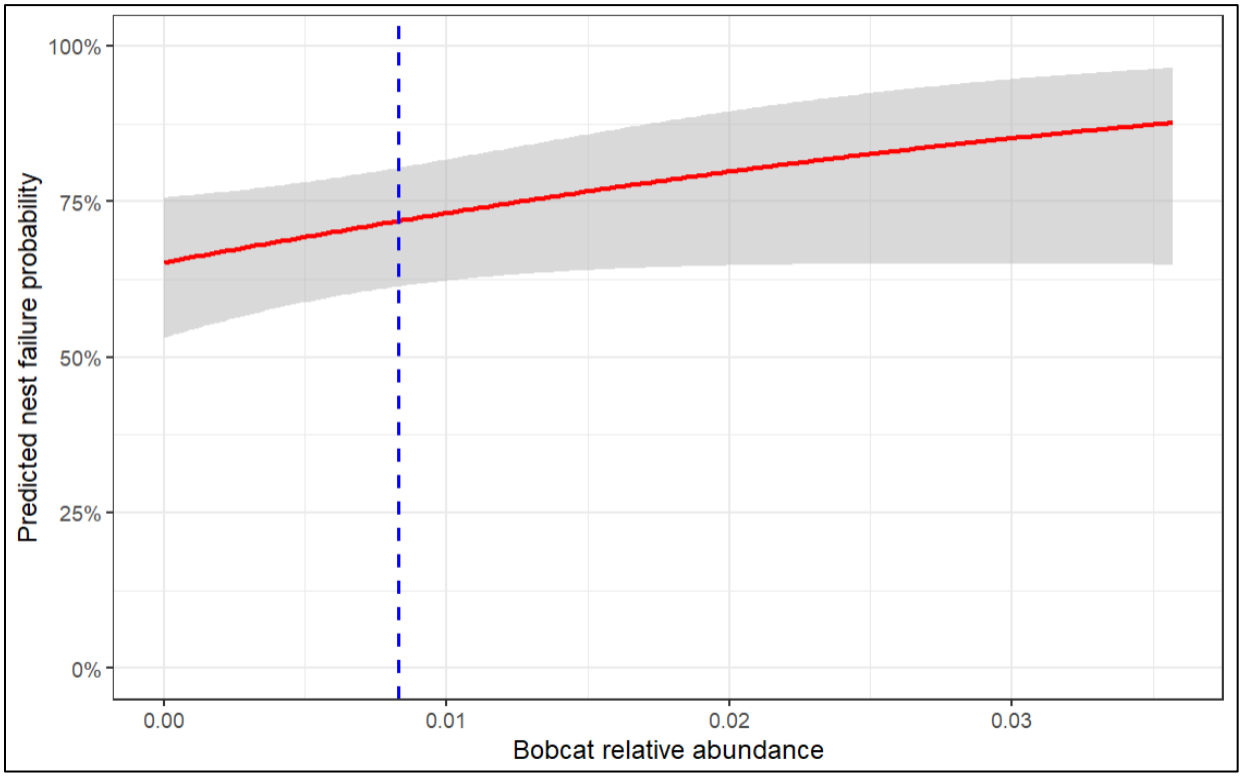

Figure 2.5: Bobcat relative abundance (detections per camera night) in red with 95% confidence intervals (gray) related to the predicted wild turkey nest failure probability. Mean bobcat relative abundance from the study sites is displayed (blue) to show average bobcat relative abundance from camera data.

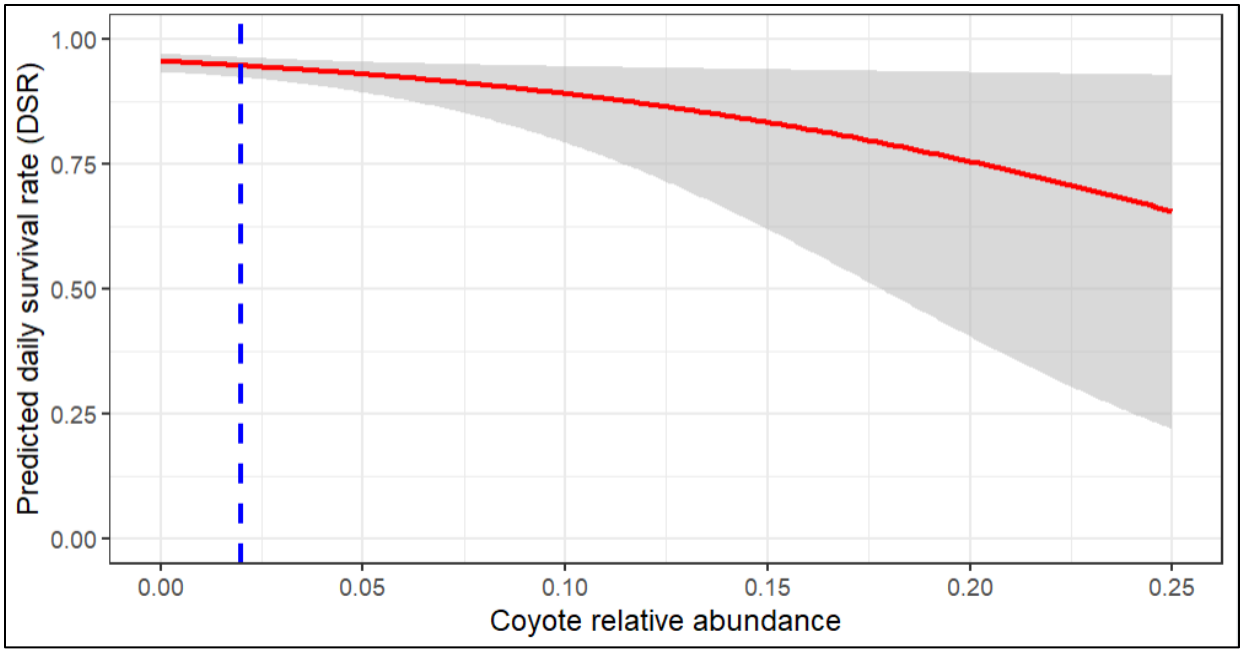

Figure 2.6: Coyote relative abundance (detections per camera night) in red with 95% confidence intervals (gray) related to the predicted wild turkey daily nest survival. Mean coyote relative abundance from the study sites is displayed (blue) to show average coyote relative abundance from camera data.

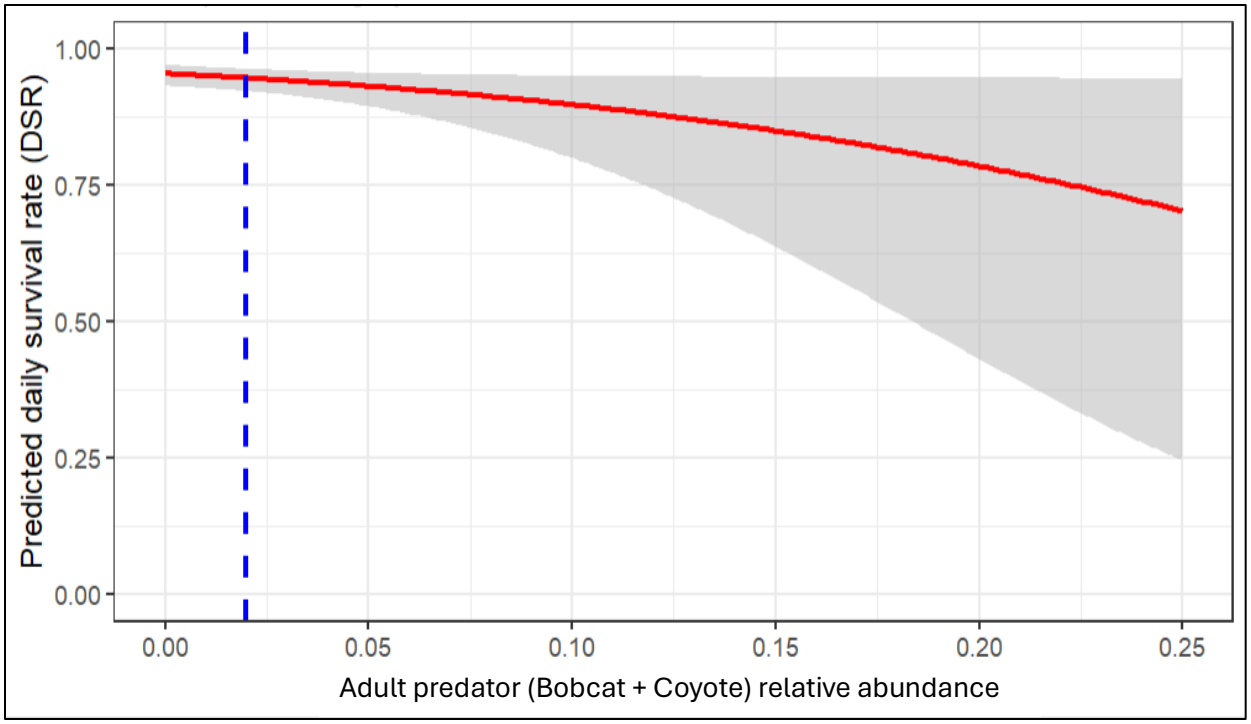

Figure 2.7: Adult predator (Bobcat + Coyote) relative abundance (detections per camera night) in red with 95% confidence intervals (gray) related to the predicted wild turkey daily nest survival. Mean adult predator relative abundance from the study sites is displayed (blue) to show average adult predator relative abundance from camera data.

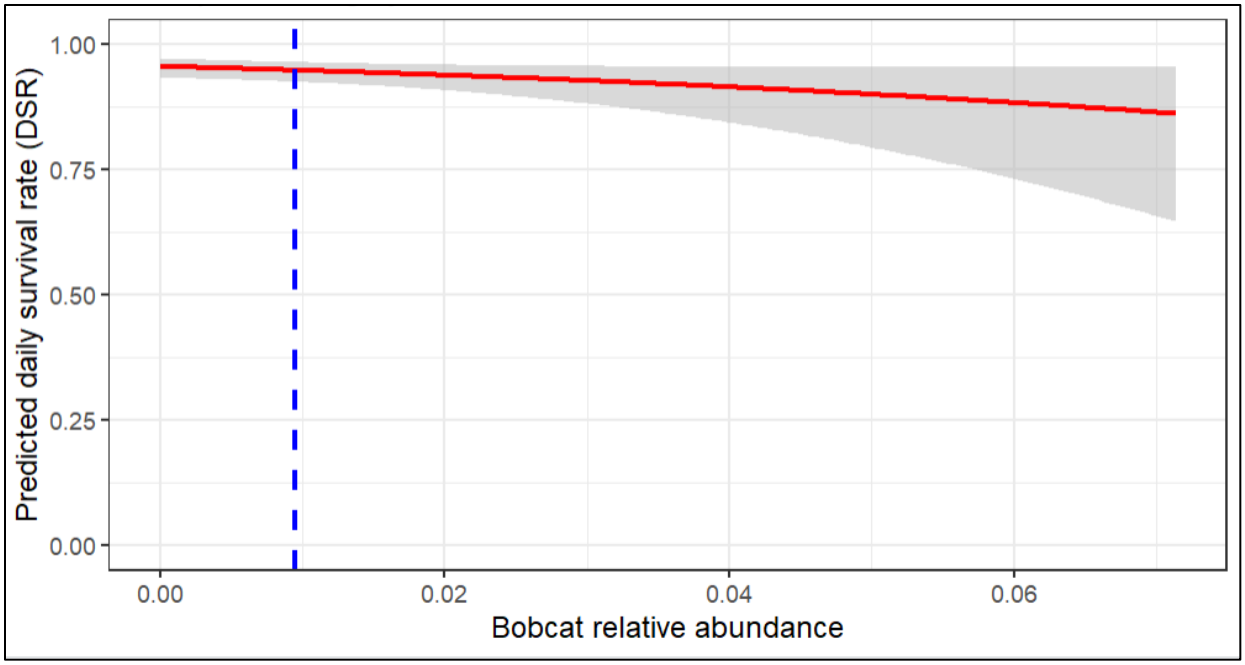

Figure 2.8: Bobcat relative abundance (detections per camera night) in red with 95% confidence intervals (gray) related to the predicted wild turkey daily nest survival. Mean bobcat relative abundance from the study sites is displayed (blue) to show average bobcat relative abundance from camera data.

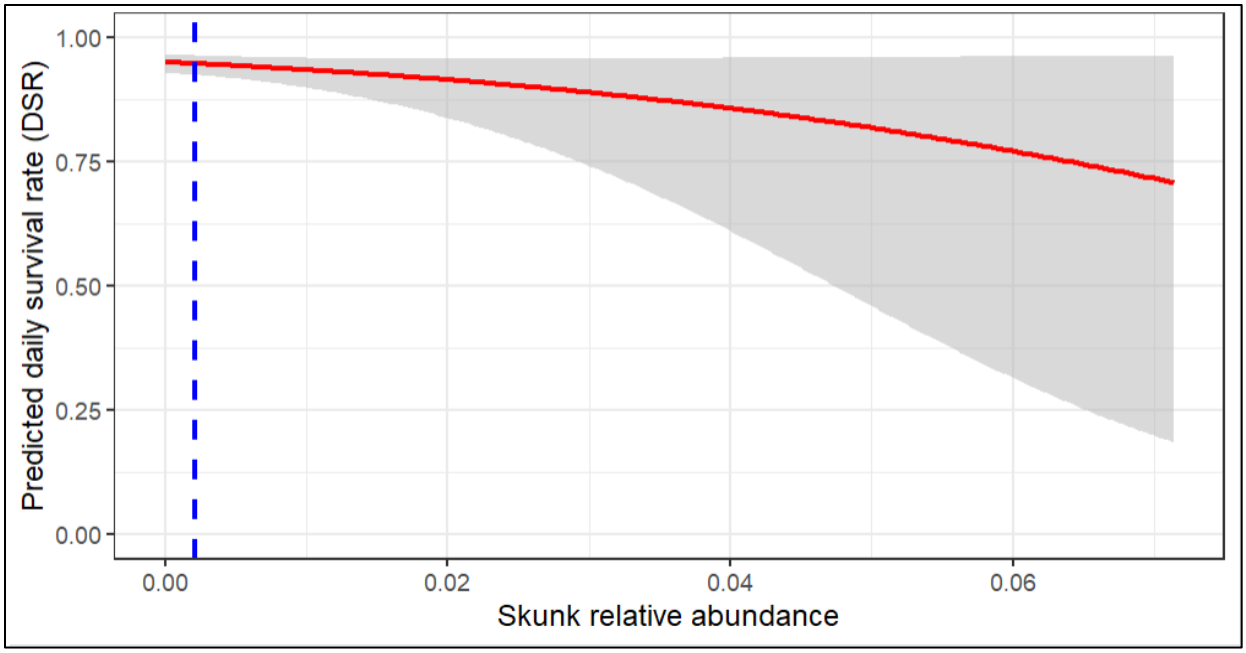

Figure 2.9: Skunk relative abundance (detections per camera night) in red with 95% confidence intervals (gray) related to the predicted wild turkey daily nest survival. Mean skunk relative abundance from the study sites is displayed (blue) to show average skunk relative abundance from camera data.

CHAPTER THREE: WILD TURKEY (*MELEAGRIS GALLOPAVO*) BROOD RESOURCE-SELECTION AND POULT SURVIVAL IN SOUTH-MIDDLE TENNESSEE

ABSTRACT Wild turkey (*Meleagris gallopavo*) populations have experienced poor recruitment in the southeastern United States as evidenced by the decline of poult-per-adult female ratios. A lack of habitat that provides broods with optimal structure for cover from predators and an adequate food source may be a contributing factor in the decline. We investigated the linkage between brood resource selection and poult survival by trapping and radio-tagging female wild turkeys and locating and monitoring their nesting activity via radio-telemetry. We trapped and sutured radio-tags to poults 1–5 days post-hatching. We located broods (n = 58) with radio-tagged poults (n = 262) until 28 days post-hatch, 2018–2023. We measured vegetation characteristics at each brood location (n = 425) and at an associated random point in five study counties in south-central Tennessee (Bedford, Giles, Lawrence, Maury, and Wayne). We conducted a matched-case resource-selection analysis to determine the strongest relationships between our vegetation covariates and selection by females with poults. Females with poults exhibited strong selection for a greater percentage of forb cover and greater visual obstruction in the 51–100 cm strata and avoided areas with relatively dense midstory stems compared to vegetation structure available at random points. Resource-selection model performance improved from AICc = 483.76 to AICc = 466.76 for the top model when we added a point-type factor (field, edge, forest) to the model suite. Two-day interval poult survival during the 14 two-day intervals (28 days) averaged 0.918 (± 0.021 SE) and differed among three time periods post-hatch: intervals 1–4 (days 1–8; 0.942 ± 0.023 SE), intervals 5–7 (days 9–14; 0.811 ± 0.064 SE) and intervals 8–14 (days 15–28; 0.967 ± 0.033 SE). Poult survival for the entire 28-day period was 29.7%. Poult survival increased with increasing tree basal area 9–14 and 15–28 days post-hatch, corresponding to when poults began to tree roost. Landcover composition surrounding the nest was related to poult survival during the first 4 days post-hatch. Increasing mature forest was

negatively related to poult survival, whereas increasing pasture/hay was positively related to poult survival. A lack of understory cover for broods in mature forests and improved visibility around pasture/hay for brooding females likely affected survival of young poults. The selection of edge between forests and openings indicated that the structure of groundcover was either too dense for mobility or did not provide overhead cover in the interior of the adjacent vegetation types. Our data indicated that relatively poor brood survival was likely a contributing factor to the declining wild turkey population in south-central Tennessee. Provision of quality brood habitat, with suitable levels of forb cover, visual obstruction, and woody stem densities, well distributed across a given management area, should be a management priority. Predator management also may be required to address unsustainable levels of predation to reverse population declines.

INTRODUCTION

Wild turkey (*Meleagris gallopavo*) populations have been declining in Tennessee since 2013 (Ziolkowski et al. 2023) and habitat availability and survival of broods may be important factors linked to the population decline (Byrne et al. 2015, Londe et al. 2023, Buehler and Harper 2024). Although females may have several attempts at producing a successful nest through renesting (Williams et al. 1978, Reagan and Morgan 1980, Porter et al. 1983, Vangilder et al. 1987, Keegan 1993), females typically have only one chance to raise a successful brood. All previous stages of the reproduction cycle, from mate selection, to breeding, to nest-site selection, laying, incubation, and hatching become dependent on brood survival (Ritchison 2023). Thus, successful brood-rearing becomes perhaps the most critical step in the reproduction and recruitment process. In theory, females that successfully hatch a brood should select specific vegetation characteristics that may promote survival of their broods (Wood et al. 2018). Successful brood-

rearing should set the stage for recruitment into the fall population and ultimately, recruitment into the breeding population the following spring.

The linkage between resource selection and survival of wild turkey broods has been demonstrated in several studies, but few contemporary studies since 2010 with declining turkey populations have been published. Because mammalian and avian poult predator populations have increased dramatically since 2000 in the Southeast (Sargeant et al. 1993, Woolf and Hubert 1998, Carroll et al. 2007), resource selection-survival relationships that were documented prior to 2000 may have changed. In pre-2000 studies, females with broods selected old-fields and forested sites where greater understory woody cover and plant diversity were positively linked to brood survival (Pack 1980, Metzler and Speake 1985, Campo et al. 1989, Peoples et al. 1996, Hubbard 2000). In contemporary studies, there is increasing evidence that young forest may serve as an ecological trap for turkey nesting and perhaps for broods also (Flaspohler et al. 2001, Schlaepfer et al. 2002). Female turkeys may select these areas for brooding but young forest cover may serve as refugia for predators (Baum 2024).

Poult survival is impacted by many factors, with survival generally lowest during the first 2 weeks post-hatching before poults can fly (Hurst et al. 1996, Roberts and Porter 1998, Rolley et al. 1998, Spears et al. 2007). Given that mammalian predator populations are increasing (Sargeant et al. 1993, Woolf and Hubert 1998) and predation is the primary source of brood mortality (Hubbard et al. 1999, Hughes et al. 2005), females with broods may change behaviors in response to the increased predation risk (Abrams 1984, Proffitt et al. 2009, Campbell et al. 2012, Chamberlain 2020). Broods have been documented to select early successional vegetation with an open structure at ground level that allows mobility and supports abundant invertebrates for food (Storch 1994, Peoples at al. 1996, Aldridge and Boyce 2007, Chamberlain

2020). However, brooding females may select against fields with dense vegetation and thatch at ground level that precludes movement by the brood (Martin et al. 2015), as well as fields with tall, rank vegetation that limits visibility of the female. Understanding the vegetation composition and structure currently selected by females with broods in a declining population is crucial for developing habitat management strategies that maximize resource use linked to survival (Healy 1985, Hubbard et al. 1999, Spears et al. 2007, Backs and Bledsoe 2011, Nelson et al. 2023).

Historically, estimates of poult survival have been fairly low, with past reports of 60–80% poult mortality within 4 weeks (Everett et al. 1980, Speake 1980, Speake et al. 1985, Vangilder et al. 1987, Vander Haegan et al. 1988). More recently, poult mortality has been reported in some studies to be greater than historic estimates (82–100%) for radio-marked and observed poults (De Filippo 2024, Quehl et al. 2024, Butler et al. 2025). Poult survival traditionally has been monitored either by conducting brood flush counts for radio-tagged females (Glidden and Austin 1975, Vander Haegen et al. 1988, Hubbard et al. 1999, Shields and Flake 2006) or in a more limited number of studies by directly monitoring fate of radio-tagged poults (Hubbard 1999, Quehl et al. 2025). Quehl et al. (2025) demonstrated that survival estimates for a 28-d period were comparable regardless of monitoring method.

We monitored poults and sampled vegetation at brood locations to develop a contemporary relationship between wild turkey resource selection and brood survival. Our primary objective was to assess the brood locations and determine what specific vegetation characteristics were important for brood selection and to test the hypothesis that selection also was linked positively with brood survival. We hypothesized that vegetation composition and structure would affect selection by brooding females. We predicted brooding females would

show stronger selection for areas with greater forb coverage, because forbs are known to provide both invertebrates for food and cover from predators, and areas with relatively open structure at ground level, allowing poult mobility, and vegetation that did not limit visibility of the brooding female. We further predicted selection for the edge of forests and fields because a majority of the old-fields across our study sites contained dense, rank, tall vegetation, and forests typically did not have an understory dominated with herbaceous plants that would provide good cover or food for broods. We also hypothesized that brood survival would be affected by vegetation structure. We predicted survival would be greater where more open vegetation types, such as pasture and hayfield, were available, providing relatively low cover for broods and allowing visibility by the brooding female. Our ultimate goal was to provide a description of ideal brood vegetation structure that landowners/managers could target to promote successful brood survival on their properties to sustain or increase turkey populations.

STUDY AREA

We conducted the study in five counties in south-central Tennessee: Bedford, Giles, Lawrence, Maury, and Wayne, from 2018–2023, with two individual trap sites located in the northern and southern part of each county (Figure 3.1). We monitored turkeys on more than 400 private properties and two public wildlife management areas (Yanahli and Tie Camp), totaling more than 30,000 ha of public and private land. Yanahli WMA was owned and managed by TWRA and comprised 5,179 ha in Maury County. The landscape at Yanahli consisted primarily of mature forest (deciduous, evergreen, mixed), pasture/hay, and cultivated crops (U.S. Geological Survey 2024). TWRA managed Yanahli primarily for white-tailed deer (*Odocoileus virginianus*), wild turkey, and northern bobwhite (*Colinus virginianus*). Bascom Southern Timber Company owned Tie Camp WMA, a 1,325-ha WMA in Wayne County. Tie Camp

consisted primarily of mature deciduous, evergreen, young forest, and grassland/herbaceous cover types (U.S. Geological Survey 2024). Tie Camp WMA and the surrounding land were managed by Bascom Southern Timber Company primarily for timber production. The landscape across the 5-county region varied but was typified by mature deciduous, mixed, and coniferous forest, pasture/hay fields, row crops, and human-developed cover types. Average annual rainfall across the study area was approximately 146 cm and average annual high and low temperatures were 21.22°C and 8°C (U.S Climate Data 2024). The predominant soil types included Bodine cherty silt loam and gravelly silt, Gladeville rock outcrop, Ashwood, Brandon silt loam, Biffle gravelly silt loam, and Frankstone cherty silt loam (United States Department of Agriculture [USDA] 2024).

METHODS

Trapping and Tagging

We baited trap sites with cracked and whole-kernel corn and monitored turkey visitation of trap sites with trail cameras, January–March 2016–2023. We captured turkeys via rocket nets (Delahunt et al. 2011) with a goal of maintaining 10–12 radio-tagged female turkeys in the area surrounding each trap site (n = 100–120 total females with radio-tags each year). We captured additional females, 2017–2023, as needed to maintain 10–12 radio-tagged females per site.

We banded female turkeys with a uniquely numbered aluminum band (National Band and Tag Company: style 1242FR8A, Newport, Kentucky, USA) and attached a VHF (Advanced Telemetry Systems: Series A1500, Isanti, Minnesota, USA) or GPS (Lotek: GPS PinPoint, Wareham, United Kingdom) transmitter via backpack harness (Guthrie 2011). We recorded age (adult/juvenile), weight (g), tarsus length (cm), beard length (cm, if applicable), and body condition score (Robins 1998). We released all females at the capture site following processing

(University of Tennessee IACUC protocol #0561-0720). VHF transmitters weighed 80 grams and had a life expectancy of about 5.7 years. The Lotek GPS transmitters weighed 92 grams and had an expected battery life of approximately 2.5 years. VHF and GPS radio-tags were equipped with a mortality switch that was triggered after eight hours of inactivity. VHF radio-tags also had an activity switch that aided in our documentation of incubation.

VHF and GPS Monitoring

We tracked radio-tagged females 2–3 times weekly with Yagi 3-element antennas prior to the nesting season and then every other day after we detected nesting. We triangulated the location of each turkey with VHF radio-tags from 3 points that generated directional bearings >30° apart within 45 minutes. We entered triangulation data into LOAS software (Ecological Software Solutions, Kevin Sallee, California, USA) to estimate turkey locations. We set GPS radio-tags to collect location data three times daily at 9:00, 15:00, and 23:59 h (roost location); however, during the nesting season, GPS transmitters recorded locations every 2 hours from 7:00 to 18:00 hours in addition to one roost location (23:59 hours) each day. We downloaded data from females with GPS tags biweekly with a LOTEK PinPoint Commander.

Nest Monitoring

Each VHF radio-tag was equipped with an activity sensor that produced a varying signal pulse rate when the female was in motion. We monitored the activity sensor, along with comparing multiple location estimates, to determine when a female began incubating a nest. We documented nesting of GPS-marked females by reviewing downloaded locations on a map each day using ArcGIS Pro (ESRI, Redlands, CA). We assumed a female was incubating when GPS locations were clustered within a 50-m radius for a 24-hour period and included a roost location. Once we determined a female was incubating (using VHF and GPS hens), we circled the nest within

approximately 25 m while monitoring the female with telemetry to document approximate nest location. We monitored nests every other day for the first three weeks of incubation and then monitored them daily by checking the radio signal from ~30 m from the approximate nest site until nest completion or apparent failure. After the nest hatched or failed, we located the nest, counted the number of hatched, unhatched, or destroyed eggs and recorded nest location with a handheld GPS (Garmin Etrex Handheld GPS, Olathe, Kansas).

Poult Trapping and Radio-tagging

We trapped poults within five days of hatching. We located the female before civil daylight while she was roosted on the ground with her brood. Typically, 3–4 observers circled the female using telemetry equipment to confirm location and then closed the circle around the location to flush the female from the poults (Hubbard et al. 1999, Quehl et al. 2024). We placed all captured poults in a small cooler with a heating pad to maintain their body temperature during processing (Hubbard et al. 1999, Spears et al. 2005). Our average handling time of captured poults was 41.2 min (range: 14–100 min, SD = 16.9 min). We radio-tagged 1 to 6 poults ($\bar{x}$ = 2.4) within each brood by suturing the transmitters (Advanced Telemetry Systems: Series A1065, Isanti, MN, USA) to their backs (Burkepile et al. 2002). Transmitters were 1.3 g and had an average life expectancy of 78 days (range: 38–97, SD = 20.4). The average mass of poults at capture was 57.4 g; thus, the radio-tag represented 2.3% of their mean body mass.

Brood Monitoring

We monitored broods every day for the first two weeks and then every other day until day 28 post-hatching. We estimated a brood location by first locating the female via radio telemetry and then walking a circle around the female and poults while recording GPS tracks. We initially located the female, as opposed to tracking individual poults, because the female radio-tag had a

large battery with much greater range than the signal strength and range of poult radio-tags. As we performed the circle around the female, we also monitored the poults' frequencies to ensure all poults were with the female. When we completed the circle around female and poults, we estimated the location in the approximate middle of the circle.

Brood Vegetation

We measured brood vegetation characteristics where broods were located during tracking and at an associated random point. We located the random point by determining the average daily movement for all broods with radio-tagged poults. We used the average daily movement (277 m) as the maximum distance and set the minimum distance at 20 m from which to select random points. We generated a random azimuth and random distance within our criteria from the brood use location to generate a random point. Random points were checked with United States Department of Agriculture (USDA) land cover data in ArcGIS (ESRI, Redlands, California) to confirm that they were in potential area that a female with a brood could have selected for use (i.e., not human-developed or water). At each plot, we positioned a 30-m transect in a randomly-selected compass direction. We identified plants to species at each meter along the transect. We measured vertical obstruction with a vertical profile board (Nudds 1977) at each cardinal direction from plot center (North, East, South, West) at a distance of 11.3 meters (1/10 of a hectare). In 2023–2024, we measured openness at ground level at 15.2 cm above ground with a ground-sighting tube (Gruchy and Harper 2014). We used the ground-sighting tube at meter marks 10, 20, and 30 along the transect and viewed a 2.54-cm-diameter vertical pole located parallel to the transect. We moved the pole farther from the transect, and when the pole was no longer visible through the sighting tube, we measured that distance. We defined overstory species as woody species with a diameter >11.4 cm DBH (diameter at breast height). We measured

overstory basal area with a 2.5 m^2/ha basal area prism. We defined midstory species as any tree, bramble, or shrub >1.37m tall and 4.0 cm ≤ DBH ≤ 11.4 cm; we counted midstory stems within a 5-m radius of plot center (Table 3.1).

Land Cover

We quantified land cover composition around each nest by generating a 3,770-m radius buffer (~4,465-ha area) around every nest location using ArcGIS Pro area. The buffered area was intended to represent the area of a female's average home range that she could potentially use during active nesting (laying and incubation) stages. We calculated the buffer radius by averaging hen home ranges from 2018–2021, which were calculated from annual movements from recorded location data points. We then calculated land cover composition within each buffered area around each nest by tabulating the area by cover type in ACRGIS Pro Spatial Analyst using U.S. Geological Survey (USGS) National Land Cover Database (NLCD) (U.S. Geological Survey 2024). We used the NLCD to constitute our land cover types included in analysis: mature forest (deciduous forest, mixed forest, evergreen forest), young forest (shrub/scrub), pasture/hay, grassland/herbaceous, and other (developed, open water, and emergent herbaceous wetlands). To ensure spatial accuracy, we explicitly defined the environment settings: we set the snap raster and cell size to match the resolution and alignment of the land cover raster, and we conducted the processing using the WGS 1984 UTM Zone 16N projected coordinate system to maintain consistent projection and units in meters. The output table provided the area (m^2) of each land cover class within each buffer.

DATA ANALYSIS

We conducted a correlation analysis in Program R (Version 4.5.1, R Core Team 2025) to address multicollinearity of continuous covariates and removed covariates that were highly correlated (*r*

> 0.70). We removed the covariates VOLO and VOUP, which were correlated (>±0.7) with VOMI. For the resource-selection analysis, we created case-controlled conditional logistic regression models using the clogit function from the survival package in Program R version 4.4.1 (Therneau et al. 2024, R Core Team 2025) with a use vs. availability framework. We assessed the effect of each of our covariates univariately. We then built multivariate models with covariates which met a $P < 0.25$ univariate criteria of significance to examine additive effects. Finally, we added Point Type (field, edge, forest with edge as reference level) to the model set, as both an additive and interactive term, to evaluate model performance after accounting for point type. We retained models with ΔAICc scores < 2.0 for interpretation. We used Beta coefficients and 85% confidence intervals which did not cross 0 as evidence of resource selection for a given covariate (Arnold 2010, Tan and Tan 2010). To aid in interpretation of biological significance of individual covariates, we compared individual covariate means for use and available points by point type (field, edge, forest) using two-sample Welch's *t*-tests. P-values < 0.05 were deemed statistically significant (Table 3.2).

For the poult survival analysis, we again conducted a correlation analysis and removed vegetation covariates that were highly correlated. We estimated poult survival during the first 28 days post-hatching, with encounter histories based on fourteen 2-day intervals. We used two-day time intervals because that approach best matched our 1–2 day tracking schedule and minimized the number of intervals in the dataset that contained no data. Survival differed by time, so we broke the 28-day period into three subsets (days 1–8, 9–14, 15–28) based on visual inspection of the changes in survival by time (Figure 3.2). We conducted the survival analyses using known fate models in Program R with the RMARK package (Laake 2013). We averaged vegetation plot data for each of the three survival periods for inclusion as time-period-specific covariates in the

survival analyses. We ran separate models for the ground sighting-tube data and compared those models against the null model (constant survival), because those data were only collected for the 2022 and 2023 field seasons. We also evaluated nest cover type covariates in models based on days 1–4 (2 survival intervals) to test the hypothesis that the nest landscape influenced poult survival immediately after hatching. We used an AICc model selection framework to select the most parsimonious model within the model suite (Anderson and Burnham 2002). We considered models within 2.0 ΔAICc to be supported. We used an 85% confidence interval for β value interpretation (i.e., CIs of β values that included zero were not supported as effects), based on simulations and recommendations by Arnold (2010) and Tan and Tan (2010).

RESULTS

We monitored 58 broods (138 radio-tagged poults) from 2018–2023 and sampled a total of 850 vegetation plots (425 random, 425 brood). Mean FOCO was greater at poult locations than FOCO at random locations for field and forest sites ($P \leq 0.03$; Table 3.2. Mean GRCO was lesser at poult locations than GRCO at random points in fields ($P < 0.01$). VOMI was greater at poult locations than VOMI at random locations in edges ($P = 0.01$). And STTB was lesser at poult locations than STTB at random points in fields ($P = 0.05$). The best-supported model for resource selection for broods all ages contained positive selection for FOCO (β = 1.35, 85% CI: 0.69 to 2.01), and VOMI (β = 0.24, 85% CI: 0.13 to 0.34), and negative selection for STCT (β = -0.01, 85% CI: -0.01 to -0.00) (Table 3.3). Adding Point Type as an additive term to the top model improved fit (AICc = 467.66), with strong selection for FOCO (β = 1.34, 85% CI: 0.64 to 2.04) and VOMI (β = 0.22, 85% CI: 0.12 to 0.33) and selection against “Field” point type (β = -1.23, 85% CI: -1.83 to -0.64) and STCO (β = -0.01, 85% CI: -0.01 to 0.00; Table 3.3).

The known-fate survival analysis 1–4 days post-hatch with land cover covariates, or percent cover types within 544-m buffer of each nest, had two competing top models with β coefficients that did not overlap 0: Mature Forest (AICc = 70.81) was negatively related to poult survival (β = -4.69, 85% CI: -8.78 to -0.60) and Pasture/Hay (AICc = 71.62) was positively related to poult survival (β = 5.03, 85% CI: 0.40 to 9.66). Therefore, broods had greater survival with more pasture/hay in the surrounding areas, whereas broods with greater amounts of mature forest in the surrounding area experienced lower survival. None of the other cover type models performed better than the constant survival model (AICc = 72.65, β = 2.90, 85% CI: 2.40 to 3.39; Table 3.4).

The two-day interval survival rate was 0.917 (n = 138, SE = 0.01) with a 29.7% (SE = 0.05) chance of poult survival to day 28. The DSR_{2day} for the first time period (days 1–8) was 0.942 (SE = 0.023), the DSR_{2day} for the second time period (days 9–14) was 0.811 (SE = 0.064), and the DSR_{2day} for the third time period (days 15–28) was 0.967 (SE = 0.033). The top model was additive with time period and TBAR (AICc model weight = 41.0%, AICc = 403.14; Table 3.5). TBAR was not related to survival during time period 1 (β CI overlapped 0) but TBAR was positively related to survival during time period 2 (TBAR: β = 0.23, SE = 0.15, 85% CI: 0.01 to 0.45) and TBAR was positively related to survival in time period 3 (TBAR: β = 0.44, SE = 0.20, 85% CI: 0.15 to 0.73; Figures 3.3 and 3.4).

The second best-supported survival model contained just the time-period factor (AICc = 404.56) and contained 20.0% of AICc model weight. In this model, the second time period had the lowest survival rate and the third time period had the greatest survival rate. Other covariates in subsequent models had weak support (85% β CI not containing 0), but all of those models had ΔAICc > 2.0, so we did not evaluate them further.

In a separate model analysis including the sight tube covariate, the best supported model included the time period factor with sight-tube model (additive model, AICc = 92.12, Table 3.6). β coefficients for the site tube covariate for time periods 1 and 2 overlapped 0, reflecting no apparent relationship with survival. The addition of the Sight Tube covariate as a quadratic term had less support than the sight tube covariate as a linear term (AICc = 95.72).

DISCUSSION

We monitored 58 wild turkey broods over 6 years and documented selection for areas with greater forb cover, greater visual obstruction at 50–100 cm, and less woody stem density than what was available in the surrounding area, which aligned with our hypothesis that vegetation composition and structure would affect selection by brooding females. Landscape composition surrounding the nest site was important for brood survival as survival of young broods (days 1–4) increased when the surrounding landscape contained more open vegetation types and less mature forest cover, which also aligned with our hypothesis that vegetation structure would affect brood survival. There was a disconnect, however, between resource selection and survival in that selection for forb cover and visual obstruction at the 50–100 cm level and selection against woody stem cover did not confer any apparent survival benefit. This disconnect may have significant population demographic and management implications, as brooding females were moving considerable distances (i.e., >500 m) daily to locate a range of certain vegetation characteristics that may not be ideal for enhancing poult survival. Given the relatively poor poult survival rates that we documented and the distances traveled, ideal habitat characteristics for brooding females apparently are not widely available on our sites, such that females are unable to match their resource selection with optimal survival. This disconnect indicates management is needed to provide and better distribute habitat suited for brooding females with appropriate

vegetation structure and composition containing both characteristics for female selection and poult survival.

The documented patterns of resource selection differed based on the cover type that the brood occurred in: open field, field-forest edge, or forest interior. The majority of our brood locations were associated with an edge (68.5%) and females selected against field and forest interiors, compared to the edge. Many studies have highlighted the selection of edges by brooding females (Speake et al. 1975, Everett et al. 1985, Day 1991, Holder 2006), and edges typically were selected when the forest or field patch interiors were not structurally favorable when compared to the edge (Everett et al. 1980). Fields become unsuitable for broods when vegetation, especially grass, and thatch at ground level preclude movement by poults and when vegetation grows tall enough to limit visibility of the brooding female. Alternatively, forests become unsuitable for broods when there is inadequate understory vegetation to provide cover and support insects available for foraging and when dense woody stems limit visibility for the brooding female. As poults age and can fly, they are better able to avoid predation. A majority of the fields and forests on our study sites aligned with these characteristics, indicating management of these vegetation communities should change to better-suit brooding females.

Selection of areas with greater amounts of forb cover, increased visual obstruction 51–100 cm, and less woody stem density is consistent with previous research (Metzler and Speake 1985, Porter 1992, Spears et al. 2007, Nelson et al. 2022). Greater forb cover provides increased food resources for the female and the brood, such as seeds and invertebrates (Harper et al. 2001, Fettinger et al. 2002, Chitwood et al. 2017, Nelson et al. 2022). Females selected for visual obstruction at the 51–100 cm level because that allowed visibility for the female while providing cover for the brood. Our models also showed consistent female selection against increasing

woody stem counts, which included shrubs and saplings >1.37 m tall and ≤11.4 cm dbh (McCord et al. 2014). Nelson et al. (2022) and Ross and Wunz (1990) also reported brooding females avoiding dense woody stems for day use and roosting. Selection against increasing woody stems highlights how denser vegetation reduces visibility for the female and mobility for the poults (Nelson 2022). Furthermore, areas with dense woody stems provide hunting and ambush cover for various mammalian predators (Kolowski and Woolf 2002, Chamberlain et al. 2003).

Survival of young poults was related to landcover composition around the nest, suggesting females may be balancing nest success with poult survival selective pressures, such as the presence of predators. On average, females with broods moved >500 m away from the nest site within the first 2 days post-hatching and >800 m away by day 7. These results were similar to Chamberlain et al. (2020), who reported brooding females moved an average of >200 m from the nest one day post-hatch and >1000 m five days post-hatch with the distance continuing to increase as poult age increased. The tendency to move away from the nest site may be in response to females balancing the benefit of exploiting suitable areas for brooding with the potential risk of encountering predators (Mainguy et al. 2006, Chamberlain et al. 2020), or a never-ending search to find high-quality brood habitat in the first place, which may be largely lacking in the area.

Poult survival for the first time period (days 1–8) post-hatching was unrelated to any of the vegetation covariates we measured, consistent with Wood et al. (2019), who reported no relationships between landscape and vegetation metrics with brood survival. We expected the sight-tube covariate to be an important correlate with survival because ground-level vegetation obstruction can make poult travel difficult if not impossible (Martin et al. 2015, Johnson 2019). However, our sight-tube models did not have statistical support during the initial time period

when poult travel could be most impaired. It is unclear whether this lack of initial response to vegetation structure reflects a lack of suitable brooding cover and a continual search for such cover, or if encounters with predators prompted a continual movement searching for areas with reduced predator presence. That said, we consider the quality of brooding cover on our study sites structurally poor, with overgrown fields and unmanaged forests.

Vegetation covariate-survival relationships became significant after the initial time period (days 1–8) of the 28-day monitoring period, likely reflecting the changing needs of poults as they developed and become capable of flight. Our results highlighted a positive effect of increasing total basal area on survival as poults reached 9–14 days post-hatch and again during the last time period (days 15–28). This relationship is likely linked to the ability to tree roost which provides an invaluable predator escape tactic as they gain the ability to perform short flights within 10 days post-hatch (Williams 1997, Healy et al. 1985). Other studies have noted increased use of mature forest as poults continued to age (Phalen et al. 1986, Williams et al. 1997, Chamberlain 2020).

Our poult survival estimates were relatively low compared to other recent studies, consistent with our other reproduction and survival parameters, and likely reflect a diverse and relatively abundant predator community on our study sites. The fur market has declined exponentially, resulting in exponential mammalian population growth (Sargeant et al. 1993, Woolf and Hubert 1998). Protection of raptors under the Migratory Treaty Act of 1918 has permitted similar increases in many raptor populations as well. For example, Cooper's hawk (*Astur cooperii*) and red-tailed hawk (Buteo jamaicensis) populations in Tennessee have increased by 491% and 245%, respectively, based on 1993–2022 North American Breeding Bird Survey data analysis (Sauer et al. 2020). Lack of top-down control of predator populations across

our study sites, leading to unchecked predator population increases and unsustainable predation pressure, is a likely explanation of our low poult survival.

MANAGEMENT IMPLICATIONS

Based on our nest and poult survival data, we calculated a poult-per-female ratio of 1.53 poults-per-female (n = 104), using the 56-day survival estimate (0.18) for our study from Quehl et al. (2025) and using the number of confirmed hatched eggs from 2018–2023. This estimate is similar to a recent estimate of 1.4 poults-per-female reported in Tennessee for 2020 (Danks 2021) and is 25% less than 2.0 poults per female, which is considered the minimum needed to maintain a stable population (Vanglider and Kurzejeski 1995). The poor poult-per-female estimate, along with poor poult survival, clearly illustrate that management should focus on provision of high-quality habitat for brooding females to enhance poult survival and ultimately improve recruitment. Land managers should consider addressing vegetation structure, especially where fields contain too dense, tall vegetation and where forests lack a forb-dominated, herbaceous understory. Transitioning mature, closed-canopy forest to a more open woodland condition while maintaining frequent disturbance, especially prescribed fire, to allow for better visibility for brooding females and better mobility for poults would be an efficient and effective way to manage for high-quality brooding cover. Additionally, some level of predator management is likely needed on many properties to increase brood survival.

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APPENDIX

Table 3.1: Wild turkey resource selection vegetation covariates sampled across study sites and used in various modeling analysis, south-central Tennessee, 2018–2023. Covariates are defined and coded for reference.

Covariate	Code	Description
% Forb Cover	FOCO	Percent forb coverage from 30m transect calculated from species identified at each meter
% Grass Cover	GRCO	Percent grass coverage from 30m transect calculated from species identified at each meter
% Woody Cover	WOCO	Percent woody coverage from 30m transect calculated from species identified at each meter
% Semi-woody Cover	SWCO	Percent semi-woody coverage from 30m transect calculated from species identified at each meter
Visual Obstruction 51–100cm	VOMI	Percent coverage of Nudds board at 51–100cm averaged from each cardinal direction at a distance of 11.3m from plot center
Stem Count	STCT	Count of every stem (shrubs, saplings, and brambles) within a 5-m radius plot for stems >1.37 m tall and ≤11.4 cm dbh
Total Basal Area	TBAR	Count of overstory trees measured with a 2.5 m2 /ha-factor prism from plot center
Sight Tube	STTB	Measure of distance from transect to a 2.54-cm-diameter vertical pole at ground level when the pole was no longer visible using a 15.2 cm ground-sighting tube. (2022–2023 data only)

Table 3.2: Means and standard errors of vegetation covariates at brood use and available locations by point type (field, forest, and edge) from wild turkey brood locations, south-central Tennessee, 2018–2023. P-values are from two-sample Welch's *t*-tests comparing brood use and available locations within each point type.

Covariate	Point Type	Mean: Use	Mean: Available	SE: Use	SE: Available	P-Value
FOCO	Field	0.66	0.46	0.07	0.05	0.03
	Forest	0.16	0.14	0.02	0.01	0.37
	Edge	0.31	0.26	0.02	0.02	0.02
GRCO	Field	0.48	0.76	0.06	0.04	0.00
	Forest	0.25	0.20	0.03	0.02	0.11
	Edge	0.39	0.39	0.02	0.02	0.96
SWCO	Field	0.17	0.14	0.06	0.03	0.66
	Forest	0.18	0.16	0.02	0.01	0.35
	Edge	0.17	0.16	0.01	0.01	0.55
STCT	Field	4.97	11.92	3.43	6.26	0.33
	Forest	20.89	24.13	1.79	1.95	0.22
	Edge	16.08	19.56	1.31	1.92	0.14
TBAR	Field	2.81	2.12	1.38	0.85	0.15
	Forest	27.66	27.95	1.21	0.98	0.20
	Edge	16.74	17.27	0.81	1.01	0.16
VOMI	Field	3.08	2.42	0.53	0.42	0.34
	Forest	2.19	2.25	0.12	0.09	0.73
	Edge	2.54	2.20	0.08	0.09	0.01
WOCO	Field	0.09	0.07	0.05	0.02	0.65
	Forest	0.20	0.22	0.02	0.02	0.37
	Edge	0.17	0.16	0.01	0.01	0.76
STTB	Field	0.93	2.98	0.20	0.81	0.03
	Forest	12.21	5.04	7.08	0.44	0.32
	Edge	3.49	4.22	0.26	0.34	0.09

* Sight Tube (STTB) data are from 2022–2023 only.

Table 3.3: Wild turkey brood resource selection vegetation covariates run univariately, multivariately, additively, and interactively from sampled brood use and available areas in south-central Tennessee, 2018–2023. The results are listed from lowest to highest AICc value.

Covariate	AICc	Δ AICc	Term	P-value	Beta Estimate	SE	Lower 85% CI	Upper 85% CI
STCT, VOMI, FOCO + Point Type	467.66	0.00	STCT	0.13	-0.01	0.00	-0.01	0.00
			VOMI	0.00	0.22	0.07	0.12	0.33
			FOCO	0.01	1.34	0.49	0.64	2.04
			Point Type: Field	0.00	-1.23	0.41	-1.83	-0.64
			Point Type: Forest	0.00	-0.75	0.20	-1.03	-0.46
VOMI, FOCO + Point Type	469.49	1.83	VOMI	0.01	0.19	0.07	0.09	0.29
			FOCO	0.00	1.51	0.47	0.83	2.19
			Point Type: Field	0.00	-1.27	0.41	-1.86	-0.68
			Point Type: Forest	<0.00	-0.78	0.20	-1.07	-0.50
VOMI, FOCO * Point Type	469.64	1.98	VOMI	0.00	0.28	0.08	0.16	0.41
			FOCO	0.00	1.51	0.54	0.74	2.29
			Point Type: Field	0.03	-2.45	1.11	-4.05	-0.84
			Point Type: Forest	0.94	-0.03	0.39	-0.59	0.53
			VOMI: Point Type: Field	0.61	-0.11	0.22	-0.43	0.21
			VOMI: Point Type: Forest	0.02	-0.33	0.14	-0.54	-0.12
			FOCO: Point Type: Field	0.17	2.61	1.90	-0.13	5.34
			FOCO: Point Type: Forest	1.00	0.00	1.00	-1.44	1.45

Table 3.3: Continued

Covariate	AICc	Δ AICc	Term	P-value	Beta Estimate	SE	Lower 85% CI	Upper 85% CI
STCT, VOMI, FOCO * Point Type	470.96	3.30	STCT	0.11	-0.01	0.01	-0.02	0.00
			VOMI	0.00	0.34	0.09	0.20	0.47
			FOCO	0.02	1.26	0.56	0.45	2.06
			Point Type: Field	0.03	-2.41	1.13	-4.04	-0.78
			Point Type: Forest	0.99	-0.01	0.41	-0.60	0.59
			STCT: Point Type: Field	0.95	0.00	0.01	-0.02	0.02
			VOMI: Point Type: Field	0.69	-0.10	0.25	-0.46	0.26
			VOMI: Point Type: Forest	0.01	-0.37	0.15	-0.59	-0.16
			FOCO: Point Type: Field	0.20	2.55	2.00	-0.34	5.43
			FOCO: Point Type: Forest	0.85	0.20	1.02	-1.27	1.67
STCT, FOCO + Point Type	477.29	9.63	STCT	0.48	0.00	0.00	-0.01	0.00
			FOCO	0.00	1.61	0.47	0.92	2.29
			Point Type: Field	0.00	-1.17	0.40	-1.75	-0.59
			Point Type: Forest	<0.00	-0.76	0.20	-1.04	-0.48

Table 3.3: Continued

Covariate	AICc	Δ AICc	Term	P-value	Beta Estimate	SE	Lower 85% CI	Upper 85% CI
STCT, FOCO * Point Type	482.03	14.37	STCT	0.72	0.00	0.00	-0.01	0.01
			FOCO	0.00	1.54	0.54	0.76	2.32
			Point Type: Field	0.02	-2.68	1.11	-4.27	-1.08
			Point Type: Forest	0.05	-0.63	0.32	-1.09	-0.16
			STCT: Point Type: Field	0.99	0.00	0.01	-0.02	0.02
			STCT: Point Type: Forest	0.61	0.00	0.01	-0.02	0.01
			FOCO: Point Type: Field	0.12	2.69	1.74	0.19	5.19
			FOCO: Point Type: Forest	0.78	-0.26	0.96	-1.64	1.11
STCT, VOMI + Point Type	484.35	16.69	STCT	0.03	-0.01	0.00	-0.01	0.00
			VOMI	0.00	0.24	0.07	0.14	0.34
			Point Type: Field	0.00	-1.10	0.39	-1.66	-0.53
			Point Type: Forest	<0.00	-0.78	0.19	-1.06	-0.50
STCT, VOMI, FOCO	486.06	18.40	STCT	0.02	-0.01	0.00	-0.01	-0.00
			VOMI	0.00	0.24	0.07	0.13	0.34
			FOCO	0.00	1.35	0.46	0.69	2.01
STCT, VOMI * Point Type	486.15	18.49	STCT	0.03	-0.01	0.00	-0.02	0.00
			VOMI	0.00	0.34	0.09	0.21	0.46
			Point Type: Field	0.05	-1.27	0.65	-2.21	-0.34
			Point Type: Forest	0.74	-0.12	0.38	-0.67	0.42
			STCT: Point Type: Field	0.98	0.00	0.01	-0.02	0.02
			STCT: Point Type: Forest	0.56	0.01	0.01	-0.01	0.02
			VOMI: Point Type: Field	0.80	0.05	0.20	-0.24	0.33
			VOMI: Point Type: Forest	0.02	-0.34	0.14	-0.54	-0.13
VOMI, FOCO	490.63	22.97	VOMI	0.01	0.19	0.07	0.09	0.28
			FOCO	0.00	1.60	0.44	0.96	2.24

Table 3.3: Continued

STCT, FOCO	496.67	29.01	STCT	0.19	0.00	0.00	-0.01	<0.01
			FOCO	0.00	1.66	0.44	1.02	2.30
FOCO	497.88	30.22	FOCO	<0.001	1.78	0.44	1.15	2.41
STCT, VOMI	503.43	35.77	STCT	0.00	-0.01	0.00	-0.02	-0.01
			VOMI	0.00	0.26	0.07	0.16	0.35
VOMI	512.38	44.71	VOMI	0.00	0.21	0.06	0.11	0.30
SWCO	513.61	45.95	SWCO	0.10	0.89	0.55	0.11	1.68
GRCO	515.78	48.12	GRCO	0.47	0.21	0.29	-0.21	0.62
WOCO	516.30	48.64	WOCO	0.90	0.07	0.54	-0.71	0.84
STCT	556.61	88.95	STCT	0.01	-0.01	0.00	-0.01	0.00
TBAR	572.63	104.97	TBAR	0.07	0.00	0.00	0.00	0.00

Table 3.4: Models ranked lowest to highest AICc score of land cover data surrounding nests from tabulated 541.9m buffer zone 1–4 days post-hatch for wild turkey poult survival in south-central Tennessee, 2018–2023.

Model	AICc	Δ AICc	Z-score	P-value	Beta Estimate	SE	Lower 85% CI	Upper 85% CI
Mature Forest	70.81	0.00	-1.65	0.10	-4.69	2.84	-8.78	-0.60
Pasture/Hay	71.62	0.81	1.56	0.12	5.03	3.22	0.40	9.66
S.Dot	72.65	1.84	8.46	0.00	2.90	0.34	2.40	3.39
Grassland/ Herbaceous	72.74	1.92	-1.54	0.12	-8.65	5.63	-16.75	-0.55
Young Forest	73.90	3.09	0.14	0.89	0.36	2.66	-3.48	4.20
Other	74.68	3.87	0.85	0.40	6.19	7.32	-4.34	16.73

Table 3.5: Top overall models ranked by lowest to highest AICc score of vegetation covariates from sampled brood use areas across our three Time Periods (Days 1–4, 5–7, 8–14 post-hatch) for wild turkey poult survival in south-central Tennessee, 2018–2023. Numbers 1, 2, and 3 after vegetation covariates represent its associated Time Period.

Model	AICc	Δ AICc	Weight	Term	Beta Estimate	SE	Lower 85% CI	Upper 85% CI
Time Period + TBAR	403.14	0.00	0.41	Time Period 1	-0.68	0.52	-1.43	0.07
				Time Period 2	-2.00	0.52	-2.75	-1.25
				Time Period 3	3.49	0.48	2.80	4.18
				TBAR1	-0.05	0.22	-0.37	0.27
				TBAR2	0.23	0.15	0.01	0.45
				TBAR3	0.44	0.20	0.15	0.73
Time Period	404.56	1.42	0.20	Time Period 1	-0.43	0.44	-1.06	0.20
				Time Period 2	-1.78	0.43	-2.40	-1.16
				Time Period 3	3.24	0.39	2.68	3.80
Time Period + STCT	405.42	2.28	0.13	Time Period 1	0.50	0.59	-0.35	1.35
				Time Period 2	-0.97	0.62	-1.86	-0.08
				Time Period 3	2.37	0.54	1.59	3.15
				STCT1	0.37	0.37	-0.16	0.90
				STCT2	0.28	0.98	-1.13	1.69
				STCT3	6.98	4.32	0.76	13.20
Time Period + FOCO	406.08	2.94	0.09	Time Period 1	-0.57	0.49	-1.28	0.14
				Time Period 2	-1.93	0.48	-2.62	-1.24
				Time Period 3	3.40	0.44	2.77	4.03
				FOCO1	-0.10	0.20	-0.39	0.19
				FOCO2	0.07	0.14	-0.13	0.27
				FOCO3	-0.34	0.16	-0.57	-0.11
Time Period + GRCO	406.44	3.30	0.08	Time Period 1	-0.63	0.52	-1.38	0.12
				Time Period 2	-1.98	0.51	-2.71	-1.25
				Time Period 3	3.45	0.47	2.77	4.13
				GRCO1	0.06	0.22	-0.26	0.38
				GRCO2	0.00	0.14	-0.20	0.20
				GRCO3	-0.42	0.23	-0.75	-0.09
Time Period + WOCO	408.46	5.32	0.03	Time Period 1	-0.42	0.44	-1.05	0.21
				Time Period 2	-1.76	0.43	-2.38	-1.14
				Time Period 3	3.23	0.39	2.67	3.79
				WOCO1	-0.04	0.21	-0.34	0.26
				WOCO2	0.20	0.15	-0.02	0.42
				WOCO3	-0.09	0.20	-0.38	0.20

Table 3.5: Continued

Model	AICc	Δ AICc	Weight	Term	Beta Estimate	SE	Lower 85% CI	Upper 85% CI
Time Period + SWCO	409.07	5.93	0.02	Time Period 1	-0.43	0.45	-1.08	0.22
				Time Period 2	-1.79	0.44	-2.42	-1.16
				Time Period 3	3.26	0.39	2.70	3.82
				SWCO1	-0.21	0.19	-0.48	0.06
				SWCO2	-0.04	0.14	-0.24	0.16
				SWCO3	0.12	0.20	-0.17	0.41
Time Period + VOMI	409.23	6.09	0.02	Time Period 1	-0.43	0.44	-1.06	0.20
				Time Period 2	-1.77	0.44	-2.40	-1.14
				Time Period 3	3.24	0.39	2.68	3.80
				VOMI1	0.06	0.23	-0.27	0.39
				VOMI2	0.10	0.14	-0.10	0.30
				VOMI3	-0.18	0.19	-0.45	0.09
S.Dot	429.86	26.72	0.00	S.Dot	2.41	0.13	2.22	2.60

Table 3.6: Models ranked by lowest to highest AICc score of sight tube covariate from sampled brood use areas across our three Time Periods (Days 1–4, 5–7, 8–14 post-hatch) for wild turkey poult survival in south-central Tennessee, 2022–2023. Numbers 1, 2, and 3 after covariates represent its associated Time Period.

Model	AICc	ΔAICc	AICc Weight	Term	Beta estimate	SE	Lower 85% CI	Upper 85% CI
Time Period + STTB	92.12	0.00	0.71	Sight Tube 1	0.36	0.31	-0.09	0.81
				Sight Tube 2	0.43	0.33	-0.05	0.91
				Sight Tube 3	49.25	0	49.25	49.25
Time Period + $STTB^2$	95.72	3.60	0.11	Sight Tube 1	-0.12	0.00	-0.12	-0.12
				Sight Tube 2	-38.43	0.00	-38.43	-38.43
				Sight Tube 3	55.37	0.00	55.37	55.37
Time Period	96.57	4.45	0.08	Time Period 1	-0.58	1.1	-2.16	1.00
				Time Period 2	-1.91	1.1	-3.49	-0.33
				Time Period 3	3.36	1.02	1.89	4.83
S.Dot	98.75	6.63	0.03	S.Dot	2.41	0.28	2.01	2.81

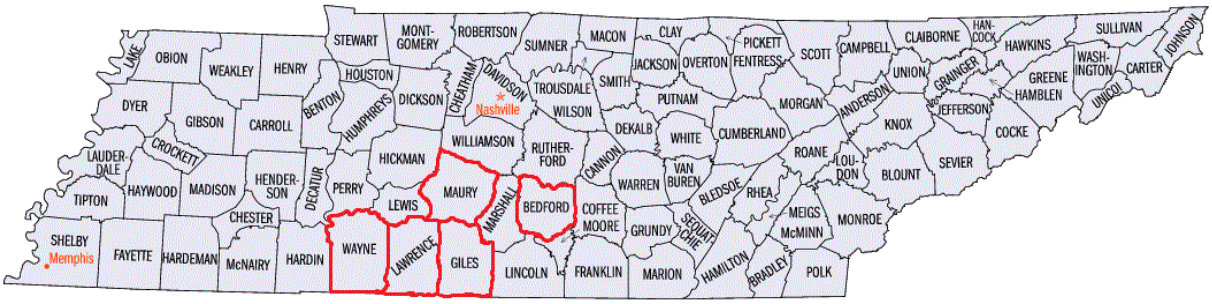

Figure 3.1: Counties in south-central Tennessee (outlined in red) involved in the wild turkey study, 2023–2024.

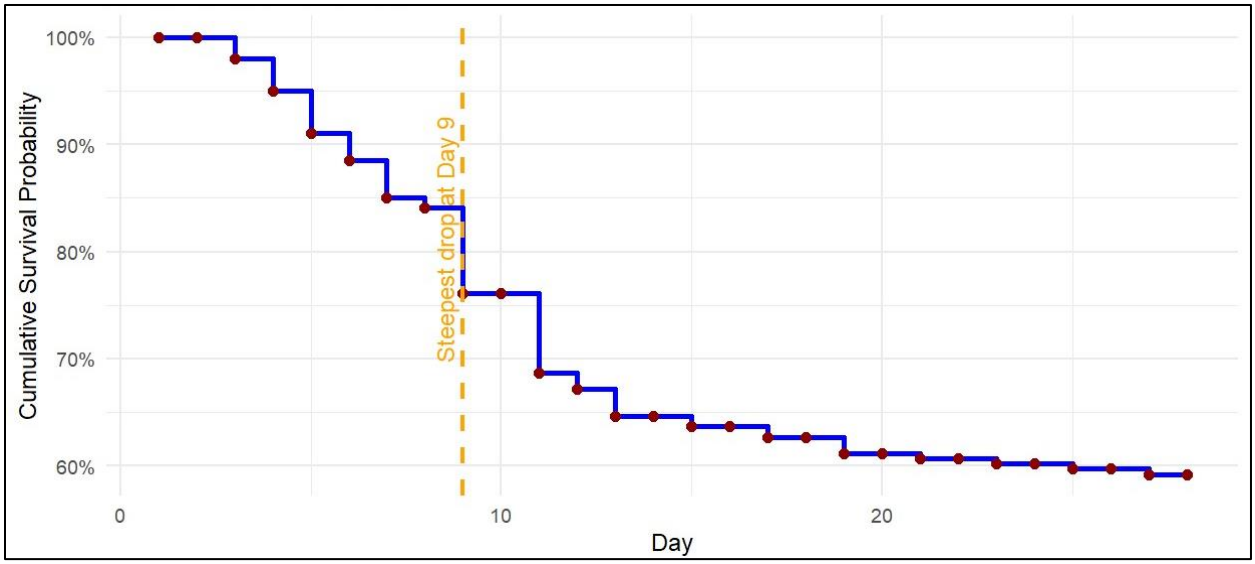

Figure 3.2: Empirical survival curve from capture history database showing survival of poults captured from south-central Tennessee, 2018–2023.

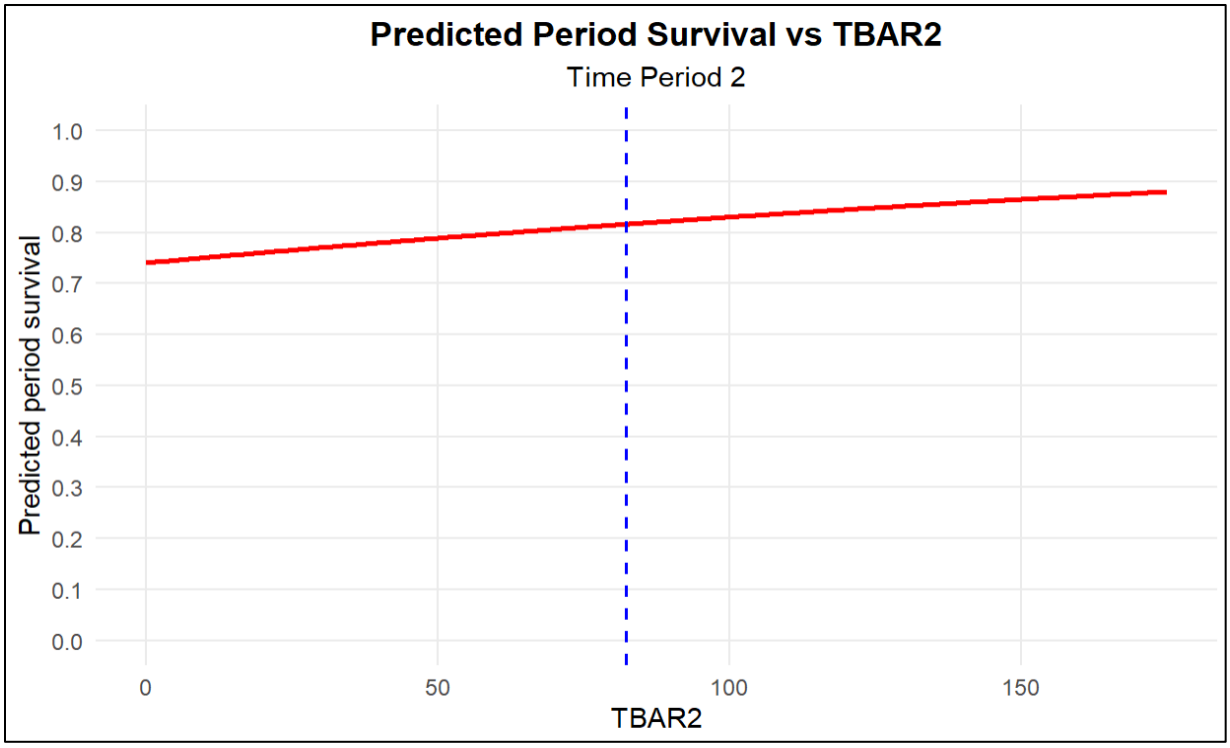

Figure 3.3: Total Basal Area (TBAR2) shown as a time specific vegetation covariate across the corresponding Time Period (Time Period 2) to represent its relationship with poult survival. Predicted survival across the period is indicated in red, along with the covariate mean (blue).

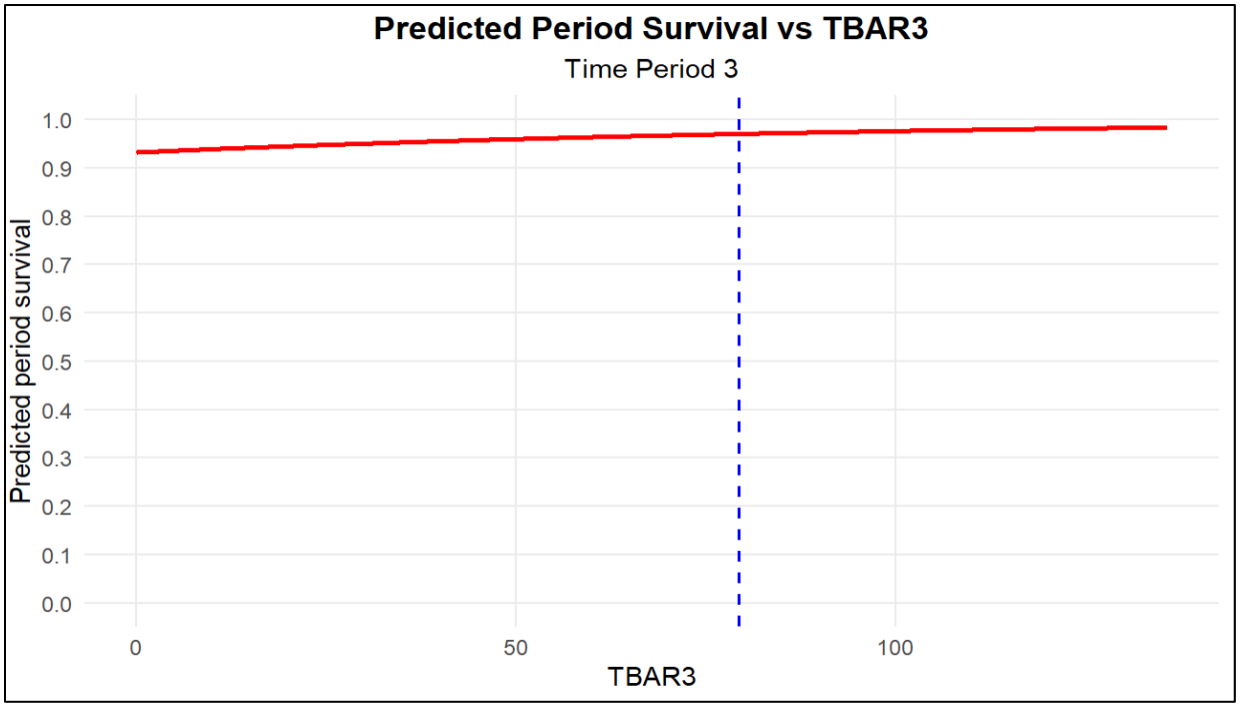

Figure 3.4: Total Basal Area (TBAR3) shown as a time specific vegetation covariate across the corresponding Time Period (Time Period 3) to represent its relationship with poult survival. Predicted survival across the period is indicated in red, along with the covariate mean (blue).

VITA

Casey Elizabeth Swafford was born in Crossville, Tennessee on December 22, 1994. Her family is from the beautiful Sequatchie Valley, where they own acreage that functions as a family farm. It was on this farm that Casey's father cultivated a love for riding horses and being outdoors. Casey then went on to study at Tennessee Technological University where she earned a Bachelor of Science degree in Wildlife and Fisheries Science in 2017. Afterward, she moved out west to work as a technician with the greater sage-grouse in Wyoming. She then worked various technician jobs with turkey, deer, and bobwhite quail in Tennessee, Georgia, and Texas before accepting the position to work on earning her Master of Science degree at the University of Tennessee-Knoxville.